RURAL ECONOMY

An Economic Analysis of Recreational Fishing and Environmental Quality Changes in the Upper Oldman River Basin

D. Watson, W.L. Adamowicz and P.C. Boxall

Project Report 93-01

PROJECT REPORT

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ABSTRACT

A Discrete Choice Travel Cost model, based on data collected from a survey of recreational anglers, was used to estimate changes in recreational fishing benefits in the Upper Oldman River region of Alberta resulting from the construction of a dam. The results show that this model is useful for measuring the impact of public works projects on non-market economic benefits. Predictions of the distribution of trips to each fishing site before and after placement of the dam are also identified by the model.

The model is sensitive to the variables chosen and the measurement of quality attributes. The quality attributes which affect the choice of site include the potential to catch fish (catch rate and size of fish), access, and the size of the water body. Including the value of travel time in the travel costs causes an increase in the welfare estimates, but does not affect the variables used.

Construction of the dam and creation of the reservoir reduces recreational fishing benefits of the area. The welfare impacts of the decline of recreational fishing quality range from an annual loss of $96,239.10 to a loss of $30,545.20 depending on the model specification, and whether the value of time is included. The government efforts at mitigating the dam's effect by construction of fish habitat in remaining reaches may improve the welfare of users to levels equal to or greater than the original benefits. The mitigation effort, assuming a success rate that is considered most probable, results in an annual gain in welfare of from $209,499.80 to $22,971.60 depending on the model specification, and whether the value of time is included.

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SECTION 1: INTRODUCTION

1. Introduction

This report is the second phase of a project designed to examine socio-economic aspects of sportsfishing in southern Alberta. The initial phase of this project included a survey of 5,000 recreational anglers who fished in the Southern Fish and Wildlife Division Administrative Region. The results of this survey are summarized in "A Socioeconomic Evaluation of Sportsfishing Activity in Southern Alberta" by W. Adamowicz, P. Boxall, D. Watson and T. Peters (Project Report #92-01, Department of Rural Economy, University of Alberta). The second phase of this study uses the survey data to examine the impact of changes in environmental quality in the Crowsnest region on benefits associated with recreational fishing. Two types of impacts are examined: 1) the impact of water course changes due to the Oldman River Dam; and 2) the subsequent impact of changes due to the mitigation efforts initiated after construction of the dam. These impacts are examined using the information from the survey, creel censuses, and some biological and recreational management information. This report also illustrates the application of new economic approaches to evaluating environmental quality changes.

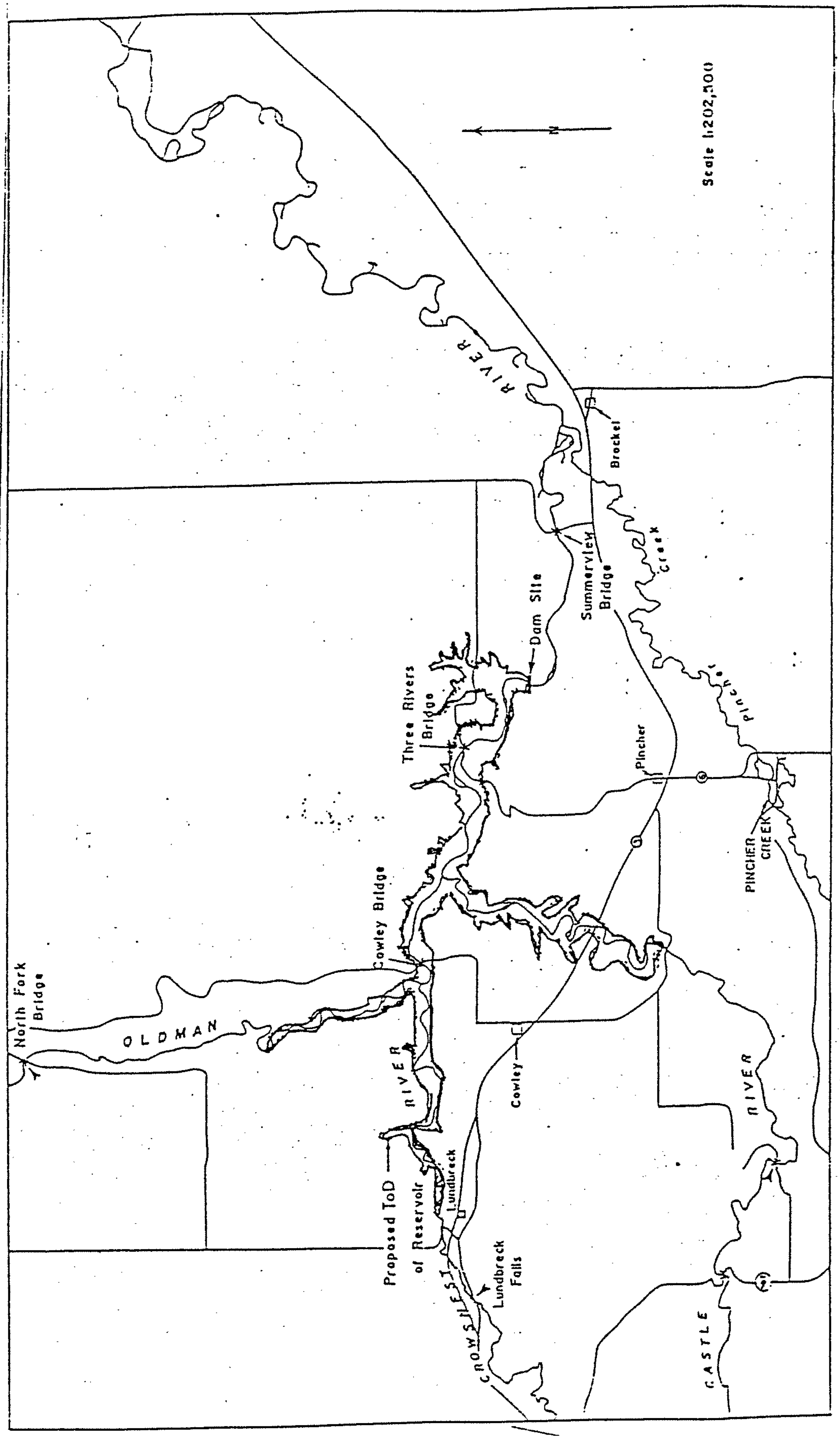
1.1 The Situation

In 1985 the Province of Alberta announced the construction of a dam on the Oldman River which would flood portions of the Oldman, Crowsnest and Castle Rivers and create a large reservoir (see Figure 1). The creation of the reservoir was deemed necessary for reasons of irrigation water supply, municipal water supply, and flood control. However, portions of the flooded rivers, in their original state, were also highly esteemed for recreational fishing, and other recreational activities. For example, the Federal Environmental Review of the project (FEARO 1992, p.18) states:

> The Oldman River and its tributaries, the Castle and Crowsnest Rivers, have been described as 'the blue ribbon trout streams'. Surveys upstream from the damsite suggest that 60% of the high quality habitat for adult brown trout, 62% of the high quality habitat for adult mountain whitefish and 75% of the high quality habitat for adult rainbow trout in these three rivers was inundated by the reservoir.

Benefit/Cost Analysis (BCA) was carried out to examine the dam project (M. Anderson and Associates, 1986). BCA is a method of evaluating the relative merits of alternative public investment projects in order to achieve efficient allocation of resources (Treasury Board of Canada, 1976). However, the BCA for the Oldman Dam did not consider potential losses in values

Figure 1: Extent of the Reservior



of recreational fishing. In order to fully estimate the gains and losses resulting from a project, Howe (1984, p.vi) states that:

> Water projects have impacts extending beyond those capable of monetary quantification, and environmental, aesthetic, and equity impacts must be forecast and described if projects are to be designed and ranked in order of their contribution to human well-being.

This study was undertaken to determine the effect of environmental changes on the non-market benefits of recreational fishing in the Upper Oldman River basin. This is the first study that tries to measure these non-market values. The need for such a study is outlined in the following statement (Erythana Ventures Corp., 1991, p.11).

> ...a number of reports have also been prepared with respect to the effect of the Dam on fisheries and on vegetation, both in the river valley and in the river itself. However, the majority of these reports do not explicitly review the effects of the dam upon recreational fishing and recreational uses of riparian vegetation and generally do not address socio-economic issues, but rather focus upon biophysical considerations.

In order to measure changes in most opportunities to participate in recreational activities, non-market benefit estimation procedures are necessary. Non-market estimation techniques try to determine a value for goods that are not traded in a market. Market goods, for example, the purchase of fishing tackle or the cost of licenses and entry fees to parks are not included. The total value of the trip is assumed to be greater than the value of market expenditures, as it would include leisure and other non-market components of utility.

Given accurate estimates of benefits and costs, that include recreational benefits foregone, mitigation may be attempted. The government's recognition of the importance of the recreational fishing activity is evident from efforts undertaken to mitigate the effects of the dam. Mitigation may be examined from either a physical or economic viewpoint to determine if there has been a net loss of recreational value in the region. A physical viewpoint would measure if the amount and quality of available sites has changed. This study will examine the economic benefits of the proposed mitigation effort.

While this study does not estimate all of the recreation benefits of the area, it is an important addition to the debate over the values and impacts of the dam's construction. It may be useful to show the importance of similar socioeconomic studies in assessing future construction projects, as well as the value of mitigation efforts. For example, similar economic models could be considered in evaluating the effects of additional or alternative reservoirs in the area. The study will also assess some empirical issues related to the economic model used. These include specification, incorporating subjective quality data, and the value of travel time to recreationists.

1.2 Background Information

1.2.1 Fishing/Recreation in Alberta

Outdoor recreation is an important activity for a large part of the population of Alberta. The outdoor recreation resources of the province also draw a large number of tourists to the province. The activities involved increase the general well-being (utility) of the population and are an important part of the economic activity in the province. Fishing is a popular recreation activity for Albertans, and also attracts tourists from outside the province. The report on sport fishing in Alberta for 1985, (AFW 1986), states that over 340,000 angling licences were purchased in the province and the total population of anglers exceeded 430,000[1]. Non-resident license sales exceeded 12,000, with approximately half being sold to non-Canadians. Approximately 5.4 million angler days were spent in Alberta and over $139 million was spent on fishing-related activities. The rivers and streams that originate in the eastern slopes of the Rocky Mountains, especially close to their headwaters, are important trout fisheries for the province. This is due both to the quality of the trout fishing, and the aesthetic value of mountain fishing.

1.2.2 The Oldman River Dam

The Oldman River Dam was constructed on the Oldman River, downstream of the confluences with the Crowsnest and Castle River, approximately 15 km north-east of the town of Pincher Creek. The dam will store spring run-off and supply a constant flow of water during the summer months for irrigation and municipal uses downstream. At the full reservoir supply level (FSL), the dam will cause flooding of 21.9 km of the Oldman River, 9.1 km of the Crowsnest River, and 12.8 km of the Castle River. The total area of the reservoir at FSL will be 2,420 hectares.

1.2.3 Environmental Quality Changes

The most direct and obvious effect of the dam is the flooding of 43.8 km of rivers in the area. This means a complete loss of recreational fishing value for this portion of the region. As FEARO (1992, p.18) suggested: "The reservoir is not expected to be very productive of game fishes ....". Thus, the reservoir will not be a substitute site

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[1]Licenses are not required for anglers under 16, or over 65 years of age.

for fishing in the near future. If the loss of the flooded reaches is seen as critical to users, some anglers may choose not to fish.[2]

The portions of the three rivers not flooded (above FSL) are assumed in this study to be unaffected by the dam. This assumption is not necessarily accurate, as the fluctuating levels of the dam will affect upstream flows to some extent, and the ecosystem, in some seasons. There are other potential effects on fisheries, both above and below the dam, (FEARO 1992, p.18):

> The dam blocks all upstream and most downstream fish migration. Species that undertake seasonal migrations past the dam site include rainbow trout, bull trout, and mountain whitefish. The blockage created by the dam will be most critical for rainbow trout and bull trout since the populations of these species downstream from the dam site appear to spawn upstream from the dam site.

This effect would be greatest in the Crowsnest River, the site of spawning for many species (Beak Associates Consulting Ltd., 1986). Other downstream effects will be outside the geographical area of this study.

1.2.4 Mitigation Effects

The Alberta government has been working to mitigate the effects of the dam on recreational fishing through the construction of mitigation structures in the remaining areas of the three rivers affected by the dam (FEARO 1992, p.18):

> Inundation of productive riverine habitat for sport fishes and changes in the riverine habitat for fishes downstream of the dam are acknowledged consequences of the Oldman River Dam project. In recognition of this the proponent has implemented and is designing programs to mitigate or compensate for anticipated losses in recreational fishery resources.

The stated goal of the mitigation is "no net loss of recreational fisheries opportunity" (Dominion Ecological Consultants, 1988). No net loss is defined in this report as "the replacement above full reservoir level of the high quality riverine fishery habitat which will be lost to flooding but also including the mitigation of impacts on downstream fish populations".

The type of structures are outlined in reports by R.L. & L. Environmental Services (1991) and Dominion Ecological Consultants (1988). The plans involve enhancing the physical habitat to increase the carrying capacity of the streams in the hope that this will increase populations of fish available for the anglers. Structures have

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[2]For the purposes of this study, "not fish" includes both literally not fishing, and choosing a new site outside of the study area.

currently been built on the upstream portions of the three rivers affected, with the potential for added construction in the future. No structures are anticipated on other watercourses in the area.

The reservoir itself is generally considered to be of little potential value as a fishery, however it may act as a wintering habitat for fish (Erythana Ventures Corp., 1991).

The method used in this study to estimate the future (post-dam) fishing potential of the remaining reaches is based upon the amount of habitat affected considering the actual physical changes that have occurred. The habitat types that are deemed high quality for adult trout species, either flooded or built, were used as a proxy for these physical changes.

1.3 Study Plan

The second section of this report provides background information on the modelling efforts possible for non-market valuation of recreation. A detailed description of the discrete choice model follows. The theory of welfare estimation using this method is discussed, along with applications suited to assessing public works projects.

In the third section, the source of the data used is described. A discussion of some of the problems associated with the data is included. The data used for estimation are described. The environmental quality changes caused by the dam are outlined. Calculation of habitat change and the study population are detailed.

The fourth section contains the results of the modelling efforts. Benefit estimates and a description of the sensitivity of them to various variables are shown. Section five provides a discussion of the results and outlines some conclusions.

SECTION 2: RECREATION DEMAND THEORY

2.1 Benefit Measurement and Recreation Demand Models

An emerging issue in the management of natural resources is the measurement of the benefits of services that resources provide. An important step in this measurement process is the estimation of demand for the various services. One resource that is typically not priced and is consequently under-valued in the decision-making process are fish and wildlife resources (e.g. Phillips 1983). One of the more highly profiled services that fish and wildlife resources provide is recreational fishing. This has been one of the most popular activities used in the resource economics literature to investigate various demand models and valuation methodologies (e.g. Bockstael et al 1989, Wilman and Pauls 1987, wilman and Perras 1989).

The main objective of non-market valuation is to derive a money based measure of the impact of changes in the quality or quantity of a good or service which is not typically priced in a market. There are two main approaches to valuation, the **direct** (or survey) approach and the **indirect** (or inferential) approach. The indirect approach is the method which is most comfortable to economists. Almost all traditional economic analysis employs information on actual behaviour and attempts to construct models which represent (or could generate) this behaviour. Interpolation or extrapolation of this model can be used to estimate the monetary impact of changes in quantity or quality. The direct approach involves "conversation" (Smith 1990) with individuals in an attempt to reveal their "values" for the non-market good or service.

Contingent Valuation (CV) is the most popular of the direct techniques. The term contingent valuation arises from the fact that the valuation of the good is contingent on the assumption of a market for the good. CV in its simplest form is a description of the situation (a fishing day) and a question of the form "what would you be willing to pay for a day of fishing, over and above all other expenses you might incur". Problems encountered with the use of CV center upon the existence of biases claimed to be inherent in the technique. This debate over bias is well documented in Mitchell and Carson (1989). The current study is based upon a survey which did not ask CV type questions.

2.1.1 The Travel Cost Method

One popular approach to estimating recreation demand is the Travel Cost Method (TCM). This method was first proposed in 1947 by Harold Hotelling in a letter to the U.S. National Park Service which was interested in measuring benefits provided by park recreation sites. Since that time extensive research has been conducted on this and other methods, and the TCM has emerged as one of the more robust approaches to modelling recreation demand (Smith 1988).

The TCM uses the costs incurred by a recreationist in accessing a particular site as a proxy for the market price of that recreation. In its earliest formulations (e.g. Clawson 1959), TCM involved establishing zones of origin relative to the recreation site, and the demand for site based recreation was derived by regressing the number of trips per capita in each zone against travel costs per trip. More sophisticated forms of this regional

TCM involved the incorporation of variables describing zone characteristics, site characteristics, and a measure of the costs and quality of substitute sites (e.g. Donnelly et al. 1985).

Further investigation of the simpler TCM models highlighted a number of serious issues. These are: the question of consistency with an underlying utility function when estimating economic benefits, the opportunity cost of travel time, the ad hoc nature of establishing the zones of origin[3], the role of substitute sites, the effects of site quality changes, and the deletion or addition of sites to a recreationist's "choice set" (Smith 1988). One of the major disadvantages of the standard TCM is that it cannot be used to value quality changes (Adamowicz 1991). Because of these issues, effort in the recent literature has been directed towards alternate forms of the standard TCM. The effect of substitutes and quality changes, in particular, have generated considerable interest due to heightened awareness of the general public to deterioration in the quality of the environment.

One proposed TCM model which attempts to incorporate site and quality variables is the Generalized TCM (Smith and Desvouges 1986). This is a two stage model that utilizes cross sectional data. The first stage estimates separate travel cost functions for a number of sites. The second stage involves estimating a systematic quality parameter using the coefficients from the travel cost functions regressed on the established site quality measures. However, this model does not consider site substitution effects. This is the result of using cross sectional data; it assumes that a recreationist will not reallocate his/her trips to other sites after a quality change at one site, but that he/she will simply change the number of trips taken to the affected site.

Another form of the TCM which focuses on the characteristics of recreation sites rather than on the site itself is the hedonic TCM (Brown and Mendelsohn 1984). The hedonic TCM develops implicit prices of quality attributes related to site characteristics in a two stage regression procedure. The theory used here is that recreationists will travel farther for better quality attributes and hence will be willing to pay more to travel. However, although this method incorporates site substitution due to quality changes, negative prices can be observed (e.g. Smith and Kaoru 1987). This results from the assumed positive or increasing relationship between costs and quality attributes. Another problem is that the estimated demand functions are associated with attributes and not directly with the recreation sites themselves. Thus it is not clear how to assess changes in quality at any one specific site, and how this affects demand across available sites.

Recently, discrete choice modelling has been applied to behaviour related to recreation services provided by natural resources like fish and wildlife (e.g. Carson et al. 1989, or Feenberg and Mills 1980). Discrete choice models are based upon research reported in the transportation literature (Domencich and McFadden 1975; Ben-Akiva and Lerman 1985). These models, also called random utility models (RUM), are useful for investigating situations where consumers face a discrete rather than a continuous set of choices. Because of this property, the

[3]In fact using a zonal TCM implies a zonal utility function, or in other words a utility function that represents every member living in that zone.

models have been used to investigate the choice of specific sites related to recreation, and have been incorporated into the broader category of travel cost models.

Random utility models have the advantage of being established within a utility maximizing framework. In this framework a recreationist selects a site that yields the highest utility based upon the characteristics of the choice of sites available. However, since RUMs focus on discrete sites, they can explicitly model the substitution of alternate sites. In addition, these models can treat entry and exit from the recreational activity due to changes in site quality. These "corner solutions" (zero visits to some sites) cannot be handled easily in traditional TCM models. The most popular RUM used in modelling recreation choices is the multinomial logit model (Stynes and Peterson 1984).

