Responses of woodland caribou to winter ecotourism in the Charlevoix Biosphere Reserve, Canada

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Abstract

We assessed the impact of ecotourist visits during winter on woodland caribou Rangifer tarandus caribou time budgets in the Charlevoix Biosphere Reserve, Canada. We compared the behaviour of caribou during and after ecotourist visits with their behaviour during days without visits. In the presence of ecotourists, caribou increased time spent vigilant and standing, mostly at the expense of time spent resting and foraging. After visits, caribou tended to rest more than during control days. Caribou reduced time spent foraging during ecotourist visits as the number of observers increased. The impact of ecotourists appeared to decrease as winter progressed. Visits were short (x̄ = 39.3 min) and caribou never left their winter quarters because of human presence. However, caribou abandoned their wintering area twice in response to wolf presence. Although winter is a difficult period of the year for caribou, our results suggest that with proper precautions caribou in Charlevoix can tolerate ecotourist visits. © 2000 Elsevier Science Ltd. All rights reserved.

Keywords: Activity budget; Ecotourism; Rangifer tarandus caribou; Winter; Woodland caribou

1. Introduction

Sustainable ecotourism can contribute positively to economic development and conservation, its challenge being to satisfy simultaneously the demands of ecotourists and the needs for conservation (Giannecchini, 1993; Burnie, 1994). Non-consumptive uses of wildlife are rapidly developing (Boyle and Samson, 1985; Duffus and Dearden, 1990) and negative impact of ecotourists on numerous species of wildlife have already been reported (Anderson, 1988; Henson and Grant, 1991; Stockwell, Buteman and Berger, 1991; Burger and Gochfeld, 1993; Jacobson and Lopez, 1994; Lott and McCoy, 1995).

Measurements of behaviour have often been used to evaluate the effects of disturbance. Woodland caribou (Dumont, 1993) and Asian rhinos (Rhinoceros unicornis) (Lott and McCoy, 1995) were shown to spend less time feeding and more time alert when visited by ecotourists. The foraging behaviour of bighorn sheep (Ovis canadensis) was also disrupted by tourists (Stockwell et al., 1991). Therefore, changes in resting, foraging and vigilance behaviour could indicate disturbance of wildlife by ecotourists.

Beside changes in behaviour, displacement of animals from their preferred habitats to less profitable environments could have important consequences. During summer, Dumont (1993) found that woodland caribou of the Gaspésie herd (Québec) were displaced from mountain peaks by hikers. Cows and their calves moved from alpine meadows to coniferous subalpine forests where calves were severely preyed upon by coyotes (Canis latrans) and black bears (Ursus americanus) (Dumont, 1993). Tourist use of hiking trails in Switzerland was followed by a decrease in use of nearby areas by male alpine chamois (Rupicapra rupicapra) (Gander and Ingold, 1997).

Winter is a very difficult time of the year for the caribou of the Charlevoix herd because they must dig craters in 110 to 150 cm of snow to reach terrestrial lichens, their main forage during this period (Vandal, 1985). Similarly,
Stardom (1975) found that winter activities of caribou in southeastern Manitoba were limited by snow conditions. Disturbance may force the animals to leave a suitable foraging site to look for another one that could be of lower quality. Increased movements could entail high energetic costs, especially when caribou have to walk in deep snow (Fancy and White, 1986), and eventually affect body condition and survival. Also, snowmobile and ski trails established for ecotourism may favor wolf (Canis lupus) access to caribou (Bergerud, 1988). Wolf predation has often been reported as an important factor limiting caribou population numbers (Bergerud, 1974a; Bergerud and Mercer, 1989; Seip, 1991).

The presence of woodland caribou was a key element in the creation of the Grands-Jardins Provincial Park in 1981 in southeastern Québec, Canada. This park is a conservation core of the Charlevoix Biosphere Reserve of the World Natural Heritage. Re-introduced caribou are a natural and unique legacy in the Charlevoix Biosphere Reserve because of their historical, ecotouristic and scientific value (Jolicoeur et al., 1993). The species is very rare in southern Québec and appears vulnerable because population numbers are low and mortality is high (Banville, 1998).

Winter is the best time to observe woodland caribou in Charlevoix because animals are known to gather in specific areas. Because caribou are visited by ecotourists in winter, we chose to monitor their responses during this critical period. The objectives of this study were to determine the effects of winter ecotourism on the behaviour of different age–sex classes of caribou. We predicted that time spent vigilant, standing and walking would increase in the presence of ecotourists, while time spent resting and foraging would decrease. Furthermore, we assessed whether caribou habituated to ecotourist visits during winter and examined if human presence forced them to abandon natural wintering areas. Finally, we monitored how wolves used snowmobile and ski trails in the area to access caribou range.

2. Methods

2.1. Study area and population

We conducted this study in the Grands-Jardins Provincial Park (47°45′ N, 70°50′ W), a 310 km² area situated 120 km northeast of Québec City in the Charlevoix Biosphere Reserve, Canada. The area is located in the Laurentian Highland which belong to the Canadian Shield. Climate and forest vegetation are typically subarctic (Boiclair et al., 1990). The annual average temperature is −0.5°C and the average number of days without freezing is 40 (Boiclair et al., 1990). Annual snowfall is heavy (> 400 cm), and snowcover remains at least 6 months of the year, being generally > 80 cm from January to April (Vandal, 1985; Boiclair et al., 1990). The area is characterized by open black spruce (Picea mariana) forest with dwarf birch (Betula glandulosa) and Ericaceae spp. in the understory. An extensive lichen community composed mainly of Cladina spp., Cladonia spp. and Cetraria spp. covers the ground.

Caribou were originally common in the region, but they disappeared in the mid-1920s (Jolicoeur et al., 1993). From 1969 to 1972, 82 caribou born in enclosures from parents captured in northern Québec were reintroduced in the region (Jolicoeur et al., 1993). After approximately 10 years during which caribou experienced high mortality due to wolf predation, poaching, and harsh winter conditions, about 40 animals survived to form the nucleus of the new reintroduced population (Jolicoeur et al., 1993). The population has been increasing slowly and is now estimated at 125 animals (Banville, 1998). The Charlevoix herd represents the only successful reintroduction of caribou in the presence of wolves in North America (Bergerud and Mercer, 1989).

2.2. Data collection

We recorded the impact of ecotourists on caribou behaviour from 6 January to 15 March 1995. Animals were classified in age–sex classes according to antler and body size characteristics. We sampled 58 different caribou: 18 adult males, 26 adult females, 4 yearling males, 5 yearling females and 5 calves, observed in groups of 2–34.

We considered 6 different behaviours to establish time budgets: vigilance, foraging, resting, standing, walking, and other (mainly social interactions) (Dumont, 1993; Duchesne, 1996). The behaviour of each animal in the group observed was recorded by scan sampling at 4 min intervals (Altmann, 1974).

All visits to the caribou area were in the form of organized tours led by naturalists. For each visit, two observers found the caribou and recorded the behaviour of animals before the ecotourists arrived. Another observer guided the ecotourist group (5–19 people) to the caribou and ensured that people stayed together. Observers and ecotourists travelled by skis or snow shoes, and all visits took place in the early afternoon. A total of 11 ecotourist visits occurred during the winter (1.1/week on average) and each visit lasted an average of 39.3 min (range 12–60 min). Weather conditions and the number of weekends during the winter limited the number of visits. The visits always started from the same site, and the ecotourists plus one observer joined the two other observers using caribou trails. Many caribou trails were dispersing onto a plateau of lichen woodland. Ecotourists and observers were positioned at least 10–15 m from the caribou. They were instructed to remain together, not to walk towards animals and to avoid talking loudly or making rapid movements. Most visits were terminated when people started to get cold,
but also when caribou moved away. We recorded the caribou behaviour before, during and after ecotourist visits. Due to few observations of caribou before visits, we grouped these data with data collected during days without visits to form our control sample. Observations during days without visits were also conducted in the afternoon, mainly from 1200 to 1500 h. To limit the possibility of bias, we considered only records including \( \geq 3 \) scans during the ecotourist visits, and \( \geq 8 \) scans after the visits and during days without visits.

