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Bears and Pipeline Construction in Alaska

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ABSTRACT. Serious problems were encountered with bears during construction of the 1274-km-long trans-Alaska oil pipeline between Prudhoe Bay and Valdez. This multi-billion-dollar project traversed both black bear (*Ursus americanus* Pallas) and grizzly bear (*U. arctos* L.) habitat throughout its entire length. Plans for dealing with anticipated problems with bears were often inadequate. Most (71%) problems occurred north of the Yukon River in a previously roadless wilderness where inadequate refuse disposal and widespread animal feeding created dangerous situations. Of the 192 officially reported bear problems associated with the Trans-Alaska Pipeline System (TAPS) (1971-79), about 65% involved the presence of bears in camps or dumps, 13% the feeding of bears on garbage or handouts, 10% property damage or economic loss, 7% bears under and in buildings, and only 5% charges by bears. Remarkably, no bear-related injuries were reported, suggesting that bears became accustomed to people and did not regard them as a threat. Following construction of the TAPS there have been proposals for pipelines to transport natural gas from Prudhoe Bay to southern and Pacific-rim markets. Based on past experience, some animal control measures were developed during the planning phase for the authorized gas pipeline route in Alaska. Fences installed around 100-person "survey" camps were found to be effective in deterring bears in two traditionally troublesome areas.

Key words: bears, pipelines, bear-human conflicts, Alaska

RÉSUMÉ. Au cours de la construction de l'oléoduc trans-alaskien réalisée sur une longueur de 1274 km entre Prudhoe Bay et Valdez, de sérieux problèmes sont survenus, dans lequels des ours étaient impliqués. La totalité de cette ligne coûtant plusieurs milliards de dollars traversait des zones fréquentées par l'ours noir (*Ursus americanus* Pallas) et le grizzly (*U. arctos* L.). Les plans permettant de faire face aux problèmes qui avaient été prévus avec les ours se sont souvent révélés inadéquats. La plupart des problèmes (71 %) sont survenus au nord du fleuve Yukon, dans un région sauvage où il n'existait pas de route auparavant et où l'élimination inadéquate des déchets jointe à la pratique courante d'offrir de la nourriture aux animaux, créèrent une situation dangereuse. Des 192 rapports officiels concernant les problèmes dus aux ours en rapport avec la construction du Trans-Alaska Pipeline System (TAPS) de 1971 à 1979, 65 % environ impliquaient la présence d'ours dans des camps ou des décharges, 13 % le fait que les ours venaient manger dans les poubelles ou chercher la nourriture qui leur était offerte, 10 % des dégâts matériels ou des pertes économiques, 7 % la présence d'ours en dessous ou à l'intérieur des bâtiments, et seulement 5 % des attaques pars des ours. Fait surprenant, on n'a rapporté aucune blessure due à des attaques par les ours, ce qui donne à penser que ces derniers s'étaient habitués à la présence humaine et ne se sentaient pas menacés. Après la construction du TAPS, il a été question de construire des pipelines pour transporter le gaz naturel de Prudhoe Bay vers les marchés du sud et de la ceinture du Pacifique. Au cours de la phase de planification du trajet qui avait été approuvé pour le gazoduc en Alaska, on a mis au point des mesures de contrôle en s'appuyant sur l'expérience acquise. L'installation de clôtures autour des camps «d'arpentage» regroupant 100 personnes, s'est révélée une mesure efficace pour repousser les ours, à deux endroits où il y avait toujours eu des problèmes.

Mots clés: ours, pipelines, conflits ours-homme, Alaska

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INTRODUCTION

Bear-human conflicts have long been recognized in remote and rural areas. Problems have particularly come to the attention of the general public with the establishment of wilderness areas and national parks, where people are encouraged to visit and to view wildlife (Martinka, 1982). As human activity in previously remote bear habitat increases, so do bear-human encounters (Jope and Shelby, 1984; Bromley, 1985; Clarkson *et al.*, 1985). Reports of bears along roadways in Yellowstone, Yosemite, Great Smoky Mountains and other national parks resulted in increased visitor use but also increased problems resulting from animals feeding on handouts and garbage (Burghardt *et al.*, 1972; Herrero, 1976; Harms, 1980). Similar problems have been anticipated by those who plan resource exploitation and related development in wilderness areas where bears occur (Pruitt, 1970; Hinman, 1974; Harding and Nagy, 1980; Schallenberger, 1980; Hosking, 1984), but the severity of such problems has often been greatly underestimated.

