University of Alberta

The Development of Fire-Induced Damage Functions for Forest Recreation Activity

by

Michael Rausch ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of

Master of Science

in

Agricultural and Resource Economics

Department of Rural Economy

Edmonton, Alberta
Fall 2006

Your file Votre référence
ISBN: 978-0-494-22355-0
Our file Notre référence
ISBN: 978-0-494-22355-0

ABSTRACT

This study develops an intertemporal damage function to examine the effects of forest fires on non-market recreation values along the eastern slopes region of Alberta, Canada. Camping activity is analyzed, and distinctions are made between recreational site soil qualities and recreationists who camp in established campgrounds and random camping areas. The intertemporal damage function discovers that campers are not drastically affected by fire activity to their favourite recreational sites as most recreationists chose to camp nearby immediately following a forest fire, and most return to their favourite site within 10 years after a blaze. This demand function allows land managers to predict changes in spatial visitation patterns in response to fires and fire management activities. Furthermore, fire management is a dynamic problem since decisions made today will affect the probability and characteristics of fires into the future; the responses and trip-taking behaviour of recreationists to these patterns are similarly dynamic.

Acknowledgements

There are numerous individuals I would like to thank for helping me along the way towards the completion of this project. This list includes Dr. Vic Adamowicz and Dr. Sean Cash for reviewing and offering advice for the survey, and for making a variety of other recommendations that were greatly appreciated. Thank you Dr. Uldis Silins for your insights on the biology of Alberta's forests, Brendan Brabender for supplying some of the survey photographs, Jim Copeland for making the survey available online, Dr. David Ortiz for always coming through when needed, and Rick Pelletier for supplying the study region map and making the Crowsnest Pass maps possible. Lastly, thank you to the support staff, professors, colleagues, and particularly friends from the Department of Rural Economy, a family that I will miss.

The Sustainable Forest Management Network (SFMN) must be acknowledged for its generous financial support that made this study possible. Thank you Bonita McFarlane for playing a significant role in shaping the direction of this project as co-supervisor, your insights and expert opinion were much appreciated. Most importantly I thank my primary supervisor Dr. Peter Boxall for making the opportunities and experiences afforded by this schooling and thesis project a reality. Your passion for this field, genuine care and interest in students, great sense of humour, refusal to take anything too seriously, and patience answering a vast number of questions has not gone unnoticed. Lastly, thank you to my friends and family, new and old, for all your contributions and support…

for Brett

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CHAPTER 1: INTRODUCTION

Since the turn of the 19th century, North American forest ecosystem policies typically included eliminating fire from forests through immediate and aggressive suppression. Years of this type of policy resulted in dense and overgrown mountainous forests that contained high levels of fuel comprised of deadwood and underbrush, particularly in the United States (Starbuck et al. 2006). Heavy fuel-laden forests (most notably open-canopy) are susceptible to the occurrence of wildfires, and the increasing trend of warmer temperatures only adds to the probability of greater forest fire activity (Flannigan et al. 2005; Johnson et al. 2001). In fact, fire weather is expected to be more severe under a warmer climate as forecasted due to climate change; thus, greater areas burned, more ignitions, and longer fire seasons are predicted (Flannigan et al. 2005). It is obvious that the occurrence of forest fires appears to be an increasingly significant issue every season (Carle 2002).

The impacts of forest fires also appear to be growing in significance because more stakeholders are continually affected, including people and companies who use and occupy forested land and plants and animals whose habitats are often under constant threat. One component of measuring the impact of a forest fire is quantifying the damage to timber stands and infrastructure, a task that is usually possible. However, there are also losses that are more difficult to measure but should be considered, including recreational, intrinsic, spiritual, ecological, community, and existence values. These values represent important forest benefit flows which should be explicitly present in forest policy decisions and actions, however their inclusion is often omitted because they are not easily measured or quantified in dollar terms (Stevenson et al. 1997).

With alternative fire fighting and prevention strategies continuing to evolve and increasing fire management options, calculating abatement costs and the economic effects of forest fires is extremely important to land managers who must shape policies aimed at improving a forest's overall health. An important area includes the impact of wildfires on forest recreation demand (Starbuck et al. 2006). Although considering such values in forest management is becoming commonplace, calculating the impacts of fire on recreation and the resulting economic consequences remains an obstacle for forest and fire managers because there is little information on the effects of fire on recreation use (Englin et al. 2001). This sentiment is echoed by Hesseln et al. (2004) and Loomis et al. (2001). Likewise, Hesseln et al. (2003) reiterate that there is a need to expand the volume of forest fire and recreation studies than currently present, both in terms of geography and activity examined. This study aims to fill the void and increase the level of knowledge concerning forest recreation values. To do this, I focus on camping activity in the eastern slopes region of Alberta, Canada, from the moment a wildfire has been extinguished to the old growth stage.

Valuing recreation implies calculating non-market values which can be difficult to accurately reflect in monetary terms (Cameron 1992; Hesseln et al. 2004). In this study, actual behaviour data and contingent behaviour data are used to generate a model that predicts recreation behaviour following forest fires in Alberta's central and southern Rocky Mountain (eastern slopes) region. This project addresses the shortcoming outlined by Englin et al. (2001) that there is not a solid empirical basis for determining how recreation behaviour changes immediately following a fire and during the recovery/regeneration interval. This particular study is also unique because changes in trip taking are not typically discussed or explicitly modeled (Starbuck et al. 2006).

This study combines two types of information regarding camping trip decision making; revealed preference (RP) data gathered directly from outdoor recreationists and stated preference (SP) data which is generated through responses to contingent behaviour scenarios utilizing colour pictures of forest stands in a survey. An intertemporal damage function is constructed from both pieces of information, and using the combined data methodology increases the accuracy of this model. The damage function can determine how the presence of forest fires from different time periods alters overall forest recreation values in Alberta's Rocky Mountain Region.

CHAPTER 2: REVIEW OF FIRE AND RECREATION LITERATURE

There is debate surrounding the prominence of forest fires in North America, particularly intense fires. Are fires more frequent now than they were years ago, or has greater media coverage and reporting created an illusion of more forest fires? Are they more severe? If there are in fact more forest fires today, is this due to human activities or simply a natural cycle? These concerns seem to parallel, perhaps not in an unrelated manner, the debates surrounding global warming and changing weather patterns. One thing is certain, however; an increasing number of people and structures are becoming vulnerable to the threat of fire (SILVIS Lab 2006). There are more people, homes, and industrial interests in the forested wildland/urban interface (defined as the region where human development meets wilderness regions) throughout North America (SILVIS Lab 2006). In addition, concerns persist about the *threat of* or conversely the *exclusion* of fires from preserved forested areas (Carle 2002).

Some people believe that years of strict fire suppression policies in North America have not only deprived forests from natural fire-induced benefits, but they have also made forests more prone to severe wildfires. These beliefs are not new, as supporters and opponents of "strict versus flexible" fire abatement strategies have been debating ever since large scale fire fighting policies began early in the 20th century. According to writer and timber owner Stewart Edward White, in a March 1920 article:

> "...one may prevent fires for five, ten, twenty-five, fifty years. But one cannot eliminate all carelessness, all cussedness, all natural causes...we are painstakingly building a fire-trap that will piecemeal, but in the long run completely, defeat the very aim of fire protection itself...keep firmly in mind that fires have always been in the forests, centuries and centuries before we began to meddle with them. The only question that

remains is whether, after accumulating kindling by twenty years of so of "protection", we can now get rid of it safely..." (Carle 2002:30).

White believed that an effective method to remove this "kindling" was through the use of prescribed burning, calling fire "a bad master but an excellent servant" (Carle 2002:30). Critics counter that purposefully igniting fires welcomes the very risk that is trying to be eliminated, it destroys new growth and thus a forests' future, and they believe it is irrational, wasteful, and even immoral to burn a forested stand (Carle 2002). However, controlled burning is nonetheless regaining popularity as a fire prevention measure. In combination with more values at risk to forest fires, and greater recognition and analysis of non-market forest values such as recreation, there has been a recent increase in research on recreation and fire induced disturbances in forested environments.

Much of the recreation/fire literature focuses on activities that entail either trail or route choice, where the landscapes change as one travels onward (e.g. canoeing, hiking, and biking). Taylor and Daniel (1984) were one of the few to study site choice for camping, a stationary activity because the landscape remains static during participation. They examined the relationship between people's acceptance of controlled burn policies and their campsite choice preferences. Taylor and Daniel (1984) asked participants to rate slides of forest scenes based on two criteria; scenic beauty and acceptability for recreation. The slides depicted pine forest stands that were burned by either a low or high intensity fire 1 to 5 years previously, or not burned at all. The authors found that the recreational acceptability of differently affected landscapes varied depending on the activity; camping was found to be especially sensitive to fire effects as campers strongly disliked any fire damage (including low-intensity) to their camping areas (Taylor and Daniel 1984). This is likely because people must actually live in an affected region for a period of time instead of simply having the option to pass through, as with hiking or canoeing. Since individuals constantly view the surroundings of their chosen recreational site with a stationary activity like camping, they are likely to be more discriminating in their choice of campsite.

The first study that focused on measuring the economic effects of forest fires on outdoor recreation demand, and the first to use photographs to elicit SP responses, was conducted by Vaux et al. (1984). Other non-market valuation studies had previously measured the effects on forest recreation caused by insect and logging disturbances using contingent valuation methods (CVM). Believing that fire damage was similar in nature, Vaux et al. (1984) felt that CVM could be extended to examine the effects of fire on recreation. CVM techniques consist of establishing hypothetical markets and scenarios, and estimating the economic value of the good in question based on transactions occurring in this hypothetical setting. Vaux et al. (1984) showed respondents pairs of forest pictures from different time periods before and after fire, and asked them to select the photograph they preferred as a site for recreational activity. Then they asked participants their "willingness to pay" (WTP) to visit this particular site. A market was thus established, and the economic impact of fires on recreation values was calculable. Vaux et al. (1984) found that less intense fires had positive economic effects on recreation demand, while intense (crown) fires may have had a detrimental impact on recreational values.

A number of recreation demand studies involving fire were conducted in Manitoba's Nopiming Provincial Park. The first, a study conducted by Englin et al. (1996), used a discrete choice travel cost model developed by utilizing actual observed choices of canoe routes in the park. The discrete choice model was used to develop a linear intertemporal damage function (Englin et al. 1996). The model is intertemporal since losses caused by wildfire eventually fade to zero as the forest regenerates over time. By evaluating the welfare changes following forest fires, non-market values generated by the forests in the form of recreational opportunities were estimated. The authors found that canoe routes along sections of forest that had re-grown for ten years provided negative amenity values, while mature forest stands provided important positive amenity benefits (Englin et al. 1996).

Boxall et al. (1996*b*) updated the previous study by more thoroughly evaluating which characteristics significantly affected the benefits of recreational canoeists in Nopiming Park. A multinomial logit version of the travel cost random utility model (RUM) was utilized to allow for the direct valuation of forest attributes (Boxall et al. 1996*b*). They found that canoeists preferred routes that predominantly featured jack pine and white spruce trees species, while they would pay to avoid black spruce and aspen tree species, fire-damaged forests, portages, and cottages (Boxall et al. 1996*b*). Boxall et al.'s study, and others discussed below, reinforce that although "...park management variables play a role in determining recreation values, the ages and types of forests located at recreation sites are more important" (Boxall et al. 1996*b*:982).

Englin et al. (2000) developed a Faustmann rotation framework to determine the optimal timber rotations in a multiple-use forest. They incorporated not only timber and amenity values into their model, but also forest fire risk. Using results from Boxall et al.'s (1996*b*) study, the authors estimated a two-piece linear amenity damage function. They proposed that recreational values were negative immediately following a forest fire. However, these amenity values would rise linearly during regeneration, become positive after 17 years of regeneration, and then plateau after about 65 years (Englin et al. 2000). The authors used the values associated with two ages of jackpine stands to develop this function. Their results showed that the optimal rotation age should increase as more people use the park for recreational purposes (since these values rise with age), while rotation ages should fall as the risk of fire increases (Englin et al. 2000).

The Manitoba-based research led to a similar study using different behavioural measures for hiking trips following forest fires in Idaho, Wyoming, and Colorado (Englin et al. 2001). This U.S. study used trip frequencies rather than site choices as measures of revealed recreation preferences. Furthermore, sampled recreationists were required to make trip frequency adjustments in response to pictures depicting fire affected stands.

Englin et al. (2001) found that the number of years since wildfire had a statistically significant effect on recreation demand, holding other factors constant, and they were able to propose a temporal pattern of recreational use following a forest fire. Their intertemporal damage function for forests of the intermountain western U.S. was characterized by an initial positive visitation response to recent fires, then decreasing visitation rates for 17 years, followed by a rebound in use over the next 8 years (Englin et al. 2001).

Utilizing the same data as Englin et al. (2001), Loomis et al. (2001) study the effects of fire on mountain recreation in Colorado. Different answers regarding trip behaviour in response to fire between hiking and mountain biking participants was found; hikers stated they would take more trips to non-crown fire affected stands, but were not significantly affected by crown fires. Mountain bikers responded in an opposite manner by increasing visits to aging crown-fire sites, but would take fewer trips to non-crown fire affected areas as they age. Interestingly, any fire activity would increase per trip consumer surplus value for hikers, but the welfare per trip decreases for bikers. Loomis et al. (2001) theorized this is because hikers are curious to see a recently burnt area (often lush in flowers, altered landscapes, etc.), whereas bikers may avoid them because they have more difficulty traversing the prevalent fallen logs in a burnt region. Keeping these reversed preferences in mind, the authors suggested that providing fire information along trails would better satisfy both recreational types and increase overall recreation benefits in National Forests (Loomis et al. 2001).

An identical survey and model structure was also used by Hesseln et al. (2003) as they examined the effects of different intensities of fire on hiking and biking visitation in New Mexico. Results indicated that mountain bikers took an average 6.2 trips per year, with a net benefit of $150 per trip. Hikers would take an average 2.8 trips per year, with $130 of net benefit per excursion. Analyzing the period from the initial fire strike until 40 years afterwards, both recreation groups exhibited decreased visitation rates as the area recovered from wildfire. However, hikers experienced an increase in per trip net benefits during the regeneration period. In contrast, the visitation demand (and subsequently per trip net benefits) for mountain bikers decreased and eventually would fall to zero trips by year 40. Taking into consideration that these results differed from similar studies in other states, the authors suggested that people often behave differently in response to fires of varying intensities based on the recreational activity they prefer to engage in. They also stated that recreational users in different geographical locations probably behave differently in response to fire.

Similar to the previous paper, Hesseln et al. (2004) examined the economic effects of forest fires on hiking demand in Montana and Colorado. Information was collected by intercepting participants at trailheads and asking contingent behaviour questions based on colour photographs of forest stands that were burnt at different times and to different degrees. Respondents were asked if their trip frequencies would change in response to these fires. The authors found that Montana hikers would take a greater number of trips than their Colorado counterparts. However, the welfare value per hiking trip was higher in Colorado than Montana ($55/trip compared to $12/trip). For both states, results indicated that the annual value of trips taken actually decreased as forest stands recover and regenerate following a crown fire. Subsequently, visitation also decreased for both activities throughout the duration of the 40-year span they analyzed following wildfire (Hesseln et al. 2004).

Starbuck et al. (2006) utilized similar research methods to understand the linkages between fire and fuels management policies and changes in forest recreation demand. However they also used the resulting recreation estimates to simulate regional economic impacts. Mail surveys were distributed to New Mexico park visitors who were approached onsite; the focus of the survey asked how the number of trips to their current site would change if half of the trail exhibited fire damage as depicted in photographs, using the actual number of trips to that particular trail that year as the base value. Three varied fire scenarios were used, and four different recreation demand models were developed. The authors found that most visitors decreased their trip frequency to affected sites by about 7% following catastrophic fire, slightly increased their number of trips to areas of low-intensity (i.e. "thinning") fires, and decreased the number of trips by 4.5% to areas which experienced catastrophic fire years ago. Starbuck et al. (2006) had two main findings; forest recreation users responded to changes in site attributes, and fire damage can influence the number of trips taken to a site depending on its severity.

In an effort to continue developing the knowledge base outlined in the literature discussed above, the broad objective of this paper is to understand further the fluctuations and movements of recreation values immediately following forest fires and during the regeneration period. More specifically, camping activity in Alberta's mountainous eastern slopes region is analyzed with an original data set. Special distinctions are made and behavioural differences are observed between the two primary types of campers in Alberta and between the soil qualities of camping sites. Lastly, an advanced econometric technique that models recreational behaviour more accurately is also incorporated to further validate results.

Therefore, this present study differs from all other literature discussed for various reasons. Taylor and Daniel (1984) and Vaux et al. (1984) asked respondents to rate the appearance of slides, and did not construct travel cost models. Englin et al. (2000) included RP trip counts in their study, however these trip values pertained to a region (not at the individual micro level) and their research focused on a timber rotation model, not a travel cost model. Boxall et al. (1996*b*) and Englin et al. (1996) developed site choice travel cost models, however they used RP information only. The remaining fire and recreation demand studies all estimated travel cost count data models using pooled RP/SP data and photograph-based contingent behaviour questions (as does this study), however different econometric techniques (described in section 3.3) are used for this project.

This paper also develops several unique components. Firstly, it is one of the few recreation/fire studies to examine camping activity. Most focus on trail-based recreational activities. This point should be kept in mind when comparing findings with other recreation demand studies since camping is unlike other forms of outdoor recreation (see discussion by Taylor and Daniel (1984)). Likewise, comparisons should be viewed with caution because participants in this study are not avid trail users; less than 29% of recreationists in my sample participated in trail-based activities like hiking, biking, canoeing, boating, and horseback riding *combined* while camping. Another unique component of this study is that a distinction is made between random and regular campers. A different geographical location compared to most recreation-based studies is also analyzed (the eastern slopes region of Alberta), and unique distinctions are made between poor and good soil site qualities. Lastly, as touched upon in the preceding paragraph, econometric techniques that are not typically employed to estimate recreation demand travel cost models were used as well.

CHAPTER 3: RECREATION DEMAND METHODS

3.1 TRAVEL COST MODEL APPROACH TO RECREATION DEMAND

Forested areas supply market goods and services such as timber and hotel visits, which are easily quantified in dollar terms. However, many nonmarket values like recreational activities such as camping are also produced by forests. This is a type of good or service for which traditional economic markets do not exist because of its public good nature, thus it lacks representative prices. Without traditional prices attached to nonmarket goods, their value to the public is more difficult to quantify. This lack of information often leads to nonmarket goods being undervalued or excluded from economic analysis.

Some goods and services are quasi-public goods, as in a portion of their total participation cost is captured in the payments of fees or other expenses. For example, activities such as hunting, fishing, and camping are examples of quasi-public goods because they require the purchase of licenses or permits provided by the government. The fees charged for these permits, however, are determined through administrative convenience and not set through market forces. Thus, the fees paid for camping on public lands in Alberta do not measure the total economic value of the activity.

Several techniques have been developed in an attempt to determine the economic value of quasi-public goods. One of these techniques is known as the "travel cost model" (TCM), which measures the value of outdoor recreation activities by linking the distances traveled to recreation sites with the total costs of participation (Loomis and Walsh 1997). The good in question, therefore, is the number of trips taken by an individual over a specified time period.

Hotelling (1947) first outlined the idea that travel costs could serve as implicit prices for recreational visits based on an assumption of weak complementarity between the cost of a private good (travel) and the availability of a recreation site (e.g. a publicly provided campsite) (McFarlane and Boxall 1998). McFarlane and Boxall (1998:6) further explained that "At different prices (i.e., distances) different quantities (numbers of trips) will be consumed (taken) to the site and these price-quantity variations identify a demand curve for the site". Economic benefits of recreational sites can therefore be derived by calculating consumer surplus, which is the area located under the demand curve but above the entrance fee price recreationists pay when visiting a site. Consumer surplus values in a recreational context represent the maximum prices that recreationists are willing to pay for a site versus what they actually pay, and provide a basis for the calculation of nonmarket values (McKenney and Sarker 1994). Attaching monetary measures to nonmarket values such as recreation is beneficial to forest managers because these values help represent the total benefits generated by forests (Loomis and Walsh 1997). Knowledge of these values can allow for more informed recreation management policy decisions.

Travel cost variables are used as a proxy for price in travel cost recreation demand models because recreational fees (e.g. campsite and park entrance fees) are not representative of the total costs incurred while taking a recreational trip (Boxall et al. 1996*a*; Loomis and Walsh 1997). Travel costs include both the monetary costs incurred by traveling from a residence to a recreational site, and the recreationists' opportunity cost of travel time. This explains why it cannot be said that two recreationists incurred the same cost to visit a particular campsite if one of them traveled 500 km to the site while the other traveled only 10 km, despite both of them paying the same camping fee. Thus, distance traveled is more indicative than fees of the true cost of visiting a recreational site and is the reason people take fewer trips to sites located further away. This logic follows traditional economic thinking.

Recreation demand in standard TCMs is determined by examining the relationship between annual trips taken (i.e. units consumed) and trip prices (i.e. travel costs plus permit fees) (Siderelis et al. 2000). It is assumed that all trip decisions for a given time period are made at the beginning of the period. Whether the number of trips taken are revealed through actual behaviour or arise from hypothetical scenarios posed to recreationists in surveys, trip frequencies are a function of travel costs, individual recreationist characteristics like income and age, and site characteristics such as stand age and forest type. This is represented by the following demand model:

$$V_{ij} = f(P_{ij}, Q_i, Z_j, \beta), \qquad j = 1, 2, \ldots, N \tag{1}$$

where V is the number of trips (i.e. quantity demanded) to recreation site i by person j, P is person j's travel cost (i.e. price) to recreation site i, Q are attributes of recreational site i, Z are the individual characteristics of person j, and β is a vector of unknown parameters. This equation, when applied to a sample of recreationists, estimates a demand function for the given recreation site. However, since site quality is invariant at a single site in most situations, it is impossible to uncover the influence of site quality in a single site demand model like the one displayed in eq. 1. When data are pooled over multiple sites for a sample of recreationists, however, it is possible to estimate demand parameters on site quality as these quality features are likely to vary over the set of sites. A TCM using this analytical framework is typically called a pooled or multi-site TCM. It is assumed under multi-site TCM frameworks that all participants take at least one trip to each site in the bundle of sites examined (Fletcher et al. 1990). This assumption would imply that every recreationist in a sample of data from a number of sites took at least one trip to each of the sites used in generating that sample. This restrictive assumption has led researchers studying fire and recreation to develop single site model frameworks using data from a number of sites (e.g. Englin et al. 2001). This approach ignores the role of substitutes by considering a region or network of recreation areas as the single site. Rosenthal (1987) shows that omitting substitute prices from TCMs results in an upward bias on welfare measures derived from the demand model.

3.2 History of Travel Cost Models

As mentioned in the previous section, Hotelling (1947) spawned the development of TCMs. Since then, the literature has gone through three developmental stages according to Phaneuf and Smith (2006). The first stage is based on Clawson (1959) and Trice and Wood's (1958) initial research. This stage is characterized by TCMs that were estimated using zonal data, which consists of aggregate trip totals from differently-located population zones, and activity participation models that are essentially reduced form models (Phaneuf and Smith 2006). The dependent variable in these formulations is visits per capita (visits from a zone divided by the population residing in that zone).

Difficulties were encountered in the first stage of TCM developments because aggregate data were used, so studies could not accurately focus on trip decision-making at the individual micro level. Research in the second stage overcame this difficulty, as Burt and Brewer (1971) produced the first known application of the TCM on a micro level, estimating a system of demand equations concerning lake recreation (Phaneuf and Smith 2006). Burt and Brewer's (1971) paper led to a wave of recreation demand research that examined factors regarding the opportunity cost of travel time, the role of substitute trips, trip length, and site attributes.

The third and final stage of travel cost literature began with Hanemann's dissertation and subsequent studies (1978; 1984; 1985) which introduced the random utility model (RUM) to travel cost models. The RUM approach allows for the application of econometric techniques which overcome the mixed discrete/continuous choice recreation demand problem (Phaneuf and Smith 2006). Bockstael et al. (1987) completed the theoretical advancement of Hanemann's (1978) paper by bridging previous demand orientation work to the new RUM framework and its mixed discrete/continuous perspective on recreationist site choice. This advancement led to the use of count data models in the recreation demand literature.

3.3 COUNT DATA ISSUES AND DEVELOPMENTS IN TRAVEL COST MODELS

Earlier travel cost models used ordinary least squares (OLS) regression models to estimate the demand parameters in the function represented by eq. 1. However, there are several drawbacks to using this econometric method. First, OLS permits the prediction of negative and non-integer trip values, which do not reflect the true nature of recreation behaviour. Second, commonly used functional forms such as semi-logarithmic are not permitted under OLS to include non-users (i.e. people taking zero trips) in the estimation of parameters (Englin and Cameron 1996). Finally, OLS estimations inaccurately consider trip values as non-discrete continuous variables.

Two breakthroughs at the beginning of the third stage of TCM development overcame the problems caused by OLS estimators. Studies by Shaw (1988), Smith (1988), and Grogger and Carson (1991) were among the first to utilize count data econometric techniques for estimating travel cost models. Count data frameworks effectively model individual recreational behaviour because they accurately consider trip values as non-negative integers. Another advantage of count data models is that they provide both per trip welfare measures *and* quantity demanded measures, both of which are required to determine total welfare measures (Englin and Shonkwiler 1995). The ability to calculate annual welfare measures contrasts with earlier non-count recreation demand models because non-count models can only estimate consumer surplus values and not quantity demanded measures (i.e. trips), which are required to derive annual welfare (Englin and Shonkwiler 1995).

The research by Shaw (1988) and Smith (1988) were attempts to address the three problematic intrinsic data characteristics associated with OLS methods and onsite sampling of recreation behaviour: i) the inability to calculate discrete, non-negative integers (since trip values are whole numbers above zero), ii) truncation (non-users are excluded from the sample), and iii) endogenous stratification (over sampling of heavy users who frequent the site more often than casual users). Since all previous recreation demand estimations using onsite samples did not recognize and address the presence of these problems, TCM results generated by standard count data estimators such as the Poisson model are biased according to Shaw (1998).

The Poisson TCM assumes that the dependent variable, total trips taken by a recreationist (V_j), is distributed according to the Poisson probability distribution. Equation 2 represents this model:

$$P(V_j = v_j) = \frac{\exp(-\lambda_j)\,\lambda_j^{v_j}}{v_j!}, \qquad j = 1, 2, \ldots, N \qquad \textbf{(2)}$$

where observed trips are represented by v_j = 0, 1, 2, ..., and j indexes individuals. A common specification chosen for λ is $\lambda_j = \exp(x_j\beta)$, where x_j represents a vector of exogenous variables that includes costs (P_{ij}), recreational site characteristics (Q_i), and individual specific characteristics (Z_j). The log-likelihood function resulting from this equation allows for the estimation of parameters using maximum likelihood methods.

While the standard Poisson estimator is useful in accommodating the travel cost framework and the non-negative integer aspect of trip frequencies, it is not capable of overcoming the truncation problem caused by onsite data collection. Truncation arises when data are collected from recreationists located onsite and thus there are no observations from non-users, or people with trip frequencies less than 1 (i.e. zero trips). Grogger and Carson (1991) dealt with this issue by using truncated Poisson estimators which adjust the likelihood function and acknowledge that trip values in the model only exhibit values greater than zero. This adjustment is represented by:

$$P(V_j = v_j | v_j > 0) = \frac{\exp(-\lambda_j)\lambda_j^{v_j}}{v_j!(1 - \exp(-\lambda_j))}, \qquad j = 1, 2, \ldots, N \qquad \textbf{(3)}$$

This has been called the positive Poisson model. Further developments of the Poisson model by Shaw (1988) permitted explicit consideration of the truncation issue as well as the endogenously stratified nature of on-site sampling. Using Shaw's (1988) model to estimate demand functions allows for inferences on the demand parameters of the population in a site's "market area", rather than just inferences on the overall sample population.

These developments of the Poisson model did not effectively overcome the existence of a statistical restriction imposed through the use of the Poisson distribution however. This restriction is that the conditional mean and variance of the dependent variable are equal (Haab and McConnell 1996; Yen and Adamowicz 1993):

$$E(v_j | P_{ij}, Q_i, Z_j) = \exp(x_j \beta) = Var(v_j | P_{ij}, Q_i, Z_j) \qquad \textbf{(4)}$$

Recreation demand data gathered onsite typically exhibits overdispersion, which exists when the conditional variance is greater than the conditional mean. Thus, a criticism of Poisson models is that they cannot accommodate overdispersion. Maintaining the mean-variance equality assumption with an overdispersed data set leads to underestimation of standard errors, which in turn leads to inaccurate parameter estimates and potential errors in the prediction of trip quantities (Cameron and Trivedi 1986; 1990; 1998; Creel and Loomis 1990; Englin and Shonkwiler 1995; Gomez and Ozuna 1991; Grogger and Carson 1991; Haab and McConnell 1996). This restriction led to a search for improved count data estimators.

Hausman et al. (1984) and Cameron and Trivedi (1986) advanced the negative binomial (NEGBIN) model as a count data formulation that can address the overdispersion problem. These authors applied the NEGBIN model to examine the counts of patents issued and doctor visits respectively. Grogger and Carson (1991) were the first to use the NEGBIN for travel cost models in their application of fishing trips in Alaska. Their fishing application included the use of both untruncated and truncated NEGBIN models. Englin and Shonkwiler (1995) completed the suite of NEGBIN estimators in TCM applications by developing an endogenously stratified and truncated NEGBIN model. Their application involved hiking demand in the Cascade Mountains of Washington state.

The NEGBIN model allows for overdispersion by compounding the Poisson distribution with a gamma distribution, which subsequently allows heterogeneity to also be gamma distributed. The NEGBIN model incorporates an overdispersion parameter (α) in its variance component, which permits the conditional variance to be greater than the conditional mean and thus allows the overdispersion issue to be accommodated[1]. Following Englin and Shonkwiler (1995) and Yen and Adamowicz (1993), the conditional mean and conditional variance for the random trip variable v_j in a NEGBIN model is represented by:

$$\begin{aligned} E(v_j|P_{ij},Q_i,Z_j) &= \exp(x_j\beta) = \lambda_j \\ Var(v_j|P_{ij},Q_i,Z_j) &= \lambda_j(1+\alpha\lambda_j) \end{aligned}, \quad \alpha > 0 \qquad \textbf{(5)}$$

When examining eq. 5, one can see that as the value of α increases, the conditional variance becomes increasingly greater than the conditional mean. If α has a value of 0, however, the conditional mean and variance are equal. In this case, the data exhibit no overdispersion and the NEGBIN likelihood function collapses to a Poisson distribution.

Utilizing the NEGBIN model requires a different likelihood function, which is shown in eq. 6.

$$\Pr(V_j = v_j \mid v_j > 0) = \frac{\Gamma\left(v_j + \frac{1}{\alpha}\right)}{\Gamma(v_j+1)\Gamma\left(\frac{1}{\alpha}\right)}(\alpha\lambda_j)^{v_j}(1+\alpha\lambda_j)^{-(v_j+1/\alpha)} \qquad \textbf{(6)}$$

where v is the observed number of trips taken by individual j, Γ represents the gamma distribution, and α is the overdispersion parameter. Similar to eq. 5, if α equals zero, the likelihood function represented in eq. 6 also breaks down into the Poisson function displayed in eq. 2 (Englin et al. 2001; Yen and Adamowicz 1993). The log likelihood function (LL) for eq. 6 is as follows:

[1] The NEGBIN model allows for overdispersion but does not provide economic interpretations of overdispersion (Haab and McConnell, 1996).

$$LL = \sum_{j=1}^{N}[\ln\Gamma\left(v_j + \frac{1}{\alpha}\right) - \ln\Gamma(v_j) - \ln\Gamma\left(\frac{1}{\alpha}\right) + v_j \ln\alpha + v_j x_j \beta - \left(v_j + \frac{1}{\alpha}\right)\ln(1+\alpha e^{x_j\beta})] \quad \textbf{(7)}$$

where $e^{x_j\beta}$ replaces λ (Englin et al. 2001).

As mentioned previously, when recruiting respondents at recreation sites where the probability of surveying a non-recreationist is zero, the visitation data become truncated and endogenously stratified (Egan and Herriges 2004). This issue is a concern when researchers expect the count model to provide estimates of latent demand. This requires one to account for endogenous stratification and truncation in estimating model parameters. Then, the latent demand for the population is found by substituting the population means into the model and calculating quantity demanded values (Englin and Shonkwiler 1995).

However, using endogenously truncated and stratified data are acceptable if statements generated by the model's results are only applied to the recreationists sampled. Since my study's sample consists of camping participants recruited by onsite sampling, conclusions drawn from this analysis will apply strictly to those campers. This condition is not a major hindrance since this present study focuses solely on active recreationists. Another reason this condition is not overly problematic is explained by Englin et al. (2001), who stated that the general population likely plays a peripheral role (if any) in fire/recreation analysis. They claimed that the quality changes under consideration from fire are more likely to drive people out of the market rather than draw new users from the general population into the market. Thus, as with Englin et al. (2001), the truncation and stratification issue when using pooled RP/SP data sets was not accommodated for in this analysis.

Much of the existing literature on the impacts of fire on recreation has used count data models similar to those described above. However, a major issue in examining the effects of fires on recreation is the lack of variation in ages of forests surrounding actual camping areas. For this reason, most of the studies discussed in Chapter 2 utilized stated preference (SP) information in addition to actual trip frequencies collected onsite (RP information). Thus, the count frameworks imposed on the trip frequency data involved the presentation of hypothetical quality changes in forest conditions resulting from fire. Survey mechanisms involving photographs are generally used to depict these quality changes. Loomis et al. (2001), Hesseln et al. (2003; 2004), and Starbuck et al. (2006) all used photographs in surveys to develop pooled RP/SP data to estimate Poisson count travel cost models. Englin et al. (2001) used a NEGBIN count data framework in estimating a pooled RP/SP model to understand fire damages on trip behaviour. This next section discusses the issue of using pooled data in these models.

3.4 POOLING RP/SP DATA

As mentioned above, the lack of camping sites located in a wide and varied spectrum of different forest stands forms a need for extra information outside the range of reality regarding recreational behaviour in response to fire-damaged sites. In most studies cited in Chapter 2, younger aged forest stands are underrepresented in the RP data. This is also the case for this Alberta study because only a small number of interviews could be conducted in camping areas that were recently damaged by forest fires and/or on poor soil quality soil sites. Thus, augmenting the data set with extra information beyond the current domain of observed conditions increases the data variation and sample size, both of which increase strength in the estimation of the travel cost model parameters and subsequently confidence in results (Englin and Cameron 1996).

Englin and Cameron (1996) were among the first researchers to examine how RP data can be augmented. An effective method used in recreation demand literature to increase data size and variation is to incorporate data generated by contingent behaviour questions. This technique produces SP data, defined as responses to hypothetical scenarios where site quality and/or prices are modified. This type of information is deemed valid because SP methods have been found to have highly desirable properties in predicting actual recreation behaviour in forested settings (Haener et al. 2001). These types of questions give participants an opportunity to reveal their preferences, based on their decisions in response to situations outside the realm of actual experience. Morey and Breffle (2003) explain that merging SP and RP data provide different information about an individual and that combining these data will lead to improved estimates of their preferences. Specific to recreation studies, pooling SP data with RP data creates amplified conventional travel cost models not possible from using observed recreation information alone (Boxall et al. 2003; Englin and Cameron 1996; Haener et al. 2001; Loomis and Walsh 1997; Siderelis et al. 2000; Starbuck et al. 2006).

Englin and Cameron (1996) were the first to pool RP and SP count data for a recreation demand study. Much of the literature on fire and recreation has used their general approach by pooling actual observed RP data with anticipated SP data. Speaking specifically about the benefits of pooled RP/SP data in modeling fire and recreation behaviour, Englin et al. (2001:1837) state that "This approach is well suited for the fire question, because it allows the cost effective sampling of users' response to fire-affected forests of different ages while maintaining a strong link to their actual observed behavior".

A popular contingent behaviour technique used to generate SP data is the use of photographs. Brown et al. (1988) claim that numerous environmental perception and contingent behaviour papers, beginning in the late 1960s, experienced success using photographs to elicit preference-based responses. Studies have also found that decisions regarding forest recreation activities based on photographs are consistent with actual behaviour (Starbuck et al. 2006). This is a desirable outcome for collecting SP data because effective pooled models are built on SP answers that mirror reality.

Using pictures is suitable for fire and recreation studies in particular because photographs capture the changing appearances of fire-affected areas at different points during the re-growth period (Starbuck et al. 2006; Vaux et al. 1984). It is important to capture the time-dependent aspect of changing physical attributes in previously-burnt forests because this in turn influences recreationist site valuation (Starbuck et al. 2006; Vaux et al. 1984). The other studies reviewed in Chapter 2 that asked hypothetical trip questions centered on photographs that depicted forest fire damage are Loomis et al. (1999), Englin et al. (2001), Loomis et al. (2001), Hesseln et al. (2003; 2004), and Starbuck et al. (2006).

This present study incorporated colour photographs in a survey. These photographs depicted previously burnt and differently aged forest stands that simulate the surroundings of the actual campsite respondents were interviewed in. Respondents were asked if the number of anticipated future trips to this campsite would change from the actual number of trips they took, given the new simulated appearance. Thus, while intended behaviour was measured, these questions were anchored upon actual campsite appearances familiar to respondents. All information pertaining to the recreationist and the campsite remains constant except for the surrounding stand age, which varies across SP scenarios. This SP question format was similar to that used by Englin et al. (2001), who stated that this structure is effective because it enriches the set of fire regimes facing respondents. As encouraged by Englin and Cameron (1996) to ensure validity, parallel models were estimated that contained binary variables which distinguished the RP observations from the SP observations. Significance tests on these dummy variables were conducted to test for differences between observed and stated data, to determine if people's contingent behaviour preferences were reasonable given their actual behaviour.

There is a concern regarding the structure of photograph-enhanced travel cost models however, because this framework does not explicitly account for substitute sites; no travel cost variable representing alternate camp sites is present in the demand function (Fletcher et al. 1990; Hesseln et al. 2004). As a consequence, the absolute value of net benefit per trip estimates may be overestimated because fewer options are available to the recreationist (Siderelis et al. 2000; Hesseln et al. 2004). The reason alternate sites are not included in this present study (and for all applicable studies discussed in Chapter 2:) is because substitute prices cannot be directly incorporated into semi-logarithmic demand functions (Englin et al. 1998), which most count data models are.

Furthermore, locating suitable photographs for the SP portion of this present project was difficult for one site, let alone for all possible alternate sites in the region. Thus, all trips to the eastern slopes are considered to be to one site regardless of location within this region, and the photographs were assumed to relate to all sites in this entire region. The total number of eastern slope trips for each respondent under the hypothetical fire scenarios was initially assumed to be constant between years, and respondents were allowed to adjust the number of trips taken in response to fire damage. Thus, an assumption in this approach is that trip locations do not change – in essence the model employed does not consider possible substitution behaviour that could result from fire damage, just changes in the number of trips to the fire damaged site. Basic information concerning the relative distances recreationists would travel to substitute sites was collected and applied in a general fashion for the spatial extension, however the demand function itself does not include a substitution behaviour component.

Hesseln et al. (2004) claim that the effect of substitute sites is *implicitly* included in this type of model due to differences in appearances between hypothetical scenarios however. To demonstrate, if respondents view a photograph group and would not wish to camp there, they will indicate their desire to decrease or outright eliminate the number of trips they take to that location. While making this decision, they may already have an alternate site in mind despite the fact that their substitute site is not explicitly included in the question. As shown in Chapters 5 and 7, the onsite interview and survey both clearly reminded respondents to consider substitute sites and to name them (if applicable) when faced with hypothetical recreational trip questions. This still does not address the problem of substitute site absence in the actual demand function, however, therefore this problem remains an issue.

When augmenting a RP trip frequency data set with contingent behaviour data, a researcher must consider some of the econometric concerns discussed previously. For example, the researcher may be concerned about truncation and endogenous stratification. Given the qualifier that if these issues are ignored, the model parameters are only representative of the recreationists sampled onsite, the pooled RP/SP data may not be truncated. For example, if a hypothetical behavioural change reported by an individual results in a trip frequency of 0, clearly a value of 0 for the dependent variable is now a valid observation. This requires one to use the positive Poisson model or the standard NEGBIN model to estimate the pooled RP/SP TCM. This practice will be followed in my study.

A final consideration involves the panel nature of the information used to estimate TCM parameters. The contribution of Englin and Cameron (1996) showed that the multiple RP and SP observations of trip frequencies represent panel data. In other words, researchers have multiple count information from the same individual. Most of the fire and recreation studies discussed in Chapter 2 ignored this feature and merely pooled the RP and SP information when estimating model parameters.

Englin and Cameron (1996) used a fixed effects Poisson model in their RP/SP count model application. The empirical application did not address site quality changes, but examined changes in travel costs in the hypothetical SP scenarios. The fixed effects estimator was appropriate in their case because their model essentially only had an intercept, travel cost variables, and one dummy variable for the RP data on the right hand side. The consistency of the observed and contingent data was assessed via hypotheses tests concerning the influence of the RP binary variable in the regression model. Fixed effects estimators net out individual effects by allowing each individual in the data to have an implicit dummy variable that shifts the model intercept term to correct for their personal characteristics. This allows the researcher to focus only on the factors in the model that change across the within individual responses. Since Englin and Cameron's (1996) application only had travel costs varying across within-individual observations, and their demand model was relatively simple, the fixed effects Poisson estimator was a reasonable choice.

In more complex RP/SP demand formulations however, researchers may want to include individual specific characteristics in the demand model and hold travel costs fixed. The focus of the demand model may simply be the variation in site quality across the various within-individual observations. In these cases, the random effects estimator may be more appropriate since it is reasonable to assume that the changing site quality measures are uncorrelated with the other independent variables in the model (Hausman et al. 1984). Due to the large number of recreationists in the sample relative to the small stand age dimension (6 groups) and the reason explained above, a random effects specification was chosen instead of the alternative fixed effects specification. Therefore, since only the forest stand age was altered in the contingent behaviour scenarios for the present study, changes in trips were squarely attributed to the respondent's perception of forest age due to fire activity as well as other differences across respondents.

Hausman et al. (1984) were the first to advance random effects NEGBIN modeling theory. This interpretation allows the estimation of an individual specific error component in the econometric model. In random effects models, the overdispersion parameter α is allowed to vary randomly across groups with a beta distribution (unlike a gamma distribution, as with regular NEGBIN models), requiring the estimation of two additional parameters related to the beta distribution (A and B) (Hausman et al. 1984).

Since the variance of the effects are allowed to differ in the "within and between dimensions", Hausman et al. (1984:933) label the random effects NEGBIN model as essentially a "variance components" version of the standard NEGBIN.

Englin and Cameron (1996:134) stated that researchers in other sub-fields of economics long valued sequence effects models because they net out "unquantifiable individual heterogeneity while retaining the economic relationship of primary interest". They referred to pooled models as "simple" and "naïve", and stated that progressing to panel models that incorporate sequence effects was more appropriate. Hesseln et al. (2004) and Egan and Herriges (2004) also encouraged future fire and recreation studies to link RP and SP data together in a panel framework so that sequence effects can be evaluated; panel models were not utilized in any other fire/recreation literature reviewed.

At least two other non-fire recreation studies have used sequence effects, but other differences remain when compared to this study. Englin and Cameron (1996) estimated a fixed effects model to analyze angling demand and used a WTP technique instead of photographs for the contingent behaviour component. Siderelis et al. (2000) also used a panel estimator, but they did not use photographs for the contingent behaviour component. They constructed a random effects model to study trail recreation demand in North Carolina. Both studies used Poisson models, unlike the NEGBIN model used here.

CHAPTER 4: DEVELOPMENT OF DATA SAMPLE

In order to develop an intertemporal damage function for Alberta's mountain region based on a recreation demand model, data were needed on the trip-taking behaviour of recreationists along the eastern slopes. Databases of recreational users who visit the eastern slopes do not exist for research purposes, so locating and gathering information from recreationists was required to develop an original sample. Due to budgetary and time constraints, participants were contacted and interviewed in camping areas instead of interviewing the general population to ensure the sample size of recreational users was high[2]. Information gathered from the onsite visits helped comprise the actual RP data for each respondent, however more information was still required.

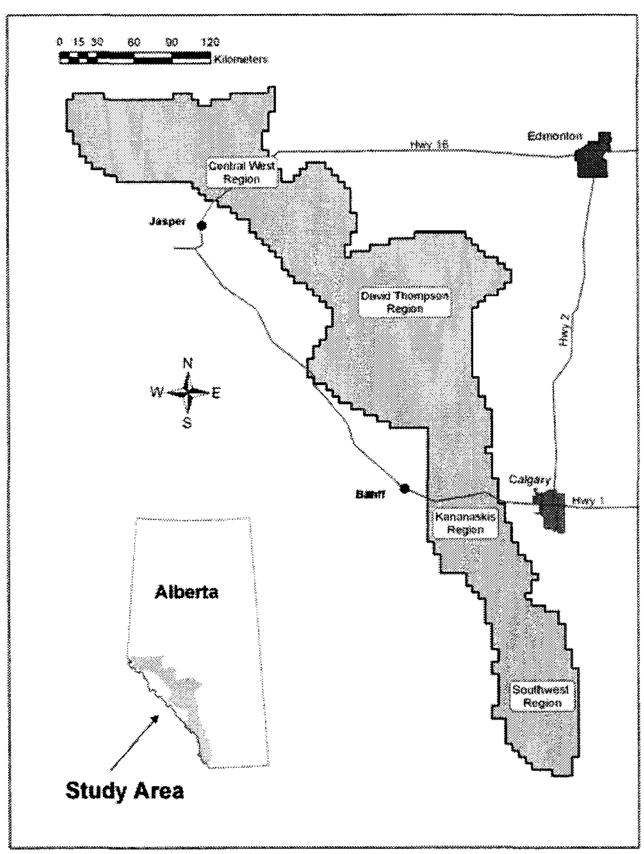
To gain further knowledge of the RP data, enlarge the overall sample size, and extend the scope of reality by increasing variation in the targeted site attribute (stand age), an in-depth survey that gathered RP and SP information was needed. Following the onsite interviews, respondents were then asked if they would participate in an in-depth survey what would be administered at a later date through mail or email. The survey asked a variety of questions; the most important were picture-based contingent behaviour questions that generated SP data.

[2] This leads to a truncated data set (see section 3.3).

4.1 INITIAL CONTACT METHODOLOGY

Since spatial representation accuracy of recreation use was not a specific concern for this project, the data collection effort gathered a "convenience" sample to construct the economic model. Nonetheless, an attempt was made to achieve spatial and temporal representation. Researchers visited Provincial Recreation Area (PRA) campgrounds and random camping sites in the eastern slopes region of Alberta from July until the first week of September in 2004. The universe of areas (inference space) sampled included camping sites in the southwestern portion of the province in the Crowsnest Pass, up to central-western campsites near the Willmore Wilderness Area. The sampling region is displayed in Figure 4.1.

FIGURE 4.1 – STUDY AREA AND SAMPLING REGION



Campsites were visited in the mornings and evenings, and after stating university affiliation, researchers asked to speak to the leader of the camping party. Interviewees were required to be greater than 18 years of age, were invited to take part in the study, and were informed of the requirements. If they did not display interest, the individual was thanked for their time and the researcher vacated the campsite. If the recreationist was interested however, a short survey was conducted onsite which typically lasted five minutes. If at any time the individual reflected discomfort, the interview was terminated.

The onsite interview consisted of 13 questions (see Appendix A) which ranged in topic from current trip information, to the recreationists' camping history in that particular campground, to how their site choice decisions would change if a fire had occurred in the vicinity at an earlier time. At the conclusion of the interview, participants were asked if they would like to partake in a more in-depth survey that would become available in the fall of 2004. The respondent's name and mail/email address was collected if they wished to participate.

4.2 Initial Contact / Onsite Interview Response Rates

Initial contacts began July 3, 2004, during the long weekend holiday in Canada and just a few days after grade schools finish for the school year, making it a busy time for camping. The last contacts were made on September 5, 2004, which was also a long weekend holiday in Canada. This period is a popular camping time as well, and is generally regarded as the last camping weekend for the year due to the commencement of grade school and colder weather.

In total, eight trips by surveyors lasting a total of 20 days were made to camping locations in the mountain and/or foothill regions in Alberta during this period. All sites where located on paved, gravel, and dirt roads and were accessible by a regular vehicle, thus no access discrepancies existed between every camping area visited. Of the 42 PRA campgrounds that were visited, interviews were conducted in 33 of them. One was closed and locked, two were deemed unsuitable for the purposes of this project (i.e. they were more similar to highway rest areas than campgrounds, with very few trees or natural foliage surrounding the campsites), and six were empty.

In addition, numerous random camping sites were visited as well. Random campers are people who camp in undesignated areas on public lands, and are not subject to camping fees or regulations. Also known as "bush" campers, random campers believe in right of access and many experts believe that random campers are the most common forest recreation users in Alberta's eastern slopes region.

Initial contacts were made with 557 eligible campers. Of these contacts, 482 interviews were conducted in PRA campgrounds (86.5%) and 75 were with random campers (13.5%). Five ineligible participants were also contacted; two people were approached in PRA campgrounds that had already completed the interview, and three people were approached who lived too far from Alberta to be included in the sample. Therefore, the *total* number of contacts made (i.e. the sum of all eligible and ineligible contacts) was 562.

People who traveled a great distance were excluded from the sample because their inclusion would imply that they journeyed for the sole purpose of visiting that particular campsite, which was not the case. Including long distance travelers in the analysis would significantly alter the parameters of recreation demand models because these observations could cause multi-destination trip bias in the travel cost variable, and consumer surplus values would be subsequently overestimated (Englin et al. 2001). People usually have numerous stopping points and activities planned when undertaking long journeys, whereas most local campers were taking shorter trips whose primary objective was to camp.

Of the 557 eligible contacts, 546 (98.0%) agreed to the onsite interview. Of the 546 total onsite participants, 533 were Alberta residents (97.6% of the onsite interview population). Further interview breakdowns are shown in Table 4.1, which displays the camping locations where people were initially contacted, whether they participated in the onsite interview, and if they consented to take part in the fall survey. The locations are all in the western portion of the province and are listed geographically in order from the most northern region (Central West), to the most southern (Southwest).

TABLE 4.1 – INITIAL CONTACT RESULTS *(values measured in number of campers)*

REGION OF EASTERN SLOPES	CAMPSITE TYPE	INITIAL ELIGIBLE CONTACTS	ONSITE INTERVIEWS	CONSENTED TO MAIL/INTERNET SURVEY
Central West	*PRA*	104	102	96
	Random Camp	0	0	0
	Total	104	102	96
David Thompson Region	*PRA*	152	150	140
	Random Camp	20	20	18
	Total	172	170	158
Kananaskis	*PRA*	94	90	80
	Random Camp	3	3	1
	Total	97	93	81
Southwest	*PRA*	132	132	128
	Random Camp	52	49	45
	Total	184	181	173
TOTAL OF ALL LOCATIONS	*PRA*	482	98.3% (474/482)	93.7% (444/474)
	Random Camp	75	96.0% (72/75)	88.9% (64/72)
	Total	557	98.0% (546/557)	93.0% (508/546)

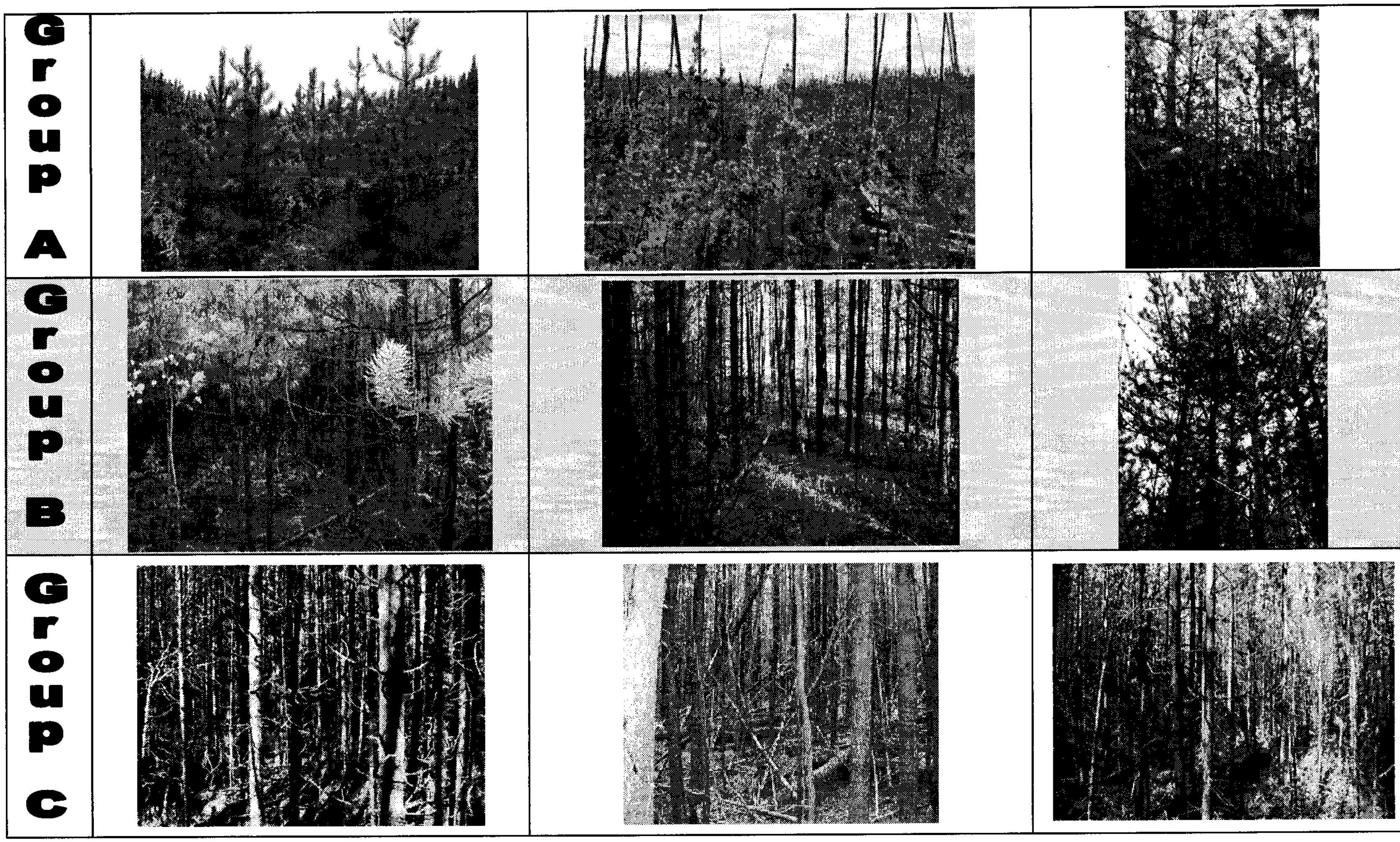
4.3 MAIL/INTERNET SURVEY COMPOSITION METHODOLOGY

The beginning of the 22 question survey (see Appendix B) examined respondents' long-term and short-term camping history. Respondents then identified the number of camping trips they took in 2004 to the eastern slopes, their favourite campsite, and the number of trips to their favourite campsite. More RP questions and the SP portion followed, both of which centered on a series of sequential colour photographs of Alberta mountain and foothill forests (primarily comprised of lodgepole pine) that were previously exposed to intense fires at differing time periods. These questions completed the RP data and formed the basis of the contingent behaviour data and helped uncover the effects of fire disturbances on forest recreation responses.

