Credit Valley Conservation

The Credit River Watershed

Valuation of Angling

CREDIT VALLEY CONSERVATION

Final Report

The Credit Watershed: Social, Economic and Environmental Services Provided to the Watershed Community

Valuation of Angling

Submitted to

Credit Valley Conservation

Prepared by

DSS Management Consultants Inc.

January, 2008

CREDIT VALLEY CONSERVATION

DSS Management Consultants Inc.
Designers of Decision Support Systems

January 17, 2008
Sent by e-mail

Credit Valley Conservation
1255 Old Derry Road
Mississauga, Ontario
L5N 6R4

Attention: Mike Puddister, Manager Lands & Stewardship

Re: The Credit Watershed: Fishery Valuation Analysis
Our file no. 339

Dear Mr. Puddister:

Following is our final report regarding the above study. This report describes the results of our analysis in detail and includes a number of conclusions and recommendations. The report has benefited from the comments that you and others provided on earlier drafts.

The economic values that have been estimated provide an important basis for guiding future management decisions. That being said, these are the first estimates of the economic value of the fishery that have been produced. For this reason, these estimates can be improved over time by refining and expanding the methodology set out in this report. Recommendations are included in this respect.

On behalf of the project team, thank you for the opportunity to undertake this interesting work on your behalf. We hope that you will find these results useful for securing funds to conserve and enhance this valuable fishery.

Sincerely

Edward Hanna,
Principal

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Executive Summary

Purpose and Scope

The analysis and results presented in this report are part of a longer-term initiative by Credit Valley Conservation (CVC) to develop a comprehensive understanding of the economic value of ecological goods and services (EGS) provided by the Credit River watershed. This study addresses a subset of these EGS, the economic value of the Credit River fishery.

The following economic value estimates are partial estimates of the total value of the Credit fishery. They measure only the angling use value of the fishery. Passive use values, option value, bequest value and existence value likely represent a significant portion of the overall value of the fishery and are not included.

Methodology

Angling on the Credit River is a non-marketed public good. Economic valuation of non-marketed angling opportunities requires specialized techniques. This analysis employs a form of the revealed preference methodology, namely the product travel cost approach.

The product travel cost methodology assumes that anglers choose from a selection of available types of angling opportunities (i.e., products) based on access cost (i.e., travel cost) and the nature of each angling product. Anglers are assumed to behave as rational consumers of angling opportunities and to choose the desired combination of quantity and quality of angling products available at the lowest price.

A key element is the product definition procedure. Observed angler behaviour is used to deduce the key factors affecting their choice where to fish (e.g., success rate, fish size, quality of the natural environment). An important ancillary management application of the results is the ability to forecast how anglers will respond to changes in the fishery.

An online angler survey was designed and administered to provide the required data. A total of 494 responses to the survey were received. Analysis of the responses demonstrated that a reasonably representative sample of the total angler population was obtained. These responses were used to create an angler database which included the origin, angling destination and associated travel costs for each of the reported angling trips.

Credit River Angler Population

The Credit River is estimated to support over 30,000 angler days per year. These anglers are similar in age (i.e., average age about 40 years) and gender (over 80% male) to the provincial angler population. The great majority of the anglers came from the Golden Horseshoe area; one quarter came from Mississauga. Shore angling and wading are the most common methods of fishing. The top five most heavily fished destinations in declining order are:

1. Erindale Park to Hwy 403 (#17)
2. Trout Unlimited Private Agreement Waters (#9)
3. Forks of the Credit Provincial Park (#5)
4. Lake Ontario Waterfront (#18)
5. Middle Credit River (#11)

The greatest number of angling trips was reported for the spring season, the least for the winter season. Nearly half of the respondents classified themselves as avid anglers (i.e., 47%). This proportion is considerably higher than the provincial average. As well, avid Credit River anglers tended to fish more during the year relative to the provincial average (i.e., 100 days compared to 16 days). The factors that most strongly influenced anglers' decisions to fish the Credit are the limited availability of suitable alternate sites and fish size. Other important factors are the species available, success rate, proximity to residence/work and prior knowledge of the area.

Valuation of Angling Products

The total value of the Credit fishery is equal to the sum of the value of the various angling products supplied throughout the watershed. Demand functions for each of the 30 angling products offered by the Credit were developed. These functions were combined with travel cost information to estimate the value of each product for anglers from each of 28 origins within the province.

The value of an angler day varies significantly from origin to origin and from product to product. Generally, the origins closest to the Credit enjoy the greatest value since their travel costs are the lowest (i.e., they can enjoy the angling product for the lowest price). The average value of an angling day varies significantly from a low of $9/trip in the fall to a high of $148/trip in the spring. These average values generally are in accord with those reported from other studies.

The total value of each angling products varies significantly by season. The greatest value is realized during the summer season and the lowest is during the winter season. The highest value product is fishing for fall migratory rainbow. During the spring, two high-value products are evident, namely, fishing for migratory rainbow and fishing for resident brook and brown trout. A highly valued summer fishery involves a mix of cold and warm water species as well as a coldwater fishery for resident trout in the upper reaches of the river. The winter fishery consists primarily of migratory rainbow trout which is limited by regulations and seasonal weather constraints.

The overall value of this fishery with respect to each origin is a function of distance, population size and demographics. The greatest total value from the fishery is realized by anglers from the Toronto origins. These anglers are close to the Credit and comprise a large population. As well, the demographics of Toronto are somewhat different than those of Mississauga and Brampton.

The more intensively angled destinations are generally more valuable in aggregate. For example, Erindale Park supports a large amount of angling pressure, is close to many anglers and provides year-round angling opportunities for large anadromous salmon and rainbow trout. As a result it is the most valuable destination overall.

The total annual value of the fishery is estimated to be in the order of $1.2 million. This converts to a cumulative net present value of around $48 million.

Conclusions and Recommendations

1 Angler Database

The online survey methodology proved to be highly cost efficient. A large number of detailed responses were obtained for a fraction of the cost that would have been required to obtain comparable results using a mail-out survey or a streamside survey. It is recommended that the DFO recreational fishing survey databases be analysed to refine the estimated total Credit River angler population. Doing so will increase confidence in the accuracy of the value estimate. In addition, various options for refining and periodically updating the value estimates are outlined.

2 Broaden the Scope

Many anglers who fish the Credit fish other watersheds as well. The results of the product travel cost methodology are greatly strengthened as the scope of destinations increases. Ideally, the methodology should include the major angling destinations that anglers from the identified origins are traveling to; the result being the ability to forecast regional angler behaviour and not just local angler behaviour. Accordingly, conservation authorities in the region could coordinate their programs and anticipate their impacts on angling behaviour in adjacent watersheds.

The results of the product travel cost methodology are valuable to analyse the economics of potential management actions/projects. Specifically, the benefit of a management project in terms of improved angling opportunities can be calculated and compared to the costs of the improvement. In this way, a strong financial case can be made in support of fishery improvements that yield a positive benefit.

Similarly, if a proposed change to the watershed is anticipated to have a negative impact on one or more river sections, the economic loss in terms of lost fishing opportunities and their value can be estimated. This type of information can be used effectively to modify and improve land use proposals and to support requests for mitigative measures.

3 Include Additional Values

The product travel cost methodology proved useful for deriving a menu of angling products. Reasonable correlations between angling products and angling behaviour were observed. However, the methodology only measures the value of the watershed for angling uses. Supplementing these values with estimates for additional values (e.g., option value, bequest value and existence value) would increase the overall value of the fishery considerably. If future surveys are undertaken, adding a section on stated preferences would allow these additional values to be estimated. As well, including a survey of non-anglers to obtain their willingness to pay for these other values would increase the robustness of the valuation of the fishery.

4 Application of the Results

The results of the product travel cost methodology are valuable to analyse the economics of potential management actions/projects. Specifically, the benefit of a management project in terms of improved angling opportunities can be calculated and compared to the costs of the improvement. In this way, a strong financial case can be made in support of fishery improvements that yield a positive benefit.

Similarly, if a proposed change to the watershed is anticipated to have a negative impact on one or more river sections, the economic loss in terms of lost fishing opportunities and their value can be estimated. This type of information can be used effectively to modify and improve land use proposals and to support requests for mitigative measures.

5 Management Decision Support Software System

To make the best use of these results, the demand functions, supply costs, demographics and other supporting information should be integrated in a decision support software system. Doing so will permit CVC personnel who may not be skilled in economic analysis to use the results easily for practical applications. This type of software would have generic applications that would benefit other authorities. For this reason, the CVC should seek a cost-sharing arrangement with other authorities' measures.

6 Future Applications of the Product Travel Cost Methodology

This economic valuation methodology is equally applicable to other forms of outdoor recreation. As the CVC expands the scope of its EGS valuation information base, consideration should be given to using this methodology to value these activities.

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Acknowledgements

DSS Management Consultants Inc. acknowledges the following contributions.

Mike Puddister, Manager Lands & Stewardship at Credit Valley Conservation directed the project and provided critical comments on various drafts of this report and overall guidance on the purpose and context for the study. Mike's ongoing support and patience while the data and analysis on which this report is based were compiled was essential.

Jeff Wilson, Project Co-ordinator, Ecological Goods & Services, joined Credit Valley Conservation toward the latter stages of this study but provided insightful comments and suggestions for improvements to the analysis and the text of the report.

Leslie Luxemburger provided logistical support within Credit Valley Conservation; he undertook the streamside survey and he coordinated the online survey database development. Leslie's enthusiasm and understanding of the project and associated methodology were critical for obtaining a useful and reliable angling database.

Dave Beaton, Supervisor, Community Outreach at Credit Valley Conservation showed a keen interest in the study from the outset. His probing questions were essential for us to crystallize the data collection and analysis methodology. His insight as both a manager and an avid angler ensured the study stayed on focus.

Bob Morris, a biologist with Credit Valley Conservation, has extensive and detailed knowledge of the fishery which he readily shared with us. His familiarity with the biology of the fishery and the demographics of the angler population were invaluable.

This project was undertaken with the assistance of an advisory committee. The members of the committee provided useful feedback during the design of the methodology and commented on the draft final report. The members of the committee are:
Jim Anderson, Ducks Unlimited Canada
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Dr. Peter Victor, Economics Advisor

Some of the cover page photos were obtained from the following sources:
Credit River Anglers Association (http://www.craa.on.ca/index.shtml).
The Credit River Alliance (http://www.creditriveralliance.ca/)

1 Introduction

This report describes the methodology, data and results of an economic valuation of the Credit River fishery. This first section provides the context for the technical sections of this report.

1.1 Background

DSS Management Consultants Inc. was retained by Credit Valley Conservation (CVC) in June 2006 to develop estimates of the economic value of the Credit River fishery. DSS prepared a detailed technical proposal outlining the methodology that would be used for this analysis. This report describes the results of that work.

Management decisions/actions by the CVC affect the quality and quantity of the supply of natural resources (what are commonly referred to as ecological goods and services or EGS) available in the Credit River watershed. This analysis is part of a longer-term initiative by CVC to develop a comprehensive understanding of the value of EGS provide by the Credit River watershed. This study is focused on a subset of these EGS, more specifically, on the economic value of the angling opportunities supplied by the Credit River watershed.

As a public agency, the CVC makes management decisions designed to enhance the public good (i.e., that are designed to yield a positive net social benefit) while ensuring the conservation of the Credit's natural resources. For example, the CVC strives to provide the optimal supply of angling opportunities that will yield the greatest benefit to its "shareholders" (i.e., the residents and municipal governments in the watershed), while ensuring sustainability of the fishery. The CVC however, does not have absolute control over all factors affecting the supply of angling opportunities[1]. Therefore, the CVC must evaluate its management options within a broader context of other influences. The results of this study are designed to assist the CVC in carrying out this mandate.

1.2 Scope of Report

This report provides details on the methodology and data used to produce estimates of the use value of the Credit River fishery. The methodology includes the value of the fishery resulting from its use by anglers. The geographic boundary of the angling activities included in this analysis is defined by the Credit watershed. The Credit provides important spawning and nursery habitat that contributes to the Lake Ontario fishery which is outside the watershed *per se*. The value of this ecological service and the associated use values realized through the Lake Ontario fishery are not included this analysis.

The methodology does not include non-use values (e.g., existence value, option value, bequest value), which may be considerable given that these values are held by a broad cross-section of the general population, not only by anglers and given the large urban population proximal to the Credit. Likewise, the methodology does not capture the value of other outdoor opportunities afforded by the Credit and its fishery (e.g., amenity values, nature viewing, outdoor education). As such the

[1] For example, the setting of angling regulations is the responsibility of the Ontario Ministry of Natural Resources. The CVC works with OMNR in this respect but ultimate management responsibility for the fishery rests with the provincial government. Likewise, many land use decisions that affect the fishery are the responsibility of municipal and provincial governments. The CVC provides advice on these decisions but ultimately responsibility for many land use decisions rests with other agencies.

economic value estimates included in this report should be considered a partial estimate of the total value of the Credit fishery. Adding in these additional values would increase significantly the estimated total value of the fishery.

1.3 Report Organisation

Section 2 of this report explains the economic theory and principles on which the product travel cost methodology is based. Basic concepts central to the methodology are introduced and explained.

Section 3 presents the results of the analysis. Each of the steps that were taken to derive the estimates of the value of the fishery is described. As well, the results of the analysis are discussed in detail.

Section 4 provides a summary of the conclusions and recommendations arising from the analysis. These range from ways to improve the analysis in the future to how best to apply the results of the analysis for management purposes.

A number of appendices are included. These appendices contain the detailed information and results of the analysis.

2 Angling Valuation Methodology

This section describes the economic theory underlying the product travel cost methodology used to value the Credit River fishery. As well, the practical applications of the results for guiding management decisions are explained. The section starts out by discussing some basic economic concepts. The conventional travel cost methodology is described and its limitations are discussed. Next the product travel cost methodology is described and its advantages are discussed relative to other economic valuation methodologies.

2.1 Non-market Goods and Consumer Surplus

Many ecological goods and services (EGS) are referred to by economists as non-marketed goods and services. Angling on the Credit River is a good example of a non-marketed service. From an economic perspective, non-marketed goods are distinctly different from private goods that are exchanged through competitive markets.

For example, consider a private put-and-take fishing pond where the owner charges anglers an entrance fee for the opportunity to fish. In the case of this private operation, the supply of angling opportunities is considered a private marketed service. Access to the fishery is regulated by the owner and an entrance fee is charged. The entry fee reflects a balance between the private cost of supplying the angling opportunities which is borne by the operator and the willingness of anglers to pay the entrance fee (i.e., their demand for angling). Valuation of the angling opportunities consumed at this type of private operation involves multiplying the number of angling days times the daily entrance fee (i.e., the market price); similar to the approach that would be used to value the supply of say a fleet of new cars (i.e., the value of the fleet is equal to the number of cars times their market price).

As noted, angling on the Credit River is largely a non-marketed service. Anglers need to purchase an annual provincial fishing licence. However once this licence is purchased, individual anglers can

spend as much time as they wish fishing where ever they wish[2] during the open season. In most open access locations in Ontario, no daily angling fee must be paid. Likewise, there is no restriction on how many people may choose to fish at one location at one time. Access to angling is open to the public and to a large extent the opportunity for an individual to fish is not affected by the behaviour of other anglers. These are some key characteristics of non-marketed public goods.

Valuing non-marketed angling opportunities is quite different than valuing angling at a private put-and-take fishing operation from an economic valuation perspective. With open access angling, there are no independent sellers and buyers. The producer of angling days and the consumer are one in the same. Angler days are the tangible "products" of the Credit River fishery. Anglers produce angler days by consuming angling opportunities. As a result there are no competitive prices for these angling opportunities established through exchanges in the market between producers and consumers. However, economists have developed methods to derive estimates of what the price would be for these angling opportunities if they were exchanged through a competitive market.

Two basic approaches are used, each of which has its strengths and weaknesses. The first approach is referred as the stated preference methodology. Many variants of the stated preference methodology have been developed (e.g., see Adamowicz and Deshazo. 2006; Adamowicz et al, 1998; Adamowicz et al, 1994; Breffle, 1998; Louviere 2000; Johnston, 2002; Freeman, 2003; Winkler, 2004). The basic methodology involves some form of survey that requires respondents to state explicitly or reveal by the trade-offs they choose how important (i.e., how much they would be willing to pay or willing to accept) for a marginal increase/decrease in the supply of a given good or service. For example, a stated preference survey could have been designed and administered to Credit River anglers. The objective of the survey would have been to ask anglers how valuable the opportunity to fish on the Credit was to them. The design and administration of this type of survey is critical to obtain reliable results (Johnston, 1999). As well, critics point to the hypothetical nature of the valuation which poses a number of serious and difficult-to-overcome challenges (Winkler, 2004).

Many of these challenges regarding the validity of stated preference values can be resolved by using the other basic approach, referred to as the revealed preference methodology. This methodology is not based on hypothetical questions but on the actual observed behaviour of users. Of course, a weakness of this approach is that it is limited to the values that people derive from actively using a resource and does not include non-use values (e.g., existence values, bequest values and option values). Nonetheless, the observed behaviour methodology is ideal for valuing the use of the fishery by anglers.

2.2 Basic Travel Cost Methodology

The travel cost methodology developed in the 1960s (Clawson and Knetsch, 1966) was the first form of the revealed preference methodology for valuing natural resources. The original methodology has been refined considerably over time but the fundamental underlying principles have remained constant.

[2] The one exception is private land along the river in which case angling opportunities can be capitalized by the landowner through restricting access and charging an entrance fee of one sort or another. This study does not include these fees in the total value of the fishery and are not large relative to the total value of the fishery. Similarly, the price of private land bordering on the Credit may be enhanced due to the ability to have exclusive access to the fishery. Technically, both of the sources of values should be added to the estimates of the value of the fishery included in this report to obtain the total value.

The idea behind the travel cost methodology is that by examining the amount of use of a given site (i.e., what is referred to as a destination) by people from different origins (i.e., different places of residence) and estimating the travel costs (both travel distance and time) from each origin to the destination, a demand function unique for that site can be derived. The resulting demand function can be used to estimate the total benefit net of travel costs (what is referred to technically as consumer surplus) that each user enjoys by visiting the site.

By summing the consumer surplus enjoyed by each visitor, the total value of the site can be estimated for that year. This value is the total amount that the visitors would be willing to pay to continue enjoying access to the site each year and is somewhat comparable to the private annual value of angling opportunities that would be estimated for a private put-and-take fishing operation.

The basic travel cost methodology was designed to estimate the all-or-nothing value of a single destination (e.g., a national park). The basic approach does not provide insights into the features of the destination that are of greatest importance. Likewise the approach does not provide insights into the consequences of improving or declining quality of the destination or the impact on its value of new competing destinations. These types of considerations are commonly encountered by managers of these types of destinations and can play a critical role in determining their economic value and in selecting the best management alternative.

2.3 Product Travel Cost Methodology

This study is based on a variant of the basic travel cost methodology, referred to as the product travel cost methodology. The product travel cost methodology is described in detail by Talhelm et al. (1987). This methodology differs in a number of important respects from the basic travel cost approach.

The product travel cost methodology is designed to deal simultaneously with multiple, competing destinations similar to the situation that a private put-and-take angling operation faces (i.e., such operations must compete with various types of alternate destinations/activities, some of which may be angling related and some may involve quite different types of leisure activities). As well, the methodology provides insights into the contribution of key site features to the overall value of the destination.

Specifically, the product travel cost methodology is based on the idea that not all angling opportunities are equal and that anglers choose from among a selection of multiple different types of angling opportunities (i.e., products) based on access cost (i.e., travel cost) and the nature of the angling product supplied by a given destination. Within this framework, anglers are assumed to behave as rational consumers of angling opportunities and to choose the desired combination of quantity and quality of angling products available at the lowest cost.

The product travel cost methodology involves a series of steps that are described in Section 3. A key element is the product definition process. This procedure provides an objective means to deduce from observed angler behaviour the key characteristics of a destination (e.g., success rate, fish species present, average/maximum size of fish, quality of the natural environment) that are of importance to anglers when choosing where to fish. The methodology then uses these angler-defined angling products to estimate their value to anglers.

This added information on angler preferences is valuable to managers. Managers are able to better understand how the quality of angling opportunities can be improved and hence the overall value of the fishery enhanced. Importantly, the results of the methodology also allow managers to forecast how anglers will respond to improvements to the fishery brought about by management. This type of economic information assists in producing compelling financial justification for investments in fishery management actions.

2.4 Angling Products

The definition of angling products is an iterative exploratory process. The procedure is consistent with the underlying fundamental assumption of all revealed preference methodologies, namely, that anglers are rational consumers of angling products (i.e., they will choose to "consume" the least cost option that offers the desired qualities).

The idea is that when angling products are accurately characterized (i.e., in terms of the attributes important to anglers), the travel behaviour of anglers will follow predictable logical patterns. More specifically, anglers from a given origin will generally choose to fish at the nearest (i.e., lowest cost) destination offering a desired product. In other words, anglers will not choose to travel further destinations unless there is a material difference between the angling opportunities offered at more distant destinations relative to nearer destinations.

The product travel cost methodology involves testing combinations of product definitions to see how much residual "excess" (i.e., unexplained) travel is present. The objective is to arrive at final set of angling products that result in a rational pattern of angler travel behaviour (i.e., that reasonably accurately explains angler travel patterns).

Reducing the amount of excess travel is a trial-and-error process. A large part of the process involves having a reasonable understanding of the angler population, the general characteristics of the available angling destinations and creative pragmatism. One might argue that each angling destination is unique and that it should be its own product. In some respects this is true. Indeed, if each destination is defined as being unique, there can be no excess travel. However, having all destinations being defined as unique reduces greatly the value of the product travel cost methodology. One of its strengths is gaining insight into the site features of importance to anglers and using this insight to forecast angler behaviour in the future. For this reason, some aggregation of angling destinations into similar groups is desirable.

Every angling destination is more similar to some destinations than it is to others. Furthermore, anglers clearly lump certain destinations as being approximately comparable when choosing where to fish as evidenced by angler travel patterns. As a result, creative pragmatism is required to arrive at a balanced set of angling products that are reasonable to predict angler behaviour and capture the major angling product characteristics that drive angler decisions as to where they will fish. If this is achieved, the valuation of the fishery also will be accurately captured.

Details on the product definition procedure used to arrive at the set of angling products for the Credit River fishery are provided in Section 3.

3 Product Travel Cost Methodology

This section describes the steps followed in applying the product travel cost methodology to the Credit River fishery. The types and sources of data used are presented. As well, the analytical steps are described in detail.

3.1 Overview of Methodological Steps

The product travel cost methodology is based on the observed travel patterns of anglers. Specifically, the methodology requires an angling behaviour database which includes information on:

- the number of angling trips from a given origin to a given destination
- the characteristics of the destinations relevant to anglers (e.g., species of fish present, size, abundance, special regulations, access, entrance fees, quality of natural environment, crowding).
- travel distances and times from each origin to each destination.

The following steps were followed to compile the angler database and to apply the product travel cost methodology to the Credit River fishery.

1. The Credit River was subdivided into a continuous series of 18 sections (i.e., angling destinations).
2. Angling surveys were designed and administered to anglers.
3. The results of the surveys were error-checked and entered into a statistical database.
4. Reported angler origins were aggregated into major centres.
5. Demographic data for each origin were compiled.
6. Travel distances and times were estimated from each aggregated origin to each destination.
7. Angling products were defined using an excess travel cost methodology similar to that described by Talhelm et al (1987).
8. The total angler population was estimated from past angler surveys.
9. Demand functions were estimated for each angling product.
10. The consumer surplus associated with each angling product was estimated.
11. The total value of each angling product and the fishery overall were calculated.

The details associated with each of these steps are discussed following.

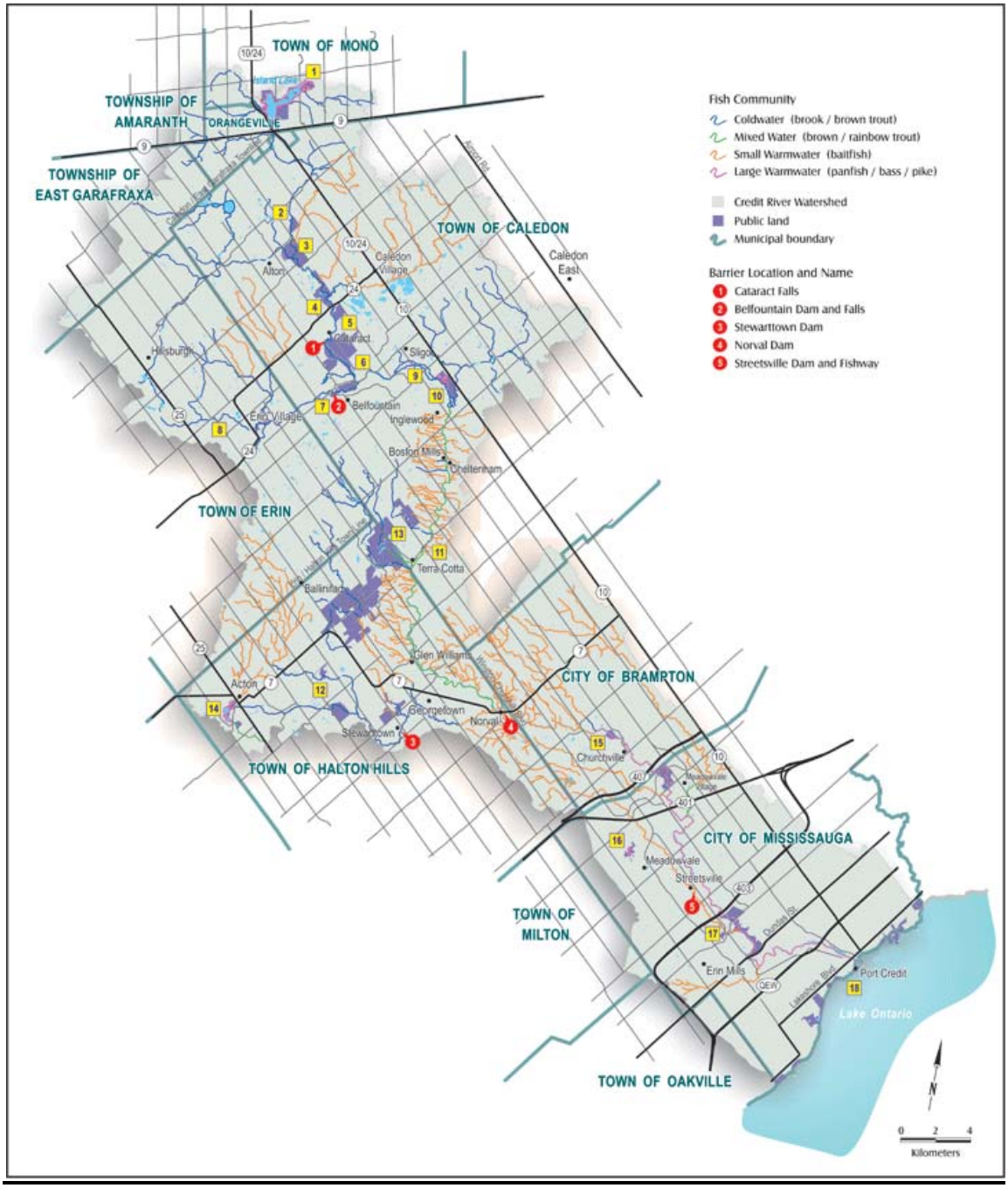
3.2 Definition of Destinations

The first step in the product travel cost methodology is to define those destinations that are expected to vary significantly from one another in terms of one or more of the following characteristics:

- Travel costs from major angler origins
- Offer distinctly different angling opportunities

In the case of the Credit, CVC staff used their knowledge of the watershed to define 18 contiguous destinations (Figure 3-1). These same sections were used for the Credit River Fisheries Management Plan (CVC and OMNR, 2002) and other CVC programs. A 19th destination, the Lake Ontario waterfront was not included in the analysis. This destination was considered more closely associated with Lake Ontario as opposed to the Credit River *per se*. Excluding this destination does highlight the fact that this analysis considers only the value of angling on the Credit. This analysis does not account for the contribution of the Credit to the Lake Ontario fishery and the associated economic value of that fishery.

Figure 3-1 – Credit River Angling Destinations



The 18 destinations include a diversity of angling opportunities. In the southern part of the watershed, angling for migratory salmon and rainbow trout is significant; whereas, many of the northern sections offer angling for resident trout species. More detailed information on the angling opportunities in the Credit are provided in the fisheries management plan.

3.3 Angler Surveys

The angling data required to apply the product travel cost methodology were not available at the start of this study. A number of creel censuses have been done for the Credit over the years but critical angler information (e.g., origin) was not collected. As a result, an angler survey needed to be designed and administered specifically for this analysis.

An important initial decision involved the best means to administer the survey. This decision was influenced by:

- accuracy of results
- cost of administration
- project schedule and the time required to obtain a representative sample

Two survey administration methods were selected. The primary survey method was a voluntary, self-administered online survey that asked anglers to report their angling activities over the preceding year. The online survey was advertised to the angling community through angling organizations, via local angling supply outlets, through signage at popular entry points for anglers along the river, by direct contact with individual anglers and on the CVC website.

The second method was a conventional streamside survey that was conducted through the late summer and early fall months of 2006. An abbreviated version of the online survey[3] was administered on site to anglers encountered fishing at various destinations throughout the watershed. This survey dealt only with their angling behaviour for the day they were encountered. All anglers encountered on site were also asked to visit the CVC website and to fill out the online survey.

Prior to the surveys being administered, they were pilot tested to ensure clarity and to ensure that the time required to complete each survey was reasonable. Various refinements were made to the surveys based on the results of this testing.

The streamside survey was administered to 154 anglers over the period August 28, 2006 to October 7, 2006. The online survey was available from August 3, 2006 to January 31, 2007. A total of 494 responses were received.

3.4 Angling Data

The responses to the angling surveys were entered into a relational database. For comparative purposes and for the estimation of angling values, the streamside survey results were distinguished from the online results[4]. However, for the purpose of providing summary descriptive statistics of the angler population, the results were combined.

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[3] See Appendix A for the stream-side version of the survey and see http://www.creditvalleycons.com/recandleisure/fishing.htm for the online survey.

[4] The stream-side survey was not based on a stratified random sampling methodology. Instead, the stream-side survey was intended primarily to contact anglers and to encourage them to fill out the online survey. As part of the stream-side survey anglers were asked about their angling behaviour for that specific day only. As a result, these results could not be used to extrapolate over the entire watershed or over an entire year. As well, since anglers encountered during the stream-side survey were encouraged to complete the on-line survey, combining the results of the two surveys would have led to double counting.

Each record was examined to ensure internal logical consistency. Records with obvious inconsistencies or which were missing critical data were deleted from the dataset used for the product travel costs analysis.

Following is a brief description of the angling statistics contained in the database. Where available, the provincial average values are shown in brackets. These provincial average values are from the provincial summary report based on the 2000 recreational survey[5] (OMNR, 2003).

These descriptive summaries of the responses deal with some of the major indicators of the dataset in terms of being representative of the overall angler population. The purpose of this report is to estimate the value of the fishery. Ensuring that the survey angler sample is reasonably representative is important for deriving reliable estimates of the value of the fishery. However, the survey also asked a number of questions that provide valuable insights into the perspectives of the angler population that will be valuable for guiding future fishery management. This report does not delve into these details. Nonetheless, the angler survey database provides a rich repository for further "information mining" for management purposes. Further analyses of these data should occur on an as-needed basis.

3.4.1 Angler Demographic Profiles

Of the respondents to the online survey, 95% were male (provincial average is about 80%). The average age of the respondents was about 40 years (provincial average is about 38). Over 13% of the respondents had post-graduate university degrees while 23% had no higher than a high school diploma. About one third of the respondents had an undergraduate university degree.

The high proportion of respondents with higher education suggests either that the sample is biased toward this segment of the angler population or the overall angler population is skewed in this direction relative to the general population. Given the similarities between the streamside and online survey results in this respect, this apparent bias may actually be an accurate representation of the skewed nature of those individuals comprising the angler population.

Two thirds of the anglers (i.e., 67%) self-identified as having a Canadian ethnic background. Those of recent European background comprised 20%.; while Asian and South Asian backgrounds together comprise about 8% of the total sample. The low proportions of Asian and South Asian anglers may be due to cultural barriers associated with the angling survey methodology. Anecdotal observations suggest that this ethnic group comprises more than 8% of the angler population and is likely under-represented in the sample population. For this reason, it is likely that the survey under-represents angling activity, particularly for this ethnic group.

More than a third of the respondents (i.e., 37%) reported a household income in excess of $100,000. The reported average household income was around $110,000. Slightly more than 10% reported household incomes less than $40,000.

3.4.2 Distribution of Angler Origins

The great majority of the anglers came from the Golden Horseshoe area; one quarter came from Mississauga. Anglers from Toronto and Brampton comprised 32% of the total angler population

[5] The provincial summary report based on the 2005 recreational fishing survey results was not available at the time this report was prepared.

(i.e., 18% and 14% respectively). Some of the more distant origins included Sault Ste. Marie, North Bay and upper state New York.

The origins of the anglers in the streamside survey and the online survey were comparable. The streamside survey reported slightly higher proportions of anglers from Mississauga and Brampton compared to the online survey.

3.4.3 Distribution of Angling Effort

Table 3-1 shows the reported angler effort by season and destination. The rows in the table correspond to the 18 destinations within the Credit watershed. Four pairs of columns indicate the number of respondents and the number trips reported for each destination for each of the four seasons. The red-highlighted column indicates the rank order of the destinations based on the total number of reported trips to each.

Table 3-1 – Reported Trips by Destination for Each Season

Destinations	Rank (Total # of trips)	Spring		Summer		Fall		Winter	
		# of Respondents	# of trips	# of Respondents	# of trips	# of Respondents	# of trips	# of Respondents	# of trips
1. Island Lake CA	11	10	66	20	64	5	9	10	19
2. Upper Credit River CA	10	14	96	10	45	5	22		
3. MNR Grange Property	12	8	7	8	102	4	32		
4. Charles Sauriol CA	16	12	23	9	13	1	4		
5. Forks of the Credit Provincial Park	3	36	150	39	164	21	72		
6. Brimstone and Forks of the Credit Rd.	7	20	76	19	110	11	30		
7. Belfountain CA and Lower West Credit	8	22	84	26	91	8	33		
8. Upper West Credit / Erin and Hillsburgh	13	8	62	9	40	2	3		
9. Trout Unlimited Private Agreement Waters	2	20	223	23	159	10	68	1	1
10. Ken Whillans Resource Management Area	6	11	59	21	145	9	55	5	14
11. Middle Credit River	5	9	45	10	42	7	237	1	1
12. Silver and Black Creeks	15	6	25	5	16	1	5		
13. Terra Cotta Conservation Area	18	1	1	4	15	4	9		
14. Fairy Lake	17			6	12	1	10	4	9
15. Norval, Churchville etc.	9	23	91	14	77	8	17	2	4
16. Lake Aquitaine	14	1	25	14	28	1	10		
17. Erindale Park to Hwy 403	1	75	658	104	269	91	659	46	782
18. Lower Port Credit	4	18	98	34	146	19	121	3	7
Totals		294	1,789	375	1,538	208	1,396	72	837
Unique Respondents		162		278		172		66	
ELIGIBLE RESPONDENTS	299								

The top five most heavily fished destinations in declining order are[6]:

1. Erindale Park to Hwy 403 (#17)
2. Trout Unlimited Private Agreement Waters (#9)
3. Forks of the Credit Provincial Park (#5)
4. Lower Port Credit (#18)[7]
5. Middle Credit River (#11)

[6] These results are based on the online survey results only.

[7] This destination extends from Erindale Park south to the mouth of the river at Port Credit. This destination does not include angling in Lake Ontario.

Many respondents reported angling at multiple sites within the watershed during the same season. Some anglers reported angling in the Credit during some seasons and not others. For these reasons, the numbers of respondents in any of the four seasonal columns does not equal the total number of unique respondents. As well, the total number of respondents is less than the total responses received since some responses were not included due to serious inconsistencies or missing information in the response.

The greatest number of angling trips was reported for the spring season, the least for the winter season. The fishing intensity in the summer and fall was only slightly less than in the spring; but the distribution of the trips differed somewhat in the fall. This change in distribution reflects a change in target species (e.g., the fall salmon run) and seasonal restrictions (i.e., the upper Credit is closed to trout fishing after September 30).

3.4.4 Angling Behaviour

As part of the survey, anglers were asked to provide information on their overall angling behaviour and other leisure pursuits.

Nearly half of the respondents to the online survey classified themselves as avid anglers (i.e., 47%). Only 6% indicated that they were occasional anglers and that fishing was not an important priority for them. This level of avidity contrasts with the provincial survey results which indicate that almost 80% of provincial anglers are of average to below average skill (note, it is assumed that a linear relationship exists between avidity and skill level). The streamside survey population comprised a somewhat lower proportion of avid anglers (i.e., 39%) but even with this sample, most respondents exhibited characteristics common to fairly keen anglers (i.e., 85%).

The majority of the respondents began fishing when they were children or adolescents (i.e., before they reached the age of 20). The avid anglers tended to have begun fishing at the earliest age. This angling history is similar to the provincial average. The average length of time fishing for Ontario resident anglers is 21.6 years and given an average age of 38 years, this means that provincial anglers in general also tend to start fishing in their adolescence.

The total amount of time spent fishing per year increased with the reported importance of angling; the most avid anglers tend to fish the most (i.e., an average of almost 100 days a year for avid anglers compared to less than 10 days a year for occasional anglers). The overall provincial average is 16.4 days per year.

Credit River anglers spend most of their time fishing rivers (i.e., on average 54% of their time) with lake fishing being the next most common activity (i.e., 35% of angling time). River fishing is concentrated on coldwater species; whereas angling for warm-water species accounts for over 60% of the time spent lake fishing. The provincial average for river fishing is 14%.

In terms of the factors that most strongly influence their decision to fish the Credit, two factors were most important, namely, the limited availability of suitable alternate sites to fish and the size of the fish. Other important criteria were species available, success rate[8], proximity to residence/work and

[8] Despite anglers reporting success rate as being important for choosing to fish the Credit, the product definition results did not show a consistent relationship between reported angling success rate and angler travel patterns.

prior knowledge of the area. The least significant factors were the environmental setting and crowding. While some variation is evident among the different avidity classes of anglers with respect to these factors, these differences are not consistent or significant.

In terms of other outdoor activities, hiking, camping and hunting were the top three outdoor activities reported. The priority order of these activities varied somewhat by angling avidity but these three outdoor activities were consistently mentioned by all groups. Provincially, about 40% of anglers also purchased a hunting licence.

Fly-tying was mentioned as the primary leisure activity by three of the four avidity groups and was third on the list for the fourth group. Hockey, volunteer activities, reading and family were other leisure activities commonly mentioned.

3.4.5 Angling Methods

The most avid anglers tended to flyfish more frequently. The opposite was true for float-fishing and spin casting. Not surprisingly, a similar pattern is evident in terms of preferred bait. Fly fishers prefer artificial bait whereas live bait is more common with less avid anglers.

Shore angling and wading are the most common methods of fishing. Wading is more common with avid fly fishers.

3.4.6 Management Issues

Respondents were asked to provide feedback concerning their views on the fishery and its management.

Increased enforcement was consistently mentioned by all groups of anglers. As well, many anglers mentioned the need for improved fisheries management and protection of the aquatic ecosystem. Other management issues mentioned included catch and release, litter and public education.

3.4.7 Representativeness of Sample

A concern with using an online survey to sample the angler population is the fact that the respondents self-select. In other words, the respondents are not randomly sampled. Instead, individual anglers decided whether or not to go online and completed the survey. For this reason, greater risk of bias in the sample is present as compared to responses obtained through a random sampling strategy. The preceding comparative summary of the data obtained from the online, streamside and provincial surveys provides some insight into the likely presence of bias in the sample.

The demographics of the streamside and online survey were similar. As well, the demographics of the Credit angler population sample were similar in many respects to the reported results for the province as a whole with some notable but predictable exceptions. The similarities between the streamside and online survey results suggest that the online sample resulted in a reasonably representative profile of the Credit angler population similar to what would have been obtained with a conventional streamside creel census. As well, when compared to the provincial averages, the Credit angler population is similar in terms of basic demographics (e.g., gender and age); albeit, the Credit angler population does represent an above-average group of anglers in terms of avidity and their preference for stream fishing. These tendencies appear to be accurate reflections of this angler population and not spurious artifacts resulting from sample bias. For these reasons,

the online survey database is concluded to provide a reasonably representative sample of the Credit angler population.

3.5 Angler Origins

Survey respondents provided their home addresses including their postal codes. These reported origins were used to develop a menu of generic origins. As expected, the great majority of the Credit anglers come from the Golden Horseshoe area. For this reason, origins like Mississauga and Toronto were subdivided into more specific local origins using the reported postal codes (e.g., Mississauga was subdivided into four discrete origins). Conversely, some lumping of more distant origins has been done (e.g., Oshawa, Whitby, Brooklin and Ajax) where the number of respondents was low. In some cases quite distant origins were lumped (e.g., Callander, Gravenhurst, and Sault Ste. Marie). While the travel distances are quite different among these origins, the small numbers of anglers from these origins have little effect on the demand equations.

This exercise resulted in a total of 28 discrete origins (Table 3-2). For each origin, a centroid was estimated based on population distribution. All trips made by anglers from a given origin were assumed to originate from the centroid coordinates.

Table 3-2 – Generic Angler Origins

Acton	AcG	Port Perry	Ce	Milton	Ml	NW Toronto	To1
Georgetown		Sunderland		Aurora	Ne	NE Toronto	To2
Inglewood		Cambridge	Cm	Bradford		SE Toronto	To3
Norval		Guelph		King City		SW Toronto	To4
Bolton	Bo	Kitchener		Newmarket		Belleville	Tr
Kleinburg		Waterloo		Callander	No	Peterborough	
Palgrave		Collingwood	Co	Gravenhurst		Trenton	
Woodbridge		Markdale		Sault Ste Marie		Ajax	Wh
Brantford	Bt	Ancaster	Ha	Oakville	Oa	Brooklin	
Paris		Burlington		Grand Valley	Or	Oshawa	
Simcoe		Hamilton		Mono		Whitby	
NE Brampton	Br1	Essex	Lo	Orangeville			
SW Brampton	Br2	London		Shelburne			
Caledon	Ca	NE Missisauga	Mi1	Ottawa	Ot		
Belfountain		SE Mississauga	Mi2	Delaware	Sc		
Erin		SW Mississauga	Mi3	Niagara Falls			
Melville		NW Mississauga	Mi4	St. Catharines			

3.6 Origin Demographic Data

Once the origins were defined, the following demographic data were compiled for each origin:

- Total population 20 years and over by highest level of schooling
- Average census family income in 2000 of all households
- Number of households in different family income categories

These data were used in the demand equation estimation procedure to determine the importance of household income on angling demand. As well, the population data were used to derive population-level angling demand coefficients. Further details are provided in Section 3.10.

3.7 Travel Distances and Times

Travel distances and travel times were obtained for all origin-destination combinations (see Appendix B, Table B-1). These distances and times were based on the best route from the origin to the destination. The best route was selected based on road types, expected travel time and distance. In general, the fastest route was selected as the best route since travel time was generally more expensive than travel distance.

Travel costs were derived based on a combination of travel distance and travel time[9]. The standard government allowance for travel (i.e., $0.435/km) which includes fuel and wear and tear on the vehicle was used to estimate costs associated with travel distance.

Travel time estimates included a 15-minute allowance for packing and unpacking at the start and end of each trip (i.e., a total of 30 minutes per trip). The travel time for each origin to each destination was estimated and the opportunity cost of this travel time was adjusted based on the reported average household income of each respondent. An average number of wage-earners per household of 1.56 was used based on provincial statistics relating to average number of household wage-earners[10]. A constant average number of hours worked per year of 1,654 hours was used to convert the reported household income to an equivalent hourly wage. It was assumed that the value of non-working time was equivalent to 75% of the wage rate. This proportion is similar to estimates derived by value of leisure time research (Shaw, 1992; Smith, 1997). The household incomes were gross (i.e., before tax) so this allowance includes an adjustment for taxes in the value of personal time.

This methodology assumes that all anglers have the opportunity to substitute time spent fishing with wage-earning work that would increase household income. A large literature dealing with the opportunity cost of time suggests that more complex relationships exist for different types of individuals (Bockstael et al., 1987; Casey et al, 1995; Feather and Shaw, 1999; and Hynes et al, 2005). The methodology used in this analysis captures one of the major determinants of the opportunity cost of time, namely, wage rate. Capturing more complex relationships would have required collecting much more detailed demographic information from the respondents. Doing so would have increased considerably the length of the survey and resulted in fewer useable responses. This methodology provides a reasonable compromise in terms of accuracy and practicality.

Trip expenditures (e.g., meals and accommodation) are commonly included in travel cost analyses but were not included in this analysis[11]. Given that the majority of the angling trips to the Credit were day trips, travel costs account for the majority of the access costs. Excluding the costs of meals and accommodation will lead to underestimates of the access costs particularly for anglers from more distant origins who travelled to the Credit exclusively for angling. The result will be that the gross total value of Credit fishery will be underestimated. On the other hand, the estimated net value

[9] The purpose of the trips to the Credit varies although the great majority of the day trips were primarily to go fishing. Anglers from more distant origins did not specify the primary purpose of their trips. It was assumed that angling was the primary purpose of all trips and the full cost of travel was assigned to accessing the site for angling purposes.

[10] Respondents provided information on their relationship status. Single anglers were assumed to be the sole household wage-earner. Anglers reporting living with a partner were assumed to have the provincial average number of wage earners in the household.

[11] A more complicated angler survey would have been required to obtain trip specific expenditures. Recalling these expenditures on a trip by trip basis over an entire year was not considered reasonable. For this reason, accurate estimates of the costs of meals and lodging for each trip were not available.

of the fishery will be less affected. Both cost and demand functions are influenced by excluding these expenditures. The result is that they tend to cancel each other out to a certain extent when estimating the net value of the fishery. For these reasons, excluding an allowance for meals and accommodation expenditures will not significantly affect estimates of the net value of the fishery.

No cost allowance was included for the time spent angling. The opportunity cost of the time spent angling is assumed to be uniform for all anglers and not to vary by origin or destination. Adding this cost would not improve the derivation of the demand functions. Somewhat like including a standard allowance for expenditures on meals and accommodation, adding an allowance for the opportunity cost of the time spent angling would not affect significantly the results of this analysis since the cost would be common to all anglers and products.

3.8 Angling Products

The definition of angling products is an iterative process that is based on observed angler behaviour. The objective is to arrive at a set of angling products that are useful for management and reasonably reflect observed angler behaviour.

The process involves two basic steps. The first step involves defining alternate combinations of products. Each product is defined based on key differences among the destinations (e.g., species present, success rate). The second step involves estimating the amount of excess travel that is observed when these products are compared to actual travel patterns. By iteratively, refining the product definitions, the amount of excess travel can be reduced.

A key step in the product travel cost methodology is determining the angling products that will be included. This process is part science and part art. As the number and complexity of the products increases, the potential for excess travel decreases (i.e., the potential for anglers to travel to more distant destinations when a closer/cheaper destination is available declines as more and more destinations are unique). By definition, no excess travel can be present if each destination is defined as a unique product.

However there is a trade-off. As the product definitions become more complex and unique, less insight is provided regarding the likely substitution behaviour that can be expected when the nature of a destination is changed through management or other influences. The objective is to find a practical balance between complexity and simplicity such that the resulting set of angling products provides a reasonable characterization of angler travel patterns and is useful for future fishery management analysis.

The angling product definition procedure is an iterative process. The first stage is to identify characteristics of the destinations that might influence angler choices. In the case of the Credit fishery, the species present and success rate were expected to be dominant characteristics affecting angling behaviour. This expectation was based on discussions with fishery managers and angler responses to the survey (See Section 3.4.4.). Fish size was implicitly included through the combination of season, species and river section used to define products. Salmon species are invariably large given they are mature fish entering the river to spawn. Likewise, rainbow trout in the lower sections of the river below the Norval dam tend to be large migratory fish; whereas resident rainbow in the upper sections are much smaller.

Another major reason given for fishing the Credit is lack of substitutes. The amount of competition from other potential angling destinations (e.g., the Grand River or the Humber River) cannot be determined explicitly from a survey focused solely on one watershed. Expanding the analysis to watersheds throughout the Golden Horseshoe would provide improved information to quantify the amount of competition with other angling destinations.

Fishing opportunities vary by season due to regulations and the migratory behaviour of some fish species (e.g., rainbow trout, salmon). For this reason, angling products supplied by each destination vary significantly by season as does angler behaviour. For these reasons, seasonal products were defined. The derivation of these seasonal angling products is discussed following.

3.8.1 Spring Season

Angling products were defined and analysed first for the spring season. Two angling product characteristics (i.e., reported fish species being sought and reported angler success rate or CUE – catch per unit of effort) were used to define different sets of products. These different product types involved using different categories of fish species sought (e.g., coldwater and warmwater vs. rainbow trout, brook/brown trout and warmwater species) and different categories of CUE.

Initially, different categorizations of CUE were tested to determine their influence on angler travel behaviour. These results indicated that scaling the CUEs into three categories (i.e., 1.0<, 1.0< to <2.75, >2.75 fish/trip) provided adequate resolution to predict angler behaviour.

The next step was to define different combinations of fish species. The result was that three sets of angling products were defined for the spring season. Table 3-4 shows the different combinations of spring angling products tested.

Table 3-3 – Spring Angling Product Combinations

	Product Types					
	1		2		3	
Code	**Fish Type**	**CUE**	**Fish Type**	**CUE**	**Fish Type**	**CUE**
Spb1	c	1	b	1	b	1
Spb2	c	2	b	2	b	2
Spb3	c	3	b	3	b	3
Spr1	w	2	r	1	r	2
Spr2			r	2	w	1
Spw1			w	1	t	1
					t	2
	Species					
	c	coldwater	b	brook/brown	b	brook/brown
	w	warmwater	r	rainbow	r	rainbow
			w	warmwater	t	all trout species
					w	warmwater

As expected, as the number of products increased, the amount of excess travel decreased. However, the decrease in excess travel was not directly proportional to the number of products (Figure 3-2). Indeed, the angling product set with seven products resulted in essentially the same amount of excess travel as the product set with six types (i.e., $10,435 for six products vs. $10,332 for seven products); whereas, going from four products to six products reduced the excess travel by almost 50%.

Figure 3-2 – Excess Travel by Number of Products

On the basis of these results, the six product set (i.e., Product Set #2 in Table 3-3) was selected to characterize the spring fishery. Using this product set, 68% of the total travel cost was accurately predicted. With the remaining 32% of the travel cost that was excess (i.e., not fully explained by the product set), much of this excess travel was attributable to the relatively minor differences in travel costs between proximal competing destinations. Given the relatively small difference in product "price" among some destinations, the likelihood increases that other less significant factors not included in the product definition will affect angler choices. This imprecision is partly reflected in the uncertainty ranges provided for the valuation estimates presented in Section 3.12.

Table 3-4 shows the correspondence between the angling products and the destinations.

Additional combinations of products could be defined using these characteristics by altering the ranges used to define each category. For example, CUE could be broken into to four categories or lumped into two. The other possibility is to add additional site characteristics (e.g., size of fish, suitability for different types of angling like fly fishing). As additional characteristics are added the number of products compounds rapidly until there are more product types than destinations. For this reason, the number of destinations and the differences among them define the practical maximum number of angling products that can be defined. The product set with six angling products represents a balance between excess simplicity and excess complexity.

3.8.1 Summer Season

A similar product definition process was used for each of the three other seasons with several refinements. The CUE ranges were modified given the change in angler success rate from one season to another. Likewise the primary species sought at some destinations changed from one season to another due to migratory fish species coming and leaving the river in some sections.

Table 3-4 – Angling Products Available at Specific Destinations

Destination	Spring	Summer	Fall	Winter
1	Spw1	Sw4	Fw4	Ww4
2	Spb2	Sr3	Fb3	
3	Spb3	Sr1	Fb2	
4	Spb3	Sb3	Fb4	
5	Spb2	Sb4	Fb2	
6	Spb2	Sb3	Fb2	
7	Spb3	Sb4	F42	
8	Spb2	Sb4	Fr3	
9	Spb2	Sb3	Fb2	Wr3
10	Spb2	Sw2	Fw4	Wr4
11	Spr1	Sb3	Fr1	
12	Spb3	Sr4		
13	Spb1	Sw4	Fm4	
14		Sw4	F42	Ww4
15	Spr2	Sm2	F42	Wr2
16	Spr2	Sm4	Fb2	
17	Spr2	Sm2	Fr1	Wr1
18	Spr1	Sm1	Fr1	Wr1

Table 3-5 shows the summer angling products that were determined to be best for predicting observed angler behaviour. This product set resulted in 9.9% excess travel.

Table 3-5 – Summer Angling Products

Product Types				
Code	**Fish Type**	**CUE**	**Species**	
Sb3	b	3	b	brook/brown
Sb4	b	4	r	rainbow
Sr1	r	1	t	all trout species
Sr3	r	3	w	warmwater
Sr4	r	4	m	warm/coldwater
Sw2	w	2	**CUE (fish/trip)**	
Sw4	w	4	1	<1.0
Sm1	m	1	2	1.0<:<2.0
Sm2	m	2	3	2.0<:<3.5
Sm4	m	4	4	>3.5

3.8.2 Fall Season

Table 3-6 shows the fall angling products that were determined to be best for predicting observed angler behaviour. This product set resulted in 16.5% excess travel.

Table 3-6 – Fall Angling Products

Product Types			Species	
Code	Fish Type	CUE	b	brook/brown
Fb2	b	2	r	rainbow
Fb3	b	3	t	all trout species
Fb4	b	4	w	warmwater
Fr1	r	1	m	warm/coldwater
F42	r	2	CUE (fish/trip)	
Fr3	r	3	1	<.05
Fr4	r	4	2	0.05<:<0.13
Fw4	w	4	3	0.13<:<0.2
Fm4	m	4	4	>0.2

3.8.3 Winter Season

Table 3-7 shows the winter angling products that were determined to be best for predicting observed angler behaviour. This product set resulted in 4.6% excess travel. This low excess travel is largely a function of the limited number of angling products available at this time of the year.

Table 3-7 – Winter Angling Products

Product Types			Species	
Code	Fish Type	CUE	b	brook/brown
Wr1	r	1	r	rainbow
Wr2	r	2	t	all trout species
Wr3	r	3	w	warmwater
Wr4	r	4	m	warm/coldwater
Ww4	w	4	CUE (fish/trip)	
			1	<1.0
			2	1.0<:<2.0
			3	2.0<:<3.5
			4	>3.5

3.9 Total Angler Population

The total value of the Credit fishery is equal to the sum of the value assigned to the fishery by each of the anglers who fish the river from time to time. The angler survey was not a comprehensive census of the entire angling population. Instead, the respondents represent a sample of that population. To estimate the total value of the fishery, the responses from the sample needed to be extrapolated to the entire angler population.

Typically with on-site creel census surveys, some form of stratified random sampling strategy is used. The advantage of this approach is that the portion of the angling activity captured by the survey can be estimated and used to estimate the total angling pressure and the size of the angler population. With a voluntary online survey, the respondents are not randomly

selected. The respondents self-select. As a result, the proportion of the total angler population represented by the survey respondents cannot be derived statistically from the sample. The following approach was used to derive an estimate of the portion of the total angler population represented by the respondents to the surveys.

As part of a study of special regulations for the Upper Credit, a creel census was conducted in the mid 1990s. The census was limited to the spring and summer seasons and included the river sections corresponding to destinations 4, 5, 6, 9 and 10b. The results of this creel census indicated that the total angling pressure was on average in the order of 2,200 angler-hours per kilometer of stream length. Using a conversion of 5 hours per angler day, the angling pressure was estimated to be 440 angler-days per kilometer. This angling pressure factor was combined with the measured stream lengths for each destination to estimate the total angling pressure for each. The results are shown in Table 3-8.

Table 3-8 – Proportion of Annual Angler Pressure Captured by Online Survey[12]

Destinations	Stream Length (m)	Estimated Angler Days	Sample Angler Days	Percent of Population Sampled
4. Charles Sauriol CA	2,023	890	40	4%
5. Forks of the Credit Provincial Park	5,242	2,306	386	17%
6. Brimstone and Forks of the Credit Rd.	2,131	938	216	23%
9. Trout Unlimited Private Agreement Waters	1,932	850	451	53%
10b Ken Whillans Resource Management Area-stream	3,231	1,422	72	5%
Totals		**6,406**	**1,165**	**18%**

The next step was to derive the portion of the total angling pressure that was captured by the CVC online survey. The proportions varied as shown in Table 3-8 from 4% to 53%. Overall, the online survey responses were estimated to represent an average of 18% of the angling pressure for these destinations. It was assumed that the online survey responses for the other destinations and seasons not included in the special regulations creel census area were comparable to the average percentage captured for these five river sections.

Using this methodology, the total Credit River angler pressure in 2006 was estimated at 30,154 angler days[13]. This total angler pressure was used to estimate the proportion of the per capita angling demand for each origin.

Table 3-9 shows the forecast angling pressure for each of the sections of the Credit River for different seasons of the years. The greatest pressure occurs in the spring with the summer and fall fishery being fairly equal. The least fishing pressure occurs during the winter.

[12] Angler hours were converted to angler days based on an average angler day being 5 hours.

[13] The Department of Fisheries and Oceans conducts every five years a recreational fishing survey. Data for the 1995, 2000 and 2005 survey include information on fishing destination. These data were not available for the purposes of this study but further analyses of these data might provide another useful estimate of the overall angling pressure for the Credit River. The DFO survey is based on a random stratified sampling procedure.

Table 3-9 – Angler Days by River Section by Season and Overall

Destination	Spring	Summer	Fall	Winter	Annual Total
1. Island Lake CA	367	356	50	106	878
2. Upper Credit River CA	533	250	122	0	906
3. MNR Grange Property	39	567	178	0	783
4. Charles Sauriol CA	575	325	100	0	1,000
5. Forks of the Credit Provincial Park	882	965	424	0	2,271
6. Brimstone and Forks of the Credit Rd.	330	478	130	0	939
7. Belfountain CA and Lower West Credit	158	172	62	0	392
8. Upper West Credit / Erin and Hillsburgh	344	222	17	0	583
9. Trout Unlimited Private Agreement Waters	421	300	128	2	851
10. Ken Whillans Resource Management Area	891	1,167	421	78	2,557
11. Middle Credit River	250	233	1,317	6	1,806
12. Silver and Black Creeks	139	89	28	0	256
13. Terra Cotta Conservation Area	6	83	50	0	139
14. Fairy Lake	0	67	56	50	172
15. Norval, Churchville etc.	506	428	94	22	1,050
16. Lake Aquitaine	139	156	56	0	350
17. Erindale Park to Hwy 403	3,656	1,494	3,661	4,344	13,156
18. Lower Port Credit	544	811	672	39	2,067
Season Total	**9,780**	**8,162**	**7,566**	**4,646**	**30,154**

The distribution of the fishing pressure varies considerably by season. Destination 17, Erindale Park, consistently receives the greatest pressure through all seasons of the year. During the spring and summer the fishing pressure increases in the upper reaches of the river and at various conservation areas. During the fall salmon run, the middle Credit experiences considerable fishing pressure relative to the other seasons of the year.

3.10 Angling Demand Functions

Once the angling products were defined and the level of use from each origin was derived, the process of estimating demand functions could proceed. Demand varies among each of the angling products. In total, 30 angling products were defined. Therefore, demand functions for each of these products[14] were required.

The statistical procedure for deriving the demand functions was labourious. The reason is that many different potential mathematical forms for the demand functions and different variables need to be tested to determine which combination best fits the observed angler behaviour for each product. This required statistically fitting the observed data for each product to various different demand functional forms and comparing the resulting statistics. Some efficiencies were achieved as this process proceeded since similar generic mathematical forms of the demand functions emerged as being the best. As well, some forms of the demand function were rejected since they were

[14] For several products, insufficient observations were available to estimate a reliable demand function. Given the small proportion of the total angling effort represented by these products, their exclusion will not affect significantly the estimated total value of the fishery.

inconsistent with the underlying economic theory (e.g., increasing demand with increasing price). Appendix C provides the demand functions estimated for each of the angling products.
As is evident from the r^2 values and F statistics, some demand functions fit the data better than others. To capture this variation in precision in the estimated total value of the fishery, error ranges have been estimated for the consumer surplus estimates.

3.11 Derivation of Consumer Surplus

The supply and demand functions for each angling product provide a rigourous quantitative means to estimate the consumer surplus associated with each angling product. The basic approach is as follows.

The consumer surplus is represented by the area under the demand function above the supply cost function. The demand equations in Appendix C are nonlinear. The area under the demand function is derived by solving for the integral of the demand function equation. The demand equations vary by angling product but are constant among origins.

The supply costs (i.e., the travel costs from a given origin to the nearest source of the angling product) vary by origin; so too does the forecast of angling activity from each origin. This means that consumer surplus must be estimated for each origin[15]. However, the supply cost functions are horizontal (i.e., the marginal supply cost of angling for a given destination is independent of the number of angling trips). As a result, the area under the supply cost function for each origin can be easily calculated.

The resulting consumer surplus is expressed in $/trip units for each product/origin combination. As well, the level of angling use is forecast for each product/origin combination and is expressed in trips/capita units. The total consumer surplus for a product/origin combination is calculated by multiplying by the population of the origin times the trips/capita times the $/trip. The aggregate consumer surplus for a given angling product is calculated by summing the estimated total consumer surpluses from all origins.

3.12 Consumer Surplus by Product

Table 3-10 presents the average value of an angler day for each of the angling products. The average values are calculated by dividing the aggregate consumer surplus for a given angling product by the forecasted total number of trips from all origins.

The average value of an angling day varies significantly by product type from a low of $9/trip in the fall to a high of $148/trip in the spring. Of course, the average value of an angler day varies significantly from origin to origin. Generally, the origins closest to the Credit enjoy the greatest value since their travel costs are the lowest (i.e., they can enjoy the angling product for the lowest price). This relationship is discussed in Section 3.13.

[15] Note that no anglers from some origins fished the Credit for some angling products. As a result, no consumer surplus is estimated to be associated with these origins for that product.

Table 3-10 – Average Value of an Angler Day[16]

Code	Spring	Code	Summer	Code	Fall	Code	Winter
Spb1	$54	Sb3	$29	Fb2	$9	Wr1	$17
Spb2	$30	Sb4	$28	Fb3	$25	Wr2	N/E
Spb3	$20	Sr1	$17	Fb4	$30	Wr3	N/E
Spr1	$78	Sr3	$47	Fr1	N/E	Wr4	$79
Spr2	$30	Sr4	$62	F42	$18	Ww4	$16
Spw1	$31	Sw2	$17	Fr3	$31		
		Sw4	$17	Fr4	$15		
		Sm1	$148	Fw4	$11		
		Sm2	$18	Fm4	N/E		
		Sm4	N/E				

These results are in the range of estimates reported by other studies[17]; although several of the higher values are anomalous. Additional angling data would be required to refine and improve these estimates.

Table 3-11 presents the annual value of each angling product. The annual value is the sum of the consumer surpluses for all of the origins.

Table 3-11 – Annual Consumer Surplus by Product

Code	Spring	Code	Summer	Code	Fall	Code	Winter
SPb1	$21,308	Sb3	$60,019	Fb2	$1,916	Wr1	$18,616
SPb2	$111,786	Sb4	$58,879	Fb3	$9,053	Wr2	N/E
SPb3	$55,085	Sr1	$8,454	Fb4	$29,593	Wr3	N/E
SPr1	$87,649	Sr3	$19,442	Fr1	N/E	Wr4	$25,703
SPr2	$137,993	Sr4	$7,172	Fr2	$4,753	Ww4	$1,931
SPw1	$3,645	Sw2	$62,235	Fr3	$201,378		
		Sw4	$10,978	Fr4	$2,219		
		Sm1	$165,412	Fw4	$13,046		
		Sm2	$49,263	Fm4	N/E		
		Sm4	N/E				
Season Total	**$417,466**		**$441,855**		**$261,957**		**$46,250**
Annual Total	**$1,167,529**						

[16] The acronym "N/E" indicates that a value was not estimated. The reason is that insufficient data were available to estimate a reliable demand function.

[17] For example, a value of $35/angler day was used in the Hamilton Harbour Remediation Benefits Assessment (IRIS et al, 2006), A recent study of the benefits of Atlantic salmon re-introduction to Lake Ontario imputed a value of $19/angler day based on an analysis for Michigan (Greig and Fortin, 2007).

The total annual consumer surplus supplied by the angling products varies significantly by season. The greatest value is realized during the summer season and the lowest is during the winter season. The total annual value of the fishery is estimated to be in the order of $1.2 million.

The highest value product is fishing for fall migratory rainbow. During the spring, two high-value products are evident, namely, fishing for migratory rainbow and fishing for resident brook and brown trout. A highly valued summer fishery involving a mix of cold and warm water species is present as well as a coldwater fishery for resident trout in the upper reaches of the river. The winter fishery consists primarily of migratory rainbow trout which is limited by regulations and seasonal weather constraints.

As mentioned previously, the precision of these estimates of consumer surplus varies considerably. A crude estimate of the error range for the total annual value can be derived by summing the high and low error range estimates for each angling product. The error range estimated using this crude approximation is in the range of ± 100%[18]. Certainly the lower range which implies the fishery has no value is unreasonable. Conversely, there is potential that the fishery is considerably more valuable than the central value. A more realistic judgmental error range is in the order of ± 50%. This error range can be reduced by more intense sampling. However, these values partly reflect the inherent variability within the angler population including a diversity of preferences and motives for fishing. As a result, a significant amount of unexplained variation (and thus a large error range) can be expected even with intensive sampling.

Another source of uncertainty not captured in this statistical error range is the uncertainty associated with the estimate of the total angler population. Changes to the proportions of the angler population captured in the online survey will translate directly into proportional changes. Improving the estimate of the total angler population is likely to yield the greatest return in terms of improving the precision of the total value estimate.

3.13 Consumer Surplus by Origin

The consumer surplus can be expressed by origin. Generally, the value of an angling day and the total consumer surplus declines as the distant between the origin and destination increases. The reason is that the supply costs (i.e., travel costs) increase with distance resulting in a lower net value.

Table 3.12 presents the average value of an angling day by origin for the four seasons of the year. Table 3.13 presents the total value of the Credit fishery for each origin by season and overall.

The highest values for a fishing day occur during the fall season and are associated with anglers residing in Mississauga. The reason for the significant variation among different sections of Mississauga is not immediately evident. A possible explanation is the variation in demographics within Mississauga with some areas having a greater proportion of dedicated anglers. Further analysis would be required to better understand these local differences in demand.

[18] Statistically speaking, the probability that the range is this high is extremely low. Ideally, a Monte Carlo sampling methodology should be used if more accurate error ranges are needed. The error ranges for the demand function coefficients are derived using standard statistical methods.

Table 3-12 – Average Value of an Angler Day by Season and Origin[19]

Origin	Spring	Summer	Fall	Winter
Ot		$4		
Ce	$1		$15	
Tr	$15	$19		$25
Wh		$3	$11	
To1	$24	$7	$30	$13
To2	$28	$59	$31	$17
To3	$28	$26	$17	$62
To4	$38	$36	$28	$7
Ne	$17	$30	$17	$14
Bo	$41	$35	$43	$5
Ca	$29	$42	$20	
Or	$39	$41	$19	$14
Co		$41		
AcG	$42	$24	$76	$98
Ml	$36	$50	$21	$19
Br1	$38	$21	$18	$33
Br2	$32	$38	$20	$69
Mi1	$30	$20	$87	$48
Mi2	$40	$40	$26	$17
Mi3	$45	$62	$36	$14
Mi4	$36	$41	$24	$16
Cm	$28	$32	$23	$8
Oa	$45	$64	$6	$8
Ha	$30	$15	$24	$9
Bt	$31	$0	$11	$14
Sc	$23	$24	$32	$37
Lo	$21	$18	$5	
No		$24		

Several geographic patterns are indicative of the effect of competing sites on the derived value. For example, the Whitby (Wh) origin is located in the eastern portion of the GTA which has a number of nearby, high-quality anadromous fisheries (e.g., Duffin's Creek. Oshawa Creek, Bowmanville Creek and Ganaraska River). The result is that few anglers from this origin travel to the Credit. Conversely, anglers from the London area (Lo) derive a higher value from the Credit River fishery despite being much further away but having fewer alternative comparable fishing alternatives.

The overall value of the Credit River fishery for different origins follows a predictable geographic pattern overall. The greatest value is realized by anglers from the Toronto (To) origin[20]. This group of four origins is close by the Credit and has a large population. As well, the demographics of Toronto are somewhat different than those of Mississauga and Brampton. The overall value of this fishery with respect to each origin is a function of distance, population size and demographics. These results are important from a management perspective in several regards.

[19] Blank cells indicate that no anglers from these origins reported fishing the Credit during the season.

[20] The value of the To1 destination is much lower than that for the other three Toronto origins. This is largely due to the fact that only three responses were received from this origin despite that large area encompassed. The low number of responses may be by chance or due to a relatively low angling participation rate in this part of the city or a combination of these potential causes.

Table 3-13 – Total Value of Credit Fishery by Season and Origin

Origin	Spring	Summer	Fall	Winter	Annual Total
Ot		$27			$27
Ce	$1		$284		$285
Tr	$982	$600		$1,416	$2,998
Wh		$66	$3,586		$3,652
To1	$2,718	$115	$7,265	$396	$10,495
To2	$31,331	$48,626	$33,977	$1,406	$115,340
To3	$65,920	$96,153	$28,447	$5,240	$195,759
To4	$58,072	$55,728	$43,043	$1,336	$158,180
Ne	$2,252	$10,584	$2,296	$934	$16,067
Bo	$16,009	$18,829	$8,933	$358	$44,129
Ca	$13,927	$18,584	$3,442	$216	$36,170
Or	$8,981	$13,091	$1,506	$548	$24,127
Co		$379			$379
AcG	$12,625	$5,389	$6,303	$13,010	$37,327
Ml	$2,323	$3,811	$1,843	$1,053	$9,029
Br1	$36,977	$15,321	$7,175	$710	$60,183
Br2	$36,109	$38,935	$18,211	$11,385	$104,640
Mi1	$18,984	$18,136	$37,807	$1,436	$76,362
Mi2	$24,627	$24,816	$14,427	$1,140	$65,010
Mi3	$14,621	$14,584	$11,800	$641	$41,646
Mi4	$21,619	$15,475	$8,225	$1,125	$46,443
Cm	$7,978	$5,418	$5,368	$491	$19,255
Oa	$16,393	$26,264	$522	$53	$43,232
Ha	$19,460	$6,795	$16,048	$2,305	$44,609
Bt	$1,606		$583	$107	$2,296
Sc	$868	$1,470	$477	$943	$3,758
Lo	$3,086	$1,739	$389		$5,214
No		$919			$919
Total	$417,466	$441,855	$261,957	$46,250	**$1,167,529**

First of all, these results show that management efforts by the CVC will benefit not only residents in its constituent municipalities but will benefit also anglers in other municipalities. In fact, a significant portion of the total benefit is realized by anglers outside of the watershed. These results provide a basis for discussing an improved basis for fair sharing of the costs of management.

Within the watershed, the benefits are widely distributed among the municipalities. These results reinforce the collective interest that all of the municipalities share in conserving this important fishery.

3.14 Consumer Surplus by Destination

The consumer surplus can be expressed by river section. The value of the fishery for a given section is equal to the value of an angler day from each origin times the number of anglers from the origin that fish at the destination.

Table 3.14 presents the average value of an angling day by destination for the four seasons of the year. Table 3.15 presents the total value of the Credit fishery for each destination by season and overall.

Table 3-14 – Average Value of an Angler Day by Season and Destination

Destination	Spring	Summer	Fall	Winter
1. Island Lake CA	$31	$17	$6	$21
2. Upper Credit River CA	$32	$47	$56	
3. MNR Grange Property	$54	$17	$9	
4. Charles Sauriol CA	$20	$33	$20	
5. Forks of the Credit Provincial Park	$30	$28	$30	
6. Brimstone and Forks of the Credit Rd.	$21	$25	$22	
7. Belfountain CA and Lower West Credit	$20	$28	$15	
8. Upper West Credit / Erin and Hillsburgh	$31	$31		
9. Trout Unlimited Private Agreement Waters	$30	$34	$27	
10. Ken Whillans Resource Management Area	$31	$17	$13	
11. Middle Credit River	$77	$33	$31	
12. Silver and Black Creeks	$23	$62		
13. Terra Cotta Conservation Area		$17		
14. Fairy Lake		$17		$18
15. Norval, Churchville etc.	$27	$18	$18	
16. Lake Aquitaine	$34		$14	
17. Erindale Park to Hwy 403	$30	$18	$31	$66
18. Lower Port Credit[21]	$79	$148	$31	$78

The variation in the value of an angler day by destination and season reflects both the variation in the angler preferences for certain angler products and the accessibility of the products. The gross value of more distant products (i.e., destinations) is moderated by the increase in supply costs (i.e., the travel costs associated with accessing more distant products).

The variation in value from one season to another partly reflects changes in the nature of the angling products from one season to another. These results provide considerable insight into the specific types of angler products of greatest value to anglers.

Similar patterns are evident with the total value results in Table 3.15when compared to value of angling day results in Table 3.14. These total value results incorporate the effect of angling intensity. The more intensively angled destinations will generally be more valuable. For example, Erindale Park supports a large amount of angling pressure, is close to many anglers and provides year-round angling opportunities for large anadromous salmon and rainbow trout. As a result it is the most valuable destination overall.

[21] As discussed in Section 3.12, the high value of angler days for the lower Credit destination are questionable and appear anomalous. Further investigation of the veracity of these high values is warranted.

Table 3-15 – Total Annual Value of Each Credit River Section by Season and Overall

Destination	Spring	Summer	Fall	Winter	Annual Total
1. Island Lake CA	$3,645	$7,807	$2,847	$1,204	$15,502
2. Upper Credit River CA	$11,569	$19,442	$4,763		$35,775
3. MNR Grange Property	$21,308	$8,454	$1,916		$31,678
4. Charles Sauriol CA	$25,317	$9,173	$3,930		$38,420
5. Forks of the Credit Provincial Park	$42,379	$35,045	$19,343		$96,767
6. Brimstone and Forks of the Credit Rd.	$14,070	$27,879	$2,682		$44,631
7. Belfountain CA and Lower West Credit	$13,869	$10,666	$2,219		$26,754
8. Upper West Credit / Erin and Hillsburgh	$19,454	$14,320			$33,773
9. Trout Unlimited Private Agreement Waters	$21,334	$15,094	$6,371		$42,799
10. Ken Whillans Resource Management Area	$17,051	$62,235	$10,199		$89,484
11. Middle Credit River	$17,903	$6,721	$9,302		$33,926
12. Silver and Black Creeks	$1,829	$7,172			$9,002
13. Terra Cotta Conservation Area		$1,830			$1,830
14. Fairy Lake		$1,342		$728	$2,069
15. Norval, Churchville etc.	$9,557	$10,898	$4,753		$25,208
16. Lake Aquitaine	$2,186		$1,557		$3,743
17. Erindale Park to Hwy 403	$126,250	$38,366	$162,661	$18,616	$345,893
18. Lower Port Credit	$69,746	$165,412	$29,415	$25,703	$290,276
Season Total	$417,466	$441,855	$261,957	$46,250	**$1,167,529**

These results indicate the overall most valuable destinations within the watershed and may be of assistance in focusing management efforts. This being said, the results of this analysis should be used to review the fisheries management plan to identify any areas where refinements to the plan may be warranted.

3.15 Total Present Value of the Fishery

The total present value of the Credit River fishery is equal to the discounted value of the future stream of benefits that the river will produce for anglers to enjoy in the future. The idea of present value is easiest to understand in terms of an annuity. Imagine that the Credit River fishery was an annuity that provided an annual payment equal to the estimated annual consumer surplus (i.e., around $1.2 million). How much money would need to be invested in the annuity today to sustain this yield of payments indefinitely? The corresponding amount of money required to sustain an annual payment of $1.2 million is the net present value of the fishery.

A key issue when estimating present value is the appropriate discount rate. A large literature exists that discusses appropriate discount rates for environmental resources[22]. For the purposes of this study, a mean discount rate of 2.5% has been used. This discount rate is close to the long-term real

[22] Burgess (1981) and Jenkins (1981) provide good overviews of the theory and foundations for discounting from a public policy perspective. Watson (1992) expands and updates this discussion of discount rates from a Canadian perspective. Voinov and Farley (2007) examine discounting from a broader sustainable development perspective. Together these authors provide citations for most of the seminal works in this field. It is beyond the scope of this report to delve further into this literature. The overriding conclusions are that examining a range of discount rates is helpful and that selecting the most appropriate discount rate depends on the specific nature of the decision at hand.

rate of return and has been used in other comparable applications[23]. The result is that the net present value of the Credit River fishery is estimated to be in the order of $48 million. If a discount rate of 5% is used (which is closer to the value commonly used for conventional public projects like infrastructure), the net present value is in the range of $24 million (doubling the discount rate reduces the present value by half and vice versa). If a discount rate of 0% is used as argued by some environmental groups, the value of the fishery is infinite.

Care is warranted in interpreting this result. The product travel cost methodology captures only the active use value of the fishery. The active use value is the value enjoyed by anglers from having the opportunity to fish the Credit. The active use value represents only a portion of the total value of the fishery. Other values not included are:

- passive use value (the value people realize from viewing fish and/or anglers in the river),
- option value (the value people ascribe to maintaining the opportunity to fish the Credit at some point in the future, regardless of whether they currently fish the Credit or not),
- bequest value (the value people ascribe to being able to pass on the opportunity to fish the Credit to future generations) and
- existence value (the value people ascribe to maintaining the Credit River fishery indefinitely without any expectation of fishing the Credit at some future time but simply for the satisfaction of knowing that a healthy wild fishery will persist indefinitely into the future).

The total value of the fishery would be the sum of these individual categories of value. As a result, the active use value estimated as part of this study should be viewed as a partial estimate of the total value of the fishery.

[23] For example, a base discount rate of 2.5 % was used by IRIS et al (2006) and DSS (2005).

4 Conclusions and Recommendations

This section presents the conclusions arising from the preceding analysis and recommendations for using the results and for improving the estimates in the future.

4.1 Survey Methodology

The online survey methodology proved to be highly cost efficient. A large number of detailed responses were obtained for a fraction of the cost that would have been required to obtain comparable results using a mail-out survey or a streamside survey. A relatively small number of the responses were unusable. The accuracy of the responses could not be verified since no independent data sources were available. Nonetheless, the internal consistency of the responses and the apparent reasonableness of the responses suggest that the responses were sufficiently reliable for this analysis.

Two major limitations were evident. The respondents self selected. Likely the sample contains an over-representation of anglers who use the Credit the most. In general, the most avid anglers were most likely to learn of the survey and to take the time to complete the survey online. This bias is evident in the angler profiles (see Section 3.4.1). This bias will tend to over-estimate angling pressure in the sample. However this bias is counteracted by the methodology used to estimate the total angler population (see Section 3.9). Indeed, this over-representation will tend to under-value the fishery since the apparent proportion of the angling population included in the sample will tend to be over-estimated.

The second major limitation is the absence of a random sampling strategy. As noted the probability of an angler responding to the online survey is likely strong tied to avidity. More casual anglers are likely under-represented. Furthermore, given the absence of a random sampling strategy, the responses cannot be extrapolated to obtain an estimate of the total angler population. Having to rely on the results of a separate and somewhat dated creel census that pertained to only part of the watershed has introduced uncertainty in the economic value estimates.

Both of these limitations can be overcome in the future. The DFO recreational fishing survey databases provide a sample of provincial anglers who fished the Credit. The size of this sample will need to be determined. However, three separate samples are available (i.e., 1995, 2000 and 2005). By analyzing each of these samples and estimating the total Credit River angler population, much greater confidence in this statistic can be achieved. As well, these databases contain various demographic data that also can be used to determine how representative the online survey database is of the overall angler population.

Another possible means to improve the precision of the results in this report is to conduct a limited random sample streamside creel census. If the anglers sampled provide sufficient information to characterize them along the same lines as was done for the online survey responses, extrapolation factors can be derived for the different angler population segments and applied to the online survey results. The level of effort with this approach can be tempered with the desired level of precision. In other words, the survey need not be as comprehensive as would be required in the absence of the online survey results and need not duplicate much of that survey. The key is that the survey is based on a suitable stratified random sampling strategy such that sufficiently precise total angler population estimates can be derived.

One final consideration is the potential to augment the current angler database. Two possibilities exist. One possibility is to conduct the online survey again in several years. Most of the work required to design the survey is done. For this reason re-surveying the angler population using the online survey would be relatively inexpensive. The subsequent responses could be compared to the original responses to see if there are major differences and what the causes for these differences might be. In the best of cases, the results of repetitive surveys could be used to verify predicted angler behaviour in response to changes in the fishery.

The second possibility is to introduce an angler diary program. The idea is to ask anglers to record their angling behaviour over a given period of time (e.g., a season or a whole year). This program could be complementary with any future online survey and would provide a useful basis to independently verify the accuracy of the online survey results. The challenge with angler diary methodology is obtaining a representative and sufficiently large sample population that will reliably complete diaries. On the other hand, if the anglers keep complete records including their fishing activity on the Credit and elsewhere, considerable insight into competitive sites may be obtained as well as valuable data pertaining to the Credit River fishery itself.

4.2 Product Travel Cost Methodology

Given that this was the first practical application of the product travel cost methodology for this fishery, indeed for any fishery in Ontario, the reasonableness of the results is highly encouraging. This application of the methodology will provide a good example for others to follow in the valuation of recreational fisheries.

The product travel cost methodology proved useful for deriving a menu of angling products. Reasonable correlations between angling products and angling behaviour were observed. Following are some potential improvements to the product definition procedure and the forecasting of angler behaviour. These suggestions however, primarily involve improvements in the underlying data and scope of the analysis. The basic methodology itself proved to be quite robust.

The product travel cost valuation methodology only measures the value of the watershed for angling uses. As such, these results provide only a partial measure of the value of the fishery, namely the value to anglers for the immediate opportunity to fish in the river. Adding in additional values (e.g., option value, bequest value and existence value) would increase the overall value of the fishery considerably. These additional values would require the application of a different valuation methodology (i.e., some form of stated preference survey). If future surveys are undertaken, adding a section on stated preferences would allow these additional values to be estimated. As well, including a survey of non-anglers to obtain their willingness to pay for these other values would increase the robustness of the valuation of the fishery.

4.3 Product Definitions

There are several areas in which the results derived from the product travel cost methodology could be improved in the future. One is the precision with which the angling products have been defined.

The current set of products is defined by three characteristics of the fishery, namely season, species and catch success. Further separation of angling products by including additional product characteristics (e.g., crowding) may be valuable for management purposes even if the improvement in the precision of the estimated value of the fishery is not great. However, further refinements of this nature will require larger sample sizes which will involve greater expenditures

on data collection and synthesis. Any improvements of this nature should be tied directly to management needs and the specific management questions that need to be informed by the results of this type of more in-depth analysis.

4.4 Competing Destinations Outside The Watershed

The current set of destinations is limited to those within the Credit River watershed. Many anglers who fish the Credit fish other watersheds as well. The results of the product travel cost methodology are greatly strengthened as the scope of destinations increases. An important limitation with including just one watershed is that the differences in products and travels costs are not as great as they are when multiple watersheds are included. Nonetheless, the impact of competing sites on the value of the fishery is implicitly included in the demand equations. In other words, expanding the scope of the destinations would improve the resolution among angling products but would not likely change materially the overall estimate of the value of the Credit River fishery.

Ideally, the methodology should include the major angling destinations that anglers from the identified origins are traveling to. This approach allows the demand functions to include specific terms for competing and substitute destinations; the result being the ability to forecast regional angler behaviour and not just local angler behaviour. From the management perspective of the CVC, extending the analysis in this way is not reasonable, at least not by the CVC alone. However, if the CVC was to cooperate with other adjacent conservation authorities (e.g., TRCA, CLOCA, NVCA, LSCA, GRCA), a much more comprehensive analysis would be possible. The results of such an analysis would be valuable for the conservation authorities in the region to coordinate their programs and to anticipate the impact of programs in adjacent watersheds on local programs.

During the course of the research for this study, Trout Unlimited indicated that they were in the midst of undertaking some form of angling valuation survey. Their survey was still in the design stages and was not available. If a broader scope of the analysis is contemplated, consideration should be given to partnering as well with regional or provincial angler groups to enlist their support and cooperation.

Similarly, the DFO recreational fishing survey results could be used for this purpose. Indeed, in future surveys, consideration should be given to expanding the local sample size and obtaining greater detail in terms of destinations. Doing so in cooperation with other conservation authorities could provide a highly valuable database for watershed management decisions.

4.5 Estimation of Valuation of Fishery

The current estimates of the value of the fishery are somewhat uncertain for the reasons discussed in this report; however, the results of this analysis provide a reasonable basis to estimate the cost of marginal improvements in precision. Specifically, these results provide a foundation for estimating the value of additional analyses that might yield improvements in the precision of the value of the fishery.

The preceding recommendations discuss various means whereby the precision of these estimates can be improved. However before efforts are initiated to improve the precision, the desired level of precision should be determined and balanced against the expected data collection and analysis costs. Certainly, the current results provide reasonable results that accord generally with other comparable studies and for this reason are felt to be reasonably indicative of the magnitude of the use value of the fishery. Efforts to improve the precision of the estimates should be carefully

tempered against management needs and the specific applications for which the results will be used.

4.6 Management Applications of Results

The results of this analysis are valuable beyond determining the economic value of the fishery. A major attraction of the product travel cost methodology is the ability of managers to forecast angler behaviour in response to changes in the fishery.

For example, if habitat improvements were being considered for a particular river section that would change significantly the nature of the fishery in that section, the demand functions can be used to forecast how the angler population is likely to respond. Note such changes will not only result in increased angling in the improved section, some redistribution of use of other sections will result. Anticipating the new distribution of anglers within the watershed will ensure that adequate preparations are made to accommodate the change in use.

The results of the product travel cost methodology are valuable to analyse the economics of potential management actions/projects. Specifically, the benefit of a management project in terms of improved angling opportunities can be calculated and compared to the costs of the improvement. In this way, a strong financial case can be made in support of fishery improvements that yield a positive benefit.

Similarly, if a proposed change to the watershed is anticipated to have a negative impact on one or more river sections, the economic loss in terms of lost fishing opportunities and their value can be estimated. This type of information can be used effectively to modify and improve land use proposals and to support requests for mitigative measures.

To make the best use of these results, the demand functions, supply costs, demographics and other supporting information should be integrated in a decision support software system. Doing so will permit authority personnel that are not skilled in economic analysis to use the results easily for practical applications. This type of software would have generic applications that would benefit other authorities. For this reason, if the CVC decides to pursue the development of this type of software, they should do so on a cost-sharing basis with other authorities.

Once the software shell is developed, updates to the demand functions, supply costs, demographics, etc. can be rapidly incorporated and applied immediately to management questions. In this way, the results of the analysis can be kept current and accessible to managers.

References

Adamowicz, W.L. and J.R. Deshazo. 2006. Frontiers in Stated Preferences Methods: An Introduction. Environmental and Resource Economics 34(1): 1-6

Adamowicz W., P. Boxall, M. Williams and J. Louviere. 1998. Stated preference approaches for measuring passive use values: Choice experiments and contingent valuation. American Journal of Agricultural Economics 80:64-75.

Adamowicz, W.L., J. Louviere, and M. Williams. 1994. Combining stated and revealed preference methods for valuing environmental amenities. Journal of Environmental Economics and Management 26: 271-292

Bockstael N. E., I. E. Strand and W. M. Hannemann. 1987. Time and the Recreational Demand Model. American-Journal-of-Agricultural-Economics 69(2): 293-302.

Breffle B., E. Morey and T. Lodder. 1998. Using Contingent Valuation to Estimate Neighborhood's Willingness-to-Pay to Preserve Undeveloped Urban Land. Urban Studies 35: 715– 27.

Burgess, David, F., The social discount rate for Canada: Theory and Evidence. Canadian Public Policy VII:3:383-394

Casey J. F., T. Vukina and L. E. Danielson. 1995. The Economic Value of Hiking: Further Considerations of Opportunity Cost of Time in Recreational Demand Models. Journal-of-Agricultural-and-Applied-Economics 27(2): 658-68.

Clawson M. and J. L. Knetsch. 1966. Economics of outdoor recreation. Johns Hopkins University Press, Baltimore, Maryland.

Credit Valley Conservation (CVC) and Ontario Ministry of Natural Resources (OMNR). 2002. Credit River Fisheries Management Plan. http://www.creditvalleycons.com/bulletin/downloads/CRFMPFinal2002.pdf

DSS Management Consultants Inc. (DSS). 2005. Health and Environmental Damages Attributable to Provincial Air Pollutant Emissions and Transboundary Air Pollution. Prepared for Ontario Ministry of the Environment. Toronto. 48p.

Feather P. and W. D. Shaw. 1999. Estimating the Cost of Leisure Time for Recreation Demand Models. Journal of Environmental Economics and Management 38: 49-65.

Freeman III.M.A. 2003. The Measurement of Environmental and Resource Values: Theory and Methods, Second Edition. RFF Press (Washington DC). ISBN: 1-891853-62-7.

Greig, L. and M. Fortin. 2007. Socio-economic Analysis for Atlantic Salmon (Lake Ontario Population): Economic Impact Analysis. Prepared by ESSA Technologies Ltd., Richmond Hill, ON for Fisheries and Oceans Canada, Policy and Economics, [Sarnia, ON], 30 pp + Appendices

Hynes S., N. Hanley and C. O'Donoghue. 2005. Measuring the opportunity cost of time in recreation demand modelling: an application to whitewater kayaking in Ireland. http://www.economics.stir.ac.uk/staff/hanley/sitechoice4.pdf

Institute for Research and Innovation in Sustainability (IRIS), Schulich School of Business and DSS Management Consultants Inc. 2006. Benefits Assessment: Randle Reef Sediment Remediation. Prepared for Environment Canada. York University, Toronto. 44p plus app.

Jenkins, Glenn, B., The public sector discount rate for Canada: Some further observations. Canadian Public Policy VII:3:399-407

Johnston, R.J., S.K Swallow and T. F. Weaver. 1999. Estimating willingness to pay and resource tradeoffs with different payment mechanisms: An evaluation of a funding guarantee for watershed management. Journal of Environmental Economics and Management 38:97-120.

Louviere J. J., D. A. Hensher and J. D. Swait. 2000. Stated Choice Methods: Analysis and Applications. New York: Cambridge University Press.

Ontario Ministry of Natural Resources (OMNR). 2003. 2000 Survey of Recreational Fishing in Ontario: A Descriptive Analysis. Conservation and Planning Section. Peterborough, Ontario. 237 p.

Shaw W. D. 1992. Searching for the Opportunity Cost of an Individual's Time. Land Economics 68(1): 107-115.

Smith, V. K. 1997. Time and Valuation of Environmental Resources. Resources for the Future, Washington, DC, 29 p.

Talhelm D. R., J. E. Hanna and P. Victor. 1987. Product Travel Cost Approach: Estimating Acid Rain Damage to Sportfishing in Ontario. Transactions of the American Fisheries Society 116:420-431.

Voinov, Alexey and Joshua Farley. 2007. Reconciling sustainability, systems theory and discounting. Ecological Economics 63: 104 – 113

Winkler R. 2006. Valuation of ecosystem goods and services: Part 1: An integrated dynamic approach. Ecological Economics 59(1): 82-93.

Appendix A – Streamside Angler Survey

Credit Fishing Behaviour

A. Date____ Fishing Location _____

A.1 What time did you start fishing today? ___

A.2 Until what time do you expect to fish today? ___

A.3 Do you plan to fish this general location of the river all day? ___ Yes = 1 No = 0

A.4 Where else do you expect to fish in the Credit River Watershed? (List up to 3)
1. _____
2. _____
3. _____

A.5 Do you fish in stocked ponds ___ Yes = 1 No =0
A.5.1 If yes, please indicate type of pond: ___ Public (PU) or Private (PV)

A.6 Did you travel here today solely to fish? ___ Yes =1 No =0
A.6.1 If no (0), please indicate the other reasons for coming to the Credit area today:
_____

A.7 Please indicate the importance of the following factors in terms of how they influence your decision to fish the Credit River Watershed. Use the following importance scale to assign ratings to each variable listed:

1 = Very important
2 = Somewhat important
3 = Indifferent
4 = Somewhat Not Important
5 = