Using vehicular traffic count data to estimate the factors driving water-based recreation use in northwestern Ontario, Canada.

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Abstract

Within Canada's publicly owned forests (i.e., Crown forests), little information is available about how and when people use lakes and rivers for recreation. I report an example of using traffic monitoring to identify both the spatial and temporal patterns of water-based recreational trips for a set of lakes in northwestern Ontario, Canada. To gather recreational trip data, monitoring devices were strategically located along roads and trails that access lakes. I used information about the lakes, roads and trails and user days to help explain variations in spatial and temporal patterns of recreation demand. A fixed effects negative binomial regression model was used to estimate the effect of physical and temporal attributes on daily traffic counts at the water-based sites. This analysis supported 12 of 14 hypothesized relationships between the spatio-temporal attributes and traffic counts. Recreationists in northern Ontario were more likely to pursue water-based recreation at sites with large-sized waters that hold walleye (*Sander vitreus*), that have better access, and that are close to human communities. Individuals were also more likely to recreate during holidays or culturally significant events during periods of warm temperatures and minimal levels of precipitation. These attributes were generally supported by the literature and through nine interviews with local recreationists, Ontario Ministry of Natural Resources (OMNR) officials, and tourism operators.

Being able to identify and model where and when water-based recreation occurs should greatly improve resource managers' abilities to proactively manage the resources. This information may allow managers to spatially segregate competing activities (including industrial resource extraction) through the development of zoning techniques that concentrate recreational activities in areas of greatest demand. Understanding the temporal attributes that drive

recreational use may also allow for the development of temporal segregating techniques, including alternative winter forest harvesting schedules, to mitigate conflict between competing activities.

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Chapter I - Introduction

"*Recreational development is a job not of building roads into lovely country, but of building receptivity into the unlovely human mind*" (Leopold, 1949, p. 295).

In Canada, a fundamental shift in the valuation of forests has begun that is moving forest management of public lands from simply sustaining timber production to sustaining a broader range of forest values (McFarlane & Boxall, 2000). Today, forest management has begun to move towards more sustainable management prescriptions that emphasize non-timber values and community involvement to address the growing conflicts between competing values on the land (Racevskis & Lupi, 2006). One of the more frequent land use conflicts arises from the forest resource's ability to generate both market values (e.g., timber production) and non-market values (e.g., wildlife and recreation) for communities (Racevskis & Lupi).

Individuals attach a diverse set of interests and values to forested landscapes. Today, managing publicly-owned forests is a complex process that attempts to balance a broad range of values and interests while ensuring sustainable industrial forest harvesting outputs (McFarlane & Boxall, 2000; Cordell & Tarrant, 2003).[1] The inability to balance these outputs and ever increasingly diverse values has contributed to the growing number of conflicts over the management of public lands (Robson, Hawley, & Robinson, 2000; Hunt, Lemelin, & Saunders, 2009). Many of these conflicts arise from decisions that seek to allocate scarce resources among economic, leisure, and other interests (e.g., environmental groups).

Use conflicts among outdoor recreation, resource-based tourism, and forestry abound in northern Ontario (Hunt et al., 2009). For example, Hunt, Twynam, Haider, & Robinson (2000)

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[1] A value is an expressed preference of any one thing compared to others (Brown, 1984).

found that some recreational activities occurring in northern Ontario, such as non-consumptive activities, are best suited in areas that are spatially segregated from periodic forest harvesting activities. Satisfying all parties involved in resource allocation decisions is a difficult task for managers (Bengston, 1994). This task is made more difficult when managers have a poor understanding of places that are important for economic and leisure pursuits and that are valued by individuals. Resource managers must address these deficiencies by elevating their understanding of the diversity of values on the land base (Bengston) and the importance attached to different places and times of year by people (Haab, 2003; Brown, 2005; Hunt, Boots, & Boxall, 2007).

While a large portion of nature-based recreational use occurs within Ontario's parks and protected areas, a significant amount of this use also occurs on non-protected Crown lands alongside forestry operations (FEDNOR, 2002; Browne, Rutherford, & Gunton, 2006; Hunt, & McFarlane, 2003). However, outside of Ontario's specifically designated parks and conservation reserves, forestry operations are the dominant use of public lands, and thus, the designated forest management plans act as a default for land use planning. In 1994, the Crown Forest Sustainability Act was enacted to regulate Ontario's forest management planning strategies and recognize both timber extraction values and non-commodity resource values including recreation in forest management planning (OMNR, 1999). The Act arose from growing pressure from the public and academic communities to begin recognizing a need for greater representation of diverse interests and uses in forest land-use planning and management (Teitelbaum et al., 2003).

Understanding the physical attributes (e.g., lake size, road type, distance) that influence recreational behaviour at these recreational sites is an important dimension to begin planning and managing for these uses. However, only understanding where people recreate provides only a limited view of their behaviour. Neither timber nor non-timber activities occur consistently across time, but rather vary considerably across and within seasons (Provencher & Bishop, 1997; Wright et al., 2001; Haab, 2003; Hunt et al., 2007). For example, Hall and Shelby (2000) found that the most common coping strategy of recreationists when faced with conflict was changing the timing of their trips. This strategy ranked just ahead of resource and activity substitution that results when an individual alters the site or the activity pursued on the trip (Hall & Shelby). By beginning to understand the temporal variations of recreational behaviour, temporal segregation techniques (e.g. altering the timing of timber harvesting around high valued recreational events) may also be developed to mitigate conflicts between forestry and recreational activities.

Yuan, McIntyre, Payne, and Moore (2004) recently established a method to map non-timber values (such as nature-based recreational opportunities) on a land-base. This approach may allow managers to proactively identify valued recreational areas prior to creating resource extraction prescriptions, thus, reducing possible conflicts on the land base. This method identifies and predicts the occurrence of spatial valuation zones (SVZ), which are areas of importance to individuals that pursue nature-based recreation or resource-based tourism activities (McIntyre, Moore, & Yuan, 2008). This thesis was produced in part to add insights into this approach by furthering the understanding of how uses of these SVZs vary across time.

This thesis was produced to understand the attributes that influence outdoor recreation on public, non-protected lands in northern Ontario, Canada. Recreational pursuits in northern Ontario are primarily focused around water-based settings (Twynam & Robinson, 1997; FEDNOR, 2004). Therefore, this study collected recreational use information at selected water-based recreational destinations in previously established spatial valuation zones (SVZs) (Lesueur, 2008). This collection was done with traffic counting devices, placed alongside roads and trails that provided recreationists with motorized vehicle access to selected water-bodies. The physical attributes of the sites were measured to help explain variations in traffic counts. The temporal attributes of the surveyed period were also measured to assist in explaining the variations in the traffic counts.

To better understand how these spatio-temporal attributes influence recreationists, I also conducted nine interviews with knowledgeable local recreationists, tourism operators and government officials. Information from these interviews was used to verify the preliminary conclusions from the quantitative count data. Therefore, the qualitative data was not presented as results. Instead, quotes from interviews are presented in the discussion section to support or refute the findings from the quantitative analysis. These interviews helped to ground the interpretation of the traffic counter data within the context of the local users of the area. By discussing the temporal patterns deduced from the traffic counter data in interviews with the users of the area, I was able to achieve a greater understanding of the attributes that influence people to choose where and when to recreate in Crown forests. The importance of this approach is recognized by researchers who call for the need to better understand the more abstract and intrinsic motives of recreational site choices (Brown, 2005).

Purpose Statement

This study will explore and compare the spatio-temporal patterns of water-based recreation occurring within spatial valuation zones identified in areas within the Lake Nipigon, Black Sturgeon and Dog-River Matawin Forest Units.

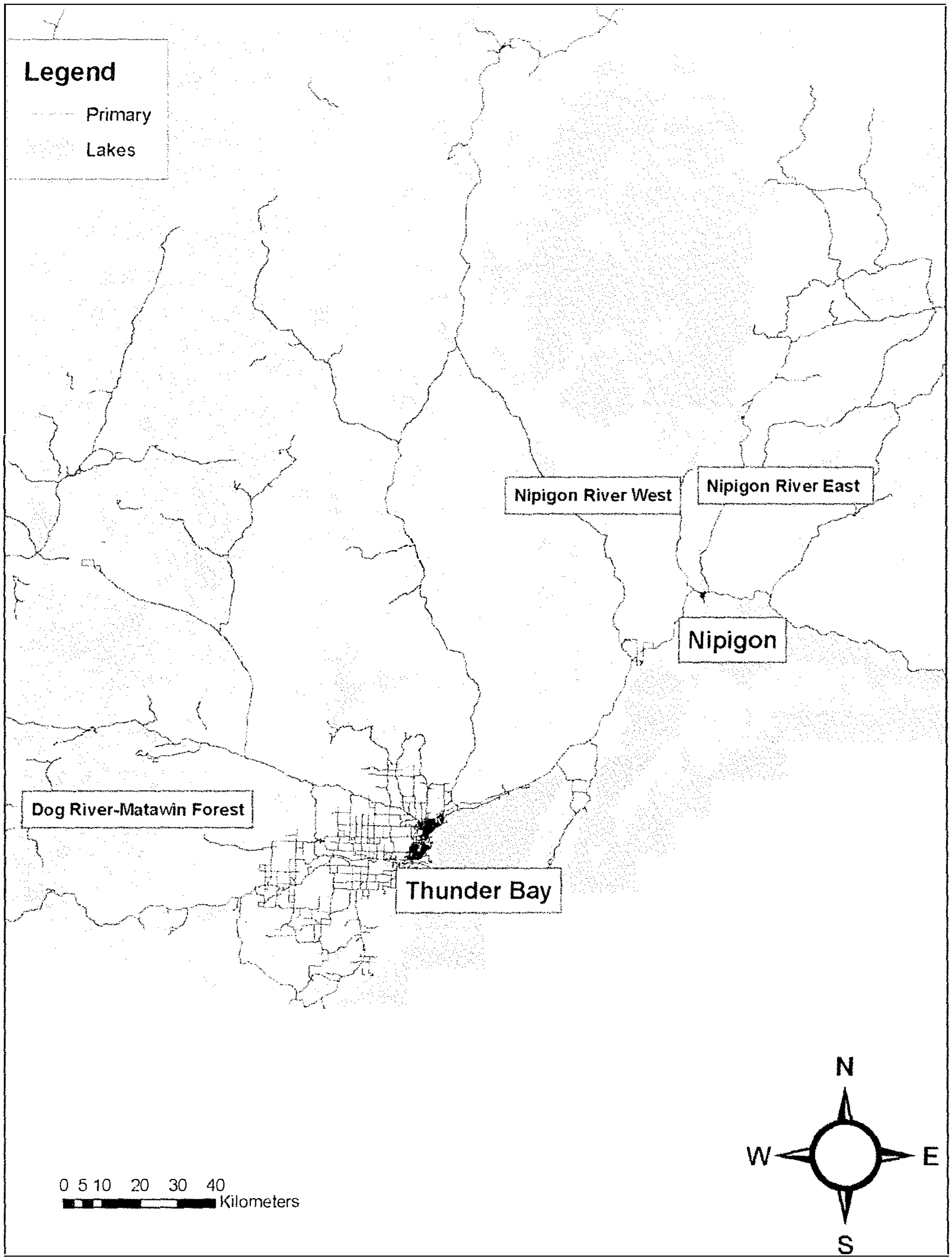

Figure 1 - 2008 Study Area

In particular, two primary research questions guide this research:

1. What are the patterns of water-based recreation use on selected Crown lands of northern Ontario?
2. What factors influence these patterns of use?
    a. What are the factors that influence where individuals pursue their recreational activities?
    b. What are the factors that influence when individuals pursue their recreational activities?

The remainder of the thesis is organized as follows. The next chapter reviews relevant literature surrounding these research questions and context. The following chapter addresses the research approach, model development and methods of analysis. The final chapters focus on the results of the analysis, along with a discussion of these results and concluding remarks.

Chapter II - Understanding Water-Based Recreation on Crown Lands

Nature-Based Recreation in northwestern Ontario

Canadians hold strong values towards the natural environment and the nature-based activities they engage in within it (Gray et al., 2003). In 1996, Gray et al. reported that 85 per cent or 19.9 million Canadians participated in nature-based recreational activities with recreational angling, wildlife viewing and hunting being the most popular. Within northern Ontario's Crown (i.e., publicly-owned) forests, nature-based recreation and tourism are estimated to be highly valued activities (FEDNOR, 2004). In 2002, 6.3 million people visited northern Ontario, with 61 per cent engaging in nature-based recreational pursuits (FEDNOR). Recreational angling and hunting activities accounted for almost half (47%) of this visitation (FEDNOR). Growth in angling and hunting activities is expected to continue in northern Ontario (FEDNOR).

Hunt and McFarlane (2003) reported that the most popular activities that Ontario residents participated in were non-consumptive activities, such as wildlife viewing, hiking and bird watching, followed by the more consumptive forms of recreation, including angling, berry picking and hunting. In 2002, the most popular nature-based recreational activities reported in northern Ontario were angling, hiking, and wildlife viewing (FEDNOR, 2004). Lesueur (2008) found similar results, reporting that the most frequent activities engaged in by residents along the north shore of Lake Superior in northwestern Ontario were angling and hunting. These dominant recreational activities in northwestern Ontario have been found to be driven by the presence of a water setting and good quality road access (Hunt et al, 2009; Hunt & Lester, 2009). Therefore, it was assumed that northwestern Ontario residents would most likely recreate near water-based settings that are accessible by roads and trails.

Water-based settings provide several opportunities for nature-based recreational activities, including angling, camping, swimming, canoeing, kayaking, and motor boating. Twynam and Robinson (1997) reported that nature-based tourists in northern Ontario preferred recreating in settings that featured lakes, rivers, undisturbed natural scenery and access to drinking water. Northwestern Ontario moose hunters also preferred recreating near water bodies (Bottan, Hunt, & Haider, 2003). This preference by hunters likely arose because better quality moose habitat includes wetlands and hunters might prefer camping near water. Consequently, water-based settings are very important to northwestern Ontario recreationists.

Ontario offers many water-based settings with over 250,000 inland lakes and four of the Great Lakes (Lester et al., 2003). Lakes found in northern Ontario have not been subjected to the same stress and angling pressures as their counterparts in southern Ontario resulting in higher quality angling opportunities and consequently, elevating the importance of angling in the region (Lester et al.). Recreational angling is not only important for the leisure pursuits of recreationists (Curtis, 2003; FEDNOR, 2004), but also for the economy of northern Ontario (Haider & Hunt, 1997; Lester et al.). Most of this recreational angling and nature-based recreational use in northern Ontario occurs outside of protected areas on Crown lands (Hunt & McFarlane, 2003).

Management of nature-based recreational activities on Crown land is limited, as district land use plans and fisheries and wildlife management plans only provide guidance for the maintenance of a limited range of recreational values. The only existing management guides for the protection of recreational values and activities are those associated with resource-based tourism operations (OMNR, 2001). For resource managers to address this lack of guidance for managing Crown land recreation, it is important to inventory recreational opportunities and use. It is also important to understand the factors that influence the choice of places and times of use by recreationists for their activities (Hunt, 2005). Mapping where and how visitors are using the forests represents one important way to create this inventory and to explore the importance of different factors (Hall & Shelby, 2000; Pierskalla et al., 2007).

To begin addressing these needs, Lesueur (2008) identified high recreational use areas (HUA) within the Crown Forests to the north of Lake Superior. These HUAs were recognised to be important and valuable recreational areas by residents of the North-shore communities (McIntyre, Lesueur and Moore, In Press). While useful, the broad scale used to describe these recreational sites does not address the significant spatial and temporal differences that potentially affect the importance and use of these sites. For example, individuals pursue activities and value recreational settings differently within and between seasons (Provencher & Bishop, 1997; Wright et al., 2001; Haab, 2003; Hunt et al., 2007). Understanding the fine scale differences in the importance of sites and times of year provides valuable information for resource managers. Information concerning the temporal variations in recreation use may provide opportunities to schedule forestry operations around times of low recreational use. Consequently, needs exist for information about factors that affect the timing and location of outdoor recreation trips. Understanding these factors becomes highly important for resource managers needing to understand the site choice decisions of recreationists (Hunt, 2005). Past research aimed at understanding complex recreational behaviours has used pattern and process-based research tools.

Patterns, Processes, and Preferences

Behavioural research on outdoor recreationists usually involves descriptions of the patterns of behaviour or investigations of processes that are thought to produce these patterns. These research approaches all have varying ways to understand the ‘intention’ to pursue an activity. This section provides a review of some literature that has focused on understanding the patterns, processes or preferences of recreational behaviour.

Pattern-Based Research

Typical pattern-based research for outdoor recreation describes how people value and use the land by inventorying the supply of natural resources and how these lands are used and valued (Hull, Stewart & Yi, 1992). Researchers have argued that mapping the distribution of these values and uses provides a valuable and necessary focus for recreational research (Hull, Stewart & Yi). These value and use patterns have led researchers to focus on how visitors derive satisfaction from recreational settings (Clark & Stankey, 1979; Robertson & Regula, 1994; Pigram & Jenkins, 2006). Early recreation management strategies were focused on providing a variety of recreational settings to provide a number of recreational opportunities to visitors. The Recreational Opportunity Spectrum (ROS) (Driver & Brown, 1978; Clark & Stankey) was one recreational management framework that focused on supply-based inventories of recreational settings.

Initially, the ROS was developed to provide a general zoning approach for recreational management that would allow visitors to select from a diversity of recreational settings (Driver & Brown, 1978; Clark & Stankey, 1979). ROS zoning strategies, ranging from ‘primitive’ to ‘urban’ settings and varying levels between these two extremes, allows managers to ensure that a diversity of settings exists in a managed area (Driver & Brown; Clark & Stankey; Cole & Hall, 2006). Using indirect management strategies, the 'primitive' setting manages for non-motorized recreation to occur in an area with minimal human development (Dearden & Rollins, 2002). This 'primitive' setting accommodates recreational users who seek a more wilderness experience. By contrast, the 'urban' setting maintains easy, roaded access to areas containing developed facilities with more direct managerial control (Dearden & Rollins). 'Urban' settings provide opportunities for individuals who wish to experience a more modified natural setting with minimal management and easier accessibilities. While initially developed using actual levels of demand for and value of the settings by recreationists, the application of the ROS does not provide further insights into how these attributes are valued or used. Recent technological advancements have helped progress these pattern based research approaches.

The growth of geographic information systems (GIS) technology and spatial statistics are helping researchers merge values data with spatial information (Brown, 2005). One type of research, public-participation GIS (Brown), focuses on involving participants (e.g., recreationists, First Nations, urban residents) in developing maps for a variety of planning purposes. In recreation, this approach involves asking visitors to indicate on maps, the places that they use and value for different reasons (Brown). By collecting enough data, patterns emerge that illustrate places that are particularly important to recreationists and others (Brown). This provides managers with a sense of where individuals intend to recreate. Forest settings may then be managed for their actual value to the user, rather than the general opportunities they may provide.

Although pattern-based research accounts for contextual factors, managers and others also need to know how changes might affect these patterns. A potential limitation with the public-participation GIS research is that the patterns of spatial values will change for a variety of reasons including changes to recreational demand, infrastructure, and/or resource modifications (e.g., loss of forests, development of roads). This limitation is problematic for resource managers who must try to account for these changes when managing resources. Therefore, researchers have taken a more deductive approach to recreational research that focuses on developing recreational models based on the various land characteristics that influence recreation patterns (Hunt, 2005). Pattern-based research may then act as a building block from which researchers use inductive approaches to develop theories of behaviours. Research on the behavioural processes within nature-based recreation has become more widely used in developing these theories.

Process-Based Research

Numerous competing and complementary theories exist to try and understand processes that individuals use to make decisions such as choosing recreational pursuits. The Theory of Planned Behaviour (Fishbein and Ajzen, 1981) and utility theoretic approaches are two popular ways that have been adopted to describe the processes of human behaviour. The Theory of Planned Behaviour focuses on the individual and the development of attitudes (and preferences) while the utility theoretic approach attempts to understand how these preferences (and behaviours) are influenced by the environment (or physical and temporal contexts).

Originally developed by Fishbein and Ajzen (1981) as the Theory of Reasoned Action, the Theory of Planned Behaviour links behaviours and behavioural intentions to attitudes, societal norms, and perceived behavioural controls. Behavioural intentions are thought to be influenced by both the specific attitude of the individual towards performing the behaviour and the importance of these attitudes to the individual (Fishbein & Ajzen, 1975, 1981).

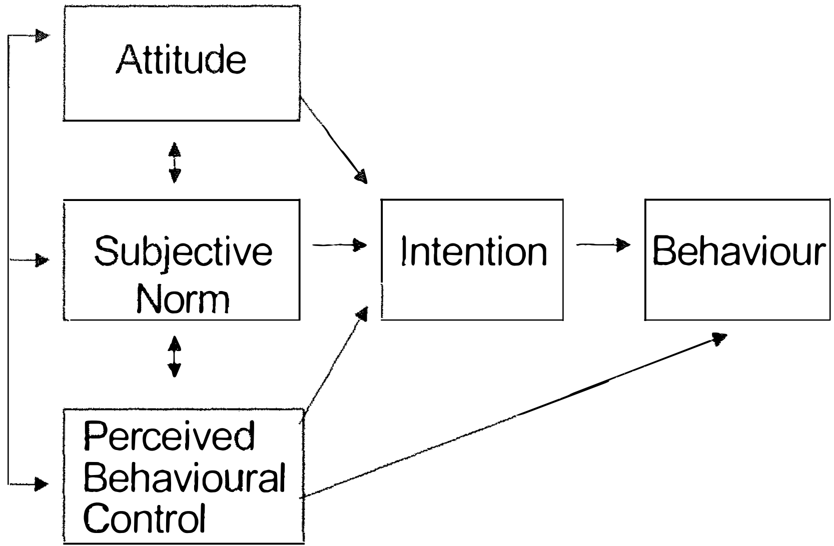

Figure 2 - The Theory of Planned Behaviour (Ajzen, 1991)

An individuals' attitude is regarded as the positive or negative evaluation of the perceived behaviour (Fishbein & Ajzen, 1975, 1981). For example, this might involve a recreationist's positive or negative evaluation of their past experience canoeing on a particular water body. Subjective norms and the importance of these norms to the individual also influence behavioural intentions. These norms refer to the perceived behavioural expectations of significant groups or other individuals for a given behaviour (Fishbein & Ajzen). An example of this might involve attempting to remain quiet while paddling on the water body, expecting that the surrounding camps or fellow canoeists would prefer such actions. Finally, Ajzen (1991, 1998) noted the importance of perceived behavioural control to the individual would affect that individual's intentions. Perceived behavioural control is a person's belief about his or her ability to undertake the behaviour in question (Ajzen; Ajzen & Driver 1992). An example of this control may be a person's beliefs about his/hers ability to paddle a certain set of rapids, or to climb a certain mountain.

The Theory of Planned Behaviour, Ajzen (1991) theorizes that behavioural intentions are related to actual behaviours. Consequently, changes to individual attitudes, societal norms, and/or perceived behavioural control can all affect leisure behaviours (Ajzen & Driver 1992). For example, Hrubes, Ajzen, and Daigle (2001) examined the ability of the Theory of Planned Behaviour to predict the participation of hunters. Intentions were found to be the most significant predictor of behaviours, while perceived behavioural controls were found to be insignificant at predicting the likelihood to hunt.

While useful for understanding individual socio-psychological factors that influence a recreationist's intention to pursue an activity, the Theory of Planned Behaviour is not well suited to understand how different setting conditions might affect the locations and timing of recreational trips. Instead, preference-based research is better suited to understand and predict how changes to the physical environment might affect one's intention to recreate.

Some researchers examine the preferences that recreationists have for physical attributes (factors) that might influence demand for recreation. In essence, these approaches avoid detailed examinations of individual preferences and instead measure current preferences among recreationists for a variety of physical attributes that comprise a recreational site. Amongst the most popular preference-based approaches is the utility theoretic approach (Hunt, 2005).

Two theories comprise the utility theory approach when dealing with discrete goods such as choosing a recreational site. First, utility maximization assumes that a recreational participant behaves to maximize his/her welfare or utility (Hunt, 2005). For recreational activities such as angling, it is typically assumed that utility arises from the factors that define alternatives (e.g., facilities, encounters with others) and the cost of accessing the site (e.g., time, resources) (Hunt). Each attribute has a particular value to each individual, reflecting its importance. During the process of choosing a particular recreational site, the individual is assumed to weigh each attribute at each particular site according to its value, and choose the site that will provide the greatest overall utility, or value to the individual (Hunt).

The second theory, known as random utility theory, takes into accounts the uncertainty involved in predicting behaviours of people such as recreationists. Although Thurstone (1927) developed the theory to account for uncertainty on the part of the chooser, random utility is now assumed to arise from the inability of the researcher to account for all aspects that lead to utility formation for a chooser (Ben-Akiva & Lerman, 1985). This inability of researchers to account for all elements of utility formation, adds some uncertainty into utility theoretic models. In fact, this uncertainty changes these models from deterministic to probabilistic. In other words, researchers can only estimate a probability that any individual will select any given recreational site. Focusing on individual attributes, rather than the whole good or service enables researchers to assess how changes in individual site and temporal attributes might affect recreational choices over time and space (e.g., Parsons, Jakus, & Tomasi, 1999; Haab, 2003; Hunt et al., 2007).

Researchers may develop choice models of recreation sites using three types of choice data. The most widely used data for recreation-based choice models use actual or reported choices by recreationists (i.e., a revealed preference choice model) (Hunt, 2005). Developing models using revealed preferences have the validity of using actual behaviours, yet the limited variability and collinearity (e.g., lake sites with paved access may also tend to have a boat launch) between attributes may affect the estimation of preferences for the attributes (Hunt).

Researchers have also used hypothetical or intended choices (i.e., stated preference choice model) (Hunt, 2005). Because stated preferences are based on intentions, researchers can design choice experiments with rules that assist in the estimation of preferences (Louviere, Hensher & Swait, 2000). These estimations are limited due to their heavy reliance on the connection between a recreationist's intention and actual behaviour. Stated preference models, however, do have the ability to evaluate scenarios and sites with a higher degree of variability and even examine the effect of scenarios that may not currently exist (Hunt).

More recently, researchers have begun to develop joint models that use both stated and revealed preferences (e.g., Ben-Akiva & Morikawa, 1990). Though limited in their application, joint models, using both revealed and stated preference data, have the validity of using actual behaviours combined with the statistical rigour of estimating an increased variety of independent site variables using stated preferences (Hunt).

In some cases, the dependent variable is not a choice but rather a count of recreational trips (Haab, 1996; Haab & McConnell, 1996). In these instances, a count-based regression model is used that predicts the number of recreational trips at a site through the use of attributes that describe the site. Recreational count models tend to follow a non-linear regression model that attempts to account for the variability and uncertainty in choice decisions (Haab & McConnell). For example, in a negative binomial regression count model, a random term is included to represent the unexplained between-subject variability. Therefore, to identify the significant attributes that influence recreational behaviour, this study will draw on elements from choice modeling theories, while developing a model based upon count-based regression analysis.

Important Physical Attributes for Water-Based Recreation Demand

"The angler is a predator foraging in a patchy environment whose choice behaviour is affected by the rewards of angling in different lakes" (Lester et al., 2003, pg 1316).

Past research on water-based recreation provides many insights about expected attributes that should influence the locations and timing of recreational trips. As mentioned, not only is water-based recreation in northern Ontario primarily focused on angling (Hunt & Lester, 2009), research on water-based recreation also often focuses on angling (Parsons & Kealy, 1992; Pollock, Jones, & Brown, 1994; Englin & Lambert, 1995; Train, 1998; Cook & Yuonk, 1998; Lester et al., 2003; Hunt, 2005). While this research also focuses on recreational angling, most of the attributes identified below are applicable for all water-based recreationists (e.g., distance, access, weather). Attributes that affect the choice of where individuals pursue water-based recreation are typified by those that attract and constrain recreationists. Attractants include resource quality, environmental quality, and facility development. Some of the recreational constraints of pursuing water-based-recreational activities include cost, congestion and regulations. Many of these attributes are drawn from the recreational angling literature.

Site choice attractants

As expected, the quality of angling is an important attribute for anglers when selecting an angling site (Englin & Lambert, 1995; Kaufman, Snucins, Gunn, & Selinger, 2009). Quality angling has been measured in many ways including catch success rate, expected catch rate, number of varying fish species, quantity of the fish stock, and lake size (Parsons, & Kealy, 1992; Pollock et al., 1994; Englin, & Lambert; Train, 1998; Cook, & Yuonk, 1998; Lester et al., 2003; Hunt, 2005). Catch rate has been measured as catch per unit effort (e.g., catch per hour), obtained through site surveys or randomly estimated on the basis of previous catch and total catch rate in the area (Englin, & Lambert; Provencher, & Bishop, 1997; Schuhmann, & Schwabe, 2007). However, measuring and obtaining individual angler’s catch rate information is time consuming and very costly (Pollock et al.). In lieu of these time and cost constraints, researchers often use certain physical attributes that provide proxies for angling quality.

The presence of particular game species has been used as a measure of angling quality (Lyons, Talks & Hickley, 1999; Cook & Yuonk, 1998; Lester et al., 2003; Hunt, 2005; Hunt et al., 2007). Much of the literature focused on anglers within the northern Boreal context refer to certain species such as walleye (*Sander vitreus*), lake trout (*Salvelinus namaycush*), brook trout (*Salvelinus fontinalis*) and northern pike (*Esox lucius*) as desirable species for anglers using the area (Cook & Yuonk; Lester et al.; Hunt; Hunt et al.). Hunt et al. developed a site choice model for the northern Ontario anglers and they forecast a substantial increase in angling activity within an area (sometimes an increase of 800 per cent) after the recovery of a walleye fishery. The presence and size of a particular fish population has been shown to be influenced by the size of the fishery itself, which has also been demonstrated to be a strong predictor of recreational activity (Walters & Cox, 1999).

Many researchers have examined lake size as an influence of angling activity under the assumption that as the lake size increases the diversity of fish species and size of some fish also increase (Hunt & Lester, 2009). Large body fisheries help support a large number of bigger fish, while consequently supporting many smaller fish populations (Walters & Cox, 1999). When examining the effect lake size has on an angler's site choice, researchers tend to use the logarithm of the lake area (Parsons & Kealy, 1992; Train, 1998). This occurs as researchers expect to see a diminishing effect of lake size on anglers' site choices (Parsons & Kealy). For example, the difference of the effect of lake size for lakes between 101,000 and 150,000 ha will be far less than the difference for lakes that are between 1,000 and 50,000 ha.

The level of facility development at a water-based setting is another attractant for some recreationists. For example, this development may include the presence of boat launches or developed camps or Recreational Vehicle (RV) sites. Adamowicz (1994), when examining Alberta anglers, determined that the number of camping sites at an angling destination was significantly related to site choice. Train (1998) was also able to show that the presence of a campground significantly and positively affected anglers' choices of angling sites.

Another attractant found to influence behaviours of water-based recreationists is environmental quality (Haider & Hunt, 1997; Mace, Bell, & Loomis, 1999; Hunt, Twynam, Haider & Robinson, 2000; Brown, 2005; Solon & Brunt, 2006). While resource quality focuses on the activity (e.g., angling), environmental quality represents the backdrop in which the recreation occurs. Some research suggests that recreationists engage in nature-based activities to escape the over-populated, polluted and congested urban world in which they live (Mace et al.). For example, Haider and Hunt examined the preferences of a particular angling group, the remote, fly-in angling tourist, and found that these anglers preferred to recreate in more pristine environments.

The ecological quality of a particular angling lake relating to the health of the fish community would have a direct relation on the attractiveness of a particular destination for an angler. Quality of the water at a particular angling destination has been used as an indicator of environmental quality. Quality of water has been measured in many ways, with the majority of measures examining the elements that most effect game species (Englin, & Lambert, 1995). These indicators include the varying levels of pH, calcium, aluminum, the amount of dissolved oxygen, clarity and nutrient levels, all of which have been found to have a significant effect on fish species within the lake and subsequently on the choices of anglers for these lakes (Englin &

Lambert; Lipton & Hicks, 1999; Hunt, 2005). These particular water quality indicators have also been shown to be significant to individuals seeking recreational swimming and beach opportunities (Freeman III, 1995; Needleman, & Kealy, 1995). Although water-based recreationists may not have the ability to measure or obtain this information, the resulting effects on the game species within the lake and water clarity and odor are important to their choices.

The aesthetic value of a site is another environmental quality measure that drives site choices of recreationists. Aesthetic value has been measured many ways including level of sound (dB), affective natural beauty, and absence of industrial activities (Train, 1998; Mace et al., 1999; Hunt, Twynam et al., 2000). Train determined that anglers who placed higher than average value on the particular fish stock also placed a higher than average value on the aesthetic appeal of the site. This indicates that anglers not only select sites based on their ability to catch prized fish stocks, but also to be able to recreate in a quality natural environment.

Constraints on Site Choice

Several factors may constrain an angler from using a particular water body. The most noted angling site constraints include cost, congestion, and regulations.

Researchers typically focus on travel costs or distance and almost always find significant and negative relationships between choice of water-based settings and cost (Provencher, & Bishop, 1997 Hunt et al., 2007; Hunt, & Lester, 2009). Travel costs are measured in different ways and include vehicle operating costs and sometimes the value of travel time (Provencher & Bishop; Hunt et al.; Hunt & Lester). The difficulty of access to a water body can also be viewed as a cost that constrains many recreationists. Access to water bodies may vary between a simple walk-in trail to fully developed road access. Griffin and Walters (1999) assessed angling effort in an Australian river system that prior to 1986 was privately owned and impassable. Before 1986, the river system experienced very low angling pressure. In 1986, when it became government parkland and an all-season paved access was created, visitation jumped to 30-40 anglers per day during the summer months (Griffin, & Walters). Two cases from northern Ontario also support the important role of quality of access on water-based recreation. Kaufman et al. (2009) found that angling effort for lake trout in northeastern Ontario increased as access improved from no access, to trail to gravel road. Likewise, Hunt et al. (2007) found that angling trips by resident northern Ontario anglers increased as access improved from trails to better quality gravel roads.

An increased number of access roads into recreational areas provide both positive and negative impacts. They create optimal situations for those visitors seeking areas with easier and more abundant ways to access recreational destinations, yet at the same time, this may affect those visitors seeking a more primitive wilderness experience at the site (Bengston & Fan, 1999). Therefore, research also suggests that some recreationists may prefer less developed forms of access as a means to engage in more primitive or remote forms of recreation. Remote wilderness characteristics, such as solitude and minimal human interference, are highly valued attributes of recreational quality that lie in direct conflict with the introduction of improved road access (Mace et al., 1999; Hunt et al., 2007; Laven, Manning, & Krymkowski, 2005). Decreasing travel cost and improving accessibility to a water body will increase use of the area, thus increasing the pressure on the resource (Walters, & Cox, 1999). This increased level of use and pressure on the resource may then result in visitors seeking areas with more difficult access.

Continued increase of the number of visitors to a site may cause a recreationist to view the site as being congested (Schuhmann & Schwabe, 2004). Congestion at a water-based site has also been found to be a constraining factor in anglers' choice of angling sites (Schuhmann & Schwabe). This result is consistent with the concept of social carrying capacity (Cole, 2001).

Social carrying capacity, as it relates to visitor use, states that people have limits to the number of users or encounters they are willing to tolerate in recreational settings. This suggests that feelings of crowding and less subjective measures such as increased number of encounters should negatively affect choices by recreationists (Cole). Congestion has also been found to be a significant constraint on an angler's site choice. Schuhmann and Schwabe were able to show that an increase in number of expected visitors at a given angling site may cause a negative impact on an angler's choice to recreate at that site. A difference was found, however, between the different types of anglers. The effect was stronger for anglers that "keep" their catch than anglers who "release" them. This finding suggests that an increase in visitors to an angling site may reduce the likelihood of keeping prized fish (Schuhmann, & Schwabe). Therefore, congestion is not only a measure of the number of individual or group encounters, but may also be a measure of the impacts of groups on the sites resources.