Resource exploration in Alaska has occurred for many years, but until the Prudhoe Bay petroleum discovery in 1968 there was little development in northern Alaska. When it was determined that the remote Prudhoe Bay reservoir was large enough to exploit, several alternative oil-transport modes were studied, leading to selection of the Trans-Alaska Pipeline System (TAPS). Because about one-half of the pipeline would be elevated to avoid permafrost, great concern was expressed by resource personnel over whether big game, principally caribou (*Rangifer tarandus* L.) and moose (*Alces alces* L.), would be able to cross the right-of-way. Similarly, the number of rivers and streams crossed by the project stimulated much concern over the impact on fish resources. Although potential problems with grizzly (*Ursus arctos*) and black (*U. americanus*) bears, wolves (*Canis lupus* L.), and red (*Vulpes vulpes* L.) and arctic (*Alopex lagopus* L.) foxes were also recognized, relatively little was done in the early planning to reduce conflicts.

Carnivores, especially black and grizzly bears, presented serious problems along several segments of the pipeline route. We review problems with bears to illustrate the need for the planning processes of large resource and industrial projects in remote areas to include these concerns so that problems can be minimized. This review was part of a larger study (Follmann *et al.*, 1980) conducted for the proposed natural gas pipeline that would transport Prudhoe Bay gas to markets in Canada and in the contiguous 48 states. The desire of the Northwest Alaskan Pipeline Company to avoid the

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problems encountered by the builders of the TAPS led them to plan well in advance for any contingencies that might arise regarding human-carnivore conflicts.

TRANS-ALASKA OIL PIPELINE EXPERIENCE

Project Description

The 1274-km-long oil pipeline extends from Prudhoe Bay on the Arctic Ocean to the ice-free port of Valdez in southcentral Alaska (Fig. 1). From Valdez to Livengood, approximately 160 km north of Fairbanks, the project right-of-way paralleled existing roads, whereas north of Livengood (including the entire segment north of the Yukon River) the gravel-surfaced Dalton Highway had to be built through a roadless wilderness in advance of pipeline construction. Following the 1968 petroleum discovery, several camps were constructed between the Yukon River and Prudhoe Bay in anticipation of immediate pipeline construction. These camps were isolated until the Dalton Highway was built in 1974 because permit issuance was delayed. The camps were occupied year-round by small maintenance crews and supported additional workers during the summer, when pre-construction activities increased. A winter "ice and snow" road was used to transport equipment and supplies to the camps.

Construction of the TAPS began in 1974. With the completion of the Dalton Highway and initiation of pipeline right-of-way clearing, the work force increased greatly. Twenty-one large construction camps housed pipeline and marine terminal workers, and seven smaller camps were erected at pump station sites. Eleven camps south of the Yukon River were enclosed with chain-link fence erected on-grade to a height of 2.1 m and topped with three strands of barbed wire to prevent access by unauthorized persons. Pipeline construction camps north of the Yukon River were not fenced, because theft and unauthorized access were not concerns. All permanent pump station sites were fenced, but the adjacent supporting camps where food and garbage were located were not.

