MOOSE RESPONSES TO WILDLIFE VIEWING AND TRAFFIC STIMULI

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ABSTRACT: We examined behavioral response of moose to wildlife viewers and traffic stimuli at a moose viewing blind located on a roadside salt lick in northern New Hampshire during summer, 1997-1999. Feeding, fleeing, alertness, looking, grooming, and moving were measured relative to a standard viewer and a variety of stimuli associated with viewers and traffic. In general, moose were reasonably tolerant of most stimuli as moose never fled the lick > 15% of the time. Educational material likely influenced viewer behavior. Stimuli that caused a reduction in feeding and increased fleeing were loud viewers, cars stopped, and trucks passing, as well as combinations of stimuli including these factors. Viewing satisfaction and impacts can be addressed by considering these findings at moose viewing sites.

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Wildlife managers should understand and minimize the often poorly understood and measured impacts of nonconsumptive wildlife users on species and habitats (Duffus and Dearden 1993). The behavioral response of moose (*Alces alces*) to viewing has been explored in a few park situations. McMillan (1954) studied moose in Yellowstone National Park that were subjected to heavy tourist pressure and often were photographed at close range. By comparing moose in a heavily used tourist area to moose in a lesser visited area, he found that: (1) the closeness of approach permitted was dependent on the manner of approach; (2) some moose were able to recognize an individual; and (3) their awareness of a person was dependent on visibility, not the individual. Moose eventually reduced their wariness to human approach, with approach distance dependent upon the moose's activity. Cobus (1972b) also found that the reactions of moose to humans indicated a developed tolerance in Sibley Provincial Park, Ontario, Canada.

McMillan (1954) examined the response of moose to sounds and found that moose in Yellowstone reacted to the snapping of twigs or rustling through brush. The metallic click of a field notebook brought a quick response, whereas shouting, a sharp whistle, automobile horns, and other sounds from the highway failed to produce any response. Cobus (1972b) found that voices frequently scared moose that seemed relatively unaffected by the sight and scent of viewers at a lake. He also noted that the noise of traffic passing the lake caused no reaction, but a sudden car horn or slam of a door frequently disturbed moose 457 m (500 yards) away. The effect of road traffic from 1973-1983 was examined in Denali National Park, Alaska, where there was a 50% increase in daily vehicular traffic on the main park road. This elevated volume correlated with a 72% decrease in moose sightings (Signer and Beattie 1986). A study of moose reactions to snowmobile traffic in the Greys River Valley in Wyoming showed that moose bedding within 300 m and feeding within 150 m of passing snowmachines altered their behavior in response to disturbance (Colescott and Gillingham 1998).

Moose often appear unalert because they can be approached closely without eliciting a visible reaction. However, deVos (1958) found that ear position was a good indicator of the level of alertness, and moose extended their ears upward at a 45 degree angle to the head when alert. He also found that flight, flushing distance, and the relative sign of alarm varied among moose. In Yellowstone National Park, Wyoming, Altmann (1958) found that flight distance varied by month and situation. For example, during the fall hunting season moose fled at 183-274 m (200-300 yards), whereas a cow with a new calf could be approached within 27-64 m (30-70 yards) in May and June.

In New Hampshire, moose are viewed commonly along major roadways where salt licks are created by runoff of road salt. Moose are observed primarily from cars, although a substantial number of viewers exit their vehicles at many salt licks. Given the popularity of moose viewing, its direct relationship to tourism in northern New Hampshire (Silverberg 2000), and the concern for viewer safety and minimizing impacts of viewers, the New Hampshire Fish and Game Department constructed a moose viewing blind on Route 26 in Dixville Notch, New Hampshire, approximately 16 miles east of Errol, New Hampshire and 16 miles west of Colebrook, New Hampshire.

