Snowmobile Use in Voyageurs National Park: A Visitor Use Estimation Tool

Final Report

Prepared for
Voyageurs National Park
National Park Service

by
Mae A. Davenport, Ph.D.
Jerrilyn L. Thompson
Joanna M. Rosendahl
Dorothy H. Anderson, Ph.D.
Cooperative Park Studies Program

In consultation with
Sanford Weisberg, Ph.D.
School of Statistics

University of Minnesota

September 2003

UNIVERSITY OF MINNESOTA

Cooperative Park Studies Program

Department of Forest Resources
College of Natural Resources

115 Green Hall
1530 Cleveland Avenue N
St. Paul, MN 55108

Office: 612-624-3699
Fax: 612-625-5212
jthompso@forestry.umn.edu

November 5, 2003

Barbara West
Voyageurs National Park
3131 Highway 53 South
International Falls, MN 56649-8904

Dear Barbara,

We are pleased to forward to you the report: *2003 Snowmobile Use in Voyageurs National Park: A Visitor Use Estimation Tool.* Enclosed are ten bound copies and one unbound copy of the report. Please pass onto Chris Holbeck for distribution within the park as appropriate.

Please contact us with any questions you might have. It has been a pleasure working with you. We will be in touch.

Thank you.

Sincerely,

Dorothy H. Anderson, PhD
Professor and Leader, CPSP

Jerrilyn Thompson
Research Coordinator, NPS

Mae A. Davenport /bw
Mae A. Davenport, Ph.D.
Research Associate

Cc: Chris Holbeck; Steve Cinnamon, Midwest Region (2 bound copies); NPS: Technical Information Center (1unbound copy)

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University of Minnesota
Department of Forest Resources
Cooperative Park Studies Program
115 Green Hall
1530 Cleveland Avenue North
St. Paul, MN 55108-6112
612 624-3699
http://www.cnr.umn.edu/CPSP

September 26, 2003

ACKNOWLEDGMENTS

Preparation of this report and the research was funded primarily by the National Park Service (Midwest Region), Voyageurs National Park, and the University of Minnesota (Department of Forest Resources and Minnesota Agricultural Experiment Station). Technical assistance was received from the Cooperative Park Studies Program at the University of Minnesota. The authors would like to thank the staff at Voyageurs National Park, especially Chuck Remus and Dave Little, for their assistance in the field. Gratitude is also extended to the resort owners for their hospitality and support over the project's three winter seasons.

The Cooperative Park Studies Program is a University partnership with the NPS (Midwest Region) and Biological Resources Division, US Geological Survey.

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INTRODUCTION

This report describes the Voyageurs National Park Snowmobile Use Study conducted by the University of Minnesota's Cooperative Park Studies Program (CPSP) in collaboration with Voyageurs National Park (VOYA) and presents a Snowmobile Use Estimation System to guide future snowmobile use estimates. Specifically, this report details the:

- Need for research
- Study objectives
- Measurement equipment and techniques
- Sampling strategy
- Analysis procedures and formula
- Study limitations
- Trip characteristics
- Use estimation system, and
- Application

Need for research

Estimating winter visitor use in VOYA is difficult because the park boundary is sinuous with multiple unregulated entry points. A visitor use estimation tool is needed to provide park managers with accurate visitor use statistics.

Measuring dimensions of visitor use and characteristics of visitor experiences provides park managers with key information for developing policies, planning programs, monitoring change, and in turn, evaluating those policies, programs, and changes. Use estimates, or measurements of the number of visitors to an area during a specific period of time, are fundamental to understanding visitor use. Knowing how much use an area gets provides only minimal insight for park planning. However, when coupled with other visitor use or resource information, visitor use estimates help managers identify trends and anticipate change. For example, linking use estimates with trail conditions or visitor perceptions of crowding at access areas can help managers maintain high resource quality and visitor experiences. Monitoring use levels as well as other biophysical and social variables enables managers to identify acceptable levels of social and biophysical impacts. Visitor use information helps to ensure that the agency mission and specific management objectives are met.

Voyageurs National Park, like most national parks collect use data and submit visitor use estimates to the Public Use Statistics Office of the National Park Service. At the time this study was conducted, VOYA's use estimate formula was over ten years old and was based on use at one location within the park. The park's current snowmobile use estimation system is outdated and does not reflect contemporary trends in winter visitor use. New protocol for estimating snowmobile use in VOYA is needed to more accurately represent current travel patterns, better account for snowmobile use level variability across the park, and address the challenges posed by the park's unregulated, multiple access points.

Objectives
This study's primary goal was to design a use estimation system for generating reliable snowmobile estimates in VOYA. Snowmobiling accounts for a high proportion of winter use in VOYA and has become an increasingly popular activity in the park over the last three decades.

The specific objectives of the study were to: 1) model visitor travel patterns 2) ground-truth or test the model in the field, and 3) develop a future use estimation protocol.

The snowmobile use estimation system presented in this report integrates two components of snowmobile use in the park. The first basic component is the snowmobile traffic counts obtained from traffic counters within the park. Park personnel currently monitor snowmobile traffic levels with counters located on trails within the park. The second basic component of the system is the travel pattern model. The model is comprised of a series of coefficients of variation that represent travel patterns within the park (i.e., proportions of snowmobile at specific sites). Assuming travel patterns remain relatively consistent, the model is designed to yield accurate estimates as snowmobile use levels fluctuate.

METHODS

Several methods, using a wide array of sampling strategies and equipment, have been used to estimate visitor use in natural resource areas. In any use measurement, clearly defined objectives, appropriate measurement techniques and equipment, a sound sampling strategy, and reliable analysis procedures are critical (Watson et al., 2000; Gregoire & Buyoff, 1999; Yuan et al., 1995).