Recreational fishing is amenable to discrete choice modelling due to the discrete nature of fishing sites, the fact that anglers must purchase licenses which makes them an identifiable group, and the availability of most of the necessary information on the site qualities in the province.

The best procedure for the estimation of the non-market benefits for this study was deemed to be a Discrete Choice Random Utility Model. This model works well in a multiple site situation, with the attributes of the site known. Ideally, it should be the perceptions of these attributes by the participants that are used, but this would involve a far greater data collection effort.

2.2 Description of Discrete Choice or Random Utility Models[4]

The level of utility (satisfaction) of the recreationist (angler), V, is defined as a function of the attributes of the alternative fishing sites, Q, as in

$$V_{in} = V(Q_{in}) \tag{1}$$

where Q_{in} is a vector of attribute values for site i as viewed by recreationist n. The set of available recreation sites is denoted by C. An individual recreationist's choice set C_n may include all the sites in C or only a subset of these sites[5]. Site i will be chosen by the recreationist only if:

$$V_{in} > V_{jn}, \text{ for all } j \neq i; \quad i,j \in C_n \tag{2}$$

Utility in this model is modelled as a random variable, and the observed inconsistencies in choice behaviour are assumed to result from observational deficiencies on the part of the researcher (McFadden 1981, Smith 1989). More specifically, the random utility of recreationist n selecting any 1 recreation site can be expressed as the sum of observable and un-observable components of the total utilities. In other words:

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[4]This section is paraphrased from Coyne and Adamowicz, 1992

[5]In this study, the individual's choice set is assumed to include all the sites in C.

$$V_{in} = v_{in} + e_{in}, \tag{3}$$

where v_{in} is the systematic or observable component of the utility of choosing site i, and e_{in} is the random component referred to as the stochastic disturbance. The probability that site i will be chosen $(\pi_n(i))$ is equal to the probability that the utility of choosing site i, V_{in}, is greater than or equal to the utilities of choosing all other sites in the choice set or:

$$\pi_n(i) = Pr\{v_{in} + e_{in} \geq v_{jn} + e_{jn};\ \ \forall j \in C_n\} \tag{4}$$

The utility function was specified as a linear function of the site attributes, or

$$v_{in} = B_1 + B_2 x_{in2} + B_3 x_{in3}, \ldots + B_k x_{ink}, \tag{5}$$

where the x_{ink} are measures of site quality, and the B's are unknown parameters.

The multinomial logit model arises from the assumption that the disturbances, ϵ_{in} , are distributed as type I extreme values (Maddala 1983, Stynes and Peterson 1984). In this case, $(\pi_n(i))$ is determined by:

$$\pi_n(i) = \frac{\exp^{v_{in}}}{\sum_{j \in C_n} \exp^{v_{jn}}} \qquad for\ j \in C_n \tag{6}$$

The statements of site-choice probabilities are used to derive a likelihood function that is maximized to yield parameter estimates (Ben-Akiva and Lerman 1985:118-121). These are the parameters of the indirect utility function V_{in}.

2.3 Model Estimation

The model is estimated using Maximum Likelihood techniques. Briefly, the likelihood function outlined by Ben-Akiva and Lerman (1985) is:

$$L^* = \prod_{n=1}^{N} \prod_{i \in C_n}^{N} \pi_n(i)^{Y_{in}} \tag{7}$$

Where Y_{in} ={1 if the individual n chose i, 0 otherwise}.

When the form is linear in parameters then:

$$\pi_n(i) = \frac{e^{B'X_{in}}}{\sum_{j \in C_n} e^{B'X_{jn}}} \tag{8}$$

The maximum likelihood estimation technique finds the vector β such that the logarithm of L^* is maximized. Ben-Akiva and Lerman (1985) cite McFadden (1974) as showing that $\ln(L^*)$ is concave, so that a unique maximum potentially exists. Using maximum likelihood estimation yields an estimate of β that is consistent, asymptotically normal, and asymptotically efficient.

The maximum likelihood estimate of β is useful in that theoretically it implies that the sum of all the choice probabilities for alternative i (summed over all individuals in the sample) equals the actual number in the sample that chose i. This will prove useful below when the ability of the model to predict site choice accurately is investigated. This property can be depicted as follows:

$$\sum Y_{in} = \sum_{n=1}^{N} \pi_n(i) \tag{9}$$

2.4 Nested Discrete Choice Models

There is a known problem with the use of discrete choice models that relates to the distribution of the error terms, which are assumed by the model to be Weibull distributed. A test for this assumption, Independence from Irrelevant Alternatives (IIA), is well documented. If IIA is a problem, one solution is the use of a nested model. In a nested model, the choice of a site is deemed to follow a sequential process. For example, the angler would first decide the type of fishing to undertake, or the species of fish sought, and then the actual site is chosen. The choice set for each level of the sequence of decisions is effectively smaller, and better differentiated. However, this also imposes a much stricter behavioral assumption on the respondents. Nested models can overcome the IIA assumption, but they are more complex and require the development of a hierarchical nesting scheme. These schemes can be difficult to derive and can involve significant knowledge of the choice set. It is a point of debate in the literature which is more problematic, the behavioral assumption of a nested model, or the breaking of the IIA assumption. For simplicity, we have chosen a non-nested model.

2.5 Welfare Theory

The parameters of the indirect utility function are used to calculate the welfare measures. Initial research on welfare measures in discrete choice models was carried out by Small and Rosen (1981). Hanemann (1982, 1984) has since extended this analysis. If the multinomial logit form of the random utility model is chosen, the formula for the welfare impact (Compensating Variation or CV of a quality change) is (suppressing the subscript n on V):

$$CV = -\frac{1}{\mu}\{\ln(\sum_{i\in C_n}\exp(V_{i0})) - \ln(\sum_{i\in C_n}\exp(V_{i1}))\} \tag{10}$$

where μ is the marginal utility of income, V_{i0} is the level of utility in the initial state (or quality level) and V_{i1} is the level of utility in the subsequent state. Hanemann (1982) shows that the value for μ is equal to -1 times the β coefficient on the travel cost parameter. In the indirect utility formula:

$$V_i = \alpha + B(Y - TC_i) + \gamma Q \tag{11}$$

where TC_i is the travel cost to any site i, Y is income, Q is quality, and α and β are parameters;

$$\frac{\delta V}{\delta Y} = B\ . \tag{12}$$

Thus, the marginal utility of income is $-1 \cdot B$.

SECTION 3: THE DATA SET

3.1 Data Collection/Survey Design

The data for this model were obtained from a mail survey conducted jointly by the University of Alberta and the Alberta Fish and Wildlife Division, Alberta Lands and Forests, (hereafter called AFW). The survey concerned the 1990 fishing season, and was conducted during the winter of 1990/91. A copy of the survey is included as Appendix A. The purpose of the survey was to examine in detail the characteristics of anglers and angling site choices in the Southern region of Alberta. This information helps define the demand for fishing opportunities, and the attitudes and values of recreational anglers.

A portion of the survey asked about the quality attributes that were important for selection of a fishing site in general, and the same criteria for the respondent's favourite fishing site. Information on aspects of a typical fishing trip (fishing method, transportation, use of catch and release etc.) was requested. An important section for this study was a detailed diary for up to 15 fishing trips during the season. The diary included, among other things, the site of the trip, the date, fishing success, and the species of fish sought. A final section requested socio-economic information on the respondent (residence, age, income, and occupation). For details of the survey, and methodology, see Adamowicz et al (1992).

The population for the survey was obtained from the fishing licences sold in the province for the 1990 fishing season. The survey concentrated on fishing in all of southern Alberta (Fish Management Areas 1 & 2), and included a list of 77 of the most important sites.

For the purposes of the survey, an attempt was made to cover as close as possible, within budgetary constraints, the entire population that could potentially fish in the southern region. As such, it was assumed that 60% of the potential fishing population live in the region, another 20% live in the area between the southern region north to Calgary, and another 15% live in the area from Calgary to Leduc, as suggested by officials of AFW. These assumptions were verified by separate tests.

A total of 62,783 licences were issued by the province within these geographic boundaries. A random sampling method was used to obtain a sample size of 5,000. From this 5,000, there were 2,115 responses to the mailouts and 992 of these individuals indicated from the trip diary that they had fished in the southern region. This study involves a sub-set of that data - just trips to 19 designated sites in the Upper Oldman region (see Table 3.1 and Figure 2). The sub-set that includes those fishing in the Upper Oldman area had 236 respondents with complete questionnaires.

The responses from the questionnaire were entered into an SPSS (Statistical Package for the Social Sciences) format data set, using the MTS terminal system of the University of Alberta.

The data set from the total survey was reduced to information relevant to the Upper Oldman River basin area of southern Alberta. This was achieved by selecting (using SPSS) only those respondents who, through the trip diary, indicated that they had made at least one trip to the 19 sites in the area during the 1990 fishing season. As well, certain of the respondents indicated trips to the Crowsnest and Oldman rivers, without specification of which portion of the rivers was visited. These trips were proportionally allocated to the appropriate segments. The data on these cases were written to ASCII files, based on trips taken. Following removal of individuals who did not respond to pertinent questions, a sample of 236 individuals, and 737 trips resulted.

3.2 Site Quality Information

The ASCII data contained information on the residence (hometown) of the angler. Distances from residences to the fishing sites were determined with a measuring wheel on 1:250000 scale maps of the region. These distances were then converted to an ASCII file for use as a variable in the model.

The Lethbridge Regional Office of Alberta Fish and Wildlife completed a table of values for 40 quality attributes deemed to be important in the selection of a fishing site (see Appendix B). These 40 variables were chosen based on responses to the survey and the investigators knowledge of fishing. The survey categories were sub-divided to provide a more detailed list. Some survey categories were difficult to rate since they are highly subjective, for example, scenic quality. For this reason, proxies were attempted which related to known physical features. For most of the qualities, the estimates are objective, and assumed to be known by anglers. This includes information on parking, campsites etc. These variables can be easily measured. Several of the qualities require estimates with some degree of subjectivity. Of particular importance are catch rate and size of fish caught. The values listed for these variables are based upon creel surveys, and knowledge of the areas, but are subject to interpretation.

A second set of fish catch and fish size measures[6] was determined in consultation with J. O'Neil[7] of R.L. & L. Environmental Consultants Ltd. of Edmonton. These estimates are based on Mr. O'Neil's work in measuring fish populations in the affected streams since 1985, and a creel survey undertaken in portions of the study area in 1990 (Hildebrand and O'Neil 1992). Mr. O'Neil also assisted in estimating the probable catch rates and size caught for sites affected by the dam. The "educated guess" is based on what the populations of fish are likely to be after stabilization of the ecosystem.

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[6] To compare these two sets of estimates see Tables 4.1 and 4.2.

[7] J. O'Neil is a biologist with R.L.& L. consultants, the company responsible for fish population studies in the study area. Mr. O'Neil graciously provided information that allowed us to devise methods of estimating changes in catch rates.

Figure 2 Fishing Sites in the Study Area

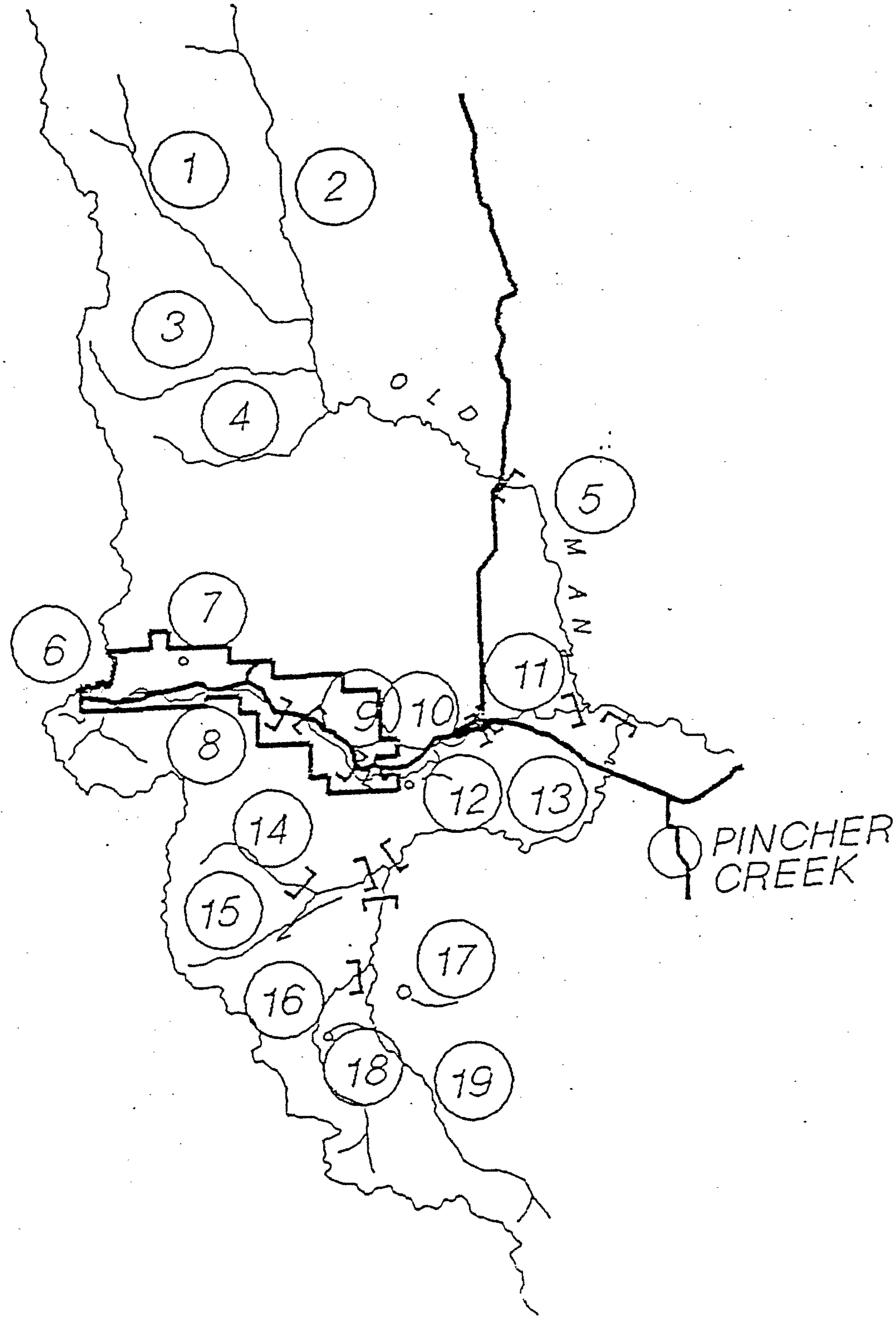

Table 3.1 Locations Used as Fishing Sites

Site Number	Legal Description	Site Name/Commentary
1	32:10-3-W5	Upper Oldman NW Branch; campsite on Hwy 517
2	23:13-4-W5	Livingstone River; campsite at Beaver Creek
3	7:11-3-W5	Dutch Creek; campground near junction with Oldman River
4	23:10-4-W5	Racehorse Creek; Campsite on Hwy 940
5	35:7-1-W5	Oldman River, Hwy 22 bridge to Peigan Reserve; crossing on Hwy 510
6	7:8-5-W5	Crowsnest Lake; campground
7	22:8-5-W5	Allison (Chinook) Lake; artificial lake on Chinook Creek
8	9:8-4-W5	Crowsnest River - Headwaters to Blairmore, at Coleman
9	30:7-3-W5	Crowsnest River - Blairmore to Passberg Bridge, at Frank Lake
10	10:7-3-W5	Crowsnest River - Passberg Bridge to Lundbrook Falls; midpoint
11	28:7-1-W5	Crowsnest River - Lundbrook Falls to mouth; midpoint
12	12:7-3-W5	Burmis Lake; at Burmis
13	35:6-1-W5	Castle River; campground near Pincher Creek
14	12:6-4-W5	Lynx Creek; near Carbondale River (Cherry Hill)
15	12:6-4-W5	Carbondale River; Provincial campground
16	15:6-3-W5	West Castle River; where road ends
17	11:5-3-W5	Beavermines Lake
18	28:4-3-W5	Barnaby (Southfork) Lake; Barnaby ridge on Southfork mountain
19	26:4-3-W5	South Castle River; junction with Grizzly Creek

3.3 Effect of Dam on Site Quality Attributes

There are two major effects of the dam on site quality attributes. The first is the shortening of the length of the reach of the three rivers affected. The change in the variable for length of stream is directly measurable for the sites affected. The second is the potential effect on catch rates in the remaining sections of these three rivers. The mitigation work undertaken by the province is an attempt to counter-act these effects. The success of this effort is not known at this time. In part, this is because the building is incomplete. As well, it takes time for the ecosystem to stabilize after construction (R.L. & L. Environmental Services 1991). The filling of the reservoir has been "pushing" fishing from the flooded reaches into the remaining stretches of river. The temperature regimes will be changed, and the productivity is not certain.

The method used to estimate the future (post-dam) fishing potential of the sites used for this study is to tally the amount of habitat affected, that is, the actual physical changes that have occurred. The habitat types that are deemed high quality for adult trout species, either flooded or built, were used as a basis for these physical changes. From work carried out before construction of the dam (R.L.& L. Environmental Services 1986) the amount of habitat for adult trout was measured, in square meters, for the three rivers affected (Crowsnest, Oldman, and Castle). The habitat in areas flooded is deemed lost. Habitat constructed through the mitigation structures was added to the site. A linear relation was assumed between habitat available and fish catch. Thus, the estimated future catch rates depend solely on the change in habitat, and it is possible to estimate future catch rates by estimating the success of the structures in attracting fish (eg 100%, 75% etc.). O'Neil (personal communication) suggests 75% is probably the best guess of the success of the structures. White (1991) has a much lower opinion of the mitigation work. An upper limit was placed on the estimate, that corresponds to what AFW rates as a first class catch rate. A sensitivity analysis on levels of success was performed to account for doubts that some may have in the mitigation structures, and because the linearity between catch rate and habitat available may not be realistic.

Fees for using Alberta Forest Service campgrounds have been instituted since the dam was constructed.

However, this involves a uniform increase in fees for all sites. As well, the environmental change under discussion is the presence of the dam, and any mitigation efforts to counteract the loss of some sites. For that reason, the price increases in campgrounds were not used in the welfare estimates of this study.

3.4 Calculation of Habitat Changes

For the purposes of calculating future catch rates, the amount of habitat available or potentially available for adult trout at affected sites was used. The change in habitat was multiplied by the original catch rate, giving an estimate of the post-dam catch rate. The specific habitat used for the calculation was type R1/BG and R2/BG.

3.5 Calculation of Populations of Anglers

In order to undertake the welfare measures outlined in the next chapter, the total population represented by the study sample needed to be extrapolated. For the survey as a whole, the number of anglers per city was available, as was the percent share of respondents from each city (Adamowicz et al, 1992). For example, in the survey, 827 of the 2,115 respondents (39.1%) lived in Calgary, (see Table C-2, Appendix C for a table of this and the following calculation). The total number of fishing licenses sold in the province, that were within the designated population area of the survey, for 1990 was 62,783. This total, multiplied by the percent share, gives the number of anglers from each city in the total population; for Calgary this was 24,549.

The data available for the sample provided information of the residence of each angler in the sample, and the number of trips undertaken from each hometown could be computed. Using the number of anglers from each city or town, the percent share of that city among the 236 separate anglers visiting the region was calculated. The number of trips per city divided by the number of anglers per city was used to determine the average number of trips per angler for that city, (see Appendix C, Table C-1).