The survey contained six photograph groups, each consisting of three colour photographs, for a total of 18 pictures. Respondents were instructed to use these pictures only as guides when answering the trip-based questions, in addition to their own mental images of their most frequented site, due to the inevitable inconsistencies which arise from photographing areas from different locations. Since stand structure could not be held constant between the different photograph groups, attempts were made to avert participants from focusing too intensely on the individual characteristics which appeared in the specific stands photographed. The photograph groups represented six forest stand age classes (i.e. years of re-growth following fire): 0-1 year, 2-5 years, 6-15 years, 16-49 years, and two groups of 110 years or more. These particular age classes were selected as being representative of distinct forest recovery succession stages. The groups are labeled based on the mean stand age of the forests depicted in each photograph group (0.5 years, 3.5 years, 10.5 years, 33.5 years, and 110 years).

To examine soil quality effects, two different photograph groups for the 110+ age classes were used; one on poor soil quality sites and the other on good soil quality sites. Due to a low nutrient base and less than ideal growing conditions, forests on poor soil quality sites are characterized by dense and overgrown populations of small, skinny trees compared to the large and wellspaced trees found on good quality soil sites (Silins 2004). Since trees growing in poor soil are relatively frail, stands on these sites typically have many dead trees that have been broken and uprooted from wind and stormy weather, leading to a cluttered landscape. Expert opinion suggested that the effects of soil quality would not be evident until stands are reasonably old however (Silins 2004). Thus, a distinction between good and poor soil quality sites was just made for older growth stands because visual differences between both quality types only begin to appear after roughly 40 years.

FIGURE 4.2 – VISUAL APPEARANCES OF SURVEY PHOTOGRAPH GROUPS



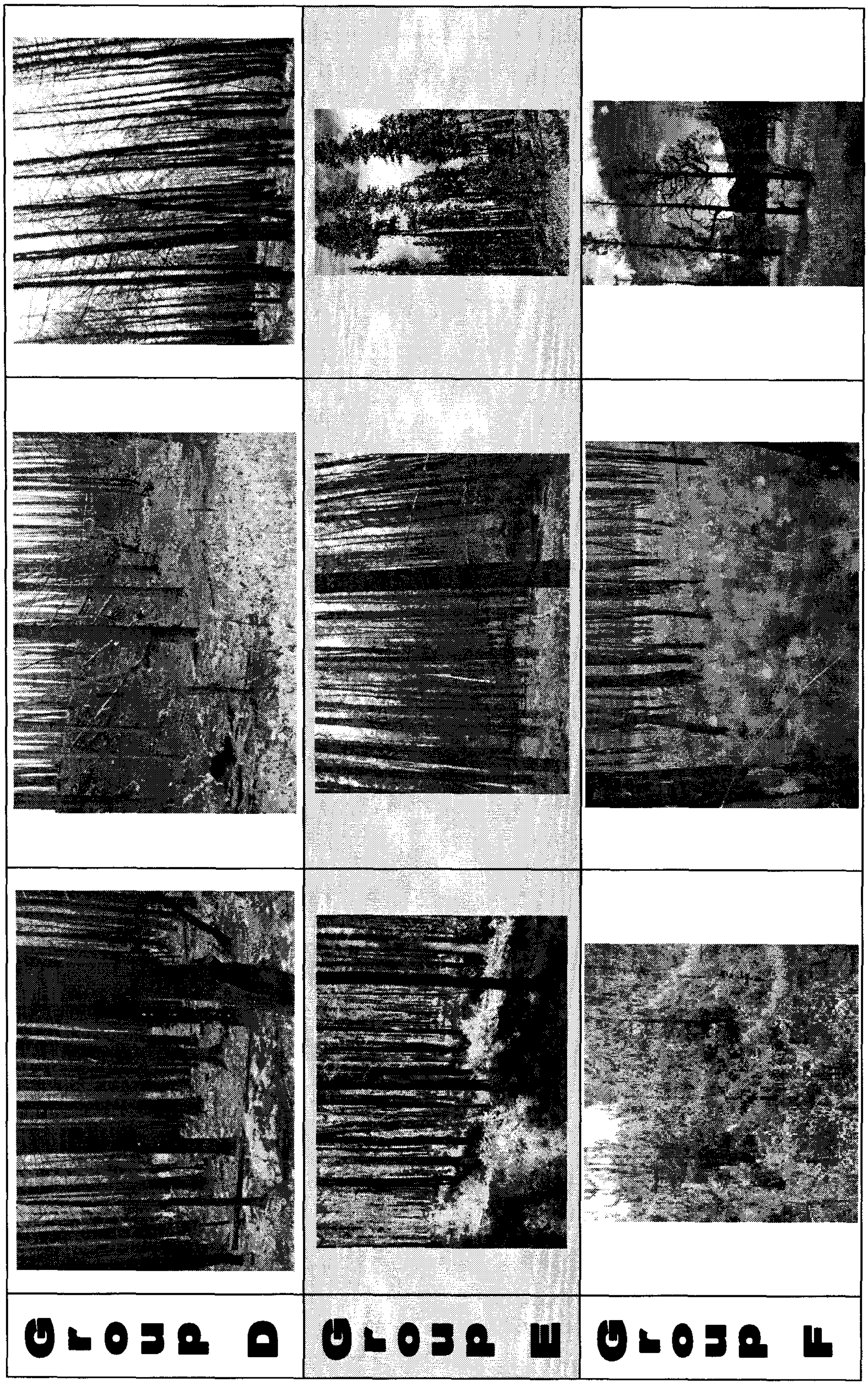

Group D
Group E
Group F

TABLE 4.2 – VARIABLE DESCRIPTIONS

MEAN STAND AGE	PHOTOGRAPH GROUP	DESCRIPTION
0.5	D	Comprised of scorched trees and minimal plant life, however rejuvenation in the form of grasses has already begun.
3.5	F	Characterized by lush greenery (small shrubs, grasses, flowers, etc.), but lacking in large living trees.
10.5	A	Green areas with bush and tree species becoming established.
33.5	B	Forest stands open without a thick canopy overhead and although trees are established, they are small.
110 (PSQ)	C	Densely populated with smaller sized trees (relative to trees in good soil quality soil), many knocked down due to minimal stature. Much debris and deadfall present.
110 (GSQ)	E	Trees are large and well spread out, however a solid canopy appears overhead and provides shade and shelter.

(PSQ) refers to poor soil quality sites while (GSQ) refers to good soil quality sites.

Respondents were first asked to select the photograph group that most resembled the surrounding area of their favourite Alberta foothill/mountain recreation area in 2004. This selection became the forest age associated with their actual trips and formed the RP data, and which subsequent contingent behaviour questions describing changes to the current conditions were judged. This format is similar to that used by Starbuck et al. (2006). The photograph groups were not displayed in chronological order in an attempt to avoid bias.

For the next three questions, respondents were told that the surrounding area of their favourite site for the upcoming 2005 season would resemble a randomly selected photograph group. Participants were required to assume that the total number of recreation trips they took in 2005 would be the same as in 2004. They were asked if the number of trips they would take to their favourite site would change, given the alteration to the surrounding area from a previous fire. If their anticipated number of trips to their favourite site in 2005 differed from 2004, the direction (more/fewer) and amount (number of trips) of this change was collected. This format allowed the respondent to incrementally adjust their anticipated behaviour instead of only having the option of whether or not to visit, and follows the TCM assumption of making all trip decisions at the beginning of a season. These questions formed the SP data. The total amount of camping days was not recorded, but rather the number of trips taken. As Morey and Breffle (2003:3) explain, "Not modeling the total number of...days simplifies data collection and modeling while still generating policy-relevant results that are often easier to defend than the results of models that explain and predict both participation and site choice".

Answers to these two sections produced two pieces of information from each respondent: their actual number of trips to the campsite at current forest conditions, and hypothetical trip values given hypothetical changes in conditions. The change in anticipated trips was then compared to the actual number of trips taken in the absence of such an alteration. These adjustments allow the researcher to make inferences regarding the effects of differently aged forests on recreation trip frequency, and thus allow for examination of the tradeoffs recreationists would make due to changes in site characteristics.

Detecting fire suppression opinions and the general attitudes towards fire were also incorporated in the survey. This was accomplished by asking respondents their level of endorsement for controlled burns, a number of true/false questions that gauged their knowledge of wildfires, and several attitudinal questions based on five point Likert scales that attempted to uncover positive or negative attitudes towards forest fires. The true/false and attitudinal questions were based on Manfredo et al.'s (1990) study which examined attitudes towards forest fires and controlled burn policies. Incorporating policy preferences and related attitudes in the analysis could help determine whether perceptions of fire also influenced the participants' decision to recreate in fire damaged forests. This is in addition to other factors that may also enter the trip decision-making process, such as aesthetics and recreational opportunities in the area. While attitudinal questions are usually used as "warm-up" exercises that can also support econometric results, attitudinal results are not typically used in the econometric analysis itself however (Morey et al. 2003).

Following the attitudinal section was a brief cheap-talk script which was used as a preliminary component before a CVM question. Cheap-talk scripts often appear before CVM questions in an attempt to ensure that respondents answer the question as if they were actually faced with the decision in reality. The CVM question followed, which centered on protecting Alberta's forests from fire[3]. Deliberation questions for people who did not support the

[3] While results to this section of the survey are not analyzed in this study, the CVM question elicited the extra amount of camping fees respondents were willing to pay for a hypothetical fire-fighting program that would decrease the amount of acres burnt yearly in Alberta by 25%.

hypothetical CVM program followed. The survey then concluded with basic personal demographical questions.

4.4 Survey Distribution and Collection Methodology

The first survey draft was composed in late September, 2004, following the onsite visits. Further refinements were made after numerous revisions and recommendations from experienced experts and the general public alike. An exact replica was also produced in HTML format for the internet version of the survey, which included a separate viewing window for the photograph insert.

The first wave of survey mailings occurred in early November, 2004. Complete mail packages were sent, as were emails to those who preferred internet access. Each email contained an automatic link to the survey webpage. Reminder postcards and emails were sent to non-respondents two and a half weeks following the initial mailing. Ideally, final contacts to people who did not respond to the first two mailings would be sent out another two weeks after the reminder postcards, however this was avoided since it coincided with the busy Christmas holiday season. Therefore, final complete survey packages were sent out to non-respondents after the holidays during the first week of January. This three-wave survey method, known as the Dillman method, is commonly used in survey-based studies. Hardcopy survey results were entered manually into a computer and were double-checked to ensure accuracy. Answers from the internet survey were automatically sent to a results file immediately upon completion.

A number of rules were established to develop a consistent database. If a person reported that they had gone on even one random camping trip that season, they were coded as a random camper even if their interview occurred in a PRA. This is because recreationists would generally have to consider themselves "random campers" to even make one bush camping trip since it is a unique form of recreation. To highlight this observation, the great majority of people who did not random camp said they had no interest in ever doing so. However, many random campers were willing to stay in PRA campgrounds even though they do not prefer them.

Campground location information (Alberta Community Development 2005), road maps, and an internet-based mapping program (Mapquest 2005) were used to calculate the distance traveled. Figures reflected the distance traveled on roads and not straight-line paths (i.e. not calculated "as the crow flies"). If a range response (e.g. "8 to 10 trips") was given for trip-based questions, the mid-point value was recorded. If the mid-point value ended in a half trip, it was rounded down to the nearest integer based on the assumption that people tend to overestimate trips taken (Hesseln et al. 2003; 2004). Finally, in cases where people replied with general terms such as "many", "lots", with a question mark, or left the space blank, the answer was coded as a missing value.

4.5 SURVEY RESPONSE RATES

Table 4.3 lists some of the groups which comprise the final survey sample.

TABLE 4.3 – SURVEY SAMPLE RESIDENT AND SURVEY PREFERENCE COMPOSITION
(number of observations in parentheses)

RESPONDENT CHARACTERISTIC	PRA CAMPGROUNDS	RANDOM CAMPING AREAS	ALL CAMPING AREAS
Alberta Resident	97.5% (474)	98.6% (72)	97.6% (546)
Preferred Mail Survey	83.6% (445)	93.8% (64)	84.8% (508)
Preferred Email Survey	16.4% (445)	6.8% (64)	15.2% (508)

Due to inconsistent address information and changes occurring between the interview and mailing periods, the number of survey participants was lower than the 508 individuals who expressed an interest in participating. Seven email addresses collected were invalid; regular mail was used instead for two of these, however the remaining five had to be removed from the sample. Two invalid mailing addresses were also received. A number of other mailing difficulties also arose; two people went on long-term vacations, two moved and did not leave forwarding addresses, one had a general delivery address and did not pick up his mail (surveys were returned by the post office), and one person passed away. Thus, these are six more observations that were removed from the sample. Therefore, in total, there were seven invalid addresses and six other issues that contributed to 13 people being removed from the original survey sample; the total possible survey sample size became 495.

TABLE 4.4 – SURVEY RESPONSE RATES *(number of observations in parentheses)*

CONTACT METHOD	PRA CAMPGROUNDS	RANDOM CAMPING AREAS	ALL CAMPING AREAS
Mail Survey	66.4% (369)	55.4% (56)	64.9% (425)
Email Survey[A]	65.2% (66)	25.0% (4)	62.9% (70)
All Surveys	66.2% (435)	53.3% (60)	64.6% (495)
Removed	2.0% (444)	6.3% (64)	2.6% (508)

[A] *This response rate may be lower than the regular mail technique because only two email waves were conducted, since both were full version mailings (i.e. unlike the reminder postcard) and the response rate was already perceived as being high. In retrospect, however, three full version email waves should have been conducted to further increase the sample size.*

The overall response rate for the survey was roughly 65%. About 59% of those who agreed to participate in the onsite interview produced a returned mail survey. The higher response rate for regular campers compared to random campers is statistically significant at the 90% level.

Although the data contain information from 320 people, not all surveys were answered in their entirety. The main component of the survey, the number of actual and stated trips, were "stacked" into panel data so that the respondent's information to other questions remained constant while only the trip values were permitted to vary subject to the differently-aged campsite scenarios. Therefore, one respondent could contribute up to four observations to the data set; one RP observation and three SP observations. After adjusting for missing values, exactly 1200 valid observations were available to be used in the analysis. This represented 93.8% of all possible observations from the 320 returned surveys.

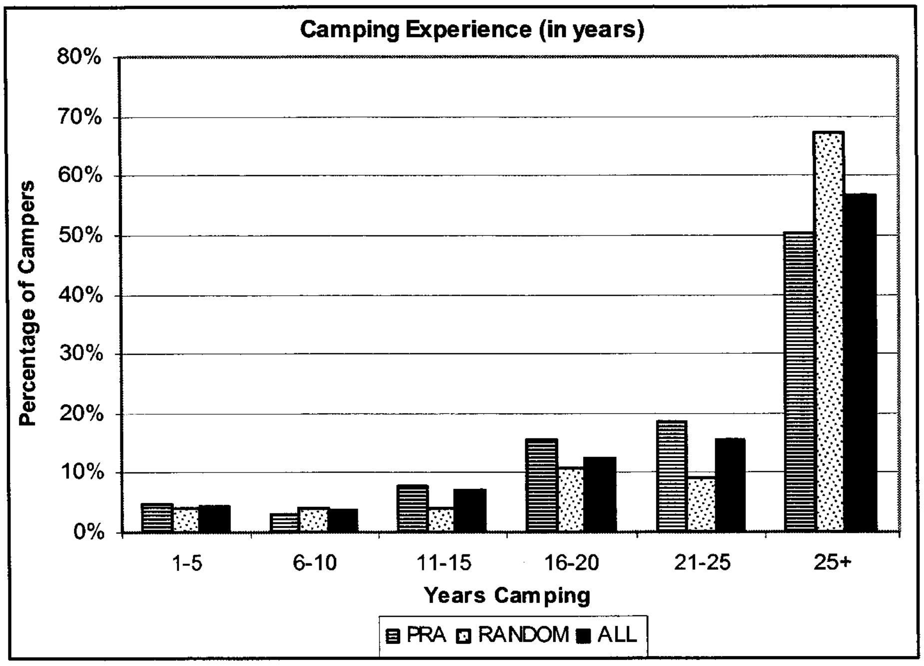
CHAPTER 5: GENERAL RESULTS OF THE INTERVIEW AND SURVEY

5.1 CAMPING EXPERIENCE AND PREFERENCES

An important distinction made throughout this study is whether a recreationist was considered a regular or a random camper. This distinction was made based on if someone was approached in a random campsite for the interview, or if they indicated in the survey that they random camped for at least one night in 2004. Respondents who were unsure if they random camped were not considered a random camper because it was assumed they would know their status with certainty due to the uniqueness of the activity. Finally, there were 26 cases where camping type could not be determined due to missing values; these respondents were not included in either camping group, but were part of the overall recreationist sample.

To better understand the group of respondents, camping experience was gauged in the survey. Figure 5.1 displays responses to the question which asked how long the respondent has been camping:

FIGURE 5.1 – CAMPING EXPERIENCE IN YEARS *(valid percentages only)*



The majority of survey respondents were experienced campers, as just under 57% of all valid responses indicated they had been camping for at least 25 years. At least half of PRA and random campers had been camping for more than 25 years, although random campers were 16.9% more likely to belong to this category. This difference is statistically significant at the 99% level, suggesting that random campers generally have more camping experience than PRA campers. The following two paragraphs also support this claim.

The average number of previous visits made to the camping area recreationists were interviewed at was 9.4 visits over the past ten years. There was a noticeable difference in responses between people in PRAs and those in random camping areas; random campers made 14.8 previous trips, whereas regular campers made only 8.5. The random camping average is significantly higher than the PRA average at the 96% level of statistical confidence.

The average number of nights all recreationists stayed in their camp site was about 5 nights. The most popular response was 2 nights, given by 36.7% of all interviewees. Once again, a statistically significant difference exists between the means of regular and random campers (at more than the 99% confidence level). PRA campers stayed an average of 3.5 nights in their campsite, whereas random campers stayed an average of about 17 nights in their campsite. Significant outliers exist however, because some random campers took one trip that lasted the entire summer. The median and mode values were similar between the two groups, indicating that the random camping outliers significantly shifted averages upward.

Observing what type of camping areas recreationists stayed in provides an indication of their preferences. Although the results below are admittedly skewed because respondents were only recruited from PRA campgrounds and random camping areas (particularly PRA sites, where 85% of interviews occurred), Figure 5.2 displays where recreationists in this study camped in 2004[4].

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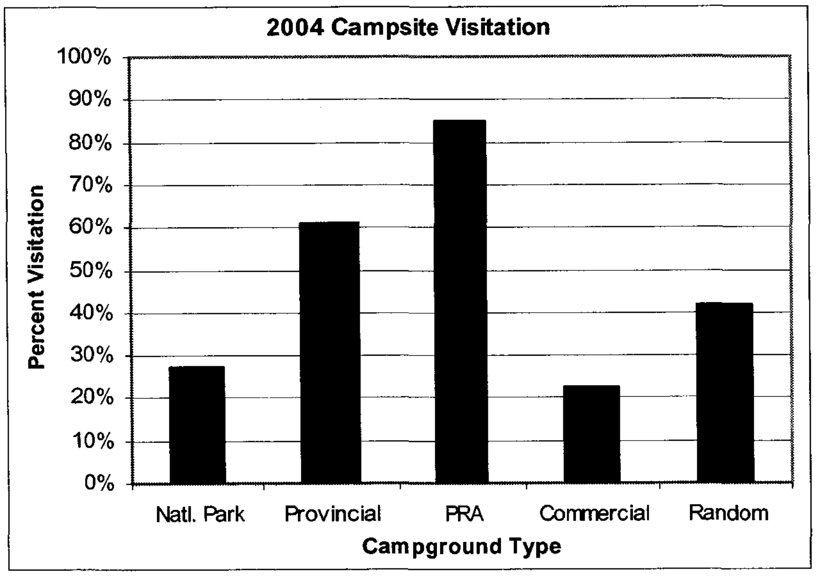
[4] It should be noted that National Park employees went on strike during the summer of 2004. Thus, park and campground fees were waived, however services and attendants were likewise restricted. It is unknown whether these effects altered visitation rates during this period.

FIGURE 5.2 – CAMPSITE VISITATION IN 2004 *(valid percentages only)*



The visitation rates in Figure 5.2 are identical to results from a preference question involving the same types of campgrounds. Thus, respondent's site preferences appear to be consistent with their site choices; this provides support for the validity of the SP component of this study since preferences appear to mirror actual behaviour.

5.2 RECREATIONISTS' DEMOGRAPHIC INFORMATION

Table 5.1 provides a summary of survey respondent characteristics.

TABLE 5.1 – SURVEY RESPONDENT DEMOGRAPHIC INFORMATION *(number of observations in parentheses)*

DEMOGRAPHICAL INFORMATION	PRA CAMPERS	RANDOM CAMPERS	ALL CAMPERS
% Male	63.4% (161)	68.1% (119)	65.3% (311)
Age	42.0 (167)	44.1 (117)	43.0 (310)
Years of Formal Education	13.8 (164)	13.3 (114)	13.7 (301)
Household Population	2.88 (166)	3.01 (120)	2.95 (312)
Household Income[A]	$74,259.74 (154)	$82,838.10 (105)	$78,227.44 (277)

[A] *Income results are based on estimations. The survey contained check boxes of income ranges instead of asking for specific income amounts to encourage greater response rates; however, the tradeoff is lower accuracy. Therefore, midpoints of the income ranges were used for calculating the descriptive statistics. For the lowest income range, 20% was subtracted from the listed amount (thus, for the "Less than $10,000" box, an average income of $8,000 was used), while for the highest income range, 20% was added to the listed amount (thus, for the "$150,000 or more" box, an average income of $180,000 was used).*

As with many camping studies, the majority of survey respondents were male. For comparative purposes, the male proportion of the data set for Egan and Herriges's (2004) study was 63%, 56% for Loomis et al. (2001), 56% for Hesseln et al. (2004), 51% for Englin et al. (2001), and 50% for Hesseln et al. (2003). The average age of a survey respondent was 43 years; this is approximately six years older than ages of respondents in similar U.S. studies such as Englin et al. (2001), Hesseln et al. (2004), and Loomis et al. (2001). The average education level was just under 14 years or slightly below two years of post-secondary education. This is roughly equivalent to having a college diploma or completing half of a Bachelor's degree. This average is roughly two years less than the averages found in Hesseln et al. (2003), Hesseln et al. (2004), and Loomis et al. (2001).

Recreationists most likely resided in two-person dwellings (making up nearly half of the sample), followed by four-person households (almost a quarter of the sample). The average number of people residing in the participant's house was approximately three people. This is about 0.5 people higher than Hesseln et al. (2003; 2004), and Loomis et al. (2001). Lastly, there was an elevated non-response rate to the household income question (13.4%), a common finding because people are often uncomfortable revealing their financial information. Respondents were required to select an income range, and a relatively equal distribution between all income levels ensued. The average 2003 household income for all survey participants was estimated at about $78,200 (comparisons to other literature are not made due to inconsistent time periods and currency). Random campers indicated that their household income was about $8,500 higher than regular campers in 2003; this discrepancy is statistically significant at the 90% level of confidence.

TABLE 5.2 – MEMBERSHIP RATES FOR RECREATION-BASED ORGANIZATIONS *(valid percentages only)*

ORGANIZATIONAL MEMBER	PERCENT OF TOTAL		
	PRA CAMPERS	RANDOM CAMPERS	ALL CAMPERS
Natural History / Bird watching	1.2	1.7	1.3
Hunting / Fishing	9.0	19.7	13.6
Environmental / Conservation	7.2	10.3	8.1
Off-Highway Vehicle	0.6	9.4	4.5
Number of Observations	*167*	*117*	*309*

For all types of campers, hunting and/or fishing groups exhibited the highest membership rates. Other than for natural history and bird watching organizations, random campers had noticeably higher membership rates than PRA campers (particularly for hunting and fishing organizations, where random campers were more than twice as likely be members). Random campers were more likely than PRA campers to belong to a hunting/fishing organization and an off-highway group at the 99% level of confidence, suggesting that they were more formally involved in forest recreation activities and issues.

5.3 TRAVEL COST DATA

Travel distance to a site is often used as a proxy for price in recreation demand studies (since park admission fees, camping fees, etc. are not representative of the true cost to visit a recreational site), and it is a key component of the travel cost variable. Measuring distance accounts for both the financial cost of travelling (it captures the higher costs incurred as distance travelled increases), and the opportunity cost of time. To prevent outliers from skewing results, a distance travelled limit was established, similar to Englin et al. (2001) and Englin and Shonkwiler (1995). Distance values were restricted to be no more than 900 km[5] one-way for this study. Table 5.3 displays the distance measures taken from the survey, and it is these figures that are used for analysis in Chapter 6 (distance travelled figures were also collected in the

[5] Only one record was removed from the analysis, which had a distance value of 1784 km (more than double the next highest value).

onsite interview).