The major methodological challenge to total use estimation in VOYA is that access points are multiple and uncontrolled. Winter snowmobile visitors are not required to register or purchase a pass to enter the park. They also are able to enter or leave the park at an almost infinite number of access points. As a result, park officials are unable to estimate total use by tallying permits or receipts. Monitoring access points is not feasible. In response to these challenges, this study sought to model snowmobile travel patterns through onsite visitor interviews. When coupled with snowmobile traffic data acquired at specific sites within the park, the travel pattern model produces reliable estimates of total snowmobile use.

Visitor travel patterns and basic trip characteristics were documented through onsite interviews. Snowmobile traffic was monitored through photoelectric counters located on popular trails within the park. Interview and counter data were collected over three winter use seasons. The first field season was designed to collect baseline travel pattern information. The second season was designed to ground-truth the travel pattern model. However, poor snow conditions the second season necessitated a third season of data collection to validate and refine the model.

Measurement techniques and equipment
Onsite visitor interviews and snowmobile traffic monitoring were used to collect data.

Visitor interviews: Visitor interviews were conducted to identify visitor travel patterns throughout the park and basic trip characteristics. Park visitors on snowmobile were contacted by one of three field researchers from the University of Minnesota CPSP. A single visitor or a group of visitors was approached in a lodge or along the trail and asked to participate in the study. If the visitor declined to participate, the field researcher thanked them for their time and they continued their visit. If the visitor agreed, the field researcher: 1) explained the study purpose, 2) requested permission to talk to members of the group, 3) inquired about the group's trip characteristics, and 4) recorded the group's travel route. Trip characteristics were recorded on a log sheet (Appendix A). Specific information gathered from visitors included,

- routes traveled
- number of people in a group,
- number of snowmobiles in a group,
- number of days visitors spent in VOYA,
- mileage visitors traveled on each route,
- number of hours visitors spent on each route,
- percentage of time spent off groomed trails (2002 and 2003 only), and
- city of residence (2002 and 2003 only).

The researcher or group member drew the travel routes on a map provided (Appendix B). Routes represented the path traveled by the group that day (or route planned for that day) and the direction of travel. On some occasions, routes traveled on previous days by a group on the same trip were also documented. A typical interview lasted from 1-5 minutes. Following each interview, the time, date, and location of the interview were recorded and a route number was assigned to the map.

Snowmobile traffic monitoring: Photoelectric traffic counters were used to identify snowmobile use levels within VOYA. Two types of counters, one with a passive infrared sensor and one with an active infrared sensor, recorded use on the Black Bay portage. Moose Bay, Mukooda Lake, and Rainy Lake locations each had one passive infrared counter. Active infrared counters transmit a light beam to a reflector up to 100 feet away. A sensor records the number of times the beam is broken. Passive infrared counters use temperature sensors to detect moving objects. Passive infrared counters are more susceptible to spurious counts from weather changes or wildlife (Yuan et al., 1995). All of the counters were located along groomed snowmobile trails and recorded two-way traffic.

Sampling strategy

Interviews: One of the challenges to this sampling strategy was accurately representing the population for which inferences will be made. In this case, the sampling goal was to accurately represent travel patterns of snowmobilers in VOYA. To do so, the sampling strategy was to contact as many visitor groups using snowmobiles as possible:

- at different locations within the park,
- at different times of the day, and
- on weekdays and weekends.

Sampling across these different strata improved the likelihood that different types of users (e.g., local and non local residents) with potentially different travel patterns would be represented. Furthermore, since travel patterns are influenced by weather conditions, which can fluctuate year-to-year, data collection occurred over three winter seasons. In some instances, the sampling plan specifics, such as time of day, were adapted onsite to increase visitor group contacts.

Specific sample periods were, March 8 through March 11, 2001; January 6 through January 21 and February 15 through 17, 2002; and February 28 through March 2, 2003 (Appendix C). Study sites included, Thunderbird Lodge on Rainy Lake; Sandy Point Lodge and Outfitters on Kabetogama Lake; Ash Trail Lodge, Frontier, and Ash Ka Nam on Ash River; and Voyagaire Lodge and Houseboats on Crane Lake. Lodges were selected because these locations have relatively high use concentration and offer a less obtrusive interviewing environment. Permission to interview guests at lodges was gained from each of the lodge owners beforehand. In 2002 and 2003 interviews were conducted on the trail as well as at the lodges (Appendix C). Conducting interviews on the trail helped to increase the sample size and ensure a representative sample. Trail sites were chosen that provided the field researchers with an optimal opportunity to stop snowmobilers, while ensuring the safety of the researcher and study participants. Park rangers provided assistance in stopping snowmobile groups on the trail.

Traffic counters: Three locations, Black Bay, Moose Bay, and Mukooda were monitored throughout the 2001 and 2002 winter use seasons. An additional location, Rainy Lake, was monitored in 2003. During the interview sampling periods, park staff logged traffic counts in the morning and evenings on most days. Park staff availability dictated the exact times counts were recorded.

Counter error is a major obstacle in estimating use (Watson et al. 2000). Counter calibration requires a one to two-hour period of personal observation of snowmobile traffic passing the counter. This procedure generates two counts: the true count (as recorded by personal observation) and the count registered by the counter. The ratio of the two counts yields a counter error coefficient. The counter error coefficient is used as a multiplier to adjust future counts registered by the counter. Establishing the counter error coefficient is critical for accurate use estimation. Counter calibration sessions were conducted over the three sampling seasons to reduce counter error. Park staff availability led to fewer calibration sessions than desired. When comprehensive calibration figures were not available, counter error coefficients were estimated based on the data available.