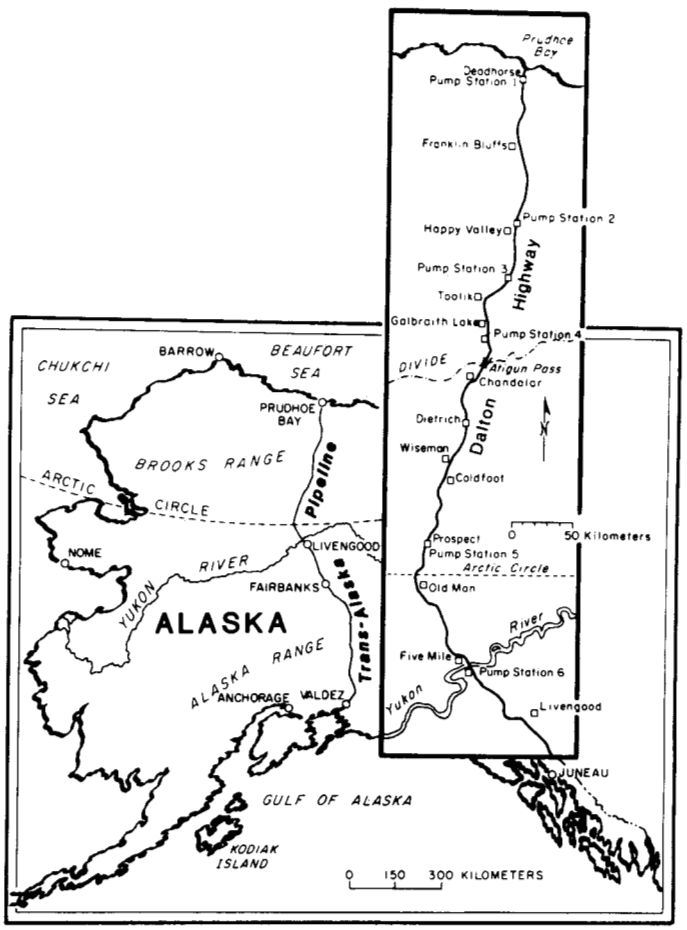

FIG. 1. Route of the TAPS right-of-way to transport North Slope crude oil to the ice-free port of Valdez, showing locations of pipeline construction camps north of the Yukon River.

Construction camps were equipped with standard large garbage containers and incinerators. The incinerators were designed to completely burn all wastes, and ashes were to be buried in select disposal sites. Before entering the field all construction workers were required to attend an environmental briefing, where they were warned not to feed animals. Emphasis was placed on the dangers to workers' health and on the detrimental effects of feeding the animals.

The pipeline route had many mobile crews working along it during the 3.5-year construction period, but activity at any point was usually restricted to several months. Such activities included right-of-way clearing and site preparation, pipeline construction and right-of-way rehabilitation. The mobile work crews moved along the route and did not cause continued disturbance. In contrast, the camps that housed and fed construction crews were fixed sites, with continuous activity for the duration of the project.

To prevent depletion of game resources Alaska Department of Fish and Game (ADF&G) regulations prohibited hunting within 8 km of the pipeline right-of-way in the previously roadless area north of the Yukon River. Trapping was permitted but was not widespread, because only authorized personnel used the Dalton Highway during pipeline construction. Normal hunting and trapping regulations applied south of the Yukon River.

Animal Nuisance Problems

Many animal nuisance problems occurred during the construction phase of the TAPS. These were caused for the most part by the readily available food and garbage in camps, at work sites and at disposal sites and by the active feeding of bears by construction workers. Bears became habituated to such an extent that major problems ensued, including entry into and the residency of some bears in construction camps and work sites. These situations led to property damage, work stoppages and threats to human safety. The extent of these problems is described below.

More (71%) animal nuisance problems occurred north of the Yukon River, where less heavily hunted populations of unwary bears had many opportunities for contact with humans both at mobile work sites and at the unfenced camps. These represent 80% of 85 instances for grizzly bears and 64% of 107 instances for black bears (Table 1). Improper waste disposal, inadequate incineration and availability of food due to carelessness or active feeding by workers conditioned bears to associate humans and their activity with food. The bears rapidly habituated to humans, which probably lessened the potential for certain types of fear-induced aggression (Jope and Shelby, 1984; Jope, 1985). Those animals actively sought out work sites and roadsides to beg for food

TABLE 1. Bear problems reported during TAPS preconstruction through operation, by problem category, 1971-79[1]

Problem category	Grizzly bear	Black bear	Total
Charges	4	5	9
Under/in buildings	1	12	13
In camps/dumps	56	68	124
Property damage/economic loss	13	7	20
Feeding on garbage/handouts	11	15	26
Total	85	107	192

[1]Source of information was Joint State/Federal Fish and Wildlife Advisory Team files. Sample distribution north of the Yukon River is 68 for grizzly bears and 69 for black bears; south of the Yukon River it is 17 for grizzly bears and 38 for black bears.

