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## George's Island, Labrador - A high-density predator-free refuge for a woodland caribou subpopulation?

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**Abstract:** The movement patterns and demographic parameters were measured for caribou (*Rangifer tarandus caribou*) on George's Island (Labrador, Canada) to determine if the population is separate from the Mealy Mountain Caribou Herd. Movements between George's Island caribou and nearby Mealy Mountain caribou were examined through satellite telemetry (April 2005 to April 2006). Demographic information was collected through aerial classification surveys. The predator-free island is currently maintaining a density of 22.5-26.5 caribou/km<sup>2</sup>. Female survival appears high and the recruitment rate in late fall-early spring was 19.0-29.2% calves. Mainland caribou moved very little throughout the year, travelling no more than 53.7 km on average from their initial collaring locations. Also, satellite data indicated no mixing between animals on George's Island and the mainland. The elevated caribou density and high proportion of calves suggest that George's Island could at times be acting as a predator-free recruitment area and that George's Island may be a subpopulation from which animals disperse to the mainland.

**Key words:** high density, island population, predator-free, *Rangifer tarandus caribou*, subpopulation, ungulate population.

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### Introduction

The objective of this study was to better understand George's Island caribou and their relationship to the mainland caribou nearby. At the onset of the study, it was unclear if George's Island caribou were a separate population from the mainland caribou. To better understand their relationship and movements, five caribou on George's Island and a number on the mainland were outfitted with satellite collars (Jeffery, 2005). For the purposes of this paper, a population is composed of a number of smaller groups that are more homogenous within than between. These smaller groups, which may overlap, are considered subpopulations of the greater population.

George's Island, Labrador, Canada, is located at the mouth of Groswater Bay, in the Atlantic Ocean. Twelve km<sup>2</sup> in area and 9 km from shore, George's Island currently supports one of the highest caribou

densities ever recorded. Other reports have found that high density caribou populations range from 7-8.5 caribou/km<sup>2</sup> (Slate Islands, Lake Superior, ON) (pers. comm. A. Bergerud) to 18.1 on St. Matthew Island, AK, (Klein, 1968), 19.1 (St. Paul Island, AK) (calculated from Scheffer, 1951), and 23 (South Georgia Island, UK) (Leader-Williams, 1988). Many populations that increase rapidly have a subsequent decline which is frequently accepted to be density-dependent (Gunn *et al.*, 2003) even though stochastic weather events may be the limiting factor (Gunn, 2003; Gunn *et al.*, 2003; Miller *et al.*, 2005b).

When and how caribou colonized George's Island is uncertain. Fishers using the area between the early 1970s and mid-1980s report no caribou on the island (pers. comm. Gene Mesher and Ben Rowe). However, caribou were reported on the island as part of a raptor

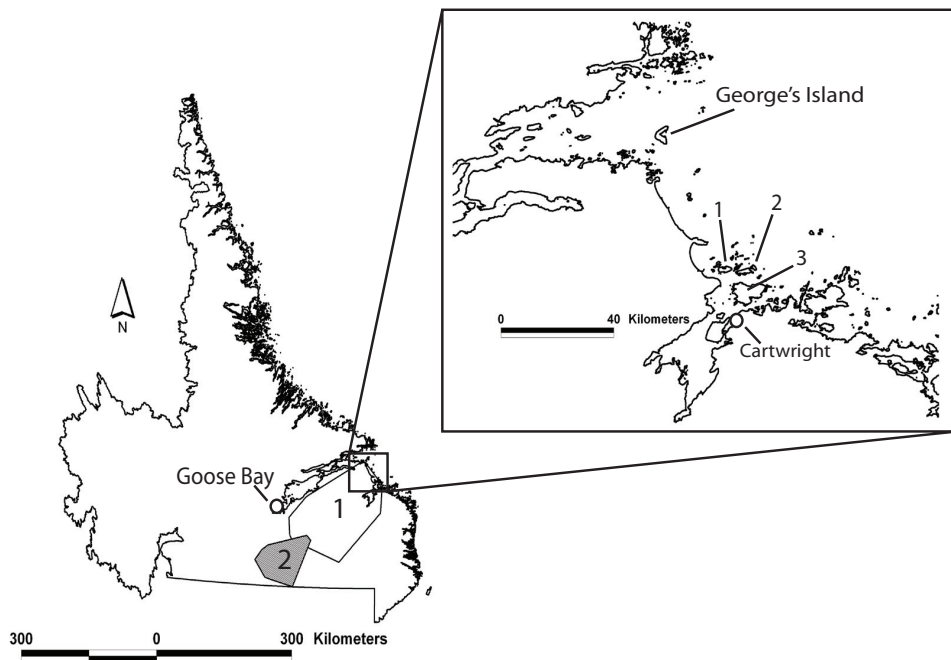


Fig. 1 Map of Labrador, Canada showing ranges of two woodland caribou subpopulations (*Rangifer tarandus caribou*): (1) Mealy Mountain caribou range (32 536 km<sup>2</sup>) and (2) Joir River caribou range (7057 km<sup>2</sup>). Inset shows George's Island and Horsechops (1), Newfoundland (2), and Huntington (3) Islands.

survey in July 1985 (pers. comm. Joe Brazil). Caribou were next documented in 2002 during a waterfowl survey (pers. comm. Greg Robertson), and were again observed by one of the authors in 2003 and 2004. As caribou have been present on George's Island since 1985, periodic movements to the mainland may have occurred without being observed. Caribou in the Canadian Arctic Archipelago migrate between islands, possibly to reduce grazing pressure on individual islands by accessing other ranges (Miller *et al.*, 2005a).

The caribou on George's Island are adjacent to the Mealy Mountain Woodland Caribou Herd. Protected since being listed as 'threatened' in 2002 (COSEWIC, 2002), the Mealy Mountain herd was most recently estimated at  $2106 \pm 1341$  (Jeffery, 2005). Recent documentation (Jeffery 2005; 2006; Otto 2002; Schmelzer *et al.*, 2004) has considered the Mealy Mountain caribou a discrete population. In this paper, subpopulation structure of the Mealy Mountain herd will be investigated using movement over space and time, and by determining demographics including % calves and calves:100 females. During April 2005, collars were deployed on Mealy Mountain caribou as well as those in the adjacent Joir River area (Fig. 1). Although no population estimate has been completed, observations in 2005 by authors of this paper indicate a minimum of 48 caribou in the Joir River area. Their

affiliation of these animals has not yet been determined. It is not clear if they are part of the larger Mealy Mountain herd, or if they are a separate population.

## Material and methods

### Study site

George's Island is 12 km<sup>2</sup> in area and 9 km from shore. The vegetation is sparse and stunted. Balsam fir (*Abies balsamea*), black spruce (*Picea mariana*), Labrador tea (*Ledum latifolium*), crowberry (*Empetrum nigrum*), dwarf birch (*Betula pumila*), alder (*Alnus* sp.) and willow (*Salix* sp.) all occur on the island, especially in more sheltered areas. There are also areas of grass and sedges. There are virtually no lichens. Careful examination of the island found no large predators, but there are several other mammals, including arctic fox (*Alopex lagopus*), red fox (*Vulpes vulpes*), and arctic hare (*Lepus arcticus*). Polar bears (*Ursus maritimus*) have also been sighted in the area (pers. comm. Harry Martin) and on one occasion, an otter (*Lutra lutra*) was caught in a net nearby (pers. comm. Ben Rowe). It is likely that meadow voles (*Microtus pennsylvanicus*) and short-tailed weasels (*Mustela erminea*) also exist on the George's Island as they are present on other small islands in the vicinity (pers. comm. Harry Martin).

### Collaring

Caribou were live-captured by net gun (Coda Enterprises, Mesa, AZ, USA) from an A-Star 350B helicopter and manually restrained by a crew of four people. Each animal was hooded during the capture and fitted with 2 coloured ear tags (Reyflex, Ketchum Manufacturing Inc., Brockville, ON, Canada) and a satellite collar (Telonics A-3300, Telonics Inc., Mesa, AZ, USA). Captures, including chase time, combined with handling efforts ranged from 20 to 40 minutes. Five female caribou were collared on George's Island (Fig. 1) on April 22, 2005. Part of a larger collaring effort, 18 caribou were collared on the mainland between April 19-22, 2005 (13 Mealy Mountain caribou, 5 Joir River caribou) (Jeffery, 2005).

### Classification and counts

Minimum counts and classifications were completed in later winter 2005, fall 2005, and late winter 2006. Individuals were classified by age (adult or calf) and sex (presence or absence of a vulval patch) from helicopter. Recruitment is defined as the percentage of calves in the population.

### Analysis

Satellite collars (Platform Terminal Transmitters or PTTs) were set to a 4-day transmission cycle (Service Argos, Landover, Maryland, USA). Argos rates the accuracy of each location on a scale from 3 to -2 indicating greatest to least accuracy. All locations with a location class less than 1 were discarded due to their inherent imprecision (Rodgers, 2001). The best and most recent location from each reporting cycle was used in the analysis.

