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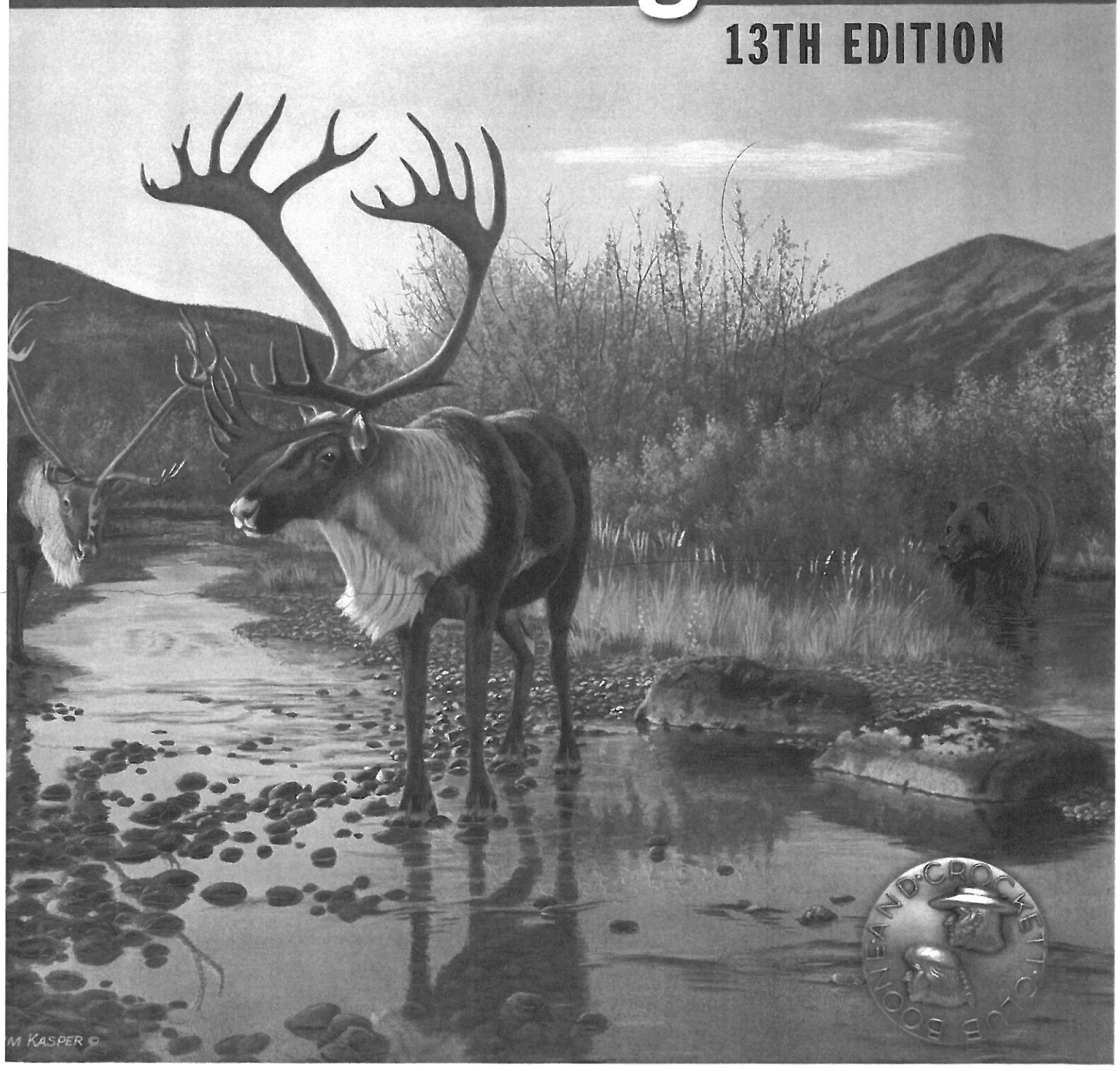


Newfoundland's Woodland Caribou

Science and Management for a Declining Population

Colleen E. Soulliere and Shane Mahoney (B&C Professional Member)

Canada's Newfoundland caribou population is currently the only woodland caribou population in North America that is not protected under endangered species legislation. This makes Newfoundland the only place where non-residents can legally hunt woodland caribou, though these opportunities have diminished over the last decade. In the late 1990s, there were about 100,000 caribou on the island of Newfoundland. This population has declined by about 65 percent in the past 15 years. Despite some positive signals in recent years and evidence that the decline is slowing, the population is predicted to continue to decline slowly for the next several years.