(Figs. 2 and 3) or loitered in and around camps and at waste disposal sites (Fig. 4). Some bears frequented garbage containers, incinerator stockpiles and kitchens to obtain food. Some kitchen workers provided animals with substantial quantities of food. Bears caused expensive work stoppages, entered buildings, damaged property and created potentially dangerous situations (Table 1; Fig. 5). The combination of unwary bears who did not avoid people, the presence of camps and extensive human activity along a route that traversed prime bear habitat for much of its length, and lack of fences around construction camps all set the stage for bear problems.

Incinerators were present in each camp, but in some cases the volume of waste materials produced was so great that wastes were stockpiled to await incineration. When this happened or when incinerators were in disrepair, wastes were accessible to animals. Even ashes from incompletely incinerated wastes attracted animals when taken to disposal sites, as did unburied inorganic materials (Fig. 4).

Feeding of animals by workers was a chronic problem (Figs. 2, 3, and 5), which was not easy to document. Feeding occurred most often at construction sites, where monitoring was most difficult because of the large number of work sites and because workers would notify others of the whereabouts of environmental staff responsible for enforcing the animal feeding prohibition. Clean-up procedures after meal breaks were often neglected or inadequate and aggravated the problems associated with providing handouts to animals. Litter in

FIG. 3. A panhandling black bear on the Dalton Highway north of the Yukon River.

all forms was a problem along the route: 853 separate reports on inadequate clean-up were filed (Alaska Pipeline Office files). Food attractants were probably included among the litter in many of those reported cases.

That bears were conditioned to loitering around work sites and camps exacerbated other problems. Relatively few charges by bears were reported, but the potential for liability was of great concern to environmental officers and company management. Bears at construction sites caused various degrees of disruption, all contributing to delays in work progress. In some cases workers stopped to take pictures or feed the animals (Fig. 2). If, for example, an aggressive-appearing grizzly bear approached, workers sought refuge in vehicles or other facilities. These types of delays were expensive and frowned upon by the TAPS management.

By far, the most frequent problem encountered during the project was the presence of bears in camps and dumps (Table 1). Improper garbage disposal and animal feeding exacerbated the potential danger in some camps. The 10 black bears that resided under buildings at Five-Mile Camp and the 13 grizzly bears that frequented Chandalar Camp (Fig. 1) during one summer posed serious threats to worker safety, but no injuries occurred. The regularity with which many bears appeared in camps attests to the quantities of available food that attracted these animals to camps and dumps. Also, we

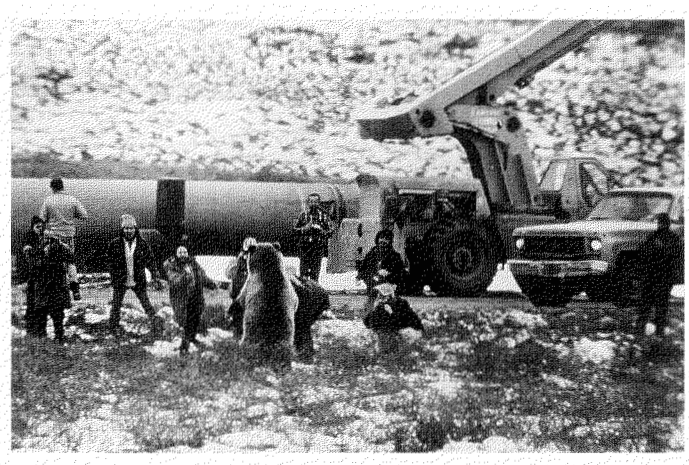

FIG. 2. Disruption of a TAPS work crew by a grizzly bear in the Brooks Range, Alaska.

FIG. 4. A North Slope grizzly bear searching for food at a site of improperly discarded garbage.

FIG. 5. A TAPS construction worker enticing a grizzly bear with food on the North Slope of Alaska.

think that this regular occurrence in camps reflected a sense of tolerance in bears for humans once the bears had become accustomed to their presence and realized that, generally, people posed no threat to their safety.

