

Measures of landscape connectivity for the management and establishment of protected areas in Western Canada: protection of woodland caribou (*Rangifer tarandus caribou*)

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SUMMARY

The nationally threatened boreal woodland caribou still resides in the Prince Albert National Park greater ecosystem (PAGE), but there is concern that management activities inside the park and increased forestry activities outside of the park could compromise the ability of this elusive species to remain a part of the greater ecosystem. Consequently, a coalition of several agencies, including Prince Albert National Park, Saskatchewan Environment, Prince Albert Grand Council, Prince Albert Model Forest, and Weyerhaeuser Canada Ltd., have launched a research project whose purpose is to obtain the data required to develop appropriate land management plans. More precisely, This project aims at producing landscape models (maps) reflecting both summer and winter habitat requirements for woodland caribou. The winter model will be structured around the importance of lichen producing stands and optimal foraging strategies. For the summer model, the high quality habitat attributes will reflect predation avoidance strategies (areas of higher importance corresponding to areas with fewer predators) since significant amount of predation occurs at this time of year. Time series analysis will be conducted to provide users with the ability to project future scenarios, based on changes in available habitat and landscape connectivity, and the implications for woodland caribou. Finally, the project will further an innovative technique that uses DNA extracted from fecal pellets, which can be collected without disturbing the animals, to estimate the size of the population and track population changes through time.

To date, a vegetation map has been finalized for the entire study area and 19 GPS collars have been purchased and deployed successfully on woodland caribou (January 2005) to gather ecological data. Fixed-winged overflights occurred in June 2005 to upload the first five months of telemetry data (see attached map for preliminary results). In February 2006, these caribou will be recaptured and the battery of the collars replaced. Also, 4 wolves will be captured and collared in the area to the north and west of the Park (area used by caribou #479, 480, 481, 482, 483). Wolves' habitat use pattern and movements will be monitored over a 2-year period to better understand how their presence on the landscape influences the distribution of caribou.

On the DNA front, collection of fecal material was successful over the entire PAGE area in January 2005. Laboratory analyses of the fecal material are been done by the Natural Resources DNA Profiling and Forensic Centre at Trent University. Part of the PAGE area will be resurveyed in late January 2006 and additional fecal material collected to derive population estimates.

BACKGROUND AND OBJECTIVES

Although predation by wolves is the major cause of death of woodland caribou (*Rangifer tarandus caribou*) in undisturbed habitat, it is the northwards expansion of industrial development and its associated activities into the boreal forest that pose a serious threat to the persistence of woodland caribou. Logging activity in particular will result in a major change to the composition of the landscape, with a general loss of old-growth pine and spruce forests and a progression to younger aspen and birch forests, reducing the amount of habitat available for woodland caribou. Younger forests could also lead to an increase in moose and white-tailed deer and consequently an increase in wolf densities. Logging activities and the construction of transmission corridors and fire breaks will also potentially fragment remnant habitat and reduce landscape connectivity, causing the isolation of caribou populations.

The conservation of woodland caribou therefore requires land management strategies that not only maintain caribou habitat but also maintain connectivity among habitat patches or mosaic to facilitate movement of caribou throughout the landscape (O'Brien et al. 2005). We have developed landscape metrics and a landscape analysis model capable of identifying winter critical habitat and movement corridors at different spatial scales (Manseau et al. 2002, O'Brien et al. 2005, Fall et al. 2005). The model is based on spatial graph theory. Landscapes are represented as mathematical graphs, consisting of nodes representing habitat patches and lines representing the connecting links between the patches. Connecting links can be as simple as the shortest straight-line distance between patches while more complex links are based on movement costs. Movement costs reflect the connectivity of the landscape, which is the degree to which the intervening landscape between habitat patches facilitates or impedes the movement of the animals (Taylor et al. 1993). Impedance values for each habitat type are derived from habitat selection indices using GPS telemetry data. The accuracy of the model depends on the algorithms' abilities to capture 'real-world' processes. The algorithms are continuously refined and tested using data from field work in an iterative manner.