Data analysis and derivation of the statistical formula

Data from the log sheets and route maps collected over the three sampling seasons were entered into a database using the software program, Statistical Package for the Social Sciences (SPSS 10.0). Each completed map was examined. The number of times was recorded that a route traced by a visitor on the map passed any of 23 checkpoints. The researchers identified the 23 checkpoints prior to the analysis (Appendix D). These tallies were entered into the database and multiplied by the number of snowmobiles in the group as reported on the log sheet. For example, if one group reported having four snowmobiles in their group and indicated that they passed checkpoint #6 four times, the adjusted traffic count at checkpoint #6 would be 16. Basic summary statistics were conducted on the data in totality and across three strata: sampling season, day of week (weekend/weekday) and place of residence (local/nonlocal). The travel pattern model developed reflects the proportion of the total number of snowmobiles in the sample that passed specific checkpoints identified by the researchers on a park map (i.e., the amount of traffic at the checkpoints generated by the total number of different snowmobiles).

To estimate the total use N, several assumptions were made. First of all if 'j' counters are set up in the park and the counters are spaced far enough apart to be considered to be independent of one another, then the count at the j^{th} counter is C_j. Further, it was assumed that the counts C_j represent a Poisson distribution with means Nm_j, where m_j is the average number of times a user will pass the j^{th} counter. Finally, if c_j is the number of times the users in the sample pass the j^{th} counter, then c_j have Poisson distributions with mean nc_j. Some groups may pass a counter more than once. These assumptions are adequate to estimate use and standard error (Figures 1 and 2).

$$N = \left[\frac{\Sigma C_j'}{\Sigma c_j} \right] n$$

Where N represents the total number of snowmobiles in the park.
C_j is the calibrated traffic count observed at counter j,
c_j is the total route count at counter j represented by the sample of n snowmobiles, and
n is the number of snowmobiles represented by the sample.

Figure 1. Statistical formula for estimating total snowmobile use

A formula for the variance was also developed (Figure 2).

$$\text{Variance}(N) = \frac{N(N+n)}{\Sigma c_j}$$

Standard error (N) = sqrt (Var (N))

95% confidence interval (N) = 1.96 (Std error (N))

Figure 2. Formula for estimating the estimate variance

The population variance is approximated by using the total number of snowmobiles in the park (N) from the formula estimate, the total number of snowmobiles in the sample (n) and the sum of the route count at each counter location represented by the sample (c_j). The standard error is estimated by taking the square root of the variance. The confidence interval is derived by taking the estimated total (N) plus or minus 1.96 multiplied by the standard error.

Study limitations
A review of the literature reveals several limitations associated with use estimation techniques and equipment. Some degree of measurement error (false or misrecorded counts) is present whenever traffic counters are used. Mechanical equipment used to count vehicles is subject to many factors that can contribute to error such as improper installation, vandalism, equipment malfunction, weather, wildlife, and characteristics of the traffic counted. As a result, traffic counts used to estimate total snowmobile use were adjusted by a counter error calibration coefficient. These coefficients are generated through the calibration process described above. The accuracy of future estimates depends on proper calibration of the raw traffic counts.

It is important to note that this project was designed to provide a protocol for estimating park visitors on *snowmobile*, not all winter park visitors. Groups with potentially high visitation numbers not represented in this study include, ice fishers entering the park by automobile, cross-country skiers entering the park, and visitors entering the Rainy Lake Visitor Center.

Another limitation of this study is that the model generated is based on travel patterns of winter visitors over a three-year period. The travel pattern model presented here will be valid as long as use patterns remain relatively consistent. However, if patterns change (e.g., new access areas are developed or new policies are adopted that affect snowmobile routes), the model must be ground-truthed again and may need to be adjusted. In this event, it is recommended that the study methods detailed above be replicated to test the model's use proportions.

FINDINGS

The study findings are organized in three sections: trip characteristics, travel pattern model, and use estimation formula. The findings below were drawn from 541 groups interviewed over three winter use seasons in VOYA (Table 1).

Table 1. Number of groups contacted each season

	Groups	Percent
2001	102	18.9
2002	304	56.2
2003	135	25.0
Total	541	100.0

Trip characteristics
Groups averaged between four and five people with four to five snowmobiles in each group (Table 2). They visited the park for two and a half days and traveled over 110 miles in about seven hours on their route. The groups reported riding off trail on less than 13 percent of their route. The person per snowmobile ratio was relatively consistent over the three seasons for an overall average of 1.05 people per snowmobile.

The majority of the snowmobile routes collected from the respondent groups were on a weekend day (Friday through Sunday) (Table 3). Less than 10 percent of the routes collected were on a weekday (Monday through Thursday). Over 80 percent of the group leaders interviewed were nonlocal residents, or lived outside an estimated twenty-mile radius of the park (Table 4). The twenty-mile radius was chosen as the local/nonlocal boundary, because it reflects the natural break in the travel patterns data (see Appendix E).

Table 2. Respondent group characteristics over three years

	2001 (n=102)		2002 (n=304)		2003 (n=135)		Total (n=541)	
Respondent groups*	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**
People	492	4.82	1413	4.65	530	3.96	2435	4.51
Snowmobiles	464	4.55	1353	4.45	501	3.74	2318	4.29
Days visited	223	2.19	756	2.69	322	2.46	1301	2.53
Miles traveled on routes	11970	126.0	30730	103.5	15793	122.4	58493	112.27
Hours spent on routes	598.0	6.64	1770.5	6.3	1016.5	7.9	3385.0	6.7
Percent off trail			13.56%		10.37%		12.5%	
People per snowmobile		1.06		1.04		1.06		1.05

*In some instances, respondent groups were interviewed more than once in the sampling period. Groups were interviewed only once each sample day.