On 13 occasions bears were reported in or under buildings (Table 1). This is a very conservative estimate, because not all such incidents were officially reported. As noted above, some bears lived beneath buildings. Buildings, principally dining halls and kitchens, were entered when doors were left open, but this was an infrequent occurrence. Before the structures were skirted to prevent entry, black bears, in particular, sometimes took shelter under buildings. Bears rested there and in the fall some even selected those spaces as winter hibernacula. Their presence increased the potential of injury to maintenance crews needing access to the spaces. Damage also occurred in some instances (Table 1). For example, in summer 1975, 10 black bears living under buildings at Five-Mile Camp caused extensive damage to electrical and plumbing installations. The greatest facility damage resulted from grizzly bear activity in three camps located in the Brooks Range. One grizzly bear developed the ability to remove windshields from trucks to obtain sack lunches. Most damage was to buildings where bears attempted to gain entry or damaged the interior once inside.

Even after the work force was reduced in late 1977, when the pipeline became operational, problems with nuisance bears continued. Animals accustomed to handouts still frequented some camps, even breaking into abandoned buildings; truckers and others traveling the Dalton Highway to and from the Prudhoe Bay area continued to feed panhandlers (Fig. 3). A female grizzly bear with three young caused a work stoppage for 200 workers at a repair site in the Brooks Range in 1979 (H.V. Reynolds, unpubl.), and grizzly bears caused some problems in this general area again in 1982.

Rampant problems with bears created a demand for some action to control the problems, but attempts often were inadequate.

Animal Control Measures and Enforcement of Regulations

Animal control measures were implemented during TAPS construction. Hazing, transplanting and shooting were most frequently employed to deal with problem animals. Some experimentation with use of the emetic lithium chloride was attempted, but methods of application and observations of results were sporadic and inconclusive.

Hazing: Hazing was the most frequent technique employed to deal with problem bears. Vehicles and even helicopters were used to chase animals from construction sites. Helicopters effectively scared animals but their effect was short lived if attractants were still present or if the animals had become accustomed to obtaining food at sites of human activity. The high cost of charter did not allow the use of helicopters for this purpose except in conjunction with other assignments. Cracker shells (explosive devices fired from 12-gauge shotguns) and M-80 firecrackers were commonly used to frighten bears. They were ineffective in most cases because their use was not associated with the permanent removal of garbage and other attractants, and bears rapidly learned that the noise was not injurious.

Relocating Bears: Twelve grizzly bears and one black bear were captured in culvert traps and moved to areas remote from the pipeline. The results of these efforts are unclear because most animals were not marked and it was usually not possible to determine if those bears returned. One grizzly bear that was removed from the corridor later caused problems at a pipeline camp about 128 km north of the original disturbance. The second time it was moved 120 km from the pipeline and was later killed at a hunting guide's camp 112 km from the second point of release (H.V. Reynolds, unpubl.).

Shooting: Nuisance grizzly bears were relocated except where they had directly threatened people or otherwise were determined to be incorrigible. This policy was an attempt to protect this species in an area representing its northernmost distribution and where reproductive potential is low. Problem black bears were more often killed in control actions (n=25) than were grizzly bears (n=13). These 38 bears do not include an additional but unknown number of poached or road-killed bears.

Only shooting permanently eliminates a specific problem animal. When shooting a bear was determined to be the only solution, the workers who contributed to the nuisance animal's behavior were usually strongly opposed to such control actions and in several instances, threatened biologists given the assignment of killing an animal with physical injury.

Enforcement of Regulations Prohibiting Animal Feeding: As noted above, feeding of animals was a chronic problem, even though workers were aware that such behavior was prohibited. The problem became so severe that the ADF&G issued an emergency regulation in 1976 that prohibited feeding of animals. Feeding continued (Milke, 1977), but violators were more discrete in their activities.

During the latter part of the TAPS project, management staff began to dismiss workers caught feeding animals. This solution was temporary, however, because workers dismissed from one segment of the pipeline could be hired back, through a union hall, in another area of the project where their previous behavior was unknown.

RECOMMENDATIONS FOR FUTURE PROJECTS

Planning

The TAPS experience with nuisance bears provided considerable insight on how to deal with large development proj-

ects. Major emphasis must be placed on anticipation and prevention of problems. This approach is preferable both ecologically and economically to the alternative of waiting until problems occur before plans are made.

Advance planning of facilities and procedures is necessary (Follmann, 1989). Details should be included in the initial design and construction plans submitted with permit applications. It is not sufficient, as was the case on the TAPS project, that general statements regarding food and garbage handling facilities and procedures be made without consideration being given to their design and detail. Detailed submittals should be developed in consort with resource agencies responsible for environmental protection to ensure that mechanisms are present that will minimize, to a large extent, potential threats to wildlife and to the health and safety of construction crews.