The a) current displacement  $\pm$  standard error (distance between the most recent location and capture location), b) maximum displacement  $\pm$  standard error (farthest distance moved from capture location), and c) mean daily movement rate  $\pm$  standard error for the year were calculated in Excel (Microsoft Corporation, 2002) for each caribou to identify differences in movement patterns between George's Island and mainland caribou. Home ranges were generated in Arcview GIS 3.2a (Environmental Systems Research Institute, Inc.) with the 'Animal Movement' extension (Hooge & Eichenlaub, 1998).

### Results

At the time of submission, no collared animals have moved off George's Island since deployment in 2005. Similarly, no collared mainland caribou have crossed onto George's Island although they have travelled to other islands (Fig. 1). Mainland caribou had mean daily movement rate of 1.3 km  $\pm$  0.1 (0.7-2.1) and in the year since capture, the mean maximum displacement was 53.7 km  $\pm$  5.1 (38.1-68.2). As of April 2006, mean current displacement for mainland caribou was 18.5 km  $\pm$  3.9 (0.7-56.6).

Demographic parameters were determined for the mainland Mealy Mountain and George's Island caribou (Tables 1 and 2). Minimum counts indicated that the density on George's Island was at least 22.5 caribou/km<sup>2</sup> and recruitment was healthy with a high percent calves observed in all surveys (19.0-29.2) (Table 1). Based on the March-April 2006 data, George's Island has a considerably higher male:100F ratio than the other two groups. Examination of individual home ranges indicates that there is a limited

Table 1. Population dynamics for woodland caribou (*Rangifer tarandus caribou*) on George's Island, Labrador, Canada.

Date	Minimum count	Density (caribou/km <sup>2</sup> )	% calves	Calves:100F
March 22, 2005	270	22.5	26.7	
December 19, 2005	318	26.5	29.2	55.3
April 18, 2006	274	22.8	19.0	43.7

Note: Per cent calves is the proportion of calves in the minimum count. F = females.

Table 2. Population dynamics for three groups of woodland caribou (*Rangifer tarandus caribou*) in the Mealy Mountain area, Labrador, Canada. March-April, 2006.

Group	Total	% calves	Calves:100F	Males:100F
George's Island	274	19.0	43.7	86.6
Mealy Mountain	625	17.8	34.4	59.1
Joir River	60	23.3	46.7	53.3

Note: Per cent calves is the proportion of calves in the total number of caribou. F = females.

amount of overlap between mainland animals, i.e. Joir River and Mealy Mountain caribou. Additionally, no collared caribou have moved off George's Island. Based on these findings, these groups should be considered subpopulations.

## Discussion

The main objective of this study was to determine if the George's Island caribou are discrete from the mainland Mealy Mountain caribou. To date, no collared caribou have moved onto the island or off the island onto the mainland. There has been movement between the mainland and other islands in the same area vicinity. Horsechops, Newfoundland and Huntington Islands are 2.5, 4.5 and 6.5 km from shore, respectively. Satellite collar data confirms at least 1 excursion to each island and movement between Newfoundland and Huntington Islands. Approximately 70 Mealy Mountain caribou were observed on Huntington Island during April 2006, and extensive caribou sign is frequently observed on all three islands. Additionally, local knowledge confirms that land fast ice usually forms between these islands and the mainland during late winter-early spring (pers. comm. Harry Martin). George's Island, however, is not known to be regularly connected to the mainland by ice because of the greater distance from shore, and the deep water and strong current at the mouth of Lake Melville (pers. comm. Harry Martin and Derek Pottle). Consequently, conditions suitable for movement to and from the mainland may occur infrequently, i.e. a combination of a slack tide, extreme cold weather and near 100% loose ice cover such that an ice bridge may be temporarily solidified. Such conditions did exist in March 1984 when a temporary ice bridge formed that allowed snowmobile travel across Groswater Bay approximately 65 km west of George's Island (pers. comm. Harry Martin and Frank Phillips). Perhaps similar conditions existed between George's Island and the mainland during the same period as the first recorded caribou observations occurred following this event. Of interest, a group of small islands (about 0.3 km<sup>2</sup> total area) exists midway between George's Island and shore but showed no evidence of caribou use when examined in April 2006.

Mainland caribou moved very little; for example, their average daily movement was only 1.3 km/day, and they have stayed within 53.7 km of their initial locations. Current displacement was on average only 18.5 km from where they had been collared. Only a few caribou exhibited larger movements, wintering in coastal areas and moving inland during the calving season. Examination of individual home range placement indicated that Mealy Mountain and Joir River

caribou are subpopulations of the same population. The larger population, however, seems to be composed of a number of subpopulations which, based on satellite collar locations, appear to mix infrequently. What little mixing there is occurs between groups at the margins of the home range and those in the centre. Minimal mixing between groups and areas may be part of the reason there has been no movement recorded to and from George's Island.

Caribou movement between islands has been previously observed. In the Canadian Arctic Archipelago, caribou make seasonal migrations from 30-84 km across sea ice between islands (Miller *et al.*, 2005a). Movements between islands are not limited by the presence of sea-ice as Peary caribou have been shown to swim in the open ocean between the Queen Elizabeth Islands for 1.6-2.5 km (Miller, 1995). This indicates that George's Island caribou may not be limited by a lack of land fast sea ice. The mainland adjacent to George's Island has the highest caribou density within the entire Mealy Mountain range (Jeffery 2005; 2006; Otto 2002). This could indicate that some animals are in fact leaving George's Island. Movements of George's Island caribou are unknown prior to collaring in 2005. Since their arrival to the island, there may have been movements to the mainland as the island's resources may have been depleted without such an exchange (Miller *et al.*, 2005a). Furthermore, satellite data captures the movement of adult female caribou, but not of males and yearlings. Collaring males and yearlings would provide assessment of the degree of dispersal to the mainland. Such additional data would determine if George's Island is acting as a predator-free source for the Mealy Mountain caribou population (Pulliam, 1988).

George's Island has 22.5-26.5 caribou/km<sup>2</sup>, a higher density than other published accounts. Densities in predator-free herds are often high (18.1-23 caribou/km<sup>2</sup>) (Klein, 1968; Leader-Williams, 1988), although exceptions do exist (Heard & Ouellet, 1994; Ouellet *et al.*, 1996; Tyler, 1987). The population demographics on George's Island indicate very good calf recruitment as the calf percentage (29.2) almost reached 'the intrinsic rate-of-increase' in December 2005 (Bergerud, 1980). Other predator-free herds have experienced similar or greater proportions of calves, i.e. South Georgia Island - 25.5 to 60.6 calves:100 females (Leader-Williams, 1980); Coats Island - 93 ± 1.3:100 (Heard & Ouellet, 1994). As predators may be the most important factor contributing to calf mortality (Bergerud, 1980; Layne *et al.* 1995; Whitten *et al.* 1992), their absence may be the primary factor maintaining the high calf proportion on George's Island. Furthermore, adult mortality appears minimal. Surveys of the island, both aerially and by foot, have

returned only one carcass (April 2006) and all females have survived since being collared. High adult survival combined with high recruitment is driving the caribou density on George's Island. Although unlikely, there may be a risk of polar bear predation at times. Polar bears are frequently observed along coastal Labrador and will occasionally travel much farther south than George's Island (Brazil & Goudie, 2006; Stirling and Parkinson, 2006). A nuisance polar bear was moved to the island in 2003, before the caribou population was understood.

Although there have been very few recorded mortalities on George's Island, the April 2006 survey revealed a small number of animals in very poor condition. Several animals stumbled when moving away from the helicopter and appeared weak, listless, and dull, when subjectively compared to mainland animals surveyed at the same time. Bergerud (pers. comm.) found that when nutritionally stressed, caribou on the Slate Islands became weak and emaciated. Although calf proportions have remained high on George's Island, indicating sufficient body condition for females to produce and rear young, the weak caribou observed could be a sign that the population has reached its limit. Although several studies have cited density-dependent food availability as the factor limiting reindeer and caribou herds (Klein, 1968; Leader-Williams, 1980; Skogland, 1985; Ouellet *et al.* 1996), research also indicates that severe winter weather conditions can limit food availability through snow depth, icing or stochastic events such as storms, forcing caribou to compete for resources in the areas that remain open (Adamczewski *et al.*, 1988; Solberg *et al.*, 2001). Recent work challenges Klein's explanation that the St. Matthew Island reindeer crash was density-dependent and suggests instead that eruptive populations are partially or wholly limited by stochastic weather events (Gunn, 2003; Gunn *et al.*, 2003; Miller *et al.*, 2005b). George's Island is extremely exposed to the Atlantic Ocean. Should there be a particularly severe weather event George's Island caribou would certainly be affected.

Mainland Mealy Mountain caribou can be divided into subpopulations, such as the Joir River subpopulation, based on movement and demographics. The subpopulations show varying degrees of overlap. In this context, George's Island would be considered a subpopulation as no mixing has been observed to date. However, the highest density of Mealy Mountain caribou occur directly adjacent to George's Island (Jeffery, 2005; 2006; Otto 2002) supporting the possibility that there may be some movement from George's Island to the mainland. There are still many unanswered questions about the caribou on George's Island. Without historical data, we are unable to

ascertain exactly how long the population has been on the island and what its rate of growth has been. A continued long term study, including satellite tracking of both George's Island and mainland animals, and further demographic surveys, is required to better define the relationship between these groups.

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