A Comprehensive Review of the Ecological and Human Social Effects of Artificial Feeding and Baiting of Wildlife

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Annotated Bibliography of the Scientific Literature

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Executive Summary

The Ecological and Human Social Effects of Artificial Feeding and Baiting of Wildlife

In recent years, events within Canada and the United States have drawn attention to potential negative consequences of feeding and baiting wild animals, especially enhanced transmission of infectious diseases such as bovine tuberculosis and chronic wasting disease. This report was prepared to gather available science-based information on the ecological and human social effects of artificial feeding and baiting of wildlife into one readily accessible document. The contracting agencies, Parks Canada and Saskatchewan Environment, recognize that an objective review of existing literature may help to answer questions and concerns within and outside the agencies, and help to guide subsequent decision-making concerning management and research pertaining to feeding and baiting.

Although the objectives for artificial feeding and baiting with feed often differ, the effects of these practices are considered together. In essence, both provide natural or artificial food for wildlife at specific locations in the environment.

Significant ecological effects of providing feed to wildlife have been documented through observation and experimentation at the individual, population, and community levels. In Saskatchewan and Manitoba, the increased potential for disease transmission and outbreak is perhaps of greatest and immediate concern. Nevertheless, even if spread of disease is prevented, other significant ecological concerns exist. Disruption of animal movement patterns and spatial distribution, alteration of community structure with reduced diversity and abundance, the introduction and invasion of exotic plant species, and general degradation of habitat are all major negative effects that have been documented at different locations throughout North America. Although information gaps exist, current information appears sufficient to conclude that the potential for negative ecological effects as a result of providing food to wildlife through artificial feeding or baiting is high. Nevertheless, our current understanding of the specific mechanisms operating between cause (feeding or baiting) and effect is often too crude to allow accurate prediction of the nature or magnitude of effect.

The human social effects of providing food to wildlife concern numerous issues (economics, human safety, wildlife ownership, etc.), and perceptions regarding specific issues can be quite disparate. The science-based information is limited in part because philosophical differences lie at the root of many of the issues and science is not the appropriate tool for resolution, e.g., science cannot determine whether hunting over bait is ethical or not.

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Introduction

Brief Statement of Report Objective

This report provides a comprehensive review of the ecological and human social effects of artificial feeding and baiting of wildlife. The peer-reviewed scientific literature has been the primary source of information for this report. Nevertheless, "non-scientific" information from varied sources (e.g., government websites, expert personal opinion, and the popular press) is included too. This latter information has helped to identify information gaps in the scientific literature, and uncover common misconceptions regarding artificial feeding and baiting of wildlife.

Brief History and Background of the Request

Food is provided to wildlife in Saskatchewan and Manitoba both as a method to stabilize the effects of winter mortality and control wildlife damage to agricultural produce, and as a method to attract wildlife for the purpose of hunting. In recent years, events within both provinces (e.g., chronic wasting disease in wild deer within Saskatchewan, bovine tuberculosis in elk in Manitoba) and broader have drawn attention to potential negative consequences of feeding and baiting wild animals, and have raised concern about the potential impact of these practices. Although perspectives may differ between the two contracting agencies, Parks Canada Agency and Saskatchewan Environment, both have recognized a need to gather available science-based information on the positive and negative impacts of feeding and baiting into one readily accessible document. Such an objective review may help to answer questions and concerns within and outside the agencies, and help to guide subsequent decision-making concerning management and research pertaining to feeding and baiting in respective jurisdictions.

Artificial Feeding of Wildlife

Artificial feeding is defined broadly as placing natural or artificial food into the environment that supplements the food source contained naturally in the home range of a given wild species. Artificial feeding is practiced with intent at various scales and for many reasons: from the maintenance of an active bird feeder in the backyard of a private citizen, to the mass feeding of approximately 14,000 elk and 600 bison during winter at the National Elk Refuge and Grand Teton National Park, Wyoming. Numerous terms are synonymous with intentional artificial feeding, each giving some clue as to the purpose for feeding. These are:

- **Supplemental feeding** – the provision of food to enhance individual and population features, e.g., antler size, number and survival of young, etc.;
- **Emergency feeding** – the provision of food when natural food sources become inaccessible or severely restricted;

- **Winter feeding** – the provision of food to offset reduced food availability caused by winter conditions (Fig. 1), i.e., snow cover, snow depth, etc.; and
- **Intercept feeding** – the provision of food to reduce damage to agricultural crops, livestock, or timber stands (Fig. 2).

It is important to realize that artificial feeding may also occur unintentionally. Garbage dumps, compost heaps, standing agricultural crops, and artificial environments such as golf courses are all potential sources of food used by wild species.

Figure 1. White-tailed deer at winter feeding site in Wisconsin.

Figure 2. Intercept feeding white-tailed deer as part of the Wildlife Landowner Assistance Program in Saskatchewan.

Baiting of Wildlife

Like artificial feeding, baiting can involve placing natural or artificial food, or alternatively non-food materials such as scent lures and decoys, to attract or entice wild animals to a specific area. However, baiting differs in purpose from artificial feeding. It is used as a technique to:

- Aid hunters and trappers (Fig. 3);
- Vaccinate wild populations against disease;
- Poison problem wildlife; and
- Capture of wildlife for management or research purposes (Fig. 4).

Figure 3. Black bear at bait site used for hunting.

Figure 4. Black bear captured for research by bait and a leg-hold snare.

Occurrence of Artificial Feeding and Baiting of Wildlife in Canada

The occurrence of artificial feeding and baiting of wildlife in Canada varies among the provinces and territories (Table 1). In recent years, as these practices have come under increased scrutiny, regulations have been changed within some jurisdictions. For example, the Ontario spring black bear hunt was banned in early 1999 by the provincial government following increased pressure from environmental activists including World Wildlife Fund Canada and the Animal Alliance of Canada. Most recently, Manitoba Conservation has banned the baiting of cervids (deer, elk, moose, and caribou) for hunting to support efforts to prevent the spread of bovine tuberculosis and to keep chronic wasting disease (CWD) out of the province (see Appendix A).

Table 1. Occurrence of artificial feeding and baiting of wildlife in Canada by province or territory as of September 2002.

Jurisdiction	Artificial Feeding Practiced	Hunting by Bait Permitted
Yukon Territory	No	Yes, for wolf and coyote
Northwest Territories	No	Yes, for bear[A]
Nunavut	No	No
British Columbia	No	No
Alberta	Yes	Yes, for bear and wolf
Saskatchewan	Yes	Yes, for bear and cervids
Manitoba	Yes	Yes, for bear
Ontario	Yes	Yes, for bear
Quebec	Yes	Yes, for bear and deer
New Brunswick	No	Yes, no species restrictions
Nova Scotia	No	Yes, for bear and deer
Prince Edward Island	No	Yes, for coyote and red fox
Newfoundland & Labrador	No	Yes, for bear and cervids

[A] Legislation in the Northwest Territories allows baiting for bears by permit. However, issuance of a permit is contingent upon approval by the local community. To date, no permits have been issued because most communities are opposed to hunting bear by bait (Lynda Yonge[1], personal communication).

[1] Lynda Yonge – Wildlife Management Specialist, Government of the Northwest Territories, Yellowknife, NT

The Ecological Effects of Artificial Feeding and Baiting

For the sake of this report a distinction is made between ecological and human social effects. In general, many of the potential ecological effects discussed are based on scientific study and substantiated by empirical data. In contrast, many of the human social effects reflect the perceptions or beliefs of different groups, views that conflict in some cases. Although quantitative or semi-quantitative data are presented sometimes as evidence to support or refute specific effects, it is unlikely that resolution of these conflicts will ever be inferred from the factual findings of science. Instead, hope for resolution will likely depend upon broad education and meaningful discourse.

Although the objectives for artificial feeding and baiting with feed often differ, the effects of these practices are considered together. In essence, both provide natural or artificial food for wildlife at specific locations in the environment. Although baiting has not been studied as widely as artificial feeding, we believe many research results from the study of artificial feeding also are applicable to baiting. This is because differences in ecological effects from one feed or bait site to another are less likely to be explained by the objective for providing food (i.e., supplement or bait?) and more likely to be explained by the cumulative influence of many factors including: type, quantity, and distribution of food; duration of feeding; social behavior of target species; and population and community composition. Nevertheless, despite our lack of distinction between artificial feeding and baiting when considering ecological effects, every effort has been made when providing specific examples from scientific studies to indicate which of the two practices was employed.

The ecological effects of artificial feeding and baiting concern:

- Physical condition and reproductive success;
- Population processes;
- Disease;
- Community processes; and
- Wildlife mortality by hunting.

Detailed discussion of each of these follows:

Physical Condition and Reproductive Success

Physical condition and reproductive success are closely linked; animals in good condition generally have better reproductive success than animals in poor condition. Artificial feeding has been used in attempt to improve the physical condition and reproductive success of a variety of wild species (Fig. 5). However, the success of these efforts have not always been consistent and suggest that many other factors, in addition to food availability and quality, also influence physical condition and reproductive success. Specific examples illustrating the varied effects include:

- Black bears (*Ursus americanus*) that frequented garbage dumps to supplement their diet were found to be heavier, and their reproductive rates were higher, than bears eating only a natural diet (Rogers et al., 1974).

- Artificial feeding programs in Canada and the United States have improved the nutritional status and reproductive success of ungulate populations (Robinette et al., 1973; Ozoga and Verme, 1982; Carpenter et al., 1984; Boutin, 1990).

- Artificial feeding during winter does not improve fecundity in elk (*Cervus elaphus*) (Smith, 2001).

- The effect of artificial feeding on the physical condition of deer is variable depending on density of deer, the feeding practices related to the sex and age ratios, and the severity of the winter (Tarr and Perkins, 2002).

- Artificial feeding during winter increases the fecundity and fawn survival of white-tailed deer (*Odocoileus virginianus*) (Verme, 1965; Murphy and Coates, 1966; Ozoga and Verme, 1982).

- Artificial feeding does not increase the birth weights of elk calves (Smith et al., 1997). Birth weights appear to be largely density dependent, so increased birth weight as a result of artificial feeding is likely only to be detected when population densities of elk approach the carrying capacity of winter yards (Smith, 2001).

- Artificial feeding improved nesting success of bald eagles (*Haliaeetus leucocephalus*) in Alaska (Hansen, 1987) and white-tailed eagles (*Haliaeetus albicilla*) in Sweden (Helander, 1978).

- Winter feeding did not improve reproductive success of bald eagles in Maine (McCollough et al., 1994)

Lewis (1990) suggests that although improved physical condition and reproductive success are generally perceived as beneficial effects of artificial feeding, they may prove detrimental in the long term. This is because, as physical condition and reproductive success improve, population growth will eventually exceed the carrying capacity of the range.

Figure 5. Artificial feeding is used to improve physical condition and reproductive success in a variety of wild species.

Population Processes

The provision of food for wildlife at focal locations in the environment has been demonstrated to affect numerous processes at the population level. The spatial distribution of animals can be altered so that population density is significantly increased in the vicinity of the food source (Boutin, 1990; Schmidt and Gossow, 1991; Easton, 1993; Tarr and Perkins, 2002). As animals converge toward focal food sources, their normal daily or seasonal movements can be disrupted (Baker and Hobbs, 1985; Lewis, 1990; Paquet, 1991; Fersterer et al., 2001). As density of animals increases around a focal food source, competition among individuals can also increase (Jarman, 1974; Schmitz, 1990; Grenier et al., 1999). Ultimately, survival may be enhanced or reduced depending on the purpose for providing food, the manner in which food is distributed, and the level of competition or interaction among population members.

Specific examples of effects on population processes include:

- Relative to central areas within Riding Mountain National Park, the density of bears is greater at the periphery of the park close to bait sites located on adjacent agricultural lands (Paquet, 1991). In addition, the home ranges of female bears in Riding Mountain National Park are larger than home ranges in other parks where baiting does not occur. These observations suggest a source-sink model of population regulation (Pulliam, 1988; Pulliam and Danielson, 1991) in which the park represents a territory suitable for the production of dispersing offspring, and the sinks are baited areas around the park periphery where the expected rate of reproduction is insufficient to replace the parents.