The viewing site provided viewers an opportunity to view moose out of their vehicle off the roadway, thereby reducing traffic congestion, road safety concerns, and direct human-moose interactions. The site had the potential to change how people viewed moose and how moose responded to viewing. Specifically, people can park their cars away from the lick, walk a short pathway with educational signs, and view moose from within the blind. The planning phase provided the opportunity to design a research project that would explore behavioral responses of moose to viewer-caused stimuli. Three factors at the Dixville Notch site distinguish it from previous research in parks: (1) visitors were encouraged to leave their cars and walk to a blind; (2) educational information was available; and (3), the viewing location was on a well-traveled highway. This study was designed to categorize moose reaction to stimuli caused by wildlife viewers and vehicular traffic in order to determine whether there were predictable and measurable behavioral responses.

STUDY AREA

A 4-hectare study site that incorporated the viewing area was located just east of Dixville Notch State Park, in the township of Dixville Notch, New Hampshire on Route 26. The area was harvested (clearcut) in 1991 and is characterized by a regenerating northern hardwood/spruce-fir forest community. On the north side of the road was a substantial road run-off salt lick about 175 m long, with a smaller 70 m lick on the south side.

The site included a 6-car parking lot, trail, and viewing blind built in December 1996. The trail was approximately 125 m long with educational signs, and led to the viewing blind that could accommodate up to 20 people. The blind afforded a view across the roadway, and had viewing slits that faced the lick and a moose trail entering the lick from the east.

METHODS

We recorded reactions of moose to viewer and traffic stimuli during June and July, 1997-1999. We recorded time, viewer numbers, and moose behavior on a data grid (Lehner 1979). Most observation periods occurred during the early evening when moose were most likely to visit the lick (Silverberg et al. 2002). Typically, multiple moose behaviors and stimuli were recorded during each observation. Seven specific stimuli were categorized: car passing, truck passing, car stopped, car stopped with human outside of vehicle, viewer walking to or from blind, viewer in the blind talking, and viewer talking loudly.

Moose response was defined as one of 6 behaviors: feeding, looking, alert, moving, fleeing, and grooming. The number of moose in the lick and their sex, if determinable, were recorded during each observation period. A moose was considered feeding if it was actively feeding or licking mud. Looking was defined as when a moose appeared to stare at the stimulus. Alertness was defined as when a moose stopped its previous behavior, stared, and had its ears in a 45 degree position (deVos 1958). A moose was regarded as moving if it took several steps and resumed its previous behavior. Fleeing meant a moose rapidly moved from the lick to cover. Grooming was defined as licking or moving to repel insects.

An observation period was defined as the elapsed time when a moose entered the lick to the time it left, or it was too dark to continue observation. We recorded all moose behavior and stimuli that occurred every other minute. Because moose were not marked, and moose have affinity for specific salt licks, the same moose was probably observed on different days. Multiple observations occurred each observation period. These two facts meant that observations were not independent.

The researcher hereafter referred to as the "perfect viewer", set the standard of behavior to which the behavior of other wildlife viewers was compared. The perfect viewer approached the blind quietly, was quiet in the blind, and usually was in the blind before moose visited the lick. Presumably, moose rarely detected the presence of the perfect viewer or, at the very least, showed no reaction to the perfect viewer. Baseline moose behavior was recorded only when the perfect viewer was present and there were no other human stimuli. The recording sheets and other written comments of the researcher were used to construct a narrative of each period to provide further description of the interactions.

Analysis of single and multiple combinations (2-4) of stimuli were necessary because multiple stimuli often occurred simultaneously (e.g., car stopped and truck passing). Moose response was quantified by totaling the number of observed responses and calculating the percentage of each response that was exhibited for individual and combinations of stimuli. A Chi-square test ($P = 0.05$) of independence (Zar 1996) was used to compare the patterns of behavioral responses to different stimuli to the pattern of responses associated with the perfect viewer. Emphasis was placed on interpreting the change in feeding and fleeing because reduced feeding and increased fleeing are negative responses for both moose and viewers.