TABLE 5.3 – ONE-WAY DISTANCE FROM THE RESPONDENT'S MOST FREQUENTED EASTERN SLOPES REGION SITE IN 2004 TO THEIR RESIDENCE

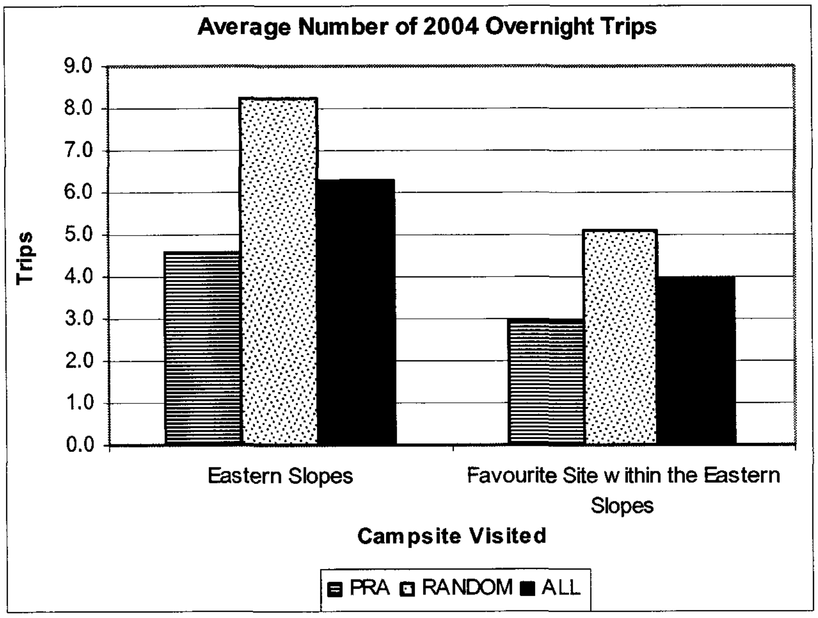
	Distance Travelled (km)		
	PRA Campers	Random Campers	All Campers
Mean	220.7	209.5	215.9
Standard Dev.	145.257	133.904	138.770
Number of Observations	*170*	*122*	*318*

People drove an average of 216 km one-way to their most frequented eastern slopes camping site in 2004. The average distance travelled for random campers was less than for PRA campers. However, this difference is not statistically significant at conventional levels. The distance travelled measures collected from the survey were similar to the onsite interview results. However, the discrepancy between random and regular campers was even greater in the interview; PRA campers travelled an average distance of about 222 km compared to approximately 150 km for random campers. The difference in mean values from the onsite interview between both camping groups was statistically different at greater than the 99% confidence level. Another key component of the travel cost measure is the recreationists' household income (see Table 5.1), which was used to determine the opportunity cost of travel time.

Finally, in the absence of an exact group size value, the average household size value of 2.95 was used as an estimate for average group size[6]. Many families travelled together, and groups of non-families often mirrored the respondent's household size as well. Although an imperfect estimate, it is virtually identical to the group size values of 3.00 and 2.54 used by Hesseln et al. (2004).

5.4 Actual Trip Data and Information – RP Data

FIGURE 5.3 – AVERAGE NUMBER OF 2004 OVERNIGHT TRIPS TO THE EASTERN SLOPES REGION OF ALBERTA AND TO RESPONDENTS' MOST FREQUENTED CAMPSITE



Although the average number of eastern slope trips per respondent in 2004 was 6.29, the majority of people who completed the survey only camped one time in the eastern slopes of Alberta in 2004. The mean number of eastern

[6] For a more detailed description of household size descriptive statistics, please refer to section 5.2.

slope trips also reveals that random campers took 3.67 more overnight trips in 2004 than regular campers. This difference is statistically significant at more than the 99% confidence level. In terms of trips to a most frequented site, random campers once again took more trips on average than those who camped in PRAs. The difference in means is statistically significant at greater than the 99% level of confidence.

These results tell us that random campers took more overnight recreation trips than PRA campers to Alberta's eastern slopes region during the summer of 2004. It appears that random campers tended to establish a preferred site and then visited that particular site more often throughout the year. This was probably because discovering and/or preparing a random site takes time and effort, thus campers liked to make use of their earlier work. Meanwhile, PRA campers often camped only once all year or tended to vary their destinations if they camped more often, opting for variety. Thus, they took fewer trips to a singular "most preferred site".

Examining the proportion of trips a camper took to their favourite site (displayed in Table 5.4) tells a different story, however.

TABLE 5.4 – PROPORTION OF OVERNIGHT TRIPS TO THE EASTERN SLOPES REGION IN 2004 TAKEN TO THE RESPONDENT'S MOST FREQUENTED SITE *(standard deviation appears in parentheses)*

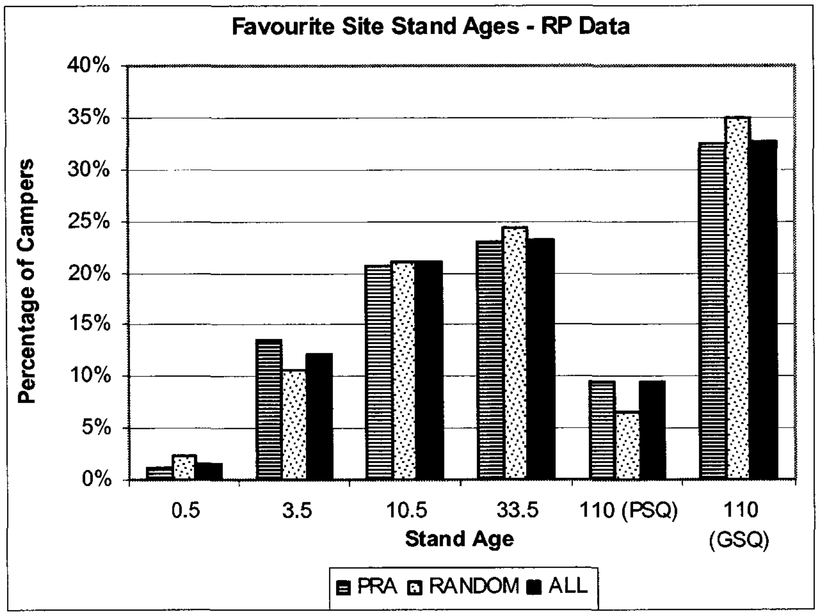
	PERCENT OF TOTAL		
PROPORTION OF TRIPS TAKEN TO A FAVOURITE SITE	PRA CAMPERS	RANDOM CAMPERS	ALL CAMPERS
Campers who visited a favourite site	71.5% (0.278)	64.8% (0.256)	69.0% (0.274)
All trips taken to a favourite site	60.9%	60.9%	60.0%
Number of Observations	*147*	*107*	*281*

When averaging all of the individual respondents' proportions of eastern slope trips taken to a favourite site, the results counter the theory that regular campers preferred to visit a variety of campgrounds. When going on a camping trip, PRA campers were 6.7% more likely to visit their most frequented site than random campers; this discrepancy is statistically significant at the 95% confidence level. This result is slightly misleading however, due to the large number of PRA campers who made only one trip all year. When someone takes only one trip all season, the proportion of trips to a "most frequented site" is 100%. Since most one-time campers visited PRA campgrounds, these 100% values inflated the regular camper "Proportion of campers who visited their favourite site" category. Removing one-trip cases from the data result in similar averages for both random and PRA campers, negating the discrepancy.

Proportions were also calculated of all trips to a favourite site against the sum of all eastern slope trips. This method gives more weight to people taking numerous trips because their totals appear more frequently than someone who only took one trip. This method still produced similar results; both types of campers took about 61% of all trips to a favourite site. Therefore, it appears that both regular and random campers behave similarly in terms of the proportion of trips they take to their most frequented site.

Lastly, a survey question asked respondents to select a group of photographs (shown in Figure 4.2) that most represented the area surrounding their most frequented camp site. This information was used to establish the actual age of their favourite site. Combining the actual age of the forest around a respondent's most frequented site with the actual number of trips they took there produces the RP data. Figure 5.4 displays the photograph groups which were selected as representative of favourite campsites.

FIGURE 5.4 – MOST FREQUENTED SITE STAND AGE, BASED ON PHOTOGRAPH GROUP SELECTIONS *("Stand age" (i.e. years since fire) refers to the mean age of forest stand pictures used in each photograph group. "PSQ" refers to poor soil quality sites while "GSQ" refers to good soil quality sites.)*



Approximately one third of all respondents stated that the area surrounding their most frequented campsite resembled an older growth forest (110 years old) on good soil quality. The older the stand age for a photograph group became, the more often that group was selected; the only exception to this trend was for poor soil quality, older growth sites. Recreationists clearly avoided those camping areas. There are no noticeable differences in the answers given by PRA and random campers for this question.

5.5 Fire Attitudes and Knowledge

A good indicator of someone's attitude towards forest fires is their opinion on how forest fires should be fought, if at all. Respondents were asked to indicate their most preferred fire-fighting strategy from the list in Table 5.5.

TABLE 5.5 – DEGREE OF SUPPORT FOR DIFFERENT FOREST FIRE APPROACHES *(valid percentages only)*

	Percent of Total		
Fire-Fighting Strategy	PRA Campers	Random Campers	All Campers
Let it burn out, under constant watch	35.2	35.0	35.1
Fight only once the fire is large enough	30.9	20.0	25.6
Fight the fire immediately, at any cost	34.0	45.0	39.3
Number of Observations	*162*	*120*	*308*

The first two forest fire fighting options are more flexible than strict suppression methods because they describe tactics where fires are not immediately addressed. These strategies are becoming more prevalent again in forest management policies and they allow greater realization of the natural processes of fires and can have lower abatement costs if successful. Along with this stance, however, is a greater opportunity for severe fires to develop and burn out of control. The last option posed in the question reflects the strategy characterized by "Smokey the Bear" campaigns of immediate suppression. Under strict suppression policies, fires may be contained more quickly but costs are typically higher and the natural benefits of fires are prevented as well.

The immediate suppression option was the most popular response among all campers, garnering 39% support. From the three choices however, no single option was a dominant choice. Regular campers had greater support for more flexible strategies; they were more supportive of fighting fires only "once the fire is large enough" (at the 95% level of confidence), whereas random campers had greater support for the traditional "fight the fire as soon as possible, at any cost" strategy (at the 90% level of confidence). This may be due to the fact that random campers spend more time at their favourite sites (see section 4.1), and could thereby be more inclined to see it protected from fire.

Even though the sample majority selected the traditional risk-averse strategy of immediate abatement as their preference, combining support for the first two (more flexible) options reflects a general trend towards less conventional fire management schemes. The first two options garnered support from nearly 61% of the valid sample, as opposed to 39% of the sample who support swift and complete control of fires. These results display the general shift towards more flexible schemes: Rauw's (1980) U.S. study from 25 years earlier found that 65% of respondents supported controlling forest fires at any cost. This may be because public support and acceptance tends to rise for flexible fire-fighting schemes as education and familiarity increases (Carpenter et al. 1986; Cortner et al. 1984; Manfredo et al. 1990). Breaking it down by camping type, 66% of PRA campers supported flexible schemes and 34% immediate abatement; random campers displayed 55% and 45% support levels respectively. This difference is statistically significant at the 90% level of confidence, indicating that regular campers were more likely to support more lenient fire abatement strategies.

An additional survey question gauged support for controlled (i.e. prescribed) burning as a fire prevention tool. The results suggest that respondents favour fire *management* over fire *control* policies. About 81% of the sample supported the use of controlled burns as a preventative fire measure[7], and responses were relatively consistent across random and regular campers. This result is in line with previous studies, as Carpenter et al. (1986) reported that 81.7% to 89.4% of people agreed with low-intensity controlled burns, and Taylor and Daniel (1984) stated that 90% of their sample supported light, low-intensity prescribed burns. A more recent study had a different outcome however, as Manfredo et al. (1990) stated that 54-57% of respondents had positive attitudes towards a controlled burning policy while 43-46% had a neutral or negative attitude.

[7] This percentage of respondents replied either "Strongly Support" or "Somewhat Support" to a five-point Likert scale question.

Another survey question solicited recreationists' levels of agreement with 12 items which gauged attitudes regarding forest fires. Responses were coded based on whether the answer displayed a "negative" or "positive" attitude towards forest fires, and a score was generated. The higher the score, the more positive a respondent's attitude was towards forest fires. To accommodate invalid or missing responses and to better reflect actual attitudes, an average score was established[8]. The overall mean value for attitudinal averages was 2.99, which is almost exactly the midpoint of the possible range (1 to 5). This means that campers were neutral in terms of having a positive or negative attitude towards forest fires. Results between PRA and random campers differed by only 0.01 units.

Lastly, respondents were asked to answer a true/false quiz that tested their knowledge of forest fires and its effects. The average correct score for the forest fire quiz was 57% for all campers. The performance for each question of the quiz can be grouped into three categories: a thorough understanding of questions d.) and e.), an adequate understanding of questions a.), b.), and f.), and limited knowledge of question c.). There were no significant differences in quiz performance between random and PRA campers. Results are displayed in Table 5.6.

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[8] Otherwise, blank answers would register as zero and could inaccurately give respondents a more negative attitude (lower score) towards forest fires.

TABLE 5.6 – FOREST FIRE QUIZ RESULTS *(valid percentages only)*

FOREST FIRE QUIZ QUESTION	ANSWER	PERCENT CORRECT PRA CAMPERS	 RANDOM CAMPERS	 ALL CAMPERS
a.) Forest fires usually result in the death of most animals in the burnt area.	False	64.1	61.5	62.9
b.) Most forest fires along the eastern slopes of Alberta are caused by lightning.	True	46.7	46.7	47.9
c.) Controlling all forest fires would reduce the habitat of animals such as elk.	True	21.6	27.9	23.8
d.) Forest fires destroy minerals and nutrients that are needed by trees and other plants.	False	74.9	70.5	72.7
e.) Forest fires can be an important force in controlling outbreaks of disease and insects in forests.	True	77.8	75.4	76.5
f.) It takes years before significant plant growth occurs in a fire-damaged forest.	False	58.4	57.4	56.7
Entire Quiz		57.2	56.6	56.7
Number of Observations		*167*	*122*	*315*

5.6 CAMPING PREFERENCES FOLLOWING FIRE

A series of interview questions examined each recreationist's intended behaviour following forest fire damage to their camping areas. One question asked if campers would still visit the campsite for the same length of time if a *light-intensity*[9] fire had damaged half of the campground earlier that same year. Results are posted in Table 5.7.

[9] "Light-intensity" fire damage was defined to the participant as roughly half of the camping area they were interviewed in being burnt, however the area would not have sustained any significant damage to infrastructure and/or large trees; only half of all smaller plant life would be affected.

TABLE 5.7 – WILLINGNESS OF RECREATIONISTS TO CAMP IN THEIR FAVOURITE SITE FOLLOWING RECENT LIGHT-INTENSITY FIRE DAMAGE

	PERCENT OF TOTAL WHO ANSWERED "YES"		
IF A LIGHT-INTENSITY FIRE DAMAGED YOUR FAVOURITE SITE EARLIER THIS YEAR...	PRA CAMPERS	RANDOM CAMPERS	ALL CAMPERS
Would you still visit?	76.8	86.5	81.2
If you would still visit, would you stay the same length of time?	97.6	96.5	97.5
Number of Observations	*164*	*155*	*506*

Most campers displayed a resilient attitude, as about 81% of the sample would not be deterred to camp in a location with recent fire damage and 97.5% of these people would stay for the same length of time. A statistically significant discrepancy at the 95% level exists between regular and random campers regarding the decision to visit. This suggests that random campers were more accepting of camping in slightly fire-damaged sites.

Next, respondents were told that a *severe*[10] fire recently damaged their favourite site, making it impossible to visit. They were asked if they would rather camp in a substitute site as an alternate plan or simply stay at home. The vast majority of respondents (94.7%) stated that they would camp elsewhere and not stay home. This indicates that outdoor recreationists prefer to substitute camping sites instead of activities[11]. Once again, there was a gap in responses between PRA and random campers. About 96.3% of regular

[10] "Severe-intensity" fire damage was defined to the participant as most of the camping area they were interviewed in being burnt to a significant degree, with damage to infrastructure and/or large trees. The camping location could not be camped in during the fire year, but would re-open the following year following re-construction and cleanup.

campers expressed a willingness to camp somewhere else in case of severe fire damage, whereas 91.6% of random campers said they would camp elsewhere. This difference is statistically significant at the 90% confidence level. Although the discrepancy is minimal, random campers appeared less likely to search out a substitute site (however, the 91.6% that would search for a substitute site still represents a high proportion). A follow-up component to the "severe fire damage" question followed. It asked how long recreationists would wait before re-visiting their favourite site, if it had been damaged by a severe fire, for a visit similar in length to their actual trip.

TABLE 5.8 – PERCENTAGE OF CAMPERS THAT WOULD RE-VISIT A FIRE DAMAGED FAVOURITE SITE AND STAY FOR THE SAME LENGTH OF TIME (AS WHEN INTERVIEWED)

	PERCENT OF TOTAL WHO WOULD RETURN		
WOULD RETURN IF THE FIRE OCCURRED...	PRA CAMPERS	RANDOM CAMPERS	ALL CAMPERS
1 year ago	84.8	89.0	85.8
2 years ago	87.2	94.8	90.1
5 years ago	95.7	100.0	97.6
10 years ago	100.0	100.0	100.0
30+ years ago	100.0	100.0	100.0
Number of Observations	*164*	*155*	*507*

Predictably, more people would re-visit as more years elapse since the fire; most recreationists prefer vegetation near their camping sites, thus re-visitation rates would rise the more the forest regenerated. Since over 85% of

[11] A follow-up question asked for the name and location of the substitute site. For a detailed description of substitute site locations, please refer to section 7.3.

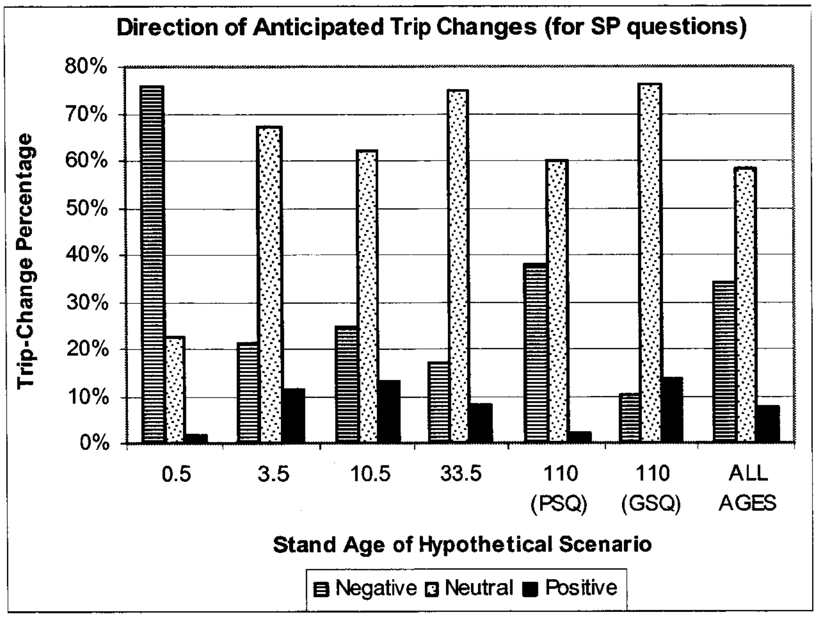
participants stated that they would return only one year following the fire, the substitute site discussed previously appears to only be a short-term substitute. There were two differences in responses between PRA and random campers; random campers were more likely to return to their favourite site two and five years following severe fire damage, at the 95% and 99% levels of confidence respectively. Random campers appeared more willing to return to fire-damaged sites sooner than PRA campers.

The differences in answers between both types of campers for the previous three questions seemed to indicate that random campers had a deeper connection to their favourite camping spot; they seem to have developed a perceived property right. They were more likely to camp in a site damaged by light-intensity fire, less likely to search out a substitute site, and were willing to return to their favourite campsite sooner than PRA campers after a severe fire. Their loyalty may have been due to sentimental value if they discovered and/or altered the site to suit their preferences. Being less likely to abandon a preferred random camping area is also practical, since finding and establishing a new favourite random campsite takes more effort than simply locating a different managed campground on a map (as occurs with regular campers).

5.7 Hypothetical Scenario Responses – SP Data

Respondents were given three questions that asked if the number of trips they planned to take to their most frequented campsite in 2005 would change from 2004 if the surrounding landscape appeared as a randomly chosen photograph group instead of the current actual appearance. These decisions regarding anticipated trips subject to new site conditions (in the form of altered forest ages) comprised the SP data. Figure 5.5 displays the rate and direction of trip-changes.

FIGURE 5.5 – DIRECTION OF TRIP CHANGE IN 2005 IF THE SURROUNDING AREA OF THE RESPONDENT'S 2004 MOST FREQUENTED SITE NOW APPEARED AS ONE OF THE PHOTOGRAPH GROUPS BELOW *("Stand age" refers to the mean forest stand age depicted in each photograph group (i.e. years since fire). "PSQ" refers to poor soil quality sites and "GSQ" refers to good soil quality sites)*



A general trend appears to exist in these data where fewer people change the number of future trips as stand age rises (as shown by rising "Neutral" values). This, it appears that recreationists tended to prefer older growth forests to younger stands. For stands that experienced a fire within one year, over 75% of respondents said that they would decrease the number of future trips taken there. This is the sharpest decrease in trips for all stand ages found in the analysis. It also posts the lowest totals for neutral and positive trip changes. There is less trip-changing for the intermediately-aged forest stands (photograph groups with mean stand ages of 3.5 to 33 years), as the trip adjustment proportions stayed relatively constant.

Older growth forest stands on good soil quality sites apparently provide the most desirable results for recreationists. These sites had the lowest rate of negative trip change, and the highest neutral *and* positive trip change percentages. Lastly, survey participants avoided older growth poor soil quality sites. The poor soil quality photograph group had the second least desirable totals in all three categories; only the recently burnt stand photograph group (0.5 years) had worse totals. Comments made by recreationists concerning this photograph group often cited the messy appearance and difficulty navigating through the underbrush as the primary reasons for wishing to change the number of trips they would make there in 2005.

Results were somewhat mixed depending on whether the respondent was a PRA or random camper. The results suggest that random campers were more willing to camp in recently burnt areas than PRA campers. They had lower "Negative" trip-change percentages in four of the six categories, although in some cases only a slight difference exists. It can be stated with 90% statistical confidence that random campers were less likely to decrease their future number of trips to recently burnt sites and were less likely to change their trips in 3.5 year old stands than PRA campers. These results reflect the preferences revealed by random campers in section 5.6 (Table 5.7 and Table 5.8), where they display less willingness to leave their favourite site if it was affected by fire. This may also explain why random campers were more in favour of strict forest fire abatement, as discovered in section 5.5 (Table 5.5).

Regular campers appeared to enjoy well established stands more than random campers as they took significantly more trips to older growth good soil quality sites at the 90% level of statistical confidence. Looking at all ages collectively though, PRA campers were more likely (at the 90% confidence level) to remain neutral concerning their future number of trips subject to altered surroundings.

The information highlighted in Chapter 5 comprised the data used in the econometric analysis. The intertemporal damage function explicitly modeled the relationship between trip taking and stand age, personal demographic, attitudinal, and recreational behaviour information (both revealed and stated). Distinguishing responses between regular and random campers was also included in the damage function estimations to determine if camping type significantly influenced trip-taking behaviour.

CHAPTER 6: DEVELOPMENT OF THE FIRE-INDUCED RECREATION DAMAGE FUNCTION

Recreation behaviour is ever-changing, influenced by a variety of factors that shift over time; nearby population and socioeconomic demographics, attitudes towards forest recreation, access, weather, park quality, etc. Another major factor is forest stand age, which itself is affected by fire activity. Since the age of a forest changes every year, this relationship is dynamic. Therefore, recreation behaviour evolves as a forest recovers from a forest fire and ages. The purpose of this chapter is to create an intertemporal damage function, which captures the dynamic recreation relationship quantitatively.

6.1 Methods and Development of the Model

Given the data and information in Chapter 5, eq. 8 displays a function that describes how recreation behaviour may change with stand age in addition to being influenced by other factors:

$$V_{ij} = f(P_{ij}, Sage_i, Q_i, Z_j, \beta) \qquad \textbf{(8)}$$

where V is the number of trips to recreational site i by person j, P is person j's travel cost to recreation site i, *Sage* is the forest stand age of recreational site i (contained previously in Q_i), Q are the remaining characteristics of site i, Z are the individual characteristics of person j, and β is a vector of unknown parameters.

Section 3.4 mentioned that the primary reason for collecting SP data and supplementing it with actual RP data was because of a lack in forest stand variation, both in ages and soil qualities, for RP observations. Only 1.3% of respondents replied that the area surrounding their most frequented site had a stand age of about 0.5 years, 12.1% said it was about 3.5 years old, and just 9.2% said that it appeared as an older growth poor soil quality site. This means that 77.4% of the remaining sample chose one of the remaining three older stand age groups. To overcome shortages for these groups, SP observations were collected and stacked into panel data form. The resulting combined data set provided more variation in stand age and soil quality to examine the influence of these variables on trip-taking behaviour.

The information from interviews and surveys suggested that fires affect trip behaviour in initial years following fire, but may not persist for long periods. This is shown in two tables from section 5.6. First, 81% of respondents would still visit their favourite campsite even if a light-intensity fire had swept through the area earlier that year (Table 5.7). Table 5.8 revealed that 86% of campers said they would return to their favourite site only one year after severe forest fire damage. This figure rises to 90% of campers two years following severe fire, 98% five years after fire, and fully 100% of all campers interviewed after ten years elapsed.

The number of years since the last fire occurred was used to represent stand age in the analysis. Based on results discussed in the previous paragraph, the relationship between recreationists and the number of trips they take is clearly not linear. Therefore, to accurately portray the effect of stand age on the number of trips taken, an appropriate non-linear functional form had to be chosen to represent stand age (Loomis and Walsh 1997). Different functional forms were utilized, including quadratic, reciprocal, logarithmic, and square root forms. Models using binary variables to represent discrete time periods following fire activity and hybrid models with dual binary/continuous stand age variables were also estimated, as was a framework that estimated two separate models by splitting the data set into two groups based on soil quality. Both individual variable and overall model diagnostic results were analyzed (e.g. Box-Cox transformation, log-likelihood and goodness of fit (Chi-square) values, individual t tests on the stand age variable and other parameters) to determine the most suitable form, and resulting graphs were also examined to test for intuitiveness and representation of interview results.

Furthermore, there also appeared to be differences in recreational behaviour relating to site quality as recreationists tended to avoid older growth sites in poor soil quality regions. Poor quality sites registered the second lowest visitation rates for actual trips, and were the only exception to the trend of increasing visitation with increasing stand age (Figure 5.4). The poor soil quality photograph group also had the second least desirable totals in terms of trips taken under the contingent behaviour scenarios, finishing ahead of only recently burnt stands (Figure 5.5). The distinct effect of poor soil quality campsites had to be carefully integrated into the intertemporal damage function to accurately reflect the trip-taking behaviour of recreationists. The inclusion of another site attribute variable was considered, whether access to the camping area was available via paved or gravel/dirt roads; however, due to statistical insignificance, this variable was excluded from further analysis.

Candidate variables that comprise the vector Z also had to be selected in order to reflect the socioeconomic differences between respondents. Individual characteristics were chosen based on three criteria; whether they effectively portrayed socioeconomic differences, their inclusion in similar studies (i.e.

those reviewed in Chapters 2 and 3), and their statistical strength in this present study based on exploratory regressions. The age of a recreationist is the most important determining socioeconomic factor affecting outdoor recreation demand (Loomis and Walsh 1997), in addition to other factors associated with age, thus it was included (as does Boxall et al. 1996*a*; Englin et al. 2001; Englin and Shonkwiler 1995; Hesseln et al. 2003; 2004; Loomis et al. 2001). Another factor that can greatly affect recreational behaviour and that contains vast demographic implications is income, and it was also used in all other prominent studies reviewed. The household variable is used as a proxy for recreational group size, and it is used in Hesseln et al. (2003; 2004) and Starbuck et al. (2006). Finally, a respondent's membership in a hunting and/or fishing organization was selected to help gauge the level interest in recreation and environmental issues (Starbuck et al. (2006) included a similar variable).