- In the short term, intercept feeding was successful in altering the movements of bears in spring to include feeding sites in their travels and, consequently, reduce damage to saplings (Fersterer et al., 2001). However, as the number of bears attracted to feeding sites increased, the effectiveness of intercept feeding decreased.

- Artificial feeding was not observed to prevent or delay any white-tailed deer from migration, although the longer a feeder was in operation, the proportion of non-migratory deer increased (Lewis, 1990).

- Winter mortality of elk on feeding grounds in Wyoming was lower than occurred in unfed populations of elk (Smith, 2001).

- Artificial feeding may help to maintain and support some endangered species including trumpeter swans (*Cygnus buccinator*) (Gale, 1989; Gomez and Scheuring, 1996), and local "at-risk" populations including bald eagles (Hario, 1981; Helander, 1981; Helander, 1985; McCollough et al., 1994).

- Artificial feeding increased the carrying capacity of habitat for bald eagles during times of decreasing prey population and was effective at drawing eagles away from contaminated food sources (McCollough et al., 1994).

Disease

The provision of food to wildlife has been implicated widely as a causative factor that increases the occurrence of infectious and non-infectious disease. Animals are attracted to artificial sources of feed in higher density than normally occurs under natural conditions (Thorne and Herriges, 1992; Williams et al., 1993; Fischer et al., 1997). As animal density increases, competition for food also increases resulting in more frequent contact among individuals (Baker and Hobbs, 1985; Schmitt et al., 1997). Contact can be direct through physical contact, or indirect as occurs when two animals share the same portion of food. If one or more animals are harboring an infectious organism or prion, its transmission to uninfected individuals is facilitated by the increased frequency of contact among animals congregating at the feeding site (Miller et al., 1998; Michigan Bovine TB Eradication Project, 2002). It is also suggested stress from crowding reduces immunocompetence in some animals, increasing the likelihood of disease (Smith and Roffe, 1992; Smith, 2001). Disease can affect individual animals, populations, or communities. Depending on the nature of the disease and the feeding location, disease can be transmitted within or between species (Schmitt et al., 1997; Smith, 2001), between wildlife and domestic animals (Thorne and Herriges, 1992), or even between wildlife and humans (Rupprecht et al., 1995). Non-infectious disease also can occur when wild species are fed foods incompatible with their digestive function (Wobeser and Runge, 1975), foods of poor nutritional quality (Ohio Wildlife Center, 2000; see www.ohiowildlifecenter.org/WildlifeInfo/nuisancewaterfowl.htm), or spoiled foods that have become toxic (Perkins, 1991; Davis, 1996; Breed, 2002).

Specific examples of disease occurrence attributed to artificial feeding or baiting include:

1. *Bovine tuberculosis in wild cervids* – In 1994, bovine tuberculosis (TB) was detected in a population of white-tailed deer in an area of Michigan where there were no infected livestock or bison to serve as a reservoir (Schmitt et al., 1997). Focal sources of concentrated feed and high densities of deer were determined to be the factors maintaining this disease and increasing its prevalence. High concentrations of deer around feeding and baiting sites facilitate disease transmission through increased animal-to-animal contact and possibly through contamination of feed (Palmer et al., 2001; Schmitt et al., 2002). Bovine TB also has been detected in wild mule deer (*Odocoileus hemionus*) in Montana (Rhyan et al., 1995). However, in contrast to deer in Michigan, infection of deer in Montana appears to have occurred as a result of contact between wild deer and infected livestock. In 1998, a bovine TB surveillance program was established in west-central Manitoba following detection of the disease in wild elk within and around Riding Mountain National Park. High densities of elk around bait sites and hay bales or standing crops on agricultural lands adjacent to the park coupled with increased interaction between elk and livestock are believed to play a role in maintaining the disease in cattle and elk from this area (Parks Canada Agency, 2001b). In Michigan, a variety of environmental and farm management factors have been identified to be associated with increased risk of bovine TB on cattle farms including higher TB prevalence among wild deer and cattle farms in the area, herd size, and ponds or creeks in cattle housing areas (Kaneene et al., 2002).

2. *Chronic wasting disease in deer* – In Fort Collins, Colorado, artificial feeding by private citizens is believed to have contributed to the infection of 49 free-ranging cervids with chronic wasting disease (CWD) (Spraker et al., 1997). Experimental and circumstantial evidence suggests infected animals probably transmit the disease through animal-to-animal contact, and through contamination of food or water sources with body fluids (saliva, urine) and feces (Williams and Young, 1980; Miller et al., 1998). Further, conditions of high animal density or confinement can create conditions where transmission of CWD occurs at a faster rate than under natural conditions (Fig. 6) (Miller et al., 2000). Several government agencies in Canada (Appendix A – see www.gov.mb.ca/chc/press/top/2002/08/2002-08-16-01.html) and the United States (Michigan Department of Natural Resources, 2002 – see www.michigan.gov/dnr/0,1607,7-153-10370_12150-29070--,00.html; Wisconsin

Department of Natural Resources, 2002 – see www.dnr.state.wi.us/org/land/wildlife/regs/02CWDregs.pdf; New York Department of Environmental Conservation, 2003 – see www.dec.state.ny.us/website/regs/part189.htm) have recently changed their regulations regarding artificial feeding and baiting in an effort to prevent or reduce infection of wild cervids with CWD.

Figure 6. Captive elk infected with chronic wasting disease.

3. *Bovine brucellosis in elk and bison* – In the western United States, brucellosis in wildlife of the Greater Yellowstone Ecosystem is an issue of national importance to the National Park Service as well as other federal and state agencies. At issue is the risk of transmission of brucellosis from wildlife to domestic animals (Cheville et al. 1998; Smith, 2001), the health and welfare of wildlife under National Park Service stewardship, and management of federal lands. Brucellosis in elk in the ecosystem is enhanced as a direct result of management actions that cause dense winter aggregations of elk on feeding-grounds (Thorne and Herriges 1992; Williams et al., 1993; Smith, 2001). The disease, however, is not found among free-ranging elk herds subsisting on natural forage because the route of transmission requires contact with reproductive products. The feeding-grounds of the Greater Yellowstone Ecosystem include the National Elk Refuge and 22 sites in Wyoming. Together, these sites are home to an estimated 22-25,000 elk. Once introduced to bison (*Bison bison*) the disease is maintained via their naturally gregarious behavior.

4. *Carbohydrate overload in wild ruminants* – Wild ruminants can die from feeding on highly digestible, low-fiber feed (Wobeser and Runge, 1975). Ruminants need to change their diet of roughage to grain slowly to give the bacteria in their gut a chance to adjust to changes in feed type. Otherwise, rapid exposure to a concentrated grain diet will often cause a fatal disruption of the body's acid-base balance. Animals that survive the immediate effects of "carbohydrate overload" often die in the days or weeks that follow due to secondary complications of the disease. A variety of feeds can cause carbohydrate overload (also called grain overload, lactic acidosis, or enterotoxemia), including grains, lentils, bread, and corn. In Saskatchewan from 1995 to 2001, two to four wild deer submitted each year to the diagnostic pathology service of the Canadian Cooperative Wildlife Health Centre were diagnosed as dying of carbohydrate overload. Given the small likelihood of finding a wild animal that is either dying of or has recently died of carbohydrate overload, it is likely a considerably larger number of wild deer that succumb to this disease go undetected.

5. *Psoroptic mange in elk* – Elk at the National Elk Refuge in Wyoming have survived on artificial feeding during the winter months for approximately 90 years. Each year, 20-30 adult male elk die from psoroptic mange (Samuel et al., 1991; Smith, 2001). Infected elk have also served as a reservoir for infection of a sympatric population of bighorn sheep (*Ovis canadensis*).

6. *Demodectic mange in white-tailed deer* – White-tailed deer receiving artificial feed in Maine have suffered from outbreaks of demodectic mange caused by the spread of mites while at feeding stations (Maine Department of Inland Fisheries and Wildlife, 2002; see www.state.me.us/ifw/hunt/deerfeed.htm).

7. *Starvation of white-tailed deer* – Winter feeding of white-tailed deer can lead to starvation of some individuals if the feeding delays the migration of deer to their winter yards, or if artificial; feeding is terminated abruptly (Ozoga and Verme, 1982).

8. *Mycoplasmal conjunctivitis in house finches* – Since 1994, mycoplasmal conjunctivitis has been found in a variety of bird-feeder type birds, especially house finches (*Carpodacus mexicanus*). In the past 8 years, the disease has spread westward from the eastern United States (Fischer et al., 1997; Hartup, 1998). Although it is not fully understood how the disease is transmitted among house finches, artificial feeding is suspected to facilitate transmission (Fischer et al., 1997; Hartup et al., 1998). The use of tube feeders that offer few perches increases contact among birds. Further, seed contaminated by the infectious organism *Mycoplasma gallisepticum* is protected from moisture within the tube feeders.

9. *Salmonellosis in passerine birds* – Outbreaks of salmonellosis in Michigan occur mostly in passerine birds concentrated around feeders during winter. (Michigan Department of Natural Resources, 2001; see www.michigan.gov/dnr/1,1607,7-153-10370_12150_12220-27268--CI,00.html). The disease is transmitted directly through ingestion of feed contaminated with feces containing the bacterium *Salmonella typhimurium*.

10. *Nutritional deficiencies in fed birds* – Many people feed wild birds, including waterfowl, to supplement their diet. However, birds maintained on artificial feed are frequently submitted to wildlife rehabilitation centers as a result of severe nutritional deficiencies and metabolic bone disease (Ohio Wildlife Center, 2000; see www.ohiowildlifecenter.org/WildlifeInfo/nuisancewaterfowl.htm).

Although provision of food to wildlife is more commonly associated with increasing the occurrence of disease, it has also been used effectively in some circumstances to prevent disease. For example, the widespread dispersal of bait containing vaccine has been an effective and feasible method of preventing the spread of rabies in areas of Ontario and Texas (Farry et al., 1998a; Farry et al., 1998b; Rosatte et al., 2001).

Community Processes

The potential effects of providing food to wildlife typically extend well beyond the population of the targeted species, especially if food is provided over a prolonged period. Disease has already been described to affect multiple species in a community. Competition among species for limited resources often increases as the density of animals increase in a feeding area (Williamson, 2000). Over many years, the composition of a community can change markedly – plant and animal diversity is reduced, and plant abundance declines (Casey and Hein, 1983; DeCalesta, 1994). The ability of a habitat to support animal life, its carrying capacity, is diminished (Doenier et al., 1997; Williamson, 2000). Further, if plant materials are provided for artificial feed, there is increased likelihood of invasion by exotic plant species (Fig. 7) (Kosowan and Yungwirth, 1999; Alien Plant Working Group, 2000; Spurrier and Drees, 2000). Processing of plant materials into pellets through crushing and steaming greatly reduces, but does not entirely eliminate, the presence of viable weed seeds (Cash et al., 1998). The effects of invasion can be devastating (IUCN, 1999; Alien Plant Working Group, 2000) and include:

1. Reduction of biodiversity;
2. Loss of and encroachment upon endangered and threatened species and their habitat;
3. Loss of habitat for native insects, birds, and other wildlife;
4. Loss of food sources for wildlife;
5. Changes to natural ecological processes such as plant community succession;
6. Alterations to the frequency and intensity of natural fires;
7. Disruption of native plant-animal associations such as pollination, seed dispersal and host-plant relationships; and
8. Alterations in soil characteristics resulting in soil erosion.

The prevention of introducing biological invaders into the environment has been identified to be of the highest priority by the International Union for the Conservation of Nature (1999).

Figure 7. Exotic plant seeds left remaining and germinating at ungulate bait site in Saskatchewan.

Specific examples of effects on community processes include:

- In Wyoming, moose (*Alces alces*) suffered a reduction in the carrying capacity of their habitat because elk maintained on artificial feed had reduced the amount of willow in the area (Williamson, 2000).

- Casey and Hein (1983) studied the effects of 27 years of artificial feeding of ungulates on the community structure of an eastern deciduous forest. Populations of white-tailed deer, elk and mouflon sheep (*Ovis musimon*) were maintained at higher densities in feeding areas than in neighboring areas where artificial feeding did not occur. Further, the amount of under-story was decreased, little ground cover remained, trees were larger, and there were an increased number of dead trees in feeding areas. As a result, ground-nesting birds such as wild turkeys (*Meleagris gallopavo*) were less abundant in the feeding areas. There also was an increase in bark-foraging species and cavity-nesting species because of the change in the composition of the trees.

- The provision of supplemental food for deer on rangelands in Texas may negatively impact populations of neighboring wild turkeys and other ground-nesting birds by concentrating potential nest predators, such as raccoons and skunks, near feeders (Cooper and Ginnett, 1998; Cooper and Ginnett, 2000).

- Doenier et al. (1997) studied the browse pressure exerted by deer around artificial feeding sites. The effects of over-browsing, such as loss of plant species and increases in less desirable plant species, were seen within a one mile radius of feeding sites.

- Weeds contained in the feed at artificial feeding sites and seeds deposited in the area by birds, animals, or wind, threaten the integrity of a community. If the invading plant species have a high rate of reproduction, means of dispersal, and disturbed areas caused by over-browsing, biological invasion is a distinct possibility (Spurrier and Drees, 2000). This possibility has been recognized in numerous areas of Saskatchewan and Manitoba where exotic plant species appear to have been introduced into communities through baits used for ungulates (see, for example: "Wildlife Feed May Be Weedy, Diseased" by Karen Briere in Western Producer, March 23rd, 2000). The spread of exotic plant species is facilitated by the species feeding on the bait, as well as by transport of seeds on vehicles and other equipment (Adam Kosowan[2], personal communication). Invasion of native grassland by exotic plant species is considered a major problem in Saskatchewan (Thorpe and Godwin, 1999 – see http://www.serm.gov.sk.ca/ecosystem/biodiversity/threats_bio.pdf). Exotic invasion is not yet a serious threat in the forest regions, but there is some invasion of species such as Kentucky blue grass, quack grass, Canada thistle, and caragana in the southern edge of the forest, which is affected by proximity to settlement and livestock grazing.

Wildlife Mortality by Hunting

Baiting, and to a lesser extent artificial feeding, are believed by some to influence the numbers of wild animals killed by hunting. In fact, a basic question of concern to resource managers is does baiting lead to an increase in wildlife mortality by hunting, either for the population as a whole or for specific segments of the population, and if so what impact could this have on the population over the short and long term. Unfortunately, answers to these questions are not easily determined. Considerable debate and differing opinion remain on exactly how or if wildlife mortality by hunting is affected by providing food, as illustrated in the following examples:

- The numbers of black bears killed by hunters over bait around Riding Mountain National Park (RMNP), Manitoba, is high. Given the low reproductive rate of black bears, the mortality resulting primarily from hunting is likely to be unsustainable (Paquet, 1991). The immediacy of this concern, however, might be obscured in the short term by source-sink population dynamics (Pulliam, 1988) where the protected area within the park provides a source of bears that disperse toward the baiting areas. However, over many years, it is possible that the genetic pool for black bears of RMNP will be reduced through high hunting success coupled with the selective killing of larger bears. Alternatively, the severe hunting pressure on local black bears could be offset by immigration from other outlying populations (Lamport, 1996).
- Hunting black bears over bait can potentially enable hunters to better discriminate target animals and avoid killing of sensitive sex and age classes, e.g., lactating females (Obbard, 2002). However, based on hunter survey data from Ontario, Lamport (1996) concluded that the ability of the average hunter to correctly determine the sex of a bear over bait is poor (Fig. 8). The results from this survey, as well as results from other studies (Litvaitis and Kane, 1994), suggest selectivity is

[2] Adam Kosowan – Boreal Ecologist, Saskatchewan Environment, Prince Albert, SK

less important to hunters than successfully killing a bear, regardless of its sex or age class.

Figure 8. Shooting stand and bait site constructed for hunting black bears in Ontario.

- Winterstein (1992) reported that hunters in Michigan were 20 percent more effective in harvesting deer when using bait than those not using bait (3.8 versus 3.1 deer harvested per 100 days of hunting). A 1999 phone survey found that 44 percent of hunters were successful using bait, while 52 percent were successful without bait (Michigan Department of Natural Resources, 1999 – see www.michigandnr.com/publications/pdfs/huntingwildlifehabitat/Issue_Reviews/99baiting.pdf). A more recent survey in Michigan indicated that archers using bait required fewer days to harvest a deer than non-baiters (4.9±4.3 versus 1.8±2.1 deer/100 days) (Frawley, 2002). In contrast, firearm hunters using bait required approximately the same time to harvest a deer than non-baiters (8.3±3.3 versus 7.4±2.5 deer/100 days). Overall, baiting appeared to contribute more towards greater harvest rates among archers than firearm hunters (Frawley, 2002).

- A survey by the Wisconsin Department of Natural Resources in 1993 found that 50% of hunters were successful with bait, while 54% were successful without bait (Wisconsin Bureau of Wildlife Management, 1993).

- Deer that were provided artificial feed during summer were more likely than unfed deer to seek out bait sites providing similar feed during hunting season (Lewis, 1990).

Conclusions Regarding The Ecological Effects of Artificial Feeding and Baiting

Significant ecological effects of providing food to wildlife have been documented through observation and experimentation at the individual, population, and community levels. The increased potential for disease transmission and outbreak is perhaps of greatest and immediate concern; recent outbreaks of bovine tuberculosis and chronic wasting disease in Canada and the United States giving credence to this point. Nevertheless, even if disease is prevented, other significant ecological concerns exist. Disruption of animal movement patterns and spatial distribution, alteration of community structure with reduced diversity and abundance, the introduction and invasion of exotic plant species, and general degradation of habitat are all major negative effects that have been documented at different locations in North America. Further, it would appear the costs of such effects are unlikely to be outweighed by any long-term benefits. For example, the record of success for artificial feeding programs has been generally low (Carhart, 1943; Doman and Rasmussen, 1944; Dahlberg and Guettinger, 1956; Keiss and Smith, 1966; Lewis and Rongstad, 1998). In many instances, large-scale feeding efforts have created feed-dependent populations existing in numbers that exceed the carrying capacity of their environment (Ozoga and Verme, 1982; Ontario Ministry of Natural Resources, 1997 – see www.mnr.gov.on.ca/mnr/pubs/deer2.pdf; Williamson, 2000).

The Human Social Effects of Artificial Feeding and Baiting

The human social effects of providing food to wildlife through artificial feeding or baiting are not as amenable to scientific research as the ecological effects. In many cases, social effects reflect the sometime conflicting perceptions or beliefs of different groups. Acceptance of perceived effects or resolution of conflicting views is more likely to occur through broad education and meaningful discourse than through scientific study. The major human social effects concern:

- Economics;
- Human safety;
- Regulations – compliance and enforcement;
- Wildlife ownership;
- Hunter success;
- Discord among hunters; and
- Discord between jurisdictions.

Detailed discussion of each of these follows:

Economics

Providing food to wildlife can involve transactions of large sums of money and perhaps this as much as anything has encouraged continuation of artificial feeding and baiting despite compelling evidence for significant negative ecological effects. Although reported statistics are scattered and few, the following examples illustrate the scale of business (Fig. 9).

- In 1991, hunters in Michigan used over 13 million bushels of bait for deer, with a net value in excess of 50 million dollars ($U.S.) (Winterstein, 1992).

- In 1995, artificial feeding and baiting in Michigan generated a minimum value to farmers of about 15 million dollars ($U.S.) and two to three times that amount to retailers (Michigan Department of Natural Resources, 1999 – see www.michigandnr.com/publications/pdfs/huntingwildlifehabitat/Issue_Reviews/99feeding.pdf; Williamson, 2000).

- In 1993, approximately 13 million dollars ($CAN) was spent in Ontario for supplies and services associated with the spring and fall black bear hunting season, much of which is done over bait (Lamport, 1996).

- Outfitting (includes hunting, angling, and touring) is the largest single source of export dollars in the Saskatchewan tourism industry. The direct income from the industry is about 80 million dollars ($CAN) annually (Sask Net Work, 2003 – see http://www.sasknetwork.gov.sk.ca/pages/lmi/sectorstudies/inetsectors/Tourism/outfit_sp.htm)

- Recent statistics on bird feeding in the United States indicate people spend nearly $4.7 billion ($U.S.) annually on bird feeding and watching wildlife. Of that, they spend: $3.2 billion on birdseed and wildlife food; $832 million on birdfeeders, birdbaths and nesting boxes; and $636 million on binoculars and spotting scopes (see – www.franchisegator.com/cgi-bin/profile.php?key=58).

Figure 9. Bagged corn sold for the baiting of white-tailed deer in Wisconsin.

The cost of supplies and services are largely transparent – the manufacturer, distributor, or service sets a price and the consumer knowingly pays it. In contrast, the costs of maintaining artificial feeding programs or dealing with the negative ecological effects of providing food to wildlife (e.g., disease containment, habitat degradation) are often obscure, but generally considerable, long term, and borne by society as a whole. This is illustrated in the following examples:

- The financial cost of feeding mule deer is estimated at $183.37 ($U.S.) per deer saved, and may prove cost-prohibitive to some wildlife managers (Baker and Hobbs, 1985)

- In 1997, the cost of feeding bears to protect trees in western Washington was $300,000 ($U.S.) (Partridge, 2001).

- By the end of 2001, the Canadian Food Inspection Agency had paid close to $30 million ($CAN) in compensation to elk farmers for losses in association with chronic wasting disease (CWD) (Inch, 2002 – see www.inspection.gc.ca/english/anima/heasan//cahcc/cahcc2001/plen-aj-e.shtml). Although this cost was in association with captive elk only, the disease is transmitted between and among both captive and free-ranging cervids (Miller et al., 1998; Miller et al., 2000) and considerable amounts of money also have been spent in association with CWD surveillance and depopulation of wild deer. In Saskatchewan, total costs for CWD testing of hunter- and control-killed deer since 1999 are close to $500,000 ($CAN) (Trent Bollinger[3], personal communication).

- Albeit unintentional, standing agricultural crops, stored hay and grain, and livestock all represent potential sources of food for wildlife (Fig. 10). Failure of agricultural producers to prevent access by wildlife to these food sources can be costly. In 2000 and 2001, over $2.2 million ($CAN) was paid in compensation to producers in Saskatchewan for crop damage caused by large game (Saskatchewan Crop Insurance Corporation, 2002 – see www.saskcropinsurance.com/pdf/SCICannualreport0102.pdf). A further 2.8 million ($CAN) was paid for damage caused by waterfowl. During the same period, 3.4 million ($CAN) was paid to producers in Manitoba for damage caused by wildlife (large game and waterfowl combined) (Manitoba Crop Insurance Corporation, 2002 – see www.mcic-online.com/Downloads/Financials.pdf). Further, wildlife agencies in both provinces have been forced at times to use intercept feeding in attempt to reduce damage to agricultural products.

- Although the recovery of the trumpeter swan **(***Cygnus buccinator***)** is a great success story for wildlife conservation, the increased number of birds wintering in southern British Columbia is putting pressure on the agricultural lands they have come to depend on. Since each swan can eat up to 1.2 kilos of grass per day, their foraging habits might translate into substantial forage losses to the farmer (Environment Canada, 2002; see www.ecoinfo.ec.gc.ca/env_ind/region/swan/swan_e.cfm).