RESULTS

A total of 48 observation periods occurred: 9 in 1997, 19 in 1998, and 20 in 1999. Without the moose being marked it is difficult to determine the exact number of moose observed, however, because of antler development, multiple moose in the lick at one time, and the number of days between observations, it is possible to make a realistic estimate of the number of moose observed in each year: 1997, 5 males, 3 females, and 2 calves; 1998, 9 males, 4 females, and 2 calves; 1999, 11 males, 9 females, and 3 calves. Observation periods ranged from 5-93 minutes, averaging 22 minutes. These observation periods occurred only when moose were in the lick and the length of the observation period depended upon the amount of time the moose were present. An average of 6.4 cars passed, 1.6 trucks passed, 3.2 cars stopped, and 0.9 humans were out of their car during an observation period. No observation period consisted of only viewers in the blind and moose in the lick. During the 342 minutes of observation when only the perfect viewer was present, feeding, looking, and alertness were the most common behaviors (> 20%); grooming and fleeing were observed < 5% of the time (Fig. 1).

A difference in behavioral response pattern relative to that of the perfect viewer was found when a truck passed ($\chi^2 = 26.5$, df = 5, $P = 0.000$) or a car stopped ($\chi^2 = 18.8$, df = 5, $P = 0.002$) (Table 1). When trucks passed, moose fled 14.5% of the time, or > 3 times as often as with the perfect viewer, and feeding declined > 25% (Fig. 2). When cars stopped, moose fled 12% of the time, or nearly 3 times more than with the perfect viewer, and feeding behavior declined by > 30% (Table 1, Fig. 2). Moose were most alert (> 29%) when a truck or car passed the lick.

Cars passing had minimal effect on feeding, as did visitors talking in a normal voice, or walking to the viewing blind (Table 1, Fig.1). Conversely, although only 20 minutes of loud viewers were recorded, they caused the largest reduction in feeding (> 46%, Fig. 2). Trucks passing caused moose to flee 14.5% of the time (Fig. 2).

Analysis of combinations of stimuli (2-4; Table 2) indicated that a change in behavior, relative to the standard visitor, occurred only if a truck passed or a car stopped. Chi-square values were within the same ranges, indicating no additive effects. Eight combinations were significant ($\chi^2 >$ 12, $P < 0.05$), including truck passing-car

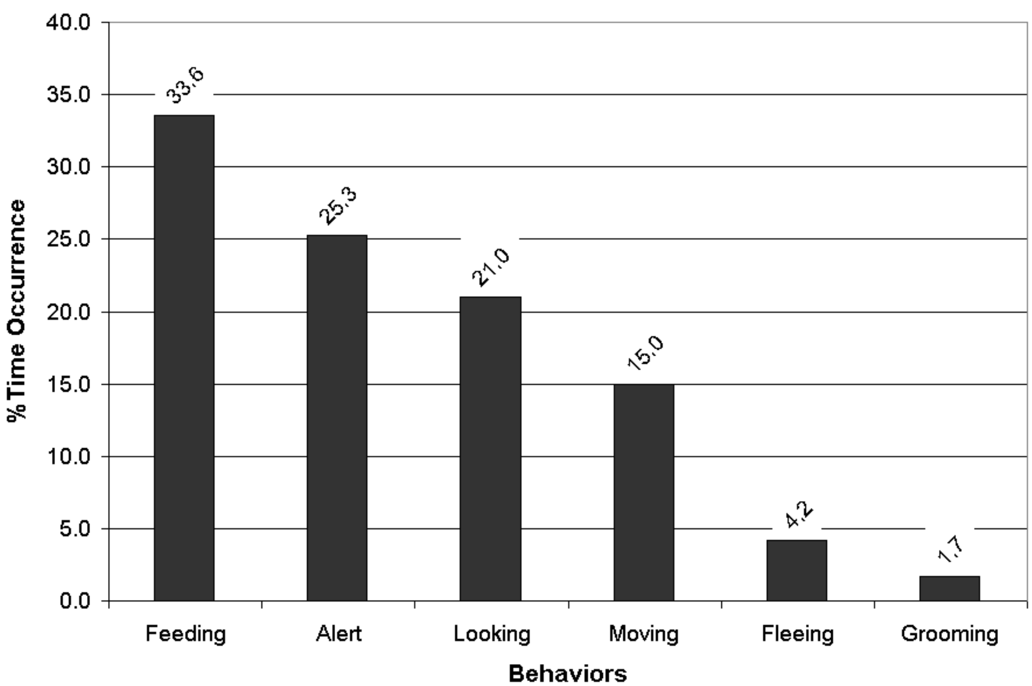

Fig. 1. Behavioral responses of moose when only the researcher was present at the Dixville Notch Wildlife Viewing Area, summer 1997-1999. These data were used to compare all other response patterns to individual and combined stimuli.

Table 1. Chi-square analysis results of single stimuli and behavioral responses of moose, and percent time feeding and fleeing as observed from the viewing blind, Dixville Notch Viewing Area, summer 1997-1999.

Stimulus	Number of Observations	Chi-Square	df	*P*-value	% Time Fled	% Time Feeding
Perfect Viewer	246				4.2	33.6
Car Passing	267	3.84	5	0.572	7.1	31.3
Truck Passing	72	26.5	5	**0.000**	14.5	24.2
Car Stopped	117	18.5	5	**0.002**	12.0	23.3
Viewer Walking	37	5.08	5	0.406	9.0	35.2
Viewer Talking	128	2.81	5	0.779	3.8	31.6
Viewer Loud	20	4.54	5	0.475	7.4	18.5

stopped, viewer walking-truck passing, viewer walking-car stopped, viewer walking-truck passing-car stopped, truck passing-car stopped-human out of car, viewer talking-visitor walking-car stopped, viewer talking-viewer walking-trucks passing-car stopped, viewer walking-car passing-truck passing-car stopped, and viewer walking-truck passing-car stopped-human out of car (Fig. 2). The narratives indicated that if a moose didn't flee when a car stopped, it generally fled when a person approached within 5 m. No moose showed aggression towards people.

DISCUSSION

The primary purpose of a wildlife viewing site is to provide a satisfactory viewing

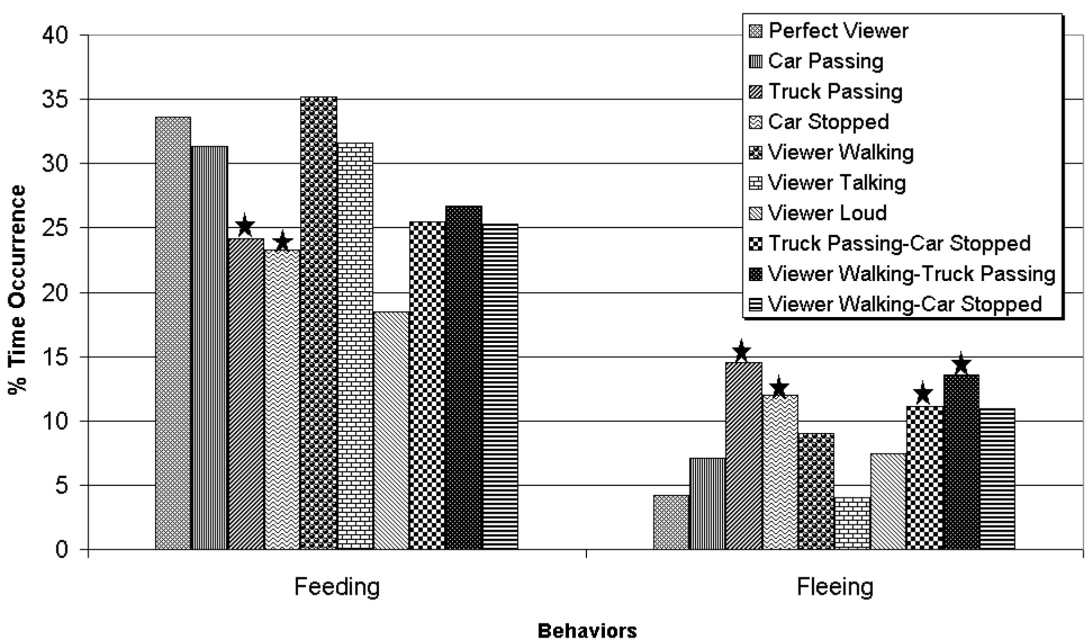

Fig. 2. Moose feeding and fleeing response to various stimuli and combination of stimuli at the Dixville Notch Wildlife Viewing Area, summer 1997-1999. Stars represent stimuli that caused significant change in behavior.

opportunity with minimal impact. Consequently, it was necessary to determine whether the act of viewing may reduce the opportunity to view moose. In general, reactions of moose to humans at the Dixville Notch Wildlife Viewing Area indicated a high tolerance of human stimuli. The presence of quiet, well-behaved viewers had minimal effect on feeding activities and fleeing occurred < 4% of the time. In no situation did moose flee the lick > 15% of the time or feeding occur < 20% of the time, except when visitors were loud, but results were not significant (Fig. 2). Similar tolerance was found in park situations by McMillan (1954), deVos(1958), and Cobus (1972b).

Although the incidence of loud viewers was low, feeding declined to its lowest level and looking increased measurably, although not significantly (Fig. 2). Conversely, moose showed little reaction when viewers walked to or from the site, talked in normal tones, or viewed quietly from the blind. Educational signs placed along the trail may have had a positive impact on most viewing behavior, and/or viewer behavior was affected by the presence of the researchers. The signs provided tips for viewers like visiting the area at dawn and dusk, being patient, keeping a respectful distance, and being quiet. It is highly probable that impacts can be reduced by on-site education of wildlife viewers.

While there was minimal change in moose response to viewers in the blind, responses to trucks passing and cars stopping were measurable and pronounced as moose fled at > 3 times the rate relative to response to the standard visitor. Although observers in some parks found little response to vehicular traffic (McMillan 1954, Cobus 1972a), moose sightings declined in Denali National Park when traffic increased measurably (Signer and Beattie 1986). In addition, changes in feeding behavior were observed in Wyoming with snowmobile traffic (Colescott and Gillingham 1998). It should be emphasized that local summer traffic at Dixville Notch was > 3,000 cars

Table 2. Chi square analysis results of two simultaneous stimuli and behavioral responses of moose, and percent time feeding and fleeing as observed from the viewing blind, Dixville Notch Viewing Area, summer 1997-1999.

Stimuli	Number of Observations	Chi-Square	df	*P*-value	% Time Fled	% Time Feeding
Perfect Viewer					4.2	33.6
Car Stopped-Human-Out-of-Car	47	5.48	5	0.360	6.6	27.2
Car Passing-Truck Passing	304	2.36	5	0.79	7.8	27.2
Car Passing-Car Stopped	357	6.71	5	0.242	7.5	28.6
Truck Passing-Car Stopped	236	15.3	5	**0.002**	11.1	25.2
Viewer Walking-Truck Passing	102	12.12	5	**0.033**	13.6	26.7
Viewer Walking-Car Passing	289	3.96	5	0.055	6.9	29.3
Viewer Walking-Car Stopped	207	18.9	5	**0.002**	10.9	25.3
Viewer Talking-Viewer Walking	149	1.59	5	0.901	4.7	32.1
Viewer Talking-Viewer Loud	56	8.32	5	0.138	8.5	30.8

daily, with a speed limit of 89 km/h (55 mph), unlike parks with slow moving traffic. Logging and semi-tractor trailer trucks were audible at considerable distances as they gained speed entering and leaving the Notch and moose responded to such noise. Each summer one or more moose were killed at the site, and the obvious relationship between vehicle collisions and roadside saltlicks has implications for positive moose viewing.

The incidence of wildlife viewing is greater in parks than at the Dixville Notch study site, and moose subjected continuously to viewing presumably become habituated to stopped cars. Given that the Dixville Notch Wildlife Viewing Area was established in 1997 and the site is on a well-traveled highway, the ratio of stopped cars to cars passing is relatively small. Consequently, local moose were probably not habituated to stopped cars and responded with reduced feeding and increased fleeing. The negative influence of stopped cars on moose behavior and viewing opportunities could be alleviated with road signs prohibiting such activity.

Presumably the increased fleeing response attributed to a combination of stimuli was indicative of the single strongest stimuli, that is a truck passing or car stopped. There appeared to be additive effects with certain combinations, for example, moose fled twice as often when a car stopped and a viewer was walking versus the single stimuli of a viewer walking. When viewers were talking, walking, and a car stopped, moose fled twice as often as when viewers were walking or talking. One exception was the combination of viewer talking, walking, car stopped, and humans-out-of-cars, as moose fled only 5.3% of the time. One particular moose represented the majority of these observations, and relative to other moose, appeared extremely tolerant of all stimuli.

It should be recognized that moose less tolerant of people could use the site predominantly at night. Most human visitation occurred during midday and early evening when moose visitation was relatively low; moose visitation was highest at 2200-2400 h and 0400-0600 h (Silverberg et. al. 2002). On the few occasions when loud viewers were present, the decline in feeding behavior probably had minimal impact because the incidents were short, lasting less than 5 minutes. Substantial impact on feeding behavior could influence use of salt licks on a daily or long term scale. If disturbances were more frequent and of longer duration, moose may alter their visitation time and duration, or conversely, become habituated to the presence of noisy visitors. Individual moose could be monitored to determine their frequency and time of visitation, and whether individual, age, or gender patterns exist. Although certain behavioral changes occurred, the overall effect may not be meaningful in the context of time spent to fulfill nutritional requirements.

Wildlife viewers have a potentially negative influence on moose behavior and their own viewing opportunities. Specifically, this study documented that cars stopped adjacent to the lick and viewers out of their cars increased fleeing behavior and ultimately reduced viewing opportunity and satisfaction. Further, combinations of stimuli often had additive impact. Several points relevant for managing moose viewing sites included: (1) viewing can alter moose behavior; (2) quiet viewers had no measurable impact on moose; (3) education of viewers should reduce potential disturbance of moose; and (4) viewing sites on heavily trafficked roads introduce stimuli not easily controlled. Consideration of these findings should help ensure satisfactory, low-impact viewing opportunities throughout the northeastern United States where moose populations and public interest in viewing moose are expanding.

REFERENCES

ALTMANN, M. 1958. The flight distance in free-ranging big game. Journal of Wildlife Management 22:207-209.

COBUS, M. W. 1972a. Moose as an aesthetic resource and their summer feeding behavior. Proceedings of the North American Moose Conference and Workshop 8:244-275.

_______. 1972b. Moose (Alces alces) and campers in Sibley Provincial Park: a study of wildlife aesthetics. M.S. Thesis, University of Guelph, Guelph, Ontario, Canada.

COLESCOTT, J. H., and M. P. GILLINGHAM. 1998. Reactions of moose (*Alces alces*) to snowomobile traffic in the Greys River Valley, Wyoming. Alces 34:329-338

DE VOS, A. 1958. Summer observations on moose behavior in Ontario. Journal of Mammalogy 9:128-139.

DUFFUS, D. A., and P. DEARDEN. 1993. Recreational use, valuation and management of killer whales (*Orcinus orca*) on Canada's Pacific coast. Environmental Conservation 20:149-156.

LEHNER, P. N. 1979. Handbook of Ethological Methods. Garland STPM Press. New York, New York, USA.

MCMILLAN, J. F. 1954. Some observations on moose in Yellowstone Park. American Midland Naturalist 52:392-399.

SIGNER, F. J., and J. B. BEATTIE. 1986. The controlled traffic system and associated wildlife responses in Denali National Park. Arctic 39:195-203.

SILVERBERG, J. K. 2000. Impacts of wildlife viewing: a case study of Dixville Notch wildlife viewing area. Ph.D. Dissertation, University of New Hampshire, Durham, New Hampshire, USA.

_______, P. J. PEKINS, and R. A. ROBERTSON. 2002. Impacts of wildlife viewing on moose use of a roadside salt lick. Alces 38:205-211.

ZAR, J. H. 1996. Biostatistical Analysis. Third edition. Prentice Hall Incorporated, Englewood Cliffs, New Jersey, USA.