Factors beyond just forest condition and travel cost, for example, also contribute to recreationists' trip-taking decisions. People's attachment to a favourite camping area may be simply related to what they are used to. "Habit" factors were considered by recording years of camping experience and the number of trips over the past 10 years participants made to the site where they were interviewed. When incorporated into the model, the camping experience variable did not form a statistically significant relationship with the dependent variable. The past trips information, meanwhile, did not specifically refer to favourite sites; this was not pursued in the survey because recreationists' had difficulty recollecting the number of trips over the past 10 years in the interview and often responded with range values. Thus, past trips were not included in the model either.

Another important predictor of future behaviour can be attitude, so the forest fire attitudinal average (see section 5.5) was also incorporated into the econometric framework. This variable was statistically significant at the 99% level, and it showed that the more negative someone's attitude towards forest fires was, the more trips they took; a recreationist on the most negative end of the attitudinal scale was predicted to take a full trip more than a recreationist with an extremely positive outlook on forest fires. Despite its significance and relevancy, the attitudinal variable was not included in the final model (as is typically the case, according to Morey et al. (2003)) because incorporating an endogenously calculated variable makes the model non-transferable to other data sets and restricts its practicality. Removing the attitudinal average variable did not affect the overall model, as neither other variables nor the final results were altered with any significance upon its removal. The same reasoning of not creating models containing endogenous variables withheld the use of the true/false question scores (see section 5.5 and Table 5.6) from entering the final model to account for the effect of fire knowledge on trip-taking behaviour, however this variable was found to not even remotely explain the variation in the dependent variable regardless. Finally, gender, education, and urban/rural residency are other often used individual characteristics that were also dropped due to displaying little strength statistically in the analysis.

Perhaps the most important demographic variable that could be included in this study is the participant's random camper status, a variable not found in related literature. This not only distinguishes the unique behaviour of random campers but also the unique behaviour of regular campers. Differences between these two types of recreationists was found consistently throughout Chapter 5:; camping experience, trip lengths and frequencies, income, membership in outdoor recreation and/or environmental organizations, preferred fire-fighting strategy, camping preferences following fire, and responses to contingent behaviour scenarios. Random campers tended to be more experienced and took more longer length trips (sections 5.1 and 5.4), had higher income and membership rates (section 5.2), preferred more strict fire-fighting programs (section 5.5), and were less willing to leave their favourite campsite due to fire damage (sections 5.6 and 5.7). The random camping component was represented by a binary variable that was also interacted with two other parameters to observe if the number of trips taken by random campers was alternately affected by travel cost and stand age.

Based on these descriptions, the variables used for analysis are displayed in Table 6.1 along with some basic statistics:

TABLE 6.1 – VARIABLE DESCRIPTIONS

VARIABLE	DESCRIPTION	MEAN	STANDARD DEVIATION
TRIPS	Dependent variable, pooled RP and SP data, total number of trips taken along the eastern slopes in 2004[A].	2.56	4.154
RC	Binary variable, if RCC=1 then respondent random camped along the eastern slopes at least once during the summer of 2004, 0 else.	0.41	0.493
TC	Travel cost (calculation described in section 7.2).	92.50	64.330
TCRC	Random camp/travel cost interaction term, RC×TC.	38.34	61.045
Sage	Stand age.	41.13	45.797
SageRC	Random camp/stand age interaction term, RC×Sage.	18.14	37.098
PSQSA	Soil quality/stand age interaction term, PSQ× SA. PSQ is a binary variable, if PSQ=1 then campsite is located in a poor soil quality forest stand, 0 else.	14.48	33.078
AGE[B]	Respondent's age.	42.43	13.067
HSEHLD[B]	Number of people in respondent's home (including self).	2.96	1.218
INC[B]	Respondent's household income in 2003 before taxes, in thousands (INCOME/1000). Taken at median of range.	78.00	38.387
HUNT	Binary variable, if HUNT=1 then respondent is a member of a hunting and/or fishing organization, 0 else.	0.14	0.343

[A] *Trips to all camping sites within the eastern slopes region are considered equivalent despite possible differences in location or physical attributes, allowing all trips to be classified and summed together. See section 3.1 for a more detailed explanation.*
[B] *Means substituted into missing values*

Therefore, the resulting model appears as follows:

$$V_{ij} = \beta_0 + \beta_{RC} RC_j + \beta_{TC} TC_{ij} + \beta_{TCRC}(TC_{ij} \times RC_j) + \beta_{Sage} Sage_i +$$

$$\beta_{SageRC}(RC_j \times Sage_i) + \beta_{PSQSA}(PSQ_i \times Sage_i) + \beta_{AGE} AGE_j +$$

$$\beta_{HSEHLD} HSEHLD_j + \beta_{INC} INC_j + \beta_{HUNT} HUNT_j \qquad \textbf{(9)}$$

There are two constant terms in this model, one that applies to all recreationists and one that only applies to random campers. The travel cost variable depends on the locations of recreational site *i* and recreationist *j*'s home. Likewise, this term is also interacted with the random camp variable (as is the stand age variable) to determine if possible differences in the influences of travel costs and/or stand age on trips for random campers exist. Stand age and travel cost were selected to be interacted with the random camp variable because they were believed to have had the most profound effect on trips taken.

The stand age coefficient relied on the age of the forest surrounding campsite *i*, and this variable was also interacted with the poor soil quality variable to identify poor quality sites. The "PSQ" dummy variable only applied to older aged stands since visual differences between soil quality sites only appear once the forest matures (Silins 2004). The remaining variables are all socioeconomic coefficients that rely on the personal demographic information of each respondent; age, size of household, income, and membership in a hunting/fishing organization.

Based on all the literature reviewed in Chapter 2 and the econometric review in Chapter 3, a count model framework is the most suitable for modeling recreational demand and was therefore chosen for this analysis. Issues to be considered were overdispersion, truncation, endogenous stratification, and consistency of the RP and SP data.

A Wald test was used for the first issue, which is based on the asymptotic t ratio of the estimated parameter α that is estimated in the NEGBIN model (Yen and Adamowicz 1993). A second overdispersion test is the OLS regressions-based test proposed by Cameron and Trivedi (1998;78). This involves calculating λ_j using the Poisson coefficients, and then regressing $\frac{(v_j - \lambda_j)^2 - v_j}{\lambda_j}$ against $\alpha_1\lambda_j$ and $\alpha_2\lambda_j^2$. Statistically significant α parameters from these regressions suggest that overdispersion exists and that a Poisson model is deemed unsuitable for the data.

Issues concerning endogenous stratification and truncation could not be resolved for this study because, according to Englin et al. (2001), no method currently exists to correct SP data for these problems when it is pooled with truncated RP data. The issue is that SP data could contain observation values of 0. In other words, a recreationist who had a positive number of actual trips may chose 0 trips in a hypothetical setting. However, as mentioned in Chapter 3:, I am more interested in the responses of surveyed recreationists and not necessarily the general population.

Lastly, consistency between RP and SP responses was verified with the test described by Englin and Cameron (1996) and used by Hesseln et al. (2003; 2004) and Loomis et al. (2001). Models were estimated containing a dummy variable that identified responses as RP information. If this parameter was statistically insignificant, and if its inclusion and exclusion in the estimation did not affect the overall model or sign, size, and/or significance of other variables, it could then be stated that no systematic differences between RP and

SP responses existed. This result would indicate that survey respondents were being consistent in their responses to the contingent behaviour scenarios, and their answers would be in line with their actual behaviour as well. A non-significant result for the RP dummy indicates a successful test and validates the SP data, thereby reinforcing the integrity of results.

Finally, as Englin et al. (2001) mention, a further issue is that all of the studies in Chapter 2 used pooled models for their combined RP and SP data. Pooled models do not consider the fact that combined RP/SP data contain multiple observations from each individual, and so these models estimate observations independently. Only panel estimators calculate parameters that maintain a link of dependency among data generated from the same respondent. The model in this study linked the RP and SP responses to the originating respondent by using a random effects count model, a type of sequence effects framework (see section 3.4).

6.2 Calculation of the Travel Cost Variable

To calculate travel cost, a basic travel rate of 30 cents per kilometer (a value seen in recent studies for "out of pocket" expenses such as vehicle and gas costs, etc.) was multiplied by the total number of kilometers driven round trip and calculated per person. Next, this value was added to a fraction (25%) of the hourly household wage rate, to incorporate the opportunity cost of time[12]. This value was then multiplied by the total round trip travel time, using

[12] To calculate the hourly rate, the respondent's yearly salary was divided by the standard number of hours worked in a year (2080).

an average speed of 95 kilometers per hour (this speed is based on those used in other recreation-based literature). This travel cost formula, also used by Haener et al. (2001:634), is displayed in eq. 10:

$$\text{TRAVEL COST} = ((0.30 \times 2 \times \textit{Distance}) \,/\, \textit{Avg. Group size}) \times ((\textit{Income} \,/\, 2080 * 0.25) \times (2 \times \textit{Distance} \,/\, 95)) \qquad \textbf{(10)}$$

Incorporating a portion of the wage rate into the overall travel cost is a method frequently used by US federal agencies for valuing the cost of time (Loomis and Walsh 1997; Loomis et al. 2001; US Water Resources Council 1983). Failure to do so can lead to specification errors that underestimate the true value of the recreation trip (Allen et al. 1981). Accounting for the opportunity cost of time prevents the travel cost variable and consumer surplus values from exhibiting omitted variable bias. The reason time and distance costs are meshed together and not treated separately is because other authors have found that travel time is too collinear with distance to allow its effect to be estimated independently (Englin and Shonkwiler 1995). The fraction of the wage rate selected (25%) is based on Cesario's review of the transportation literature, and also used in other recreation demand literature (e.g. Englin and Shonkwiler 1995; Loomis and Walsh 1997; Loomis et al. 2001).

6.3 Model Hypotheses

Following conclusions from other studies, I predicted that stand age would have a positive effect on the number of trips taken; the older the forest, the more trips someone would wish to take there. This was also observed in the survey photograph group selections for RP and SP data (Figure 5.4 and Figure 5.5), as people indicated a preference towards older aged stands. Conventional economic thinking gives the inclination that the travel cost variable should be negative. I believed that random campers would take more trips than established campground campers based on interview and survey findings (section 5.1 and Figure 5.3), and I also believed that recreationists would visit good quality sites more frequently than poor quality sites due to differences in visual aesthetics and reduced amounts of woody debris that hinders movement (Figure 5.4 and Figure 5.5). Personal demographics were all hypothesized to be positive; people were predicted to take more trips the older their age (due to increased time availability), the more people present in their household (due to the increased probability that at least one household member enjoys outdoor recreation), the higher household incomes they had (easing financial constraints for leisure), and if they were a member of a hunting/fishing organization (membership implies an interest in outdoor recreation).

I predicted that the resulting intertemporal damage function would show a sharp drop in the number of trips immediately after a forest fire because most people indicated with comments that they were averse to lodging in areas that were recently burnt by a severe fire. I hypothesize this despite some studies finding a rise in trips right after a wildfire because other literature focuses on trail-based recreational activities, where day trips are taken and people move through the affected area. While there may be high levels of curiousity to make quick visits to recently-burnt regions, these types of conditions are not ideal for an activity like camping where surroundings remain constant and people would have to sleep in the charred region. In addition, recreationists may also not be able camp directly following fire since facilities would need to be repaired.

I felt that the regeneration phase would begin quickly however (Table 5.8 and Figure 5.4), and I felt that the number of trips taken would increase gradually until approximately 50 years following fire. At this point, it was hypothesized that good quality sites would continue to see trips increase with forest age but at a slower rate than previously (Table 5.8 and Figure 5.4). Meanwhile, trips to poor quality soil sites would probably fall at a decreasing rate as the forest stand ages beyond 50 years, but eventually stabilize after roughly 100 years (Figure 5.4 and Figure 5.5).

6.4 Results for RP-Only Models

LIMDEP software was used to estimate parameters under a variety of model frameworks as various functional forms were used to represent stand age. Based on results of several specification tests, and after analyzing the resulting curves graphically, the reciprocal functional form of stand age was clearly the strongest performer. It registered the strongest Box-Cox transformation, log likelihood, and Chi-squared results (i.e. goodness of fit), displayed the most significant stand age variable statistically, and contained the greatest number of other statistically significant parameters in the overall model. In addition, the reciprocal stand age intertemporal damage function seemed to yield the curve that best represented recreationists' behaviour based on preliminary interview and survey results. This behavioural pattern consisted of a sharp drop-off in trips following fire, followed by a steep increase in trips immediately following, and then with a slowly increasing trend in trips as the forest continues to age.

Using a reciprocal functional form to represent stand age, different travel cost count data models were constructed in an effort to develop estimators that accurately describe the relationships between site characteristics, personal demographics, and the number of trips taken. Two models solely using RP data were first created to gain an understanding of the *actual* behaviour of recreationists in 2004. The RP sample was truncated, and since this can be accommodated for (unlike in RP/SP models), the RP models were calibrated for truncation.

TABLE 6.2 – RESULTS FOR RP-ONLY MODELS *(Note: parameters are generated by a Poisson count model, thus results correspond to an exponential formula) (Standard errors given in parentheses)*

VARIABLE	MODEL 1 NON-RC POISSON (RP ONLY)	MODEL 2 POISSON (RP ONLY)
Constant	-1.2314*** (0.1995)	0.8405*** (0.2263)
RC	--	0.6177*** (0.1364)
TC	-0.0041*** (0.0007)	-0.0020* (0.0011)
TCRC	--	-0.0042*** (0.0016)
SARCP	-0.4521** (0.2137)	-0.5183 (0.4587)
SARCPRC	--	0.2187 (0.5003)
PSQSA	-0.0019 (0.0012)	-0.0015 (0.0014)
AGE	0.0052* (0.0029)	0.0057* (0.0031)
HSEHLD	0.0653** (0.0292)	0.0585* (0.0326)
INC	0.0026*** (0.0009)	0.0028*** (0.0009)
HUNT	0.4107*** (0.0818)	0.4543*** (0.0890)
λ_j *t-statistic*	5.962	5.497
λ_j^2 *t-statistic*	6.232	5.698
Log Likelihood	-578.076	-481.865
Chi squared	100.611	131.276
Observations	304	273

**Significant at the 90% level of confidence or greater.*
***Significant at the 95% level of confidence or greater.*
****Significant at the 99% level of confidence or greater.*

The basic, non-random camper RP-only Poisson model was relatively strong, with only one variable not being statistically significant at a minimum 90% level (the poor site quality variable). Perhaps the most encouraging finding is that the travel cost variable was negative and highly significant. This follows conventional economic thinking, telling us that the RP data provided by the respondents were intuitive and reasonable. The reciprocal stand age parameter also had a negative value, which results in people taking more trips as the forest ages. The other significant parameters were all of the demographic variables, all of them positive.

Next, the random camper component was added to the basic Poisson RP-only model. This included the random camper dummy variable and two interaction terms; the dummy variable with stand age and with travel cost. The model lost some strength when compared to Model 1, as three variables became significant at lower confidence levels. Travel cost became significant at only the 90% level, while stand age lost its statistical significance altogether. The random camp variable is highly significant however, and its positive value verifies my hypothesis and clearly reflects the findings from Chapter 5 that random campers take more recreational trips than regular campers. The random camp/travel cost parameter is also highly significant and negative, however the random camp/stand age variable does not aid in predicting the number of trips a recreationist will take. All variables retain the same basic magnitudes and signs from Model 1, indicating that the addition of the random camper component was justified.

Using the simple least squares, auxiliary regression based test for overdispersion proposed by Cameron and Trivedi (1990: 1998)[13], results from both Poisson count models generated *t* statistics for λ_j and λ_j^2 that rejected the Poisson null hypothesis of equidispersion at the 99% critical level. This indicates that overdispersion was present in the RP-data regressors at the 99% confidence level, and that a NEGBIN model would be more suitable. The sample was expanded to include SP data in the following section, where another Poisson model was developed to determine if overdispersion continued to exist in the combined data set.

6.5 Results for Combined RP/SP Models

A sequence of three other travel cost count data models were next constructed, pooling SP data with the RP data set. It was hoped that the greater number and variety of responses, and a wider spectrum of scenarios to all age and soil quality groups, would lead to stronger models that more accurately portray the intertemporal damage function of recreationists along Alberta's eastern slopes. As encouraged by Cameron and Trivedi (1998), both Poisson and NEGBIN models were estimated.

[13] Overdispersion exists in the data before the inclusion of regressors since the variance-mean ratio is 18.152/3.408 = 5.327. As per Cameron and Trevedi (1998:79), further regression-based tests should be conducted (i.e. Auxiliary regression-based test and Wald test) to determine if overdispersion disappears upon inclusion of regressors.

TABLE 6.3 – RESULTS FOR COMBINED RP/SP MODELS *(Note: parameters are generated by Poisson and NEGBIN count models, thus results correspond to exponential formulas) (Standard errors are given in parentheses)*

VARIABLE	MODEL 3 POOLED POISSON (RP + SP)	MODEL 4 POOLED NEGBIN (RP + SP)	MODEL 5 NEGBIN RANDOM EFFECTS PANEL (RP + SP)
Constant	0.8875*** (0.0967)	0.6842*** (0.1839)	3.4597*** (0.6401)
RC	0.6298*** (0.0621)	0.7112*** (0.1111)	0.7170*** (0.2036)
TC	-0.0032*** (0.0005)	-0.0029*** (0.0007)	-0.0024*** (0.0009)
TCRC	-0.0034*** (0.0007)	-0.0039*** (0.0011)	-0.0038** (0.0019)
SARCP	-0.4955*** (0.0517)	-0.4979*** (0.0717)	-0.4747*** (0.0464)
SARCPRC	0.1037 (0.0714)	0.0813 (0.1025)	0.0259 (0.0604)
PSQSA	-0.0025*** (0.0005)	-0.0025*** (0.0008)	-0.0021*** (0.0005)
AGE	0.0043*** (0.0014)	0.0070*** (0.0025)	0.0075** (0.0038)
HSEHLD	0.0449*** (0.0149)	0.0489* (0.0272)	0.0511 (0.0442)
INC	0.0023*** (0.0004)	0.0028*** (0.0008)	0.0028** (0.0014)
HUNT	0.3005*** (0.0462)	0.2722*** (0.0871)	0.3254** (0.1467)
RP Dummy	0.0617 (0.0388)	0.0531 (0.0690)	0.0538 (0.0680)
A	--	0.5749*** (0.0860)	--
A	--	--	35.0238
B	--	--	1.9402
λ_j *t-statistic*	7.110	--	--
λ_j^2 *t-statistic*	6.620	--	--
Log Likelihood	-2752.367	-2294.862	-2005.807
Chi squared	700.424	915.010	--
Observations	1042	1042	1200
Individuals	--	--	315 (unbalanced)

**Significant at the 90% level of confidence or greater.*
***Significant at the 95% level of confidence or greater.*
****Significant at the 99% level of confidence or greater.*

Examining Model 3, it appears that including responses from the contingent behaviour component of the survey improves markedly upon the Poisson RP-only model as the greater number of observations increases confidence in the results; all coefficients are statistically significant above the 99% level except one (the stand age/random camp interaction term), and the Chi-squared value is also stronger than for Model 2. Similar to Englin and Cameron (1996), a RP dummy variable was included in a test model to see if there were any systematic differences between the RP and SP data. The coefficient for this variable is statistically insignificant and did not alter other parameters when removed. This means that respondents were not over- or understating their anticipated number of future trips, indicating that they answered the survey in a rational and reasonable fashion. That the SP data mirrored actual RP data is a positive result; therefore, adding SP data to the sample is validated.

The signs for all of the coefficients remained the same when comparing Model 3 to Model 2, and all but three of the variables retained similar magnitudes as well. The three magnitudes which changed were travel costs (increased by over one-third), poor site quality (increased by two-thirds), and the hunting/fishing variable (decreased by one-third). In addition, every coefficient became more statistically significant and results remained intuitive and reflected other studies. Travel cost and poor soil site quality became significant at more than the 99% level and each has a negative effect on trips, and stand age also became significant at greater than 99% and still influences the number of trips to rise as stand age increases. Other positive parameters include the random camping and hunter/fisher binary variables, age, household size, and household income. As with Model 2, the λ_j and λ_j^2 auxiliary regression *t* statistics were once again well above the critical value, strongly rejecting the Poisson null hypothesis of equidispersion and indicating the presence of overdispersion at the 99% confidence level. This suggested that a NEGBIN model would be more effective than a Poisson.

Model 4 includes the same variables and data set from Model 3, but it is estimated under a NEGBIN framework. A Wald test on the asymptotic *t* ratio of the estimated overdispersion parameter shows that α is statistically significant at more than the 99% level, which indicates that the conditional mean and variance was not equal in the pooled RP/SP data. This finding reinforces the conclusion drawn from Model 3: the use of a NEGBIN estimator for this study would produce more efficient coefficients than a Poisson model. Englin and Shonkwiler (1995) and Englin et al. (2001) obtain the same result and also decide to use a NEGBIN framework.

As evidenced by the elevated log-likelihood and Chi-squared values, the NEGBIN model in Model 4 is indeed more effective than the Poisson model. Results remained consistent and intuitive as parameters have identical signs, similar values, and the same statistical significances compared to Model 3 (with the household residents variable being the lone exception, as its significance fell from the 99% level to the 90% level). Incorporating the RP variable to test for hypothetical bias once again rendered a statistically insignificant parameter and did not alter other coefficients upon its removal, telling us once again that respondents were not over- or underestimating their SP answers. This finding allows us to use the contingent behaviour answers in the analysis.

Lastly, in an attempt to capture the intertemporal damage function more effectively, the NEGBIN count data model from Model 4 was advanced to a random effects model to account for sequence effects. Unlike most other studies, Model 5 linked all RP and SP observations together to the corresponding respondent and variances were permitted to vary both across sites and the various within-recreationist observations.

To ensure that a NEGBIN model was also appropriate for examining random effects, Model 5 was estimated in two statistical programs. The analytical package STATA was chosen as an alternate estimator because it generated diagnostic results not reported in LIMDEP. All coefficients estimated by STATA match the LIMDEP results, validating the STATA-generated diagnostic results. A likelihood-ratio test of the pooled model and panel model suggests that the parameter vectors from each model are significantly different. This tells us that a significant difference exists when estimating the parameters as a pooled or panel framework, and based on the strong diagnostic results of the panel estimator, the latter model is better suited for the data. Thus, the NEGBIN panel model was deemed appropriate. The additional parameters A and B from the beta distribution (which describe the distribution of the overdispersion parameter α across recreationists) generated by LIMDEP and STATA were both identical as well.

The random effects model was successfully estimated and the results did not change markedly from the previous models; these are two positive findings. The intercept value is larger than for Models 3 and 4. However, the predicted number of trips remains roughly the same despite the other parameters remaining relatively constant. The only real discrepancy in coefficient values between the two NEGBIN models is that the stand age/random camp interaction term is noticeably smaller in Model 5. This variable is actually statistically insignificant in Models 4 and 5, suggesting that random campers do not have different preferences for stand age than other campers. The travel cost/random camp interaction term, age, household income, and the hunting/fishing member binary variable all slip from the 99% level of confidence to the 95% level of confidence in Model 5 compared to Model 4. Lastly, the household residents coefficient falls from the 90% level of confidence to not being statistically significant than zero at any conventional level. These changes are relatively minor however, and the random effects model performs well.

Since the more intricate and encompassing random effects panel model was successfully estimated, the Wald and panel log-likelihood test versus pooled favours panel models, its parameters mirror the other pooled models, and its log likelihood function is the largest of all combined data estimators, Model 5 is the preferred model for this study. Hausman et al. (1984) explained that the random effects negative binomial model is attractive not only because it allows for overdispersion, but unlike regular negative binomial frameworks, it also allows for an individual recreationist specific variance to mean ratio.

The RP variable test for Model 5 was also successful as the RP variable is insignificant in all three combined data models, and parameters remained constant regardless of whether or not the RP variable was included in the model. Thus, the SP data can be successfully combined with the RP data. This suggests that the survey mechanism employed accurately portrayed real-life camping scenarios; participants understood the survey theme and questions, and respondents answered questions consistent with their actual behaviour.

6.6 CONSUMER SURPLUS

Consumer surplus is the difference between someone's willingness to pay and the actual payment required, and it is found by integrating the area under the demand curve. Consumer surplus values are welfare measures, and can be used to derive the economic effects of a forest fire on outdoor recreation. NEGBIN models are well regarded for estimating consumer surplus values because NEGBIN parameters have relatively low standard deviations (Yen and Adamowicz 1993). Therefore, the resulting surplus values can be reliable and conservative compared to other econometric frameworks.

Since NEGBIN count data models are equivalent to semi-log demand functions, consumer surplus values can be calculated by simply taking the reciprocal of the travel cost variable(s) (Loomis et al. 2001). Since a random camp/travel cost interaction term was created in this study, consumer surplus can be calculated for both types of campers. Regular campers are considered the base case, with the distinction for random campers stemming from the inclusion of interaction terms and an intercept shift parameter ("RC"). The consumer surplus values are per person because the travel cost variable was calculated on a per person basis. Therefore, the individual per trip consumer surplus values are calculated as the negative inverse of the travel cost variable(s):

$$CS_{REGULAR} = -1 / (\beta_{TC}) \quad \textbf{(11)}$$

$$CS_{RANDOM} = -1 / (\beta_{TC} + \beta_{TCRC}) \quad \textbf{(12)}$$

Table 6.4 provides consumer surplus estimations generated by each model displayed in Tables 6.2 and 6.3.

TABLE 6.4 – ESTIMATES OF PER TRIP CONSUMER SURPLUS FOR CAMPERS IN THE EASTERN SLOPES OF ALBERTA *($CDN 2004)*

MODEL	PER TRIP CONSUMER SURPLUS	
	REGULAR CAMPERS	RANDOM CAMPERS
(1) Non-RC Poisson (RP Only)	$245.38	
(2) Poisson (RP Only)	$496.42	$160.21
(3) Pooled Poisson (RP + SP)	$310.57	$152.19
(4) Pooled NEGBIN (RP + SP)	$348.88	$147.56
(5) NEGBIN Random Effects Panel (RP + SP)	$414.27	$160.24

The consumer surplus per trip for regular campers is between about $311 and $496 for all five models, and ranges between $147 and $160 for random campers. Regular campers had an average $414 consumer surplus per trip compared to $160 for random campers in preferred Model 5. The consumer surplus for random campers was 61.3% lower than their PRA counterparts, likely due to a difference in preferences. Only values from the panel NEGBIN model will be used in further analysis.

