Analysis of the revealed preferences of Backcountry Recreationists for Forest and Park Management Features in the Canadian Shield Region[1]

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August 21 1995

[1] Funding from the Canada-Manitoba Partnership Agreement in Forestry and the Manitoba Model Forest is gratefully acknowledged. We gratefully acknowledge the assistance of Lily Peters with various aspects of data collection, Eric Ellehoj with GIS analysis, and Grant Williamson, Trucia Howard, Kelly Levesley, Jim Crone and John McQueen for assistance with other stages of the project.

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Introduction

Forest recreation in eastern Manitoba and northwestern Ontario is an important use of the landscape. Over 2 million hectares of land have been largely withdrawn from extractive industrial operations and designated as provincial parks or wilderness areas. Three of these parks (Atikaki, Nopiming and Whiteshell) are found in Manitoba, 5 (Quetico, Woodland Caribou, Wabakimi, Brightsands and Turtle River) in Ontario, and 1 (Boundary Waters Canoe Area) in Minnesota (Figure 1). Each of these parks has a different management regime, level of use, and scale of development either in the park or in the surrounding area. Despite this, however, they should be viewed as a "system" of parks in that for some types of uses (e.g. wilderness canoeing) management regulations at one place may affect levels and patterns of use in the others.

Few studies of recreation in the Canadian subset of these parks have been conducted. In contrast, there has been a rich history of research into the economic and social psychological aspects of wilderness recreation in the Boundary Waters Canoe Area. We feel that forest recreation in this system of parks is more important than the deficiency of research effort suggests. We further submit that expansion of the forest industry, agriculture, and urban development is making these wilderness park areas in the system more attractive to backcountry recreationists and that this could lead to overuse. Consequently a major research effort was initiated in 1992 into estimating the economic values associated with backcountry recreation in eastern Manitoba. During this effort it became clear that forest recreation in the area's 3 parks was related to recreation and regulations occurring in the other 6 parks in Ontario and Minnesota. This led to expansion of the research effort in 1994 to attempt to include all of the parks in the system.

The primary research effort involved attempting to understand the influence of forest characteristics, levels of development, and recreation management features on recreation site choice. For this we chose one park in the system, Nopiming Provincial Park, for detailed analysis and modelling of the site choice behaviour of backcountry recreationists. We chose this park because there appeared to be a relatively small number of backcountry areas, and the park also maintained a registration system for backcountry visitors in previous years. This paper describes some of the results of this investigation.

THEORETICAL BACKGROUND

Economic theory uses behaviour as an underpinning to value goods and services. Economic models operate on the assumption that individuals make best use of opportunities and resources available and that they respond rationally and predictably to changes in the conditions they face. These changes can involve prices, wages, financial endowments, and modifications of the natural environment. This behavioural basis for economics sets it apart from other social science disciplines such as sociology or psychology which rely largely on attitudes, in turn provided by what people say, not what they do. This basis for economic analysis is powerful in that behaviour can be observed; values are thus inferred by observing what people do in the context of what is available or attainable (or what they could have done).

Samuelson (1938) was the first to suggest that by merely observing individuals choosing among various bundles of goods that a theory of behaviour can be devised in which consumers maximize utility based on some principles of rationality. The concept involves consumers "revealing" their preferences for goods and services. This idea led researchers to develop a set of approaches to examine nonmarket goods (goods which do not have observed prices associated with them) where observed choices of these goods involve the indirect expenditure of valuable assets such as time and money. Thus the valuation of the nonmarket good or service has associated with it some market purchase. This linkage is called the assumption of weak complementarity for it allows the isolation of the demand for the nonmarket good through complementary market purchases. Methods which utilize this complementary linkage are called revealed preference methods and they are typically used to examine recreational values. The most popular of these is the travel cost model (TCM) where the nonmarket good (recreation value) is assumed to be complementary to expenditures on travel (travel costs). The TCM uses visits to a set of recreation sites as choices and travel costs (both time and expenses) as the complementary market purchases.

While these methods can be used to estimate the value of some nonmarket activity like backcountry recreation, they have also been adapted to estimating the value of changes in the conditions surrounding the "consumption" of the nonmarket good or service. From the resource management perspective this approach can be used to value changes in the quality of the environmental or resource conditions associated with management decisions. Three types of TCMs have been proposed to examine the value of quality changes associated with recreation use. These are the varying parameter model (Smith and Desvouges 1986), the hedonic TCM (Brown and Mendelsohn 1984), and the discrete choice TCM or random utility model (RUM) (Fletcher et al. 1990). While each has particular strengths and weaknesses, the RUM approach is particularly appealing because it is consistent with notions of utility as a function of environmental attributes and socioeconomic characteristics, the ability to substitute between a defined set of recreation sites, the ability to model complex behavioural processes, and the determination of measures of economic welfare directly from the estimated model.

In this study we use this random utility model (RUM) to examine the relative importance of forest and park management features on recreation choice behaviour and a Poisson count data model to examine the frequency of trips to recreation sites. These two models are linked in a mixed process following Yen and Adamowicz (1993) and Englin et al. (1995). This linked model is useful in that it can be used to estimate economic values of changes in the "quality" of the forest environment both through the number of trips and the choice of sites to visit.

The RUM involves assuming that a recreationist, represented by *i*, receives utility from visiting a site, *j*, which can be represented by U_j. This utility is composed of two parts, a deterministic portion V_j and a stochastic term ε_j such that:

$$U_j = V_j + \epsilon_j \ . \tag{1}$$

This general model can be applied to a recreational canoeist by considering that an individual faces a choice of one site from a set of *C* possible sites. Each recreation trip occasion is assumed independent of the others, and site choice is modeled as a function of the characteristics of each alternative site. The probability (π) that site *j* will be visited is equal to the probability that the utility gained from visiting *j* is greater than or equal to the utilities of choosing any other site. Thus for individual *i*:

$$\pi_i(j) = \text{Prob}[\, V_{ij} + \epsilon_{ij} \geq V_{ik} + \epsilon_{ik} \; ; \; \forall \, k \in C \,] \tag{2}$$

The conditional logit model estimates these probabilities if the ε's are assumed to be independently distributed Type-I Extreme Value variates (Weibull). McFadden (1974) shows that this assumption allows the site choice probabilities to take the conditional logit form:

$$\pi_i(j) = \frac{\exp(V_{ij})}{\sum_{k \in C} \exp(V_{ik})}. \tag{3}$$

Once the variables in the observed or deterministic component of the utility function V are specified and a functional form selected, one can estimate parameters of the utility function using maximum likelihood techniques. The functional form commonly chosen for V is linear (e.g., Bockstael et al. 1990; Coyne and Adamowicz 1992):

$$V_{ij} = \beta_1 + \beta_2 X_{ij2} + \beta_3 X_{ij3} + \cdots + \beta_n X_{ijn} + \mu(Y_i - P_{ij}), \tag{4}$$

where X_{ijn} represents n site attribute variables, Y_i is income, P_{ij} is the travel cost of visiting the site, and the βs and μ are parameters to be estimated. Income generally drops out of the formulation because it does not vary by site; in essence site probabilities are assumed to be homogenous of degree zero in income.

Using this model to examine recreation choice behaviour requires a set of recreation sites (C) among which individuals are choosing to visit, as well as actual objective quantitative assessments of the attributes associated with the different sites. This information comprises the values of the various X_ns assumed to be important inputs in a recreationist's indirect utility function (V). This coupled with a set of data which provides the actual choices or revealed preferences of the recreationists for the sites in C, allows estimation of the conditional logit model using maximum likelihood techniques.

The underlying utility theory allows computation of per trip welfare estimates. Hanemann (1982) showed that the expected utility on any given choice occasion is the sum of utility gained from each choice times its respective probability of being chosen. He used expected utility to estimate the compensating variation associated with a change in prices or quality attributes associated with choices. Thus, measuring a change in welfare associated with decreasing some quality attribute in the indirect utility function involves estimating the amount individuals must be compensated to remain at the same utility level as before the decrease. The following formula from Hanemann (1982) shows this calculation:

$$CV = -\frac{1}{\mu}[\ln(\sum_{j \in C} \exp(V_{j0})) - \ln(\sum_{j \in C} \exp(V_{j1}))] \qquad (5)$$

where CV is the compensating variation, μ is the marginal utility of income, V_{j0} is the utility level in the initial state or quality level, V_{j1} is the utility level following a change in quality.

Recently Morey (1994) suggested it is difficult to interpret the per trip welfare estimates without a model that generates seasonal trips unless one assumes that each trip is independent. Yen and Adamowicz (1994) proposed a model that nests the per trip RUM with a Poisson model of seasonal trips where the trip count model is generated by summing a series of binomial choice occasions during the season. As Hellerstein and Mendelsohn (1994) show the sum of these choice occasions converges to the Poisson distribution. In this model the number of trips taken by an individual is a function of the utility associated with a trip (the inclusive value) and demographic variables. In this framework seasonal trips can be modelled as:

$$\log(q) = \alpha_0 + \alpha_1 IV + \sum_{i=1}^{n} \alpha_i Z_i \,, \tag{6}$$

where q is the number of trips in a season, α_0 is the intercept, α_1 is the parameter on the inclusive value, IV, and α_i denotes the parameters with n demographic variables (Z_i). The IV for individual i is calculated by:

$$\ln \left(\sum_{j=1}^{J} e^{V_{jit}}\right)$$

using the parameters of the multinomial logit model described above. Through estimating and linking both models one can examine the value of site qualities and how changes in qualities affect total visitation to recreation sites.

We apply these methods to backcountry recreation trips to Nopiming Park in 1993.

METHODS

The Study Area

Nopiming Provincial Park is a 1440 km^2 area located about 145 km east of Winnipeg (Figure 2). It is situated in the Precambrian Shield area and contains numerous rock outcrops and flat hummocky bogs. The rock outcrops can rise as much as 36 metres above the surrounding countryside and are a prominent feature in the park. The park is poorly drained and contains some sedge meadows, bogs, rivers and many lakes of differing sizes. The river systems, which include Manigotagan, Moose, Black, Oiseau, and Winnipeg Rivers, contain many small rapids and waterfalls and thus are attractive to backcountry recreationists interested in canoeing and kayaking. Nopiming is the only park in the system in which logging is permitted on a limited scale. This has made Nopiming one of the significant environmental issues in the province of Manitoba.

Environmental Characteristics

Most of the land in the park is forested. The rock outcrops are covered with jack pine (*Pinus banksiana*) in varying size classes. The bogs contain mostly black spruce (*Picea mariana*) although tamarack (*Larix laricina*) is also present. Due to a recent history of widespread fires jack pine has gained prevalence and is probably the most abundant tree species in the park, followed by black spruce, trembling aspen (*Populus tremuloides*), and white spruce (*Picea glauca*). Other tree species are also present but are not nearly as common as these. The recent fire history coupled with logging has resulted in large areas of regeneration. Rarely does a stand cover more than a 20 hectare area.

Considerable effort was expended in obtaining information about the landscape, forest and recreation features for backcountry waterway routes (hereafter called canoe routes) in the park. This was done by one or more of us actually travelling along each route and systematically collecting information on the quality and quantity of campsites and portages, noteworthy landscape features including the proximity of cutblocks, and the presence of cottages, bridges, waterfalls, rapids and motor boats.