- Impacts of invasive plant and animal species on native habitats in the United States range from insidious to catastrophic, and cost Americans about $138 billion ($U.S.) annually (Fig. 11) (Pimental et al., 2000; Spurrier and Drees, 2000; also see – http://biology.usgs.gov/cro/invasives.pdf).

[3] Trent Bollinger – Wildlife Disease Specialist, Canadian Cooperative Wildlife Health Centre, Saskatoon, SK

Figure 10. Albeit unintentional, standing agricultural crops, stored hay and grain, and livestock all represent potential sources of food for wildlife.

Figure 11. From native forest to introduced plants – exotic plant species thriving along an ungulate shooting lane in Saskatchewan.

Human Safety

Various issues of human safety have been identified in association with providing food to wildlife, including artificial feeding and baiting. However, conclusive information is lacking in many instances. Issues include:

- Deer feeding sites located near well-traveled highways may increase deer/vehicle collisions (Wisconsin Conservation Congress, 2000 – see www.dnr.state.wi.us/org/land/wildlife/hunt/deer/deer2000/b&freport.pdf; Stewart, 2001 – see http://msucares.com/pubs/infosheets/is1624.pdf; also see – www.state.me.us/ifw/hunt/deerfeed.htm; Manitoba Conservation, 2002 – see www.gov.mb.ca/natres/wildlife/huntingg/general_information/notice.html).

- Wild animals conditioned to human food sources may lose their natural wariness of people and become aggressive toward people either in protection of, or in seeking other, human food sources, e.g., camp food, garbage (Fig. 12) (The Humane Society of the United States, 2002 – see http://www.hsus.org/ace/12810; Pennsylvania Game Commission, 2003 – see http://sites.state.pa.us/PA_Exec/PGC/newsroom/2003/nr002-03.htm). Black bears conditioned to human food sources have been associated with injury to humans, particularly inside national parks where carrying of firearms is restricted (Herrero, 1970; Herrero, 1985). Although there are few published data available demonstrating a causal relationship between feeding and the creation of nuisance bears, the circumstantial evidence has been broad enough to convince many government agencies to develop policies on the feeding of bears. For example, in the United States, the U.S. Forest Service (USFS), the Bureau of Land Management (BLM), the U.S. Fish and Wildlife Service, and the National Park Service all publish materials telling the public not to feed bears, materials that warn: "Do Not Fed Bears!," "Bears Are Dangerous!," and "A Fed Bear Is A Dead Bear" (Examples from each of these agencies are found at http://www.fs.fed.us/r4/sc/yankeefork/Bear.html, http://www.or.blm.gov/Rogueriver/WildRogueOnly/Bears.htm, http://www.r6.fws.gov/endspp/grizzly/factsheets/grizz%20foods.pdf, and http://www2.nature.nps.gov/nps77/health.new.html). A troublesome finding is that two of these agencies (the USFS and BLM) also permit baiting for bears on federal lands in nine of the 27 states that allow bear hunting, the nine states being Alaska, Idaho, Maine, Michigan, Minnesota, New Hampshire, Utah, Wisconsin, and Wyoming (Scheick, 2002). Clearly, the allowance of baiting in these states contradicts federal policies on the feeding of bears. Contradicting policies on feeding and baiting bears are also found in Canada where a number of provincial government agencies that permit baiting of black bears for hunting also warn against providing food to these animals as it can lead to dangerous human-bear interactions or damage to human property (Nova Scotia Department of Natural Resources, 1996 – see http://www.gov.ns.ca/natr/wildlife/conserva/20-01-1.htm; Ontario Ministry of Natural Resources, 2000 – see http://www.mnr.gov.on.ca/mnr/bears/index.html; Saskatchewan Environment, 2000 – see http://www.serm.gov.sk.ca/media/saskatchewan%20environmentnewsline/bears.htm

and
http://www.serm.gov.sk.ca/media/saskatchewan%20environmentnewsline/reduce_bear_encounter.htm; Alberta Sustainable Resource Development, 2002 – see http://www3.gov.ab.ca/srd/fw/bears/manage.html; and Manitoba Conservation, 2002 – see www.gov.mb.ca/natres/wildlife/huntingg/general_information/notice.html).

Figure 12. Black bears conditioned to human food sources may lose their natural wariness of people and become aggressive either in protection of, or in seeking other, human food sources.

- In Ontario, 82 municipalities have recently joined together with the Canadian Outdoor Heritage Alliance (COHA) to pressure the provincial government to reinstate the spring black bear hunt as many believe cancellation of the spring hunt in 1999 has resulted in an increase of nuisance bears (COHA, 2002; see http://www.coha.net/press/press_release16.html and http://www.coha.net/published_articles/published_articles8.html). The Ontario Ministry of Natural Resources attributes the abnormally high incidence of problem bears over the past 5 years to a reduction in natural foods due to unusual weather conditions and point out that similar events have been recorded in years prior to cancellation of the spring hunt (Ontario Ministry of Natural Resources, 1998 – see http://www.mnr.gov.on.ca/MNR/csb/news/sept28nr98.html; Martyn Obbard[4],

[4] Martyn Obbard – Research scientist in predators/conservation biology, Ontario Ministry of Natural Resources, Peterborough, ON

personal communication). Nevertheless, the COHA advocates that hunting (over bait) is the only well regulated management tool for keeping an "out of control black bear population at a safe and sustainable size." Apparently, wildlife officials from various agencies in North America also share the view that baiting is needed to help control bear populations (see http://www.biggamehunt.net/sections/Politics/Congressman_Announces_Plan_to_End_Bear_Baiting_01060312.html). Most recently, Karen Noyce, a bear researcher with the Minnesota Department of Natural Resources, was quoted widely in the media as saying that "bear baiting has helped keep the population in check." In response to public pressure in Ontario, the Ontario Ministry of Natural Resources has recently established a Nuisance Bear Review Committee to undertake an independent review of scientific information related to the nuisance bear issue in the province (Further information available at http://nuisancebear.mnr.gov.on.ca/index.html).

- After a prohibition of hunting black bears with bait or hounds came into effect in 1993 in Colorado, neither the geographic distribution of bear kill nor the size or growth rate of the statewide bear population changed (Beck, 1997).

- In general, jurisdictions that permit the feeding of wildlife through artificial feeding or baiting have restrictions concerning type and amount of feed, location and identification of feed/bait site, and duration of feeding/baiting. These restrictions are placed in part to minimize human injury. Still, it is unlikely any persons injured as a result of wildlife conditioned to human food sources would have legal recourse (Brendan Delehanty[5], personal communication).

- Hunting over bait is presumed to be safer than other hunting techniques because it allows hunters to remain stationary near their bait pile instead of moving about and encountering other hunters. Hunters frequently have a clear line of sight to their bait pile allowing them a better view of their target and reducing the chance of an accident (Michigan Department of Natural Resources, 1999; see www.michigandnr.com/publications/pdfs/huntingwildlifehabitat/Issue_Reviews/99baiting.pdf).

Regulations – Compliance and Enforcement

Where artificial feeding or baiting is permitted, regulations are often maintained concerning type and amount of feed, location and identification of feed/bait site, and duration of feeding/baiting. However, although wildlife agencies are aware that not all persons will comply fully with regulations, it is nearly impossible to assess the level of compliance within a jurisdiction. Further, enforcement of regulations is sometimes problematical. Examples that illustrate these points include:

- In a letter to Michigan deer hunters, Peter Bull writes, "Unfortunately, many hunters were not as comfortable with the baiting compliance survey which accompanied the

[5] Brendan Delehanty – Lawyer, MacPherson Leslie & Tyerman, Saskatoon, SK

baiting survey. In fact, we have concluded that our attempt to determine the percentage of Michigan's deer hunters who violate the baiting regulations (either intentionally or unintentionally) was unsuccessful. Too many hunters obviously were uncomfortable with our methodology." (Bull, 2002; see http://www.fw.msu.edu/faculty/peyton/october_update.pdf)

- Use of bait may also facilitate illegal activities such as shooting deer at night. Shooting deer at night over bait is perceived by Michigan Department of Natural Resources law enforcement to be a widespread problem and is probably more common than spotlighting deer from vehicles (cited as a personal communication by R. Asher in Michigan Department of Natural Resources, 1999; see – www.michigandnr.com/publications/pdfs/huntingwildlifehabitat/Issue_Reviews/99baiting.pdf). Lighted bait piles occur primarily on private land, making it difficult to catch violators.

- A ban on baiting may be easier for Michigan Department of Natural Resources law enforcement personnel to enforce than a quantity restriction on the amount of bait used (Fig. 13). However, field personnel in DMU 452 reported good compliance with the five-gallon quantity restriction in place during the 1998 hunting season (Michigan Department of Natural Resources, 1999; see – www.michigandnr.com/publications/pdfs/huntingwildlifehabitat/Issue_Reviews/99baiting.pdf).

- Because baiting is a dispersed activity and hounding is still legal for other species, Measure 18 (a regulation introduced in Oregon in 1994 banning the use of hounds and bait for hunting bears) has proven difficult to enforce. Compliance with special bear hunting regulations in the Indigo Wildlife Management Unit was poor and may represent poor compliance with all bear regulations, including the ban on the use of hounds and bait (Boulay et al., 1997).

Figure 13. A Wisconsin conservation officer surveys a bait pile that exceeds the legal quantity restriction.

Wildlife Ownership

In all jurisdictions of Canada and the United States, wildlife is held in public trust and is supposed to be managed for the benefit of all citizens. It is a resource too important to be owned by any one individual. However, artificial feeding and baiting are forms of wildlife privatization as animals are attracted to and held on private lands (Michigan Department of Natural Resources, 1999 – see www.michigandnr.com/publications/pdfs/huntingwildlifehabitat/Issue_Reviews/99feeding.pdf; Williamson, 2000; Maine Department of Inland Fisheries and Wildlife, 2002 – see www.state.me.us/ifw/hunt/deerfeed.htm). As wild animals become dependent on food provided by private individuals or government agencies, the principles of animal husbandry replace those of wildlife management (D. Langford, quoted in Brown, 2001).

Hunter Success

In general, the effect of baiting on hunter success (i.e., the proportion of hunters who harvest an animal) has been considered in two ways. One way has been to compare hunter success between those who use bait and those who don't while hunting for the same species at roughly the same point in time. The other way has been to look at the change in hunter success rate in an area where baiting was once legal but has since been banned. Unfortunately, it has been difficult to draw any general conclusions about hunter success because "hunter success rates" are affected by many other factors in addition to whether or not bait was used, e.g., method of kill, different seasons and localities, residency status of hunter, number of hunters, etc. The following points illustrate some of the different analyses regarding the effect of baiting on hunter success:

- Winterstein (1992) reported that hunters in Michigan were 20 percent more effective in harvesting deer when using bait than those not using bait (3.8 versus 3.1 deer harvested per 100 days of hunting). A more recent survey in Michigan indicated that archers using bait required fewer days to harvest a deer than non-baiters (4.9±4.3 versus 1.8±2.1 deer/100 days) (Frawley, 2002). In contrast, firearm hunters using bait required approximately the same time to harvest a deer than non-baiters (8.3±3.3 versus 7.4±2.5 deer/100 days). Overall, baiting appeared to contribute more towards greater harvest rates among archers than firearm hunters (Frawley, 2002).

- A survey by the Wisconsin Department of Natural Resources in 1993 found that 50% of hunters were successful with bait, while 54% were successful without bait (Wisconsin Bureau of Wildlife Management, 1993).

- A Texas study reported higher success rates, reduced kill distances, more deer observed, and less time required to harvest a deer when hunting over bait (Synatzske, 1981). Further, baiting was determined to be an effective tool for increasing deer harvest in areas where higher harvest rates are required.