This massive reduction in caribou numbers presents a major challenge to sustainable resource management and is of great concern for the province of Newfoundland and Labrador. The caribou is the only ungulate species native to the island and is iconographic of the vast and relatively untouched Newfoundland wilderness. Caribou have been hunted by humans in this region since about 4,500 B.C. and their importance as a food source for aboriginal and European settlers through the island's history is well documented. In addition to the residential caribou hunt, which is still primarily a food-based activity, the local outfitting industry, worth about $40 million annually, relies heavily on the ability to provide a unique opportunity for clients to hunt woodland caribou trophies. In 2011, the region is faced with a great deal of uncertainty about the future of the caribou population. Wildlife researchers and managers are tasked with determining how best to conserve the population while also ensuring sustained use for hunting and tourism opportunities without unreasonably impeding other resource economies, such as forestry and outdoor recreation.

Opposite: *Rutting group of woodland caribou in the Northern Peninsula area. Photo by Steve Gullage.*

A (Very) Brief History of the Newfoundland Caribou

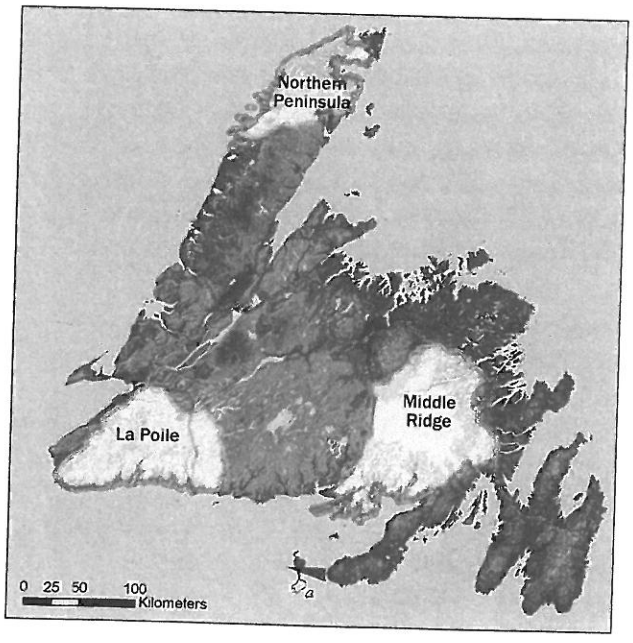
The island of Newfoundland is located off the east coast of mainland Canada in the north Atlantic Ocean. It is a big island, approximately 43,000 square miles of land, with a small human population largely concentrated in coastal areas reflecting a history predominantly characterized by economic reliance on the sea. Despite forestry and mining operations, an extraordinary amount of the island is undisturbed by development. Though caribou coexist with human development and human-altered landscape, the vast bog fen complexes and maritime barrens across the south and central portions of the island support the largest herds.

Newfoundland's earliest fame was woven with the immensely rich fish stocks once found off her shores, but the significance of caribou as a valuable land resource was not overlooked by newcomers and visitors. Since the Viking expeditions to the island, the caribou have lured and captivated travel writers, hunters, and photographers; these records, particularly those of the last century, have provided rich anecdotal information about the historic state of the caribou population. In the 1950s, A.T. Bergerud initiated a program of scientific monitoring and research that, though

modified and added to over time, still continues. This effort has provided Newfoundland with an unparalleled long-term database on the island's caribou, which provides the unique opportunity of not only tracking and describing changes to the caribou population, but also the ability to test hypotheses and scientifically answer questions about why population trends occurred. This research and monitoring program forms a strong knowledge base for management and an important baseline for current and future science.

It is precisely because of this long-term data collection that in the early 2000s, wildlife researchers were able to confirm anecdotal reports from hunters and outfitters that there seemed to be fewer caribou and especially fewer young caribou in the herds than previously. By looking at trends in recruitment (portion of calves in the population) and birth rates, it was evident that signs of declining numbers were an effect of poor calf survival rather than low birth rates. Importantly, adult survival did not change measurably during this time period, so the decreasing population was known to be a result of changes affecting calves specifically.

In the years prior to the drop in population, several ecological and biological changes occurred, many of which offered insight into probable explanations for the caribou situation. Jawbones turned in by hunters indicated a reduction in body size for females and measures of antler points indicated that males had smaller antlers at-age than in previous years. Calf birth weights had likewise decreased. In combination, these indices clearly demonstrated that Newfoundland's caribou were decreasing in body size, raising the possibility of heightened susceptibility to various environmental challenges. Caribou ranges also shifted, and the timing of migrations in some herds notably changed, suggesting responses to quality or availability of range. Years of poor calf survival and low recruitment resulted in an aging population, creating a risk of imminent reductions in birth rates and providing a possible explanation for smaller birth weight of calves.



Above: *Map of Newfoundland indicating study areas.*

During the same time period as these changes were occurring in the caribou population itself, eastern coyotes, which had arrived from mainland Canada in the 1980s by crossing sea ice, had begun to increase in abundance and disperse throughout the island. Wolves have been extirpated since the 1920s, thus Newfoundland caribou had not lived with a canine predator for many decades. Reports of coyotes killing caribou during the winter became more numerous through the late 1990s and early 2000s. If coyotes were a capable predator of adult caribou, it was suspected that they were likely very efficient predators of caribou calves. Public opinion at the time, and even now, strongly suggested that coyotes were responsible for the decline in caribou. Further, there was a strong advocacy from some sectors of the public for eradication of coyotes.

Despite the purported connection between the arrival of coyotes and the collapsing caribou population, there was no scientific evidence to confirm such an association. Recognizing this and the fact that coyotes are notoriously difficult to control even with the most aggressive efforts, the next prudent step was taken: wildlife researchers repeated earlier studies to determine broadly the causes, rates and timing of calf mortality (and changes to these since the 1980s) and specifically to determine the actual role, if any, of coyotes in the caribou population decline. Starting in 2003, VHF radio collars were deployed on about 100 caribou calves each year. These calves were monitored, and when they were found dead, the carcasses and mortality site were investigated to determine the cause of death.

By 2007, a very clear picture of how calves were dying had emerged: predation was the primary source of mortality and had evidently increased in prevalence compared to previous rates confirmed when the caribou population was increasing. Black bears were identified as the most dominant predators, though coyotes were contributing substantially. Lynx and bald eagles were also killing calves but with less impact. What remained unknown was whether changes to the predator populations (new predators and/or increases in predator population size) were responsible for the caribou population decline or whether smaller calf size and possible nutritional stress were making calves more vulnerable to predators than before. None of the major predators of young caribou are dependent on caribou (all are capable of consuming a diverse array of food items); thus, the predator populations could potentially be stable or even increase despite the reduction in caribou availability, potentially having even greater impact on caribou populations as they continue to decline.

It became apparent that from a holistic perspective, significant knowledge gaps existed in understanding the predator-prey system. In addition to questions about predator-caribou dynamics, there was scant information available on the predators themselves. Given the continuing decline in numbers, future caribou management would likely require predator management, so the need to understand predator behavior and abundance was great. Meanwhile, the other trends observed in the caribou population suggested the decline might have been triggered by density-dependent effects; perhaps there had been too many caribou as the population neared its peak. Such density-caused declines are certainly well documented in the scientific literature on wildlife management, and the long absence of the caribou's principal predator, the wolf, might have enabled caribou populations to reach exceptionally high numbers in a delimited island environment. Having established through previous research in Newfoundland that caribou tend to avoid areas of human disturbance and resource extraction activities, there was also the possibility that caribou were relegated to poorer habitat because of human development, with forestry, mining and hydroelectric undertakings all having been shown to induce avoidance and changes in habitat use.