In addition, a copy of the provincial forest inventory database was obtained and the forest company provided fire history maps and cutblock information for the period 1989-1993 for those townships included in the park. This information was provided in ARC/INFO format. The townships were translated and loaded into a SPANS Study Area (directory) and were merged to form a contiguous layer of data. All base information was also loaded in this manner, joining vectors where appropriate. The canoe routes were traced on the corresponding water bodies and each route segment was given a different attribute. All route segments were then individually buffered and joined after clipping the overlap area from each section. The buffered sections were given attributes corresponding to the various data available.

All canoe routes were buffered to 200m (including islands), while fires and cutblocks were buffered to 2 km in intervals of 200m. Where possible, forest stands were classified into species based upon the inventory classification which involved the predominant tree species present in a stand (comprising >40% of the trees) and two age classes based on cutting class. Species included jack pine, black spruce, white spruce and aspen. For simplicity we used two age classes: "mature", which included trees of 10 m height or greater and/or which have reached rotation age (cutting classes 3, 4 and 5); and "young" which included the smaller sized trees and disturbed areas that in some cases have been restocked (cutting class 0, 1, and 2). A number of additional groupings of stand types and cutting class were attempted (see below), but this classification worked best in the choice models. However, this rudimentary classification is imperfect from the pure ecosystem perspective. Information was lacking on the forest understorey and it is improbable that recreationists recognize many of the different types of ecosystems found there. However, our classification system is comparable to broad groupings of a number of the vegetation types proposed for ecosystem classification in Manitoba's forests, particularly for the conifer stands dominated by jack pine and black spruce (vegetation types V24-V33; Zoladeski et al. 1995).

Forest industry harvest data for the period 1990-1993 (hereafter called cutblocks) was obtained in ARC/INFO format from the forest company (Abitibi-Price Ltd.) and incorporated into the GIS database. The area of canoe route buffers that comprised these cutblocks was calculated and this was used as an environmental attribute. The area of cutblocks was not very large, and the forestry company is required to leave forest buffers of a minimum 100m along water routes. This required buffer can in many cases be larger depending on the topography of shore, but the major consideration is minimizing visibility of any potential logging activity. This suggests that recent cutblocks are difficult to see while canoeing and that most canoeists may never know that they are there. In fact our observations of recreationists while travelling the routes ourselves support this suggestion as we noticed that few, if any, individuals travelled more than about 50 meters from the water. However, the presence of cutblocks may influence other environmental features that influence route choice behaviour. One of these may be wildlife habitat heterogeneity which could impact the size of wildlife populations and the types of wildlife species present for viewing by recreationists.

Overlays among the canoe buffers and forest and other data were performed using the SPANS Unique Conditions overlay process which generates an output map and table containing information about all input layers. Spatial crosstabulations were performed among some layers to examine statistical relationships. An area analysis on all buffered areas was conducted to determine proper percentages for overlap areas. In addition, coverages were also measured for the length of the canoe route they comprised. Thus, two measures were determined for each overlay: i) their contribution to the total buffer area; and ii) the lineal length of the shoreline along the canoe route they comprised. The GIS was also used to display the results of the analysis, including campgrounds, buffered area, fires etc. Maps for each route segment were also created.

Revealed Preference Data

Recreation in the park involves camping at 3 campgrounds managed by the provincial parks branch, fishing, hunting, and backcountry camping involving canoes, kayaks, and in limited cases motorized boats. Cottages are found on a few lakes in the park, largely in the southernmost areas and the northernmost areas. There is a single road that runs through the park north to south, and no fees are collected for entering. Park staff have maintained a voluntary backcountry registration system for a number of years at 6 designated backcountry entry points. Preliminary analysis of registration records for 1991 and 1992 suggest that at least 250 user groups visit the park in a year for backcountry recreation. Eight different backcountry canoe routes were identified from information on the registrations.

Upon inspection of maps of the park we felt that there were many other points that recreationists would be using to enter backcountry areas of the park. In discussions with park users (see focus group below) and park managers an additional 11 registration stations (for a total of 17) were established throughout the park in the spring of 1993. Each station was located near parking areas and contained a wooden box holding a redesigned registration survey form, maps, and signage attempting to facilitate completion of the registration survey. The survey asked for the name and address of the group leader of the recreation group, the number of people in the group, information about the social backgrounds of the group members, type and number of watercraft, the starting and completion dates of the trip, the number of times they had visited the route in the last 10 years, their awareness of other routes in the park, and they were asked to trace their expected route and camping locations on a map located on the back of the survey. We utilized the registrants' postal or zip code and town or city of residence to derive individual characteristics. This information was linked to the latest census data to estimate incomes, levels of education, and household sizes. Further details on the survey can be found in Watson et al. (1994).

To facilitate preliminary understanding of the importance of various features of the park to backcountry recreationists, a focus group was held with a sample of 12 individuals drawn at random from the 1992 registrations. The results of this suggested that landscape/scenery attributes were rated most important by the recreationists. Other features were rated lower. In order of importance these were: maintained portages, degree of difficulty, diversity of water, wildlife viewing, access, campsites, fishing/hunting potential, and the presence of facilities such as firepits, pit privies and picnic tables. The importance of the landscape attribute was probed further by providing photographic images of vegetation types. Jack pine stands were rated highest followed by (in order) mixed predominantly coniferous stands, wild berries and bushes, black spruce stands, white spruce stands, mixed predominantly hardwood stands, and areas burned in 1983 fires. Pictures of cutblocks were shown to the participants but they had considerable difficulty distinguishing them from burned areas. The majority of participants indicated that they had never seen physical evidence of logging in the park and that logging activities had not affected their selection and use of routes. They considered the presence of cottages along canoe routes as detracting from their experience; many indicated they avoid areas where they are found or move through them as quickly as possible. Finally, most participants agreed that power boats negatively influenced their experience and suggested they come to Nopiming largely to get away from power boats which are common in other similar recreation areas in eastern Manitoba, like Whiteshell Provincial Park.