The total population from each city was then multiplied by the percent share of visits to the Oldman Region, to obtain the total number of anglers from each city that visited the region, (Appendix C, Table C-2, column 5). To continue the example, for Calgary, this value was 2,434. This number was multiplied by the average trips per city to the region to obtain a value for the total trips per city to the Oldman region.

Table 3.2 Habitat Change Calculations

site[1]	original habitat (m^2)	lost habitat (m^2)	habitat constructed (m^2)	% change with dam alone[2]	% change with dam & mitigation (25%)[3]	% change with dam & mitigation (50%)	% change with dam & mitigation (75%)
1	45,907	0	3500	0	1.9	3.81	5.7
5	151,076	123,063	20,225	-81.4	-78.1	-74.7	-71.4
8	1,787	0	30,661	0	428.9	857.89	1286.8
11	45,700	20,950	61,858	-45.8	-12.0	21.8	55.67
13	104,938	78,663	30,590	-75.0	-67.7	-60.4	-53.1

1. Only the sites that underwent a change in habitat are listed.
2. Calculation for % change is: (result minus original / original) X 100, where result is equal to original minus lost.
3. Calculation for % change for differing success levels is: (result minus original / original) X 100,
   where result is equal to original minus lost plus constructed multiplied by percent effectiveness.

SECTION 4: MODEL DEVELOPMENT, ESTIMATION, AND RESULTS

4.1 Model Development

The survey, and the quality attributes provided by AFW, resulted in a large number of potential variables for model estimation, too many to be used initially. This is a common problem in models of this type (Leamer 1978). The process of selecting certain variables for inclusion depends upon either *a priori* beliefs, or a process of trial and error. If *a priori* beliefs are used, the final product is a model consistent with these beliefs, which may fit the data fairly well (Ortuzar 1983). Trial and error also results in a model which fits the data, but which may or may not be consistent with beliefs. There is concern that the trial and error approach, while allowing "learning" from the data, reflects relations that happen to exist in the sample, rather than true behavioral relations (Train 1979). A combination of the two seems to work best (Train 1979). The approach used here is a combination of *a priori* beliefs, and trial and error. A limited number of variables, based on prior knowledge, were initially used, and then other variables, and combinations of variables, were tested.

The variables that were selected initially for model estimation were based on prior knowledge of the criteria used by anglers for site selection. Distance to the site was chosen both because it was thought to be important, and the fact that this type of model cannot measure benefits without travel costs, which are determined from distance to the site from home. The section of the survey questionnaire that asked what attributes were important in the selection of a fishing site was also used as a source of information. A creel survey of portions of the study area (Hildebrand and O'Neil 1992), received after estimation had started, confirmed the importance of these variables. In addition, similar variables were found to be important in a study of recreational fishing in the Highwood River region (Alberta Environment at al 1992).

The four most important attributes according to the survey, were scenic value, water quality, privacy, and a chance to catch fish. A variable for scenic value was not obtained, as it is highly subjective. Proxies were attempted, such as trees around the site. Water quality was highly rated by anglers, and is important for fish populations. All of the sites in the study area had high water quality, especially in relation to other watercourses outside of the area. The creation of a variable for privacy proved to be very difficult. A congestion value was provided by the AFW staff, but congestion can be difficult to include in a model that is based on visits, since as visits increase, so does congestion. Certain combinations of attributes were attempted. Using the assumption that privacy may be related to a lack of development, or the presence of trees that shield the view of other recreationists, these variables were included.

The chance to catch fish was thought to be important from information received in the survey. The list provided by AFW contained information on different species of fish. Using information provided by other survey sections relating to species sought, and a creel survey (Hildebrand and O'Neil 1992), it appeared useful to create two separate variables: one for the catch rate of rainbow trout, and another for all other species grouped together. The variables of stream reach length and lake area were included to reflect the size of fishing areas and the possibility of uncongested angling.

It was assumed that campgrounds would become more important the farther the angler lived from the area. That is, someone living within a short distance of the site will go home for the evening, whereas someone who must travel several hours will want to camp. A variable combining these two (distance times camping spaces) was created.

Dummy variables for sites known to have particular attributes were tested for the model. Dummy variables help to capture attributes of the site not listed elsewhere. The dummy variables were included to improve statistical fit. Dummy variables cannot be included for all sites because of colinearity between the dummies and other variables. Dummies for the 3 sites with the most visits were tested (sites 1, 11, and 17). As well, dummy variables were included for site 12 (due to its poor attributes and low visits), site 18 (as this was the only site that required a hike to reach it), and site 10 (close to site 11 and similar in many qualities, but with few visits[8]).

A number of models were estimated using combinations of the variables outlined above[9]. The number of variables tested was gradually increased from the initial set in an attempt to get the best fit possible, and a model that best predicted the site visits. The variables used in the final models are listed below and their actual values re listed in Tables 4.1 and 4.2. The variables are:

DIST

This is the measured distance from the hometown of the angler to the fishing site. In a model based on Travel Cost, such as this one, distance is by definition an important variable. For estimation of the models, the one way distance was used.

DISTCAMP

This variable was created by multiplying distance by the number of camping spots available at the site. Each can be important individually but the assumption behind this variable is that camping is more important for anglers living far from the site. The number of sites is valuable if it is assumed that anglers will consider the risk of a campsite being available.

PARKING

This variable is a measure of access. While local anglers may have access to other sites through friendship with landowners, all anglers will have access if parking is available. This was a zero/one variable, parking was either available, or not.

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[8]A dummy for site 13 was also tested.

[9]The variables that were identical for all 19 sites were not used in the estimation and final model selection.

SIZECOT

This is a measure of the size of fish caught. It is based on creel surveys, and knowledge of the area. The assumption is that anglers prefer larger to smaller fish. This variable is also one of the two that define differences between models estimated. Different estimates of the size of fish caught were provided by AFW, and O'Neil.

RAINBOW

This is an index of the catch rate per hour for rainbow trout. In the original site quality attributes provided by AFW, the catch rate per hour as well as the species involved was listed. An assumption was made that rainbow trout was the most desired species, so it was separated. This is another variable that separates the models estimated.

OTHRCATX

This is an index of the catch rate per hour for all species of fish other than rainbow trout.

AREALAKE

A physical measure of the area in hectares of lakes in the region. If the site is not a lake, the area is zero.

LONGCRIK

A physical measure of the length of the reach of streams or rivers.

CC1

A dummy variable for site number one.

CC10

A dummy variable for site number ten.

CC11

A dummy variable for site number eleven.

14.2 Estimation and Model Results

Maximum Likelihood estimation of the Multinomial Logit Models was undertaken using LIMDEP, version 6.0 (Greene 1992). Separate models were estimated based upon the different values for fish catch and fish size. Tables 4.1 & 4.2 contain the values for the quality attributes used for each model. Each of these two models was then separately estimated using the dummy variables. The models are numbered as outlined in Table 4.3. Final results of the modelling efforts are shown in Table 4.4.

Table 4.1 Site Attribute Values Provided by AFW

Site	Campsites	Parking	Sizecot	Rainbow	Othrcatx	Arealake	Longcrik
1	10	1	2	0.99	0.99	0	35.7
2	22	1	3	0.00	0.71	0	29.0
3	42	1	2	0.00	1.20	0	25.0
4	37	1	2	0.00	0.30	0	26.0
5	0	1	3	0.10	0.50	0	44.0
6	0	1	2	0.00	0.01	130	0.0
7	74	1	1	0.00	0.01	6	0.0
8	0	0	2	1.00	0.13	0	15.5
9	0	0	3	1.00	0.04	0	11.5
10	0	1	7	0.70	0.08	0	18.0
11	53	1	7	0.60	0.15	0	15.9
12	0	1	4	0.01	0.00	.7	0.0
13	46	1	4	0.00	0.40	0	41.0
14	30	1	5	0.00	0.91	0	19.0
15	0	0	3	0.00	0.91	0	20.0
16	0	0	6	0.00	0.81	0	31.0
17	107	1	5	0.50	0.00	68	0.00
18	0	0	2	0.00	0.25	5	0.0
19	0	0	5	0.00	0.44	0	41.0

Table 4.2 Site Attribute Values Provided by O'Neil

Site	Campsites	Parking	Sizecot	Rainbow	Othrcatx	Arealake	Longcrik
1	10	1	2	0.99	0.99	0	35.7
2	22	1	3	0.00	0.71	0	29.0
3	42	1	2	0.00	1.20	0	25.0
4	37	1	2	0.00	0.30	0	26.0
5	0	1	3	0.10	0.50	0	44.0
6	0	1	2	0.00	0.01	130	0.0
7	74	1	1	0.00	0.01	6	0.0
8	0	0	5	0.70	0.13	0	15.5
9	0	0	5	0.75	0.04	0	11.5
10	0	1	5	0.49	0.08	0	18.0
11	53	1	6	0.55	0.15	0	15.9
12	0	1	4	0.01	0.00	.7	0.0
13	46	1	4	0.00	0.40	0	41.0
14	30	1	5	0.00	0.91	0	19.0
15	0	0	3	0.00	0.91	0	20.0
16	0	0	6	0.00	0.81	0	31.0
17	107	1	5	0.50	0.00	68	0.00
18	0	0	2	0.00	0.25	5	0.0
19	0	0	5	0.00	0.44	0	41.0

Table 4.3 Model Specification		
Model Number	Source of Values	Presence of Dummy Variables
1	AFW	NO
2	AFW	YES
3	O'NEIL	NO
4	O'NEIL	YES

Water quality is important for the quality of the fishing experience, as outlined in section 4.1. It proved to be insignificant in the modelling process. This was expected, as all of the study sites had high water quality ratings. It was not possible to use the congestion attribute, or create a proxy. The same was true for the privacy attribute. The variable for parking was only used in the models without dummies as it proved to be insignificant when dummies were included. In order to better compare the sensitivity of the models to different values for catch rate and size of fish caught, similar variables were used in models 1 and 3, and models 2 and 4.

The results of the estimation process are shown in Table 4.4. The models as estimated are all highly significant. The larger chi-squared values associated with the log-likelihood ratio tests indicate that the models based on values from O'Neil are slightly better than AFW based models. The difference is less obvious when dummy variables are included. The parameters have t-values that show them to be significant. The signs of the estimated coefficients of the parameters are all in the expected direction. The coefficient for DIST is negative as expected indicating that anglers prefer fishing sites close to their homes. All other variables have positive coefficients. DISTCAMP, which incorporates DIST, is positive due to the influence of camping spots. An increase in the value of any of the attributes used except distance, with all else held constant, will increase the utility to the angler. The absolute values of the coefficients cannot be compared to determine which variable is the most important, and there is not a direct linear relationship between changes in the coefficient and the probability of choosing a fishing site.

4.2.1 Sensitivity to Attribute Values

Comparison between models 1 and 3, or models 2 and 4, shows the sensitivity of the process to the values used for the fish catch and size variables. The values for these two variables in the models are best guess estimates from experts on the region. Some factors that could cause the difference are the catch rate for different sizes of fish, the expertise of the angler[10], and annual variations due to natural causes.

The values suggested by O'Neil result in models that have a higher chi-squared significance level than models based on AFW values, and a lower maximum likelihood estimate. This can be seen by comparing models 1 and 3. Models 2 and 4 are affected more by the use of dummy variables than the sensitivity to attribute quality values, and the comparison of them is discussed in section 4.2.2. The different attribute values used between models 1 and 3 also results in changes in many of the parameter coefficients in these models. The coefficients for the two variables RAINBOW and PARKING are quite different between models 1 and 3. The other parameters, including OTHRCATX, are not very different.

[10]It has been suggested (Hildebrand and O'Neil 1992) that the level of expertise of anglers on the Crowsnest River has increased in the last 5 years.

Table 4.4 . Multinomial Logit Estimates of Recreational Fishing Site Choice.

Variable	Coefficient (t-ratio)			
	Model 1[1]	Model 2[1]	Model 3[2]	Model 4[2]
DIST	-0.0216530 (-5.537)	-0.026401 (-6.522)	-0.024856 (-6.003)	-0.026428 (-6.531)
DISTCAMP	0.0000714 (4.139)	0.0001451 (8.709)	0.00010273 (6.349)	0.0001334 (7.731)
PARKING	0.75621 (6.511)		0.33577 (0.063)	
SIZECOT	0.15932 (4.386)	0.12554 (3.051)	0.22191 (9.366)	0.15742 (4.391)
RAINBOW	1.4877 (6.091)	0.39829 (1.383)	0.91629 (8.797)	0.42616 (2.160)
OTHRCATX	0.78315 (5.000)	0.58538 (3.261)	0.62910 (4.400)	0.52220 (2.899)
AREALAKE	0.010307 (6.165)	0.0132299 (7.748)	0.011431 (6.910)	0.012526 (7.171)
LONGCRIK	0.019374 (4.596)	0.018804 (4.025)	0.016712 (3.994)	0.016924 (3.703)
CC1		0.98209 (5.888)		0.62981 (2.281)
CC10		1.0209 (7.242)		0.70871 (4.028)
CC11		1.0883 (6.708)		0.54919 (2.573)
Log-Likelihood Test (Chi-sq)	302.032	374.194	365.821	378.989

[1] These models are based on values for the SIZECOT, RAINBOW, and OTHRCATX variables obtained from Alberta Fish and Wildlife.
[2] These models are based on values for the SIZECOT, RAINBOX and OTHRCATX variables from O'Neil.

An explanation for the sensitivity may be found in the relationship between the quality attribute values used in estimation, and the site choice probability framework of Discrete Choice Models. The values of O'Neil for RAINBOW are more strongly correlated to the actual site visits than are the values of AFW. This might result in the RAINBOW variable picking up some of the effect of other variables in the AFW model. The SIZECOT variable shows the third highest difference between models 1 and 3, with the same relation between its gradation, and that of actual trips.

4.2.2 Sensitivity to Use of Dummy Variables

Models based on O'Neil or AFW values show little difference when dummy variables are included. The maximum likelihood estimates are very similar, as are the chi-squared significance levels. These two models are similar to the O'Neil model without dummy variables. This shows the importance of the dummy variables in the AFW model. The coefficients for the variables (RAINBOW, SIZECOT and DISTCAMP) are quite similar in the two models with dummies. However, the dummy variable coefficients are quite different between models 2 and 4. The coefficients for the AFW model are much higher than those for the O'Neil model.

4.2.3 Site Visit Predictions

The predictive ability of the four models is shown in Table 4.5. The ability to accurately predict trips to the sites is a useful test of the model estimation process. It is also a useful policy tool, in that visits to the sites before and after an environmental quality change can be compared. Such a comparison is only possible if the model predictions are reasonably comparable to actual trips. The two models which use the estimates provided by J. O'Neil predict trips better than those from AFW. The models with dummy variables show higher predictive ability than those without. This is especially important for models using estimates by AFW. Tables of the changes in visits to each site, as captured by the market share are shown in Appendix D. The market share calculation is the probability of a visit to any site from any city multiplied by 100 to obtain a percentage. The tables in Appendix D, which are based on model 3, show the market share prior to the dam construction, with the dam but without mitigation, and with mitigation at 75% success. This type of calculation only allows for substitution between the 19 sites; it does not allow anglers to stop fishing, or to fish outside the area.

The change in market share from the original state, to the dam without mitigation, show that the sites that have been flooded uniformly lose market share, with site 11 having very strong losses. The trips to substitute sites are somewhat dependent on the home city. Site 17, Beavermines Lake, captures many more visits from residents on or south of Hwy 3. Sites 2 and 3 capture new visits from more northern cities, such as Calgary. Site 1 changes in market share are very dependent on the hometown of the angler. For example, residents of towns along Hwy 2 between Calgary and Fort McLeod have fewer visits, but Calgarians would have more, as would those from Fort McLeod. Towns in the Crowsnest Pass, such as Bellevue, would have fewer visits, but those residents from Pincher Creek, further south, would have more visits.

The change in market share when mitigation occurs becomes very uniform. In this case only sites 1 and 8 increase their market shares, all other sites lose market share. This includes site 11 where a great deal of mitigation work has occurred.

4.3 Welfare Measures

The welfare measures were first calculated on a per city basis for the region, and then summed to yield the total benefits change according to formula 10 in section 2.5. An example of the calculation of benefits from each residence zone to the region, for each of the models, is shown in Appendix D. The change in utility that occurs when the reservoir, and/or mitigation structures were placed in the model, was calculated on this residence basis, per trip. With the value for total trips per city, it was then possible to calculate the total benefit change per city, to the region, for each change in fishing quality studied. Measures of the change in welfare for the four models were calculated using formula 10. In order to calculate the change in total benefits, the benefit from each city to all of the sites was determined. This was done at three different success levels for the mitigation work. The dollar value of the travel to the site was determined by using a cost of operating motor vehicles provided by the Alberta Motor Association (AMA). The AMA provides estimates of motor vehicle operation for different classes of vehicle. An intermediate value was chosen. The AMA estimation of the cost of operating a mid-size car in the province is $.351/mi ($.22 per km). This value, times the round trip distance from the home town to the site, was included in the formula.

There is some debate in the literature over the use of a value for the time spent in travel in models of this type (Shaw 1992, Bockstael et al 1987, McConnell 1985). In order to gauge the sensitivity of the welfare measures to the inclusion of a value for time, the measures were calculated both with and without time values. For the time value, it was assumed that the angler could have been working, so an average manufacturing wage rate was used. The wage rate was provided by the Alberta Bureau of Statistics, and amounted to $574 per week. A work week of 40 hours was assumed to obtain an hourly rate. The average speed of travel was assumed to be 50 miles per hour. The hourly wage rate divided by the average speed, multiplied by the round trip distance was included in the formula for cost when a value for time was desired. The calculation of annual changes in total benefits, both with and without time, are shown in Tables 4.6 and 4.8.

Table 4.5 Actual and Predicted Trip Distributions by Model

Site	Actual	Model 1	Model 2	Model 3	Model 4
1	75	42	75	69	75
2	30	44	33	35	33
3	28	44	33	31	30
4	21	23	20	18	19
5	36	48	30	34	29
6	31	35	41	33	39
7	27	11	13	10	13
8	14	30	21	20	17
9	14	29	20	23	19
10	68	54	68	75	68
11	112	86	112	92	112
12	3	15	11	14	13
13	42	59	50	53	50
14	30	49	33	43	34
15	27	15	20	16	20
16	37	26	32	34	34
17	108	102	90	105	93
18	3	5	9	7	9
19	31	21	28	26	30
Chi Square[11]		132.92	42.45	67.5	39.47

[11]The Chi Square test measures the difference between the observed and predicted number of trips for each site. With 18 degrees of freedom, the critical value is 37.2 at 99.5% level

4.3.1 Discussion of Welfare Changes

All of the models estimated show that there is a welfare loss to anglers using this region due to the construction of the Oldman River Dam. Depending on the model used, the annual welfare loss ranges from $96,239.10 to $50,469.00. The models based on values provided by O'Neil show a smaller loss than the models based on values provided by AFW. The models with dummy variables show a smaller loss than models without dummy variables. These differences are probably related to the difference between the models in the coefficient for the RAINBOW variable. In calculating the environmental effect of the dam's placement, three variables were changed, RAINBOW, OTHRCATX, and LONGCRIK. There are no large differences in the 4 models for the coefficients on the variables of OTHRCATX and LONGCRIK. However, the size of the coefficient for the RAINBOW variable in Model 1 is larger than in the other three models. The effect of this difference can be seen in the higher welfare loss exhibited in Model 1 versus the other three models. The use of dummy variables equalizes the differences in the other variables, and so Models 2 and 4, with dummy variables, are closer in value than any other pairing.

The welfare gains were estimated for each of four different mitigation success levels: no mitigation (equal to zero success), 25% success, 50% success, and 75% success. In all four models, mitigation results in an eventual welfare gain from the mitigation habitat construction. For Model 1 positive gains occur at the 25% success level; for Model 3 gains occur at the 50% level; and for Models 2 and 4 the 75% level of success is necessary for the changes to be positive. The difference again highlights the sensitivity of welfare estimates to values of and incorporation of particular variables. Those models which do include dummy variables (2 and 4[12]) require larger mitigation success levels to result in gains.

[12]Note that these models also have the best trip prediction ability.

Table 4.6 Annual Welfare Impact from Fishing Quality Change:
Time Value of Travel Not Included

Model	Mitigation Success Level			
	0%	25%	50%	75%
Model 1	-58,246.5	29,036.6	86,092.9	126,794.9
Model 2	-32,221.8	-16,807.8	-3,283.5	7,206.4
Model 3	-37,580.5	-14,332.2	6,376.6	60,454.6
Model 4	-30,545.2	-18,462.4	-6,978.4	22,971.6

Table 4.7 Capitalized Value of Fishing Quality Change:
Time Value of Travel Not Included

Model	Mitigation Success Level			
	0%	25%	50%	75%
Discount Rate 5%				
Model 1	-1,164,930	580,732	1,721,858	2,535,898
Model 2	-644,436	-895,654	-65,670	144,128
Model 3	-751,610	-286,644	127,532	1,209,092
Model 4	-610,904	-369,248	-139,568	459,432
Discount Rate 10%				
Model 1	-582,465	290,366	860,929	1,267,949
Model 2	-322,218	-168,078	-32,835	72,064
Model 3	-375,805	-143,322	63,766	604,546
Model 4	-305,452	-184,624	-69,784	229,716

Table 4.8 Annual Welfare Impact from Fishing Quality Change: Time Value of Travel Included				
Model	Mitigation Success Level			
	0%	25%	50%	75%
Model 1	-96,239.1	47,976.3	142,249.0	209,499.8
Model 2	-53,239.2	-27,771.1	-5,425.3	11,907.0
Model 3	-62,093.3	-23,680.7	10,535.9	99,887.5
Model 4	-50,469.0	-30,505.0	-11,530.3	37,955.3

Table 4.9 Capitalized Value of Fishing Quality Change: Time Value of Travel Included				
Model	Mitigation Success Level			
	0%	25%	50%	75%
Discount Rate 5%				
Model 1	-1,924,782	-959,526	2,844,980	4,189,996
Model 2	-1,064,784	-555,422	-108,506	238,140
Model 3	-1,241,866	-473,614	210,718	1,997,750
Model 4	-1,009,380	-610,100	-230,606	759,106
Discount Rate 10%				
Model 1	-962,391	479,763	1,422,490	2,094,998
Model 2	-532,392	-277,711	-54,253	119,070
Model 3	-620,933	-236,807	105,359	998,875
Model 4	-504,690	-305,050	-115,303	379,553

4.3.2 Sensitivity to the Value of Time

The effect of including time values is shown in Tables 4.6 and 4.8. All four models show about a two-fold increase in the absolute value of either the welfare loss or gain associated with the environmental change. It does not affect the mitigation success level necessary to shift any particular model from a loss to a gain. This is because the value of time is included in the welfare calculation (formula 10) in a way that does not affect any of the coefficients that vary between models. It increases the magnitude of the effect of the DIST variable on the marginal utility of income. Including the value of travel time does produce a significant change in the size of the welfare effects of an environmental change. This will be discussed further below.

4.3.3 Capitalized Value of Welfare Change

The welfare effects discussed above are annual changes due to the construction of the dam. While these are important, from a policy point of view it is instructive to compare the welfare changes with costs of mitigating the dam's impacts. A similar comparison was done by Morey et al. (1992) for a similar study in Maine where it was determined that the costs of mitigating negative effects of environmental changes on fishing would not be efficient. The cost necessary to mitigate the damage would be far greater than any positive effect the mitigation would have on welfare of anglers.

Data provided by the province indicate that 5.5 million dollars have or will be spent directly or indirectly on mitigation efforts. It is difficult to apportion costs inside and outside the study area, however. The 5.5 million budget includes fish population studies to determine the effect of flooding, habitat surveying, and actual construction. The population studies include work below the damsite and outside of the geographical area of this study. There is also campsite and recreational facility construction below the dam which would have been done regardless of mitigation efforts[13]. However, due to the difficulty of apportioning funds on direct mitigation efforts, comparisons will be made using the entire mitigation budget.

Capitalization of the annual welfare change was performed using the assumption that there would be no additional annual changes, and that these values accrue in perpetuity. The formula used was:

---

[13]The largest part of the campsite effort below the dam was to adapt what had been the workers camp for the dam construction. In the absence of mitigation, money would have had to be spent to remove this work camp.

$$Present\ Value = \frac{Annual\ Value}{Interest\ Rate} \tag{11}$$

Two different interest rates were used for the calculation, 5% and 10%. These values reflect interest rates used in opposing calculations of the original benefit/cost studies carried out for the dam as a whole (Anderson, M. and Associates 1986). These rates are also commonly used in similar calculations of direct benefits (e.g. Filion et al. 1990). However, FEARO (1992) contains a discussion concerning opposition to the 5% interest rate, and why the Treasury Board of Canada suggests a rate of 10% for all benefit/cost studies.

Capitalized values for the welfare change due to construction of the dam and mitigation efforts are shown in Tables 4.7 and 4.9. Table 4.9, with the value of time included, will be discussed here. Table 4.9 values will vary in the same manner, but with a lower absolute value.

A review of the literature and studies published by the province indicates that the mitigation effort was to counteract the loss occasioned by the construction of the dam. It is not entirely clear whether the effort was intended to counteract the physical loss of habitat, or the change in economic welfare from loss of fishing opportunity. This study is limited to examining the economic aspect. Thus the comparison is between the money spent and the welfare loss that occurred.

The comparison between the amount spent on mitigation and the capitalized value of the welfare change will be made in two directions. First, the comparison will be made between the amount spent and the loss that occurred from the dam construction alone, and secondly between the amount spent and the gain that occurred from the mitigation effort. The reason for separating the two discussions rests on some of the assumptions used in welfare economics concerning loss calculations. Briefly, one of the assumptions of this type of model is that a loss can be calculated in the same way as a gain. That is, that the amount a person would be willing to pay for a gain is equal to the amount he/she must be compensated for a loss. This assumption has been challenged in work carried out by Knetsch (1990)[14].

The losses from the dam construction range from approximately $2,000,000 to $500,000 (Table 4.9). These losses are significant, and should have been included in the Benefit/Cost Analysis undertaken to determine if the dam should have been built. However, the magnitude of the recreational fishing loss due to the construction of the dam is relatively small when compared to the other costs and benefits associated with the project. At face value, the mitigation efforts also appear to result in a further loss to the province. It is not efficient to spend $5,500,000 to recover a loss of less than $2,000,000. The difference suggests a new loss of at least $3,500,000, depending on the model used, and whether the value of time is included[15]. However, this loss figure also depends on assuming that all of the $5.5 million was spent on mitigation, which is not the case.

If the mitigation effort is seen to be creating a net welfare gain, (as most of our models show) then the comparison between the monies spent and resultant welfare gains are instructive. In this case, the "starting point" is first shifted by the initial loss (at face value) before the calculation is made. That is, the loss occurred, (fishing sites damaged), and then a second effort is made to improve on this new situation. Depending on the model, the success rate, and the interest rate used, some cases come close to a breakeven point, or even a net gain. For example, Model 1, with a 5% interest rate, 75% success level of mitigation, and time value of travel included, the result would be:

loss with dam alone-$1,924,782

dam with mitigation+$4,189,996

final gain=$6,114,778

Comparing this benefit of $6.1 million with the $5.5 million spent on mitigation suggests that the gain is greater than the money spent. The above example is a special case, in all the other possible scenarios of combinations

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[14]In his work, Knetsch states that the compensation value is several orders of magnitude higher than the willingness to pay. The exact difference can vary with the scarcity of the good in question, but a general figure used is that compensation needs to be 3-4 times the willingness to pay.

[15]Using the different assumptions of Knetsch, the loss would have to be multiplied before the comparison with mitigation spending is made. With the loss values shown in Table 4-12, and a multiplication factor of 4, in approximately half of the scenarios, loss measures would be quite close to the amount of mitigation monies spent.

of interest rate, model, time value of money and success rate, if the purpose was to create a gain, then mitigation spending was higher than the resultant benefit gain. However, the figure of $5.5 million also includes work other than just the habitat construction, and there are other benefits stemming from the spending that are not accounted for here. These other benefits could include recreational activities other than fishing at the campgrounds constructed. There are also other recreational losses occasioned by the project as detailed in FEARO (1992).

SECTION 5: SUMMARY AND LIMITATIONS

This study used discrete choice travel cost models to estimate the change in welfare of anglers using the upper Oldman River Basin caused by the construction of the Oldman River Dam. These models are also used to predict the change in site visits after the environmental change was introduced. The impact of the mitigation effort carried out by the province to compensate for the loss of fishing habitat was assessed using various levels of success and discount rates.

The models reveal that a loss in welfare occurred due to the construction of the dam. These losses are significant, and should have been included in the original cost/benefit analysis. The losses calculated in this study are restricted to recreational fishing benefits. Other probable losses that occurred are for different recreational activities, such as hunting, hiking and wildlife viewing. As well, there are non-use values that are not included here, such as option value, and bequest value. Option value is similar to insurance, people are willing to pay to keep open the option of using an area in the future, even if they don't presently use it. Bequest value is the willingness to pay to preserve some area for future generations. The actual total loss would thus be greater than what has been calculated in this study.

The site quality attributes that affect the choice of fishing site in the region were determined to be: the distance from the residence of the angler to the site, the availability of and number of campsites, parking (access), the size of fish to be caught, the possibility to catch fish (separate values for rainbow trout, and all other species), the area of the lake, and the length of the stream reach.

The sensitivity of this model to several factors was examined. First, the effect of the values used for the site quality attributes resulted in separate models being estimated based on various measures of the catch rate. The use of dummy variables created two more variations of the model. For the welfare estimations the effect of a time value of travel was examined.

The shift in predicted site visitation may also have effects that are not measured in this report. One effect could be increased economic activity in the towns of the Upper Crowsnest valley. While this increase cannot be measured with these models, the change in trip predictions can be taken and used in other formulations to better determine economic impacts of the project. With more visits predicted to this area, there is the potential that the new visitors will also purchase goods and services during their trips. Some areas could experience higher congestion in a way that is not measured in this study, for example, the upper reaches of the Oldman River. Areas that have limited space, such as Beavermines Lake, could be affected during peak periods.

It is problematic that the welfare loss caused by the dam was compensated for by the mitigation efforts initiated by the government. This question was investigated using capitalized values of losses and various projected levels of success of the mitigation program.

The study points out several limitations in the use of this type of model in welfare estimation and policy planning. The first is the lack of limnological knowledge on the biophysical relations affecting the catch rate of fish. In part, this can never be totally resolved, as it partly depends on the skill level of anglers. In view of the difficulties involved in measuring in physical terms whether or not the mitigation efforts resulted in the goal of no net loss, it may have been more appropriate to plan the mitigation intensity in economic terms. In this way, the spending would have been based on the economic loss that was estimated to occur.

The linear nature of the model specification was also a limitation. The linear model assumption prevented the inclusion of the reservoir as a fishing site. The sensitivity of the welfare estimations to the time value of travel in this type of model was also identified.

The use of the results is also limited by other factors, outside of the choice of model type. One of these is the appropriate discount rate to use in comparing the mitigation expenditures with the welfare loss that occurred.

The model does show that a loss occurred due to the construction of the dam. In spite of the limitations outlined above, it is also unlikely that the mitigation expenditures were worthwhile. The need for accurate data on quality attributes, universally accepted levels of agreement on such factors as the proper discount rate, and the probable success of habitat mitigation work has been highlighted. The results and empirical problems encountered in this study identify fruitful ground for future research in policy analysis methodologies. The sense of the analysis described in this study, and some solutions to the questions raised, would probably make similar examinations of future projects easier and lessen the level of controversy such projects evoke.

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Appendix A The Data Collection Survey

Fishing in Alberta: Recreation Today and in the Future

We would like to know what you think about Alberta's angling resources. What do you look for when choosing a fishing site in Alberta? Where do you go fishing? How often? Your answers to the following questions will help us understand your views of fishing in Alberta.

1. When you decide to go sportfishing, how important are the following factors in deciding where you want to fish? Please circle one response for each question to indicate if the reason is important or not.

	Not Important		Somewhat Important		Very Important
Good chance to catch trophy-sized fish:	1	2	3	4	5
Good chance to catch limit:	1	2	3	4	5
Good chance to catch a preferred species:	1	2	3	4	5
Knowing that the lake is stocked with fish:	1	2	3	4	5
Privacy from other anglers:	1	2	3	4	5
Natural beauty of surroundings:	1	2	3	4	5
Water quality:	1	2	3	4	5
Access to wilderness areas:	1	2	3	4	5
Site limited to fly fishing:	1	2	3	4	5
Distance from home:	1	2	3	4	5
Familiarity with the area:	1	2	3	4	5
Owning land or a cabin near the site:	1	2	3	4	5
Good road access to the site:	1	2	3	4	5
Site with boat access:	1	2	3	4	5
Picnic/Camping facilities at or near the site:	1	2	3	4	5
Friends or relatives live nearby:	1	2	3	4	5

2. Please answer the following questions about trips to your favorite fishing site.

A. Approximately how many years have you fished at this site? _________ years

B. Approximately how many times have you visited this site in the past 5 years? (please check one box below)

NUMBER OF PREVIOUS VISITS (check one box):					
Less than 5		6 - 10		11 - 15	
16 - 20		21 - 30		More than 30	

C. How did you first become aware of this site?

____

D. What are the specific things about this site that you particularly enjoy?

____

3. Please answer each of the following questions about a typical fishing trip or what you usually do when you go fishing.

A. What type of transportation do you usually use to go from your home to a fishing site? Please check one of the following.

TRANSPORTATION USED TO GET TO SITE (check one box):					
Walk/Bicycle		Motorbike/ATV		Car/Truck/Van	
Camper/R.V.		Other (please specify) ________			

B. How long do you stay at the site on your typical trip to a fishing site? Please check one of the following.

1-2 Hours ☐ Half Day ☐ Full Day ☐ 2-3 Days ☐ More Than 3 Days ☐

C. Generally speaking, how enjoyable do you find the time spent travelling to the fishing site? Please circle one of the following.

	Very Unenjoyable				Very Enjoyable
Time spent travelling to the site is:	1	2	3	4	5

D. What type of fishing do you usually do? Please check one of the following.

Bait Fishing ☐ Spin Casting ☐ Trolling ☐ Fly Fishing ☐ Ice Fishing ☐

E. What method of fishing do you usually use? Please check one of the following.

From Shore ☐ Motorboat ☐ Canoe/Rowing ☐ Other ☐

F. In pounds, approximately how much fish do you take home on a typical fishing trip? Please check one of the following.

Less than 1 lb ☐ 1-4 lbs. ☐ 5-10 lbs. ☐ More than 10 lbs. ☐

G. Approximately how many years of fishing experience do you have? ________ years

H. Do you practice catch-and-release fishing? YES ☐ NO ☐

I. How far ahead do you usually plan fishing trips? Please check one of the following.

I USUALLY PLAN FISHING TRIPS (check one box):					
On the Same Day		Day Before		Few Days Before	
A Week Before		Few Weeks Before		More Than a Month Before	

J. Who do you usually go fishing with? Please check one of the following.

Spouse ☐ Friends ☐ Family ☐ Nobody ☐

4. If overfishing becomes a problem in Alberta lakes and rivers, which of the following management options would you most like to see used to address the problem? Please check <u>one</u> of the following.

MANAGEMENT OPTION I WOULD USE (check one box):					
Shorter Season		Size Limit		No Bait Fishing	
Increase Licence Fees		Increase Stocking		More Enforcement	
Catch and Release		Larger Fines for Violations		Other	

5. How much do you spend on fishing over a typical fishing season? (include all costs, such as vehicle costs (gasoline, oil, etc.), license costs, food/accomodation costs, bait costs, etc.). Please check the category below which best represents the amount you spend on fishing.

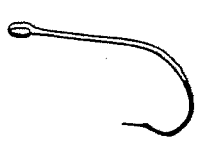
AMOUNT SPENT ON FISHING PER SEASON (check one box):					
$0 - $50		$51 - $100		$101 - $200	
$201 - $300		$301 - $500		More Than $500	

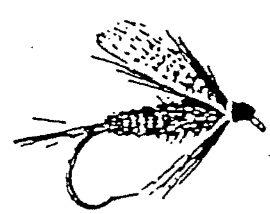
6. Did you go sportfishing in Alberta in 1990? Please check one box below.

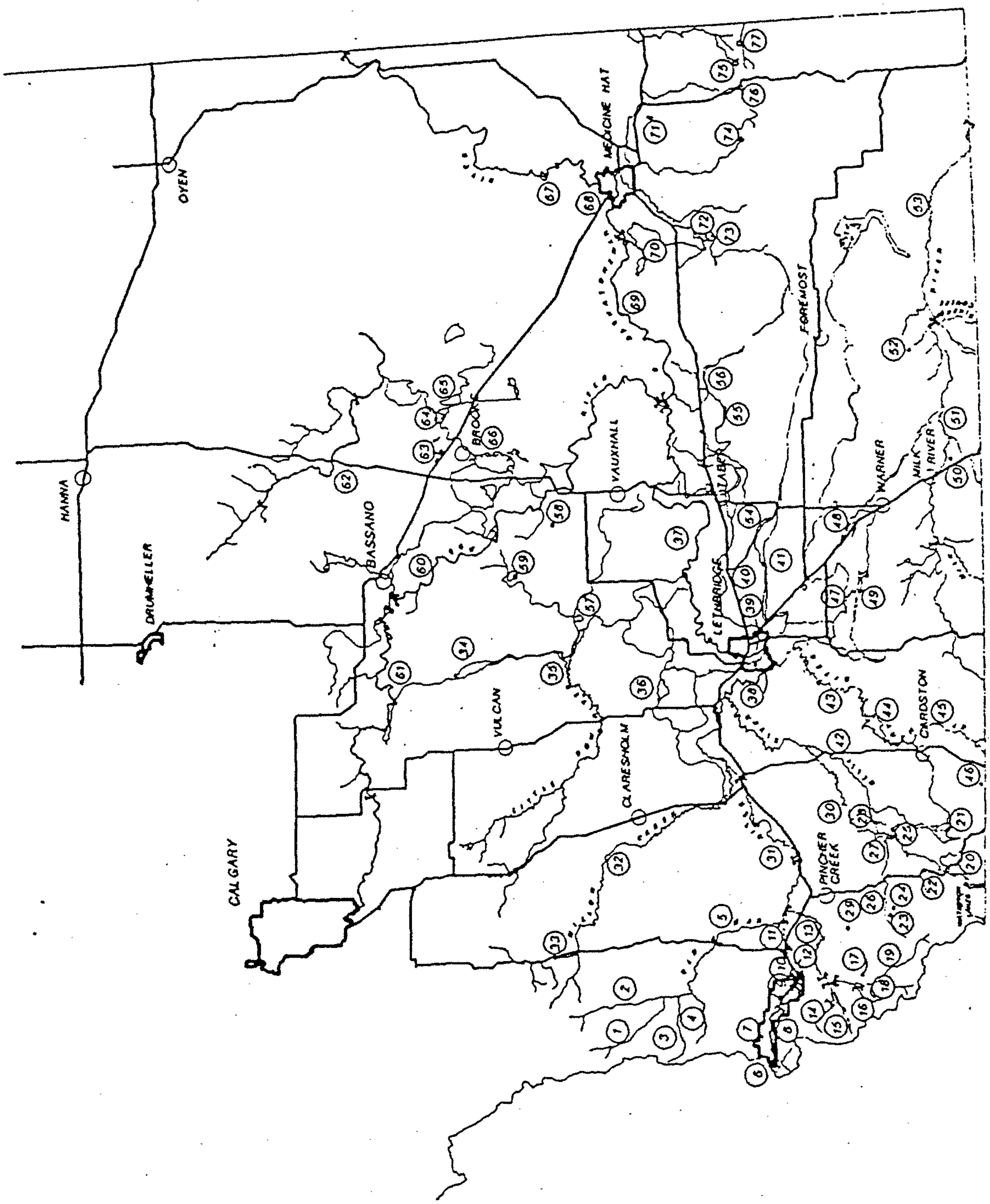
YES ☐ NO ☐

If NO (you did not go fishing in Alberta in 1990), please go to Question 10 on page 8.

If YES (you did go fishing in Alberta in 1990), please continue.
The next 4 pages of questions are very important.
Please try your best to answer them as completely as possible.







CALGARY
DRUMHELLER
HANNA
OYEN
BASSANO
VULCAN
CLARESHOLM
VAUXHALL
MEDICINE HAT
LETHBRIDGE
FOREMOST
WARNER
MILK RIVER
CARDSTON
PINCHER CREEK

4

7. Which of the following fishing sites have you ever visited or heard of <u>as a fishing site</u>? (place a check mark beside every site that you have visited or heard of). A map of these sites is provided on the page above and a more detailed map can be found at the end of this survey.

UPPER OLDMAN RIVER AREA
1 ___Upper Oldman River (NW Branch)
2 ___Livingstone River
3 ___Dutch Creek
4 ___Racehorse Creek
5 ___Oldman River-Hwy 22 Bridge to Peigan Reserve

CROWSNEST RIVER AREA
6 ___Crowsnest Lake
7 ___Allison (Chinook) Lake
8 ___Crowsnest River-Headwaters to Blairmore (Legion Bridge)
9 ___Crowsnest River-Blairmore to Passberg Bridge (Byron Cr.)
10 ___Crowsnest River-Passberg Bridge to Lundbreck Falls
11 ___Crowsnest River-Lundbreck Falls to mouth (Blairmore-Pincher Creek Areas)
12 ___Burmis Lake
13 ___Castle River

CASTLE RIVER AREA
14 ___Lynx Creek
15 ___Carbondale River
16 ___West Castle River
17 ___Beavermines Lake
18 ___Barnaby (Southfork) Lake
19 ___South Castle River

WATERTON LAKES AREA
20 ___Crooked Creek
21 ___Mami (Paine) Lake
22 ___Cottonwood Creek

PINCHER CREEK AREA
23 ___Bathing Lake
24 ___Butcher Lake
25 ___Dipping Vat Lake
26 ___Drywood Creek
27 ___Waterton Reservoir
28 ___Cochrane Lake
29 ___Beauvais Lake
30 ___Waterton River
31 ___Oldman River-near Fort MacLeod

CLARESHOLM AREA
32 ___Willow Creek
33 ___Chain Lake

VULCAN AREA
34 ___McGregor Reservoir
35 ___Travers Reservoir

LETHBRIDGE AREA
36 ___Keho Lake
37 ___Oldman River-Monarch to Forks
38 ___Nicholas Sheran Park Lake (in the city of Lethbridge)
39 ___Henderson Lake (in the city of Lethbridge)
40 ___Stafford Reservoir
41 ___McQuillan Lake

CARDSTON AREA
42 ___Belly River
43 ___St. Mary River-Upper to Reservoir
44 ___St. Mary Reservoir
45 ___St. Mary River-Below Reservoir
46 ___Police (Outpost) Lake

MILK RIVER-WARNER AREA
47 ___Cross Coulee Reservoir
48 ___Tyrrell Lake
49 ___Milk River Ridge Reservoir
50 ___Goldsprings Park Pond
51 ___Milk River - mouth of the N. Milk River to Miners Coulee Creek
52 ___Heninger Reservoir
53 ___Milk River -Miners Coulee Creek to Montana Border

TABER AREA
54 ___Chin Reservoir
55 ___Sherburne Reservoir
56 ___Unnamed Lake South of Burdett

VAUXHALL AREA
57 ___Little Bow Reservoir
58 ___Stonehill Lake
59 ___Badger Reservoir

BASSANO AREA
60 ___Bow River-Bassano Dam to mouth
61 ___Bow River-Carseland to Bassano
62 ___Red Deer River-Finegan to Dinosaur Provincial Park

BROOKS AREA
63 ___Brook's Childrens Pond
64 ___Cowoki Reservoir
65 ___Tilly B Reservoir
66 ___Lake Newell

MEDICINE HAT AREA
67 ___S. Saskatchewan River-Rattlesnake to Saskatchewan Border
68 ___Echo Dale Regional Park Pond (in the city of Medicine Hat)
69 ___South Saskatchewan River-Forks to Rattlesnake
70 ___Rattlesnake/Sauder Reservoir
71 ___Cavan Lake
72 ___Michell Reservoir
73 ___Murray Reservoir
74 ___Bullshead Reservoir
75 ___Spruce Coulee Reservoir
76 ___Elkwater Lake
77 ___Reesor Lake

8. For **each** fishing trip you took between May 1, 1990 and October 31, 1990, please complete the following information. If you do not recall the exact details, please provide your best guess. If you took more than 15 trips, please list the first 15.
NOTE: This information is very important, please try your best to complete this section and the section below.

Trip No.	Site Name (If In Southern Region, see list of sites provided)	Distance From Home To Site (miles one way)	Party Size (number in group)	Fish Species Sought (eg. trout, pike)	Number Caught / Number Released	Type of Water Body (lake, stream, etc.)
Example	Keho Lake (55)	120 mi.	2	Walleye	2 caught/0 released	lake
1		mi.				
2		mi.				
3		mi.				
4		mi.				
5		mi.				
6		mi.				
7		mi.				
8		mi.				
9		mi.				
10		mi.				
11		mi.				
12		mi.				
13		mi.				
14		mi.				
15		mi.				

If you took more than 15 fishing trips during the 1990 fishing season, how many trips in total did you take? ________ TRIPS

9. The calendar below represents the months of May to October of 1990. For each fishing trip you described above please indicate the dates that you took these trips on. Please draw a line through the days that you spent on the trip and number the trip.

For example, if your first fishing trip was on Monday, the 2nd, and the on the second trip you went on Saturday the 7th and stayed until Sunday the 8th, your response would look like:

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2 (1)	3	4	5	6	7 (2)
8 (2)	9	10	11	12	13	14

MAY, 1990

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

JUNE, 1990

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

JULY, 1990

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

AUGUST, 1990

Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

SEPTEMBER, 1990

Sun	Mon	Tue	Wed	Thu	Fri	Sat
						1
2	3	4		6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

OCTOBER, 1990

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

We would like to know some things about you and your family. The answers to these questions tell us about the people who use Alberta's fishery resources.

10. What is your place of residence (nearest city or town): ______________

11. Are you male or female (check one): Male [ ] Female [ ]

12. What is your age? ____ years

13. How many children under the age of 16 are there in your household? ______ children

If there are children under 16 in your household, how many of them fish? ______ children.

14. How many adults over 65 are there in your household? __________ adults

If there are adults over 65 in your household, how many of them fish? _________ adults.

15. Which of the following categories best represents your annual household income before taxes? (please check one category)

ANNUAL HOUSEHOLD INCOME BEFORE TAXES (check one box):							
$0-$5000		$5001-10000		$10001-15000		$15001-20000	
$20001-25000		$25001-30000		$30001-35000		$35001-40000	
$40001-45000		$45001-50000		$50001-60000		$60001-70000	
$70001-80000		$80001-90000		$90001-100000		More Than $100000	

16. Please circle the highest number of years of education that you have completed (circle only one number below).

Elementary 1 2 3 4 5 6 7 8 9

High School 10 11 12

Postsecondary (University or Technical School) 13 14 15 16 17 18 19 20+

17. How many hours do you normally work for pay each week? __________ hours

18. What do you consider your main occupation to be?

____

19. How many days of paid vacation do you get each year? __________ days

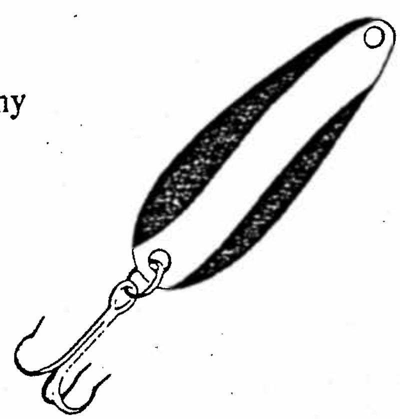
20. How well do each of the following statements apply to you? Please circle the appropriate number for each question.

	Always	Sometimes	Seldom	Never
I take time off work to go fishing	1	2	3	4
I could be working on days I take fishing trips	1	2	3	4
My job has flexible working hours	1	2	3	4

If you have any other comments or concerns, please do not hesitate to write them on any page of this survey or in the space below.

Thank you for completing this survey. Your cooperation is essential to manage Alberta's fishery resources effectively. A card has been included in your envelope. This card is an entry form for our prize draw. If you wish to enter this draw, please write your name and address on this card. The card will be separated from your survey when we receive it so that your responses will remain confidential. Please return this survey, and the card, in the stamped - self addressed envelope to:

The Department of Rural Economy
University of Alberta
Edmonton, Alberta
T6G 2H1



Thank you again for your help.

If you have questions about this survey please call Vic Adamowicz, Department of Rural Economy, University of Alberta at 403-492-4603 or Peter Boxall, Alberta Fish and Wildlife Division at 403-422-4771.

Appendix B Quality Aspects of Southern Region Fisheries

Quality Aspect	Measure
Recreation/Facilities	
Q1) Playgrounds	Presence/Absence
Q2) Campgrounds	Number of Sites
Q3) Toilet Facilities	Presence/Absence
Q4) Parking	Presence/Absence Number of Spaces
Q5) Level of Development (e.g. Cabins, Stores etc)	Rate on a Scale of 1 to 10 (1=no development; 10=fully developed)
Q6) Boat Launch	Yes/No
Q7) Level of Congestion	Rate on a Scale of 1 to 10 (1=no congestion; 10=extreme congestion)
Q8) Access Road Paved	Yes/No
Q9) Fish Cleaning Facilities	Presence/Absence
Q10) Swimmable	Yes/No
Q11) Boating Regulations	Presence/Absence
Q12) Access Fees	Yes/No; Amount
Q13) Public Access	Presence/Absence
Fishing Regulations	
Q14) Bait Ban	Presence/Absence
Q15) Size Regulations	Presence/Absence
Q16) Catch/Release only	Presence/Absence

Q17) Restrictions on Limit	Yes/No
Q18) Special License Required	Yes/No
Q19) Special Seasonal Limitations	Yes/No

Biological Aspects

Q20) Trout Fishery	Yes/No
Q21) Walleye Fishery	Yes/No
Q22) Stocked with one Species of Trout	Yes/No, and Numbers if Possible
Q23) Stocked with more than one Species	Yes/No, and Numbers if Possible
Q24) Catch Rate	Number caught per hour
Q25) Aquatic Vegetation Problems	Presence/Absence
Q26) Water Quality	Rate on a Scale of 1 to 10 (1=poor; 10=excellent)and/or provide Actual Physical Measures if Possible
Q27) Natural Reproduction Present	Yes/No
Q28) Stability of Water Flow or Stock	Rate on a Scale of 1 to 10 (1=very stable; 10=large fluctuations)
Q29) Number of Sport fish Species	Number of Species

Locational Aspects

Q30) Dugout or Slough	Yes/No
Q31) Pristine Wilderness Lake	Yes/No
Q32) In a Designated Park	Yes/No
Q33) Located close to a Metropolitan Area	Yes/No
Q34) Reservoir	Yes/No

Q35) Forested or Treed Around Area	Yes/No

Subjective Quality Aspects

Q36) Frequency of Presence of Fish and Wildlife Staff Throughout the Season (e.g. Officers)	Rate on a Scale of 1 to 10 (1=seldom; 10=frequent)
Q37) Rating by Fisheries Staff in terms of the size of fish caught(e.g. how easily can an average angler catch a big fish)	Rate on a Scale of 1 to 10 (1=difficult to catch large fish; 10=easy) An Educated Guess on the Average size of Fish Caught

Other Characteristics

Q38) Area of the Waterbody	In hectares
Q39) Length of the Reach if Stream	In miles

Appendix C Population Calculations

Table C-1 Anglers and Average Trips for the Sample

RESIDENCE	CODE	ANGLERS	PERCENT	TRIPS	TRIP AVE
Airdrie	2	1	.4	2	2.0
Bellevue	19	1	.4	1	1.0
Black Diamond	26	1	.4	1	1.0
Blairmore	29	4	1.7	41	10.25
Brooks	38	7	3.0	13	1.86
Calgary	41	82	34.7	180	2.2
Cardston	46	1	.4	1	1.0
Claresholm	58	5	2.1	10	2.0
Clive	59	1	.4	1	1.0
Coaldale	62	7	3.0	21	3.0
Cochrane	63	1	.4	3	3.0
Coleman	65	2	.8	5	2.5
Drumheller	84	1	.4	10	10.0
Duchess	85	2	.8	2	1.0
Fort Macleod	104	4	1.7	19	4.75
Granum	121	2	.8	3	0.67
Grassy Lake	122	1	.4	1	1.0
High River	133	1	.4	1	1.0
Hillspring	134	1	.4	3	3.0
Innisfail	141	1	.4	1	1.0
Lacombe	153	1	.4	1	1.0
Lethbridge	159	46	19.5	180	3.91
Magrath	165	1	.4	5	5.0
Medicine Hat	172	8	3.4	22	2.75
Milk River	173	1	.4	3	3.0
Nanton	185	1	.4	10	10.0
Okotoks	190	1	.4	2	2.0
Olds	191	1	.4	2	2.0
Picture Butte	197	3	1.3	17	5.67
Pincher Creek	198	13	5.5	73	5.62
Ponoka	201	2	.8	3	0.67
Raymond	205	5	2.1	12	2.4
Redcliff	206	2	.8	2	1.0
Red Deer	207	4	1.7	4	1.0
Stavely	232	1	.4	1	1.0
Sylvan Lake	243	2	.8	6	3.0
Taber	244	5	2.1	28	5.6
Vauxhall	256	3	1.3	6	2.0
Hillcrest	283	1	.4	8	8.0
Twin Butte	299	1	.4	1	1.0
Coalhurst	300	2	.8	3	0.67
Crowsnest Pass	305	3	1.3	21	7.0
Dunmore	307	1	.4	1	1.0
Lundbreck	326	1	.4	6	6.0
Burmis	332	1	.4	1	1.0

Table C-2 Total Anglers and Trips for Population

RESIDENCE	CODE	SURVEY ANGLERS	ANGLERS POPSIZE	OLDMAN ANGLERS	TRIPS TO OLDMAN
Airdrie	2	24	712	30	59
Bellevue	19	3	89	30	30
Black Diamond	26	3	89	30	30
Blairmore	29	9	267	119	1,217
Brooks	38	35	1,039	208	387
Calgary	41	827	24,549	2,434	5,355
Cardston	46	8	238	30	30
Claresholm	58	16	475	148	297
Clive	59	2	59	30	30
Coaldale	62	16	475	208	623
Cochrane	63	15	445	30	89
Coleman	65	7	208	59	148
Drumheller	84	21	623	30	297
Duchess	85	2	59	59	59
Fort Macleod	104	10	297	119	564
Granum	121	3	89	59	40
Grassy Lake	122	2	59	30	30
High River	133	15	445	30	30
Hillspring	134	3	89	30	89
Innisfail	141	22	653	30	30
Lacombe	153	29	861	30	30
Lethbridge	159	125	3,711	1,366	5,339
Magrath	165	2	59	30	148
Medicine Hat	172	120	3,562	238	653
Milk River	173	3	89	30	89
Nanton	185	4	119	30	297
Okotoks	190	21	623	30	59
Olds	191	17	505	30	59
Picture Butte	197	4	119	89	505
Pincher Creek	198	22	653	386	2,169
Ponoka	201	21	623	59	40
Raymond	205	9	267	148	356
Redcliff	206	17	505	59	59
Red Deer	207	116	3,443	119	119
Stavely	232	4	119	30	30
Sylvan Lake	243	25	742	59	178
Taber	244	33	980	148	831
Vauxhall	256	6	178	89	178
Hillcrest	283	3	89	30	238
Twin Butte	299	1	30	30	30
Coalhurst	300	2	59	59	40
Crowsnest Pass	305	3	89	89	623
Dunmore	307	1	30	30	30
Lundbreck	326	1	30	30	178
Burmis	332	1	30	30	30

Appendix D Trip Predictions and Market Share

Table D-1 Original Market Share without Dam

city/site	1	2	3	4	5	6	7	8	9	10	11
Airdrie	12.51%	8.74%	5.40%	3.31%	3.09%	3.73%	1.91%	1.55%	1.75%	6.53%	14.79%
Bellevue	8.82%	3.18%	2.94%	2.58%	4.57%	7.60%	1.48%	3.90%	3.86%	12.27%	12.64%
Black Diamond	11.99%	7.96%	4.52%	2.82%	3.09%	5.13%	1.62%	2.19%	2.47%	9.21%	15.17%
Blairmore	8.90%	3.20%	2.95%	2.49%	4.62%	7.28%	1.48%	3.74%	3.90%	12.39%	12.68%
Brooks	7.29%	2.07%	3.71%	2.21%	3.31%	4.22%	2.29%	1.80%	2.04%	7.58%	18.44%
Calgary	13.01%	8.94%	5.38%	3.32%	3.17%	3.83%	1.82%	1.64%	1.85%	6.88%	14.53%
Cardston	8.97%	2.29%	3.47%	2.16%	4.44%	5.66%	1.63%	2.42%	2.73%	10.16%	15.71%
Claresholm	13.28%	3.35%	4.64%	2.93%	4.22%	5.38%	1.32%	2.30%	2.59%	9.65%	14.31%
Clive	9.44%	7.30%	5.34%	3.13%	2.14%	2.59%	2.47%	1.08%	1.22%	4.53%	16.03%
Coaldale	8.84%	2.30%	3.57%	2.20%	4.32%	5.50%	1.75%	2.35%	2.65%	9.88%	16.40%
Cochrane	10.92%	7.61%	4.68%	2.87%	2.70%	4.49%	1.90%	1.92%	2.17%	8.06%	16.42%
Coleman	10.29%	3.69%	3.44%	2.97%	4.23%	8.91%	1.66%	3.61%	3.57%	11.34%	12.11%
Drumheller	10.39%	7.80%	5.44%	3.23%	2.35%	2.84%	2.33%	1.21%	1.37%	5.11%	15.91%
Duchess	7.11%	2.03%	3.70%	2.20%	3.20%	4.08%	2.35%	1.74%	1.97%	7.33%	18.60%
Fort McLeod	9.48%	2.36%	3.41%	2.15%	4.80%	6.12%	1.49%	2.61%	2.95%	10.99%	15.07%
Granum	9.35%	2.35%	3.45%	2.16%	4.69%	5.98%	1.55%	2.56%	2.89%	10.74%	15.38%
Grassy Lake	8.07%	2.20%	3.67%	2.23%	3.80%	4.84%	2.03%	2.07%	2.34%	8.69%	17.59%
High River	13.95%	9.26%	5.26%	3.28%	3.50%	4.23%	1.62%	1.81%	2.04%	7.60%	13.73%
Hillspring	9.43%	2.34%	3.35%	2.11%	4.79%	6.11%	1.45%	2.61%	2.95%	10.97%	14.73%
Innisfail	10.94%	8.07%	5.46%	3.27%	2.51%	3.04%	2.23%	1.30%	1.47%	5.45%	15.72%
Lacombe	9.84%	7.52%	5.40%	3.18%	2.20%	2.65%	2.42%	1.13%	1.28%	4.77%	16.04%
Lethbridge	9.02%	2.32%	3.53%	2.19%	4.44%	5.66%	1.68%	2.42%	2.73%	10.17%	16.07%
Magrath	8.53%	2.24%	3.55%	2.18%	4.13%	5.26%	1.79%	2.25%	2.54%	9.44%	16.47%
Medicine Hat	7.23%	2.06%	3.71%	2.21%	3.28%	4.18%	2.31%	1.78%	2.02%	7.50%	18.50%
Milk River	7.73%	2.13%	3.62%	2.19%	3.60%	4.59%	2.07%	1.96%	2.22%	8.25%	17.53%
Nanton	14.30%	9.34%	5.16%	3.25%	3.73%	4.51%	1.52%	1.88%	2.12%	7.89%	13.29%
Okotoks	13.57%	9.12%	5.29%	3.29%	3.46%	4.18%	1.69%	1.74%	1.96%	7.31%	13.98%
Olds	11.38%	8.26%	5.45%	3.28%	2.72%	3.29%	2.13%	1.37%	1.55%	5.75%	15.44%
Picture Butte	8.76%	2.29%	3.58%	2.21%	4.26%	5.43%	1.78%	2.32%	2.62%	9.75%	16.53%
Pincher Creek	9.75%	2.36%	3.25%	2.07%	5.05%	6.44%	1.31%	2.75%	3.11%	11.57%	13.97%
Ponoka	9.14%	7.13%	5.30%	3.10%	2.06%	2.49%	2.51%	1.04%	1.17%	4.35%	16.06%
Raymond	8.60%	2.27%	3.61%	2.22%	4.15%	5.29%	1.84%	2.26%	2.55%	9.50%	16.81%
Redcliff	7.14%	2.04%	3.70%	2.20%	3.22%	4.11%	2.34%	1.75%	1.98%	7.37%	18.57%
Red Deer	10.39%	7.80%	5.44%	3.23%	2.35%	2.84%	2.33%	1.21%	1.37%	5.11%	15.91%
Stavely	13.05%	3.33%	4.69%	2.95%	4.10%	5.23%	1.38%	2.23%	2.52%	9.39%	14.63%
Sylvan Lake	9.94%	7.57%	5.41%	3.19%	2.22%	2.69%	2.41%	1.15%	1.30%	4.83%	16.02%
Taber	8.44%	2.25%	3.63%	2.22%	4.04%	5.15%	1.90%	2.20%	2.48%	9.25%	17.06%
Vauxhall	8.02%	2.19%	3.68%	2.23%	3.76%	4.79%	2.05%	2.05%	2.31%	8.61%	17.66%
Hillcrest	8.82%	3.18%	2.94%	2.58%	4.57%	7.60%	1.48%	3.90%	3.86%	12.27%	12.64%
Twin Butte	9.52%	2.34%	3.32%	2.10%	4.86%	6.20%	1.41%	2.65%	2.99%	11.13%	14.53%
Coalhurst	9.09%	2.33%	3.51%	2.19%	4.50%	5.73%	1.65%	2.45%	2.77%	10.29%	15.92%
Crowsnest Pass	9.86%	3.57%	3.38%	2.91%	4.02%	10.74%	1.92%	4.02%	3.40%	10.78%	12.01%
Dunmore	7.07%	2.03%	3.70%	2.20%	3.18%	4.06%	2.36%	1.73%	1.96%	7.29%	18.62%
Lundbrook	10.37%	2.60%	3.35%	2.15%	5.43%	6.92%	1.32%	2.96%	3.34%	12.43%	14.28%
Burmis	9.04%	3.25%	2.75%	2.36%	4.70%	6.84%	1.37%	3.51%	3.97%	12.60%	12.81%

city/site	12	13	14	15	16	17	18	19
Airdrie	1.22%	6.44%	3.89%	1.87%	3.35%	16.20%	0.84%	2.87%
Bellevue	2.41%	4.98%	5.72%	4.13%	5.51%	7.29%	1.38%	4.72%
Black Diamond	1.72%	5.74%	4.58%	2.64%	3.92%	10.90%	0.98%	3.36%
Blairmore	2.44%	5.00%	5.75%	4.17%	5.57%	7.26%	1.40%	4.77%
Brooks	1.41%	7.95%	4.70%	2.18%	3.89%	20.42%	1.14%	3.33%
Calgary	1.28%	6.38%	3.94%	1.98%	3.53%	14.62%	0.88%	3.02%
Cardston	1.89%	7.34%	4.88%	2.92%	5.49%	11.80%	1.38%	4.70%
Claresholm	1.80%	6.46%	4.52%	2.77%	4.95%	10.05%	1.24%	4.24%
Clive	0.84%	6.58%	3.48%	1.30%	2.32%	27.63%	0.58%	1.99%
Coaldale	1.84%	7.44%	4.94%	2.84%	5.06%	12.30%	1.49%	4.34%
Cochrane	1.50%	6.04%	4.52%	2.31%	3.43%	14.65%	0.86%	2.94%
Coleman	2.23%	4.75%	5.39%	3.82%	5.10%	7.24%	1.28%	4.36%
Drumheller	0.95%	6.64%	3.64%	1.47%	2.62%	23.79%	0.66%	2.24%
Duchess	1.37%	7.97%	4.66%	2.10%	3.76%	21.50%	1.10%	3.22%
Fort McLeod	2.05%	7.01%	4.93%	3.16%	5.63%	9.31%	1.65%	4.83%
Granum	2.00%	7.11%	4.94%	3.09%	5.51%	9.92%	1.62%	4.72%
Grassy Lake	1.62%	7.77%	4.86%	2.50%	4.46%	16.15%	1.31%	3.82%
High River	1.42%	6.16%	3.98%	2.18%	3.90%	11.79%	0.98%	3.34%
Hillspring	2.05%	7.01%	4.86%	3.15%	5.93%	9.58%	1.49%	5.08%
Innisfail	1.02%	6.63%	3.72%	1.57%	2.80%	21.72%	0.70%	2.40%
Lacombe	0.89%	6.63%	3.55%	1.37%	2.44%	25.98%	0.61%	2.09%
Lethbridge	1.90%	7.33%	4.94%	2.92%	5.21%	11.46%	1.53%	4.47%
Magrath	1.76%	7.57%	4.85%	2.71%	5.10%	13.98%	1.28%	4.37%
Medicine Hat	1.40%	7.96%	4.69%	2.15%	3.85%	20.78%	1.13%	3.29%
Milk River	1.54%	7.85%	4.74%	2.37%	4.46%	18.21%	1.12%	3.82%
Nanton	1.47%	6.02%	3.98%	2.27%	4.05%	10.75%	1.01%	3.47%
Okotoks	1.36%	6.22%	3.96%	2.10%	3.75%	12.88%	0.94%	3.21%
Olds	1.07%	6.57%	3.77%	1.65%	2.95%	20.10%	0.74%	2.53%
Picture Butte	1.82%	7.48%	4.93%	2.80%	5.00%	12.67%	1.51%	4.28%
Pincher Creek	2.16%	6.74%	4.83%	3.32%	6.25%	8.15%	1.57%	5.36%
Ponoka	0.81%	6.56%	3.42%	1.25%	2.23%	28.91%	0.56%	1.91%
Raymond	1.77%	7.56%	4.92%	2.73%	4.87%	13.46%	1.43%	4.17%
Redcliff	1.37%	7.97%	4.67%	2.12%	3.78%	21.32%	1.11%	3.24%
Red Deer	0.95%	6.64%	3.64%	1.47%	2.62%	23.79%	0.66%	2.24%
Stavely	1.75%	6.56%	4.53%	2.70%	4.82%	10.80%	1.21%	4.12%
Sylvan Lake	0.90%	6.63%	3.57%	1.39%	2.48%	25.57%	0.62%	2.12%
Taber	1.72%	7.63%	4.91%	2.65%	4.74%	14.27%	1.39%	4.06%
Vauxhall	1.60%	7.79%	4.85%	2.47%	4.41%	16.45%	1.30%	3.78%
Hillcrest	2.41%	4.98%	5.72%	4.13%	5.51%	7.29%	1.38%	4.72%
Twin Butte	2.08%	6.94%	4.86%	3.20%	6.02%	9.18%	1.51%	5.15%
Coalhurst	1.92%	7.29%	4.94%	2.96%	5.28%	11.12%	1.55%	4.52%
Crowsnest Pass	2.12%	4.68%	5.25%	3.63%	4.84%	7.50%	1.21%	4.15%
Dunmore	1.36%	7.98%	4.65%	2.09%	3.74%	21.68%	1.13%	3.20%
Lundbrook	2.32%	5.66%	5.04%	3.57%	5.30%	7.10%	1.33%	4.54%
Burmis	2.48%	5.06%	5.83%	4.24%	5.66%	7.28%	1.42%	4.85%

Table D-2 Market Share with Dam and no Mitigation

city/site	1	2	3	4	5	6	7	8	9	10	11
Airdrie	12.73%	10.06%	5.99%	3.37%	1.85%	3.67%	1.58%	2.07%	2.46%	8.23%	8.31%
Bellevue	8.78%	3.74%	3.38%	2.69%	2.53%	6.75%	1.38%	4.65%	4.89%	14.07%	7.54%
Black Diamond	11.95%	9.09%	5.07%	2.90%	1.79%	4.79%	1.40%	2.78%	3.30%	11.03%	8.72%
Blairmore	8.85%	3.77%	3.40%	2.60%	2.55%	6.48%	1.38%	4.47%	4.93%	14.20%	7.56%
Brooks	7.89%	2.59%	4.21%	2.32%	2.05%	4.28%	1.90%	2.48%	2.94%	9.84%	10.49%
Calgary	13.12%	10.25%	5.98%	3.38%	1.88%	3.72%	1.52%	2.16%	2.56%	8.57%	8.19%
Cardston	9.16%	2.78%	3.96%	2.26%	2.54%	5.30%	1.45%	3.07%	3.65%	12.20%	9.17%
Claresholm	13.20%	3.97%	5.27%	3.04%	2.40%	5.01%	1.18%	2.90%	3.45%	11.52%	8.39%
Clive	10.36%	8.86%	6.00%	3.27%	1.41%	2.80%	1.94%	1.58%	1.88%	6.28%	8.93%
Coaldale	9.12%	2.80%	4.07%	2.31%	2.51%	5.22%	1.54%	3.03%	3.60%	12.02%	9.55%
Cochrane	11.15%	8.79%	5.21%	2.94%	1.62%	4.34%	1.59%	2.51%	2.99%	9.98%	9.28%
Coleman	10.17%	4.32%	3.95%	3.09%	2.35%	7.85%	1.56%	4.33%	4.54%	13.08%	7.20%
Drumheller	11.12%	9.29%	6.07%	3.34%	1.50%	2.98%	1.85%	1.73%	2.05%	6.86%	8.85%
Duchess	7.74%	2.56%	4.21%	2.32%	2.00%	4.17%	1.94%	2.41%	2.87%	9.60%	10.57%
Fort McLeod	9.64%	2.86%	3.94%	2.27%	2.72%	5.68%	1.36%	3.29%	3.91%	13.06%	8.96%
Granum	9.53%	2.85%	3.97%	2.28%	2.67%	5.58%	1.40%	3.23%	3.84%	12.84%	9.09%
Grassy Lake	8.51%	2.71%	4.17%	2.33%	2.27%	4.74%	1.73%	2.74%	3.26%	10.90%	10.09%
High River	13.83%	10.52%	5.86%	3.35%	2.02%	4.02%	1.39%	2.33%	2.77%	9.24%	7.84%
Hillspring	9.54%	2.82%	3.86%	2.22%	2.70%	5.63%	1.32%	3.26%	3.88%	12.97%	8.75%
Innisfail	11.54%	9.52%	6.07%	3.36%	1.58%	3.13%	1.79%	1.81%	2.16%	7.20%	8.75%
Lacombe	10.69%	9.06%	6.05%	3.31%	1.43%	2.84%	1.91%	1.64%	1.95%	6.53%	8.93%
Lethbridge	9.26%	2.82%	4.04%	2.30%	2.56%	5.34%	1.49%	3.09%	3.68%	12.30%	9.40%
Magrath	8.80%	2.73%	4.02%	2.28%	2.40%	5.01%	1.56%	2.90%	3.45%	11.52%	9.51%
Medicine Hat	7.84%	2.58%	4.21%	2.32%	2.03%	4.24%	1.91%	2.46%	2.92%	9.76%	10.52%
Milk River	8.17%	2.62%	4.09%	2.28%	2.16%	4.51%	1.74%	2.61%	3.11%	10.39%	9.98%
Nanton	14.09%	10.58%	5.78%	3.32%	2.14%	4.24%	1.33%	2.39%	2.85%	9.51%	7.64%
Okotoks	13.53%	10.39%	5.89%	3.36%	2.01%	4.00%	1.43%	2.26%	2.68%	8.97%	7.94%
Olds	11.86%	9.66%	6.04%	3.36%	1.68%	3.33%	1.72%	1.88%	2.24%	7.48%	8.61%
Picture Butte	9.05%	2.79%	4.08%	2.31%	2.48%	5.17%	1.56%	3.00%	3.56%	11.90%	9.61%
Pincher Creek	9.79%	2.84%	3.77%	2.19%	2.82%	5.88%	1.23%	3.40%	4.05%	13.52%	8.41%
Ponoka	10.12%	8.72%	5.98%	3.25%	1.37%	2.72%	1.98%	1.53%	1.82%	6.10%	8.96%
Raymond	8.93%	2.77%	4.11%	2.32%	2.43%	5.07%	1.60%	2.94%	3.49%	11.67%	9.73%
Redcliff	7.77%	2.56%	4.21%	2.32%	2.01%	4.19%	1.93%	2.43%	2.88%	9.64%	10.55%
Red Deer	11.12%	9.29%	6.07%	3.34%	1.50%	2.98%	1.85%	1.73%	2.05%	6.86%	8.85%
Stavely	13.01%	3.95%	5.32%	3.06%	2.35%	4.90%	1.22%	2.84%	3.37%	11.27%	8.53%
Sylvan Lake	10.77%	9.10%	6.05%	3.31%	1.44%	2.86%	1.90%	1.66%	1.97%	6.59%	8.92%
Taber	8.80%	2.75%	4.13%	2.33%	2.38%	4.97%	1.64%	2.88%	3.42%	11.43%	9.85%
Vauxhall	8.47%	2.70%	4.17%	2.33%	2.25%	4.70%	1.74%	2.72%	3.24%	10.82%	10.12%
Hillcrest	8.78%	3.74%	3.38%	2.69%	2.53%	6.75%	1.38%	4.65%	4.89%	14.07%	7.54%
Twin Butte	9.61%	2.83%	3.84%	2.22%	2.73%	5.70%	1.30%	3.30%	3.92%	13.12%	8.66%
Coalhurst	9.32%	2.83%	4.03%	2.30%	2.59%	5.39%	1.47%	3.12%	3.71%	12.41%	9.34%
Crowsnest Pass	9.79%	4.19%	3.88%	3.02%	2.25%	9.41%	1.79%	4.81%	4.35%	12.53%	7.12%
Dunmore	7.71%	2.55%	4.21%	2.32%	1.99%	4.15%	1.94%	2.40%	2.86%	9.55%	10.58%
Lundbrook	10.40%	3.13%	3.92%	2.28%	3.01%	6.29%	1.25%	3.64%	4.33%	14.47%	8.66%
Burmis	8.98%	3.82%	3.17%	2.47%	2.59%	6.12%	1.28%	4.22%	5.01%	14.43%	7.64%

city/site	12	13	14	15	16	17	18	19
Airdrie	1.56%	4.97%	5.31%	1.78%	3.81%	18.65%	0.69%	2.93%
Bellevue	2.79%	4.01%	7.73%	3.53%	5.75%	10.33%	1.05%	4.42%
Black Diamond	2.09%	4.49%	6.20%	2.38%	4.29%	13.65%	0.78%	3.30%
Blairmore	2.82%	4.02%	7.77%	3.56%	5.80%	10.31%	1.06%	4.46%
Brooks	1.86%	6.23%	6.56%	2.12%	4.55%	23.23%	0.96%	3.50%
Calgary	1.62%	4.93%	5.37%	1.85%	3.96%	17.16%	0.72%	3.05%
Cardston	2.31%	5.82%	6.67%	2.63%	5.93%	15.48%	1.08%	4.56%
Claresholm	2.18%	5.13%	6.18%	2.49%	5.33%	13.31%	0.97%	4.10%
Clive	1.19%	5.10%	4.93%	1.36%	2.90%	28.44%	0.53%	2.23%
Coaldale	2.27%	5.89%	6.78%	2.60%	5.56%	15.67%	1.18%	4.28%
Cochrane	1.89%	4.68%	6.15%	2.15%	3.88%	17.16%	0.71%	2.98%
Coleman	2.60%	3.82%	7.30%	3.28%	5.34%	10.14%	0.98%	4.11%
Drumheller	1.30%	5.12%	5.09%	1.48%	3.17%	25.16%	0.58%	2.44%
Duchess	1.81%	6.24%	6.51%	2.07%	4.44%	24.19%	0.94%	3.41%
Fort McLeod	2.47%	5.63%	6.78%	2.82%	6.04%	12.65%	1.28%	4.65%
Granum	2.43%	5.70%	6.78%	2.77%	5.94%	13.28%	1.26%	4.56%
Grassy Lake	2.06%	6.10%	6.70%	2.35%	5.04%	19.34%	1.07%	3.88%
High River	1.75%	4.80%	5.41%	2.00%	4.28%	14.53%	0.78%	3.29%
Hillspring	2.45%	5.63%	6.67%	2.80%	6.30%	13.21%	1.15%	4.85%
Innisfail	1.36%	5.11%	5.17%	1.56%	3.33%	23.40%	0.61%	2.56%
Lacombe	1.23%	5.13%	5.01%	1.41%	3.02%	26.99%	0.55%	2.32%
Lethbridge	2.32%	5.83%	6.79%	2.65%	5.69%	14.84%	1.21%	4.37%
Magrath	2.18%	5.96%	6.64%	2.49%	5.60%	17.63%	1.02%	4.31%
Medicine Hat	1.84%	6.23%	6.54%	2.11%	4.51%	23.54%	0.96%	3.47%
Milk River	1.96%	6.13%	6.53%	2.24%	5.05%	21.62%	0.92%	3.88%
Nanton	1.80%	4.71%	5.40%	2.05%	4.40%	13.59%	0.80%	3.38%
Okotoks	1.70%	4.83%	5.38%	1.94%	4.15%	15.61%	0.76%	3.19%
Olds	1.41%	5.06%	5.20%	1.62%	3.46%	22.08%	0.63%	2.66%
Picture Butte	2.25%	5.92%	6.77%	2.57%	5.50%	16.03%	1.20%	4.23%
Pincher Creek	2.56%	5.47%	6.64%	2.92%	6.57%	11.68%	1.20%	5.05%
Ponoka	1.15%	5.10%	4.87%	1.32%	2.82%	29.50%	0.51%	2.17%
Raymond	2.21%	5.97%	6.76%	2.52%	5.40%	16.79%	1.14%	4.15%
Redcliff	1.82%	6.24%	6.52%	2.08%	4.46%	24.03%	0.94%	3.43%
Red Deer	1.30%	5.12%	5.09%	1.48%	3.17%	25.16%	0.58%	2.44%
Stavely	2.13%	5.19%	6.18%	2.43%	5.21%	14.07%	0.95%	4.01%
Sylvan Lake	1.25%	5.13%	5.02%	1.42%	3.05%	26.65%	0.56%	2.34%
Taber	2.16%	6.01%	6.75%	2.47%	5.29%	17.57%	1.12%	4.06%
Vauxhall	2.05%	6.11%	6.69%	2.34%	5.01%	19.62%	1.06%	3.85%
Hillcrest	2.79%	4.01%	7.73%	3.53%	5.75%	10.33%	1.05%	4.42%
Twin Butte	2.48%	5.59%	6.66%	2.83%	6.38%	12.79%	1.16%	4.90%
Coalhurst	2.35%	5.80%	6.79%	2.68%	5.74%	14.50%	1.22%	4.41%
Crowsnest Pass	2.49%	3.76%	7.12%	3.14%	5.12%	10.37%	0.93%	3.93%
Dunmore	1.81%	6.25%	6.50%	2.06%	4.42%	24.34%	0.96%	3.40%
Lundbrook	2.73%	4.63%	6.95%	3.12%	5.62%	10.21%	1.03%	4.32%
Burmis	2.87%	4.07%	7.87%	3.62%	5.89%	10.36%	1.08%	4.53%

Table D-3 Market Share with Dam and Mitigation

city/site	1	2	3	4	5	6	7	8	9	10	11
Airdrie	18.90%	8.14%	5.03%	3.08%	1.47%	3.48%	1.78%	3.66%	1.63%	6.08%	14.23%
Bellevue	13.22%	2.94%	2.71%	2.39%	2.16%	7.01%	1.36%	9.12%	3.57%	11.33%	12.06%
Black Diamond	17.96%	7.35%	4.17%	2.61%	1.46%	4.74%	1.49%	5.12%	2.29%	8.51%	14.48%
Blairmore	13.36%	2.97%	2.73%	2.30%	2.18%	6.74%	1.37%	8.76%	3.61%	11.47%	12.12%
Brooks	11.36%	1.99%	3.56%	2.12%	1.63%	4.06%	2.20%	4.38%	1.96%	7.28%	18.29%
Calgary	19.57%	8.30%	5.00%	3.08%	1.50%	3.56%	1.69%	3.84%	1.72%	6.38%	13.92%
Cardston	13.77%	2.17%	3.28%	2.04%	2.14%	5.36%	1.54%	5.79%	2.58%	9.61%	15.36%
Claresholm	19.87%	3.09%	4.28%	2.70%	1.99%	4.96%	1.22%	5.36%	2.39%	8.90%	13.63%
Clive	14.56%	6.94%	5.07%	2.98%	1.04%	2.46%	2.35%	2.59%	1.16%	4.31%	15.73%
Coaldale	13.59%	2.18%	3.38%	2.09%	2.09%	5.22%	1.66%	5.64%	2.52%	9.36%	16.05%
Cochrane	16.51%	7.09%	4.36%	2.67%	1.29%	4.18%	1.77%	4.52%	2.02%	7.51%	15.81%
Coleman	15.32%	3.38%	3.16%	2.73%	1.98%	8.18%	1.53%	8.38%	3.28%	10.41%	11.48%
Drumheller	15.92%	7.37%	5.14%	3.05%	1.13%	2.69%	2.20%	2.90%	1.30%	4.82%	15.51%
Duchess	11.09%	1.96%	3.56%	2.12%	1.57%	3.93%	2.26%	4.24%	1.89%	7.05%	18.47%
Fort McLeod	14.49%	2.22%	3.21%	2.02%	2.31%	5.77%	1.41%	6.23%	2.78%	10.35%	14.66%
Granum	14.31%	2.22%	3.25%	2.04%	2.26%	5.65%	1.46%	6.10%	2.72%	10.14%	14.98%
Grassy Lake	12.50%	2.09%	3.50%	2.13%	1.85%	4.62%	1.94%	4.99%	2.23%	8.30%	17.33%
High River	20.85%	8.53%	4.84%	3.03%	1.65%	3.90%	1.49%	4.21%	1.88%	7.00%	13.06%
Hillspring	14.42%	2.20%	3.16%	1.99%	2.31%	5.76%	1.36%	6.23%	2.78%	10.34%	14.34%
Innisfail	16.69%	7.59%	5.14%	3.07%	1.21%	2.86%	2.10%	3.09%	1.38%	5.13%	15.27%
Lacombe	15.13%	7.13%	5.12%	3.02%	1.06%	2.52%	2.30%	2.72%	1.21%	4.52%	15.70%
Lethbridge	13.84%	2.19%	3.34%	2.08%	2.15%	5.36%	1.59%	5.79%	2.59%	9.62%	15.70%
Magrath	13.15%	2.13%	3.37%	2.07%	2.00%	5.00%	1.70%	5.40%	2.41%	8.98%	16.16%
Medicine Hat	11.27%	1.98%	3.56%	2.12%	1.61%	4.01%	2.22%	4.34%	1.94%	7.21%	18.35%
Milk River	12.00%	2.03%	3.47%	2.09%	1.76%	4.40%	1.98%	4.75%	2.12%	7.89%	17.33%
Nanton	21.33%	8.59%	4.75%	2.99%	1.75%	4.15%	1.40%	4.37%	1.95%	7.26%	12.62%
Okotoks	20.34%	8.43%	4.89%	3.04%	1.63%	3.87%	1.56%	4.07%	1.82%	6.76%	13.34%
Olds	17.32%	7.75%	5.11%	3.08%	1.30%	3.09%	2.00%	3.25%	1.45%	5.40%	14.96%
Picture Butte	13.47%	2.17%	3.40%	2.09%	2.06%	5.15%	1.69%	5.57%	2.49%	9.25%	16.19%
Pincher Creek	14.86%	2.22%	3.05%	1.94%	2.42%	6.05%	1.24%	6.54%	2.92%	10.87%	13.55%
Ponoka	14.12%	6.79%	5.05%	2.95%	1.00%	2.37%	2.39%	2.49%	1.11%	4.14%	15.79%
Raymond	13.26%	2.16%	3.43%	2.11%	2.01%	5.03%	1.75%	5.43%	2.42%	9.02%	16.48%
Redcliff	11.13%	1.96%	3.56%	2.12%	1.58%	3.95%	2.25%	4.27%	1.91%	7.09%	18.44%
Red Deer	15.92%	7.37%	5.14%	3.05%	1.13%	2.69%	2.20%	2.90%	1.30%	4.82%	15.51%
Stavely	19.55%	3.07%	4.33%	2.73%	1.94%	4.83%	1.27%	5.22%	2.33%	8.68%	13.96%
Sylvan Lake	15.27%	7.17%	5.12%	3.02%	1.08%	2.55%	2.28%	2.75%	1.23%	4.57%	15.67%
Taber	13.02%	2.14%	3.45%	2.11%	1.96%	4.90%	1.81%	5.29%	2.36%	8.80%	16.76%
Vauxhall	12.41%	2.09%	3.51%	2.13%	1.83%	4.58%	1.96%	4.95%	2.21%	8.22%	17.41%
Hillcrest	13.22%	2.94%	2.71%	2.39%	2.16%	7.01%	1.36%	9.12%	3.57%	11.33%	12.06%
Twin Butte	14.54%	2.21%	3.13%	1.98%	2.34%	5.84%	1.33%	6.31%	2.82%	10.49%	14.13%
Coalhurst	13.94%	2.20%	3.32%	2.07%	2.17%	5.42%	1.56%	5.86%	2.62%	9.74%	15.55%
Crowsnest Pass	14.62%	3.26%	3.09%	2.66%	1.88%	9.82%	1.75%	9.30%	3.10%	9.85%	11.33%
Dunmore	11.04%	1.95%	3.56%	2.11%	1.56%	3.90%	2.27%	4.22%	1.88%	7.01%	18.49%
Lundbrook	15.69%	2.43%	3.13%	2.00%	2.58%	6.45%	1.23%	6.97%	3.11%	11.59%	13.75%
Burmis	13.61%	3.02%	2.55%	2.19%	2.23%	6.35%	1.27%	8.25%	3.68%	11.70%	12.27%

city/site	12	13	14	15	16	17	18	19
Airdrie	1.13%	4.37%	3.62%	1.75%	3.12%	15.09%	0.78%	2.67%
Bellevue	2.23%	3.35%	5.28%	3.81%	5.09%	6.73%	1.28%	4.36%
Black Diamond	1.59%	3.86%	4.23%	2.44%	3.62%	10.07%	0.91%	3.10%
Blairmore	2.25%	3.37%	5.33%	3.86%	5.15%	6.72%	1.29%	4.41%
Brooks	1.36%	5.56%	4.52%	2.09%	3.73%	19.61%	1.10%	3.20%
Calgary	1.19%	4.31%	3.66%	1.83%	3.27%	13.56%	0.82%	2.80%
Cardston	1.79%	5.06%	4.62%	2.76%	5.20%	11.17%	1.30%	4.45%
Claresholm	1.66%	4.34%	4.17%	2.56%	4.57%	9.27%	1.14%	3.91%
Clive	0.80%	4.55%	3.30%	1.24%	2.21%	26.26%	0.55%	1.89%
Coaldale	1.75%	5.13%	4.68%	2.69%	4.80%	11.66%	1.41%	4.11%
Cochrane	1.40%	4.10%	4.22%	2.16%	3.20%	13.65%	0.80%	2.74%
Coleman	2.05%	3.17%	4.95%	3.50%	4.68%	6.64%	1.17%	4.01%
Drumheller	0.90%	4.57%	3.44%	1.39%	2.47%	22.47%	0.62%	2.12%
Duchess	1.31%	5.59%	4.48%	2.02%	3.62%	20.68%	1.06%	3.10%
Fort McLeod	1.93%	4.81%	4.64%	2.97%	5.31%	8.77%	1.56%	4.55%
Granum	1.89%	4.88%	4.66%	2.91%	5.20%	9.36%	1.53%	4.45%
Grassy Lake	1.55%	5.40%	4.64%	2.38%	4.25%	15.41%	1.25%	3.64%
High River	1.31%	4.13%	3.67%	2.01%	3.59%	10.87%	0.90%	3.07%
Hillspring	1.93%	4.81%	4.58%	2.97%	5.59%	9.03%	1.40%	4.79%
Innisfail	0.96%	4.54%	3.50%	1.47%	2.63%	20.44%	0.66%	2.25%
Lacombe	0.84%	4.57%	3.37%	1.30%	2.32%	24.62%	0.58%	1.98%
Lethbridge	1.79%	5.05%	4.68%	2.76%	4.93%	10.85%	1.45%	4.23%
Magrath	1.67%	5.24%	4.61%	2.58%	4.85%	13.29%	1.22%	4.16%
Medicine Hat	1.34%	5.57%	4.51%	2.07%	3.69%	19.97%	1.08%	3.16%
Milk River	1.47%	5.47%	4.54%	2.27%	4.27%	17.43%	1.07%	3.65%
Nanton	1.35%	4.03%	3.66%	2.08%	3.72%	9.89%	0.93%	3.19%
Okotoks	1.26%	4.19%	3.66%	1.94%	3.47%	11.90%	0.87%	2.97%
Olds	1.01%	4.49%	3.54%	1.55%	2.77%	18.86%	0.69%	2.37%
Picture Butte	1.72%	5.16%	4.68%	2.66%	4.74%	12.02%	1.43%	4.06%
Pincher Creek	2.03%	4.61%	4.54%	3.12%	5.88%	7.66%	1.47%	5.03%
Ponoka	0.77%	4.55%	3.26%	1.19%	2.13%	27.53%	0.53%	1.82%
Raymond	1.68%	5.23%	4.67%	2.59%	4.63%	12.78%	1.36%	3.96%
Redcliff	1.32%	5.58%	4.49%	2.04%	3.64%	20.50%	1.07%	3.11%
Red Deer	0.90%	4.57%	3.44%	1.39%	2.47%	22.47%	0.62%	2.12%
Stavely	1.62%	4.41%	4.18%	2.49%	4.45%	9.98%	1.12%	3.81%
Sylvan Lake	0.85%	4.57%	3.38%	1.31%	2.34%	24.22%	0.59%	2.01%
Taber	1.64%	5.29%	4.67%	2.53%	4.51%	13.57%	1.32%	3.86%
Vauxhall	1.53%	5.42%	4.63%	2.36%	4.21%	15.71%	1.24%	3.61%
Hillcrest	2.23%	3.35%	5.28%	3.81%	5.09%	6.73%	1.28%	4.36%
Twin Butte	1.96%	4.76%	4.57%	3.01%	5.67%	8.65%	1.42%	4.85%
Coalhurst	1.82%	5.02%	4.67%	2.80%	4.99%	10.51%	1.47%	4.28%
Crowsnest Pass	1.94%	3.12%	4.80%	3.32%	4.43%	6.85%	1.11%	3.79%
Dunmore	1.31%	5.59%	4.47%	2.01%	3.59%	20.86%	1.08%	3.08%
Lundbrook	2.16%	3.85%	4.70%	3.33%	4.94%	6.62%	1.24%	4.23%
Burmis	2.30%	3.42%	5.41%	3.94%	5.26%	6.76%	1.32%	4.50%

Table D-4 Change in Market Share with Dam and no Mitigation

city/site	1	2	3	4	5	6	7	8	9	10	11
Airdrie	0.22%	1.32%	0.59%	0.07%	-1.24%	-0.07%	-0.33%	0.52%	0.71%	1.70%	-6.49%
Bellevue	-0.04%	0.56%	0.44%	0.11%	-2.05%	-0.84%	-0.10%	0.75%	1.02%	1.80%	-5.11%
Black Diamond	-0.03%	1.13%	0.55%	0.08%	-1.29%	-0.33%	-0.21%	0.59%	0.83%	1.83%	-6.46%
Blairmore	-0.05%	0.56%	0.45%	0.11%	-2.07%	-0.79%	-0.09%	0.73%	1.03%	1.81%	-5.12%
Brooks	0.60%	0.52%	0.50%	0.11%	-1.26%	0.05%	-0.39%	0.67%	0.91%	2.26%	-7.95%
Calgary	0.11%	1.30%	0.59%	0.07%	-1.29%	-0.11%	-0.30%	0.52%	0.72%	1.69%	-6.33%
Cardston	0.19%	0.48%	0.49%	0.10%	-1.90%	-0.36%	-0.18%	0.65%	0.92%	2.04%	-6.53%
Claresholm	-0.09%	0.63%	0.64%	0.11%	-1.82%	-0.37%	-0.15%	0.60%	0.85%	1.86%	-5.93%
Clive	0.92%	1.56%	0.66%	0.14%	-0.73%	0.21%	-0.52%	0.50%	0.66%	1.75%	-7.10%
Coaldale	0.28%	0.50%	0.51%	0.11%	-1.81%	-0.28%	-0.21%	0.68%	0.94%	2.15%	-6.85%
Cochrane	0.22%	1.19%	0.54%	0.07%	-1.08%	-0.15%	-0.31%	0.59%	0.82%	1.92%	-7.14%
Coleman	-0.13%	0.63%	0.51%	0.12%	-1.88%	-1.05%	-0.11%	0.72%	0.97%	1.74%	-4.91%
Drumheller	0.73%	1.49%	0.63%	0.11%	-0.85%	0.14%	-0.48%	0.51%	0.68%	1.76%	-7.06%
Duchess	0.64%	0.53%	0.51%	0.12%	-1.20%	0.09%	-0.41%	0.67%	0.90%	2.27%	-8.03%
Fort McLeod	0.15%	0.50%	0.53%	0.12%	-2.08%	-0.44%	-0.13%	0.67%	0.96%	2.07%	-6.11%
Granum	0.18%	0.50%	0.52%	0.12%	-2.02%	-0.41%	-0.15%	0.67%	0.95%	2.09%	-6.28%
Grassy Lake	0.44%	0.51%	0.50%	0.10%	-1.53%	-0.10%	-0.30%	0.68%	0.93%	2.21%	-7.50%
High River	-0.11%	1.26%	0.61%	0.07%	-1.47%	-0.21%	-0.23%	0.52%	0.72%	1.65%	-5.89%
Hillspring	0.10%	0.48%	0.51%	0.11%	-2.09%	-0.48%	-0.12%	0.65%	0.93%	1.99%	-5.99%
Innisfail	0.60%	1.45%	0.61%	0.09%	-0.93%	0.09%	-0.44%	0.52%	0.69%	1.75%	-6.97%
Lacombe	0.85%	1.54%	0.65%	0.13%	-0.77%	0.18%	-0.51%	0.51%	0.67%	1.76%	-7.11%
Lethbridge	0.24%	0.50%	0.51%	0.11%	-1.88%	-0.32%	-0.19%	0.68%	0.95%	2.13%	-6.66%
Magrath	0.28%	0.48%	0.48%	0.09%	-1.72%	-0.25%	-0.24%	0.65%	0.91%	2.08%	-6.96%
Medicine Hat	0.61%	0.52%	0.50%	0.12%	-1.24%	0.06%	-0.40%	0.67%	0.91%	2.26%	-7.98%
Milk River	0.43%	0.49%	0.47%	0.09%	-1.44%	-0.08%	-0.33%	0.65%	0.89%	2.14%	-7.55%
Nanton	-0.21%	1.24%	0.62%	0.08%	-1.60%	-0.28%	-0.20%	0.52%	0.73%	1.62%	-5.65%
Okotoks	-0.03%	1.27%	0.60%	0.07%	-1.44%	-0.19%	-0.25%	0.52%	0.72%	1.66%	-6.04%
Olds	0.48%	1.40%	0.60%	0.08%	-1.04%	0.04%	-0.41%	0.52%	0.69%	1.73%	-6.84%
Picture Butte	0.30%	0.50%	0.51%	0.11%	-1.78%	-0.26%	-0.22%	0.68%	0.94%	2.15%	-6.92%
Pincher Creek	0.05%	0.49%	0.53%	0.12%	-2.24%	-0.57%	-0.08%	0.65%	0.94%	1.96%	-5.56%
Ponoka	0.98%	1.58%	0.68%	0.15%	-0.69%	0.23%	-0.54%	0.50%	0.66%	1.75%	-7.10%
Raymond	0.33%	0.50%	0.50%	0.10%	-1.72%	-0.22%	-0.24%	0.68%	0.94%	2.17%	-7.07%
Redcliff	0.63%	0.53%	0.51%	0.12%	-1.21%	0.08%	-0.41%	0.67%	0.90%	2.26%	-8.02%
Red Deer	0.73%	1.49%	0.63%	0.11%	-0.85%	0.14%	-0.48%	0.51%	0.68%	1.76%	-7.06%
Stavely	-0.04%	0.63%	0.63%	0.11%	-1.76%	-0.33%	-0.16%	0.60%	0.85%	1.88%	-6.10%
Sylvan Lake	0.83%	1.53%	0.65%	0.12%	-0.78%	0.17%	-0.50%	0.51%	0.67%	1.76%	-7.10%
Taber	0.36%	0.51%	0.50%	0.10%	-1.66%	-0.18%	-0.26%	0.68%	0.93%	2.18%	-7.22%
Vauxhall	0.45%	0.51%	0.50%	0.10%	-1.51%	-0.09%	-0.31%	0.68%	0.93%	2.22%	-7.54%
Hillcrest	-0.04%	0.56%	0.44%	0.11%	-2.05%	-0.84%	-0.10%	0.75%	1.02%	1.80%	-5.11%
Twin Butte	0.09%	0.48%	0.52%	0.12%	-2.13%	-0.50%	-0.11%	0.65%	0.93%	1.98%	-5.87%
Coalhurst	0.23%	0.50%	0.51%	0.11%	-1.91%	-0.34%	-0.18%	0.68%	0.95%	2.12%	-6.58%
Crowsnest Pass	-0.07%	0.62%	0.50%	0.11%	-1.77%	-1.34%	-0.13%	0.79%	0.96%	1.74%	-4.89%
Dunmore	0.64%	0.53%	0.51%	0.12%	-1.19%	0.09%	-0.41%	0.67%	0.90%	2.27%	-8.04%
Lundbrook	0.03%	0.53%	0.56%	0.14%	-2.41%	-0.63%	-0.07%	0.69%	0.99%	2.04%	-5.62%
Burmis	-0.06%	0.57%	0.42%	0.11%	-2.11%	-0.72%	-0.09%	0.70%	1.04%	1.82%	-5.16%

city/site	12	13	14	15	16	17	18	19
Airdrie	0.34%	-1.47%	1.42%	-0.10%	0.46%	2.45%	-0.14%	0.06%
Bellevue	0.38%	-0.98%	2.01%	-0.60%	0.23%	3.03%	-0.33%	-0.30%
Black Diamond	0.37%	-1.25%	1.62%	-0.26%	0.37%	2.75%	-0.20%	-0.06%
Blairmore	0.38%	-0.98%	2.02%	-0.61%	0.23%	3.05%	-0.34%	-0.31%
Brooks	0.45%	-1.73%	1.85%	-0.05%	0.66%	2.80%	-0.18%	0.17%
Calgary	0.34%	-1.45%	1.43%	-0.13%	0.44%	2.54%	-0.16%	0.03%
Cardston	0.41%	-1.52%	1.79%	-0.28%	0.44%	3.68%	-0.29%	-0.14%
Claresholm	0.38%	-1.33%	1.66%	-0.29%	0.38%	3.26%	-0.27%	-0.14%
Clive	0.34%	-1.48%	1.45%	0.05%	0.58%	0.81%	-0.05%	0.24%
Coaldale	0.43%	-1.54%	1.84%	-0.24%	0.50%	3.37%	-0.31%	-0.06%
Cochrane	0.38%	-1.36%	1.63%	-0.16%	0.44%	2.52%	-0.15%	0.04%
Coleman	0.37%	-0.94%	1.90%	-0.54%	0.25%	2.91%	-0.30%	-0.26%
Drumheller	0.35%	-1.52%	1.45%	0.02%	0.56%	1.36%	-0.08%	0.20%
Duchess	0.45%	-1.73%	1.85%	-0.03%	0.68%	2.69%	-0.16%	0.19%
Fort McLeod	0.42%	-1.37%	1.85%	-0.33%	0.41%	3.34%	-0.37%	-0.18%
Granum	0.42%	-1.42%	1.85%	-0.31%	0.43%	3.36%	-0.36%	-0.15%
Grassy Lake	0.44%	-1.67%	1.84%	-0.14%	0.59%	3.19%	-0.24%	0.06%
High River	0.33%	-1.36%	1.43%	-0.19%	0.38%	2.74%	-0.20%	-0.05%
Hillspring	0.40%	-1.39%	1.80%	-0.35%	0.37%	3.63%	-0.34%	-0.23%
Innisfail	0.34%	-1.52%	1.44%	-0.01%	0.54%	1.68%	-0.09%	0.17%
Lacombe	0.34%	-1.50%	1.45%	0.04%	0.57%	1.01%	-0.06%	0.23%
Lethbridge	0.43%	-1.50%	1.85%	-0.27%	0.47%	3.38%	-0.33%	-0.09%
Magrath	0.42%	-1.62%	1.79%	-0.22%	0.50%	3.65%	-0.26%	-0.06%
Medicine Hat	0.45%	-1.73%	1.85%	-0.05%	0.67%	2.77%	-0.17%	0.18%
Milk River	0.43%	-1.73%	1.78%	-0.13%	0.59%	3.41%	-0.20%	0.06%
Nanton	0.33%	-1.31%	1.42%	-0.21%	0.35%	2.84%	-0.21%	-0.08%
Okotoks	0.33%	-1.39%	1.42%	-0.16%	0.40%	2.73%	-0.18%	-0.02%
Olds	0.34%	-1.52%	1.43%	-0.04%	0.51%	1.98%	-0.11%	0.14%
Picture Butte	0.43%	-1.56%	1.84%	-0.23%	0.51%	3.36%	-0.31%	-0.05%
Pincher Creek	0.40%	-1.28%	1.81%	-0.40%	0.32%	3.53%	-0.37%	-0.30%
Ponoka	0.34%	-1.46%	1.45%	0.07%	0.59%	0.60%	-0.04%	0.26%
Raymond	0.43%	-1.59%	1.84%	-0.21%	0.53%	3.33%	-0.29%	-0.02%
Redcliff	0.45%	-1.73%	1.85%	-0.04%	0.68%	2.71%	-0.17%	0.19%
Red Deer	0.35%	-1.52%	1.45%	0.02%	0.56%	1.36%	-0.08%	0.20%
Stavely	0.38%	-1.37%	1.66%	-0.26%	0.40%	3.27%	-0.25%	-0.12%
Sylvan Lake	0.34%	-1.50%	1.45%	0.04%	0.57%	1.08%	-0.06%	0.22%
Taber	0.44%	-1.62%	1.84%	-0.19%	0.54%	3.30%	-0.27%	0.00%
Vauxhall	0.44%	-1.68%	1.85%	-0.13%	0.59%	3.17%	-0.24%	0.07%
Hillcrest	0.38%	-0.98%	2.01%	-0.60%	0.23%	3.03%	-0.33%	-0.30%
Twin Butte	0.40%	-1.36%	1.81%	-0.37%	0.36%	3.60%	-0.34%	-0.25%
Coalhurst	0.43%	-1.49%	1.85%	-0.28%	0.46%	3.38%	-0.33%	-0.11%
Crowsnest Pass	0.37%	-0.93%	1.86%	-0.49%	0.27%	2.88%	-0.28%	-0.21%
Dunmore	0.45%	-1.73%	1.85%	-0.03%	0.68%	2.67%	-0.17%	0.20%
Lundbrook	0.42%	-1.04%	1.91%	-0.44%	0.33%	3.11%	-0.30%	-0.21%
Burmis	0.39%	-0.99%	2.05%	-0.63%	0.23%	3.08%	-0.34%	-0.32%

Table D-5 Change in Market Share with Dam and Mitigation

city/site	1	2	3	4	5	6	7	8	9	10	11
Airdrie	6.39%	-0.60%	-0.37%	-0.23%	-1.62%	-0.26%	-0.13%	2.11%	-0.12%	-0.45%	-0.57%
Bellevue	4.39%	-0.24%	-0.22%	-0.20%	-2.42%	-0.58%	-0.11%	5.22%	-0.30%	-0.94%	-0.59%
Black Diamond	5.98%	-0.61%	-0.34%	-0.21%	-1.63%	-0.39%	-0.12%	2.93%	-0.19%	-0.70%	-0.70%
Blairmore	4.46%	-0.24%	-0.22%	-0.19%	-2.44%	-0.54%	-0.11%	5.02%	-0.29%	-0.92%	-0.56%
Brooks	4.07%	-0.08%	-0.15%	-0.09%	-1.69%	-0.17%	-0.09%	2.58%	-0.08%	-0.30%	-0.15%
Calgary	6.57%	-0.65%	-0.39%	-0.24%	-1.67%	-0.28%	-0.13%	2.21%	-0.13%	-0.50%	-0.61%
Cardston	4.80%	-0.12%	-0.18%	-0.11%	-2.29%	-0.30%	-0.09%	3.37%	-0.15%	-0.54%	-0.35%
Claresholm	6.59%	-0.26%	-0.36%	-0.23%	-2.23%	-0.42%	-0.10%	3.06%	-0.20%	-0.75%	-0.68%
Clive	5.12%	-0.36%	-0.26%	-0.15%	-1.10%	-0.13%	-0.12%	1.51%	-0.06%	-0.22%	-0.30%
Coaldale	4.75%	-0.12%	-0.19%	-0.11%	-2.23%	-0.29%	-0.09%	3.29%	-0.14%	-0.51%	-0.35%
Cochrane	5.59%	-0.52%	-0.32%	-0.19%	-1.42%	-0.31%	-0.13%	2.60%	-0.15%	-0.55%	-0.62%
Coleman	5.03%	-0.30%	-0.28%	-0.24%	-2.25%	-0.73%	-0.14%	4.77%	-0.29%	-0.93%	-0.63%
Drumheller	5.53%	-0.43%	-0.30%	-0.18%	-1.22%	-0.16%	-0.13%	1.69%	-0.08%	-0.28%	-0.39%
Duchess	3.98%	-0.08%	-0.14%	-0.08%	-1.63%	-0.16%	-0.09%	2.50%	-0.07%	-0.28%	-0.13%
Fort McLeod	5.01%	-0.14%	-0.20%	-0.12%	-2.49%	-0.35%	-0.09%	3.62%	-0.17%	-0.64%	-0.41%
Granum	4.96%	-0.13%	-0.20%	-0.12%	-2.43%	-0.34%	-0.09%	3.55%	-0.16%	-0.61%	-0.40%
Grassy Lake	4.42%	-0.10%	-0.17%	-0.10%	-1.95%	-0.22%	-0.09%	2.93%	-0.11%	-0.40%	-0.26%
High River	6.90%	-0.73%	-0.41%	-0.26%	-1.85%	-0.33%	-0.13%	2.41%	-0.16%	-0.60%	-0.66%
Hillspring	4.99%	-0.13%	-0.19%	-0.12%	-2.49%	-0.35%	-0.08%	3.62%	-0.17%	-0.63%	-0.39%
Innisfail	5.76%	-0.48%	-0.32%	-0.19%	-1.31%	-0.18%	-0.13%	1.79%	-0.09%	-0.32%	-0.45%
Lacombe	5.29%	-0.39%	-0.28%	-0.17%	-1.13%	-0.14%	-0.13%	1.59%	-0.07%	-0.25%	-0.34%
Lethbridge	4.82%	-0.12%	-0.19%	-0.12%	-2.30%	-0.30%	-0.09%	3.37%	-0.15%	-0.55%	-0.37%
Magrath	4.62%	-0.11%	-0.18%	-0.11%	-2.12%	-0.26%	-0.09%	3.16%	-0.13%	-0.47%	-0.30%
Medicine Hat	4.04%	-0.08%	-0.14%	-0.09%	-1.67%	-0.16%	-0.09%	2.55%	-0.08%	-0.29%	-0.14%
Milk River	4.27%	-0.09%	-0.16%	-0.09%	-1.84%	-0.20%	-0.09%	2.79%	-0.10%	-0.35%	-0.21%
Nanton	7.03%	-0.75%	-0.41%	-0.26%	-1.98%	-0.36%	-0.12%	2.49%	-0.17%	-0.63%	-0.67%
Okotoks	6.78%	-0.69%	-0.40%	-0.25%	-1.83%	-0.32%	-0.13%	2.33%	-0.15%	-0.55%	-0.64%
Olds	5.94%	-0.51%	-0.34%	-0.20%	-1.42%	-0.20%	-0.13%	1.88%	-0.10%	-0.35%	-0.48%
Picture Butte	4.72%	-0.12%	-0.18%	-0.11%	-2.20%	-0.28%	-0.09%	3.25%	-0.13%	-0.50%	-0.34%
Pincher Creek	5.11%	-0.14%	-0.20%	-0.12%	-2.63%	-0.39%	-0.08%	3.79%	-0.19%	-0.70%	-0.42%
Ponoka	4.98%	-0.34%	-0.25%	-0.15%	-1.06%	-0.12%	-0.12%	1.46%	-0.06%	-0.21%	-0.27%
Raymond	4.65%	-0.11%	-0.18%	-0.11%	-2.14%	-0.26%	-0.09%	3.17%	-0.13%	-0.48%	-0.32%
Redcliff	4.00%	-0.08%	-0.14%	-0.08%	-1.64%	-0.16%	-0.09%	2.51%	-0.08%	-0.28%	-0.13%
Red Deer	5.53%	-0.43%	-0.30%	-0.18%	-1.22%	-0.16%	-0.13%	1.69%	-0.08%	-0.28%	-0.39%
Stavely	6.51%	-0.25%	-0.36%	-0.22%	-2.17%	-0.40%	-0.10%	2.99%	-0.19%	-0.71%	-0.67%
Sylvan Lake	5.33%	-0.40%	-0.29%	-0.17%	-1.15%	-0.14%	-0.13%	1.60%	-0.07%	-0.25%	-0.35%
Taber	4.58%	-0.11%	-0.18%	-0.11%	-2.08%	-0.25%	-0.09%	3.10%	-0.12%	-0.45%	-0.30%
Vauxhall	4.40%	-0.10%	-0.17%	-0.10%	-1.93%	-0.22%	-0.09%	2.90%	-0.10%	-0.39%	-0.25%
Hillcrest	4.39%	-0.24%	-0.22%	-0.20%	-2.42%	-0.58%	-0.11%	5.22%	-0.30%	-0.94%	-0.59%
Twin Butte	5.02%	-0.14%	-0.19%	-0.12%	-2.52%	-0.36%	-0.08%	3.66%	-0.17%	-0.65%	-0.40%
Coalhurst	4.85%	-0.13%	-0.19%	-0.12%	-2.33%	-0.31%	-0.09%	3.41%	-0.15%	-0.56%	-0.37%
Crowsnest Pass	4.76%	-0.31%	-0.29%	-0.25%	-2.14%	-0.93%	-0.17%	5.28%	-0.29%	-0.93%	-0.68%
Dunmore	3.96%	-0.08%	-0.14%	-0.08%	-1.62%	-0.15%	-0.09%	2.49%	-0.07%	-0.28%	-0.12%
Lundbrook	5.32%	-0.18%	-0.23%	-0.14%	-2.84%	-0.47%	-0.09%	4.02%	-0.23%	-0.84%	-0.53%
Burmis	4.57%	-0.23%	-0.20%	-0.17%	-2.47%	-0.49%	-0.10%	4.74%	-0.29%	-0.91%	-0.53%

city/site	12	13	14	15	16	17	18	19
Airdrie	-0.08%	-2.07%	-0.27%	-0.13%	-0.23%	-1.11%	-0.06%	-0.20%
Bellevue	-0.18%	-1.63%	-0.44%	-0.32%	-0.42%	-0.56%	-0.11%	-0.36%
Black Diamond	-0.13%	-1.88%	-0.35%	-0.20%	-0.30%	-0.83%	-0.07%	-0.26%
Blairmore	-0.18%	-1.63%	-0.43%	-0.31%	-0.41%	-0.54%	-0.10%	-0.36%
Brooks	-0.06%	-2.39%	-0.19%	-0.09%	-0.15%	-0.81%	-0.05%	-0.13%
Calgary	-0.09%	-2.07%	-0.28%	-0.14%	-0.25%	-1.06%	-0.06%	-0.22%
Cardston	-0.10%	-2.28%	-0.26%	-0.16%	-0.29%	-0.63%	-0.07%	-0.25%
Claresholm	-0.14%	-2.12%	-0.35%	-0.22%	-0.38%	-0.78%	-0.10%	-0.33%
Clive	-0.04%	-2.03%	-0.17%	-0.06%	-0.12%	-1.37%	-0.03%	-0.10%
Coaldale	-0.10%	-2.30%	-0.26%	-0.15%	-0.26%	-0.64%	-0.08%	-0.23%
Cochrane	-0.10%	-1.94%	-0.31%	-0.16%	-0.23%	-1.00%	-0.06%	-0.20%
Coleman	-0.18%	-1.58%	-0.44%	-0.31%	-0.42%	-0.60%	-0.10%	-0.36%
Drumheller	-0.05%	-2.07%	-0.20%	-0.08%	-0.15%	-1.32%	-0.04%	-0.12%
Duchess	-0.05%	-2.39%	-0.18%	-0.08%	-0.14%	-0.82%	-0.04%	-0.12%
Fort McLeod	-0.12%	-2.20%	-0.28%	-0.18%	-0.33%	-0.54%	-0.10%	-0.28%
Granum	-0.11%	-2.23%	-0.28%	-0.17%	-0.31%	-0.56%	-0.09%	-0.27%
Grassy Lake	-0.07%	-2.37%	-0.22%	-0.11%	-0.20%	-0.74%	-0.06%	-0.17%
High River	-0.11%	-2.03%	-0.31%	-0.17%	-0.31%	-0.92%	-0.08%	-0.26%
Hillspring	-0.12%	-2.20%	-0.28%	-0.18%	-0.34%	-0.55%	-0.09%	-0.29%
Innisfail	-0.06%	-2.09%	-0.22%	-0.09%	-0.16%	-1.28%	-0.04%	-0.14%
Lacombe	-0.05%	-2.05%	-0.19%	-0.07%	-0.13%	-1.35%	-0.03%	-0.11%
Lethbridge	-0.10%	-2.28%	-0.26%	-0.16%	-0.28%	-0.61%	-0.08%	-0.24%
Magrath	-0.09%	-2.33%	-0.24%	-0.13%	-0.25%	-0.69%	-0.06%	-0.22%
Medicine Hat	-0.05%	-2.39%	-0.18%	-0.08%	-0.15%	-0.81%	-0.04%	-0.13%
Milk River	-0.07%	-2.38%	-0.20%	-0.10%	-0.19%	-0.78%	-0.05%	-0.16%
Nanton	-0.12%	-1.99%	-0.32%	-0.18%	-0.33%	-0.86%	-0.08%	-0.28%
Okotoks	-0.10%	-2.03%	-0.30%	-0.16%	-0.28%	-0.97%	-0.07%	-0.24%
Olds	-0.07%	-2.08%	-0.23%	-0.10%	-0.18%	-1.24%	-0.05%	-0.16%
Picture Butte	-0.09%	-2.31%	-0.25%	-0.14%	-0.26%	-0.65%	-0.08%	-0.22%
Pincher Creek	-0.13%	-2.13%	-0.29%	-0.20%	-0.38%	-0.49%	-0.09%	-0.32%
Ponoka	-0.04%	-2.01%	-0.16%	-0.06%	-0.11%	-1.38%	-0.03%	-0.09%
Raymond	-0.09%	-2.33%	-0.25%	-0.14%	-0.24%	-0.67%	-0.07%	-0.21%
Redcliff	-0.05%	-2.39%	-0.18%	-0.08%	-0.14%	-0.82%	-0.04%	-0.12%
Red Deer	-0.05%	-2.07%	-0.20%	-0.08%	-0.15%	-1.32%	-0.04%	-0.12%
Stavely	-0.13%	-2.15%	-0.34%	-0.20%	-0.37%	-0.82%	-0.09%	-0.31%
Sylvan Lake	-0.05%	-2.06%	-0.19%	-0.07%	-0.13%	-1.35%	-0.03%	-0.11%
Taber	-0.08%	-2.35%	-0.24%	-0.13%	-0.23%	-0.69%	-0.07%	-0.20%
Vauxhall	-0.07%	-2.37%	-0.22%	-0.11%	-0.20%	-0.74%	-0.06%	-0.17%
Hillcrest	-0.18%	-1.63%	-0.44%	-0.32%	-0.42%	-0.56%	-0.11%	-0.36%
Twin Butte	-0.12%	-2.18%	-0.28%	-0.19%	-0.35%	-0.53%	-0.09%	-0.30%
Coalhurst	-0.10%	-2.27%	-0.27%	-0.16%	-0.29%	-0.60%	-0.08%	-0.25%
Crowsnest Pass	-0.18%	-1.57%	-0.45%	-0.31%	-0.42%	-0.65%	-0.10%	-0.36%
Dunmore	-0.05%	-2.39%	-0.18%	-0.08%	-0.14%	-0.82%	-0.04%	-0.12%
Lundbrook	-0.16%	-1.82%	-0.34%	-0.24%	-0.36%	-0.48%	-0.09%	-0.31%
Burmis	-0.18%	-1.64%	-0.42%	-0.30%	-0.41%	-0.52%	-0.10%	-0.35%