Table 3. Day of week of routes collected from groups

	Routes	Percent
Weekend*	488	90.2
Weekday	53	9.8
Total	541	100.0

Source: Interview route maps

*Weekend is defined as Friday through Sunday, weekday is Monday through Thursday.

Table 4. Group leader's place of residence

	Groups*	Percent
Nonlocal	362	83.0
Local	74	17.0
Total	436	100.0

Source: Interview route maps

*In 2001 place of residence was not obtained.

Travel patterns model

The travel patterns model is based on the route maps and trip characteristics data collected over the three sampling seasons. The model values used in the use estimation formula are comprised of the proportions of total snowmobiles in the sample that pass the four checkpoints at the counter locations (Table 5). For example, 541 total groups representing 2,318 snowmobiles were included in the interview sample. According to the route maps, the Black Bay counter was passed 1,552 times by the 2,318 snowmobiles in the sample. This means that the Black Bay counter records 66.9 percent of total snowmobile use in the park. Similar proportions of use were identified at the Moose Bay and Mukooda counter locations. The Rainy Lake counter only accounted for 27.7 percent of the snowmobiles in the sample. It is important to note that these proportions do not tell us what percentage of the total number of snowmobiles sampled pass the counters, because a snowmobile or snowmobile group can pass a counter more than once.

Table 5. Travel patterns model for traffic counter locations

Black Bay (CP-3)		Moose Bay (CP-17)		Mukooda (CP-22)		Rainy Lake (CP-6)		All locations	
N	%*	N	%	N	%	N	%	N	%
1552	66.9	1429	61.6	1483	64.0	641	27.7	5105	220.2

Source: Interview route maps
*Percentages based on total number of snowmobiles in sample (n=2318).

Additionally, travel patterns were analyzed across three different strata: sampling season, day of week, and place of residence to identify potential variation. Travel patterns varied across these strata (Appendix F), underscoring the importance of sampling across several seasons, on weekends and weekdays, and at different locations within the park. An expanded model that includes proportions of use at all 23 checkpoints was generated (Appendix G).

Use estimation formula

The use estimation formula provides a constant value that when multiplied by the sum of the total calibrated counts from the four counters yields the total snowmobile use estimate (Figure 3). The factor, 0.454, is the percentage of the sum of the calibrated counts representing total number of snowmobiles in the park. Multiplying the total calibrated counts from the four counters by this factor yields the total snowmobile estimate. Put differently, the sum of the calibrated counts at the four counters represents 220 percent of the total number of snowmobiles in the park and in turn, must be reduced by over half. For future estimates using the model presented here, the n and c_j remain constant at 2318 and 5105, respectively. These values were derived directly from the snowmobile travel patterns data collected in this study and may only change if the model is refined through additional data collection.

$$N = \left[\frac{\sum C_j}{\sum c_j}\right] n = (\sum C_j) * \frac{2318}{5105}$$

$$N = (\sum C_j) * .454$$

Figure 3. Total snowmobile use estimation formula

To estimate the total number of visitors on snowmobile in the park the resulting value is multiplied by the person-per-snowmobile factor: 1.05.

Example A: Over a three-day period from Friday, February 28 through Sunday, March 2 in 2003 the traffic counters at Black Bay, Moose Bay, Mukooda, and Rainy Lake recorded a total of 1,430 snowmobiles (Table 5). Multiplying the raw counts from each counter by the appropriate calibration coefficients (Appendix H) yields a total calibrated count of 1,758. Multiplying this value by the snowmobile use estimate factor (.454) produces an estimate of 798 snowmobiles. Multiplying this value once again, by the person-per snowmobile factor (1.05) yields the total for the weekend: 838 visitors on snowmobile. A standard error of 22 snowmobiles is obtained by taking the square root of the variance, 487 (see Figure 2). The 95% confidence interval is 798 ± 43 snowmobiles or 838 ± 45 visitors.

Table 5. Traffic counter tallies from February 28 through March 2, 2003

	Black Bay	Moose Bay	Mukooda	Rainy Lake	Total
Raw counts	472	662	124	172	1430
Calibration coefficients*	1.09	1.30	1.47	1.17	
Calibrated counts	514	861	182	201	1758

Source: NPS statistics

*Error coefficients are only estimates based on calibration sessions conducted in previous years.

Example B: Over the 2002-2003 winter season the traffic counters at Black Bay, Moose Bay, Mukooda, and Rainy Lake recorded a total of 19,407 counts (Table 6). Multiplying the raw counts for each counter by their appropriate calibration coefficient yields a total calibrated count of 24,166. Multiplying this value by the snowmobile use estimate factor (.454) produces a snowmobile estimate of 10,971. Multiplying this value by the person-per snowmobile factor (1.05) yields the total use for the season, 11,520 visitors on snowmobile. A standard error of 136 snowmobiles is obtained by taking the square root of the variance, 18,596 (see Figure 2). The 95% confidence interval is 10,971 ± 272 snowmobiles or 11,520 ± 286 visitors.

Table 6. Traffic counter tallies for 2002-2003 winter season

	Black Bay	Moose Bay	Mukooda	Rainy Lake	Total
Raw counts	5797	8210	2854	2546	19407
Calibration coefficients	1.09	1.30*	1.47*	1.17*	
Calibrated counts	6319	10673	4195	2979	24166

Source: NPS statistics

*Error coefficients are estimates based on calibration sessions conducted in previous years.