Model Estimation and Selection

Prior to estimating the economic models a compilation of the characteristics of the water routes in the park was performed. Variables were constructed based on the route inventories, inspection of maps, and GIS analysis. Table 1 displays the complete list and coding of variables tried in the analysis of route choice behaviour. Note that with respect to the forest variables a number of other specifications involving mixed species classes were attempted. This resulted in a high degree of collinearity between forest variables and also involved over-specification of the choice model. The forest or tree species classes in Table 2 worked best and performed according to prior expectations from the focus group and our intuition.

The tree species and fire variables (hereafter called forest variables) were examined in two ways. The first involved their contribution to the **length** of the water route. The second involved their contribution to the **area** of the 200m route buffers developed with the GIS. This second specification was intuitively more appealing due to the likelihood that the length specification would not capture the true magnitude or influence of the forest variables from a visual perspective. The statistical results using the length specification were also inferior to the area specification. This result was also found by Englin et al. (1995).

The on-site voluntary survey efforts resulted in useable information from 388 trips to 20 different canoe routes in the park by backcountry recreationists in 1993. About 80% of the trips were to the 6 routes formally designated by park staff as routes. The remainder were to undesignated routes. Based upon the route that the respondent was asked to draw on the maps in the survey instrument most of the respondents travelled the entire length of the water route. About 65% of the recreationists came from Winnipeg, 30% from other parts of Manitoba, and the remainder from Canada and US residents. The postal codes, zipcodes, and addresses provided by the respondents was used to link them with the most recent census data bases in the US and Canada. This allowed estimation of income, household size, and the education level of respondents. A mail back survey or interview with the visitors of the water routes would be a preferable way to gather this data, but the budget did not allow for this opportunity.

The postal codes and addresses of respondents also allowed calculation of travel distances between their residence and water route entry points in the park. This was done with a measuring wheel and road maps. For larger cities which contributed a large number of respondents (e.g. Winnipeg), the postal code system was used to divide the city into smaller regions in order to provide more accurate estimates of distances travelled. This distance, along with the income for each respondent from census data, was used in the following formula to calculate travel costs:

$$\text{travel cost} = \$0.22*\text{distance} + [1/80*1/3*(\text{income}/2080)*\text{distance}] \,. \tag{8}$$

This formula identifies the two components of travel cost: i) the out-of-pocket expenses for the vehicle, estimated at $0.22/km (Alberta Motor Association, pers. comm.); and ii) the opportunity costs of travel time, estimated at one third of the wage rate (Cesario 1976). Note that in this second term an average speed of 80 kph is assumed and that the wage rate involves income earned over 2080 hours per year.

These variables were examined for statistical significance in explaining the probability of choosing one of the 20 routes in the park. Each recreationist was assumed to travel along the entire water route (and indeed the majority of them did) so the characteristics found in the buffers along the entire length of the route was used in the analysis. The multinomial logit analysis in LIMDEP (Greene 1992) was used to estimate RUM models. The truncated Poisson program (Greene 1992) was used to estimate trip frequency because the sample of trips was truncated at the observation 0. Programs constructed using GAUSS (Aptech 1991) were used to calculate welfare measures and the inclusive values used in the Poisson program.

The final selection of models for consideration in this report was based on the sign of coefficients based on intuition, focus groups, and previous research (Englin et al. 1995), log-likelihood ratio tests, and the size of ρ^2, a statistic analogous to R^2 used to estimate the proportion of variance explained by the model (Ben-Akiva and Lerman 1985).

RESULTS

Table 2 contains the results of the site choice RUM models. Four different models are presented. The first involves park management variables and historical forest fires. The presence of the fires and cottage developments have a negative influence on site choice, as expected, as evidenced by the negative signs on their coefficients. Larger number of portages also has a negative influence. The sign of the coefficient on long portages is positive, which is not expected, but this could be due to the relatively small number of variables in this initial model. Finally constants for the Manigotagan River and Seagrim Lake routes are positive. The former is expected given the route has some unique features such as the presence of rapids, but also has historical and symbolic value in the province. The Seagrim Lake constant was negative in previous simpler analyses (Englin et al. 1995) and its positive sign in this study is probably due to the richer set of independent variables used, particularly those involving the number and length of portages.

Given the importance of the 10 year fires on route choice, we decided to replace the burn measure with forest ones, in this case the area of immature stands of jack pine and black spruce. The coefficients for these variables are negative and highly significant in the case of jack pine. We believe this supports our finding that historical fires are a negative influence on backcountry recreation in the Canadian Shield. The park management coefficients remain similar to those in the first model.

The last two models incorporate mature forest variables and cutblock areas. Mature forests add explanatory power to the models as shown by the large increase in ρ^2 (Table 2). Mature jack pine and white spruce stands are a positive influence, while mature black spruce and aspen stands are a negative influence on site choice. The remaining variables (fires, cottages etc.) maintain their significance and signs suggesting that the models are robust. One interesting exception is the longest portage, which becomes negative and more statistically significant in these two models. This negative sign is expected. The last model incorporates the cutblock variable, and the coefficient is positive and significant at about the 10% level.

We believe the degree of influence of most of these factors make some sense in explaining backcountry site choice in this park. For example, camp sites are probably better in jack pine and white spruce areas. There may be fewer insects and the ground is probably less moist than in black spruce or aspen stand areas. The density of trees is also more conducive to camping in mature jack pine due to its more dispersed nature on rock outcrops and flat areas. Aspen tends to produce numerous shoots which results in greater ground cover in younger stages. There may also be scenic preferences at play which influence route choice - our focus groups chose jack pine stands over black spruce, hardwoods and fires. Thus, our revealed preference modelling results closely paralleled our focus group findings in terms of environmental features.

The influence of cutblocks, however, remains problematic. Given the negative reaction to logging in Nopiming Park demonstrated by the media in Manitoba, it is somewhat disconcerting to find that cutblocks may have a positive influence on site choice in the park. A number of caveats are required here: First, the coefficient is significantly different from 0 at about the 11% level. Thus, the positive relationship is not strong, and certainly less strong than the other variables presented in the RUM models (Table 2). Second, in our opinion, most recreationists are not directly aware of the recent cutblocks along the routes in the park. Our evidence on this front involves: i) our extensive field work which suggests that they are not visible from any of the water routes unless individuals make significant efforts to travel inland, something few recreationists do while they are in backcountry areas in Nopiming; and ii) the fact that the forest company is required to leave 100m forest buffers between cutblocks and water routes, but they frequently leave buffers that are larger than required. Third, it may be the features associated with cutblocks that are driving the coefficient to be positive. An important one here may be wildlife habitat. It is well known that logging creates habitat for certain wildlife species (e.g. moose, Stelfox 1983, 1988). This potential may increase numbers of certain wildlife species which influence visitation in a positive manner through the potential to view these species. The possibility of spurious results with this variable led us to utilize the third RUM model in Table 2 in further analysis and the estimation of welfare measures.

Table 3 displays the results of the trip frequency analysis. Four independent variables were used and four different models were estimated. The inclusive value used in these truncated Poisson models was calculated from the third model in Table 2. Note that in each model in Table 3 the coefficient on the inclusive value is not statistically significant, suggesting that the parameters in the RUM are not influencing the number of trips individuals make in a year to the park. It appears that trip frequency decisions are made independent of site choice in this backcountry recreation system. This result supports the same finding by Englin et al. (1995), although this present analysis involves a richer data set in terms of the number of routes, sample sizes, and a broader range of individual and route characteristics. Coefficients on income and education are also not significantly different than 0. Household size, however, appears to influence trip frequency.

Welfare Measures

We utilize the formula in equation (6) to simulate the CV associated with various quality changes in the park. First welfare measures associated with marginal values in the forest and some park management variables are calculated. These appear in Table 4 for the five most commonly visited routes in the park. Jack pine values range from $0.241/ha/trip to less than $0.001/ha/trip. These values are positive because the simulation involved a increase in this stand type by one hectare. Increasing black spruce ranges from a loss of $0.020/ha/trip to $0.002/ha/trip. Adding cottage developments along Tulabi would result in welfare losses valued at $4.752/trip, while adding them at Seagrim Lake would cause losses of $1.745/trip. Removing existing cottage developments at the Beresford route or portions of the Manigotagan River result in gains of $0.557 and $0.733/trip respectively.

We also simulated the current welfare impacts of the two 1983 severe fires, the Maskwa Lake and Long Lake burns. These fires affected large areas of the park (Figure 2) and involved damage at 2 routes and 5 routes respectively of the 20 routes we found visitors during 1993 using. The current welfare impacts of these fires were simulated in two ways. The first involves simply changing the buffer area affected by burns to zero. This means that the affected buffer area is now included as forest types NOT modelled in the RUM. This generally involves mixed species types, Balsam fir and other species not captured in the RUM variables. Table 4 provides the results of this change. The Maskwa Lake burn, which affected portions of Tulabi and Rabbit, resulted in current 1993 losses of about $3.43/trip. The Long Lake fire, which affected more routes, results in 1993 losses of $2.91/trip.

The second, and probably more accurate way to estimate current losses is to convert the burn area to a mixture of forest types: those not included in the RUM model and those types that are included. This was simulated by estimating the portion of the buffer that currently comprises the forest types included in the RUM model (e.g. mature jack pine, black spruce etc.) and converting the burn areas to a similar proportion of these forest types. The remainder of the buffer area currently affected by fire is converted to the forest types not included in the model. These results are somewhat different. The Maskwa burn now causes 1993 damages of $5.878/trip and the Long Lake burn causes current damages of $21.761/trip. While these latter estimates still remain approximations due to our lack of knowledge of the forest type prior to the 1983 fires, they are more accurate than the estimates initially performed by Englin et al. (1995) for the same fires on 6 routes using 1991 and 1992 recreation use data.

DISCUSSION

This report highlights the importance of environmental and park management features to the benefits derived from backcountry recreation in a Canadian shield setting. It is well known that fire is a natural and necessary part of this landscape and results, in combination with topography and hydrology in a mixed and continually renewing set of ecosystems. Recreationists apparently choose from these ecosystems in the selection of routes to carry out their backcountry activities. Estimates of the per trip recreational benefit of a hectare of mature jack pine range from $0.0001 to $0.24, while aspen and mature black spruce ecosystems are negatively valued. Young stands, which can represent recent fire, are negatively valued regardless of forest type. Benefit estimation of the damages from fire varied from $2.91 to $21.76 per hectare. The differences are driven primarily by the scale and location of the two burn scenarios examined.

The results of the different models using either forest type, or fire, also show that they are two approaches of tackling the same problem. A recent fire (10 year old) is the equivalent of young tree stands, and a mature forest is simply an area where fire has not occurred for 50 to 60 years. As expected, the values associated with the comparable measurement approaches are similar.

There are park management implications highlighted by these models. The welfare estimates of new cottage development or removal of existing subdivisions, show how important these are to backcountry users. Adding more cottages to the southern part of the park would be highly negative (see Table 4), but an addition to the northern part would be weakly positive. This positive value reflects the fact that users may no longer use the area, and that substitutes in the south may be used more with lower travel costs for the most frequent visitors (e.g. Winnipeg). However, the potential for users to substitute more expensive areas outside of the park are not modelled in this effort and thus represent a weakness in this study. Finally, estimates of welfare losses from forest fires for the various canoe routes could be considered when budgeting for forest fire control. This represents another potential use for this study in park management.

The positive value associated with cutblocks is problematic, however a number of caveats are required. First, the positive relationship is not strong, and certainly less strong the the other variables presented in the RUM models. Second, most (if not all) recreationists are not aware of the location of recent cutblocks. Third, as with some of the other variables, the positive sign could be related to other features associated with cutblocks rather than the cut itself. For example, young regenerating forest has been shown elsewhere to be associated with higher biodiversity, and a different mix of wildlife, than mature forest. While recent fire also results in a young regenerating forest, fire nearly always encroaches right to the water line, and is highly visible. This also means that there is limited camping potential on the shoreline, and it is aesthetically not pleasing to travel through. In the case of cutblocks however, there is a well maintained buffer screening the area from view, but the increase in wildlife would still be available.

Potentially a key omission from the analysis is the absence of any wildlife or biodiversity index. However, this could equally be highly correlated with the forest cover types already used, and thus be a replacement of current variables, rather than a group of additional variables.

CONCLUSION

These results indicate the influence of some of the features found in forests in the Canadian Shield on flows of economic benefits derived by individuals who utilize these forests for recreation. For example, mature forest stands, particularly jack pine, are important positive influences on recreation values; while recent extensive fires are significant negative influences. This study suggests that forest characteristics can be integrated into revealed preference economic models (e.g. travel cost models) and points to important future work that can be conducted which attempts to integrate forest management practices with various types of forest uses. This conclusion should be contrasted with Vaux et al. (1984) and others who suggest that these models are not sensitive enough to measure impacts of forest changes, such as fires, on recreation.

This study is one of a very few that present economic values of specific forest stand types. Englin and Mendelsohn (1991) utilize hedonic travel cost methods to value forest types in the Pacific Northwest for hiking. Others such as Crocker (1985) and Walsh et al. (1989, 1990) focus largely on valuing forest quality. While values of forest types and condition will assist landscape management initiatives, the indirect nature of service flows from forest types and conditions is also important. This points toward the need to integrate economic models more completely with biological models and data in order to fully understand the linkages between forests and their uses.

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Table 1. A list of forest, development, and park management variables used to explain water route choice for backcountry recreation in Nopiming Park, Manitoba.

Variable	Description	Coding
Mature jack pine	Forest stands of which 40% or more of the trees are jack pine greater than 10 m	Area (km^2) of buffer along complete route
Young jack pine	Forest stands of which 40% or more of the trees are jack pine less than 10 m	Area (km^2) of buffer along complete route
Mature black spruce	Forest stands of which 40% or more of the trees are black spruce greater than 10 m	Area (km^2) of buffer along complete route
Young black spruce	Forest stands of which 40% or more of the trees are black spruce less than 10 m	Area (km^2) of buffer along complete route
White spruce	Forest stands of which 40% or more of the trees are white spruce of any height	Area (km^2) of buffer along complete route
Aspen	Forest stands of which 40% or more of the trees are aspen of any height	Area (km^2) of buffer along complete route
Balsam fir	Forest stands of which 40% or more of the trees are balsam fir of any height	Area (km^2) of buffer along complete route
Fires	Extensive forest fires that occurred within the last 10 years (1983-1993)	Area (km^2) of buffer along complete route
Cutblocks	Areas that have been harvested for pulp production within the last 3 years (1990-1993)	Area (km^2) of buffer along complete route
Cottage developments	Presence of cottages along the route	Dummy variable; 1=present 0=not present
Motor boats	Presence of motor boats along the route	Dummy variable; 1=present 0=not present
Bridges	Presence of bridges along the route	Dummy variable; 1=present 0=not present
Boat launches	Presence of boat launches and parking areas at route entry point	Dummy variable; 1=present 0=not present
Beaches	Presence of bridges along the route	Dummy variable; 1=present 0=not present
Longest Portage	The length of the longest portage along the entire route	Length in m
Portages	The number of portages that must be negotiated while travelling the entire route	Number of portages

Table 2. Estimates of parameters from multinomial logit models explaining choice of water recreation route in Nopiming Park, Manitoba in 1993.

Variables	Parameters (*t*-ratio)			
Travel cost	-0.1369 (-12.010)	-0.1195 (-10.719)	-0.0600 (-4.914)	-0.0573 (-4.651)
Recent Cutblocks				0.5262 (1.607)
Burns of 10 years or less	-0.0633 (-3.723)		-0.1016 (-3.538)	-0.0895 (-2.945)
Mature jack pine			0.6798 (9.837)	0.6854 (9.624)
Young jack pine		-0.3730 (-7.355)		
Mature black spruce			-0.9988 (-6.847)	-0.9311 (-6.047)
Young black spruce		-0.0394 (-0.251)		
White spruce			6.2236 (5.929)	6.2029 (5.767)
Aspen			-3.1102 (-5.603)	-3.0299 (-5.246)
Cottage Developments	-1.7962 (-11.221)	-1.7327 (-9.968)	-1.3374 (-8.449)	-1.3498 (-8.507)
Longest portage	0.0004 (2.831)	0.0004 (2.794)	-0.0018 (-5.126)	-0.0020 (-5.208)
Number of portages	-0.0229 (-4.292)	-0.0268 (-5.130)	-0.0774 (-8.007)	-0.0722 (-7.401)
ASC - Manigotagan	2.5517 (7.513)	2.0857 (5.993)	3.8477 (6.493)	3.6939 (6.067)
ASC - Seagrim Lake	0.6605 (4.059)	0.6012 (3.695)	0.6614 (3.256)	0.7075 (3.421)
Log likelihood at convergence	-946.70	-924.86	-861.23	-858.83
ρ^2 [1]	0.186	0.204	0.259	0.261

[1] A statistic analogous to R^2 and is calculated as $[1-L(\beta)/L(0)]$

Table 3. Estimates of parameters for truncated Poisson regression models explaining the number of trips to Nopiming Park, Manitoba in 1993.