The Newfoundland Caribou Strategy: A Model for Science-based Management

In 2008, recognizing the complex nature of the decline, the government of Newfoundland and Labrador announced an unprecedented five-year, $15.3 million commitment to strategically address knowledge gaps and provide a scientific base for management actions to address the decline and ensure a sustainable caribou population for the future. Safari Club International Foundation formally partnered with the government of Newfoundland and Labrador and also committed significant funds to support the research conducted under this program. Dubbed the Newfoundland Caribou Strategy, the program prescribes the continuation of ongoing caribou research and monitoring, in addition to explicit research of predator ecology and predator-caribou-habitat interactions. The strategy also includes increased efforts at stakeholder engagement, public education, public participation, and socio-economic research. This extensive program of research, its landscape- and community-based focus, and its efforts to incorporate sustainable use parameters and indices position the Caribou Strategy as one of the foremost wildlife studies ever conducted in North America.

The Caribou Strategy was designed to be a powerful tool for caribou management, but was, from its inception, developed as a generalized model for implementing sustainable-use principles to address natural resource conservation challenges. With existing information synthesized and analyzed, knowledge gaps were identified. A team of highly regarded academic researchers with expertise in areas where knowledge gaps existed was assembled to advise on the design, implementation and analysis of research. This science capacity and selected expertise was further enhanced through the engagement of graduate students, now at three American and two Canadian universities, with plans for further outreach to other institutions. Education and outreach programs were developed to engage specific public sectors and a formal committee of stakeholder representatives was formed for information exchange. The ultimate goal of the Caribou Strategy is to provide knowledge-based recommendations for management and policy to best protect caribou as a sustainable and usable resource for the future.

The strategy illustrates a commitment to knowledge-based decision making, emphasizing scientifically defensible bases for adaptive management and a continuous process of data collation and analysis of new findings for inclusion in policy development and management planning. Since wildlife is a publicly owned resource, public perceptions and engagement are crucial: The Caribou Strategy thus deliberately assesses cultural values and social attitudes associated with both caribou and predators while at the same time an enhanced public education program is designed to increase the general public's understanding of the complexity of caribou management. Industrial sectors in Newfoundland frequently interact with caribou directly (e.g., outfitting, tourism) and indirectly (e.g., forestry, mining); and thus, there are development and operational implications of a continued decline in caribou populations. Recognizing this, stakeholder industries are engaged in the Caribou Strategy information exchange efforts. More critically, the issue of caribou population decline is viewed from an ecological perspective but always in the context of existing socio-economic pressures and realities. This ensures there is appropriate attention paid to the sustainability of management and policy decisions around the resource.

Implementing the Caribou Strategy

As of June 2011, the Caribou Strategy is more than half way through its five-year mandate. Given the scope of the project, the effort to date has focused heavily on study design and implementation, the logistics of data collection through field research and the establishment of associated graduate student projects. Much of the research agenda mandated initiation of new projects, such as capture and radio-collaring of black bears, coyotes, and lynx, which required intense preparation and development. The Caribou Strategy is an ambitious program which demonstrates the commitment of the government of Newfoundland and Labrador, not just to the issue of declining numbers of caribou, but to developing a strong scientific basis for management planning.

The bulk of the research activities are conducted in three primary study areas, which roughly represent the range of three distinct herds. The caribou in these herds comprise about half of the remaining island-wide caribou population. Study sites chosen for the research include two regions with rich long-term data (Middle Ridge, La Poile) and one region where caribou data is scant (Northern Peninsula). These study sites total 15,515 square miles of land, each site being about size of the state of Connecticut. The study areas are fairly remote and, except for the Northern Peninsula site, which has a complex network of forest-access roads through some of the area, the sites are generally restricted to helicopter, floatplane, and snowmobile access.

Since the initiation of the Caribou Strategy, 1,340 radio-collared animals have been monitored (505 caribou calves, 434 adult caribou, 72 black bears, 93 coyotes, 16 lynx), resulting in an excess of 3 million locational data points. Cause of death has been determined for about 400 caribou calves through some combination of mortality site investigation, veterinary necropsy, and genetic analysis of saliva collected from bite wounds. Multiple-herd composition surveys have been conducted three times annually, and all major caribou herds on the island have been counted through mark-resight census. Caribou hunters have submitted about 330 tissue samples to support assessments of body condition and health. Over 900 caribou pellet samples have been collected to examine food habits and parasite prevalence.