SNOWMOBILE USE ESTIMATION SYSTEM

Snowmobile use estimates are the end result of a three-phase use estimation system. First, internal traffic is monitored through photoelectric counters and tallies are recorded in a systematic fashion (e.g., Monday morning every week or every other Friday evening) from the beginning through the end of the snowmobiling season in the park. Next, calibration coefficients are derived from monthly calibration sessions (or more if any onsite adjustments are made) at each of the traffic counters used in the use estimation formula. Finally, the total number of snowmobiles and visitors on snowmobiles over a time period is computed from the calibrated tallies through the use estimation formula.

Steps in the use estimation system

Step 1. Develop snowmobile monitoring and calibration plan: The first step in estimating snowmobile use in VOYA is scheduling the days and times for monitoring use levels and calibrating the traffic counters. The monitoring plan should be determined prior to the winter season to allow enough time to identify and train personnel. Traffic tallies should be recorded at least every two weeks from each counter to be used in the use estimation formula (Black Bay, Moose Bay, Mukooda, and Rainy Lake) on the same day and at approximately the same time. The exact date monitoring will begin depends on snow conditions, however the day of week and times for recording counts and calibrating counters should be chosen ahead of time. For example, counts at Black Bay might be recorded every other Monday morning. The monitoring period would begin on the first Monday after the Black Bay counter is installed and every other Monday thereafter. Calibration (measuring counter error) should be conducted on each counter at least three times during the season and every time a counter is moved or adjusted. The best time to calibrate is when use is high, such as a Saturday afternoon. Each calibration requires a one to two-hour period of personal observation.

Step 2. Install traffic counters: To best account for early and late season snowmobile use, the counters should be installed as soon as visitor use begins and conditions allow for accurate counts and should not be removed until conditions require removal. Traffic counters should be installed in an inconspicuous location along a relatively straight trail. Consult the product manual for specific installation directions.

Step 3. Collect traffic data and calibrate counters: Counts from each counter should be obtained according to the predetermined sampling plan. If a sample day is missed, the count should be recorded as soon as possible, noting the date and time on the log sheet and the original sampling plan should be resumed. To minimize the chances of vandalism and/or theft, observers should take an indirect path to and from the counter and avoid drawing attention to the counter during observations. Tallies should be recorded on a log sheet and entered into a database as soon as possible.

During calibration, the number from the traffic counter is recorded at the beginning and end of the calibration period. The observer should be positioned near the counter, but out of the sight of visitors to minimize any interference with normal snowmobile speeds and routes through the area. Additionally, the observer's snowmobile should not be parked too close to the counter. The observed traffic counts and the counts registered by the counter over the time period should be recorded on a log sheet and entered into a database as soon as possible.

Step 4. Estimate use: To estimate total snowmobile use in the park each month, the raw monthly tallies from the Black Bay, Moose Bay, Mukooda, and Rainy Lake traffic counters are multiplied by the appropriate counter error coefficients and entered into the use estimation formula presented above. Snowmobile estimates are then multiplied by the person-per-snowmobile factor to obtain an estimate of total park visitors on snowmobile.

Model refinement

The model presented in this report is valid as long as the general travel patterns of visitors on snowmobiles remain relatively consistent. As was the case in this study, weather conditions, especially snow depth and temperature, can significantly alter travel patterns. The snowmobile travel pattern model and use estimation formula presented here should more accurately account for these changes than the park's current estimation formula because: 1) the data used to generate the model were compiled over three winter seasons with variable weather conditions and 2) the model takes into account traffic levels at four locations dispersed throughout the park.

If travel patterns are deemed to have significantly changed for a variety of reasons, such as changes in management policies or internal infrastructure inside the park (e.g., zoning restrictions, new trails or visitor centers) or changes in tourism-based infrastructure outside the park (e.g., new lodges, regional trail closures) that affect snowmobile routes, then the travel pattern model should be ground-truthed and adjusted if necessary. In this event, it is recommended that additional interviews be conducted in a replication of the study methods detailed above.

Estimating snowmobile traffic at specific sites

This study demonstrates the usefulness of combining interview data with traffic data to estimate visitor use at sites with uncontrolled, multiple access points. The travel pattern model also provides managers with a database that can be consulted for a variety of issues related to visitor use patterns and levels. For example, if park managers are concerned about snowmobile impacts on the mainland or perhaps a specific lake, the expanded travel pattern model (Appendix G) can be used to calculate the snowmobile traffic levels at that site. For example, the number of snowmobiles crossing War Club Lake, which is on the Chain of Lakes trail, may be of interest to managers. The travel pattern model reveals 2,318 snowmobiles in the sample passed by War Club Lake (CP-5) 106 times (4.6%). Applying this percentage to the 2003 snowmobile use estimate (11,520) indicates that approximately 527 snowmobiles crossed War Club Lake in 2003. Kettle Falls may also be an area of interest to park managers. Park personnel have questioned if use has declined in this area since the closing of the Kettle Falls Hotel in the winter months. Using the same logic as demonstrated above, the travel pattern model shows that the sample of snowmobiles passed by this area (CP-15) 672 times (29%). Based on the total snowmobile use estimate, this area received traffic from approximately 3,341 snowmobiles in 2003, despite the hotel closing.