Educational Program

The educational programs given all workers on the TAPS project before field assignments did not deter some workers from feeding animals. An awareness that an environmental briefing alone is ineffective in avoiding human-animal problems is very valuable for planning future large-scale projects.

The environmental briefings designed for workers prior to entry into the field must be presented so that they are both informative and interesting, to capture and maintain the attention of a diversity of people. Often workers feel that attendance at briefings is merely a necessity to gain access to the work site and that environmental issues are unimportant. Only a well-conceived presentation has a chance to overcome this attitude.

Additionally, it would be appropriate to require all workers to periodically attend follow-up briefings at the field camps and also at major project centers prior to reentry into the field following an extended absence. This multiple exposure will require a great deal of ingenuity and thought, however, to provide variation in the presentations and still convey the need to maintain a clean work environment and the prohibition of animal feeding in any form.

In addition to such education programs, individuals seen feeding animals should be permanently prohibited from working on a project. This should reduce the recurrence of this activity and reinforce the warning to other workers. If such policies were in effect and presented to workers at initial environmental briefings and subsequently at camps, the need for costly, large-scale animal control programs would be substantially reduced. Even the most incorrigible worker should be dissuaded if feeding an animal jeopardized a $75 000-100 000 yearly wage.

Food Handling and Garbage Disposal

Mobile Work Sites: The temporary nature of work at any one point along a lengthy right-of-way is simultaneously an advantage and a disadvantage. The advantage is that the total amount of time at any one point is small in the context of a project requiring one to several years of construction. This can reduce the amount of disturbance to animals in the immediate area. The disadvantage is that it is impractical to use physical barriers to keep animals away from the work site. Therefore, it is critical to emphasize proper food handling and efficient and adequate garbage collection and removal. Although animal feeding should never be tolerated, its occurrence at mobile construction sites is particularly difficult to deal with, because as animals become accustomed to these sources of food or become panhandlers, physical barriers are not practical.

Potential animal attractants must be minimized through an effective waste control program. It is essential that all food handling at work sites be carefully planned and controlled. Attractants should be suitably stored at the work site in animal-proof containers and emptied at least daily by workers assigned to this task. Wastes should be removed to camps and completely incinerated prior to burial in approved disposal sites. Under these circumstances, an animal attracted to a site by odors or activity will not be rewarded for its approach and, thereby, behavioral modifications will not likely result. Even if hazing were necessary, the likelihood of an animal returning would be greatly reduced because of the absence of a reward during previous encounters. The keys to success in these situations are minimizing attractants and maintaining avoidance behavior of the bears.

Fixed Sites: Large pipeline and other construction projects in wilderness areas characteristically have base camps for housing and feeding construction crews. These can be upwards of 1000-person facilities and may be spaced at 32 to 64 km intervals or less, depending on terrain and other features affecting construction difficulty. Although by nature temporary, these sites can be active for several years and thereby constitute a significant influence in one area.

The relative permanence of these sites provides an advantage in developing an effective animal control program. However, this does not reduce the necessity of planning for adequate food storage and proper waste disposal within a camp. Nor should it reduce enforcement of the ban on animal feeding. Even without proper food storage and effective garbage handling, erecting an effective physical barrier between the source of attraction and animals affords a considerable amount of protection and thereby reduces human-animal confrontations at these sites.

Fencing

All permanent or semi-permanent camps associated with large construction projects should be fenced to deter bears. Before any fence design is selected, potential animal problems at the site should be addressed, including the presence of other carnivores, such as wolves and red and arctic foxes. Although canids lack strength to cause damage to a fence, they are smaller and more agile, thus capable of entering through gaps that would not accommodate a bear. The degree of the anticipated problem should be the criterion upon which the final fence design is based. We feel it inappropriate to select one fence design to be used in all applications; fencing can be very expensive, and the most secure design may not be warranted in all cases.

The minimum design should consist of a 3.1 m high, 5 cm mesh chain link fence with 1 m buried vertically. Three strands of barbed wire should be placed at the top and angled outward. This design probably will be sufficient at most campsites, particularly if food handling and garbage disposal within the camp are adequate and animal feeding is prohibited.