- Information from the 1998 white-tailed deer rifle-hunting season in Saskatchewan shows that resident hunters (the majority of who do not use bait) had an average success rate of 92% in the Forest and Forest Fringe Wildlife Management Zones, compared to 76% for non-resident hunters (the majority who hunt over bait) (Schmidt, 2001). However, resident hunters spent an average of 8.6 days hunting per deer harvested compared to 5.1 days per deer harvested by non-resident hunters. Although resident and non-resident hunters killed similar proportions of bucks (81% versus 86%), non-resident hunters killed a greater proportion of older bucks than resident hunters (92% versus 72% of the buck harvest older than yearlings).

- After a prohibition of hunting black bears with bait or dogs came into effect in Colorado in 1993, the annual harvest rate changed little, hunter success rate decreased, and hunter participation increased (Beck, 1997). Since 1993, the annual harvest rate has averaged 563 bears compared to 551 annually from 1985 to 1992 (Colorado Division of Wildlife, 2001; see http://wildlife.state.co.us/huntrecap/HistoricalHarvest/bear_1957to2000.htm). Hunter success decreased from 15% before to 6% after the prohibition, whereas the number of hunters per year increased 86% over the same period.

- After a prohibition of hunting black bears with bait or dogs came into effect in Oregon in 1995, the annual harvest rate decreased, hunter success rate decreased, harvest efficiency (i.e., time required to kill a bear) increased, and hunter participation increased (Boulay, 1997). Since 1995, the annual harvest rate has averaged 804 bears compared to 993 annually from 1989 to 1994 (Oregon Division of Fish and Wildlife, 2001; see http://www.dfw.state.or.us/ODFWhtml/Wildlife/StatBooks/2001Stats/01bear_summary.pdf). Hunter success decreased from 8% before to 4% after the prohibition, whereas the number of hunters per year increased 71% over the same period. Prior to 1995, hunters expended about 194 days per bear killed compared to 395 days since the prohibition.

- Washington also banned the hunting of black bears with bait or dogs in 1997 (Washington Department of Fish and Wildlife, 2002; see http://www.wa.gov/wdfw/wlm/game/management/final_gmp_27nov02.pdf). Hunter success rates during 1999 and 2000 were around 3% compared to success rates of 10% or higher for most years preceding the prohibition. Hunter days per bear killed ranged from 60 to100 days before the prohibition to 100 to 400 or more afterwards. Hunter participation prior to the ban ranged from 11000 to 14000 hunters per year. In 2000, more than 37,000 hunters participated in the black bear hunt.

- In Saskatchewan, hunter success rates for black bear averaged more than 50% from 1994 to 1998 (Arsenault, 2001). License sales ranged from about 3000 to 4200 annually for the same period. In 1998 about 4200 hunters killed an estimated 2300 bears, expending about 7 days of hunting effort per bear killed.

Discord Among Hunters

In recent years, there has been much heated debate in the popular literature among hunters about ethical considerations regarding hunters who bait (Petersen, 1996; McCaffery, 2000; Stewart, 2001 – see http://msucares.com/pubs/infosheets/is1624.pdf). Reasons for opposition to baiting include:

- Some hunters and many non-hunters think that hunting over bait is too easy and “unfair” to animals (Lamport, 1996; Michigan Department of Natural Resources, 1999; see www.michigandnr.com/publications/pdfs/huntingwildlifehabitat/Issue_Reviews/99baiting.pdf). This practice goes against the principles of “fair chase”, a set of hunting conditions that advocate fair hunting requires the taking of prey as acceptably uncertain and difficult for the hunter (Posewitz, 1994; Peyton, 1998a). In many places, fair chase issues have served to draw non-hunters’ attention to the controversies of baiting, penned hunts, shooting preserves, hunting with dogs, etc. Non-hunter perceptions of "unfair" hunting behaviors can also create a poor image of those who participate in or allow the practice and, as a consequence, erode credibility of the agency and its hunting constituents (Peyton, 1998b). In some jurisdictions, animal rights activists have effectively used the public forum and government policy processes to affect changes in hunting regulations, e.g., cancellation of the Ontario spring black bear hunt in 1999.

- There is a perception that baiting increases interference and competition among hunters. For example, in past years, the erection of permanent tree stands over bait sites in the provincial forests of Saskatchewan restricted access to some hunters and sparked a growing conflict between resident hunters and outfitters catering to non-resident hunters (Fig. 14) (Saskatchewan Environment, 1999; see www.serm.gov.sk.ca/fishwild/Outfitting/outfitting.htm).

Figure 14. A permanent tree stand in the provincial forest of Saskatchewan.

- Hunter opinion for baiting as an acceptable hunting technique varies widely among jurisdictions. A 1999 survey of Michigan deer hunters indicated 61% of respondents supported deer baiting for hunting, while 28% disapproved (Frawley, 2000). About 48% of the hunters surveyed used bait for deer hunting. In Mississippi, a survey of deer/turkey license buyers indicated 63% of respondents were opposed to, and 36% supported, a change in hunting regulations that would allow hunting deer over bait in the state (Mississippi Department of Wildlife, Fisheries and Parks, 2001; see http://www.mdwfp.com/wildlifeissues/articles.asp?vol=6&article=54). Of these respondents, 67% agreed that hunting over bait negatively influences non-hunter attitudes towards hunting, and 65% agreed that hunting over bait is not considered fair chase. In Saskatchewan, a recent survey of hunters indicated 59% of those surveyed supported the use of bait for hunting bear, while 26% did not (Saskatchewan

Environment, 2002; see http://www.serm.gov.sk.ca/fishwild/MarketResearchStrat.pdf). The same survey indicated 34% support for baiting of deer, and 57% opposed. 12% of the hunters surveyed indicated they have used bait for deer hunting in the past three years.

Discord Between Jurisdictions

In general, free-ranging wildlife can move back and forth across jurisdictional boundaries without restriction. However, this can pose problems if neighboring jurisdictions have markedly different regulations regarding artificial feeding and baiting. For example, in 1979, Parks Canada introduced "ecological integrity" as a guiding principle for the management of national parks, a principle that was formally recognized as an amendment to the National Parks Act in 1988. Ecological integrity implies "ecosystems have integrity when they have their native components (plants, animals, and other organisms) and processes (such as growth and reproduction) intact" (Parks Canada Agency, 2001a – see http://parkscanada.pch.gc.ca/EI-IE/index_e.htm). Although artificial feeding and baiting are not permitted in national parks, many of the provinces and territories permit artificial feeding, baiting, or both activities in the areas immediately surrounding national parks (Fig. 15). Aside potential for conflict over wildlife management issues between provincial and federal authorities, there is the threat that the ecological effects of artificial feeding and baiting (disease, invasion by exotic plant species, altered community structure, etc.) will impact directly upon the ecological integrity of national parks.

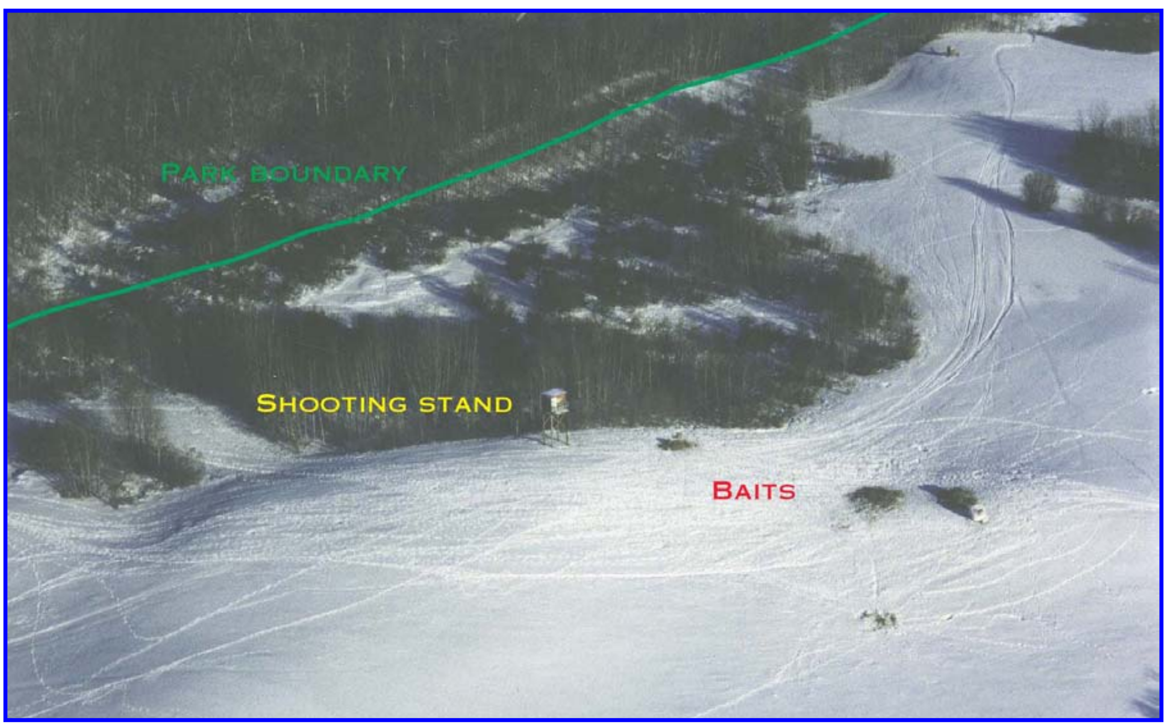

Figure 15. Shooting stand and bait sites in close proximity to boundary of Riding Mountain National Park, Manitoba.

Conclusions Regarding The Human Social Effects of Artificial Feeding and Baiting

The human social effects of providing food to wildlife concern numerous issues including economics, human safety, compliance with and enforcement of feeding or baiting regulations, wildlife ownership, hunter success, discord among hunters, and discord between jurisdictions. Because philosophical differences lie at the root of some of these issues, resolution of conflicting views is more likely to occur through broad education and meaningful discourse than through scientific study. For example, research cannot determine whether the short-term economic gains of feeding wildlife are outweighed by the potential long-term costs of ecological change (e.g., disease, introduction of exotic plant species, etc.), or whether hunting over bait is ethical or not.

Although scientific data on human injury as a result of feeding wildlife is limited, a disturbing finding is the apparent contradiction in policies on feeding and baiting maintained by numerous government agencies in Canada and the United States. Some of the same agencies that warn the public of the dangers of wildlife (especially bears) conditioned to human food sources and regulate against (intentional and unintentional) feeding of wildlife also permit the use of bait for the purpose of hunting. And yet, from a biological perspective, there is likely little difference between a garbage dump, a garden plot, an intercept feeder, round bales, or a bait site.

Information Gaps

Information gaps were considered only in regard to ecological effects (and not human social effects) where scientific research has potential to provide missing information. Although many gaps exist, current information is sufficient to conclude that the potential for negative ecological effects as a result of providing food to wildlife through artificial feeding or baiting is high. Nevertheless, our current understanding of the specific mechanisms operating between cause (feeding or baiting) and effect is often too crude to allow accurate prediction of the nature or magnitude of effect. Thus, for example, although we know providing artificial sources of feed to wild deer in Saskatchewan has potential to increase transmission of chronic wasting disease, we do not know what influence the type, quantity, and distribution of food, or the timing and duration of feeding will have on disease transmission. If this information were available, it could be used along with other biological and physical information to develop prediction models where measurements of a number of key determinants are plugged into an equation to predict the probability of an ecological effect. This approach is similar in principle to resource selection functions (RSF) where empirical data is used to estimate models of the responses of animals to resources (Manly et al., 1993). RSF models have been particularly useful for conservation and land management planning, and can be applied to examine impacts of human activity.

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Annotated Bibliography

Note: *Not all of the citations described in the following section are referenced in the main body of the report. Nevertheless, these citations collectively provide an overview representative of many of the ecological and human social aspects of artificial feeding and baiting.*

1. **Adams, CE, N Wilkins, and JL Cooke. 2000. A place to hunt: organizational changes in recreational hunting, using Texas as a case study. Wildlife Society Bulletin 28: 788-796.**

This article concerns attitudes toward hunting in Texas, attitudes that are representative of a general trend seen in recent years throughout the United States and Canada. Social pressures from urban dwellers and dwindling recruitment of young hunters are creating pressure for change in the methods of wildlife management. As a result, the policies of wildlife management are becoming influenced more by the general public and non-governmental organizations, and less by hunters, than in past.