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APPENDIX A. INTERVIEW LOG SHEET

Voyageurs National Park Visitor Travel Pattern Study

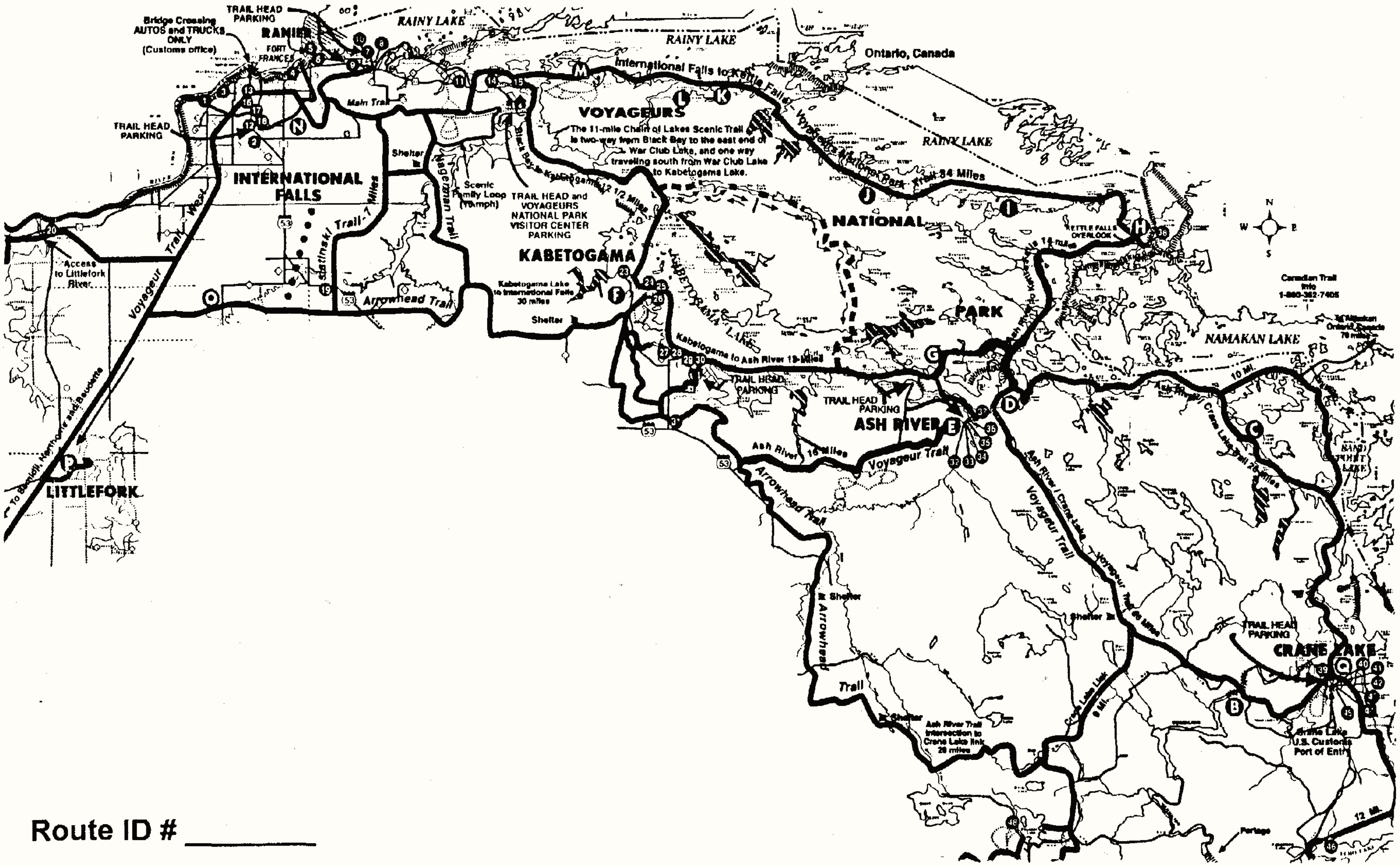
Date ____________ Time-block ___________ Location _______________ Temp/Snow Conditions: ____________________ Interviewer: __________

Route ID #	Time	Route date	People in group	Sleds in group	Days in VOYA	Miles on route	Hours on route	Starting & Ending Point	% off trails	Home town	Notes:

APPENDIX B. INTERVIEW MAP

Snowmobile Travel Routes

--show us where and in what direction you traveled.



Route ID # ________

APPENDIX C. SAMPLE PLAN

Table C1. Sample sites

	Groups	Percent
Thunderbird Lodge	106	19.6
Sandy Point Lodge	101	18.7
Voyagaire Lodge	85	15.7
Ash River Lodges	68	12.6
Black Bay Trail	59	10.9
Ash River Trail	47	8.7
Crane Lake Trail	40	7.4
Ash River	29	5.4
Rainy Lake	4	.7
Rainy Lake Trail	2	.4
Total	541	100.0