Table 6.5 compares these Alberta eastern slope trip welfare estimations to those found in other literature:

TABLE 6.5 – WELFARE MEASURES FROM OTHER STUDIES *($CDN 2004) (values from other studies converted to $CDN 2004 (Bank of Canada 2006a; 2006b) and estimated to the nearest dollar)*

STUDY	PER TRIP WELFARE MEASURES
Englin et al. (2001)	Wyoming = $398 Idaho = $231 Colorado = $195
Hesseln et al. (2003)[A]	Hikers (New Mexico) = $181 Mountain Bikers (New Mexico) = $12
Hesseln et al. (2004)[A]	Colorado = $36 Montana = $18
Loomis et al. (2001)[A]	Hikers (Colorado) = $99 Mountain Bikers (Colorado) = $247
Siderelis et al. (2000)	North Carolina = $97
Starbuck et al. (2006)	New Mexico = $203
This Study	Regular Camper (Alberta) = $414 Random Camper (Alberta) = $160

[A] *Studies which listed more than one consumer surplus value; reported values apply to older growth forest stands that experienced crown fires.*

The random camping consumer surplus value is comparable to most other recreation demand studies, but the regular camper result is higher (with the exception of Englin et al.'s (2001) total of $398 per trip for Wyoming recreationists). The difference between results from this study and others may be due to differences in the form of recreation (camping as opposed to trail-based activities) and/or the region studied (Alberta, as opposed to various American states). Another reason results may be slightly elevated is because specific substitute locations were not explicitly included in the SP portion of the survey. Despite reminding recreationists to consider substitute sites in general terms (see section 3.4), omitting specific substitutes from the decision-making process may cause consumer surplus values to rise (since fewer options are available). The most likely reason for the discrepancy in values is the length of time required for the activity examined however; the average duration for a trip in this Alberta study is 5.26 days[14], compared to single-day outings for all other studies. Accommodating for this and establishing "per day" consumer surplus values yields a regular camper value of $78.76 and $30.46 for random campers[15], measures that are more comparable to other studies. The discrepancy in consumer surplus values between random and regular campers may be due to random campers taking more trips in a season (see Figure 5.3).

[14] This figure is taken from onsite interview question 6) (see section 5.1).

[15] Mean trip length is inflated due to seven outliers that spent over 100 days on only one camping trip. Using the median value of 3 trips yields consumer surplus values of $138.09 for regular campers and $53.41 for random campers. Using the mode value of 2 trips yields a $207.14 value for regular campers and $80.12 for random campers. These figures are also comparable to other studies.

6.7 ANNUAL WELFARE MEASURES AND THE INTERTEMPORAL DAMAGE FUNCTION

Next, annual welfare measures were calculated to determine the recreational utility participants received from camping in the eastern slopes of Alberta in 2004. Annual welfare measures can be calculated by multiplying per-trip consumer surplus values by the expected number of trips taken to a specifically aged forest. Since the predicted number of trips taken by an individual is represented by $\lambda_j = \exp(x_j\beta)$, the annual welfare measure for a regular camper can be represented by λ_j / β_{TC} (Englin and Shonkwiler 1995). For a random camper, it is $\lambda_j / (\beta_{TC} + \beta_{TCRC})$. When calculating the expected number of annual trips, sample means were used for the travel cost and demographic information required for the formula.

Results from Model 5 are compared with other studies that have examined the change in annual welfare measures from one year following fire to a specified period of re-growth (often 40 years):

TABLE 6.6 – ANNUAL WELFARE MEASURE COMPARISONS TO OTHER LITERATURE *($CDN 2004) (average number of trips listed in parentheses) (values from other studies converted to $CDN 2004 (Bank of Canada 2006a; 2006b)) (Values were calculated based on older growth forest stands that experienced crown fires)*

STUDY	RECREATIONIST / LOCATION	ANNUAL WELFARE MEASURE		
		0 YEARS SINCE FIRE	40 YEARS SINCE FIRE	% CHANGE (TRIP % CHANGE)
Hesseln et al. (2003)	Hikers	$189.44 (1.24)	$171.92 (0.95)	-9.2% (-23.4%)
	Mountain Bikers	$0.26 (0.02)	$0.06 (0.00)	-76.9% (-100.0%)
Hesseln et al. (2004)	Colorado	$86.26 (0.94)	$35.23 (1.09)	-59.2% (+16.0%)
	Montana	$41.15 (2.15)	$24.78 (1.48)	-39.8% (-31.2%)
Loomis et al. (2001) [A]	Hikers	$787.61 (3.03)	$274.10 (2.78)	-65.2% (-8.3%)
	Mountain Bikers	$143.37 (1.29)	$742.16 (3.00)	+417.7% (+133.6%)
This Study (per camping day) [B]	Regular GSQ	$86.90 (1.10)	$221.93 (2.82)	+255.4% (+255.4%)
	Regular PSQ	$86.90 (1.10)	$217.37 (2.76)	+250.1% (+250.1%)
	Random GSQ	$52.05 (1.71)	$126.29 (4.15)	+242.7% (+242.7%)
	Random PSQ	$52.05 (1.71)	$123.71 (4.06)	+237.7% (+237.7%)

[A] *Results based on 50 years since fire*
[B] *Annual welfare measures were calculated per camping day to establish consistency with other studies*

Most of the recreationists in the other literature display declining annual welfare values as a forest stand ages, with the sole exception being mountain bikers in Loomis et al.'s (2001) study. All types of recreationists in this study displayed large increases in annual welfare as the forest recovers however. This may be due to activity type examined because camping is stationary compared to the other activities[16]. Due to the wide variability in percentage welfare change directions and magnitudes, comparisons with other studies are also widely varied.

Percentage increases are nearly identical across random and regular campers, and across both types of soil qualities. Both types of campers on good soil experienced slightly higher welfare increases after 40 years of re-growth than their respective campers on poor soil quality sites, having increases about 5% higher. Once again, this occurs because good soil quality sites are more highly valued. The difference is minimal, however, because both forest types still look reasonably alike after only 40 years of re-growth. Differentiation between the two becomes more exaggerated as the forest continues to age.

Annual welfare measures were also estimated from Model 5 before and after fire disturbance to determine the annual welfare loss to an older aged stand following a forest fire. "Before Fire" figures are based on forest stands 110 years old, while "After Fire" values are calculated one year following a crown fire. Table 6.7 displays these losses:

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[16] See the Taylor and Daniel (1984) discussion in Chapter 2 for a detailed explanation.

TABLE 6.7 – ANNUAL WELFARE MEASURES BEFORE AND AFTER FOREST FIRE DISTURBANCE *($CDN 2004) (number of trips listed in parentheses)*

	ANNUAL WELFARE MEASURE			
	REGULAR CAMPERS		RANDOM CAMPERS	
	GOOD SOIL QUALITY	POOR SOIL QUALITY	GOOD SOIL QUALITY	POOR SOIL QUALITY
Before Fire	$1176.19 (2.84)	$932.64 (2.25)	$669.04 (4.18)	$530.51 (3.31)
After Fire	$734.83 (1.77)	$734.83 (1.77)	$428.84 (2.68)	$428.84 (2.68)
Change	-$441.36 (-1.07)	-$197.81 (-0.48)	-$240.20 (-1.50)	-$101.67 (-0.63)
Percent Change	-37.5%	-21.2%	-35.9%	-19.2%

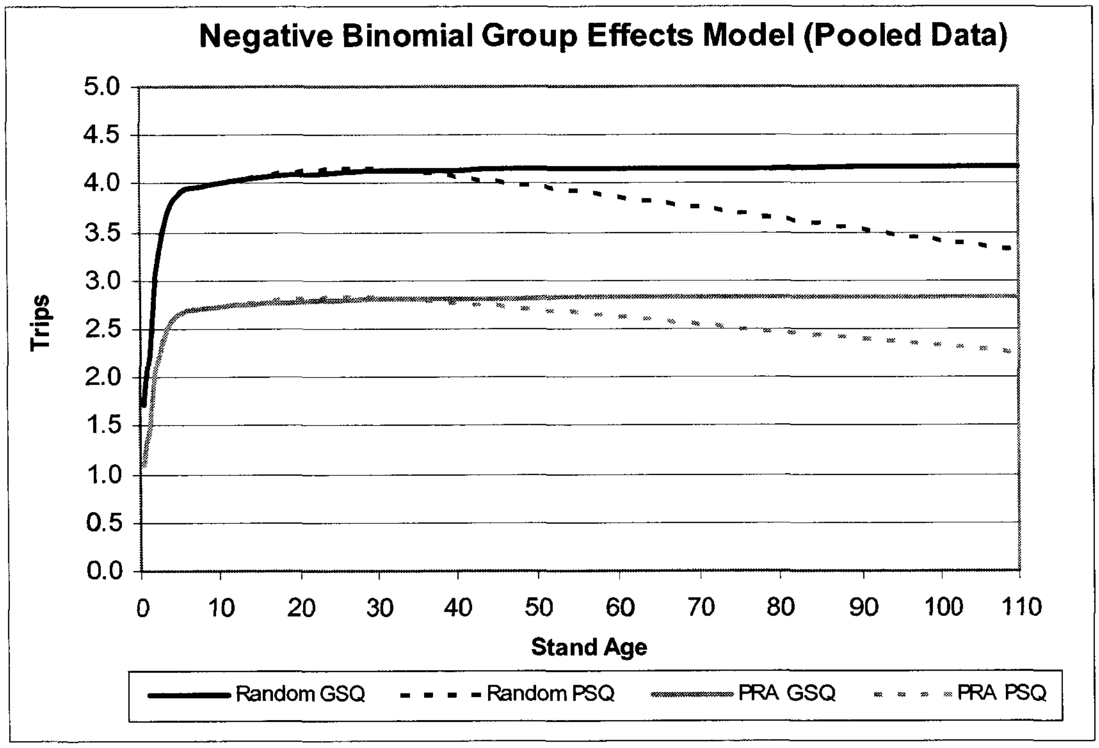
Campers in good soil quality locations are most affected by fire activity, as evidenced by greater "percent change" values compared to campers in poor soil quality sites (36%-38% versus 19%-21%). Regular campers in good quality regions face the greatest annual welfare losses, followed by random campers on the same soil type, poor soil quality site regular campers, and finally random campers in poor soil quality areas. The biggest drop in trips occurs to good soil quality site random campers, then good soil quality site regular campers, followed by poor soil quality site random campers and regular campers.

The shape of welfare changes following fire activity reflects the intertemporal damage function[17]. The curve of the damage function represents

[17] Final trip values generated by LIMDEP's random effects model must be multiplied by a conversion ratio based on the overdispersion parameter α's beta distributed parameters "A" and "B" (see section 3.4) (Greene 2005). LIMDEP estimates these parameters along with the variable coefficients. The conversion ratio is B/A, or in my study, 1.9402/35.0238 (equaling 0.0554). The conversion step must be completed in order to compensate for an apparent error in LIMDEP's random effects NEGBIN model estimation procedures.

the number of yearly trips taken by recreationists, and it is shown beginning immediately after a forest fire (the forest fire occurred at "Stand Age" 0).

FIGURE 6.1 – INTERTEMPORAL DAMAGE FUNCTION - NEGBIN PANEL MODEL ANALYZING RANDOM EFFECTS *(sample averages are used for demographic information)*



The shape of the intertemporal damage function appears as was earlier hypothesized (see section 6.3). The number of trips taken rises rapidly after a fire (the quickness of this rise was not predicted), however this rate slows after about 10 years; the marginal welfare recreationists gain from forests aging another year decreases over time because changes in the ecosystem become less noticeable each succeeding year. The sharp-climbing then sharp-plateau shape of the damage function curve resembles the intertemporal damage curve developed by Englin et al. (2000), but differs from the S-shaped damage curves discovered by Englin et al. (2001); some trail-based studies have found a sudden increase in trips following fire (such as Englin et al. (2001)), however this study finds an immediate decrease in camping activity in regions that were burnt.

Good soil quality sites experience increasing amounts of trips as the forest ages, however trips stabilize after approximately 40 years of re-growth. Trips to poor soil quality sites begin to decline at the 40 year point however. As mentioned in the example outlined by Table 6.7, the difference in trips between both soil quality sites becomes larger as forests mature and differences in appearances become enhanced. While good soil quality sites maintain a relatively constant level, poor soil quality sites have a declining trend in trips as the site matures and greater amounts of debris (disliked by recreationists) accumulate and collect over time. Both types of campers are sensitive to the visual and physical elements which develop in poor soil quality sites, but random campers are particularly affected as evidenced by their steeper curve. This is likely because poor soil quality regions produce weaker forest stands and generate more deadfall, both of which hinder the discovery and establishment of desirable random camping sites.

CHAPTER 7: SPATIAL IMPLICATIONS

In an attempt to explore the impacts of actual fire on outdoor recreation in Alberta, the damage function developed in Chapter 6 was combined with information from a study which estimated spatial recreational intensity in

Alberta's eastern slopes region (see Neupane (2005)). Neupane's (2005) camping activity figures were derived from a national survey which examined the spatial patterns of recreation for Alberta, actual recreational data, and supplemental information from expert sources familiar with the regions examined.

The spatial exploration involved a simulation of the effects of two actual forest fires from the Crowsnest Pass region of southwestern Alberta (see Figure 4.1). The first fire was a small burn in 2000 called the Cherry Creek fire, and the second was an extensive fire called the Lost Creek fire which took place in 2003. The simulation involved applying the intertemporal damage function with recreation trip estimates developed for the region by Neupane (2005), who established separate totals for both regular and random campers. The outputs of this simulation exercise are maps which represent "snapshots" of the spatial pattern of recreation activity in the Crowsnest region during different periods following the forest fires. In addition, shifting welfare measures caused by fluctuating trip frequencies were also calculated for the scenarios.

7.1 Assumptions on the Spatial Extent of the Study Area

In addition to the number of behavioural assumptions which are discussed in detail below, initial considerations regarding the underlying spatial information on recreation intensity provided by Neupane (2005) had to be made. The spatial intensity of recreation supplied by Neupane (2005) was measured in the number of *trips* taken to 16 km^2 square cells overlaid on the region in a regular lattice. Thus, Neupane's (2005) information provided the number of *trips* to each cell and not the *number* of recreationists who visited. In order for the spatial model to predict the movement of individual recreationists, it was assumed that all recreationists took the same average number of trips in a year. This assumption allowed us to use trips as a proxy for the number of campers so that in essence, the more trips a cell received each year, the more campers it hosted.

It was assumed that all local movements of campers displaced by fire only occurred within the Crowsnest region due to a number of surrounding barriers. The United States is located to the south, so it was assumed that random campers would prefer not to cross through customs and enter a different jurisdiction to camp. Similarly, to the west are the Rocky Mountains and camping there requires driving through the mountains a considerable distance, as well as entry into the province of British Columbia. To the east are the prairies, which would provide a substantially different camping experience than those found in the foothill/mountain region. There was no barrier to the north because the spatial area being analyzed included all of the potential substitute sites north of where the fires occurred.

It was also assumed that each cell affected by fire was burnt in its entirety, even if only a portion was burnt in actuality. This assumption was necessary because the fire information did not include specific details concerning the locations of burnt portions within each cell.

7.2 ASSUMPTIONS ON THE BEHAVIOUR OF RECREATIONISTS

The intertemporal damage function predicts recreational activity over time to a particular site following fire damage. As described previously, the damage function suggests that the number of trips taken to favorite sites is initially reduced after being burnt, but returns to pre-fire levels after about 10 years. Important questions regarding other behavioural responses to fires remained unanswered with the methodology employed in this study. For example, would recreationists consider substitute sites in response to fires at favorite sites? How far would affected recreationists travel to these substitute sites? With information from the onsite interviews and the survey, some important assumptions had to be made to address these behavioural questions before spatial representations of recreation could be constructed.

Since the two actual fires only affected random camping areas and did not damage any managed campgrounds, the analysis examined random camper movements only. PRA campers were not accounted for in any capacity. The total number of recreationists examined in the model also did not change for the entire duration of the analysis. Some recreationists visited substitute sites that were located a long distance from their favourite site and outside of the mapped region[18]. However, this population eventually returned to the Crowsnest region after a period of regeneration. Thus, the total recreationist

[18] Possible movements to substitute sites were based on survey data, and are explained in greater detail in section 7.3.

population for the analysis remained constant despite movements and altered site choices over time.

Another assumption was that displaced random campers did not relocate to the lowest-intensity regions of the Crowsnest Pass during the re-growth period of burnt sites. The reason for this assumption was twofold. First, these rarely-visited areas would not have increases in visitors despite higher demand because they are too isolated. Second, incorporating these areas in the analysis would have resulted in minute intensity alterations; these changes would have been so small that they would not have registered on the maps. Supported by evidence from the onsite interview, it was also assumed that the recreationists would eventually return to their original favourite site (see Table 5.8). The possibility of discovering a new permanent preferred camping area was not taken into consideration (i.e. visiting substitute sites in lieu of the original most frequented site due to fire damage was considered temporary).

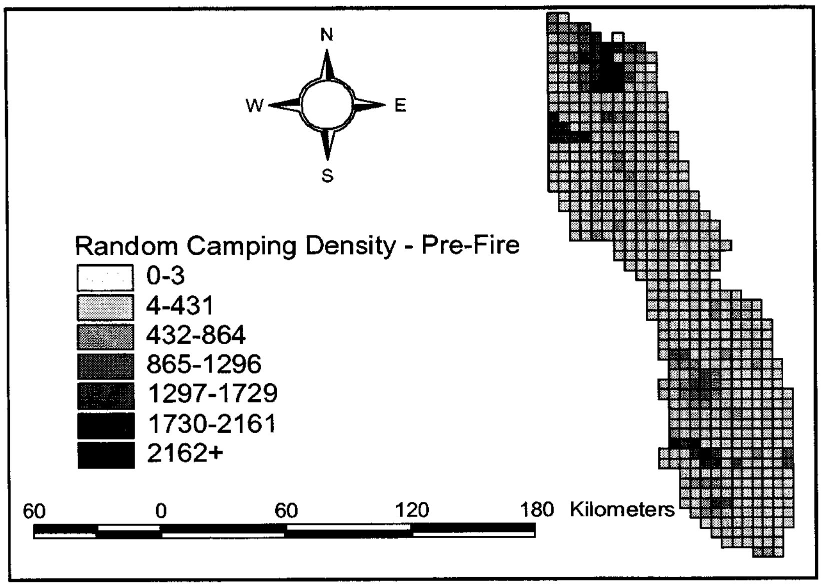
Furthermore, it was assumed that all fires were extinguished before the end of the camping season in which they occurred. Thus, the year following fire activity represents the first full year of re-growth. Using the Cherry Creek fire from 2000 as an example, it was assumed that campers could still have visited the area in 2000 after the fire was put out. In this case, those visits would have counted as trips in 2000 and the year 2000 was considered year 0 in the intertemporal damage function. Year 2001 was considered the first year of re-growth (year 1 of the intertemporal damage function, or "one year following forest fire"), and so forth.

It must be stressed that this spatial component is a simple extension based on recreational intensity maps from Neupane's (2005) study. Individual features specific to certain cells such as ease of access and proximity to water are not directly incorporated. Individual cell characteristics are indirectly accounted for, however, because higher frequency locations are visited more frequently in the spatial model. The reason some cells have higher recreational intensities than others is likely due to individual cell characteristics like proximity to water; thus while not explicitly modeled, these features are implicitly included based on Neupane's (2005) findings.

7.3 Spatial Model Methodology

Using the random camping density maps from Neupane's (2005) study as a foundation, the number of annual random camping trips taken to each Crowsnest Pass cell before the year 2000 is displayed in Figure 7.1. This map forms the "base case" for examining the impact of two actual fires in the region on camping activity.

FIGURE 7.1 – PRE-FIRE (PRE-2000) RANDOM CAMPER DENSITY MAP OF THE CROWSNEST PASS REGION, ALBERTA *(values are trips taken per year)*



The cells affected by the 2000 Cherry Creek fire and the 2003 Lost Creek fire are shown on the maps in Figure 7.2.

FIGURE 7.2 – LOCATIONS OF THE CHERRY CREEK (2000) AND LOST CREEK (2003) FOREST FIRES, CROWSNEST PASS, ALBERTA

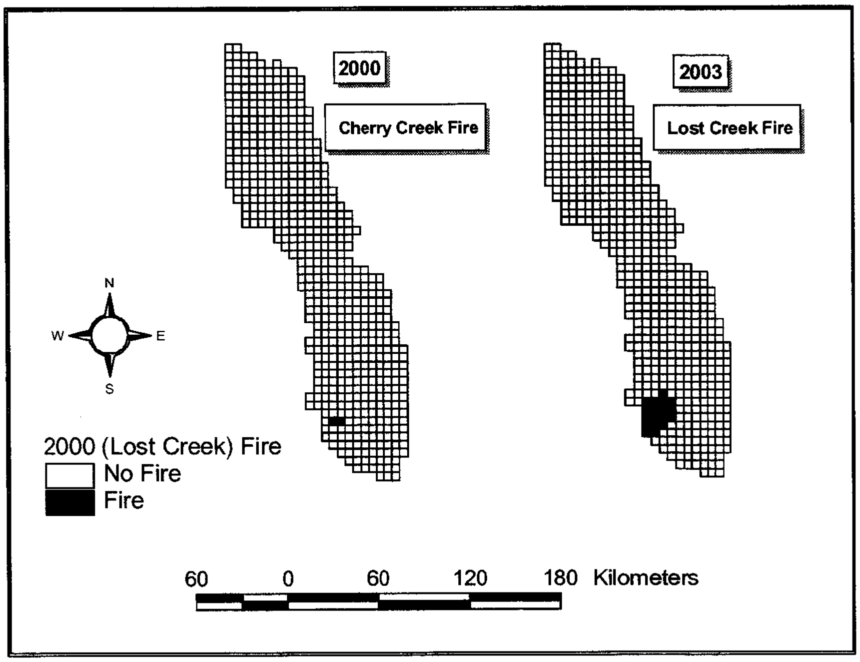


Figure 7.2 shows that the 2003 Lost Creek fire was much larger than the 2000 Cherry Creek fire. Two cells were burnt in the Cherry Creek fire, which had previously hosted 865 random campers annually before the fire. The Lost Creek fire burnt 18 cells which had a pre-fire recreational intensity of 5,674 random campers per year. It is noteworthy that the Lost Creek fire burned the same two cells that were affected by the Cherry Creek fire.

The number of random campers who were affected by these two fires are called "displaced recreationists". In essence, these are individuals whose favourite site was located in one of the fire-affected cells identified in Figure 7.2. To gauge how many "displaced recreationists" would still camp, campers were asked if they would stay at home or camp somewhere else if their most frequented site had been damaged by a severe fire that same year. The proportion of people who stated that they would still camp is called the "camping ratio". This ratio was multiplied by the number of "displaced recreationists" to calculate the total number of campers who would relocate to substitute campsites (see section 5.6). Individuals in substitute sites are called "relocated recreationists". The difference between "displaced recreationists" and "relocated recreationists" is therefore the number of recreationists that would choose to stay home instead of camp elsewhere.

Recreationists' preferences and consequently their trip behaviour changed during the re-growth period due to the changing landscape caused by regeneration. Regeneration of burnt sites affected the spatial pattern of recreational activity throughout the entire mapped region. Two components of the spatial model captured these time-dependent movements; the intertemporal damage function, and dynamic "camping ratio" values. The intertemporal damage function was used to predict the number of annual trips that return to each burnt cell. As the re-growth period increased and more people returned to previously-burnt cells, the number of "displaced recreationists" subsequently decreased over time.

The "camping ratio" also changed as the re-growth period increased, based on an interview question that determined the "camping ratio" for different time periods following a fire. It asked respondents if they would still camp in their favourite site 1 year, 2 years, 5 years, 10 years, and 30 or more years following fire damage (see Table 5.8). Therefore, multiplying the "camping ratio" specific to these time periods by the number of "displaced recreationists" calculated by the intertemporal damage function gave us an estimated number of "relocated recreationists" for specific periods following fire. Table 7.1 displays the number of "relocated recreationists" 1, 2, 5, 10, and 50 years following the Cherry Creek and Lost Creek forest fires.

TABLE 7.1 – PREDICTED EFFECTS ON RANDOM CAMPING ACTIVITY DUE TO THE CHERRY CREEK (2000) AND LOST CREEK (2003) FOREST FIRES, CROWSNEST PASS, ALBERTA *(shaded rows signify forest fire years) (figures used in the model are not rounded, however table figures are rounded whole integer estimations)*

YEAR	DISPLACED RECREATIONISTS	CAMPING RATIO (RANDOM CAMPERS)	RELOCATED RECREATIONISTS	STAY AT HOME
Pre-Fire	0	100.00%	0	0
2000 (Cherry Creek fire occurs)	855	91.5%	782	73
2001 (1 year after fire)	308	89.0%	274	34
2002 (2 years after fire)	168	94.8%	159	9
2003 (Lost Creek fire occurs)	5609	91.5%	5130	479
2004 (1 year after fire)	2020	89.0%	1798	222
2005 (2 years after fire)	1101	94.8%	1044	57
2008 (5 years after fire)	441	100.0%	441	0
2013 (10 years after fire)	201	100.0%	201	0
2053 (50 years after fire)	1	100.0%	1	0

All random campers who decided that they would stay at home immediately after a fire said they would return within five years. Only then, with a 100% camping ratio, did the number of "displaced" and "relocated" recreationists match. To maintain compatibility with camping ratios, maps depicting camping intensities 1, 2, 5, 10, and 30+ years since fire activity were created.

With the number of "relocated recreationists" for each time period following fires now estimated, precisely where they went had to be determined next. Their movement was assumed to be driven by a survey question that asked where they would camp if their most frequented site had been closed due to fire damage. The number of "relocated recreationist" trips from fire-damaged cells was then transferred to cells representing substitute campsites. Using the same measuring techniques used to calculate distance traveled for the travel cost variable[19], the distance between recreationists' most frequented site and their substitute site was measured. Resulting distances are categorized into three groups: "nearby" (0 to 40 km), "intermediate" (41 to 200 km), and "far away" (over 200 km). These totals are displayed in Table 7.2.

TABLE 7.2 – DISTANCE BETWEEN MOST FREQUENTED CAMPSITE AND SUBSTITUTE CAMPSITE

DISTANCE	PRA CAMPERS	RANDOM CAMPERS	ALL CAMPING AREAS
"Nearby" (0 to 40 km)	47.8% (65/136)	67.3% (76/113)	59.8% (253/423)
"Intermediate" (41 to 200 km)	33.8% (46/136)	18.6% (21/113)	29.8% (126/423)
"Far Away" (over 200 km)	18.4% (25/136)	14.2% (16/113)	10.4% (44/423)

The percentage of random campers in each substitute site group was then multiplied by the number of "relocated recreationists" to determine the

[19] See section 6.2 for a detailed explanation of how distance traveled values were calculated.

number of recreationists who would random camp nearby, at intermediate distances, and far away from their favourite site following a forest fire. Estimates of the numbers of these random campers are shown in Table 7.3.