In the context of the Prince Albert National Park Greater Ecosystem (PAGE) project, we are working towards landscape models reflecting both summer and winter habitat requirements. The winter model is structured around the importance of high quality habitat patches and optimal foraging strategies (Manseau et al. 2002, O'Brien et al. 2005). For the summer model, the patches of importance will be primarily based on predation avoidance strategies (areas of higher importance corresponding to areas with fewer predators) since significant amount of predation occurs at this time of year and summer food sources are more varied and widely distributed. We are developing time series analysis to provide users with the ability to project future scenarios, based on changes in available habitat and landscape connectivity, and the implications for woodland caribou. Finally, we are developing additional modeling tools to better link the results of the analysis to management issues – this will render the modeling more interactive and will allow for easier assessment of different management scenarios. Finally, we have started to assess the potential of using fecal-based DNA 1) to monitor

sizes and/or trends of animal populations, 2) to further examine the measures of landscape connectivity and the impedance values of different natural and anthropogenic landscape disturbances at different spatial scales and 3) to gain a better understanding of population structures and conservation management units.

The purpose of our project is to contribute to the conservation of woodland caribou in and around Prince Albert National Park. The results of the different analysis will contribute to different management initiatives including land-use planning and the conservation of woodland caribou in the PAGE, the PANP fire management plan and the provincial Recovery Strategy.

RESULTS AND OUTCOMES

All project objectives from 2004/2005 have been met or will be met within the fiscal year. A woodland caribou habitat map has been finalized for the area of the PAGE area. Nineteen GPS collars have been purchased and deployed successfully on woodland caribou (January 2005) to gather ecological data. Fixed-winged overflights occurred in June 2005 to upload the first five months of telemetry data (see attached map for preliminary results). In February 2006, these caribou will be recaptured and the battery of the collars replaced. Also, 4 wolves will be captured and collared in the area to the north and west of the Park (area used by caribou #479, 480, 481, 482, 483). Wolves' habitat use pattern and movements will be monitored over a 2-year period to better understand how their presence on the landscape influences the distribution of caribou.

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Preliminary research results have been presented at the Ecological Society conference in August 2005 and peer-reviewed journal articles are being prepared. Copies of these papers and presentations are available upon request.

DISSEMINATION OF RESULTS IN PEER REVIEWED JOURNALS – PAGE AREA AND RELATED WORK

D. O'Brien, M. Manseau, A. Fall and M.J. Fortin. Measuring connectivity of Woodland Caribou Habitat in Southeastern Manitoba. **Biological Conservation** (in press).

M. Manseau, D. O'Brien and N. Koper. Multi-scale analysis of woodland caribou habitat resource selection: the importance of landscape metrics. **Oikos** (in prep.)

A Fall, M.J. Fortin, M. Manseau, O'Brien, D. Assessing Habitat Connectivity using Spatial Graph Theory. **Ecological Modelling** (submitted).

M. Ball, J. Clark, S. Peterson, R. Pither, N. Morrill, S. Kingston, M. Manseau and P. Wilson. Characterization of functional DNA from faeces reduced technical issues associated with the assumptions of low-quality and quantity. **Molecular Ecology** (in prep.)

R. Pither, M. Manseau, J. Clark, M. Ball, P. Wilson and A. Arsenault. The relationship between landscape connectivity and gene flow for woodland caribou. **Molecular ecology** (in prep.).

J. Clark. A Quantitative Assessment of Habitat Connectivity and Genetic Structure for the North Interlake Woodland Caribou Herd in West-Central Manitoba. [**Draft thesis** to be submitted in the fall, Natural Resources Institute, University of Manitoba.