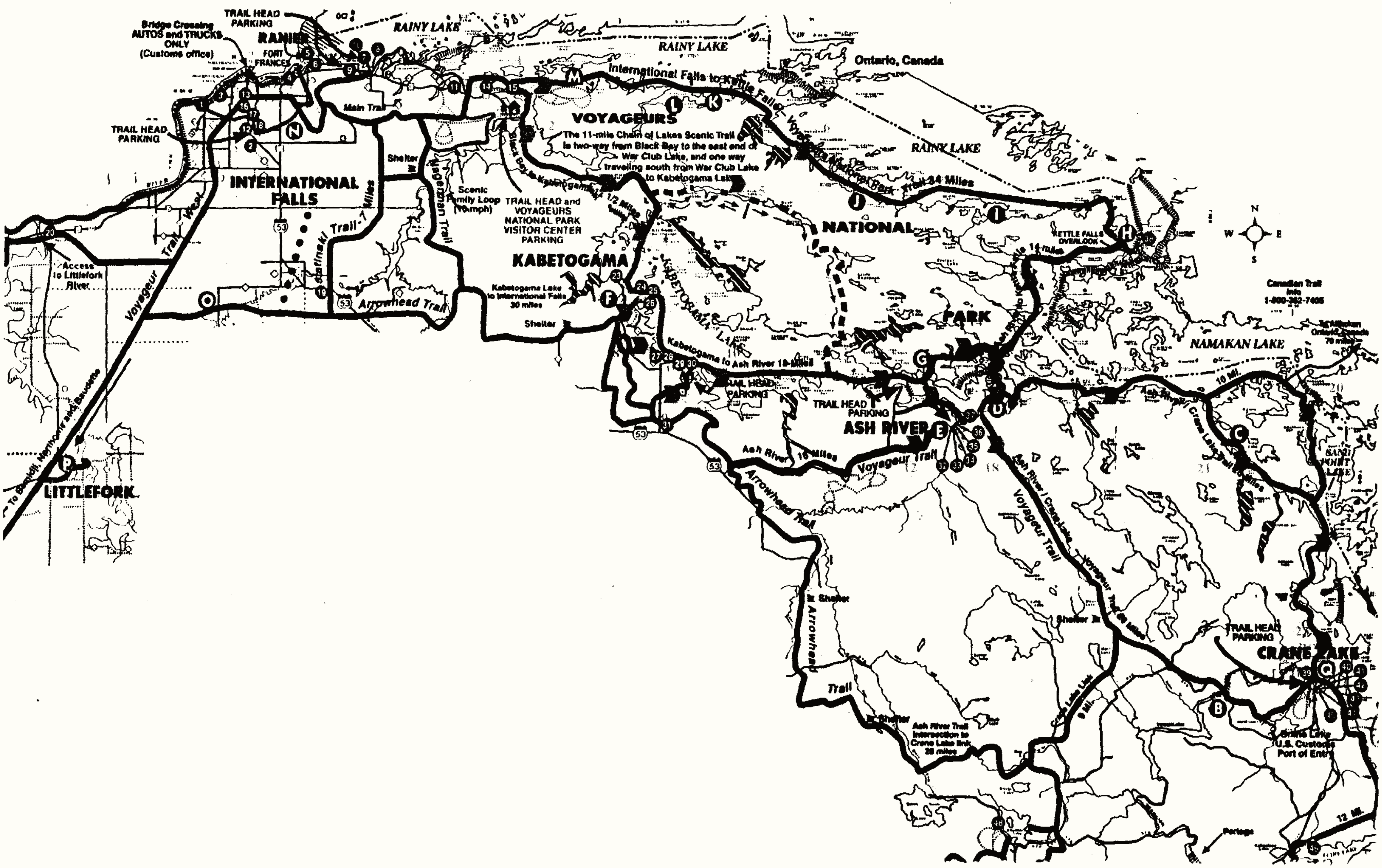
Table C2. Sample dates

		Groups	Percent
Thursday	03/08/01	4	.7
Friday	03/09/01	32	5.9
Saturday	03/10/01	65	12.0
Sunday	03/11/01	1	.2
Wednesday	01/16/02	6	1.1
Thursday	01/17/02	10	1.8
Friday	01/18/02	18	3.3
Saturday	01/19/02	71	13.1
Sunday	01/20/02	36	6.7
Monday	01/21/02	8	1.5
Friday	02/15/02	63	11.6
Saturday	02/16/02	73	13.5
Sunday	02/17/02	19	3.5
Friday	02/28/03	44	8.1
Saturday	03/01/03	81	15.0
Sunday	03/02/03	10	1.8
Total		541	100.0

Table C3. Dates of routes collected from groups

Day	Date	Routes	Percent
Thursday	03/08/01	9	1.7
Friday	03/09/01	35	6.5
Saturday	03/10/01	57	10.5
Sunday	03/11/01	1	.2
Sunday	01/13/02	1	.2
Monday	01/14/02	1	.2
Tuesday	01/15/02	2	.4
Wednesday	01/16/02	6	1.1
Thursday	01/17/02	9	1.7
Friday	01/18/02	18	3.3
Saturday	01/19/02	68	12.6
Sunday	01/20/02	35	6.5
Monday	01/21/02	9	1.7
Wednesday	02/13/02	1	.2
Thursday	02/14/02	10	1.8
Friday	02/15/02	53	9.8
Saturday	02/16/02	75	13.9
Sunday	02/17/02	16	3.0
Tuesday	02/25/03	1	.2
Wednesday	02/26/03	3	.6
Thursday	02/27/03	2	.4
Friday	02/28/03	54	10.0
Saturday	03/01/03	69	12.8
Sunday	03/02/03	6	1.1
Total		541	100.0

APPENDIX D. MAP OF CHECKPOINTS 1-23



APPENDIX E. PLACE OF RESIDENCE

Table E1. Place of residence of individual interviewed

	N
International Falls[a]	38
Minneapolis	38
Twin Cities	23
St. Cloud	18
St. Paul	18
Rochester	16
Virginia, MN	12
Hibbing	11
Wisconsin	10
Elk River	9
Ash River	8
Kabetogama	7
Iowa	6
Little Falls	6
Ely	6
Ft. Francis	5
Local[b]	5
Prior Lake	5
White Bear Lake	4
Crane Lake	4
Chisholm	4
Mountain Lake	4
Ranier	4
Bemidji	4
Grand Forks	4
Minnetonka	3
North Branch	3
East Grand Forks	3
Coon Rapids	3
Northfield	3
Orr	3
Canada	3
Owatonna	3
Illinois	3
Brainerd	3
Total[c,d]	541

[a]Shading signifies hometown within 20-mile radius of park; considered local resident.
[b]In some cases study participants reported being a "local" and exact hometown was not provided.
[c]76 other cities and states were reported as place of residence, but not included in this table when N < 3.
[d]Place of residence was not recorded in 2001.