2.3. Data analysis

All behavioural variables were checked for normality with the Shapiro-Wilk test (Sokal and Rohlf, 1981). They did not conform to a normal distribution despite transformation; thus we ranked the values of each behavioural category, correcting for ties (Conover and Iman, 1981), and used the ranks in principal components analysis (PCA; Conover and Iman, 1981; Ludwig and Reynolds, 1988). PCA is an ordination technique that allows the analysis of non-independent variables, such as the different components of a time budget, by reducing the dimensions of the complete data set to fewer orthogonal axes (Ludwig and Reynolds, 1988; Côte et al., 1997). We applied PCA to a covariance matrix of the proportion of time spent in the six behavioural categories (Ludwig and Reynolds, 1983). We assessed the effects of age–sex classes, month, and ecotourists on the first two axis scores with 3-way ANOVAs. We carried out a posteriori multiple comparisons with Fisher PLSD test (Kirk, 1982). We used \( \alpha = 0.01 \) for multiple comparisons to control error rate per experiment (Toothaker, 1993). We used linear regressions to test for a relationship between the number of ecotourists present after the visits and during days without visit.

All observations reported here were conducted in the same habitat type, i.e. in open spruce forest with extensive ground lichen cover. We could not assess whether the distance between ecotourists and caribou affected their behaviour because all observations in presence of ecotourists were conducted at close range (approximately 20 m). However, control observations were performed from 10 to 400 m. Caribou behaviour was not affected by distance from observers in all age–sex classes (all \( P \) values \( > 0.05 \)) and there were no instances of caribou leaving the area when observers arrived. Therefore, control observations conducted at different distances were pooled. Small and large groups of ecotourists were distributed randomly during the study period; there was no relationship between ecotourist group size and month (one-way ANOVA: \( F_{2,8} = 1.10, \ P = 0.4 \)).

Probability values \( < 0.05 \) were considered statistically significant. All analyses were conducted with JMP 2.0 (SAS Institute Inc., Cary, NC) and the Statview package for Macintosh (Abacus Concepts, Berkeley, CA).

3. Results

The first two PCA axes explained, respectively, 27.7 and 19.2% of the total variation in caribou time budgets. As revealed by the behaviour loadings (i.e. eigenvectors; Table 1), the first PCA axis distinguished resting from all other behaviours, but especially from walking. The second axis tended to separate standing and vigilance from foraging and “other”, which mainly included social interactions (Table 1).

There was a significant difference between age–sex classes on the first axis scores (\( F_{4,183} = 3.24, \ P = 0.01 \)), indicating that yearling females spent less time resting than adult females, yearling males and calves. Also, yearling females tended to spend more time walking and foraging than other age-sex classes (Table 2). We did not detect any difference, however, between age–sex classes on the second axis scores (\( F_{4,183} = 0.78, \ P = 0.5 \)). There was a significant effect of the presence of ecotourists on the first axis scores (\( F_{2,183} = 3.47, \ P = 0.03 \); caribou spent more time vigilant and standing in the presence of ecotourists, mostly at the expense of resting (Table 3). After visits, caribou laid down more than during control periods (days without visit) mostly because they reduced walking and foraging time (Tables 1 and 3). Also, a significant difference between controls and days with ecotourists on the second axis scores (\( F_{2,183} = 3.82, \ P = 0.02 \); Fisher PLSD) revealed that caribou increased time spent vigilant and standing in the presence of ecotourists while reducing time spent foraging.

The response of all age–sex classes to ecotourists appeared similar because we did not detect any interaction between age–sex class and presence of ecotourists on both axis scores (PCA 1: \( F_{8,183} = 0.56, \ P = 0.8 \); PCA 2: \( F_{8,183} = 1.02, \ P = 0.04 \)). In addition, caribou spent less time foraging during ecotourist visits as the number of observers increased (\( F = 9.51, \ P = 0.01, \ R^2 = 0.51 \), Fig. 1a). Time spent in vigilance tended to increase with the number of observers but the relation was not significant (\( F = 1.71, \ P = 0.2, \ R^2 = 0.16 \), Fig. 1b).

Although no effect of month was found on the first axis scores (\( F_{2,183} = 0.97, \ P = 0.4 \)), a significant interaction between presence/absence of ecotourists and month (\( F_{4,183} = 4.81, \ P = 0.001 \)) indicated that the impact of

<table>
<thead>
<tr>
<th>Behaviour</th>
<th>Eigenvector 1</th>
<th>Eigenvector 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vigilance</td>
<td>0.277</td>
<td>–0.338</td>
</tr>
<tr>
<td>Foraging</td>
<td>0.299</td>
<td>0.587</td>
</tr>
<tr>
<td>Resting</td>
<td>–0.672</td>
<td>–0.029</td>
</tr>
<tr>
<td>Standing</td>
<td>0.273</td>
<td>–0.532</td>
</tr>
<tr>
<td>Walking</td>
<td>0.539</td>
<td>0.193</td>
</tr>
<tr>
<td>Other</td>
<td>–0.127</td>
<td>0.470</td>
</tr>
</tbody>
</table>
Ecotourists were reduced as winter progressed (Fig. 2). Caribou increased time spent foraging and in social interactions while decreasing time devoted to vigilance and standing from January to February (PCA 2, effect of month: $F_{2,183}=5.13$, $P=0.007$, Table 4), but especially in the presence of ecotourists (Fig. 3). We did not detect any interaction between the presence of ecotourists and month on the second axis scores ($F_{4,183}=1.72$, $P=0.2$), nor between age–sex classes and month on both axis scores (PCA 1: $F_{5,183}=0.79$, $P=0.6$; PCA 2: $F_{5,183}=1.28$, $P=0.3$).

On no occasion did caribou leave the wintering area because of human presence. However, caribou likely abandoned their wintering range twice in response to wolf presence (30 January and 13 February 1995), moving about 15 km on each occasion. Movements of both caribou and wolves were inferred from tracks in the snow. Following the second interaction with wolves, the caribou returned to the wintering area from where they were originally displaced. On both occasions, wolves did not use snowmobile or ski trails to access caribou and no kill was documented.

### 4. Discussion

Ecotourists disrupted caribou behaviour, principally by interrupting foraging while increasing time spent vigilant. Time devoted to the main activities of caribou during winter, namely foraging and resting/ruminating, were both reduced in the presence of ecotourists. The impact of ecotourists appeared similar for all age-sex classes, although yearling females rested less than other age-sex classes in all situations. Winter foraging activities are costly for caribou because they must dig feeding craters to reach terrestrial lichens covered by up to 150 cm of snow (Vandal, 1985). Caribou spend much more energy to dig feeding craters in a uniform snowcover than when the snowcover is light and heterogeneous (Henshaw, 1968). Henshaw (1968) suggested that when snowcover is >25 cm, the selection of a site where snow conditions are favorable is critical, forcing animals to stay at the same suitable sites for all foraging activities. Many caribou during our study moved to the hilltops in late winter because snow was not as deep at high altitudes as in the valleys (Duchesne, 1996). The impact of winter ecotourism on caribou herds, therefore, should be minimized when snow conditions are severe such as in the Charlevoix region. First, the scale of the activity must not be disrupted for long periods of time in order not to jeopardize the energy budget and eventually the survival of caribou.

Although the number of visits was low, the impact of tourists was reduced as winter progressed, suggesting that animals may somewhat habituate to human presence. Encounters with people other than ecotourists were very rare in the study area. It is, therefore, possible that the repeated exposure to observers during control days ($n=22$) also contributed to the habituation of caribou. Johnson and Todd (1977) have shown that caribou habituated to the presence of a highway and to intense traffic. Isards (Rupicapra rupicapra pyrenaica) also habituated to human presence (Lamerenx et al., 1991). However, ungulates may not habituate readily to

### Table 2

<table>
<thead>
<tr>
<th>Age–sex class</th>
<th>n</th>
<th>Vigilance</th>
<th>Foraging</th>
<th>Resting</th>
<th>Standing</th>
<th>Walking</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult males</td>
<td>37</td>
<td>11.9±2.8</td>
<td>14.5±3.1</td>
<td>22.3±4.9</td>
<td>25.8±3.2</td>
<td>22.4±3.3</td>
<td>5.0±2.2</td>
</tr>
<tr>
<td>Adult females</td>
<td>45</td>
<td>5.7±2.6</td>
<td>14.8±2.9</td>
<td>41.1±4.4</td>
<td>23.0±2.9</td>
<td>13.8±3.0</td>
<td>3.3±2.0</td>
</tr>
<tr>
<td>Yearling males</td>
<td>44</td>
<td>4.4±2.6</td>
<td>16.0±2.8</td>
<td>35.4±4.5</td>
<td>21.3±2.9</td>
<td>13.2±3.0</td>
<td>9.1±2.0</td>
</tr>
<tr>
<td>Yearling females</td>
<td>42</td>
<td>10.1±2.7</td>
<td>21.2±2.9</td>
<td>17.6±4.6</td>
<td>19.9±3.0</td>
<td>23.9±3.1</td>
<td>7.7±2.0</td>
</tr>
<tr>
<td>Calves</td>
<td>44</td>
<td>11.6±2.6</td>
<td>21.6±2.8</td>
<td>36.5±4.5</td>
<td>16.8±2.9</td>
<td>12.8±3.0</td>
<td>0.8±2.0</td>
</tr>
</tbody>
</table>

*a Refers to the number of groups observed during ecotourist visits and control days, containing at least 1 individual of the specified age–sex class.

### Table 3

<table>
<thead>
<tr>
<th>Age–sex class</th>
<th>n</th>
<th>Vigilance</th>
<th>Foraging</th>
<th>Resting</th>
<th>Standing</th>
<th>Walking</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without ecotourist</td>
<td>22</td>
<td>6.9±1.7</td>
<td>22.2±1.8</td>
<td>31.9±3.0</td>
<td>18.2±1.9</td>
<td>19.2±2.0</td>
<td>3.1±1.3</td>
</tr>
<tr>
<td>During visits</td>
<td>11</td>
<td>13.7±2.5</td>
<td>11.9±2.6</td>
<td>24.8±4.4</td>
<td>26.3±2.8</td>
<td>17.1±3.0</td>
<td>6.2±1.9</td>
</tr>
<tr>
<td>After visits</td>
<td>11</td>
<td>7.5±2.2</td>
<td>14.5±2.4</td>
<td>34.5±3.9</td>
<td>22.6±2.5</td>
<td>13.0±2.6</td>
<td>7.9±1.7</td>
</tr>
</tbody>
</table>

*a Refers to the number of groups observed.
human disturbance in certain situations (Bleich et al., 1990; Côté, 1996; Côté et al., 1998).

In summer, Dumont (1993) found that the number of hikers had no impact on the behaviour of caribou from the Gaspéie herd. Caribou time budget appeared more influenced by the spatial and temporal distribution of hikers than by their number. Similarly, Cassirer et al. (1992) found that the frequency of utilisation and the proportion of the winter range used by skiers seemed to have a greater impact on elk than the number of skiers.