Good measures of predator density in the study sites are critical to understand predator population dynamics and the relationship between these and caribou population dynamics. To support DNA-based predator density estimates and black bear population monitoring, more than 2,200 hair samples have been collected and approximately 1,200 predator scat samples have been obtained. The collection of hair and scat will persist throughout the program to continuously improve knowledge of predator abundance.

After careful review of predator management programs throughout North America, and consistent with the National Research Council recommendations for predator management, experimental predator intervention was planned for and various approaches considered. The program is designed to increase in intensity annually, first testing non-

Opposite: *A woodland caribou calf fitted with a radio collar. Photo by Colleen Soulliere.*

lethal means of reducing predation pressure on caribou calves and moving toward lethal removal of predators as warranted based on experimental results, updated research findings, and public acceptance of this contained and controlled plan. In its first year, diversionary feeding of black bear was tested, with the second year expanded to include diversionary feeding of coyotes and black bears.

Système Probatoire d'Observation de la Terre (SPOT5) satellite imagery was purchased for the three study areas, a product with resolution, which approximates the accuracy of the radio-collars deployed on adult caribou, black bears, coyotes, and some of the lynx. To classify this imagery and to describe habitat composition and phenology, more than 600 field sites have been assessed.

Fourteen graduate students (master's and doctoral) have been enrolled and are working on thesis research varying from assessing the spatial behavior of predator species to direct observation of caribou behavior to a scientific assessment of Newfoundland residents' attitudes toward caribou, black bears, and coyotes.

How to "Hunt Black Bear" and "How to Hunt and Trap Coyote" workshops were developed and have been delivered to about 2,800 participants. These workshops, developed to increase public interest in predator harvest and thus develop harvest participation as a tool for predator and caribou management, specifically tackle skills and knowledge required to be an effective and efficient hunter or trapper of black bear and coyote. The workshops have been reasonably popular and feedback from attendees is used to continuously improve the participant experience.

General public information on caribou ecology and the local predator populations has been distributed through Web sites, brochures, displays, posters and interpretive programs. Stakeholders have been engaged through the formal establishment of a caribou resource committee that meets two to three times each year and serves as a conduit for information on issues related to the Caribou Strategy and generally related to caribou and predator populations. This committee was established amidst considerable public debate, frequent acrimony, and a disparate array of personalities and perspectives. Despite this diversity, the caribou resource committee has functioned well and proven of great use in fielding ideas and sharing information.

The research program has been run adaptively, with constant reevaluation of methods and protocols to improve efficiency or effectiveness. As an example, estimates of predator density have proven very difficult to obtain despite basing research design on methods that had great success in other jurisdictions. The remote and poorly accessible study areas presented a challenge to collecting samples with sufficient frequency: the cool and wet climate is not conducive to preserving DNA, and the research was further challenged by the need to measure predator density in areas where caribou are expected rather than where predators are expected. As a result of low return for effort, the primary method of sample collection was changed from stations designed to passively collect hair from local predators to the use of specially trained dogs for finding and collecting predator scat. The relatively low genetic diversity common to island populations further necessitated modification to normal laboratory procedures to accurately assess the samples. As a result of the careful monitoring/evaluation of sampling and data as it became available and timely decisions to introduce new methods, the very first estimates of regional black bear and coyote densities on the island of Newfoundland have been produced.

Increasing Knowledge

Although the bulk of effort thus far has been dedicated to achieving a smooth and effective data collection program, evaluation of these data has been ongoing. Research results emanating from the Caribou Strategy and the caribou data synthesis have been presented at eight professional conferences, including the annual Wildlife Society conferences, the 20th International Conference on Bear Research and Management, two North American caribou workshops, the 24th International Congress for Conservation Biology, and several professional meetings in recent years. Over the remainder of the Caribou Strategy, the effort of analyzing and interpreting data will increase substantially.