TABLE 7.3 – NUMBER OF RANDOM CAMPERS WHO WOULD VISIT SUBSTITUTE CAMPSITES AT VARYING DISTANCES, RELATIVE TO THEIR MOST FREQUENTED SITE *(shaded rows signify forest fire years) (figures used in the model are not rounded, however table figures are rounded whole integer estimations)*

YEAR (YEARS SINCE FIRE)	RELOCATED RECREATION-ISTS	WOULD CAMP "NEARBY"	WOULD CAMP "INTERMED-IATE" DISTANCE	WOULD CAMP "FAR AWAY"
Pre-Fire	0	0	0	0
2000 (Cherry Creek fire occurs)	782	526	145	111
2001 (1 year after fire)	274	184	51	39
2002 (2 years after fire)	159	107	30	22
2003 (Lost Creek fire occurs)	5130	3451	953	726
2004 (1 year after fire)	1798	1209	334	255
2005 (2 years after fire)	1044	702	194	148
2008 (5 years after fire)	441	297	82	62
2013 (10 years after fire)	201	135	37	29
2053 (50 years after fire)	1	1	0	0

The number or "relocated recreationists" who would camp far away were removed from the mapped region until they returned to their favourite site because their substitute sites were located beyond the map's borders. Those who said they would camp "nearby" were restricted to cells within a 40 km radius of the fire area, and those who would use substitute sites an intermediate distance away were modeled to camp in the remaining cells that were between 41 km and 200 km from the fire area.

To determine which specific cell a recreationist would pick as a substitute, the "relocated recreationists" were placed in unburned substitute cells based on the relative distance from their favourite site (not their home). The number of "relocated recreationists" that each unburned cell received was based on the recreational intensity of the cell. For example, if a particular cell within 40 km of the fire accounted for 2.5% of all "nearby" random camping trips, that particular cell received 2.5% of all "nearby relocated recreationists" in addition to the regular number of random campers that it drew. Thus, the total number of random campers in the substitute cell increased for a short-term period after the forest fires. The number of extra campers received by substitute cells decreased as the re-growth period elapsed, as more people returned to their favourite site and the number of "displaced recreationists" became smaller.

7.4 SPATIAL MODEL RESULTS

The maps in Figure 7.3 to Figure 7.5 display the estimated spatial effects of the Cherry Creek and Lost Creek forest fires on random camping recreation. The change in recreational intensities is examined by measuring camping visit fluctuations between pre-fire and post-fire trip levels for each cell. Regeneration periods of 0, 1, 2, 5, 10, and 30+ years since fire were analyzed to mirror the camping ratio information required for spatial calculations (shown in Figure 5.8). Since the Cherry Creek fire occurred in 2000, only maps 0 years (2000), 1 year (2001), and 2 years (2002) since the fire were produced because the Lost Creek fire affected the same grids again in 2003. Therefore, the "years since fire" timeline is reset to zero years in 2003. Maps 0 years (2003), 1 year (2004), 2 years (2005), 5 years (2008), 10 years (2013), and 30+ years (2053) since the Lost Creek forest fire were produced as well.

FIGURE 7.3 – CHANGE IN RANDOM CAMPING TRIPS (WHEN COMPARED TO THE PRE-FIRE BASE SITUATION) TO THE CROWSNEST PASS, ALBERTA REGION IN 2000-2002, FOLLOWING THE 2000 CHERRY CREEK FOREST FIRE *(values are trips taken per year)*

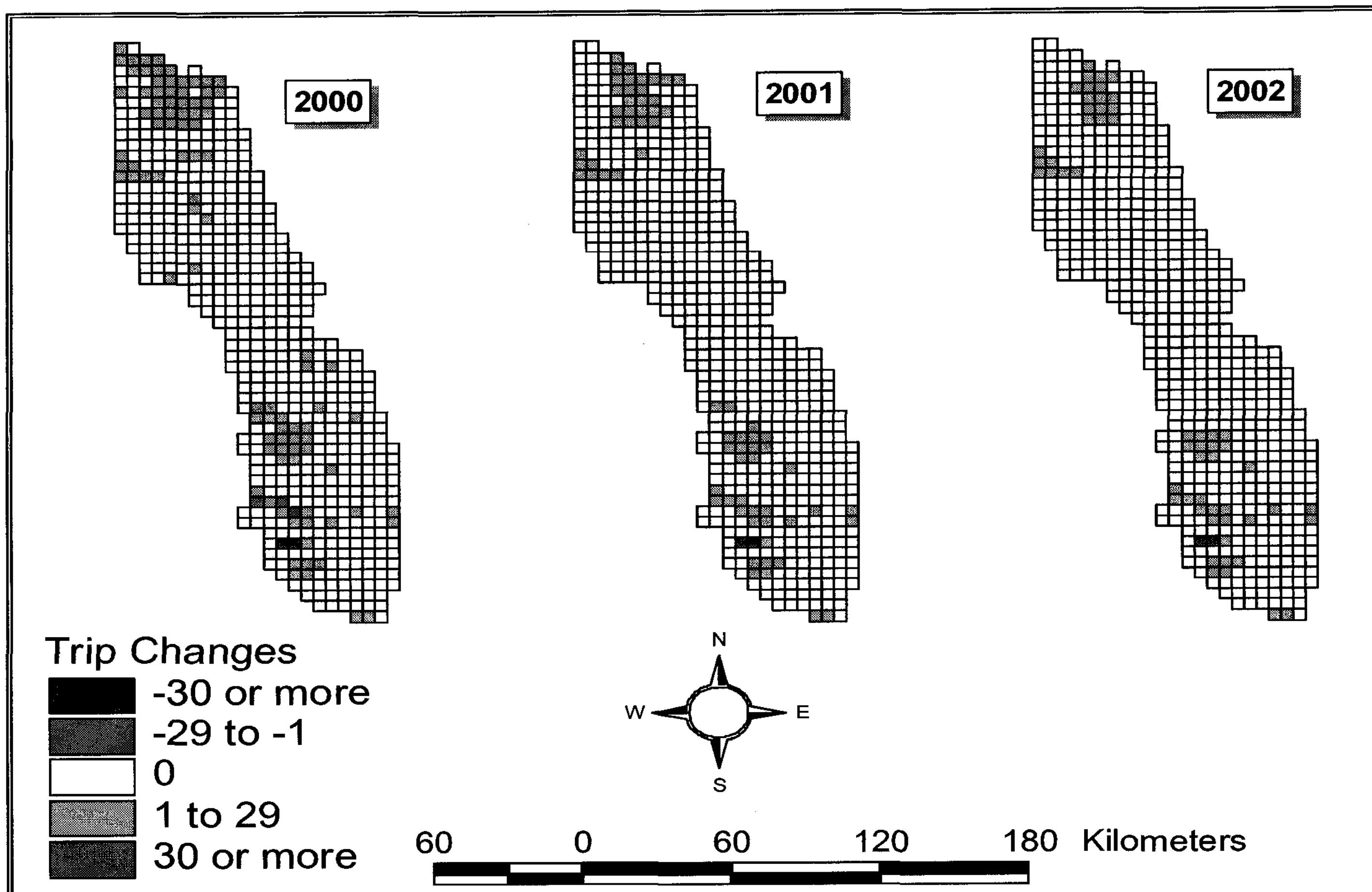


FIGURE 7.4 – CHANGE IN RANDOM CAMPING TRIPS (WHEN COMPARED TO THE PRE-FIRE BASE SITUATION) TO THE CROWSNEST PASS, ALBERTA REGION IN 2003-2005, FOLLOWING THE 2003 LOST CREEK FOREST FIRE *(values are trips taken per year)*

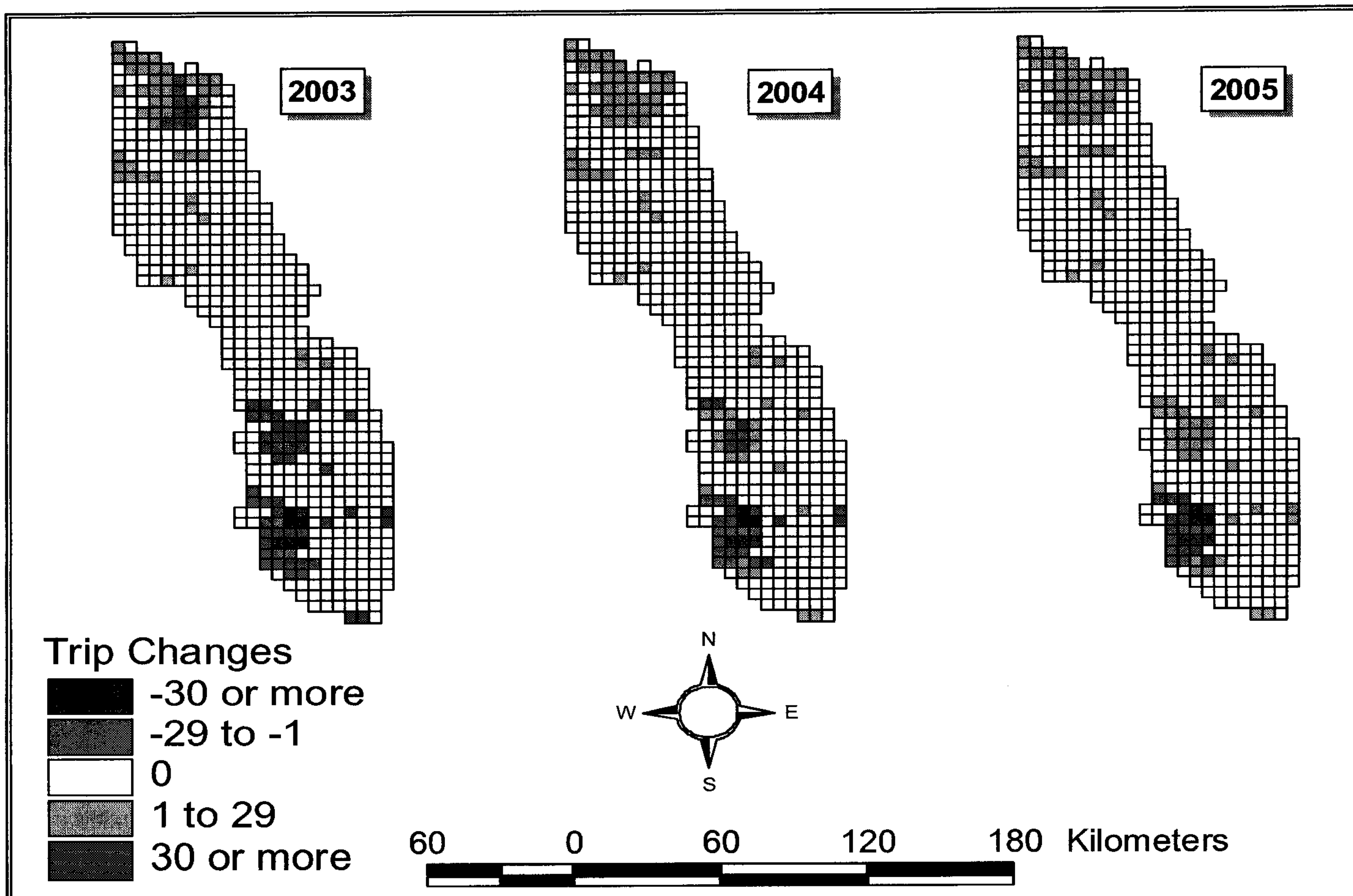
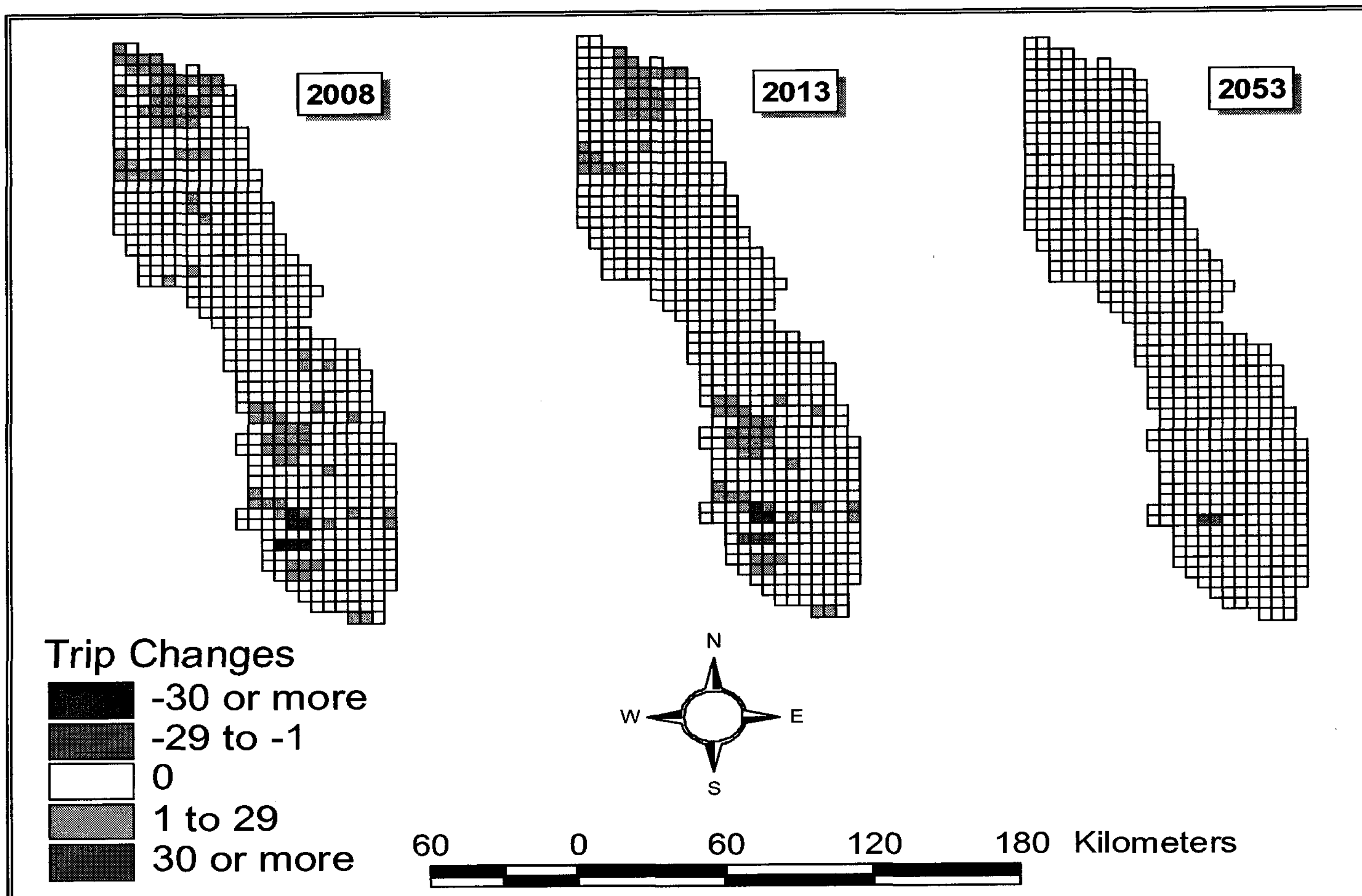


FIGURE 7.5 – CHANGE IN RANDOM CAMPING TRIPS (WHEN COMPARED TO THE PRE-FIRE BASE SITUATION) TO THE CROWSNEST PASS, ALBERTA REGION IN 2008-2053, FOLLOWING THE 2003 LOST CREEK FOREST FIRE *(values are trips taken per year)*



Although the Cherry Creek fire only affected two cells and was predicted to displace just 855 recreationists (782 of who would still camp elsewhere), it had a noticeable impact on the number of trips taken to alternate sites (see Figure 7.3). Three nearby substitute cells were estimated to receive more than 30 extra trips by "relocated recreationists" during the fire year (2000), while 92 other un-burnt cells would receive between 1 to 29 extra trips. Differential grouping of campers in substitute cells is based on pre-fire recreational intensities, thus more ideal and popular locations were modeled to attract more relocated recreationists. The following year, however, no substitute cell would receive more than 30 extra trips. There were 65 cells that were forecasted to host between 1 to 29 substitute trips in 2001, and only 53 in 2002. This declining trend displays the relative quickness that recreationists returned to their favourite campsite after being damaged by fire. The same trend occurred for the Lost Creek fire, however on a larger scale.

The effects of the Lost Creek fire were predicted to be more significant than the Cherry Creek fire because it burnt a larger area and the damaged area was also a high recreational density region. There were 18 cells damaged by fire in 2003, and none display recovery recreationally speaking over the 3-year period shown in Figure 7.4. The fire was estimated to displace 5609 campers, of which 5130 would still camp. The recreationists that would still camp would increase visitation to 47 un-burnt cells markedly; all 38 substitute cells within 40 km of the burn site and 9 other substitute cells located at an "intermediate distance" were forecasted to host at least 30 extra trips in 2003.

Therefore, during the Lost Creek fire year, all closely situated substitute sites were predicted to host a large amount of extra trips from random campers that decided to relocate. Furthermore, the northern region would also host many recreationists who travel to substitute sites, although at a rate not as pronounced as the southern portion of the study area.

There were no "intermediate distance" cells forecasted to host 30 or more extra trips in 2004 and only 17 cells located "nearby" would host this amount, while in 2005 the "nearby" figure would drop to just 6. All 93 total substitute cells receive at least one extra trip from relocated recreationists for the duration of the 3-year period displayed in Figure 7.4. While the intensity of trips taken to substitute cells decline each subsequent year after the fire, the fact that no un-burnt cells were estimated to return to pre-fire visitation levels (despite the rapid willingness of recreationists to return to damaged favourite sites) displays the increased severity of the Lost Creek fire.

The last sequence of maps, displayed in Figure 7.5, depicts the Crowsnest Pass region 5, 10, and 50 years after fire. There was little predicted change in recreation patterns from 2005 to 2008 except for 12 lower-intensity cells affected by the Lost Creek fire returning to pre-fire visitation levels. Twenty three cells that previously received extra trips from "relocated" recreationists were estimated to return to pre-fire visitation levels by 2013, leaving 70 substitute cells still hosting additional visitors. The entire study region shows recovery only 10 years after severe fire damage however, as only 3 burnt cells were still forecasted to lose 30 or more visitors yearly in 2013.

As highlighted by the intertemporal damage function, fire damage to camping sites appears to have relatively short-term effects on the trip-taking behaviour of recreationists. By 2053, 50 years after the fire, all cells would return to pre-fire levels (indicating no lingering effects on recreation due to the Lost Creek fire) except for two of the damaged cells still hosting between 1 to 29 fewer recreationists annually than before the fire. This means that recreationists are predicted to not significantly alter their trip-taking behaviour to sites that experienced fire 50 years ago when compared to older growth sites.

7.5 Spatial Model Results – Annual Welfare Measure Changes

Random camping annual welfare measure changes were calculated for the Crowsnest region. Since random campers were more willing to camp in or near fire damaged areas compared to PRA campers (see section 5.6), welfare losses for regular campers would be greater than for random campers. Using the consumer surplus value of $160.24 from section 6.3, Table 7.4 displays the estimated effects of both fires on random camper welfare in the Crowsnest Pass area. "Welfare loss" values refer to welfare generated by the region, not welfare received by individual campers; these values correspond to welfare that no longer flows into the area due to fewer trips taken by campers who chose not to visit the Crowsnest Pass. These are campers who stated that they would prefer to stay home or venture outside of the mapped region to substitute sites "far away" if their favourite Crowsnest camping area was burnt. Individual campers in substitute sites still receive recreation welfare from their new campsite, however this figure is not known since substitute sites were not explicitly modelled in the demand function.

TABLE 7.4 – LOSSES IN RANDOM CAMPING ANNUAL WELFARE MEASURES FOR THE ENTIRE MAPPED REGION DUE TO THE CHERRY CREEK (2000) AND LOST CREEK (2003) FOREST FIRES, CROWSNEST PASS, ALBERTA *($CDN 2004) (shaded rows signify forest fire years)*

YEAR (YEARS SINCE FIRE)	TOTAL REGION - ANNUAL WELFARE (RECREATION)	ANNUAL WELFARE LOSS	PERCENTAGE CHANGE (FROM BASE VALUE)
Pre-Fire	$13,981,243.16	-	-
2000 (Cherry Creek fire occurs)	$13,951,802.58	-$29,440.58	-0.21%
2001 (1 year after fire)	$13,969,612.77	-$11,630.39	-0.08%
2002 (2 years after fire)	$13,976,246.20	-$4,996.96	-0.04%
2003 (Lost Creek fire occurs)	$13,788,112.97	-$193,130.18	-1.38%
2004 (1 year after fire)	$13,904,947.80	-$76,295.35	-0.55%
2005 (2 years after fire)	$13,948,463.10	-$32,780.06	-0.23%
2008 (5 years after fire)	$13,971,231.27	-$10,011.89	-0.07%
2013 (10 years after fire)	$13,976,681.07	-$4,562.09	-0.03%
2053 (50 years after fire)	$13,981,220.50	-$22.66	0.00%

Welfare values generated by forests in the Crowsnest Pass region for random campers are significant, nearly totaling an estimated $14 million annually. The first fire, the Cherry Creek fire from 2000, resulted in a loss of over $29,000 in random camping welfare from the mapped area that year. This only represented a 0.21% drop for the entire region however, and the negative impact lessened the following two years as the forest recovered from the fire.

The impact of the Lost Creek fire in 2003 on recreation values was larger, with far more pronounced economic consequences than the Cherry Creek fire three years earlier. Over $193,000 in random camping welfare was lost in the mapped region in 2003, approaching seven times greater than the previous fire. This still only represented a 1.38% reduction in random camping annual welfare for the whole region however.

With all random campers having a willingness to return to their favourite site within five years of a fire, and the intertemporal damage function suggesting that trips taken almost return to normal within about ten years, annual welfare measures recovered quickly as well. By 2004, only one year following the Lost Creek blaze, welfare losses fell by over half to about $76,000. Losses continued to decrease by over half for every time period analyzed. To highlight how random campers were more severely affected by the Lost Creek fire, the Cherry Creek fire caused a 0.04% drop in regional annual welfare two years after ignition; a similar 0.04% drop caused by the larger Lost Creek fire occurred almost *ten* years after igniting.

Analyzing local effects, the two cells burnt in the Cherry Creek fire initially had a combined annual welfare value of $138,586 and lost nearly all (98.9%) during the fire year. The welfare loss fell to 35.6% the following year and 19.4% the second year, highlighting the quick recovery of cells to regain random camping visits and welfare values following a fire. The same welfare flow phenomenon stemming from the Cherry Creek fire occurs for the Lost Creek fire, however this time at a greater magnitude (about 6.5 times greater). Cells burnt in the 2003 Lost Creek fire lost almost $900,000 in random camper welfare losses, although the "nearby" substitute region benefited by absorbing almost $553,000 of the lost welfare. Similar to the Cherry Creek fire, the burnt region recovered quickly as losses decreased significantly each year after regeneration.

The assumptions described in sections 7.1 and 7.2 are reasonable given the behaviour of Alberta random campers and conditions in the Crowsnest Pass, and they are required for functionality of the spatial model. However, relaxing a few assumptions would likely dampen welfare losses. Three assumptions in particular are considered: the assumption that cells are considered completely burnt even if damaged to a lesser extent, the no population gain assumption, and the assumption that no random campers would use PRAs as substitute sites. In reality, it is possible that people would camp in sections of burnt cells, the population would likely increase, and some random campers would probably stay in managed campgrounds. All of these factors would lead to lower fire-induced welfare losses in the Crowsnest Pass region.

It should also be reiterated that the spatial extension only applied to random campers since no managed campgrounds were directly affected by the fires examined. However, had the Cherry or Lost Creek fires damaged established PRAs, the immediate flow of recreationists from burnt cells would have been more significant due to higher populations of regular campers than random campers. This would have had a greater negative economic impact on the Crowsnest Pass region. In addition, the return of PRA campers to burnt cells could take longer if facility re-construction was delayed or slow, a concern not applicable to random campers.

CHAPTER 8: CONCLUSIONS AND DISCUSSION

8.1 RESULTS

Using the mountain and foothill region of Alberta as an inference space, this study developed some innovations relative to the current literature on the effects of forest fires on recreation behaviour. Firstly, this study examined camping as a recreational activity instead of conventionally studied trail-based activities. A second innovation was making a distinction between "regular" campers (people who camp in established, managed campgrounds) and "random" campers (people who camp in undesignated areas on public lands with no fees or regulations, i.e. "bush" camping). Random camping is one of the most common uses of forests in Alberta's eastern slopes, and is an activity that is not well discussed in other literature.

Another innovation was incorporating a distinction between good soil quality and poor soil quality for recreational site choice scenarios; appearances between stands on these two soil types are strikingly different and therefore this distinction plays a large role in recreation trip decision making. Forest stands on good soil quality sites are characterized by strong, tall trees that are thick in diameter and spread out from one another. Trees on poor quality soil are smaller is stature with thinner diameters, and growth is thick and cluttered; there are often many uprooted and broken trees in these types of forest stands due to storms damaging the fragile trees. Visual differences between these two types of stands only appear after about 40 years however, thus the soil quality distinction is only made for older growth forest stands.

Lastly, an improved econometric model is developed in this study. A negative binomial model is utilized to handle overdispersion in the data, and unlike other recreation/fire travel cost estimators, a random effects estimator was successfully constructed. Sequence effects models (such as a random effects model) are more comprehensive estimators that maintain a link between each individual respondent and all of their observations; this link is established by keeping all demographic information constant across every scenario, with only the site attribute(s) being examined changing.

This paper also filled a void in the literature from a geographical perspective. Little information stemming from the Canadian Rocky Mountains is present that focuses on fire/recreation demand, travel cost models, and/or camping activity at the individual level. Therefore, all results discovered in this study apply solely to recreationists who frequent camping sites in Alberta's eastern slopes region. The recreation demand work done by Boxall et al. (1996*a*) and McFarlane and Boxall (1998) constructed aggregate zonal models, not micro-level models, for Alberta.

Original RP and SP data were collected with an onsite interview and a follow-up survey during the summer of 2004 from people recreating in roadside camping locations situated in Alberta's mountain and foothill regions. Based on this information, I found that the majority of campers were not overly sensitive to the threat of fire damage hindering their ability to camp in the eastern slopes region. Recreationists were experienced campers with a great affinity for spending portions of their summers in Alberta's forested foothill and mountain areas and would not be deterred from recreating in areas damaged by fire. Over 79% of respondents stated that they would still camp in a lightly burnt area damaged earlier that same year. If they could not camp in their favourite site because it had been temporarily destroyed by a high intensity fire, just under 95% said they would simply camp somewhere else instead of staying home and over 97% said they would return within five years. Of people that would search out an alternate campsite, 67% of random campers and 48% of regular campers stated that their substitute site would be somewhere "nearby" (defined as 40 kilometers or less from their most frequented site).

Clearly, the presence of fire damage from several years ago in surrounding areas would not deter most campers from pursuing their camping preferences. The econometric model derived using actual trips and contingent behaviour-induced trips reinforced this finding. Using a negative binomial random effects model, the intertemporal damage function for Alberta's eastern slopes revealed that campers return to pre-fire trip levels about 10 years after fire[20]. Recreationists still prefer to camp in older growth forests, but visitation rates increase at slower rates after the aforementioned 10 years.

Flatly stating that fire has only a minimal effect on recreation values is likely false however, as only damage to *surrounding areas* was examined (recreationists would probably value immediate campground infrastructure more highly than surrounding forests). Furthermore, more serious campers (particularly random campers) seem to be less tolerant of fire activity near their camping site; random campers favoured strict fire suppression (see Table 5.5), and people also typically took more trips the more negative their attitude towards forest fires (see section 6.1). However, if a fire has affected regions near a participant's camping location, results indicate that the majority return relatively quickly and will simply use substitute sites in the interim (often located nearby). Camping behaviour is not altered or affected significantly in the short-term; rather, location. Long-term, little to no effect occurs.

As the forest ages to about 40 years, fire effects have faded over time due to regeneration and the numbers of trips continue to increase but visual differences between good and poor soil quality sites begin to emerge. The trip-suppressing effects of poor soil quality sites are greater than the trip-increasing effects of older forests, as evidenced by the differences in curve steepness found in the intertemporal damage function. This is because the accumulation

[20] Results generated by the econometric model are cautious conclusions however, because the findings are largely based on an SP component which featured forest stands from different locations. Despite statistical tests displaying consistency between actual and stated behaviour (see sections 6.4 and 6.5), results are nonetheless built on responses to SP questions which may have been interpreted differently due to photographic inconsistencies.

of debris and growth of fragile trees on poor soil quality sites is marginally more pronounced and visible than a forest continuing to age.

The intertemporal damage function suggests that random campers took about 1.5 more trips on average than regular campers in older growth forests. If a forest stand is 100 years old (100 years following a forest fire), random campers on good soil quality sites are predicted to take about 4.2 trips per year while those on poor quality soil sites are predicted to take 3.4 trips per year. Regular campers on good soil quality sites would take roughly 2.8 yearly trips, and those on poor soil quality sites would take 2.3 trips per year. The damage function shows that random campers are the most sensitive to camping on poor soil quality sites.

The model also determined that the consumer surplus for regular campers was about $414 per trip, while for random campers it was $160. Looking at older growth forest stands, good soil quality sites lose approximately 37% of their annual welfare measure value while poor soil quality sites lose about 20% for both types of campers one year after a severe fire. Actual annual welfare losses due to fire range between $102 and $441 depending on the type of camper and the site soil quality. Declines in annual welfare were higher for good quality sites than poor quality sites because they were more valued for all campers; since more people preferred to camp in older growth good soil quality sites, its loss was greater than for less desirable poor soil quality sites.

Results revealed that random campers typically took more camping trips, their stays were longer, they had higher household incomes, and they generally belonged to more recreation-based organizations. They also took more trips than regular campers, were more likely to return to a fire-damaged favourite site, favoured strict yet costly fire-fighting abatement strategies, were more likely to have a substitute site nearby their favourite site, and their consumer surplus and annual welfare measures were lower as well.

Meanwhile, campers who use managed sites tended to favour visiting a variety of campgrounds. They drove greater distances to a larger number of different campgrounds, were more likely to camp in a substitute site if fire damaged their favourite site, and their substitute site was also located further away from their most frequented site compared to random campers.

This study also examined spatial applications of the intertemporal damage function. Spatial simulation modeling of two actual fires in the Crowsnest Pass region of Alberta, the 2000 Cherry Creek and 2003 Lost Creek fires, utilized the damage function and interview/survey results. The maps show that areas within a 40 km radius surrounding the burn site were predicted to experience a significant spike in relocated recreationists during the first two years after a wildfire. Visitation patterns were forecasted to largely return to their original levels after only about ten years of recovery however. Intermediately distanced substitute sites (between 41 km - 200 km away) were estimated to see a similar rise in relocated visitors for the same time period, however to a lesser extent than nearby regions. Lastly, changes in visitation patterns and annual welfare losses for the entire mapped region were predicted to be relatively small immediately after a fire and negligible after ten years of re-growth; affected stands of the largest forest fire, the Lost Creek fire, had estimated welfare losses of just under $900,000 the year after ignition but only about $32,200 just ten years later, representing a 96.4% drop.

8.2 IMPLICATIONS

Although there is debate as to whether the number and severity of forest fires are increasing after years of fuel accumulation and higher temperatures and/or natural cycles, or whether reporting is simply more effective since more people and interests are threatened, issues regarding wildfires appear to be continually rising. With demand steadily increasing for the multiple ranges of benefits generated by forests, understanding the economic effects of forest fires is crucial for all stakeholders and managers when making decisions regarding forest stands before, during, and after fire activity. Boxall et al. (1996*b*:989) reiterate this point, stating that "Since multiple use and integrated management of forests requires optimizing public benefits, managing forests that are at risk from fire requires an understanding of the magnitudes of the economic impacts of fire. Some of these impacts involve changes in the nonmarket economic values that accrue as a result of the fire". By evaluating the effects of forest fires on recreational activity along Alberta's eastern slopes mountain region, this present study contributes to comprehending some of the nonmarket forest values at risk to fire activity.

These results can help aid government agencies make more informed decisions regarding outdoor recreation and forest fires. The predicted flow of recreationists and consumer surplus in response to areas burnt by wildfire can be used to estimate service flows leaving affected areas and entering substitute areas, even in years following a fire. Short and long-term tourism strategies can be adjusted accordingly, as can anticipated markets for camping and recreation owners and operators. Forest managers, for both government and private forestry companies, can also use the discovered regular/random camper dynamics to better gauge recreational behaviour, preferences, and movement in Alberta's forested public lands during pre- and post-fire time periods.

The intertemporal damage function can be a valuable tool to forest managers and fire management policies alike. By offering insights into the anticipated behaviour of recreationists following fire, the intertemporal damage function can be incorporated into broader fire fighting strategies and policies for abatement cost/benefit analyses and for prioritizing locations that may be simultaneously under threat of fire. Lastly, under the large assumption that fire damage may mirror the effects of logging activity for recreationist behaviour, the intertemporal damage function could be used to assist in the determination of optimal rotation ages for forestry companies. Many campgrounds and random camping areas in Alberta are located on public lands managed by forestry companies. Forest companies receive harvest rights on these lands conditional on the rights-holders utilizing the province's forests in a manner that benefits all Albertans, including recreationists. Therefore, including recreational values into harvest schedules may lead to timber rotations that more efficiently capture the numerous benefit flows generated by forest stands.

8.3 Limitations and Future Research

Despite careful planning and execution of logistics and methodology to ensure accurate results for this study, numerous areas for improvement exist. The consistency of the photographs used to elicit SP responses is an area of concern, as different locations, ages, and species are present. An exhaustive search was conducted, however, to locate pictures taken from Alberta forests that had not only been burnt previously, but also whose age and soil quality was known with certainty. Short of taking a time-series of photographs taken from the exact same location over different decades, some inconsistencies will remain; this is why respondents in this project were told to simply use the photograph groups as guides along with their own interpretations and mental images of their most frequented campsite.

Furthermore, respondents were given 18 pictures to guide them, which is far greater than the number used in most other picture-based fire/recreation studies. Other studies typically incorporate 3 pictures, which leads to a less-comprehensive understanding of the recreational site in question and may cause some participants to focus on attributes specific to the stand pictured and not the overall intended area. The statistical consistency of the SP data is an encouraging sign that the photographs selected achieved their intended purpose. Future improvements may be available via digital imaging and alterations however, which would allow the same pictured stand to be shown at numerous stages of re-growth. The most ideal improvement to this obstacle would be greater collection of actual RP data from recently burnt regions over several years, thereby lowering the need for hypothetical SP information at all. This would require substantial time and resources however.

Another area of improvement would be to add additional photograph groups to the contingent behaviour analysis; the most critical being a series with a mean stand age between the 33.5 year and 110 year groups. Having a photograph group of forest stands about 70 years old would add an extra point to the intertemporal damage function and add an important intermediately-aged stand component. This would increase confidence in results and improve the true shape of the damage curve. Likewise, adding an even older aged photograph group (possibly 180 years old) would also be a benefit. However, this need is not as pressing as the intermediately-aged stand group since the marginal recreational benefits of forests aging continually decrease over time.

Increasing the quality and number of suitable photographs in the survey could also help alleviate the most significant limitation in this present study, the lack of substitute sites in the demand function. Not explicitly incorporating alternate site options and travel costs in the demand function counters conventional economic models and leads to the possibility of overestimated consumer surplus values. The most difficult restriction to be resolved is determining how to incorporate substitute sites in semi-logarithmic demand functions examining fire effects. If including alternate sites can be accomplished, in combination with an availability of accurate photographs that can be used to represent substitute sites, the recreation demand function could follow standard economic theory and allow other behavioural trip options available and lead to the calculation of more accurate (and conservative) consumer surplus values. Furthermore, instead of simply knowing that recreationists visit substitute sites in case of fire damage, a behavioural model of *where* they actually go could also be developed.

An additional area of improvement would be to collect three other pieces of information from the interview/survey. First off, respondents were not asked for the size of their camping group; acquiring this information would have led to a more accurate travel cost variable and subsequently more precise welfare measures. In this study, a mean group size value was used for all campers as a replacement, however it was found to adequately mirror two previous studies. Secondly, specifically asking participants if they considered themselves a random camper would have improved the grouping of recreationists by camping type. Focusing on this dynamic occurred after the study began due to emerging differences, so including this dynamic from the beginning for future studies can lead to more accurate representation of the similarities and differences between both types of campers. Lastly, asking participants if they had previously camped in burnt areas would help gauge recreationists' experience in fire-damaged landscapes. This information could help determine if respondents truly understood what camping in burnt locations entailed when faced with hypothetical fire/recreation scenarios.

Other outdoor recreation demand and forest fire literature distinguishes between light-intensity prescribed burns and high-intensity natural (i.e. crown) fires, and examines the effects of both on recreational behaviour. Often, sharp contrasts in results exist between both types of fires. Numerous studies actually find that the type of fire dramatically impacts the magnitude and direction of behavioural and welfare change following fire activity. Although questions concerning light-intensity and severe fires was briefly touched upon during the onsite interviews, this study primarily focused on areas only damaged by natural crown fires. Incorporating specific distinctions between controlled burns and crown fires would be a useful addition for future research examining the effects of overall fire activity on camping demand.

Lastly, the spatial model contained a number of assumptions for functionality purposes. Gaining knowledge concerning a number of these factors would limit the number of assumptions required, thereby improving the practicality and realism of the spatial extension. These factors include information concerning the level of attachment of recreationists to their current favourite campsites (for example, how willing and quickly would they substitute their old most frequented site for a new "favourite site" due to fire damage?), the effects of congestion in substitute sites due to higher visitation rates following fire,. More precise fire location information for the Cherry Creek and Lost Creek fires or data for smaller-sized cells would allow us to improve upon the assumption that any fire damage in a cell resulted in the entire cell being considered burnt. Asking random campers the likelihood that they would camp in a PRA as a substitute site if their random camping area was burnt (and vice versa) would be another improvement to the spatial model. Obtaining the probabilities that campers would switch camping types for substitution purposes would shed more light into understanding the behavioural differences and substitute site transferability between the two primary types of camping recreationists.

Future studies that could produce recreation intensity maps based on the number of recreationists in addition to the number of trips would also be valuable information to help the spatial model more realistically simulate movements of recreationists following fire. In this present study, the intertemporal damage function is used to determine the rate at which post-fire trip levels return to pre-fire levels. By anchoring the intertemporal damage function to the number of recreationists and not the number of trips, however, the behaviour of recreationists could be estimated based on individual personal characteristics (i.e. age, household income, membership in a hunting/fishing organization, etc.) instead of only using mean demographic values. This would lead to differential trip values within the recreationist group, as occurs in reality, however total trips to the region could still be maintained. Estimating campers to not behave identically would eliminate the assumption from section 7.1 which states that all recreationists must take the same number of trips in a year. A micro-level spatial model would estimate non-uniform movements across cells, which would create more accurate and interesting maps.

In addition to obtaining recreationist population data for each cell, future extensions could also gather more detailed site information (i.e. stand age and site quality) to further improve the simulations. Adding cell-specific characteristics to the model would increase its ability to forecast non-uniform movements across the mapped region and more efficiently mirror actual behaviour. Incorporating recreationist- and cell-specific information in the intertemporal damage function would permit the function to utilize its individual-level capabilities and produce results based on a wide array of campers and forest stands, instead of only using standardized data that inevitably produce general, broad, and uniform results.

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APPENDIX A (ONSITE INTERVIEW)

FOREST RECREATION AND FOREST FIRE SURVEY 2004

Hello, my name is ______. I am a student at the University of Alberta conducting a study examining the effects of forest fires on recreation. I am trying to determine what factors influence people to come here, the importance of recreation in this area, and how the presence of wildfire will affect your use of this area. Could I have about 5 minutes of your time to ask you some questions about your use of this area for recreational purposes? (If no, thank them and leave). The data you provide will be used in an MSc thesis and will also be published and presented in various research forums; there is no direct benefit to the participant or the community.

Results will be accessible via the Sustainable Forest Management (SFM) Network website, located at http://sfm-1.biology.ualberta.ca/english/home/.

I am required to tell you that all information you provide will be held in strict confidence and that you can terminate this interview at any time.

Are you a regular visitor here, or to any other parks in Alberta? (If no, then terminate the interview)

Have you already been interviewed by myself, or anyone else this summer for this project?
0. No (GO TO QUESTION 1)
1. Yes Do you remember where? _______________ (Thank respondent and terminate interview)

SURVEY

1) Which village, town, city, or community are you from?

____

2) What is your home postal code (to calculate distance travelled) ?

____

3) How long did it take to travel here (time wise) ? _____________________________

4) Have you been to this campground before? 0. No (GO TO QUESTION 5) 1. Yes

If yes, how many times have you visited this campground in the last 10 years? __________ times

5) How many times do you expect to visit this campground this year? ________________ visits

6) On this trip, how many nights will you stay at this campground? ________________ nights

7) Would you still have come to this campground if a forest fire occurred here earlier in the year?

Yes___________ No ___________

Would you have stayed the same number of nights?

Yes___________ No ___________

8) Would you still come and stay for the same length of time (as in QUESTION 7) if the fire had occurred:

	Yes	No
Last year?		
2 years ago?		
5 years ago?		
10 years ago?		
More than 30 years ago?		

9) Would you have camped at another campground if a fire occurred here earlier in the year?
Yes_____________ No_____________

If Yes, Do you know where?

____

10) I am going to read a list of activities and I'd like you tell me which of these members of your camping party will participate in **while you are here**. Just say "yes" or "no" as I read them (Circle all that apply):

1. fishing	5. sightseeing in car	9. swimming
2. day hikes	6. birdwatching	10. horseback riding
3. backpacking (overnight)	7. watching other wildlife	11. using off-hwy vehicles
4. mountain biking	8. canoeing or boating	12. caving (spelunking)

11) Which **ONE** of these activities will your party participate in the **most** while you are here? __

12) What type of camping equipment are you using? (circle all that apply)

1. tent 2. trailer 3. van 4. truck camper 5. tent trailer 6. RV 7. other: ____________

13) Respondent is: 0. man 1. woman 2. I talked to more than 1 person

In the second part of my study I am mailing or emailing links to a web based questionnaire to participants of this survey. That questionnaire will collect more information on the effects of fires in Alberta's forests on your outdoor activities and how these activities may change in response to fires. Would you be willing to participate in the second part of that part of the study?

0. No 1. Yes (Record name, address, email address and ID number on separate sheet)

2. Already on my list

THANK YOU FOR YOUR TIME AND PARTICIPATION!

Respondent / Interviewer Comments Section

APPENDIX B (MAIL/EMAIL SURVEY)

CAMPING IN ALBERTA'S EASTERN SLOPES: A SURVEY OF ACTIVITIES AND OPINIONS

Thank you for taking the time to complete this survey!

Please try to answer every question. If there are any questions you do not wish to answer, please leave them blank and move on to the next question.

All information you provide is strictly confidential. Your name will never appear with your answers. Only a summary of the overall results will be published.

Please return your completed survey in the postage paid envelope provided.

I greatly appreciate your help with this study.

If you have any questions regarding this survey, please contact:
[Contact information appeared here]

SECTION I: YOUR CAMPING PREFERENCES AND EXPERIENCES

Question 1: How many years has it been **since you first started camping**? (Please check *one* box that best describes your answer):

☐ 1 to 5 years
☐ 6 to 10 years
☐ 11 to 15 years
☐ 16 to 20 years
☐ 21 to 25 years
☐ more than 25 years

Question 2: Which type of campground do you prefer to camp in? *(In the white section on the left, select your degree of preference for **each** type of campground. Then, also complete the grey section on the right for **each** type of campground.):*

	PLEASE INDICATE YOUR DEGREE OF PREFERENCE FOR THE FOLLOWING TYPES OF CAMPGROUNDS					DID YOU CAMP IN THIS TYPE OF CAMPGROUND IN 2004?		
	Strongly Prefer	**Prefer**	**Neutral**	**Dislike**	**Strongly Dislike**	**Yes**	**No**	**Uncer-tain**
NATIONAL PARKS (e.g. Banff, Jasper, Waterton, Elk Island)	☐	☐	☐	☐	☐	☐	☐	☐
PROVINCIAL PARKS (e.g. Beauvais and Crimson Lakes, Aspen Beach)	☐	☐	☐	☐	☐	☐	☐	☐
PROVINCIAL RECREATION AREAS (e.g. Fish Lake, Thompson Creek, Chinook)	☐	☐	☐	☐	☐	☐	☐	☐
COMMERCIAL CAMPGROUNDS (e.g. KOA, David Thompson Resort)	☐	☐	☐	☐	☐	☐	☐	☐
RANDOM CAMPING SITES (i.e. "bush" camping on public lands)	☐	☐	☐	☐	☐	☐	☐	☐

SECTION II: YOUR CAMPING ACTIVITIES IN THE FOOTHILL AND MOUNTAIN REGIONS OF ALBERTA DURING 2004

Question 3: How many overnight camping trips did you take to the foothill and mountain areas of Alberta **between May 1 and September 30, 2004**? *(These are the shaded areas on the map below; use your best judgment for sites near the boundary. "Overnight Trip" is defined as travel to a camping site that involved at least one night stay at the site.)*

________ Overnight trips

Question 4: You were interviewed on _______________ at _____________________.

a) *Including* the time that you were interviewed, how many overnight trips did you take to this location between May 1 and September 30, 2004?

________ Overnight trips

b) Is the place that you were interviewed the location where you made the most overnight camping trips in the Albertan foothill and mountain areas in 2004?

☐ Yes ☐ No

(If you answered "Yes", skip to Question 5. If you answered "No", please answer questions c. to f.):

c) If you answered **NO** to Question b), where was the place you made the most overnight camping trips in the foothill and mountain areas of Alberta in 2004? *(Please describe the location using the nearest town, park or campground as a guide):*

Location: ____

d) How many overnight trips did you take to the location you described in Question c) between May 1 and September 30, 2004?

________ Overnight trips

e) Approximately how far is this place from your residence (one-way)?

________ kms or ________ miles

f) Suppose that your most frequented site was closed for some reason, or was somehow inaccessible to you (e.g. a road washout), which location would be your next choice?

Location: ____

Question 5: Using the series of photographs from the pullout sheet, which picture group do you think **looks most like the surrounding forest** where you took most of your overnight trips in the foothill and mountain areas of Alberta in 2004? *(Please check **one** box that best describes your answer):*

☐ Photograph Group A

☐ Photograph Group B

☐ Photograph Group C

☐ Photograph Group D

☐ Photograph Group E

☐ Photograph Group F

SECTION III: YOUR CAMPING DECISIONS IN FOREST FIRE-DAMAGED AREAS

The following questions examine the camping decisions you would make in a camping area that has been previously burnt by a forest fire.

Please note that the fire damage described in Questions #6 to #8 only apply to the forest *surrounding* the area where you visit.

Assume that all camping facilities (i.e. picnic tables, washrooms, etc.) have been replaced or were not destroyed by the fire, and the campsites are all clean as well.

Question 6, 7, and 8 *(questions 6-8 used the same format, however the photograph groups used for each question were altered)*

a) Assume that in 2005, you take the same number of overnight camping trips to the foothill and mountain areas of Alberta that you did in 2004 *(this is the same number as your answer to Question 3).*

Now suppose that there has been a change in the *surrounding environment* at your most frequented site. Pretend that it now appears like the pictures in Photograph Group ____ from the pullout sheet. Please take a few moments and look carefully at the pictures in Photograph Group ____.

If the area *around* your most frequented site now looked like the pictures in Photograph Group ____, would you **change** the number of overnight trips you plan to take there in 2005? [*Recall that you reported the number of overnight trips you took in 2004 to your most frequented site in either Question 4 a) or 4 d)*]

☐ Yes ☐ No *(Please skip to question 7 if you checked "No")*

b) If YES, would you take *more* or *fewer* overnight trips to this site in 2005?

☐ More trips → How many *more* trips? ____

☐ Fewer trips → How many *fewer* trips? ____

Please provide any additional comments you may have regarding your answer below.

____

____

____

SECTION IV: YOUR OPINIONS ON FOREST FIRES

Question 9: How do you feel about the following statements concerning forest fires? *(Please check the **one** box that best describes your answer for **each** statement):*

	STRONGLY AGREE	AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE
a. Forest fires are an ecological disaster for Alberta's forests.	☐	☐	☐	☐	☐
b. Forest fires cause future job losses in forest dependent communities.	☐	☐	☐	☐	☐
c. Forestry companies can use burnt trees in their mills.	☐	☐	☐	☐	☐
d. Forest fires create short-run jobs by employing fire fighters.	☐	☐	☐	☐	☐
e. Forest fires destroy recreation facilities such as campgrounds.	☐	☐	☐	☐	☐
f. Forest fires improve biodiversity.	☐	☐	☐	☐	☐
g. Forest fires improve conditions for wildlife.	☐	☐	☐	☐	☐
h. Forest fires destroy scenic beauty.	☐	☐	☐	☐	☐
i. Forest fires allow natural events to occur (i.e. they are part of the natural cycle).	☐	☐	☐	☐	☐
j. Forest fires are beneficial in that they remove dead vegetation.	☐	☐	☐	☐	☐
k. Forest fires result in many animals losing their homes.	☐	☐	☐	☐	☐
l. Forest fires cause a threat to human lives.	☐	☐	☐	☐	☐

Question 10: Listed below are several approaches to fire fighting. Please check the *one* box that best describes the approach you think should be taken in fighting forest fires:

☐ Forest fires should be allowed to burn themselves out, as long as human safety and infrastructure are not in danger.

☐ Forest fires should only be fought once they have reached a large enough size.

☐ Forest fires should be fought as soon as they start, no matter what the cost.

Question 11: Controlled burning is the deliberate burning of a forested area under controlled conditions (i.e. firefighters are on site watching) that allow the fire to be confined to a predetermined area.

Please indicate the **extent to which you agree** with the following statement. *(Please check **one** box that best describes your answer):*

Controlled burns should be used to DECREASE the chance of a future forest fire igniting.

STRONGLY AGREE	SOMEWHAT AGREE	UNSURE	SOMEWHAT DISAGREE	STRONGLY DISAGREE
☐	☐	☐	☐	☐

Question 12: Forest fires can threaten many things that are valuable to Albertans. Please **rank** the following items in terms of the priority you feel they should be given when deciding where to fight fires.

Rank **all** of the following items from highest to lowest importance. Use "1" to indicate the highest priority, "2" the second highest priority, etc., and "8" as the lowest priority. Please do *not* use the same number twice.

_____ Recreation Facilities such as Campgrounds

_____ Timber for the Forest Industry

_____ Private Homes

_____ Health Concerns Caused by Smoke from Forest Fires

_____ Wildlife

_____ Scenery

_____ Major Roads

_____ Fish Habitats

Question 13: Please answer the following questions concerning forest fires. *(Please check the **one** box that best describes your answer for **each** question):*

QUESTION	TRUE	FALSE	DON'T KNOW
a. Forest fires usually result in the death of most animals in the burnt area.	☐	☐	☐
b. Most forest fires along the eastern slopes of Alberta are caused by lightning.	☐	☐	☐
c. Controlling all forest fires would reduce the habitat of animals such as elk.	☐	☐	☐
d. Forest fires destroy minerals and nutrients that are needed by trees and other plants.	☐	☐	☐
e. Forest fires can be an important force in controlling outbreaks of disease and insects in forests.	☐	☐	☐
f. It takes years before significant plant growth occurs in a fire-damaged forest.	☐	☐	☐

Question 14

a) Suppose the Alberta government could develop a new forest fire-fighting program. Suppose this program would **reduce the amount of acres burnt in the province by 25%.** No specific forested region of the province would be favoured however; all forested areas would benefit equally from this program (both recreational and non-recreational areas).

Likewise, the cost would be shared fairly by all interested parties (industry, government, campers, etc.). To help fund this improved forest fire-fighting program, campers would be asked to pay an extra camping fee each time they camp in a public or commercial campground (this fee would *not* apply to random camping sites).

*Please keep in mind that previous surveys have found that the amount of money people **SAY** they are willing to pay is sometimes higher than the amount that they would **ACTUALLY** pay when this type of program becomes available. For this reason, as you read the following question, please imagine that you would **ACTUALLY** have to pay an extra camping fee every time you camp in a public or commercial campground.*

If you were asked to pay an extra $____ each time you go camping to help fund the program, **would you pay this amount**?

☐ Yes ☐ No

b) How certain are you of your answer to Question 14 a)?

VERY CERTAIN	SOMEWHAT CERTAIN	UNSURE	SOMEWHAT UNCERTAIN	VERY UNCERTAIN
☐	☐	☐	☐	☐

Question 15: If you answered "No" to question 14 a), please explain why below *(Please check **all** answers that apply)*. If you answered "Yes" to question 14 a), skip to Question 16.

☐ This extra fee simply makes the cost of camping too high.

☐ I would rather spend this amount on something else.

☐ I believe Alberta's forest fire-fighting program is already sufficient.

☐ I believe more forest fires should be allowed to burn in Alberta's forests.

☐ I do not believe that this program could actually reduce the number or size of fires.

☐ Other: ______________________________
____

SECTION V: About You

Question 16: You are: ☐ Male ☐ Female

Question 17: What is your age? ______ Years

Question 18: Are you retired? ☐ Yes ☐ No

Question 19: How many people live in your household (including yourself): ____ People

Question 20: Do you **belong** to any organization(s) similar to those below?

	YES	NO
a. A natural history or birdwatching club	☐	☐
b. A hunting or fishing organization	☐	☐
c. Other environmental or conservation organization(s)	☐	☐
d. Off-highway vehicle organization	☐	☐

Question 21: What is the **highest** level of education that you have **completed**? *(Please circle the number that best describes the level of formal education you have (measured in years)):*

1 2 3 4 5 6	7 8 9	10 11 12	13 14 15 16	17 18 19 20 21 22
(Elementary)	(Junior high)	(High school)	(University/College)	(Master's/Doctorate)

Question 22: Which category best describes your **total household income** (before taxes) in 2003?

☐ $10,000 or less
☐ $10 – $19,999
☐ $20 – $29,999
☐ $30 – $39,999
☐ $40 – $49,999
☐ $50 – $59,999
☐ $60 – $69,999
☐ $70 – $79,999
☐ $80 – $89,999
☐ $90 – $99,999
☐ $100 – $149,999
☐ $150,000 or more

Please provide any additional comments you may have.

____
____
____

THANK YOU FOR YOUR TIME AND PARTICIPATION!