Variables	Parameters (*t*-ratio)			
Constant	0.0025 (0.001)	-2.6156 (-5.451)	1.8208 (0.633)	-1.9169 (-1.916)
Income	-0.000005 (-0.186)			-0.00002 (-0.777)
Education	-0.19760 (-0.557)		-0.30950 (-1.249)	
Household Size	0.23120 (1.642)	0.26171 (1.989)		0.24948 (1.908)
Inclusive Value	0.02342 (0.445)	0.029849 (0.572)	0.02264 (0.440)	0.030774 (0.569)

Table 4. Estimates of mean per trip welfare measures associated with marginal changes in forest and some management conditions for some canoe routes in Nopiming Park, Manitoba.

Canoe route	Marginal environmental changes					
	Mature jack pine (ha)	Mature black spruce (ha)	White spruce (all ages) (ha)	Aspen (all ages) (ha)	Cottage developments (pres/aabs)	Additional portages (1 portage)
Tulabi	0.241	-0.020	NP[1]	-0.021	-4.752	-0.423
Seagrim Lk.	0.048	-0.009	NP	NP	-1.745	-0.197
Rabbit R.	0.049	-0.008	0.025	NP	-2.059	-0.168
Beresford Lk.	>0.001	-0.002	0.006	-0.001	0.557	-0.015
Manigotagan R.	0.006	-0.008	NP	-0.001	0.733	-0.020

[1] NP refers to Not Present, which means that the route did not have any of these forest types within its buffer.

Table 5. The current (1993) mean per trip welfare impacts of severe fires that occurred in 1983 on backcountry recreationists in Nopiming Park, Manitoba.

	Number of routes affected	Hectares of canoe route affected by fire	Welfare measure ($) for a forest improvement	
			Change ha of fire damaged forest to base[1]	Change ha of fire damaged forest to mature forest[2]
Actual fires				
Maskwa Lake Burn	2		3.435	5.878
Long Lake Burn	5		2.905	21.761

[1] This change involve converting the entire area of the canoe route buffer to forest types not captured in the forest type variables (e.g. mixed forest types). In other words the hectares of burned area are simply changed to 0, and none of the forest variables are affected.

[2] This change involves converting the area of the canoe route buffer to BOTH mature forest types and the others not captured in the formally in the RUM model. The conversion of burned area to mature forest is based on the proportion of mature forest (by species) in the unburned portions of the routes. In other words, if a route with a buffer area of 100 ha has 50 ha burned and 25 ha of mature jack pine remaining in the unburned portion, the quality change simulated involves converting half of the burned area (25/50 ha) to mature jack pine, and the rest (25/50 ha) to remaining forest types (ie. area of burn=0).