Large advances have been made with respect

Opposite: *A nursery group of woodland caribou. Photo by Colleen Soulliere.*

to understanding black bear and coyote ecology. Due to a low density of lynx at the initiation of the Caribou Strategy, which resulted in low capture success until recently, lynx ecology remains poorly documented, but the amount of data being collected is now increasing. The first density estimates produced for black bears and coyotes in Newfoundland suggest that coyote density is low in all study sites and that there is geographic variation in bear density. Bears are more abundant in the Middle Ridge study area than in the other sites. Home range sizes for both predators are extremely large compared to those reported for mainland North America which is consistent with low-density populations. Movement patterns observed for black bears suggest that individual bears, rather than all bears, make use of the caribou calf resource. Understanding the nature of this specialization, if confirmed by the results of the diet analysis, will be important for management policy and planning.

The continued synthesis and analysis of the historic caribou data, with the addition of new results from research and monitoring, has allowed the examination of factors which potentially influenced the population decline. As a result, several hypotheses as to the cause of decline have been eliminated. Adult mortality rates, birth rates, and changes in local weather patterns did not cause decline. Investigations into factors likely to limit the ability of the caribou population to increase in number indicate that predation remains a major factor but neither body condition nor disease is currently a problem. Further, examination of data associated with hunter-submitted samples, revealed that changes in body size (jawbone length and antler size) began to occur when the population reached 60,000-70,000 caribou; these body size trends began long before the population reached a peak but may indicate what maximum caribou population the island was capable of sustaining. Diet analyses and habitat investigations will be used to confirm or redefine this proposition.

The expansion of calf mortality research to include a region with little previous information has confirmed that low survival due primarily to predation mortality is an island-wide phenomenon. Despite similarity in process, the importance of specific predators does vary across regions, suggesting that while the arrival of a new predator undoubtedly influenced calf survival, it is unlikely to have actually caused the recent population decline. The extent to which coyote predation is both new and additional is still being investigated. Results from both calf and adult caribou telemetry studies indicate that, despite anecdotal reports to the contrary, winter survival of all caribou is high and the influence of coyotes is marginal through winter; predation is fundamentally directed at caribou calves and primarily during the first few months of life.

The first controlled experimental manipulation of black bears through diversionary feeding suggested that bear behavior can be manipulated (home ranges and movement rates reduced) during the caribou calving season. This effort, however, did not clearly result in improved calf survival. Diversionary feeding that targets both major predators (step two of the progressive experimentation) will provide a more definitive evaluation of the utility of diversionary feeding. This experimentation is enabling a thorough assessment of the specific costs for undertaking such a program in the future.

The first scientific assessment of public attitudes and values associated with caribou, black bear, and coyote was completed by a master's student at Memorial University of Newfoundland. As a result of her work, the government of Newfoundland and Labrador is in a better position to communicate with the public, has an improved understanding of where education efforts are best implemented, and is in a much better position to acknowledge public will in wildlife management.

Knowledge gaps identified at the onset of the program are beginning to close and substantial gains in science and management are expected to result from this program. As is typical of scientific research, new questions are also emerging. Although programs as large and comprehensive as the Caribou Strategy are rare, research to improve and inform wildlife management, and caribou management in particular, will continue in Newfoundland. As it is with the research programs begun in the mid-20th century, the legacy of this program will provide important tools for management recommendations and a context to future caribou population patterns. The Caribou Strategy will also leave a strong base for continued research of Newfound-

land's terrestrial predators, and most importantly, a strong model for wildlife research and sustainable use planning.

Colleen Soulliere is a Wildlife Research Biologist for the Newfoundland & Labrador Department of Environment and Conservation. Her early professional experience was gained on field projects on a variety of species including waterfowl, reptiles and large carnivores. Further, having completed a graduate thesis on anti-predator behaviour of Newfoundland caribou made Colleen a natural fit for the Caribou Strategy and she has been an integral part of research team since its initiation.

Shane Mahoney is a professional member of the Boone and Crockett Club and is the Executive Director of Sustainable Development and Strategic Science in Newfoundland & Labrador's Department of Environment and Conservation. He is one of the most recognized and influential personalities in North American conservation today, and is one of the most eloquent spokesmen for the North American Wildlife Conservation model and for hunting worldwide. Shane's long dedication to the scientific study of caribou on the island of Newfoundland was instrumental in developing the scope of and securing funds for the Caribou Strategy.