PRESENTATION AT CONFERENCES - 2005

M. Manseau, D. O'Brien and N. Koper. 2005. Optimum landscape spatial composition for woodland caribou: a multi-scale perspective. **Ecological Society of America, Montreal, QC.**

R. Pither, M. Manseau, J. Clark, M. Ball, P. Wilson and A. Arsenault. 2005. Relating the population genetic structure of woodland caribou to landscape connectivity. **Ecological Society of America, Montreal, QC.**

A. Fall. 2005. Spatial graph theory for cross-scale connectivity analysis. **Ecological Society of America, Montreal, QC.**

M. Manseau, R. Pither, J. Clark, M. Ball, P. Wilson, Dale Cross, Kent Whaley, Vicki Trim, T. Trottier and A. Arsenault. 2005. Characterising and monitoring animal populations using non-invasive fecal DNA. **Expert Workshop on woodland caribou, Model Forest, Winnipeg, MB.**

WORKSHOP/MEETING ORGANIZED UNDER THIS PROJECT 2004- 2005

I. Population genetic of woodland caribou – WCSC, Parks Canada. April 2005.

The following presentations were given:

M. Ball. Non-invasive DNA collections

P. Wilson. Genetic Profiling of Caribou.

R. Pither. Non-invasive population estimates for woodland caribou.

J. Clark. Genetic Structure and Diversity of Woodland Caribou in Westcentral Manitoba.

M. Manseau. Park management at the scale of the greater ecosystem: research priorities.

Minutes of the meeting prepared by **M.Manseau**

II. Team meeting, June 2005

The following presentations were given:

E. Beveridge. PAGE Woodland Caribou Research Project.

R. Pither. Summary of winter 2005 field work.

M. Manseau. PAGE research objectives and proposed analysis.

Minutes of the meeting prepared by **M.Manseau**

III. Attendance

Team members attended the National woodland caribou recovery meeting, the SK provincial woodland caribou recovery meeting. Members of the team will also be present at the trappers meeting scheduled for fur blocks # 4, 20, 36, 62, 69 and 73 in October and November 2005.

TRAINING AND SOFTWARE DEVELOPMENT

Spatial Explicit Landscape Events Simulation (SELES) modeling workshops were conducted in June and November 2004. Additional SELES models have been developed to 1) derive landscape attributes for telemetry points and 2) graph movement corridors between habitat patches. Initial attempts to use graph theory in the analysis of the genetic results have been made.

SELES Models developed:

- Spatial Graph Analysis (extractGraphMPG, graphAnalysisMPG)
- Create Input Layers (CreateInputLayers)
- Select random subsets of telemetry points (SelectRandomSubsets)
- Extract landscape attributes from telemetry points (ClassifyPoints)
- Extract landscape attributes from telemetry points (ClassifyPoints)
- Create Random Points (CreateRandomPoints)
- Regional Scale Sampling (RegionalScaleSampling)
- Analysis of Movement Paths
- Point ECS and Randomization Tests for Verification (PointECS)
- Link Buffering (CreateBuffers)

Method papers:

- User's Guide To Spatial Graph Models (Andrew Fall)
- Landscape Metrics Generated in SELES (Andrew Fall)
- Analytical Tools for Assessing Spatial Graphs and Animal Habitat Selection Patterns Using Telemetry Point Location Data (Dan O'Brien)

COMMUNICATION

A website is being developed and will be launched in October 2005.

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FUNDING SOURCES

- Parks Canada Species at Risk Recovery Action and Education Fund
- DNA Profiling & Forensic Centre, Trent University
- Parks Canada Western Canada Service Research Fund
- Manitoba Conservation
- Manitoba Hydro
- Habitat Stewardship Program
- Prince Albert Model Forest
- NSERC
- GEOIDE
- University of Manitoba, University of Toronto
- Saskatchewan Environment
- Weyerhaeuser Ltd.
- Tolko
- Norway House First Nation
- Prince Albert Grand Council

MAP OF PRELIMINARY GPS DATA

A map of some preliminary GPS data from 9 collars is appended below. Please note that the GPS data has not been edited for errors. Any disjunct points are likely errors, such as the only points in the park. Also keep in mind that location data for species at risk is sensitive data! Large dots were used for each of the 3700 GPS fixes to generalize the positions.