Should problems still arise or if camps are placed in areas of relatively high bear populations, then an upgrading of this design should be considered. This can be achieved by suspending two electrified barbed wires 25 cm out from the fence and about 25 cm and 1.7 m respectively above the ground. To ensure that a bear will be shocked and thus deterred, it is essential to overcome the reduced conductivity of the gravel pad upon which camps are usually placed and that of the relatively dry snow common in subarctic and arctic areas. That can be accomplished by making the barbed wire the positive pole and the chain link the negative pole. Thus, an animal would be shocked by touching the barbed wire and chain link mesh simultaneously or by touching the barbed wire while standing on a conductive surface. Additional details of these fence designs are provided in Follmann *et al.* (1980).

We recommended a fence design that was significantly more secure than the above for use along the proposed gas pipeline right-of-way in Alaska at two sites where serious problems had occurred during TAPS construction. One was immediately north of the Yukon River (Five-Mile Camp), where black bears were abundant, and the other near the divide of the Brooks Range (Chandalar Camp), where grizzly bears were common (Fig. 1). Delay in pipeline construction did not provide the opportunity to test fences at these large camps, but they were installed around small, 100-person camps that were occupied by survey crews and other study groups. These small camps were within 3.6 km of the camps at which TAPS had its greatest problems until construction was completed in 1977, and where, subsequently, the Alaska Department of Transportation and Public Facilities had erected year-round occupancy camps for Dalton Highway maintenance. Grizzly and black bears continued to be nuisances in these areas subsequent to 1977, encouraged by truckers and others who actively fed panhandlers along the highway (Fig. 3).

Details of the fence erected at the two survey camps are illustrated in Figures 6 and 7 and are further described in Follmann *et al.* (1980). Key features are the combination of a sturdily constructed chain-link mesh barrier with two strands of electrified barbed wire, vertical burial to 0.6 m and a 1.2 m apron of chain-link mesh buried horizontally on the outside of the fence to a depth of 0.6 m. Burial prevented digging under the fence. Electrical shockers used were manufactured by Baker Engineering Enterprises, Ltd. (Edmonton, Alberta, Canada) and provided a charge of 5000+ volts at 1 amp, a higher charge than standard fence chargers. The short pulse width of between 75 and 250 microseconds ensured safety should a worker accidentally touch the (+) wire.

Although fences were not monitored to evaluate their effectiveness in deterring animals, neither camp experienced any problems with bears during the summers of 1980 and 1981 when they were occupied. Workers related how bears encountered the fence and ran off when shocked or were deterred from digging by the buried fence. On an inspection trip by the authors to the camp near the Yukon River in September 1980, bear scats were observed on the gravel pad adjacent to the fence, indicating that animals still approached. Earlier in the summer one female black bear with two cubs entered the camp through a 0.6 m diameter culvert buried in the pad beneath the fence. The outer end was subsequently