APPENDIX F. TRAVEL PATTERN MODEL BY STRATA

Table F1. Travel patterns by sample year

	Black Bay		Moose Bay		Mukooda		Rainy Lake	
	N	%	N	%	N	%	N	%
2001 (n=464)	290	62.5	197	42.4	209	45.0	103	22.2
2002 (n=1353)	918	67.8	932	68.9	982	72.6	416	30.7
2003 (n=501)	344	68.7	300	59.9	292	58.3	122	24.4
Total (n=2318)	1552	66.9	1429	61.6	1483	64.0	641	27.7

Source: Interview route maps

Table F2. Travel patterns by day of the week

	Black Bay		Moose Bay		Mukooda		Rainy Lake	
	N	%*	N	%	N	%	N	%
Weekend** (n=2027)	1319	65.1	1312	64.7	1322	65.2	594	29.3
Weekday (n=291)	233	80.1	117	40.2	161	55.3	47	16.2
Total (n=2318)	1552	66.9	1429	61.6	1483	64.0	641	27.7

Source: Interview route maps

*Percentages based on number of snowmobiles (n) in each stratum.

**Weekend is Friday through Sunday, weekday is Monday through Thursday.

Table F3. Travel patterns by place of residence

	Black Bay		Moose Bay		Mukooda		Rainy Lake	
	N	%*	N	%	N	%	N	%
Nonlocal** (n=1642)	1050	63.9	1148	69.9	1188	72.3	493	30.0
Local (n=206)	200	97.1	84	40.8	86	41.7	45	21.8
Total (n=1848)	1250	67.6	1232	66.7	1274	68.9	538	29.1

Source: Interview route maps

*Percentages based on number of snowmobiles (n) in each stratum.

**Locals are visitors residing within a twenty-mile radius around the park.

APPENDIX G. EXTENDED TRAVEL PATTERN MODEL

Table G1. Travel patterns model across 23 checkpoints

Checkpoints		1	2	3[a]	4	5	6[b]	7	8	9	10	11	12	13	14	15	16	17[c]	18	19	20	21	22[d]	23
Weekend*	N	624	1319	1319	1266	103	594	505	80	203	1422	1446	447	1341	207	609	626	1312	753	1345	218	1155	1322	1322
(n=2027)	%	*30.8*	*65.1*	*65.1*	*62.5*	*5.1*	*29.3*	*24.9*	*3.9*	*10.0*	*70.2*	*71.3*	*22.0*	*66.2*	*10.2*	*30.0*	*30.9*	*64.7*	*37.1*	*66.3*	*10.8*	*57.0*	*65.2*	*65.2*
Weekday	N	56	233	233	216	3	47	122	2	10	200	2003	78	182	29	63	88	117	168	144	10	135	161	168
(n=291)	%	*19.2*	*80.1*	*80.1*	*74.2*	*1.0*	*16.2*	*41.9*	*0.7*	*3.4*	*68.7*	*70.8*	*26.8*	*62.5*	*10.0*	*21.6*	*30.2*	*40.2*	*57.7*	*49.5*	*3.4*	*46.4*	*55.3*	*57.7*
Local**	N	55	194	200	188	11	45	58	6	13	153	163	45	147	14	25	29	84	74	85	15	78	86	91
(n=206)	%	*26.7*	*94.2*	*97.1*	*91.3*	*5.3*	*21.8*	*28.2*	*2.9*	*6.3*	*74.3*	*79.1*	*21.8*	*71.4*	*6.8*	*12.1*	*17.1*	*40.8*	*35.9*	*41.3*	*7.3*	*37.9*	*41.7*	*44.2*
Non-local	N	519	1050	1050	1021	68	493	378	70	168	1267	1251	341	1157	199	520	541	1148	563	1197	158	1050	1188	1192
(n=1642)	%	*31.6*	*63.9*	*63.9*	*62.2*	*4.1*	*30.0*	*23.0*	*4.3*	*10.2*	*77.2*	*76.2*	*20.8*	*70.5*	*12.1*	*31.7*	*32.9*	*69.9*	*34.3*	*72.9*	*9.6*	*63.9*	*72.4*	*72.6*
Total	N	680	1552	1552	1482	106	641	627	82	213	1622	1652	525	1523	236	672	714	1429	921	1489	228	1290	1483	1490
(n=2318)	%	*29.3*	*66.9*	*66.9*	*63.9*	*4.6*	*27.7*	*27.0*	*3.5*	*9.2*	*70.0*	*71.3*	*22.6*	*65.7*	*10.2*	*29.0*	*30.8*	*61.6*	*39.7*	*64.2*	*9.8*	*55.7*	*64.0*	*64.3*

[a]Checkpoint at Black Bay counter, [b]Checkpoint at Rainy Lake counter, [c]Checkpoint at Moose Bay counter, [d]Checkpoint at Mukooda counter

*Weekend is Friday through Sunday, weekday is Monday through Thursday.

**Locals are visitors residing within a twenty-mile radius around the park.

APPENDIX H. COUNTER ERROR COEFFICIENTS

Table H1. Counter error coefficients

	Black Bay		Moose Bay	Mukooda	Rainy Lake
	Active	Passive			
2001	1.09	1.38	--	1.13	--
2002	--	1.18	1.30	2.03	1.17
2003*		1.09	1.30	1.47	1.17

Source: NPS calibration

*Calibration coefficients for Moose Bay, Mukooda, and Rainy Lake counters in 2003 were estimated based on previous years' calibration sessions.