2. **Asher, J. 2000. War on weeds: winning it for wildlife. Transactions of the 65th North American Wildlife and Natural Resource Conference, Washington DC, USA. 65: 42-54.**

The author draws attention to ongoing and widespread degradation of our environment through invasion by non-native plant species, and the urgent need to employ qualified people to remedy this situation. He uses examples, such as leafy spurge (*Euphorbia esula* L.), to illustrate the economic impact these non-native plants have on people and wildlife. He emphasizes that success in the "war on weeds" will require education of the general public and prevention of invasion of non-native species. I feel that general adherence with his proposal could significantly improve wildlife habitat across the country reducing need for wildlife support programs, such as supplemental feeding.

3. **Baker, DL, and NT Hobbs. 1985. Emergency feeding of mule deer during winter: tests of a supplemental ration. Journal of Wildlife Management 49: 934-941.**

The authors examine the effectiveness of emergency feeding of mule deer (*Odocoileus hemionus*) during winter to prevent mortality. Although emergency feeding helped to reduce mortality, the mortality rate remained significant (20%) even when deer were fed *ad libitum*. The authors conclude that emergency feeding cannot prevent all winter deaths, but can be used to prevent high mortality in extreme weather conditions. This is a very thorough examination of diet requirements of mule deer and wildlife managers could use this information when designing an emergency feeding program.

4. **Bellhouse, TJ. 1991. The influence of weather and feeder design on the behavior and consumption of supplementary feed by white-tailed deer (*Odocoileus virginianus*) in north-central Ontario. MSc Thesis, Laurentian University, Sudbury, Ontario.**

Among numerous methods available for feeding deer, the barrel feeder was found to be the most economical and the least likely to invoke aggressive interactions among white-tailed deer (*Odocoileus virginianus*). In addition, provision of adequate numbers of feeders helped significantly to reduce competition among deer seeking food. Although the frequency of aggressive interactions among deer increased as the winter progressed, independent of feeder type and number, the intensity of aggression decreased. I recommend reading this study before attempting to initiate a supplemental feeding program.

5. **Brittingham, MC, and SA Temple. 1992. Use of winter bird feeders by black-capped chickadees. Journal of Wildlife Management 56: 103-110.**

The authors investigate the use of feeders by black-capped chickadees (*Parus atricapillus*). They describe the use of feeders in relation to the sex, social dominance, and home range of birds, as well as in relation to ambient temperature. The authors advocate supplemental feeding of wild birds as a method of increasing positive human/wildlife interactions without causing negative effects on the bird population.

6. **Brittingham, MC, and SA Temple. 1992. Does winter bird feeding promote dependency? Journal of Field Ornithology 63: 190-194.**

The authors investigate if the use of feeders by black-capped chickadees (*Parus atricapillus*) results in birds becoming dependent on artificial food sources. Dependency was not seen, however. The authors attribute this finding to the fact that chickadees are opportunistic feeders and routinely visit a variety of different food sources, never relying on only a single source. However, the study was conducted in a rural environment, and the findings may not be applicable to birds occupying an urban habitat.

7. **Brown, TL, DJ Decker, SJ Riley, JW Enck, TB Lauber, PD Curtis, and GF Mattfeld. 2000. The future of hunting as a mechanism to control white-tailed deer populations. Wildlife Society Bulletin 28: 797-807.**

The authors investigate the effectiveness of hunting to control the size of white-tailed deer (*Odocoileus virginianus*) populations. They believe the potential for hunting as a mechanism for population control has not been achieved to date. Because public perceptions directly affect how wildlife managers deal with the growing problem of urban and suburban deer, the authors recommend greater effort must be given to educating hunters and non-hunters alike on deer biology and the value of hunting. .

8. **Bruning-Fann, C, SM Schmitt, SD Fitzgerald, JS Fierke, PD Friedrich, JB Kaneene, KA Clarke, KL Butler, JB Payeur, DL Whipple, TM Cooley, JM Miller, and DP Muzo. 2001. Bovine tubercolosis in free-ranging carnivores from Michigan. Journal of Wildlife Diseases 37: 58-64.**

In recent years, an intensive surveillance program for bovine tuberculosis (TB) in Michigan wildlife has identified infection among animals representing a variety of carnivore species. The authors provide evidence to suggest that bovine TB is not endemic in carnivore populations. Instead, it appears that carnivores have become exposed to the causative organism, *Mycobacterium bovis*, as a result of feeding upon infected white-tailed deer (*Odocoileus virginianus*). Further research is required to confirm the validity of this hypothesis.

9. Casey, D, and D Hein. 1983. Effects of heavy browsing on a bird community in deciduous forest. Journal of Wildlife Management 47: 829-836.

The authors investigate the effect of long-term supplemental feeding of white-tailed deer (*Odocoileus virginianus*), elk (*Cervus elaphus*), and mouflon sheep (*Ovis musimon*) upon co-existing bird populations in a deciduous forest community. This study provides strong evidence that supplemental feeding affects biodiversity. High concentrations of ungulates around feeding sites alter the local habitat which, in turn, leads to changes in the species composition of co-existing bird populations.

10. Cooper, SM, and TF Ginnett. 2000. Potential effects of supplemental feeding of deer on nest predation. Wildlife Society Bulletin 28: 660-666.

The authors investigate the effect that supplemental feeding of deer has had upon the nests of ground-nesting turkeys located in close proximity to feeding sites. The results of this study illustrate clearly that supplemental feeding can have far-reaching effects on non-target species.

11. DeCalesta, DS. 1994. Effect of white-tailed deer on songbirds within managed forests in Pennsylvania. Journal of Wildlife Management 58: 711-717.

The author investigates how increases in white-tailed deer (*Odocoileus virginianus*) density, as a result of supplemental feeding, have affected songbird abundance and diversity. His results indicate that intermediate canopy-nesting songbirds begin to decrease in abundance at a threshold deer density of between 7.9 and 14.9 deer/km^2. In addition to the decline in bird numbers, there was a progressive loss of tree species that resulted in habitat fragmentation and reduced biodiversity.

12. Doenier, PB, GD DelGuidice, and MR Riggs. 1997. Effects of winter supplemental feeding on browse consumption by white-tailed deer. Wildlife Society Bulletin 25: 235-243.

The authors investigate the effects of winter supplemental feeding on browse consumption by white-tailed deer (*Odocoileus virginianus*). They find that there are year-to-year differences in browse consumption that are influenced by winter conditions, independent of the availability of supplemental feed. The ability for browse plants to recover from grazing differs from one species to the next. Consequently, long-term annual variation in browse pressure alters the diversity and availability of browse and, more generally, the carrying capacity of the environment. This study provides another example of the potentially far-reaching effects of supplemental feeding programs.

13. Doman, ER, and DI Rasmussen. 1944. Supplemental winter feeding of mule deer in northern Utah. Journal of Wildlife Management 8: 317-338.

Despite the age of this report, many of the issues identified in this study remain relevant today. The authors recommend that priority be given to habitat restoration and maintaining deer within the carrying capacity of the environment over supplemental feeding. Supplemental feeding is identified as costly from both a financial and ecological perspective. This study is a key piece of research cited by many researchers today.

14. Enck, JW, DJ Decker, and TL Brown. 2000. Status of hunter recruitment and retention in the United States. Wildlife Society Bulletin 28: 817-824.

In recent years, the number of hunters is declining progressively in the United States. As the number of hunters has decreased, so to has financial support for wildlife programs. These changes are placing pressure on wildlife managers to expand public understanding of the population controls (i.e., hunting) necessary to maintain viable populations of game animals.

15. Farry, SC, SE Henke, AM Anderson, and MG Fearneyhough. 1998. Responses of captive and free-ranging coyotes to simulated oral rabies vaccine baits. Journal of Wildlife Diseases 34: 13-22.

This study is an extension of Farry et al. (1998 – see **16.**) and provides more evidence to show that vaccine baits provide an efficient method of disease control among wild animals. However, the focus of the authors is solely from a public safety perspective. They do not consider that, from an ecological standpoint, disease may serve as a population control mechanism (Randy Dibblee[6], personal communication). They also give little consideration to the implications of vaccine bait consumption by non-target species.

16. Farry, SC, SE Henke, SL Beasom, and MG Fearneyhough. 1998. Efficacy of bait distributional strategies to deliver canine rabies vaccines to coyotes in southern Texas. Journal of Wildlife Diseases 34: 23-32.

The authors investigate the efficacy of vaccinating free-ranging coyotes (*Canis latrans*) against rabies using bait (dog food) containing canine rabies vaccine. The study illustrates the one of the applications of baiting in wildlife management, and draws attention to the consumption of bait by non-target species.

17. Fersterer, P, DL Nolte, GJ Ziegltrum, and H Gossow. 2001. Effect of feeding stations on the home ranges of American black bears in western Washington. Ursus 12: 51-53.

The authors investigate the effects of intercept feeding on a population of American black bears (*Ursus americanus*). Intercept feeding was found to result in increased population size, greater concentrations of bears in the vicinity of feeding sites, and changes in bear movement patterns over time. The authors discuss the broad implications of their findings for the baiting of bears in general.

18. Grenier, D, C Barrette, and M Crête. 1999. Food access by white-tailed deer (*Odocoileus virginianus*) at winter feeding sites in eastern Quebec. Applied Animal Behavior Science 63: 323-337.

The authors investigate how the number and distribution of feeding sites in supplemental feeding programs can affect access of individual white-tailed deer (*Odocoileus virginianus*) to food. In general, competition at feeding sites prevents less aggressive individuals access to feed. In contrast, the high social dominance of bucks gives them

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[6] Randy Dibblee – Wildlife Biologist, Prince Edward Island Fisheries, Aquaculture and Environment, Charlottetown, PEI

priority at feeding sites. However, through the provision many, well-distributed feeding sites, subordinate deer were able to gain free access to food.

19. Gross, JE, and MW Miller. 2001. Chronic wasting disease in mule deer: disease dynamics and control. Journal of Wildlife Management 65: 205-215.

There is little known about how chronic wasting disease (CWD) is transmitted making prevention of this disease difficult. At present, intense management of wild and captive populations, selective culling of wild herds, and restrictions on the supplemental feeding of wild herds offer the best approaches to preventing the spread of CWD. In addition, the authors advocate the development and application of prediction models to prevent an epidemic since detection of infected populations is difficult.

20. Hartup, BK, HO Mohammed, GV Kollias, and AA Dhondt. 1998. Risk factors associated with mycoplasmal conjunctivitis in house finches. Journal of Wildlife Diseases 34: 281-288.

The authors investigate the spread of mycoplasmal conjuunctivitis in house finches (*Carpodacus mexicanus*) and identify risk factors associated with the disease. Bird feeders are implicated as significantly facilitating transmission of this disease for two reasons. First, house finches and other species congregate in large numbers at feeders increasing the likelihood of transmission from infected to non-infected individuals. Second, the design of tube feeders protects the causative organism, *Mycoplasma gallisepticum*, from the stresses of the environment and increases the likelihood of non-infected birds consuming contaminated feed.

21. Holsman, RH. 2000. Goodwill hunting? Exploring the role of hunters as ecosystem stewards. Wildlife Society Bulletin 28: 808-816.

The author advocates the need for more research into the relationship between hunting and stewardship values. He asserts that the education of hunters should include a stewardship ethic and promotion of stewardship through social norms. The author's views are quite relevant to the topic of this review because ultimately the public perception of hunters will influence the practice of baiting and supplemental feeding programs.

22. Inglis, JE. 1993. An analysis of human-black bear conflicts in Algonquin Provincial Park, Ontario (1973-1990). Proceedings of the 11th Eastern Black Bear Workshop, New Hampshire, USA.

Based on a decade of study of black bears (*Ursus americanus*) in Algonquin Provincial Park, Ontario, the author concludes that education about safe methods of storing food, bear-proof garbage containers, and relocation programs have contributed significantly to reducing bear/human conflicts in the park. Nevertheless, more research is warranted to find effective methods for problem bear control as relocation of problem bears has met with limited success.

23. Koerth, BH, and JC Kroll. 2000. Baiting type and timing for deer counts using cameras triggered by infrared monitors. Wildlife Society Bulletin 28: 630-635.
This study illustrates another of the applications of baiting in wildlife management, and draws attention to the sex and seasonal biases associated with this method of estimating population size and demography.

24. Krausman, PR. 2000. Wildlife management in the twenty-first century: educated predictions. Wildlife Society Bulletin 28: 490-495.
The author identifies the need for further research into the management of wildlife populations in a manner that is consistent with the principals of ecology, not economics. Current methods of wildlife management are becoming increasingly ineffective as more and more wildlife habitat is destroyed through human activities. A deeper understanding of the interrelationships between humans, habitat, and wildlife is required as a basis for the successful management of wildlife.

25. Lamport, C. 1996. Black bear in Ontario status and management. Federation of Ontario Naturalists, Don Mills, Ontario.
This review of black bear (*Ursus americanus*) hunting in Ontario resulted in response to a growing negative view in the province concerning the spring bear hunt, the baiting of bears, and use of dogs to hunt bear. The author has provided a very thorough report that encompasses recommendations from biologists, law makers, economists, and educators.

26. Leighton, FA. 2002. Foreign animal diseases and Canadian wildlife: Reasons for concern and the elements of preparedness. Canadian Veterinary Journal Volume 43: 265-267.
The author makes the case that the threat of foreign animal diseases to the wildlife of Canada will not only affect wildlife but also the economy of the country. The likelihood of wildlife contracting disease, or infecting humans or livestock, has increased as human activities (e.g., agriculture, eco-tourism, and hunting) encroach more and more on wildlife habitat. The author provides measures that officials should take to prevent the occurrence of epidemics. Some of these measures have direct bearing on the decision to provide supplemental feed to wildlife.

27. Lewis, TL. 1990. The effects of supplemental feeding on white-tailed deer in northwestern Wisconsin. PhD Thesis, University of Wisconsin, Madison, Wisconsin.
The author investigates the effect of supplemental feeding upon the migration, survival, and recruitment of white-tailed deer (*Odocoileus virginianus*) in relation to deer feeding programs was the focus of this paper. He concludes: (1) the effect of supplemental feeding on migration is minimal as deer did not travel more than 2.5 km to feed regularly at feeders; (2) the survival of deer is improved through winter feeding; and (3) summer-feeding increases fawn recruitment more than winter feeding. The author also notes that a greatly overlooked benefit of supplemental feeding is the educational value to the public, increasing their awareness and appreciation of wildlife and their management.

28. Lewis, TL, and OJ Rongstad. 1998. Effects of supplemental feeding on white-tailed deer, *Odocoileus virginianus*, migration and survival in northern Wisconsin. The Canadian Field-Naturalist 112: 75-81.

As an extension of the work presented in Lewis (1990 – see **27.**), the authors argue that the increased survival rate resulting from winter feeding is not significant enough to warrant governmental support of supplemental feeding programs. They recommend instead that wildlife managers make adjustments to harvest rates to ensure that deer populations are maintained within the carrying capacity of their habitat.

29. Litvaitis, JA, and DM Kane. 1994. Relationship of hunting technique and hunter selectivity to composition of black bear harvest. Wildlife Society Bulletin 22: 604-606.

The hunting of black bears (*Ursus americanus*) over bait is believed to bias the sex ratio of hunters harvest with more male being killed than females. The authors advocate close monitoring of this trend by wildlife managers and the creation of different hunting opportunities to adjust the harvest composition when required. Although the authors identify problems with current hunting practices, they do not offer any solutions.

30. McBryde, GL. 1995. Economics of supplemental feeding and food plots for white-tailed deer. Wildlife Society Bulletin 23: 497-501.

Using examples, the authors illustrate the great financial expense associated with different supplemental feeding programs. Supplemental feeding is regarded as the most expensive of available methods for increasing the carrying capacity of a habitat.

31. McCollough, MA, CS Todd, and RB Owen, Jr. 1994. Supplemental feeding program for wintering bald eagles in Maine. Wildlife Society Bulletin 22: 147-154.

The authors investigate the effectiveness of a supplemental feeding program to increase survival of bald eagles (*Haliaeetus leucocephalus*). They conclude that supplemental feeding programs may be required under special circumstances only, but should not be used routinely. The authors note that non-target species also routinely visited feeding sites.

32. McLaughlin, CR, and HL Smith. 1991. Baiting black bears: hunting techniques and management issues. Proceedings of the 10th Eastern Workshop on Black Bear Research and Management, University of Arkansas, Arkansas. 10: 110-119.

The authors present the results of a survey indicating which states and provinces permit the hunting of black bears (*Ursus americanus*) over bait. They also provide details about jurisdictional restrictions on how baiting is conducted including types of baiting, the quantity of bait, and how baits are set. Although this report is over 10 years old, it illustrates the great variation among locales in legislation concerning baiting.

33. Miller, MW, ES Williams, CW McCarty, TR Spraker, TJ Kreeger, CT Larsen, and ET Thorne. 2000. Epizootiology of chronic wasting disease in free-ranging cervids in Colorado and Wyoming. Journal of Wildlife Diseases 36: 676-690.
Based on information gathered from surveillance of wild cervid populations in Wyoming and Colorado and mathematical modeling of epidemics, the authors conclude that chronic wasting disease (CWD) has been infecting wild populations for over 30 years. They further discuss the strengths and weaknesses of surveillance approaches to determine disease prevalence. This paper underscores the great difficulty encountered when attempting to determine the history and prevalence of CWD in wild cervids.

34. Muth, RM, and WV Jamison. 2000. On the destiny of deer camps and duck blinds: the rise of the animal rights movement and the future of wildlife conservation. Wildlife Society Bulletin 28: 841-851.
The authors discuss the changing social acceptance of hunting and examine the forces influencing this change in public perception. They state clearly that wildlife managers must address the concerns of the entire public, not just hunters. In this regard, it is important to recognize that the animal rights movement has proven to be a strong force influencing public perception. Further, public perception is also being shaped by large numbers of urban dwellers that live in cities and are quite remote from wildlife and wild places. Because hunting is no longer a family tradition, the onus is on wildlife managers to educate the public and maintain support for their programs. Otherwise, the focus of wildlife management will be reduced to not much more than pest management for urban areas.

35. Obbard, ME. 2002. Do suspended baits enable hunters to better discriminate between male and female black bears? Proceedings of the 16th Eastern Workshop on Black Bear Research And Management, South Carolina. 16: 109.
The ability of hunters to correctly identify the reproductive class of black bears (*Ursus americanus*) when hunting over bait influences the population dynamics of the black bear population. The author proposes that suspended bait should increase the accuracy of hunters and sets out to determine if this is the case. Although the author's assertion holds some promise, the sample number of bears that he investigates is too small to draw any firm conclusions regarding this alternative method of baiting.

36. Organ, JF, and EK Fritzell. 2000. Trends in consumptive recreation and the wildlife profession. Wildlife Society Bulletin 28: 780-787.
Public perception and the role of wildlife management are changing. The focus of wildlife management curricula has shifted from a consumptive perspective to a non-consumptive perspective, in part, as a result of the declining number of hunters in society. Although the authors present statistics based on the United States population, the trends are undoubtedly similar in Canada.

37. Ozoga, JJ. 1972. Aggressive behavior of white-tailed deer at winter cuttings. Journal of Wildlife Management 36: 861-867.
The author investigates the effect of supplemental feeding on the social behaviour and survival rates of white-tailed deer (*Odocoileus virginianus*). He finds that aggressive

behavior around feeding sites does not prevent subordinate animals from obtaining feed. Further, the frequency of aggressive interactions diminishes as social stability develops among the deer. The author recommends supplemental feeding programs use cuttings from trees close to deer yards rather than grain. The use of natural browse in close proximity to deer yards should reduce the energy that is typically expended in traveling to feeding sites that provide grains.

38. Ozoga, JJ, and LJ Verme. 1982. Physical and reproductive characteristics of a supplementally-fed white-tailed deer herd. Journal of Wildlife Management 46: 281-300.

The authors investigate the effects of supplemental feeding on competition, growth, reproduction, mortality, and fawn sex ratios of white-tailed deer (*Odocoileus virginianus*). This detailed study also provides information regarding the effects of supplemental feeding on the sociobiology and habitat of deer. The authors place priority on the health of does as the primary objective of a supplemental feeding program.

39. Partridge, ST, DL Nolte, GJ Ziegltrum, and CT Robbins. 2001. Impacts of supplemental feeding on the nutritional ecology of black bears. Journal of Wildlife Management 65: 191-199.

Although this study lacks the depth presented by Fersterer et al. (2001 – see **17.**), the authors add support to the effectiveness of intercept feeding to prevent damage to agricultural crops by black bears (*Ursus americanus*). Further, they present data to show that supplemental feeding does not appear to increase physiological condition of bears beyond the condition that would be attained on a diet acquired naturally.

40. Perkins, JR. 1991. Supplemental feeding. Texas Parks and Wildlife Department Fisheries and Wildlife Division. 9 pp. (see http://www.tpwd.state.tx.us/wildlife_pubs/supplemental_feeding.pdf).

The author examines the practice of supplemental feeding in Texas, and makes recommendations for different types of feed to be considered in feeding operations. Most importantly, he concludes that, whenever possible, habitat management is a better choice than supplemental feeding.

41. Peyton, RB. 2000. Wildlife management: cropping to manage or managing to crop? Wildlife Society Bulletin 28: 774-779.

The author presents the case that public support for sport hunting is changing and this will ultimately affect wildlife management. In recent years, animal rights groups have had increasing input into wildlife management issues. Further, there is growing demand by hunters that issues concerning fair chase are addressed by wildlife managers to ensure that non-consumptive wildlife users distinguish between those who hunt by "fair chase" and those who hunt by other means (e.g., bait hunting) when providing input into wildlife management issues.

42. Rhyan, J, K Aune, B Hood, R Clarke, J Payeur, J Jarnagin, and L Stackhouse. 1995. Bovine tuberculosis in a free-ranging mule deer (*Odocoileus hemionus*) from Montana. Journal of Wildlife Diseases 31: 432-435.

The authors document the transmission of bovine tuberculosis (TB) from the infected livestock of a game ranch to free-ranging mule deer (*Odocoileus hemionus*). This case study highlights the serious concern of disease transmission between sympatric animal populations, and more specifically illustrates transmission of disease from livestock to wild animals. Many believe that the practices of supplemental feeding and baiting increase the probability of disease transmission in this manner. The authors advocate continuous surveillance and the implementation of disease management plans to eliminate bovine TB from wild and captive populations.

43. Rogers, LL, DW Kuehn, AW Erickson, EM Harger, LJ Verme, and JJ Ozoga. 1974. Characteristics and management of black bears that feed in garbage dumps, campgrounds, or residential areas. Conference Proceedings of the 3rd IBA - Bears--Their Biology and Management Conference, Binghamton/Moscow.

The authors captured 126 black bears (*Ursus americanus*) that included problem bears known to frequent dumps, campsites and residential areas. All bears were weighed and categorized according to sex and breeding condition to determine if the supplemental food obtained by problem bears affected their growth rate and fecundity. Problem bears were biased toward male bears. Relative to bears that were not receiving supplemental food, problem bears were heavier and had better success with reproduction. The authors conclude that supplemental feeding had an obvious effect on bear growth and reproduction.