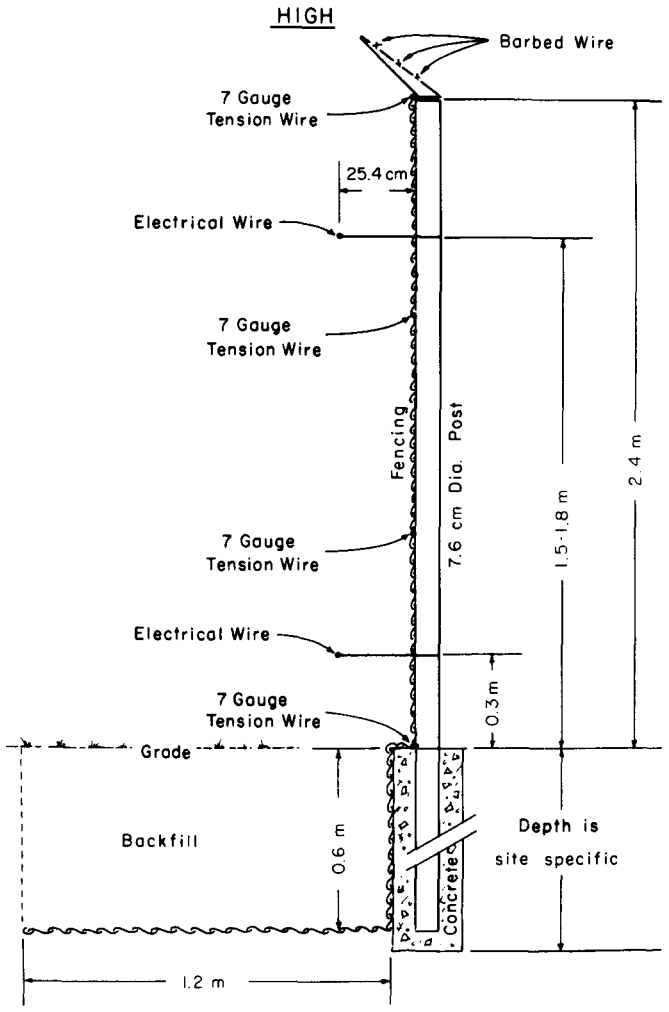

FIG. 6. End view of animal deterrent fence used effectively at two sites in Alaska.

covered with steel mesh, thus blocking this point of entry. Although the fence was effective in deterring bears, this incident points to the resourcefulness of bears in gaining access to areas they wish to explore. In general, cleanliness within the enclosure undoubtedly contributed to the success achieved by the animal control program.

SUMMARY

Based on past experience, we have a good understanding of the potential bear-human conflicts likely to occur during a large-scale construction project, such as a pipeline. Many of the solutions are simple and straightforward, yet are difficult to implement. Conscientious food and waste management, fencing of permanent and semi-permanent facilities, education and prompt action whenever potentially troublesome situations occur all can reduce the types of bear problems that were encountered during construction of the TAPS. We predict that application of these solutions will result in fewer bears being killed and that economic losses incurred by contractors will be significantly reduced.

These steps should greatly reduce the problems of human-carnivore encounters. Unfortunately, very little is known

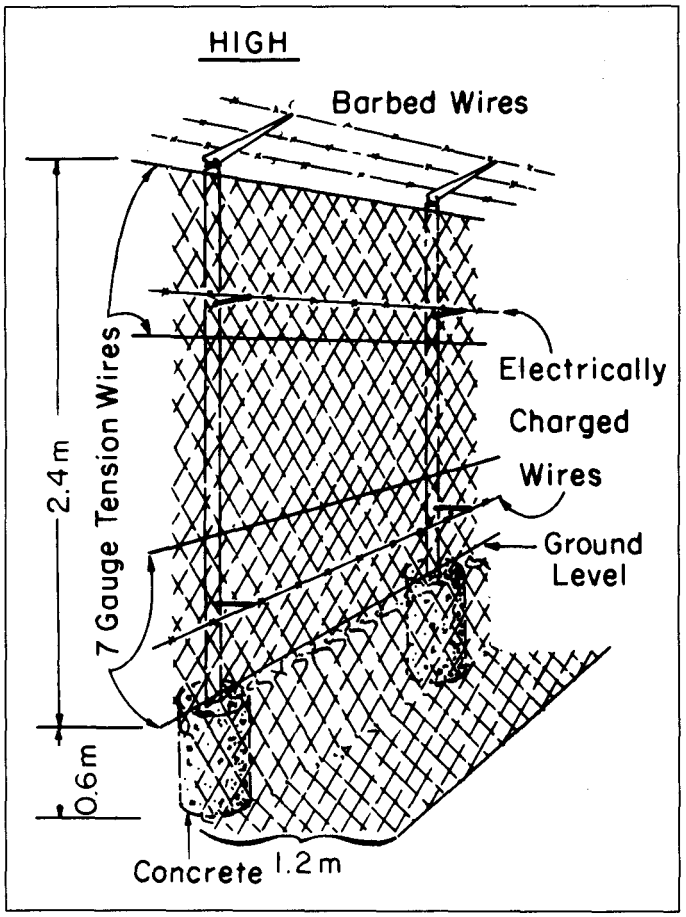

FIG. 7. Oblique view of animal deterrent fence shown in Figure 6.

about the impacts of such projects on the bear populations themselves. However, we believe adverse effects on bear populations will be reduced by minimizing bear-human conflicts.

ACKNOWLEDGEMENTS

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