The implementation of certain angling regulations on an area has also been shown to have a strong effect on angling effort at those sites (Lester et al., 2003). Managerial restrictions and regulations have been found to have varying effects on angler's site choice based on their level of fishing experience (Oh, & Ditton, 2006). It has been suggested that more experienced anglers may be aware of resource changes and disturbances and thus, are more wiling to accept the need for management intervention (Oh, & Ditton). Yet, these same researchers have found that experienced anglers are more likely to protest undesired management prescriptions and view them as a constraining attribute.

Important Temporal Attributes for Water-Based Recreation Demand

Identifying only the physical attributes that affect recreational behaviour provides an incomplete understanding. Individuals pursue activities and value recreational settings differently within and between seasons (Provencher, & Bishop, 1997; Wright et al., 2001; Haab, 2003; Hunt et al., 2007). Past studies that have explored the timing of recreational trips suggest that cultural and calendar events, climate and weather, and temporal variability in resource quality can all affect the timing of recreational trips (Hunt, et al.).

Specific culturally significant events have notable effects on the timing of trips by anglers. For example, the opening of seasons for popular game fish, angling derbies, and civic holidays all can affect the timing of trips (Provencher & Bishop, 1997; Bucher, 2006; Hunt et al., 2007). Hunt et al. also found that days within the cultural definition of summer in northern Ontario (Victoria Day to Labour Day weekends (i.e., 3rd Saturday in May to 1st Monday in September)) received more angling trips than did other days of the year. Provencher and Bishop found that Green Bay, Wisconsin anglers were more likely to time their trips to Lake Michigan to participate in angling derbies.

Public holidays are other culturally related events that increase trip taking by anglers. These holidays were found to have twice the average daily angling trips than did weekdays (Provencher & Bishop, 1997; Bucher, 2006). Public holidays also appeared to be more important for anglers taking multiple than single-day trips (Hunt et al., 2007).

Angling participation rates vary on every calendar scale, by the year, month, and day (Bucher, 2006; Hunt et al., 2007). Yearly variations have focused on the differing motivations for participating in a particular activity and possible declines in participation rates with time (Wright, Rodgers & Backman, 2001; Schramm, & Gerard, 2004). Participation intensities have also been shown to vary within a particular year, with higher concentrations during the summer months (Provencher, & Bishop, 1997; Bucher). In northern boreal regions, angling effort and catch rates seem to peak during the months of May and June and slowly decrease afterwards

(Cook, & Younk, 1998). Angling effort also varies throughout the week with weekends receiving more angling trips than weekdays (Provencher, & Bishop; Bucher; Hunt et al.).

Varying levels of angling effort/use have also been found to be related to weather, particularly temperature, precipitation, and wind (Cook, & Yuonk, 1998; Pet-Soede, Van Densen, Hiddink, Kuyl, & Machiels, 2001; Solon, & Brunt, 2006; Bucher, 2006; Hunt et al., 2007). Provencher and Bishop (1997) demonstrated that angling effort on Lake Michigan was associated with temperature and wind speed. Wind speed was also shown to have a significant effect on boating trips to other large lakes in Ireland (Solon, & Brunt). Hunt et al. also found that precipitation had a negative affect on day trips by anglers in northern Ontario. This result was also found in the Archipelago by Pet-Soede et al. who determined that angling effort was greater during the dry than the rainy season.

The quality of a fishery has a significant effect on the choices by anglers. Yet the quality of a resource varies with seasons or times of the year (Morey, Rowe & Watson, 1993; Provencher, & Bishop, 1997). Consequently, these temporal variations in the quality of the fishery have been shown to have a direct effect on the timing of angling trips (Morey, et al.; Provencher, & Bishop). Certain species, such as salmon and trout, are more active during their spawning seasons (Cooke, & Beddington, 1984). This increase in fish activity increases the success rate of the anglers, thus influencing their choice to participate during these potentially more successful times of the year.

Limitations of Past Research

While process-based models using a utility theory approach have many useful qualities, some deficiencies exist. First, these models assume that human behaviour is based on optimization, which is not often the case. Utility models also typically fail to account for context, and therefore, fall short in describing the full picture of human behaviour (Hunt, 2005). Therefore, a need exists to verify the predictions of these models (Hunt). However, few modeling researchers have taken this next verification step in their research. This absence of verification is surprising given that qualitative research techniques have been shown as an effective means of verifying quantitative data (Denzin, 1978; Madey, 1982; Sells, Smith, & Sprenkle, 1995).

One way of addressing these deficiencies in utility models is through the addition of a qualitative measure. Bidirectional or triangulation research techniques combine both qualitative and quantitative methods as a means to verify research results, instruments, or collected data (Denzin, 1978; Madey, 1982). Qualitative methods, such as interviews, provide a means of verifying results or research instruments in contextual reality. An example of this is to conduct interviews with resource managers or recreational participants using their narratives to verify data and conclusions based on statistical analyses. These additional measures may also work to contradict or extend one's findings. Verifying data from models with knowledgeable resource managers provides an additional validity test for conclusions of a quantitative study.

Chapter III - Methods

The purpose of this study was to explore and to assess the importance of physical and temporal attributes on visitation to water-based settings in northwestern Ontario. Two types of data were collected to achieve this purpose. First, electronic traffic counters were placed along roads that led to a sample of water-based recreation sites determined not to be used for industrial access. The traffic on these single access points that lead to water-based sites was assumed to be for recreational use at these sites. These count data were analyzed with a utility theoretic approach. Second, confirmatory interviews were held with residents, outfitters, and natural resource management employees. Interviewees were presented with the patterns of traffic counts derived from the analysis of the traffic counter data and were asked to comment on the patterns and speculate on their probable causes. These interviews also helped to reassure me that the selected sites were used primarily for water-based recreational activities.

Study Areas

Recreational sites were chosen from three areas.

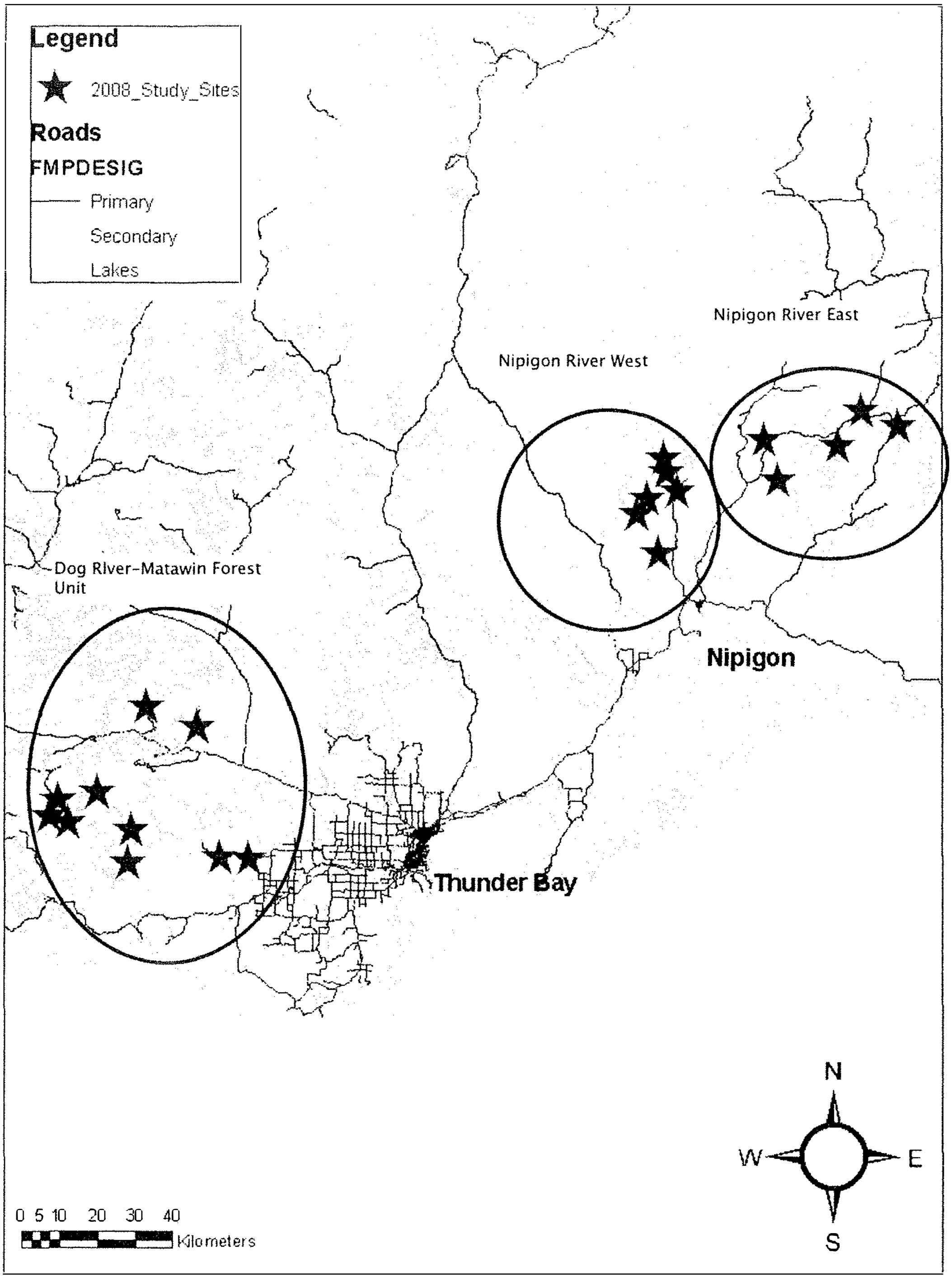

Figure 3 - 2008 Locations of water-based recreational sites used for traffic monitoring

Two of these areas, Nipigon River East and West, were identified as highly used areas by recreationists (Lesueur, 2008; McIntyre et al., In Press). While previous research had identified several other highly used recreational areas north of Lake Superior, I focused on these two areas because good quality data on roads and access points to lakes were available and the areas were near Thunder Bay, reducing my surveying travel costs. Within these two areas, 12 sites were selected. Due to the high presence of angling that exists at water-based sites in northern Ontario (Haider, & Hunt, 1997; Lester et al., 2003), the sites were chosen from various attributes related to angling quality, lake size, and accessibility. It should be noted that within this study area, it has been found that angling and hunting are the predominant activities that occur, and they are focused at the water bodies in the area (Lesueur, 2008). However, the ability to collect traffic count data from the site also affected the selection of sites (e.g., at some potential sites it would be impossible to separate traffic heading to the lake from traffic using roads to travel elsewhere). Therefore strategic placement of the counters was critical in providing confidence that the traffic being measured was only that of water-based recreationists.

An additional 10 sites were monitored in a popular recreational area west of Thunder Bay. I will refer to this area as the Dog River-Matawin Forest (DRMF). This area was chosen because the Ontario Ministry of Natural Resources has been counting traffic to some lakes in this area since 2006. This additional study area also permitted comparison of the traffic patterns among three different sub-regions in northern Ontario. A summary of the sites and the attributes used to characterize the sites is presented in Table 1.

Table 1 - Monitored water-based recreational sites and attributes of sites (* Lake area was set to 15000 ha for modeling)

Site Name	Lake Area (ha)	Fish Species	Access Type	Distance to Human Settlement (km)	Campsite	Days Monitored
10 Minute Lake	3.6	Bass, other	Trail	86	No	492
Aldina Lake	13.4	Bass, other	Trail	91.9	No	526
Barbara Lake	2360	Walleye	Road	73.1	Yes	181
Chambers Lake	186.3	Walleye	Trail	115.9	No	464
Claus Lake	39	Bass, other	Trail	47.5	No	181
Cox Lake	217	Walleye	Road	33.3	Yes	168
Drift Lake	160	Walleye	Road	108.8	Yes	498
Elizabeth Lake	364	Walleye	Road	36.4	No	168
Forgon Lake	3364	Other	Road	37	No	180
Frazier Lake	1979	Walleye	Road	34	Yes	168
Greenwater	3430.3	Lake Trout	Trail	127.3	No	471
Heart Lake	99.2	Walleye	Trail	143.3	No	182
Horseshoe	101.2	Walleye	Road	136	Yes	533
Jacob Lake	306.9	Walleye	Road	118.1	Yes	526
Little Athelstane Lake	221.6	Walleye	Road	120	Yes	481
Masinibek Lake	207	Walleye	Trail	81.7	No	181
Nelson Lake	657.6	Walleye	Road	129.2	Yes	526
Oskawe Lake	562	Bass, other	Trail	40.3	No	180
Postagoni Lake	478	Walleye	Road	51.5	Yes	181
Purdom Lake	245	Bass, other	Trail	18.7	No	181
South Bay *	484000	Lake Trout	Road	47.1	Yes	180
Trapnarrows Lake	1247	Walleye	Trail	94	No	181

Vehicle Counting

To estimate the level of recreational use occurring at these water-based recreational sites, traffic counting devices were used. Past research has indicated that the Crown land recreational pursuits are concentrated in water-based settings (Twynam, & Robinson, 1997). Past research has also suggested that recreational angling is one of the most prominent forms of water-based recreation in Ontario (Haider, & Hunt, 1997; Shantz et al., 2004). The sites were selected to avoid cases where roads and trails were used by industrial traffic. Traffic counters were placed on roads and trails that directly access points that led to water-based recreational sites. This assured that the traffic that passed the counters were only from vehicles accessing the recreational sites and not for any industrial or private uses. I also conducted numerous natural observation verifications, where I confirmed the physical attributes of the sites and the recreational focus of the visitors. Therefore, while the traffic count data simply represent vehicles, I interpret the data as trips for water-based recreation generally, and trips for recreational angling specifically.

Micro magnetometers from TRAFx Research Ltd. were used to count traffic at the sites. These devices use sensitive micro-magnetic sensors that enable them to record the dates and times of any nearby moving ferrous object (Breen, & Hosegood, unpublished manuscript). These devices have been used in resource planning research situations that require passive monitoring of vehicle use along less-developed and remote road systems (U.S. Department of Transportation, 2006; TRAFx, 2008). The counters are small and rugged enough to be buried, decreasing the chances they will be noticed or stolen (Breen, & Hosegood). The reliability of these devices has been thoroughly tested in field trials by the Ontario Ministry of Natural Resources (OMNR). The tests suggest that the recommended setting (VEH-4D [4 door vehicles], 016 [delay between counts], 000 [timestamp recording every count]) will capture all passenger vehicles within 5 m and all all-terrain vehicles within 2 m of the unit (OMNR, unpublished manuscript). Finally, these devices were previously used to collect traffic counts in 2006 and 2007 in the Dog River-Matawin Forest by the OMNR.

I installed the traffic monitoring devices (see Fig. 3) after the snow had disappeared from the access points and roads in the study areas. This occurred between April 27 and May 4, 2008. Devices were installed at this time to ensure the beginning of the water-based recreational season was fully captured and devices could be easily buried. Traffic monitoring devices were removed just before the snow season, on October 30th. This was assumed to be the end of the water-based recreational season. Devices were placed along the access road or trail, just before reaching the actual lake to ensure that individuals passing the devices were accessing the lake. Following Hunt and Hosegood (2008), a 10 second lag between counts was employed to avoid double counting slowly moving and large vehicles. The devices were buried next to a recognizable tree or marking to make retrieval simpler and covered with a large object. Pictures and a GPS point were also recorded to assist retrieval of the units.

Traffic monitoring data retrieved from sites within the Dog River-Matawin forest was also used within this study. The ten sites within the Dog River-Matawin forest that were to be monitored during this study had been previously monitored for the previous two years (2006 and 2007). The 2006 monitoring period was similar to this period, attempting to capture the non-winter water-based recreational season, while 2007 included some winter monitoring of these sites as well (see Table 1 and Figure 14)

These devices do not provide information that reveals specific activities pursued by vehicle users at the sites. These devices also do not collect information on the number of recreationists at each site. The devices simply inform researchers that a ferrous object has passed by at a particular date and time. The strategic placement of these devices was critical in assuring that the counters were gathering data of recreational users of the water bodies. Again, while the traffic count data simply represents vehicles, I interpret the data as trips for water-based recreation generally and more specifically trips for recreational angling. This information was confirmed through the use of natural observation site visitations as well as through interviews with local participants.

Confirmatory Interviews

After estimating traffic counts at the sites, nine key informants were interviewed to verify the preliminary conclusions from the quantitative count data. Information gathered from these interview discussions were then used to either support or refute the findings from the quantitative analysis. Interviews began by providing the participants with maps and graphs that illustrated traffic counts at the sites and asking them whether or not they believed that the data were accurate (see Appendix IV and V). The next set of questions were aimed at confirming the preliminary interpretations of the patterns by directing questions to uncover the specific physical and temporal attributes that affected the traffic count patterns. A copy of the generalized interview schedule is located in Appendix III.

Purposive sampling was also used to select interviewees. This sampling involved seeking out individuals who were knowledgeable of the specific activities occurring at the sites. Participants included Enforcement Officers, fish and wildlife technicians, tourism operators and recreation group representatives of either Nipigon or Thunder Bay District of OMNR. No minors (under the age of 18) were interviewed. These individuals were selected based upon their high level of knowledge of recreational activities occurring in the Thunder Bay and Nipigon Districts.

Nine semi-structured interviews were conducted in January of 2009. Interviews were continued until the point of saturation, at which point the information was repeated.

The interviews were examined using a general content analysis. The interviews were thoroughly reviewed as a means of assessing whether conclusions drawn from the quantitative traffic count data analysis were contextually appropriate and valid. Again, information from these interviews was used to verify the preliminary conclusions from the quantitative count data. Therefore, the qualitative data is not presented as results. Instead, quotes from interviews, are presented in the discussion section to support or refute the findings from the quantitative analysis. The most representative quotes were used that best highlighted and supported the explanatory variables within the research hypotheses.

Physical and Temporal Attribute Selection and Measurement

Past literature along with interviews with key informants who used the study areas were used to develop a list of factors that might explain traffic volumes at the different measurement sites. As previously discussed both spatial and temporal attributes were selected and measured.

Physical Attributes

As water-based recreational visitation is the focus, the chosen physical site attributes were indicators of angling quality, quality of access, presence of a camping facility, distance to the lake, and lake size. Angling quality was measured by both the availability of particular fish species and lake size. Availability, which is a popular measure for angling quality, was constructed from two data sources. First, inventories from OMNR along with conversations with recreationists were used to develop an inventory of fish species present at each lake. This presence and absence variable was combined with temporal information on the legality to catch and harvest the species at the lake. This information was obtained using OMNR *Angling Regulations 2008* (OMNR, 2008). Consequently, a value of one indicated that a fish species was present and legally available for anglers to catch and harvest and zero otherwise (see Table 2). Given past research in northern Ontario, both walleye and lake trout were considered important to area anglers (Lester et al., 2003; Hunt, 2006; Hunt et al., 2007) and consequently, variables were created for walleye, lake trout, and other species. Following past research results, I expected that lakes with walleye and lake trout would attract more traffic than would sites with other species. I labeled these variables *WALLEYE, LKETROUT* and *OTHER* respectively.

Accessibility of roads and trails to the lake was another selected attribute. I used two data sources to distinguish between the sites with trail and road access. To begin, OMNR inventories were used to determine whether or not sites contained trail or road access. Trail access sites were sites that were not accessible by car, truck or sports utility vehicle. This data was then confirmed through the interviews that helped to confirm the quality of the access and the types of vehicles that could access the sites. A visit to each site was also conducted to confirm the type of access. Sites that were accessible from a road (e.g., well developed, two-lane, grated) were considered a 'road' access where as sites accessed by trail or road with poor quality (e.g., grown over, washouts) were considered a 'trail' access (see Table 2). Subsequently, the variable *ROAD* was populated with a one for road and a zero for trail sites. From past research, I expected that sites with road access would have more traffic than sites with a trail access.

The amount of facility development was measured by using the presence of an unofficial camping area at the sites. The presence of a campground was indicated by the development of a fire pit and/or tent or trailer area. Again, OMNR inventories were used to determine the presence of a camping area at sites with confirmation from field visits as well. A value of one for *CAMP* indicated the presence while zero represented an absence of a camping area (see Table 2). This attribute was also assumed to indicate whether or not a site was used for overnight trips. Following past research results, I expected sites with a campground would attract more traffic than sites without a campground.

Travel cost has consistently been shown to explain choices of lakes by recreationists (e.g., Provencher, & Bishop, 1997, Walters, & Cox, 1999). A proxy for travel cost has been the proximity of an angling destination to a population center (Provencher, & Bishop; Hunt, et al., 2007). Therefore, I chose sites that had varying distances (km) to population centers. The town of Nipigon, Ontario (pop. 1,752) was the population center used to measure the distance variable for sites within East and West Nipigon River, while the city of Thunder Bay, Ont. (pop. 109,140) was used for sites within the Dog River Matawin Forest (see Table 2) (Statistics Canada, 2006). I expected to see sites closer to the population centers attracting more traffic than sites further away.

Finally, lake area is typically related to angling trips and angling quality (Parsons, & Kealy, 1992; Walters, & Cox, 1999; Hunt, & Lester, 2009). The area of the lakes at selected study sites ranged from 3.6 ha to 484,800 ha. Lake size has been shown to have a diminishing effect on an angler's site choice (Parsons, & Kealy). To address this expected diminishing effect, the natural logarithm of lake area (ha) was calculated and used within the analyses (*LOGLKESIZE*) (see Table 2). The lake size for *South Bay* was constrained to 15000 ha for the purpose of modeling. I expected that sites with larger lakes would attract more visits than sites with smaller lakes.

Temporal Attributes

The study also sought to understand temporal attributes that influence trips to water-based recreation sites. Attributes related to weather, calendar and cultural variations were included in this study.

A number of temporal attributes related to weather, particularly temperature, levels of precipitation, and wind speed were used in this study. Information concerning these variables was collected from Environment Canada using their historical climate database (www.climate.weatheroffice.ec.gc.ca). From these records, a summary of the weather events occurring during the daylight hours (sunrise to sundown), when individuals are most likely to be recreating, were examined. The precipitation attribute was measured using Environment Canada's information indicating whether precipitation was present during each hour between sun rise and sun down. The proportion of the hours with precipitation (*PRECIP*) was then estimated for each day (see Table 2). Using information from Environment Canada, the maximum temperature (C) (*TEMP*), and wind speed (km/h) (*WIND*) for each day were also calculated during the daylight hours. These estimations were performed with help from Robert Kushneriuk of the Ontario Ministry of Natural Resources (OMNR). I expected days with lower proportions of precipitation, higher temperatures and lighter wind speeds would result in more traffic, while windy days with higher precipitation and lower temperatures would have less traffic.

A number of calendar events including weekends and public holidays might also affect the timing of recreational trips. I examined whether the traffic counts occurred more frequently on a weekday (*WKDAY*), weekend (*WKEND*), public holiday (*HOLIDAY*) or during a particular year (including previously collected data from Dog River-Matawin forest). Using a 2008 calendar, a weekday, weekend, or holiday presence variable was assigned to each day (see Table

2). Days falling between Monday to Thursday were deemed a weekday, whereas Friday, Saturday or Sunday were considered weekend days. Fridays were identified as weekend days as it was assumed that most weekend recreational trips would begin on Friday. Days that occurred during the third weekend in May (Victoria Day Weekend - May 16th- 19th, 2008), Canada Day (July 1st, 2008), Labor Day weekend (August 29th - September 1st, 2008) and Thanksgiving (October 10th - 13th, 2008) were holiday days.

Finally, I examined the effect of culturally significant times of the year on the timing of trips because it has been shown to have an effect in past research (Lester et al., 2003; Oh & Ditton, 2006). I examined the culturally defined summer season for northern Ontario (May 16th - September, 1st, 2008), as well as the moose hunting season (October, 10th - October 31st, 2008). The legal opportunities to fish for walleye and to hunt for moose have been indicated as significant events to water-based recreationists in northern Ontario (Lester et al., 2003; Hunt et al., 2007) and were chosen as the culturally significant events to examine. I expected that traffic counts would be higher during these culturally significant times. Therefore, I labeled days with a presence variable that fell within these certain cultural events (*CLTRLEVENT* - coded as one if it fell within the culturally significant time and zero otherwise) (see Table 2). This information was obtained using OMNR's *Angling* and *Hunting Regulations 2008* (OMNR, 2008).

The data with traffic counts from the 22 sites over many days represents panel data. Panel data are a cross-section of individual units (e.g., recreational sites) that are observed over certain time periods (Cameron, & Trivedi, 1998). It is assumed that the same outcome is observed for each site over different points in time. To make sure this panel data effect was accounted for formally in the analyses, a dummy variable was created (*DAYSSURVEY*) that measured the number of days each site was monitored (see Table 2).

Table 2 - Independent and dependent attributes

Dependent Variable
COUNTS - Number of vehicles at site per day
Independent Physical Variables
WALLEYE - Lake contains Walleye (1-Present, 0-Absent)
LKETROUT - Lake contains Lake Trout (1-Present, 0-Absent)
OTHER - Lake contains species other than Walleye or Lake Trout (1-Present, 0-Absent)
CAMP - Site has a camping area (1-Present, 0-Absent)
DIST - Distance to the site from closest major urban center (km)
LOGLKESIZE - Natural logarithm of the lake size (ha)
ROAD - Presence of a road access (1-Present, 0-Absent)
DOGRIVER - Counts that occurred within the Dog-River Matawin Forest Unit
NIPIGON - Counts that occurred within the Black Sturgeon and Lake Nipigon Forest Units
Independent Temporal Variables
PRECIP - Avg. amount of precipitation during sunlight. (cu in)
TEMP - Avg. temperature level during sunlight. (0C)
WIND - Avg. wind speed during sunlight. (km/h)
WKDAY - Presence of a weekday (1-Present, 0-Absent)
WKEND - Presence of a weekend (1-Present, 0-Absent)
HOLIDAY - Presence of a holiday (1-Present, 0-Absent)
CLTRLEVENT - Presence of a cultural event (1-Present, 0-Absent)
YEAR06- Counts occurring in 2006
YEAR07 - Counts occurring in 2007
YEAR08 - Counts occurring in 2008

Traffic Count Data Analyses

From the literature review and exploratory qualitative interviews, I developed a series of expected results or hypotheses between the measured attributes and traffic counts. For clarity, I formally present all 14 hypotheses below. For each hypothesis, I tested the null hypothesis of no effect.

H1 *– The presence of WALLEYE in the water bodies at our sites will have a significant and positive effect on traffic counts.*

H2 *- The presence of lake trout (LKETROUT) in the water bodies at our sites will have a positive, but smaller effect on traffic counts, as compared to lakes containing WALLEYE.*

H3 *– ROAD access to a site will have a significant and positive effect on the traffic counts as compared to those with trail access.*

H4 *- The presence of a CAMPSITE will have a significant and positive effect on traffic counts.*

H5 *– Distance (DIST) to an urban center will have a significant and negative effect on traffic counts.*

H6 *– Lake Size (LOGLKESIZE) will have a significant and positive effect on traffic counts.*

H7 *– The Dog River-Matawin counts will have a statistically significant and positive effect on traffic counts.*

H8 *– Precipitation (PRECIP) will have a significant and negative effect on traffic counts.*

H9 *– Temperature (TEMP) will have a significant and positive effect on traffic counts.*

H10 *- WIND will have a significant and negative effect on traffic counts.*

H11 *- The presence of a weekday (WKDAY) will have a significant and negative effect on traffic counts as compared to the presence of a holiday weekend (HOLIDAY).*

H12 *- The presence of a weekend (WKEND) will have a significant and negative effect on traffic counts as compared to the presence of a holiday weekend (HOLIDAY).*

H13 *- The presence of the cultural definition of summer (CLTRLEVENT) will have a significant and positive effect on traffic counts.*

H14 *- The YEAR the counts occurred would have a significant effect on traffic counts.*

Testing of the hypotheses involved assessing the validity of the null hypotheses. If the probability of the null hypothesis being correct was less than 0.05, the null hypothesis was rejected and the alternate hypothesis was accepted.

Model Development

The appropriate statistical regression analysis to estimate the parameter coefficients of variables within a given model depends on the dependent variable (Creel, & Loomis, 1990; Gardner, Mulvey, & Shaw, 1995; McKean et al., 2005). My analysis involved water-based recreational trip data measured by total daily counts of vehicles (whole numbers). Because the data are whole numbers, a count-based regression model is appropriate (Creel, & Loomis). One count-based regression model is the non linear Poisson model (Shrestha et al., 2002). A Poisson regression model distribution may be written as:

Equation 1 - Poisson Regression Model

$$\Pr(Y = y_i) = \frac{e^{e^{\beta' X_i}} \left(e^{\beta' X_i}\right)^{y_i}}{y_i!}, y = 0,1,2,...$$

(Cameron, & Trivedi, 1998).

The equation states that the probability (Pr) that the count (Y) for a particular site (i) will equal some whole number y, depends on the value of y along with the attribute measures (**X**) and estimated parameters for the attributes (**β**). This model is often inappropriate because the model assumes that the predicted mean and variance are identical (Shrestha et al., 2002; McKean et al., 2005). In many cases, the estimates within the models display a greater amount of variability or overdispersion (Creel, & Loomis, 1990; Cameron, & Trevedi, 1998). The negative binomial regression represents one way to accommodate this overdispersion (Lawless, 1987; Creel, & Loomis; Cameron, & Trivedi; Akabua et al., 1999; Shrestha et al.; McKean et al.).

The standard variance, or mean parameter function for both a Poisson and negative binomial Regression analysis is $\omega_t = \exp(\mathbf{X}_t\boldsymbol{\beta}) + \alpha \exp(\mathbf{X}_t\boldsymbol{\beta})$ (Cameron, & Trivedi, 1998). The difference lies in the associated value of α. In the case of a Poisson regression model, $\alpha = 0$, where as in the case of a negative binomial regression model, $\alpha > 0$ (Cameron, & Trivedi). To account for the overdispersion of effects of count data, a negative binomial analysis incorporates a random term ($\alpha > 0$), within its analysis reflecting the overdispersed between-subject differences (Gardner, et al., 1995). Adding this random term ($\alpha > 0$) to the negative binomial (NB) regression model produces the equation:

Equation 2 - Negative Binomial Regression Model

$$\Pr(Y = y_i) = \frac{\Gamma\left(\frac{1}{\alpha} + y^i\right)}{\Gamma\left(\frac{1}{\alpha}\right)\Gamma\left(y^i + 1\right)} \left(\frac{\frac{1}{\alpha}}{\left(\frac{1}{\alpha} + e^{\beta' x_i}\right)}\right)^{\frac{1}{\alpha}} \left(1 - \frac{\frac{1}{\alpha}}{\left(\frac{1}{\alpha} + e^{\beta' x_i}\right)}\right)^{y_i}$$

$$\beta, \alpha \geq 0$$
$$y = 0,1,2,.....$$

(Cameron, & Trivedi, 1998).

The Γ represents the gamma distribution. Like the Poisson, the equation reflects the probability that the count for a particular time and site (Y) will equal a whole number (y), depends on the value of (y) along with the attribute measures ($\mathbf{X}$), estimated parameters for the attributes ($\boldsymbol{\beta}$) and a random term ($\alpha > 0$). Therefore, to test the appropriateness of using a negative binomial model, one tests the null hypothesis of $H_0 : \alpha = 0$ (Cameron, & Trivedi, 1998). If the null hypothesis is rejected, one may then assume that $\alpha > 0$, and accept a negative binomial regression model. Using a Poisson analysis in this case may lead to erroneous and overly optimistic conclusions concerning the statistical significance of the independent variables.

To estimate the weight of the parameter coefficients of the explanatory variables and to test the hypotheses, I conducted a negative binomial (NB) regression using the LimDep 8.0 (2008) program. Sixteen independent explanatory variables, including a constant, were selected to be included within the NB regression analysis. The Nipigon, holiday, camp, trail and 2008 year variables were excluded from the analysis because they would have introduced a dummy variable trap (Dog River, weekend, weekday, road, year 2007 and year 2006) (LimDep 8.0, 2008).

Fixed vs Random Effects Panel Data Analysis

The traffic count data involve a panel because the same site is measured on different occasions (days). Panel or longitudinal data are simply data of a cross-section of individual units (e.g., recreational sites) that are observed over numerous time periods (Cameron, & Trivedi, 1998). It is assumed that the same outcome is observed for each site over different points in time. To account for this panel data, a variable was added that counted the number of days that a site was monitored (*DAYSSURVEY*). The count model must also include within its analysis an individual specific term that allows us to treat the selected sites independently, reflecting each areas distinct physical make-up (Cameron, & Trivedi). This might be accomplished through either adding a fixed or random effects condition to our model (Hausman, Hall, & Griliches, 1984; Cameron, & Trivedi; Tarling, 2009).

In a fixed effects model, the added individual specific dummy term is a separate parameter for each site while for a random effects model, the parameters for each site are drawn from a specified distribution (Cameron, & Trivedi, 1998). A fixed effects analysis is said to be conditional on the effects displayed by the individual sites. Unfortunately, this fixed effects analysis does not take into account time constant explanatory variables because they are absorbed into the individual-specific effect and are not identified (Tarling, 2009). Adding this fixed effects condition ($\alpha_i + \varepsilon_{it}$) to the negative binomial (NB) regression model produces the equation:

Equation 3 - Fixed Effects Negative Binomial Regression

$$\Pr(Y = y_i) = \frac{\Gamma\left(\frac{1}{\alpha_i} + y^i\right)}{\Gamma\left(\frac{1}{\alpha_i}\right)\Gamma\left(y^i + 1\right)} \left(\frac{\frac{1}{\alpha_i}}{\left(\frac{1}{\alpha_i} + e^{\beta' x_i + \alpha_i + \varepsilon_{it}}\right)} \right)^{\frac{1}{\alpha_i}} \left(1 - \frac{\frac{1}{\alpha}}{\left(\frac{1}{\alpha} + e^{\beta' x_i + \alpha_i + \varepsilon_{it}}\right)} \right)^{y_i}$$

$$\beta, \alpha \geq 0$$
$$y = 0,1,2,\ldots..$$

A random effects analysis, however, is not dependent on the individual sites, which implies that individual effects would be uncorrelated with the independent variables (Cameron, & Trivedi, 1998). Yet, if unobserved individual effects are correlated with the observed effects, the random effects estimator would be inconsistent (Cameron, & Trivedi).

It has been shown that the choice of a fixed or random effects estimator varies according to the type of sampling methods used in the data collection (Cameron, & Trivedi, 1998). If one's sample includes a large number of observations ($n \to \infty$) and a small, fixed time period (*T*), one needs to account for a large number of incidental parameters (Cameron, & Trivedi). In these cases using a fixed effects panel data model leads to inconsistent parameter estimates of β and α_i (Cameron, & Trivedi). When this sampling scheme has been employed, a random effects model would be more appropriate. However, in cases where one has a small number of observations (n) throughout a large time frame ($T \to \infty$) the number of incidental parameters are reduced, and a fixed effects estimator would be sufficient. Because this study sample resembles that of the latter, a fixed effects estimator was chosen for the negative binomial regression model. Estimation of this model and parameters was accomplished through conditional maximum likelihood estimation.

Model Testing

In most instances the hypotheses were tested using the t-statistic for the parameter estimates from the fixed effects NB statistical model. In cases when the hypotheses involved more than one variable (e.g., fish species), a likelihood ratio test was used. A likelihood ratio (LR) test is a sensitive measure of error that seeks to produce a 'goodness-of-fit' ratio using the differences in log likelihoods from models with and without the parameters that are being tested (Tarling, 2009). The LR Test can be written as:

Equation 4 - Log Likelihood Ratio Model Test

$$LR = 2\left(\log L(\hat{\theta}) - \log L(\bar{\theta})\right) \sim x^2(g)$$

Where $\hat{\theta}$ is the estimated log likelihood from the unrestricted model (i.e., the model with the variables of interest), $\bar{\theta}$ is the estimated log likelihood from the restricted model (i.e., the model without the variables of interest), and g is the difference in the number of estimated parameters between the two models (Buse, 1982). This equation will produce a Chi-square value that can then be compared to the critical Chi-squared value of the associated to the number of degrees of freedom and determined level of significance. If the estimated probability determined by the LR statistic is less than some level (e.g., 0.05), the null hypothesis can be rejected and one accepts the alternative hypothesis that the unrestricted model has greater explanatory power than the restricted model. If the probability is greater than 0.05, one accepts the null hypothesis that including the additional parameter estimates provides no benefit.

In conducting a maximum likelihood estimation, the adjusted McFadden's rho-squared was also determined to reflect the models fit adjusted for the number of estimated parameters (this statistic is similar to the adjusted R^2 of the standard regression model). This estimation is more appropriate for a logistic regression (Naugle, Higgins, Nusser, & Johnson, 1999). Low rho-squared values do not necessarily imply poor fit, due to the output of these tests are lower than regular adjusted R^2 of the standard regression model (e.g., a value of 0.2 is considered satisfactory) (Naugle et al.).

Chapter IV - Results

The research hypotheses were tested with a statistical model that related spatial and temporal attributes to traffic counts at water-based recreation settings. At each site and each day of monitoring, traffic counts were tabulated and used as dependent variables for a fixed effects negative binomial regression. Results from confirmatory interviews (discussed in Chapter V) suggested that traffic counts at the Forgan Lake site were not recreation based. Therefore, I removed this site and report results from the 21 other sites and 6,641 days of traffic count data.

Descriptives

Summary statistics for the dependent and independent variables used in the statistical analyses are provided below (Table 3). These statistics included the mean and, where appropriate, standard deviations for each variable. Values for distance, temperature, wind, and lake size attributes were divided by 100 to align them with other attributes.

Table 3 - Descriptive statistics for physical and temporal attributes (Mean and standard deviations - SD)

	Dependent Variable	
	Mean	**SD**
Count	3.951	7.394
	Independent Physical Variables	
WALLEYE	0.633	NA
LKETROUT	0.145	NA
DIST	0.965	0.1485
LOGLKESIZE	13.275	32.579
ROAD	0.466	NA
DOGRIVER	0.702	NA
	Independent Temporal Variables	
PRECIP	0.125	0.992
TEMP	0.185	0.383
WIND	0.227	0.242
WKDAY	0.544	NA
WKEND	0.353	NA
HOLIDAY	0.101	NA
CLTREVENT	0.603'	NA
YEAR06	0.190	NA
YEAR07	0.243	NA
YEAR08	0.566	NA

** Note – Values represent actual lake size values, scaled by 100.*

The mean daily traffic counts measured at the sites was 3.95 counts/day (see Table 3 and Figure 4). Figure 4 represents the average counts per day at each of the monitored sites. The high standard deviation of 7.39 suggests that these counts varied considerably from between each sites, as well as within each site (e.g., from day to day). Seventy per cent of monitoring data were collected from sites in the Dog-River Matawin Forest Unit. Walleye were available in over two-thirds of the water bodies, while lake trout was available in 15 per cent, and other species (e.g., brook trout and bass) in the remaining 25 per cent. There were also more trail access sites (53%) than road access sites (47%). Sites within the East and West Nipigon River area varied in distance (DIST) from 34 km to 82 km from the town of Nipigon, while sites within the Dog River-Matawin Forest varied from 86 km to 143 km from Thunder Bay. The mean distance from human settlement to a site was 97 km and the mean lake size at the sites was 1327 ha.

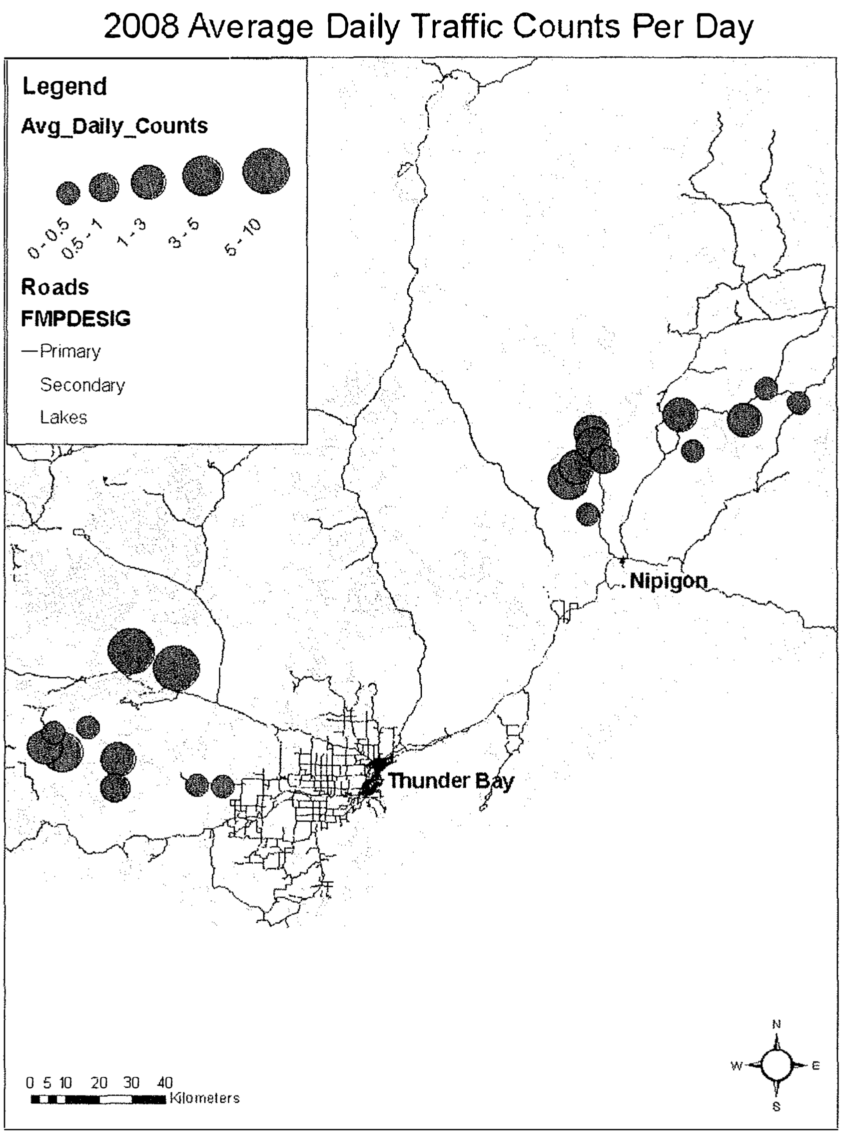

Figure 4 - Average Daily Traffic Counts at Monitored Water-Based Recreational Sites in Northernwestern Ontario

Figure 4 represents the distribution of the average counts per day at the sites over the sampled time period. The traffic counts appear to become smaller the further that one travels from a human settlement, and are higher on larger-sized lakes. A majority of the sampled days were weekdays (54%). Over one-third of the monitored days occurred on a weekend (including Friday) while 10 per cent of the days were holiday days including the associated weekend days. Three-quarters of the monitored days fell during the culturally significant events in northern Ontario (see Figure 5). Most of the monitoring effort occurred in 2008 (55%) with about an equal effort for 2007 and 2006 (24% and 19%, respectively). Finally, about 12 per cent of the average monitored days had precipitation, a mean maximum temperature of 18.6 C and an average maximum wind speed of 22.8 km/h.

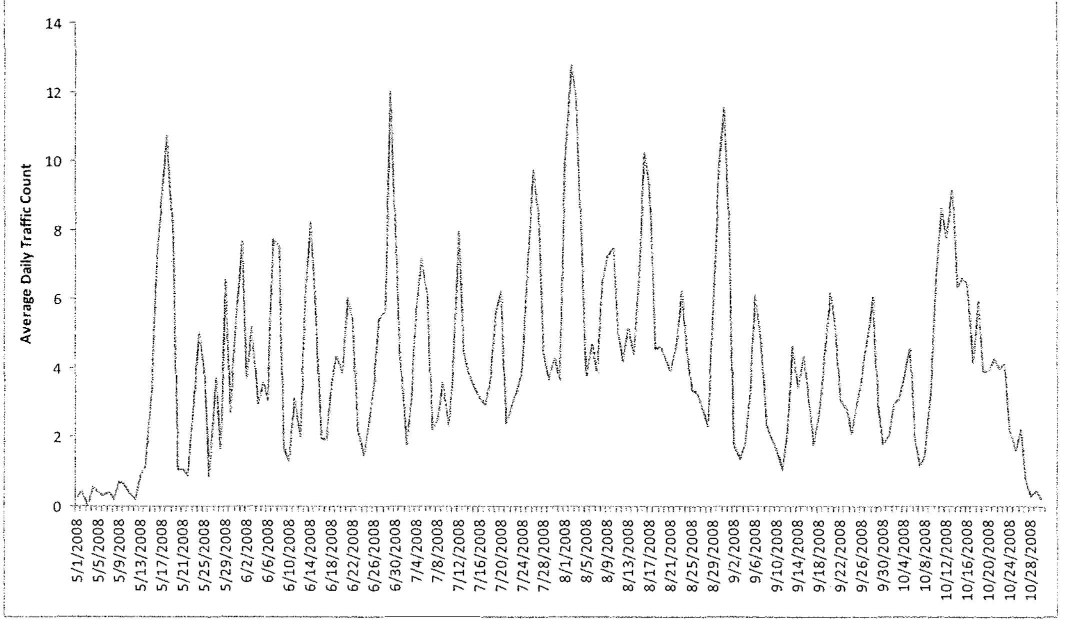

Figure 5 - 2008 Average Daily Traffic Counts By Date

Model Fit

Various analyses were conducted to develop an explanatory model. First, the collinearity among all the variables within the data set was examined. The relationship between campsite and road access was almost perfect as sites that were road accessible also contained campsites. Including both of these measures would have affected the model results. Therefore, the *CAMP* variable was removed from the model to ensure that its effects were not confounded with those of the variable *ROAD*.

Second, I tested whether a negative binomial model was needed. The estimated α parameter was positive (1.59) and significant ($p < 0.001$) indicating that the count data had a high degree of variability or overdispersion. Therefore, the null hypothesis of $H_0 : \alpha = 0$ was rejected, and subsequent analyses proceeded with a negative binomial regression model analysis.

Third, I estimated the overall fit of the negative binomial regression model. This was done through determining the adjusted ρ^2 and conducting a Likelihood Ratio test. These results can be seen in Table 4, where ρ^2 represents the adjusted McFadden's RHO value, ***LLU*** represents the unrestricted model's (all attributes) Log Likelihood value, ***LLR*** represents the restricted model's (only a constant) Log Likelihood value, ***df*** represents the degrees of freedom, and ***Prob*** represents the significance probability value. The fixed effects negative binomial model provided a statistically significant improvement in model fit over a model with only a constant (χ^2=1868.52, df =14, p<0.001). The estimated McFadden's rho-squared for this model was 0.075. With an alpha value of 0.05, the null hypothesis was rejected that indicated that the removal of the explanatory variables would negatively affect the model.

Table 4 – Negative binomial model test estimates

	ρ^2	*LLU*	*LLR*	*df*	*Prob*
Constant	0.000			14 *	<0.001
Model A	0.075	-12226.01	-13160.27		

*Note: The critical value for 14 df at 0.05 significance is 23.68

Physical Explanatory Attributes

The results supported three of the four hypothesized relationships between traffic counts and physical explanatory attributes (Table 5).

Table 5 - Fixed effects negative binomial regression parameter estimates (*p<0.05, **p<0.01)

Description	Parameter Estimate	Standard Error	Probability
Physical Variables			
WALLEYE	1.165**	0.108	<0.001
LKETROUT	0.416	0.340	0.222
DIST	-4.214**	0.169	<0.001
LOGLKESIZE	0.207**	0.254	<0.001
ROAD	1.111**	0.730	<0.001
DOGRIVER	2.636*	0.137	<0.001
Temporal Variables			
PRECIP	-0.383*	0.167	0.022
TEMP	1.943**	0.467	<0.001
WIND	-0.248	0.371	0.504
WKDAY	-0.960**	0.507	<0.001
WKEND	-0.393**	0.724	<0.001
REGEVENT	0.248**	0.454	<0.001
YEAR06	0.995	0.707	0.160
YEAR07	0.156*	0.820	0.056

It was determined that the attributes relating to the availability of certain fish species at the sites represented an improvement to the model. The attributes relating to fish species (*WALLEYE, LKETROUT*) were removed and the log likelihood estimates were compared using a standard Likelihood Ratio test. The test resulted in a probability of accepting the null hypothesis of <0.001 when compared to the model without fish species. Therefore, I rejected the null hypothesis and accepted the alternative H_0 that removal of the fish species attributes would have affect on the explanatory power of the model (see Table 6).

The results supported hypotheses *H1* that the presence and legality of catching walleye (*WALLEYE*) at a lake would result in more observed traffic to the lake. However, the results did not support hypothesis *H2* that sites with lake trout should have more traffic than sites with other fish species. These parameter estimates are displayed in Figure 10 and Table 5. Sites that held walleye displayed higher average daily counts than did those sites that held lake trout or other species (see Figure 6).

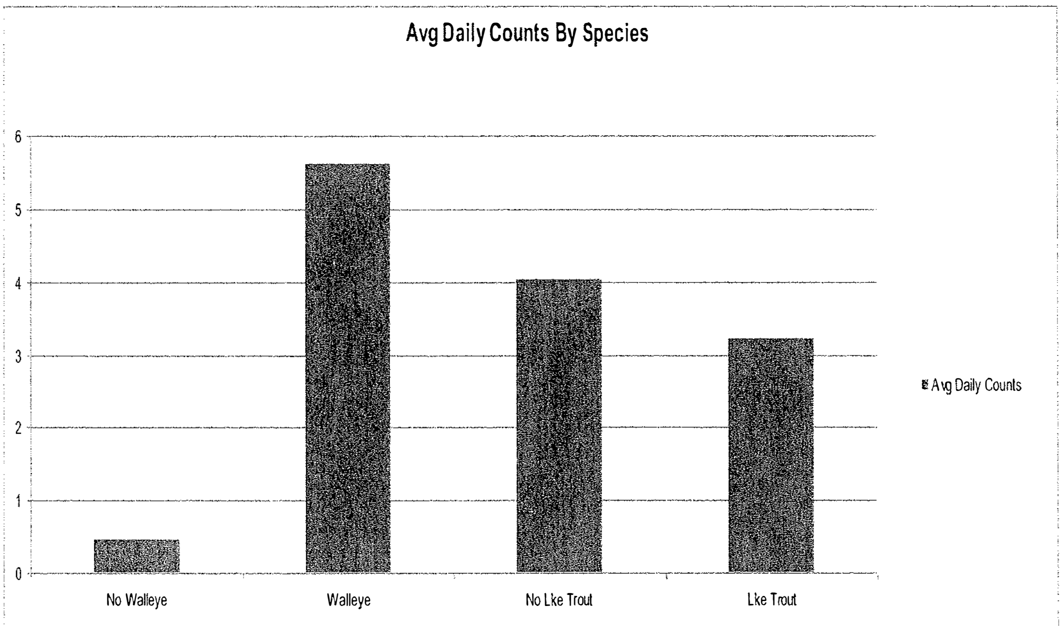

Figure 6 - 2008 Average Daily Traffic Counts at Sites Grouped by Fish Species

Including attributes relating to travel cost (access type and distance*)* to the sites also improved the model. Using a standard Likelihood Ratio test, I obtained a probability of accepting the null hypothesis of <0.001 when compared to the model with only a constant. Therefore, the null hypothesis was rejected and I concluded that including attributes for travel cost improved the model fit (see Table 6).

These results provided support to *H3* and *H4* confirming that the presence of a road access (*ROAD)*, and consequently a campground (*CAMP)*, at the sites had a positive affect on the traffic counts (Figure 10 and Table 5). Consequently, sites that were road accessible received more traffic than did sites with trail access (Figure 7).

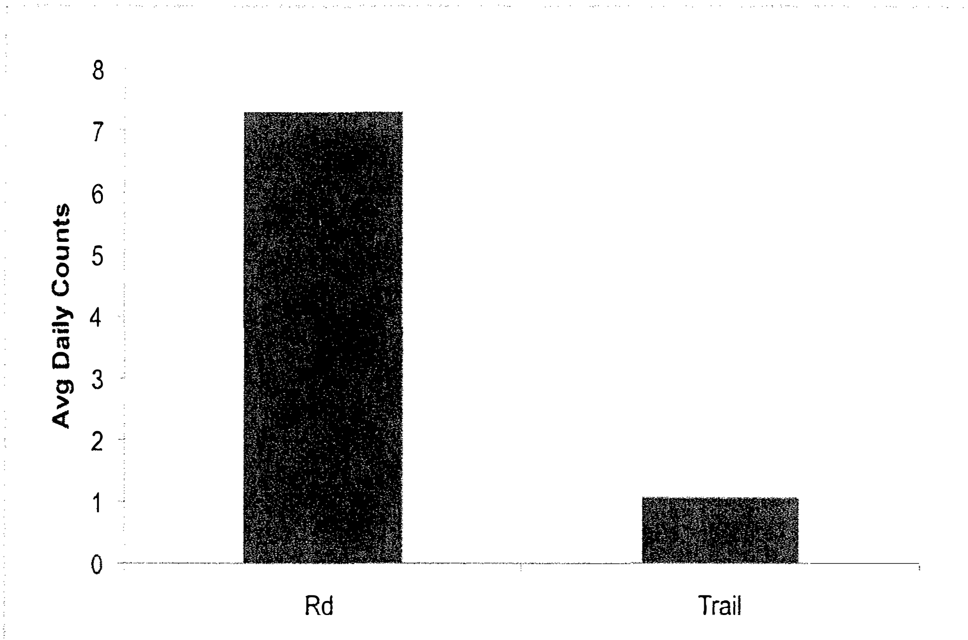

Figure 7 - 2008 Average Daily Traffic Counts at Sites Grouped by Access Type

The results also supported *H5* that the distance *(DIST)* to the sites would have a negative effect on the traffic counts (Figure 10 and Table 5). Distance had a significantly negative effect on the average vehicular traffic counts per day to the sites (Figure 8).

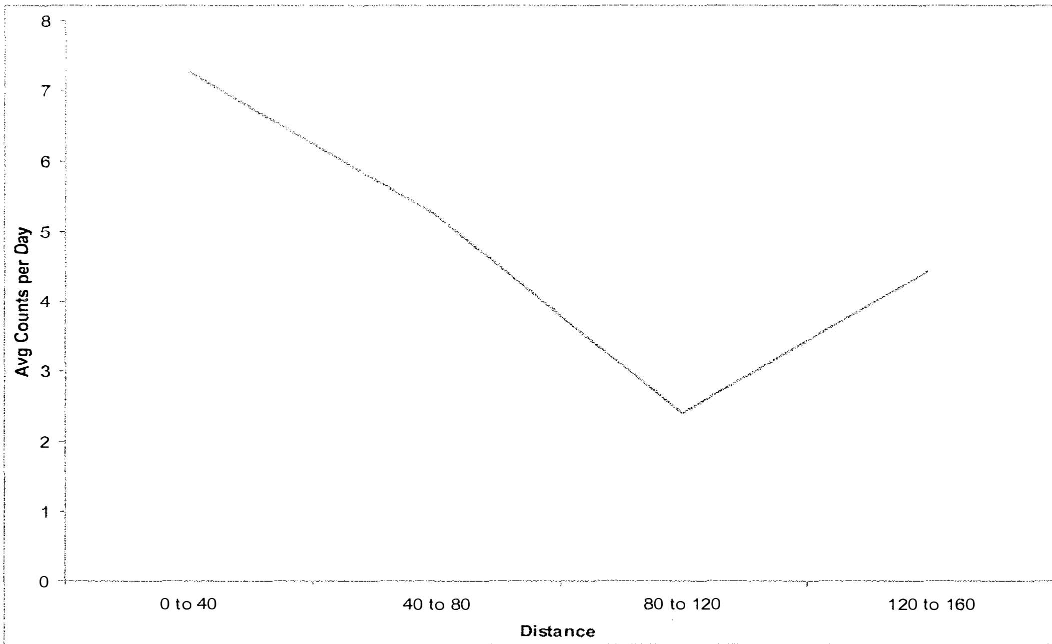

Figure 8 - 2008 Average Daily Traffic Counts at Sites Grouped By Distance to Urban Centers

The analysis supported *H6* that the size of the water body (*LOGLKESIZE*) would have a positive affect on the traffic to the site (Figure 10 and Table 5). The weight of the explanatory estimate of this attribute, though significant, was not as strong as that of the walleye, road, or distance attributes. However the statistical effect provides evidence for other noise in the data (species type, accessibility, distance). These results are displayed in Figure 9. Walleye and distance to community appeared to be affecting some of these sites more than the area of the associated lake.

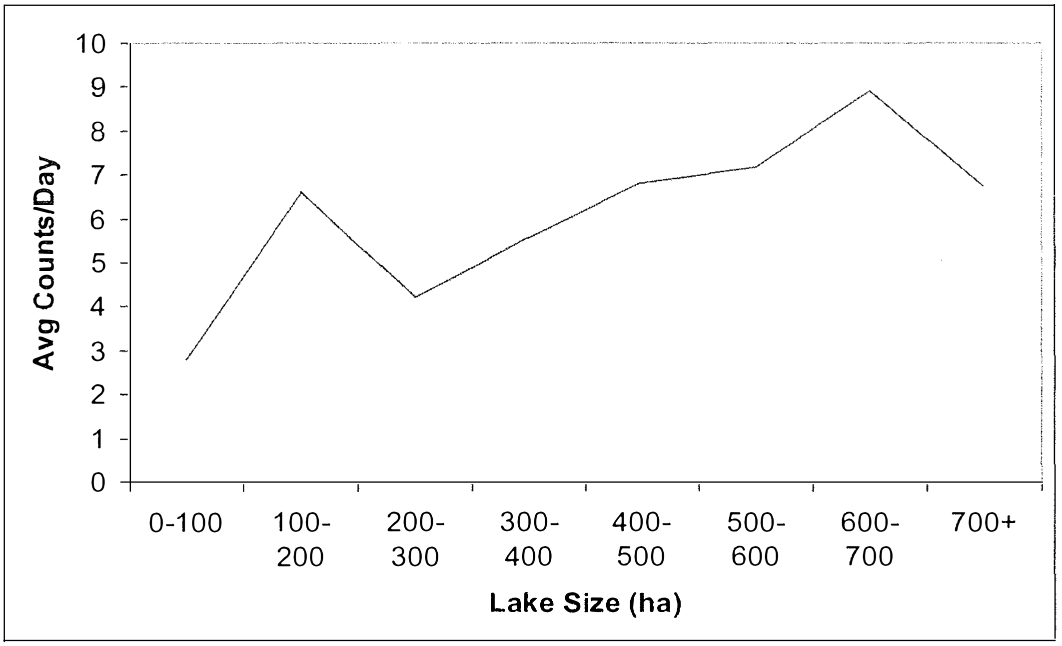

Figure 9 - 2008 Average Daily Traffic Counts at Sites Sorted by Lake Size (ha)

Finally, *H7* was accepted that sites within the Dog River-Matawin forest (DRM) would receive more traffic than sites within the Nipigon areas (see Figure 10 and Table 5). Higher traffic levels were recorded at the DRM forest sites than at the other two study areas partly because the DRM forest sites are closer to the larger urban centre, Thunder Bay.

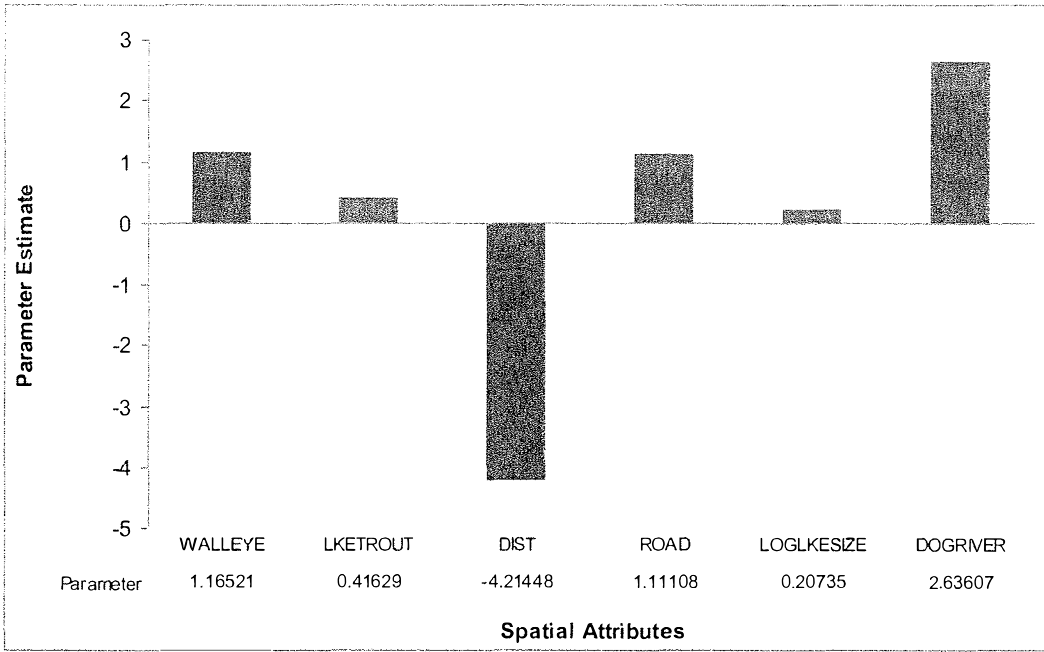

Figure 10 - Parameter Estimates for Physical Explanatory Attributes Fixed Effects Negative Binomial Regression Model

Temporal Explanatory Attributes

The results supported five of six of the hypotheses on the relationship between temporal attributes and the timing of traffic to the sites (see Figure 14 and Table 5). A likelihood ratio test rejected the null hypotheses ($p<0.001$) that excluding weather attributes (*PRECIP, TEMP and WIND*) would have no effect on model fit. Therefore, I accepted the alternate hypothesis that including the weather attributes improved the model (see Table 6).

The results supported all but one of my hypotheses relating to weather attributes. Both *H8* and *H9* were accepted that traffic volumes to the sites were greater on drier (*PRECIP)* and warmer (*TEMP)* days. Consequently, as the maximum daily temperature increased and a lower proportion of the day received precipitation, the average daily traffic counts at the sites increased (Figure 11). However, the results did not support *H10* that wind (*WIND)* had a negative effect on the traffic counts to the sites (Figure 15 and Table 5).

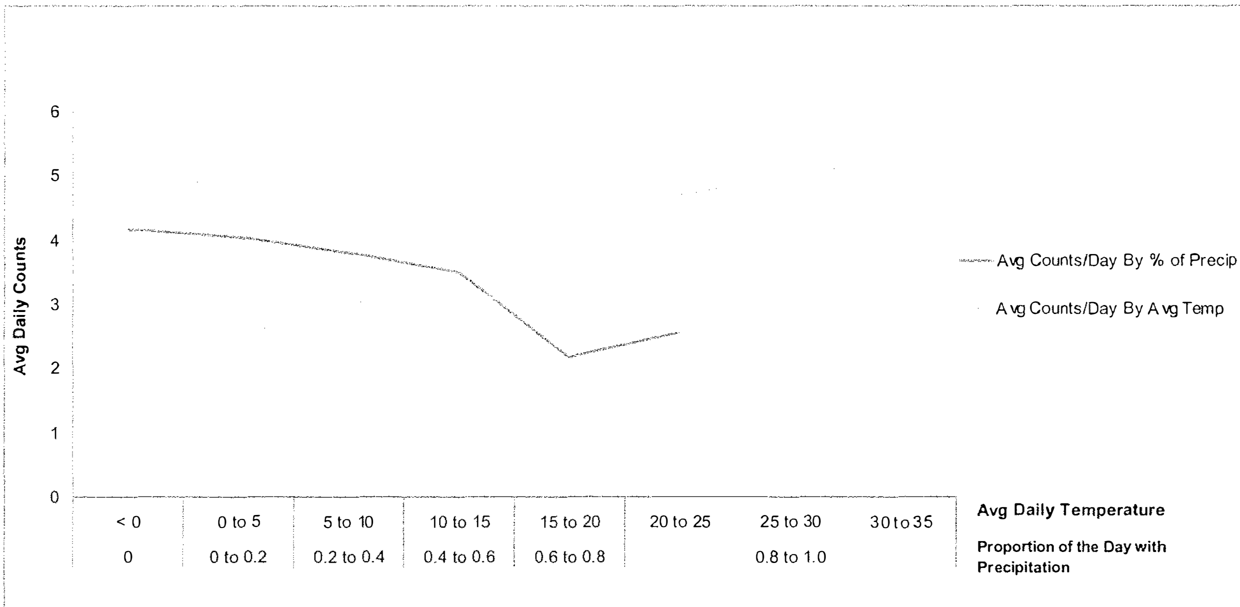

Figure 11 - 2008 Average Daily Traffic Counts Grouped by Temperature and Precipitation

These results also maintained that calendar event attributes (*WKDAY, WKEND* and *CLTRLEVENT)* improved the overall fit of the model. Using a standard Likelihood Ratio test, I obtained a probability of accepting the null hypothesis of <0.001, when compared to the model without calendar event attributes. Therefore, I rejected the null hypothesis that the removal of the calendar event attributes would have no affect on the explanatory power of the model (see Table 6).

The model supported *H11* and *H12* that the presence of a weekday (*WKDAY)* or weekend *(WKEND)* would have a significant and negative effect on traffic counts as compared to the presence of a holiday weekend (*HOLIDAY*) (see Figure 15). Weekday counts were lower than weekend counts to the sites. As expected, the holiday attribute had a significant and positive effect on traffic counts when compared to other days (see Figure 15). The weekend attribute also followed expectations with an effect on traffic that was lower than the effect for holidays but greater than that for week days (see Figure 12 and 13).

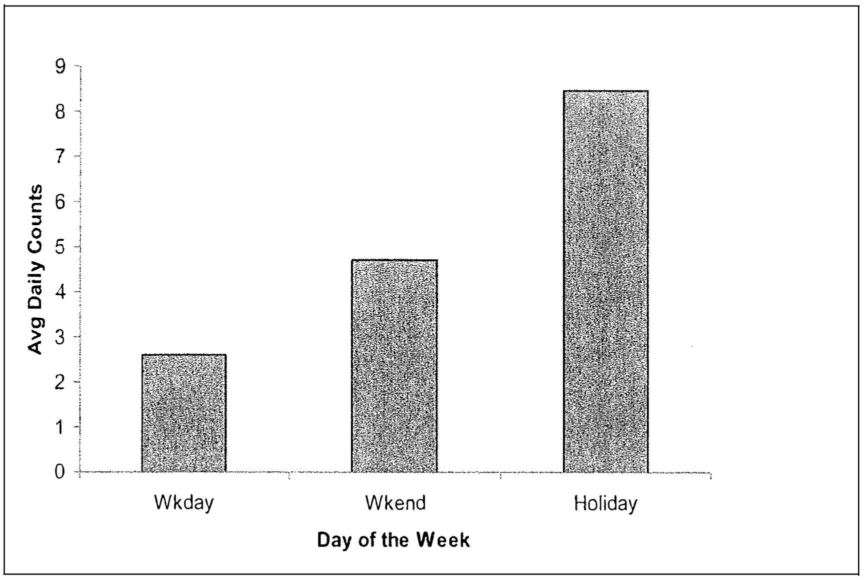

Figure 12 - 2008 Average Daily Traffic Counts Grouped by Day Type

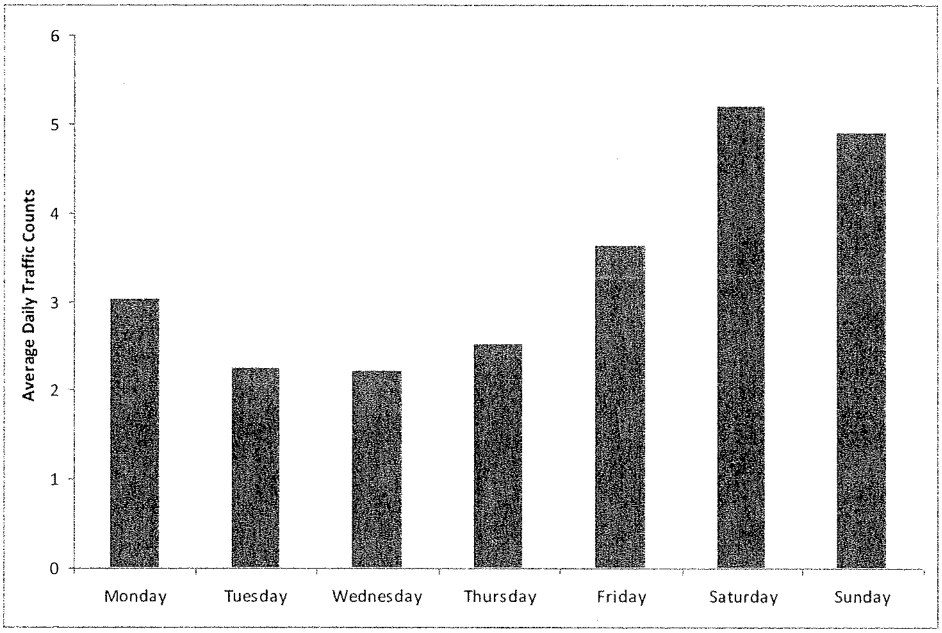

Figure 13 - 2008 Average Daily Traffic Counts By Day of the Week

Results also supported *H13* that traffic at the sites would be significantly greater during publicly recognized cultural events (*CLTRLEVENT)* (see Figure 15). Higher average daily traffic counts were measured during the culturally defined summer months of May to September, along with the beginning of the regulated moose hunting season (second weekend in October).

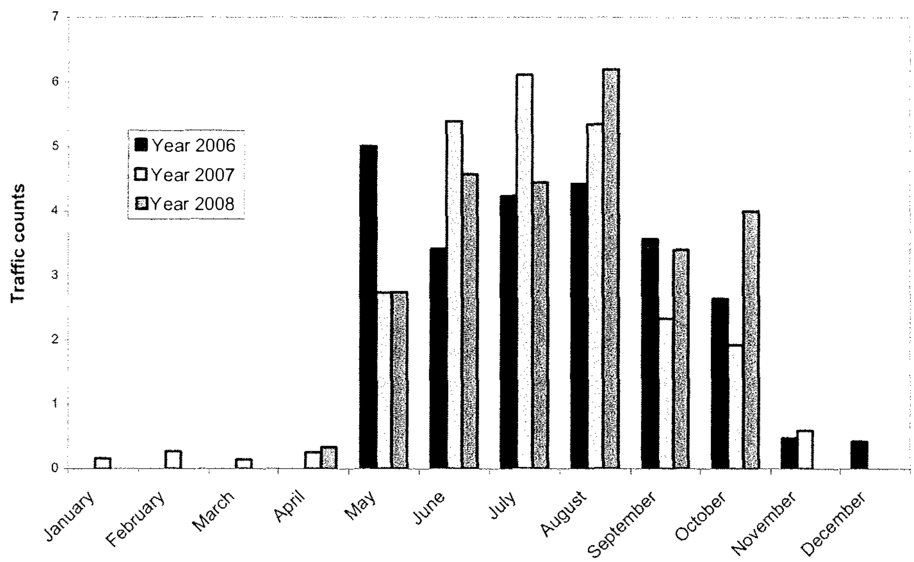

Figure 14 - 2008 Average Daily Traffic Counts By Month for Sites in northwestern Ontario, Canada. (Not all sites or days were monitored in any given month; statistical analyses was only based on data from May to October)

The recreational demand data spanned three years. Consequently, an estimation of the effect (if any) that the particular year would have had on traffic was conducted. The results from this estimation were mixed. The traffic counts that occurred during 2006 (*YEAR06)* were not significantly different than those from 2008 (*YEAR08)*. However, average daily traffic counts occurring during 2007 (*YEAR07)* were significantly higher than those occurring during 2008 (*YEAR08)*. Therefore, this result was able to support my *H14* hypothesis that the year the traffic counts occurred would have a significant effect. These effects are displayed in Figure 14. Parameter estimates are displayed in Table 5 and Figure 15.

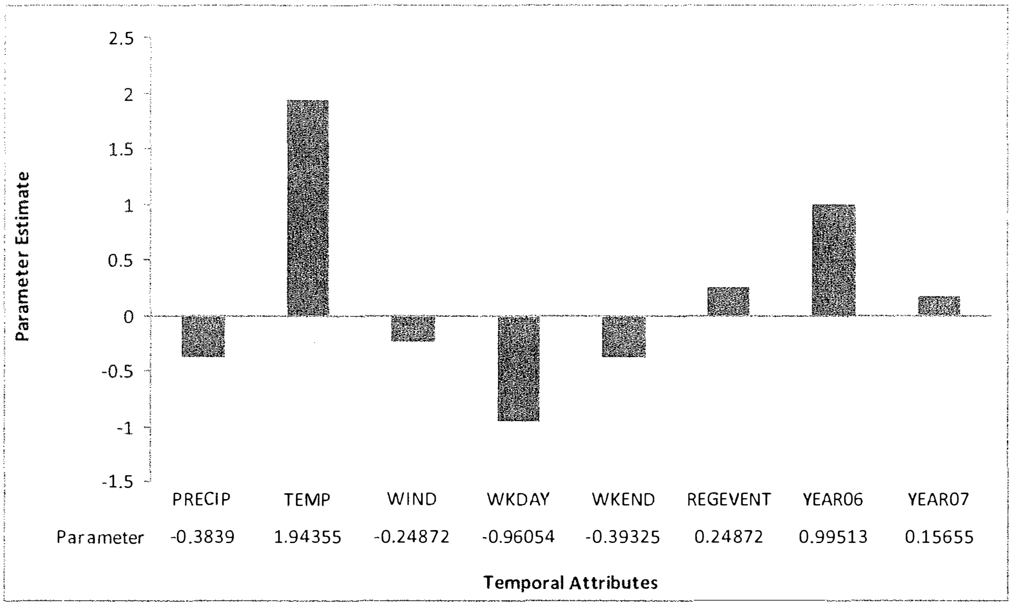

Figure 15 - Parameter Estimates for Temporal Explanatory Attributes from a Fixed Effects Negative Binomial Regression

Table 6 - Log Likelihood Model Test Estimates

Model	LLU	LLR	Chi Square	df	prob
No Weather *	-12226.01	**-12292.51**	133.00	3	<0.001
No Calendar *	-12226.01	**-12556.18**	660.34	3	<0.001
No Species **	-12226.01	**-12352.07**	252.12	2	<0.001
No ROAD/ DIST **	-12226.01	**-12519.33**	586.64	2	<0.001

Chapter V - Discussion

The purpose of this thesis was to uncover both the physical and temporal site choice factors that influence water-based recreational activities within Ontario Crown lands. This research focused on answering two primary questions:

1. What are the patterns of water-based recreation use on selected Crown lands of northern Ontario?
2. What factors influence these patterns of use?
   a) What are the physical factors that influence where individuals pursue their recreational activities?
   b) What are the temporal factors that influence when individuals pursue their recreational activities?

Overall, the mean daily traffic counts measured at the sites was 3.95 counts/day. Sites further away from population centers displayed fewer counts. The high standard deviation of the traffic counts suggested that these counts varied not only between sites, but also within each site, across the season. The majority of counts were concentrated on weekends and holidays. A significant number of counts also occurred during the moose hunting season. Overall, most counts fell during the culturally significant summer months in northern Ontario.

Drawing from past research, 14 hypothesized relationships between traffic at water-based recreational sites in northern Ontario and physical and temporal factors were developed to explain these patterns of use. These hypotheses were tested by using a fixed effects negative binomial regression model that related these attributes to traffic count data from 21 sites. Overall, the model represented an improvement over a model with only a constant and support was found for twelve of the fourteen hypotheses. Below, I discuss the results of these hypotheses tests within the contexts of past research and when possible support or lack of support from the interviews held with individuals who are knowledgeable about the study areas.

These interviews were also able to help verify a fundamental assertion of this study. This study assumed that the traffic count data leading to these sites were primarily for angling and other water-based recreational activities. Not only was this confirmed through the statistically significant and rather large parameter estimates found for fish species attributes, but this was also confirmed by numerous participants at the onset of the discussions. For example, a tourism operator stated

> "I think it [the patterns of trips] is more driven by the natural resources, and by the hunting and fishing. The Nipigon River itself, and the lands just East and West of it, a lot of them [sites] are recreational areas for either hunting or fishing."

Physical Water-Based Recreational Site Choice Attributes

Of the six tested hypotheses that were developed to explain where water-based recreation trips occurred, the results supported five.

Fish species

Using a Likelihood Ratio test, I accepted the alternate hypothesis that including the availability of fish species strengthened the model. Sites containing walleye had more vehicular traffic than did sites containing lake trout or other species (Figure 6). This result provided evidence in favour of hypotheses *H1* that walleye has a positive effect on traffic to water-based recreation sites.

These findings are consistent with past research that discusses the importance of particular fish species to site choices by anglers (Lyons, Talks and Hickley, 1999; Cook, & Yuonk, 1998; Lester et al., 2003; Hunt, 2006; Hunt et al., 2007). More specifically, research on northern Ontario anglers supports the findings that walleye is a highly desirable fish species that will affect where people take angling trips (Lester et al.; Hunt; Hunt et al.). Past research, however, also suggests that sites with lake trout should positively affect the choices of sites by anglers (Cook, & Yuonk; Lester et al.; Hunt; Hunt et al.). I was unable to confirm this effect through this study, and thus, was able to reject *H2* that the presence of Lake Trout would have a positive effect on traffic counts. This rejection of hypothesis *H2* may be attributed to the limited number of sites that contained lake trout (only two sites), one of which was only accessible by trail (*Greenwater Lake*) and the other was accessible by several access points (*South Bay / Lake Nipigon*).

From my interviews, specific lakes such as *Frazier, Elizabeth,* and *Barbara* within the East and West Nipigon River areas were frequently noted as being popular angling destinations because walleye were present. For example, one tourism operator remarked:

> "The Nipigon River itself and the lands East and West of it, the fact that we have a variety of species, some trophy fisheries, that's what attracts people from outside of the area."

A consistent higher concentration of traffic counts at lakes such as *Little Athelstane, Nelson,* and *Drift Lake* within the Dog River-Matawin Forest were also explained by participants as primarily being a result of the presence of walleye. An OMNR Fisheries Biologist commented by stating:

> "Of course it is the species. At that time of year they are primarily looking for walleye. So, they are looking for a reasonable size of fish, at a reasonable catch rate and they are

> selecting for a specific species. Now that is residents. Non-residents may see them seeking not only walleye, but also for other species, such as northern pike for example."

These interviews were also able to provide insights about the non-significant effect of lake trout on traffic. A recreationist from the Dog River-Matawin Forest commented that the sole lake trout lake within that area would only receive significant traffic during the early portions of the season when the fish were in shallow waters. When asked to comment on the low traffic numbers to lake trout sites, the participant responded:

> "Well it's a lake trout and pike lake. Focuses switch. Soon as the lake trout goes deep, it is hard to get a large boat with a down rigger in there, the tendency is to back off and the focus changes."

An interview with an OMNR fisheries biologist also suggested that the presence of lake trout in a lake might subsequently reduce the production of highly valued walleye in the lake.

> "That one [site] is a lake trout lake. So, the productivity for walleye is not that great there, and you've got to work a lot harder [for] them."

A reduced walleye population may consequently, contribute to the resulting fewer counts at sites with lake trout. These frequent references to fish species having such an important effect on the locations of water-based recreation trips again reinforce the assumption that angling is a popular activity at these water-based settings in northern Ontario.

Lake Size

Past research has repeatedly supported the effect of increased recreational demand at sites with larger-sized water bodies (Parsons, & Kealy, 1992; Walters, & Cox, 1999; Hunt, & Lester, 2009). This effect may result from the ability of larger lakes to hold a wider variety and healthier population of species (Walters, & Cox, 1999). Though my analyses were able to provide support for *H6*, the presence of a larger lake would have a positive result on traffic counts, confirmatory interviews did not highlight or verify the effect that lake size has on trip numbers. When asked to confirm why these sites were important and what was attracting individuals to these sites, the size of the water body at the sites was not discussed during any interview. It should be noted that if no initial discussion regarding lake size at the sites were mentioned, no further questioning regarding this attribute was conducted throughout the interview. No mention of lake size as a attractant during my interviews result may be attributed to the limited number of large water body sites monitored within the study.

Physical Constraints

The inclusion of travel cost attributes (i.e., distance to lake and quality of access) improved the explanatory fit of the model. The positive and significant estimate for a road access confirmed hypothesis *H3* (that sites with road access would have significantly higher traffic counts than sites with trail access). The results also confirmed hypothesis *H5* (that sites that were closer to population centers would have higher traffic counts). Further support for this conclusion came through confirmation of hypothesis *H7 (*that sites in the DRM forest (*DOGRIV*) would have greater traffic than would other sites). This result is related to the fact that sites within the DRM are much closer to a much larger population center (Thunder Bay) than other sites.

The importance of travel distance to trips to recreational sites is a common research finding (Griffin, & Walters, 1999; Hunt et al., 2007; Hunt, & Lester, 2009; Kaufman et al., 2009). As well, improved access to lakes has been shown to affect the number of trips to lakes (Hunt et al.; Kaufman et al.).

Interviews with recreationists and OMNR enforcement officers confirmed a number of the effects that travel cost attributes had on traffic to the sites. Informants indicated that consistently higher levels of traffic at sites such as *Frazier, South Bay* and *Barbara Lake* were due to their close proximity to Nipigon and their primary road accessibility. When asked what makes sites such as Frazier Lake and South Bay consistently have more traffic, a tourism operator responded "[It is], access. I mean Frazier Lake is only 20 minutes from town. So, distance as well." Several anglers stated that these sites were very popular because they could "go out" and successfully harvest their limit of fish in a short time "Well, for Frazier [Lake], people leave from town and can easily get their walleye limit." This was also the case for sites within the DRM forest. Lakes such as *Drift, Little Athelstane* and *Nelson* were discussed as displaying consistently higher levels of traffic due to their accessibility and relatively close proximity to Thunder Bay. One participant stated:

> "Athelstane [Lake] again, it has got nice easy … access. But, what it really has is access to a series of lakes. Without having to portage [to] a bunch of walleye lakes in the back."

Most of the confirmatory interviewees suggested that many of these physical attributes also have a temporal component. For example, speaking with a number of OMNR enforcement officers and fisheries biologists, the presence of walleye at an angling destination had its strongest draw during the early months of the season, in May and June. The OMNR officials explained that this results from the timing for the regulatory season to harvest the species and the colder lake temperatures that result in easier harvesting since walleye will remain in shallower waters to stay warm. When asked to comment on the July counts, an enforcement officer remarked: "[In] July traditionally, walleye fishing drops off, and you look at August and it will pick up again." Participants remarked that changes in the recreational focus also seem to occur during different times of the season, moving from a strictly angling focus to a more family oriented focus. One participant commented:

> "Again, it is all about fishing quality. In June, something different is happening here, kids are starting to get out of school in that period, weather is starting to warm up, fishing is actually starting to tail a little bit. Fishing is just a lesser part of it, but it still has to be part of it for the folks around here."

Temporal Water-Based Recreational Site Choice Attributes

With the exception of the wind attribute, the results supported all seven hypotheses relating to the timing of trips. Discussions with local recreationists, OMNR enforcement officers and fisheries biologists also verified the importance of these attributes for trip timing.

Weather Events

The inclusion of weather attributes was shown to greatly improve the overall fit of the model. In particular, the recorded temperature, measured as the maximum daily temperature, was significantly associated with more traffic, supporting hypothesis *H9*. Support for hypothesis *H8* was also found for the negative effect of precipitation on traffic volumes at the sites. No support was found for hypothesis *H10* that wind speed would affect the timing of recreational trips.

Others have noted similar results for weather (Cook, & Yuonk, 1998; Pet-Soede et al., 2001; Solon, & Brunt, 2006; Bucher, 2006; Hunt et al., 2007). For example, Hunt et al. found that precipitation negatively affected the timing of angling trips by northern Ontario recreationists. Past research also has suggested that wind speed should negatively affect trips (Provencher, & Bishop, 1997; Solon, & Brunt). Previous results, however, have indicated the effect of wind being most influential on recreationists traveling to larger water bodies (Solon, &

Brunt). This might help to explain the non-significant effect of wind speed here, as only two of the lakes studied were over 2500 ha in size.

Numerous discussions with participants helped to confirm the importance of weather events. Recreationists that were interviewed remarked that temperature and precipitation had important affects on their timing for recreation trips "Really, I am looking at the predicted weather. Is it going to rain? Is it going to be cold?" These attributes were associated with both the quality of the angling and their own safety. Anglers, and OMNR fisheries biologists, stated that temperature is a significant attribute dictating when ice will melt from lakes and allow open water angling opportunities to begin.

> "Of course, at the start of the season the fishing is the best. South Bay, it varies from when ice is out. Last year it was late. Anywhere from mid May to the end of June. As soon as the ice is out it will pick up again."

A number of participants also remarked that weather conditions, though important, may be less critical to their decision to recreate if alternate days to recreate do not exist (e.g., your trip has already been planned for a certain time). When asked if poor weather would always have an affect on their trip a participant stated:

> "I guess it depends if you booked your holidays or not. Maybe for a day trip it would be a big deterrent. People that plan to take a week off work to go moose hunting on opening weekend, they are going to go anyways."

For example, Hunt et al. (2007) found that precipitation had a stronger effect on day than multiple day trips taken by northern Ontario anglers. This may be attributed to multiple day angling trips also requiring advanced planning and scheduling, thus, resulting in a limited number of alternate times to recreate if weather is unfavorable. If weather conditions are poor, and an individual has a considerable amount of free time, the choice not to recreate on inclement weather days is more likely. As well, if these multiple day trips have already begun, the option to end the trip due to inclement weather may not be as favorable.

Calendar Events

Finally, the results confirmed hypotheses *H11* and *H12* (that the presence of a weekday and weekend day would have a significant and negative effect on traffic counts as compared to the presence of a holiday day); as well as *H13* (that days during the cultural definition of summer would have a significant and positive effect on traffic counts); and *H14* (that the year the counts occurred would have a significant effect on traffic counts). These particular attributes (*WKDAY, WKEND* and *HOLIDAY*) were able to improve the overall model. My analysis also confirmed that a greater number of traffic counts occurred during the significant cultural defined events occurring during the summer and moose hunting season. Finally, counts occurring in 2007 were significantly greater than those occurring in 2006 or 2008.

Past research has found that calendar events are important for the timing of recreational trips (Provencher, & Bishop, 1997; Bucher, 2006; Hunt et al., 2007). Hunt et al. found that recreational angling trips in northern Ontario were more likely on public holidays, such as May long weekend (third Monday in May), Canada day (July), August long weekend (first weekend in August) and Labour day (last weekend in August). Figure 4 showed this effect with the largest peaks in traffic counts occurring during those holiday weekends. Seasonality is also noted as an important factor in affecting the timing of recreation trips (Provencher, & Bishop; Cook, & Yuonk; Bucher).

Hypothesis *H13* was confirmed, supporting publicly recognized cultural events (summer events, moose hunt) as being a strong temporal attribute driving water-based recreational trips.

Significant cultural events have been suggested to be important for the timing of recreational events (Provencher, & Bishop, 1997; Bucher, 2006; Hunt et al., 2007). The culturally significant periods of both the walleye and moose hunting seasons were remarked throughout the confirmatory interviews as being significant periods for recreational engagement. Many participants highlighted the end of the culturally significant walleye season (Labor Day Weekend) when many individuals spend the last weekend of the season at their recreational cottages. For example, "School has started again. People will go out during the long weekend, [the] first week in September to close up their camps." An enforcement officer from the Nipigon District stated regarding the moose hunting season:

> "See [the] October long weekend is when moose hunting begins. That is why you have got this here [a large number of counts]. There are a lot of people camping here."

Recreationists also spoke to special culturally significant walleye angling derbies occurring during the season that would have caused high traffic counts. One of these derbies occurred on the weekend of June 12, 2008, in the Nipigon area.

> "Frazier, yes there is a walleye derby there. I think it was around the 12th. I think it was the fourth year of it. And for Elizabeth, I can see people camping there for the derby because it is so close."

Although I did not formally examine the effect of seasonality, some count data was collected during the winter months (Figure 14). The high importance of the summer season was confirmed during the interviews. These interviewees indicated that the highest level of visitation to sites occurred during July and August. Participants indicated that both theirs and their children's holidays occurred during these months that had the most favourable weather, thus, resulting in a larger number of family camping outings during these times.

"[The] number of permanent camping goes up in June. They [recreationists] will go set up their camp, park their trailer, come back a week later when their kids are out of school and they have their space claimed. Again its all clustered around weekends."

Finally, these findings also lend some support to hypothesis *H14* indicating that the year the traffic counts occurred in would have a significant effect. Average daily counts that occurred in 2007 were significantly higher than those in 2006 and 2008. Recent literature also lends support for this temporal variation (Bucher, 2006). Discussions with participants highlighted that this difference would likely have been caused by variations in fuel prices between 2006 and 2007 and in weather patterns between 2008 and 2007. "So, prices in gas were extremely high here in '06. So, people aren't going as far." Another participant remarked:

"This [2008 summer] was wet here. [In] 2008, we had some of the highest [water] flows we have ever seen. This might have caused some of the drop off [in traffic counts] here." (OMNR Fisheries Biologist, personal communication, April 24th, 2008).

Resource Management Implications

A first step to manage recreation resources is to understand the patterns of use and the processes that lead to these patterns. This thesis has contributed to this first step by identifying the physical and temporal attributes that influence trips to water-based settings in northern Ontario.

Besides providing information, the results are useful for designing management strategies that can mitigate conflicts and maintain access to suitable recreational resources for northern Ontario residents. Conflict research in nature-based recreation has traditionally focused on interpersonal and social values conflicts (Vaske, Donnelly, Wittman, & Laidlaw, 1995).

Interpersonal conflicts, or more specifically goal interference conflicts, arise when the pursuits of certain activities interfere with the outcomes or goals that other individual seek from their activities (Jacob, & Schreyer, 1980). A large portion of this type of conflict within resource management stems from recreation and resource extraction activities competing for the same resource (Hunt et al., 2000). Watson (2001) found that these goal-interference conflicts are most appropriately addressed through physical and temporal segregation of competing groups. The results from this analysis are relevant for informing the development of such techniques to accomplish this goal.

Hunt et al. (2009) indicate that one technique that managers may use to mitigate conflict arising from goal interference is the development of zoning strategies. Zoning involves identifying large areas or zones on the land that can be managed for specific values or activities (Hendee, & Dawson, 2002). For example, areas may be zoned to protect and manage for the large number of highly valued recreational activities occurring in the area. Results show that attributes such as the presence of walleye, good road access, proximity to communities and lake size, are key influences in an area being intensively used and valued. By being able to identify the physical attributes that drive demand for water-based recreation, resource managers may begin to delineate areas with similar highly valued attributes and work towards zoning those areas as special recreation zones. This may allow for special management controls to be introduced in the zone that facilitate access to, and recognition and protection of these valued areas.