In our study, caribou decreased time spent foraging as the number of observers increased (Fig. 2). Therefore, the size of ecotourist groups should be limited during winter activities of observation. Our data suggest that a limit of about 9 ecotourists per group would be reasonable (Fig. 2).

Human presence did not drive the caribou out of their wintering range but the presence of wolves made caribou move long distances on two occasions. Thus, the impact of ecotourists appeared rather benign compared to the effect of wolves, but it was likely additive to that of predators. Because of ecotourist activities in the spring and early summer, Dumont (1993) found that woodland caribou belonging to a different population were forced to move from the alpine tundra to the forest zone, where coyotes probably had an important impact on the survival of calves. Similarly, Bergerud (1974b) found that caribou left preferred habitats in situations of intense and persistent harassment.

Pruitt (1979) concluded that caribou will leave their wintering range when approximately 70% of the snow cover in the area has been disturbed during a current winter. It is thus important to ensure that ecotourists remain in groups and use caribou trails to minimize trampling and other disturbance of snow cover. Ecotourist visits were very short and occurred at a low frequency, probably explaining the low impact of the activity on caribou in Charlevoix. Nevertheless, the number of visits should be controlled to ensure the maintenance of high quality habitats with adequate snow conditions.

We conclude that with proper precautions the population of woodland caribou in Charlevoix can tolerate ecotourist visits. The future of caribou in the Charlevoix Biosphere Reserve depends on the interest of people for caribou as a non-hunted species. Ecotourism appears to be an appropriate way to increase interest for this small population, and to inform citizens about the role of this unique woodland caribou population in the preservation of local biodiversity. Ecotourism associated with

Fig. 1. Effect of the number of ecotourists present during winter visits on time spent (a) foraging and (b) vigilant for woodland caribou in the Charlevoix Biosphere Reserve, Canada. Each data point represents one group, i.e. the average of all age–sex classes present. The proportion of time spent foraging and vigilant were arcsin transformed to meet normality.

Fig. 2. Percentage of time that woodland caribou spent in vigilance (white bars) and foraging (black bars) in the presence of ecotourists in the Charlevoix Biosphere Reserve, Canada. Average±S.D. are presented for each winter month. Sample sizes are shown on the top of each bar and refer to the number of groups observed.
the Charlevoix caribou herd could contribute to prevent poaching and to develop interest into nature conservation in general while also contributing financial incomes. The practice of this activity, however, should not be conducted at the expense of the well-being of the animals. The response of caribou to humans should be closely monitored in the future. If the animals happen to leave their habitat ranges in the presence of humans, ecotourist activities should be stopped immediately and reasons of habitat shift understood before caribou watching could resume. Finally, ecotourism should remain at a small scale and be conducted with care if this activity is to be sustainable in the long run.

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References


Table 4

Woodland caribou time budgets (% ± S.E.) during winter months in the Charlevoix Biosphere Reserve, Canada

<table>
<thead>
<tr>
<th></th>
<th>Vigilance</th>
<th>Foraging</th>
<th>Resting</th>
<th>Standing</th>
<th>Walking</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>14.8 ± 2.5</td>
<td>14.1 ± 2.7</td>
<td>34.3 ± 4.4</td>
<td>23.6 ± 2.8</td>
<td>10.4 ± 2.9</td>
<td>2.9 ± 1.9</td>
</tr>
<tr>
<td>February</td>
<td>5.9 ± 1.8</td>
<td>19.2 ± 2.0</td>
<td>32.0 ± 3.3</td>
<td>17.9 ± 2.1</td>
<td>18.5 ± 2.2</td>
<td>7.0 ± 1.4</td>
</tr>
<tr>
<td>March</td>
<td>7.8 ± 2.0</td>
<td>18.2 ± 2.1</td>
<td>27.9 ± 3.5</td>
<td>23.5 ± 2.2</td>
<td>19.4 ± 2.3</td>
<td>4.5 ± 1.5</td>
</tr>
</tbody>
</table>

* Refers to the number of groups observed.