44. Rosatte, R, D Donovan, M Allan, LA Howes, A Silver, K Bennett, C MacInnes, C Davies, A Wandeler, and B Radford. 2001. Emergency response to raccoon rabies introduction into Ontario. Journal of Wildlife Diseases 37: 265-279.

The authors describe the approach used by the Ontario Ministry of Natural Resources to prevent an epidemic of rabies from occurring in the province. Through a combined approach that included capture, vaccinate, and release, coupled with widespread dispersal of bait laced with vaccine, provincial officials were able to successfully vaccinate a large number of wild animals. This report provides an example of the use of baiting to benefit both wildlife and people.

45. Rupprecht, C, JS Smith, M Fekadu, and JE Childs. 1995. The ascension of wildlife rabies: a cause for public health concern or intervention? Emerging Infectious Diseases 1: 107 – 114.

The authors present an historical global perspective of the effects of rabies infection on the human population. They clearly illustrate the enormous financial expense incurred to prevent wild animal populations from infecting humans and domestic animals. The authors also examine the positive and negative effects of using vaccine baits to prevent rabies.

46. Schmitt, SM, SD Fitzgerald, TM Cooley, CS Bruning-Fann, L Sullivan, D Berry, T Carlson, RB Minnis, JB Payeur, and J Sikarskie. 1997. Bovine tuberculosis in free-ranging white-tailed deer from Michigan. Journal of Wildlife Diseases 33: 749-758.
The authors document an outbreak of bovine tuberculosis in free-ranging white-tailed deer (*Odocoileus virginianus*) in Michigan that could not be directly linked to infected livestock. Supplemental feeding is identified as a key factor contributing to the spread of disease by concentrating deer by into unnaturally high densities that readily facilitate animal-to-animal transmission. This case history should serve as a clear warning to wildlife managers of the potential disease risks associated with supplemental feeding programs.

47. Schmitz, OJ. 1990. Management implications of foraging theory: evaluating deer supplemental feeding. Journal of Wildlife Management 54: 522-532.
The author conducts an experiment in a northern deer yard to compare the foraging behavior of naturally wintering and supplementally fed white-tailed deer (*Odocoileus virginianus*) and to assess when supplemental feeding might be warranted. He examines the effects of browse depletion and accumulating snow on diet selection across three winter sampling periods. In all time periods, both naturally wintering and supplementally fed white-tailed deer maximized their energy intake through browse consumption. The author concludes that the supplemental feeding program employed may have been inefficient, perhaps because feed was delivered in a few large feeders creating a limited resource.

48. Schwantzkopf, KS. 1990. Behaviour, social organization and feeding patterns of white-tailed deer (*Odocoileus virginianus* Rafinesque, 1832) in Saskatchewan as related to climate and supplemental feeding. MSc Thesis, University of Regina, Regina, Saskatchewan.
The author presents a case to support the use of supplemental feeding programs in wildlife management. She acknowledges that although there are inherent problems with many feeding programs, careful consideration and planning can help to avoid problems and increase the overall effectiveness of feeding programs.

49. Smith, BL. 1998. Antler size and winter mortality of elk: effects of environment, birth year, and parasites. Journal of Mammalogy 79: 1028-1044.
The author investigates the effects of numerous factors, including supplemental feeding, on the antler size and winter mortality of elk (*Cervus elaphus*). Supplemental feeding does not appear to influence antler size, nor does it affect birth weight and winter survival of elk. The author concludes that increased winter survival cannot be used to justify the implementation of supplemental feeding programs for elk.

50. Smith, BL. 2001. Winter feeding of elk in western North America. Journal of Wildlife Management 65: 173-190.
Elk (*Cervus elaphus*) at the National Elk Refuge, Wyoming, have been provided supplemental feed for 90 years providing excellent opportunity to investigate the effects of feeding on elk populations, behaviour, and the surrounding environment. The author

uses long-term information collected from this elk population to clearly illustrate many of the positive and negative effects associated with supplemental feeding.

51. Smith, BL, RL Robbins, and SH Anderson. 1997. Early development of supplementally fed, free-ranging elk. Journal of Wildlife Management 61: 26-38.

The authors investigate the contributions of animal density, weather conditions, and supplemental feeding on the reproduction of the elk (*Cervus elaphus*) in the Grand Teton National Park, USA. Annual rates and duration of supplemental feeding had no measurable effect on birth weight of elk calves. However, winter feeding may have improved the milk yield of cows resulting in calf weight gains that exceeded values previously reported for elk calves raised without winter feeding.

52. Smith, BL, and T Roffe. 1994. Diseases among elk of the Yellowstone Ecosystem, USA. *In*: van Hoven, W, H Ebedes, and A Conroy (eds). Wildlife ranching: a celebration of diversity - Proceedings of the 3rd International Wildlife Ranching Symposium. Pretoria: Centre for Wildlife Management, University of Pretoria.

Elk (*Cervus elaphus*) at the National Elk Refuge, Wyoming, have been provided supplemental feed for 90 years providing excellent opportunity to investigate the effects of feeding on elk populations, behaviour, and the surrounding environment. In this paper, the authors document the diseases that have been transmitted among elk and attributed to the unnaturally high density of elk in the area. They point out the potentially serious consequences to the livestock industry that could occur if some of these diseases were transmitted from elk to neighbouring populations of livestock.

53. Spraker, TR, MW Miller, ES Williams, DM Getzy, WJ Adrian, GG Schoonveld, RA Spowart, KI O'Rourke, JM Miller, and PA Merz. 1997. Spongiform encephalopathy in free-ranging mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*) and Rocky Mountain elk (*Cervus elaphus nelsoni*) in north-central Colorado. Journal of Wildlife Diseases 33: 1-6.

The authors discuss the occurrence of chronic wasting disease (CWD) in wild cervids in Colorado illustrating the paucity of knowledge concerning the origin, transmission, and control of this disease. They suggest that supplemental feeding by the public may enhance horizontal transmission of CWD and emphasize the need for further research on the epidemiology of CWD.

54. Spurrier, C, and L Drees. 2000. Hostile takeovers in America: invasive species in wildlands and waterways. Transactions of the 65th North American Wildlife And Natural Resources Conference 65: 315-325.

The authors provide an historical and broad ecological perspective on the invasion of non-native plant species into North America. They underscore the great financial cost incurred when attempting to combat an existing invasion, and emphasize the need to prevent introduction of non-native species rather than attempting to eliminate them following invasion. They stress that current international trade agreements are founded on short-sighted economic policies that do not consider the long-term ecological effects of invasive plant species.

55. Steffen, DJ, DW Oates, MC Sterner, and VL Cooper. 1999. Absence of tuberculosis in free-ranging deer in Nebraska. Journal of Wildlife Diseases 35:105-107.

The authors report on their surveillance of white-tailed deer (*Odocoileus virginianus*) and mule deer (*Odocoileus hemionus*) in Nebraska for the presence of bovine tuberculosis (TB). No evidence of bovine TB was found. This surveillance was carried out in response to the report of bovine TB in white-tailed deer in four counties of Michigan, possibly as a result of supplemental feeding programs initiated by private citizens.

56. Tarr, ME, and PJ Perkins. 2002. Influences of winter supplemental feeding on the energy balance of white-tailed deer fawns in New Hampshire, USA. Canadian Journal of Zoology 80: 6-15.

The authors demonstrate that provision of highly nutritious feed to white-tailed deer (*Odocoileus virginianus*) during winter raises their metabolic rate to a point where energy demands cannot be met by natural browse alone. In effect, the deer become dependent on supplemental feeding. The authors find that the effectiveness of supplemental feeding programs is influenced by a number of factors including herd density, food availability and winter conditions.

57. Thomas, JW, and DH Pletscher. 2000. The convergence of ecology, conservation biology, and wildlife biology: necessary or redundant? Wildlife Society Bulletin 28: 546-549.

The authors examine the history of wildlife management and emphasize the need for a change in perspective. They recommend an ecosystem management approach that encompasses biological disciplines combined with social, legal and economic knowledge. They make strong points supporting the need for a multidisciplinary approach to wildlife management.

58. Wobeser, G, and W Runge. 1975. Rumen overload and rumenitis in white-tailed deer. Journal of Wildlife Management 39: 596-600.

The authors present the results of a survey of 108 dead white-tailed deer (*Odocoileus virginianus*) where 30 animals were found to have died as a result of carbohydrate engorgement (grain overload). This potential for this disease is greatly increased when people provide supplemental feed or bait that is high in carbohydrates to deer.

59. Woolf, A, and JL Roseberry. 1998. Deer management: our profession's symbol of success or failure? Wildlife Society Bulletin 26:515-521.

The authors discuss some of the social issues of wildlife management. Their view is that governmental policies on wildlife management are influenced too much by public opinion, and too little by science. They argue that wildlife management today should emphasize the conservation of ecosystems in relation to all human activities, not just hunting. These views have obvious implications for the implementation of supplemental feeding programs to support an individual species.

60. Wundram, IJ. 1981. Urban ethology: an anthropological approach to wildlife in the city. Human Organization 40: 168-171.

The author explains that urban ethology is a growing field examining the interrelationship between humans and animals living in the city. She emphasizes that many city dwellers are far removed from understanding wildlife in the context of a natural environment. To rectify this lack of understanding, the author identifies the need to develop programs to educate urban dwellers about the interdependency between humans, wildlife, and the environments they co-habit.

APPENDIX A

Manitoba Government
NEWS RELEASE
Manitoba

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August 16, 2002

HUNTING REGULATIONS CHANGED TO ADDRESS BOVINE TUBERCULOSIS AND CHRONIC WASTING DISEASE

Manitoba Conservation has amended hunting regulations for cervids (deer, elk, moose and caribou) to support efforts to prevent the spread of bovine tuberculosis and to keep chronic wasting disease (CWD) out of the province.

The actions will help prevent the possible spread of disease by reducing contact between deer, elk and cattle and by addressing situations that might risk bringing CWD into Manitoba. The regulations apply to baiting, feeding, using attractants and bringing whole, killed animals into the province.

The baiting of cervids for hunting is illegal in all areas of the province, as is hunting near crops left in the field for the purpose of luring cervids. A hunter education and enforcement awareness program is being developed concerning the new baiting regulations.

Beginning this fall, a hunter will be charged for placing cervid bait for the purpose of hunting or for hunting within 800 metres of a cervid bait.

If a natural resource officer believes that farm produce is being used to attract cervids for the purpose of hunting, the officer may:

- issue an order to remove or fence the farm produce; or
- post the area to prohibit hunting, the discharge of a firearm or the possession of a loaded firearm within 800 metres of the farm produce.

Under the new regulations, it is illegal to possess a substance that contains the urine, feces, saliva or scent glands of a cervid. These attractants may transmit diseases, including CWD, to wild cervids. Most of the commercially available attractants used by hunters are produced in areas where wild or farmed cervids have tested positive for CWD. This measure is one of several initiatives to prevent the spread of this disease to Manitoba.

It is also now illegal to bring a cervid that has been killed in another province, territory or country into Manitoba without first removing the head, hide, hooves, mammary glands, entrails, internal organs and spinal column.

The antlers and the connecting bone plate that has been detached from the remainder of the skull can be imported only if all hide and other tissue has been removed and the skull plate disinfected. Capes may be brought into Manitoba but must be immediately chemically processed into a tanned product.

Further restrictions specific to game hunting areas (GHA) 23 and 23A around Riding Mountain make it illegal to use cervid feed or attractants for any purpose. Bovine TB and other diseases are more easily spread where cervids gather, such as at feed sites.

These changes support a recently announced doubling of the elk harvest in GHA 23 and 23A as part of the TB Management Strategy, developed over the last two years.

Other steps to help reduce the occurrence of bovine TB in the area include:

- the placement of barrier fencing at hay storage sites;
- research on elk movement and cattle/elk interactions; and
- increased public education.

Hunters can call 945-6784 in Winnipeg or toll free 1-800-214-6497 for more information.