This study not only helped to identify the physical attributes driving recreational demand, but also a number of the temporal attributes. By combining the understanding of the seasonality of recreational use with the timing of forestry operations, managers may begin to develop temporal zoning strategies that segregate competing activities. Scheduling forestry operations to occur outside of the peak periods between May and August may reduce conflicts resulting from operations occurring too close to highly valued recreational sites. This technique may also occur within the peak recreational season, by simply avoiding other valued periods such as weekends and holidays. Temporal zoning strategies may also be combined with spatial zoning strategies to create floating recreational reserves. Identified highly valued recreation areas may be designated, while concentrating forest harvesting activities elsewhere. After regeneration of the forests, managers may switch these zones, thus creating a floating system of areas that are managed for recreation (Yuan et al., 2004; McIntyre et al., 2008).

Another important conclusion drawn from this study refers to the importance of providing suitable access for recreation to occur. Improving or reducing access greatly affects the traffic to water-based recreation sites. Within Ontario the forestry industry and its operations are the leading developers of roads and access on Crown lands (Hunt et al., 2009). Consequently, much of the conflict over Ontario's Crown forests has resulted from the forest industries development of road systems towards or away from valued recreation sites (Hunt et al.). These results show that improving access to highly valued recreational sites will likely increase trips to these sites. However, long-term inherent effects of improved road access to a destination have also been found to exhaust the resource (Walters, & Cox, 1999; Gunn, & Sein, 2000; Laven, Manning, & Krymkowski, 2005). Increased levels of congestion, as well as resource depletion caused by improved access to sites have been the leading contributors to a reduction of recreational satisfaction or use at many sites (Walters, & Cox; Gunn, & Sein; Laven et al.). Therefore, the proactive management and strategic road planning of forestry operations to potentially enhance access to identified highly valued recreational destinations may aid in reducing conflict.

Lastly, resource managers have adopted adaptive management techniques to identify and manage conflict within a changing environment (Hendee, & Dawson, 2002). These techniques allow managers to test and to evaluate management scenarios by analyzing their effects on established social and ecological criteria. Certain management prescriptions may result in altering the physical or temporal environments in an area, which in turn may result in varying recreational patterns. The results from this analysis can aid in understanding how recreationists are likely to substitute the locations and timing of recreation activities when physical and temporal changes occur in the environment (Hunt et al., 2007). Further analysis and model development may be necessary to understand these complex decision making processes.

Limitations and Future Research

Limitations

This thesis was produced to study two research questions: (i) understand the spatial and temporal patterns of water-based recreational use and (ii) to determine the physical and temporal factors that produce these patterns. Data about recreational trips was obtained with vehicle traffic counters. While these counters have many positive aspects, the data collected by the devices does not provide information about total number of users or the activity pursuits of individuals within vehicles. Therefore, the assumption of traffic equaling use might not hold if individuals were more likely to travel together to some but not other recreational sites. However, no data exists to suggest that this different travel behaviour occurred.

To address this limitation, I employed two techniques to account for the potential errors in gathering accurate demand data at our sites and linking traffic counts to recreation use at water-based settings. First, following Hunt and Hosegood (2008), I used a 10 second lag between counts to avoid double counting slowly moving and large vehicles. I also explored the patterns of results with local recreationists, tourism operators and OMNR employees in interviews. Specifically, mapped representations of demand were produced and displayed for interviewees, and verification of the activities, level of the traffic count variance and distribution was confirmed. I also performed natural observation verifications, whereby I was able to confirm the accuracy, physical attributes of the sites, and the recreational focus of the visitors.

A second component of this study was to determine recreationists' preferences for certain physical and temporal attributes that affect trips to water-based recreation sites. This determination was performed using a utility theory approach, combining the theories of utility maximization and random utility (Hunt, 2005). In identifying these attributes, I assumed that each recreationist sought to maximize his/her utility, and was able to make rational decisions when weighing each attribute (utility maximization). The assumption that all humans act to maximize his/her utility is likely flawed, as evidence exists that individuals may also act as satisficers and not optimizers (Simon, 1978; Hunt, 2005). This points to the fact that there may be other important attributes that drive these traffic counts that I have not accounted for in this model. Some of these attributes may include such water quality, beach size, environmental aesthetics or level of congestion (Freeman III, 1995; Needleman, & Kealy, 1995; Schuhmann, & Schwabe).

Finally, there is a certain degree of randomness involved in decision-making processes for recreationists (Hunt, 2005). My analysis could not have accounted for all of the random effects and elements involved in every choice decision. However, I did attempt to control for some elements of randomness through the choice of the recreational model. Adopting a negative binomial regression analysis over a Poisson recognized the overdispersed and variable nature of my demand data. This negative binomial analysis added a random variable to the model. Extra fixed effect parameters were also added to the model to account for the heterogeneity each monitored site displayed. Finally, interviews with knowledgeable members of the community were also conducted to help understand other idiosyncratic variations in recreational trips to the sites. These interviews provided contextual insight and further reliability and validity to my identified physical and temporal attributes. However, other factors beyond these identified physical and temporal attributes may be contributing the variations in these patterns as well. This study was unable to uncover all possible recreational activities that may be occurring at these sites (e.g. berry picking, canoeing). Therefore there is still the potential that these sites may be offering other attributes that are driving these alternative behaviours.

Future Research

Though the uses of traffic monitoring devices come with some limitations, their ability to gather demand data represents an important method for recreational demand research. Traffic monitoring devices allow for a relatively inexpensive way to gather demand data over a large area at numerous sites and continuously during day and night. The ruggedness and small size of these devices also allow the easy burial of the units, allowing for reduced theft or damage of the devices. The discrete nature of these devices may also allow them to be used in other future demand studies. For example, buried traffic monitoring devices may be used to monitor the compliance levels of certain road restriction tools (e.g. signs, burms, gates etc).

Further future research endeavors into the understanding of recreational trips may begin by addressing some of the missing attributes from this study. For example, angling quality is sometimes measured by reported catch rates, expected catch rates and the quantity of the fish stock (Parsons, & Kealy, 1992; Pollock et al., 1994; Englin, & Lambert, 1995; Train, 1998; Cook, & Yuonk, 1998; Lester et al., 2003; Hunt, & Lester, 2009). A more precise measure of angling quality might provide a better understanding of the variations in traffic flow. Environmental quality, including water and aesthetic quality has also been shown to have significant effects on an angler's decision making (Englin, & Lambert, 1995 Train, 1998; Lipton, & Hicks, 1999; Hunt, 2005). Choosing to measure and adopt these attributes into one's analysis may strengthen the explanatory power of future models.

This study produced a basic model of recreation demand for water-based recreation. However, this model assumes that every individual has identical preferences for each attribute and that each individual chooses among the same set of recreational sites (Hunt, 2005). Researchers have attempted to account for the varying preferences among individuals using other techniques (e.g., latent class models or basic market segmentation) (Hunt). If data were gathered from individuals, it could be possible to account for heterogeneous preferences among recreationists. Stated preference choice models might offer this possibility where individuals are asked to choose recreation sites from sets of hypothetical sites described by attributes (Hunt). This information can then be used to produce a more accurate model of recreational choice behaviours for the purposes of modeling.

Lastly, Gimblett and Skov-Petersen (2008) suggest that computer based simulation is another effective tool for managers to use when dealing with complex management scenarios. Through the use of simulation modeling, managers might assess the effect that certain management scenarios may have on the distribution of demand across the landscape (Hunt, 2005; Hunt, & Lester, 2009). For example, how would demand to one particular lake change if managers created access or restricted access elsewhere? How would improving or depleting fish stocks at one destination affect pressure elsewhere? Simulations may also be used to monitor certain variables on the land base in a more cost effective manner by simulating the effects of demand scenarios (Gimblett, & Skov-Petersen). In a time when economic budgets are stretched, simulation techniques may become a highly valued tool.

Chapter VI - Conclusions

This research project set out to answer two primary research questions: i) what are the spatial and temporal patterns of water-based recreation and ii) what are the attributes that drive these patterns? Overall, the mean daily traffic counts measured at 21 sites was 3.95 counts/day, with a standard deviation of 7.39. This high standard deviation suggests that these counts varied considerably from day to day and from site to site. The distribution of counts varied considerably over space, with higher levels of traffic being generated at sites closer to urban centers, better quality access, and larger lakes. Traffic counts were also concentrated on weekends and holidays, and during the summer.

The results supported the importance of all but two hypotheses related to the effects of physical attributes on traffic to water-based recreation sites. As expected, higher average daily traffic counts were recorded at accessible sites with larger-sized lakes containing walleye that were near communities. As predicted, higher level of traffic counts occurred within the Dog River-Matawin Forest due to their close proximity to the large population center of Thunder Bay. This analysis, however, was unable to support the hypothesis that sites with lakes containing lake trout would have more traffic than at sites without available lake trout or walleye. Almost all temporal attribute hypotheses were also confirmed. Average daily traffic counts were greater on days with higher temperatures and minimal precipitation. My temporal hypotheses that higher average daily traffic counts would occur on during holidays and weekends and days during a significant cultural event (e.g., cultural definition of summer) were also supported. However, no evidence existed to support the hypothesis that expected lower levels of traffic counts occurred on days with higher wind speeds.

The results of this research are important for managing conflict between recreation and forestry operations. First, the results show a high degree of variation in recreational traffic between sites. By understanding the spatial attributes that contribute to this variation, managers can evaluate the potential importance of sites to recreationists. This improved understanding allows managers to design zoning strategies that segregate land uses to specific geographical areas and separate competing activities.

Second, the results reinforce previous research that emphasises the importance of accessibility to recreationists. Recreational demand was highest at sites with road and not trail access. This result implies that forestry operations and resulting maintenance and road creation activities provide important benefits to recreationists in northern Ontario. Therefore, planning forestry operations to maintain and improve access can help to create opportunities for recreationists and lessen the negative effects of activities over the landscape.

Third, the temporal attributes that drive recreational use at the sites are important to understand for the timing of forestry operations in and around recreational sites. Temporal segregation techniques, such as floating reserves, may be useful in decreasing conflict. Clearly, recreational traffic is concentrated during the months of May to October. Scheduling operations to occur in the recreational "off-season" might result in fewer concerns being expressed about forest harvesting in close proximity to these sites. Combined with targeted strategic zoning and road planning, these proactive timing efforts to accommodate recreation may result in fewer conflicts with road-based recreationists.

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Appendix I - Interview Cover Letter

Understanding Temporal Patterns of Forest-Based Recreation Within Ontario's Crown Lands

Dear Potential Participant,

You are being asked to participate in a research project being conducted by Adam Dyck, from the School of Outdoor Recreation, Parks and Tourism, Lakehead University in conjunction with the Ontario Ministry of Natural Resources. The title of the project is *"Understanding Temporal Patterns of Forest-Based Recreation Within Ontario's Crown Lands"*. The purpose of this research is to explore and compare the temporal patterns of forest-based recreation occurring within important recreational areas within the Lake Nipigon Forest Unit and Dog-River Matawin Forest Unit. The study will also investigate the attributes that explain variations in spatio-temporal patterns among sites within the recreational areas.

Your participation in this research will be extremely beneficial, as it will provide the researcher with insightful knowledge into understanding the temporal patterns of forest-based recreation. In addition, your participation will help the researcher understand the complex views, concerns and opinions surrounding the nature-based recreation within Ontario's public lands.

We are asking you to participate in an interview to explore your thoughts on the temporal patterns of forest-based recreation occurring within important recreational areas within the Lake Nipigon Forest Unit and Dog-River Matawin Forest Unit. The interview will take approximately 30 minutes to 1 hour and is based on a broad set of questions. We are most interested in hearing your thoughts, opinions and concerns about forest-based recreation in your area. Your participation is completely voluntary and you are free to refrain from answering any questions or to withdraw from the interview at any time.

The information you provide during the interview will be tape recorded. Upon completion of the research project, this data will be securely stored for five years at the university, as is required by policy.

Reports resulting from this research are anticipated and as such, the information provided by you will become public. Your names and any personal information provided will not be released within the final document.

If you have any questions concerning this study, I can be reached via email at adyck@lakeheadu.ca or (807) 472-2117. You may also contact my supervisor, Dr. Len Hunt, by e-mail len.hunt@ontario.ca or by phone (807) 343-4007. As well, you may contact the Lakehead University Research Ethics Board at (807) 343-8283.

Thank you for your time.

Sincerely,

Adam Dyck
Principal Researcher
Master's of Environmental Studies Graduate Student
Lakehead University

Appendix II – Interview Consent Form

Understanding Temporal Patterns of Forest-Based Recreation Within Ontario's Crown Lands

My signature on this sheet indicates that I agree to participate in a study by Adam Dyck, concerning *Understanding Temporal Patterns of Forest-Based Recreation Within Ontario's Crown Lands.* I understand that I will be participating in an interview. I have received explanations about the nature of the study, its purpose and procedures. I understand that when my transcript or a copy of field notes is returned to me I have the opportunity to provide further comment or clarification within 2 weeks and I give my consent to use all information in that transcript.

My signature on this sheet also indicates that I understand the following:

1. Your participation in this research is voluntary and that you are free to withdraw at any time. You may choose not to answer any question.
2. You have read a copy of the cover letter.
3. Your identity will remain completely anonymous in the final report.
4. You understand and agree with the tape recording of the interview.
5. You will have the opportunity to review field notes and/or transcripts of the interview to ensure accurate representation of your views.
6. The information you provide will be utilized to create documents for publication.
7. The data generated from this research will be kept at Lakehead University for 5 years.
8. You will receive copies of publications that result from this research should you wish. (Please indicate below)

If you wish to receive a summary of the final results, please provide your email address ____________________

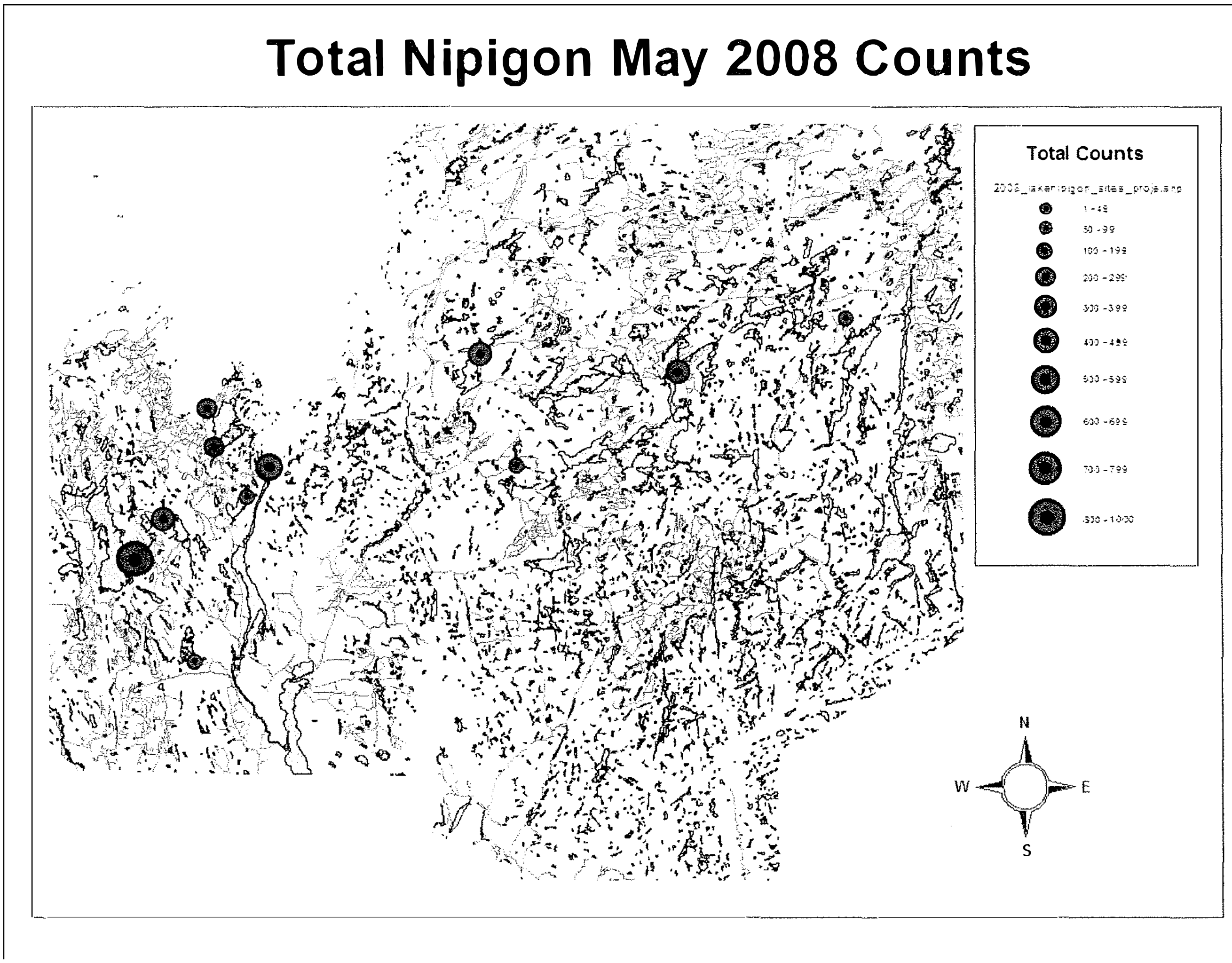
____

Signature of Participant   Please Print Name   Date

Appendix III – Interview Schedule for Confirmatory Interviews

- Are these identified spatial valuation zones on the map representative of the valued recreational destinations in the area?
- What are the features that distinguish these destinations as highly valuable?
- Are there other highly valued destinations in the area that are not highlighted on this map?
- Are these patterns of recreational use a reasonable representation of recreational use at these destinations?
- Why do you believe that use at the sites varies over time?

Appendix IV – Example of Interview Map for Nipigon East and West Sites



Appendix V – Example of Interview Map for Dog River-Matawin Forest Sites

Total Dog River Matawin July 08 Counts