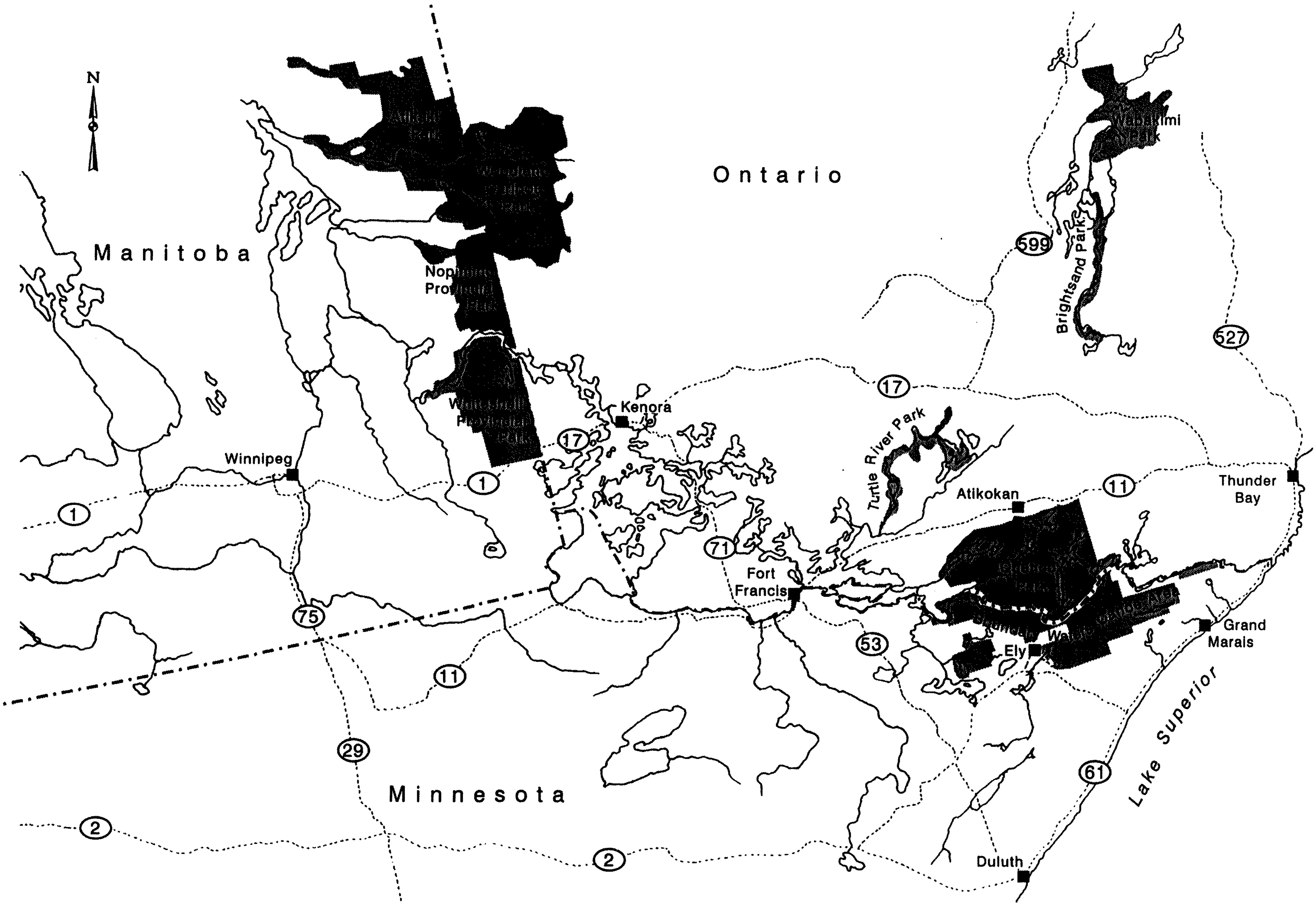

Figure 1. A map showing the locations of wilderness and recreational parks in the Canadian Shield Region of Manitoba and Ontario

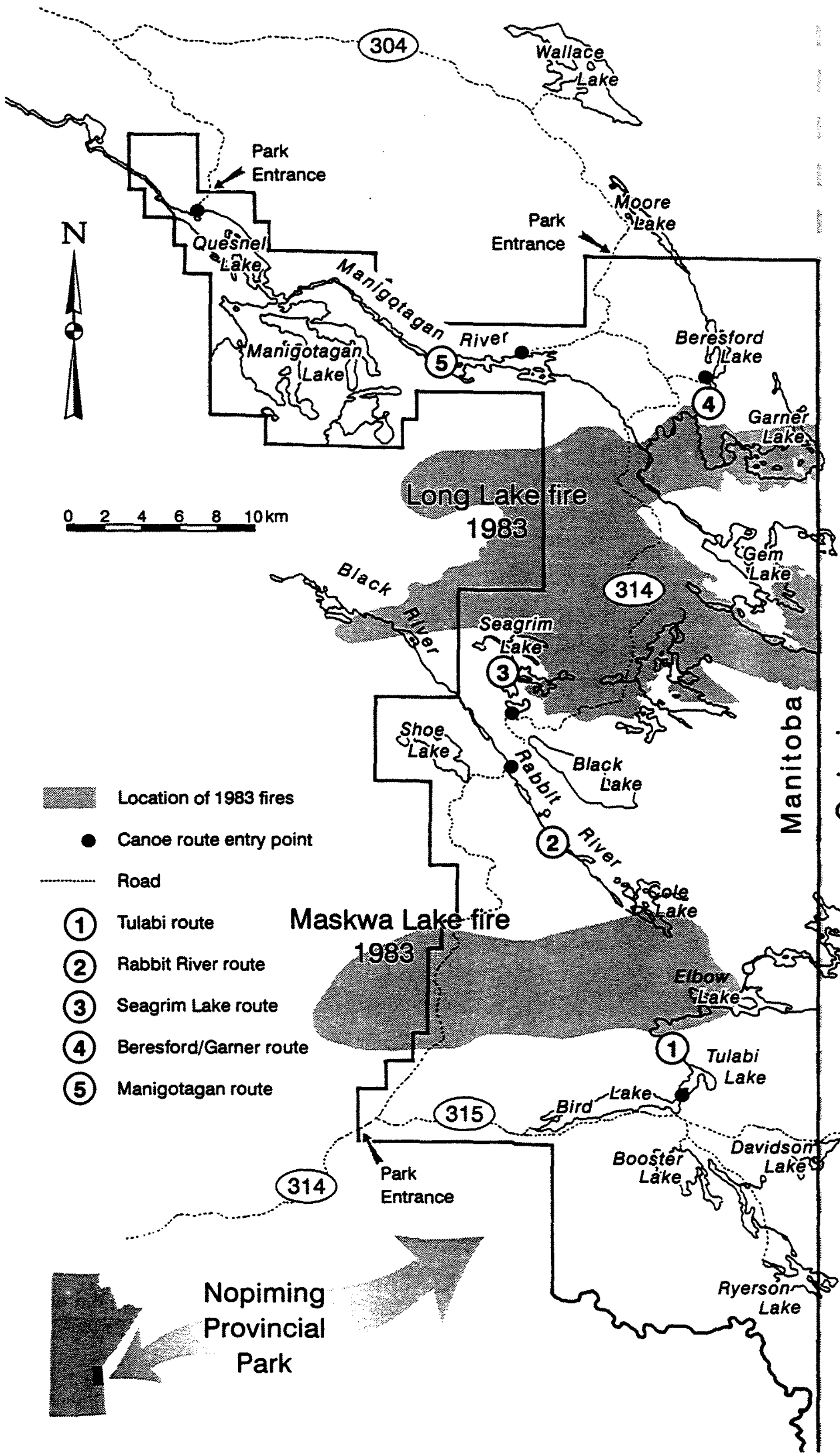

Figure 2. Map of Nopiming Provincial Park, Manitoba showing the five major canoe routes and the most recent (1983) forest fires.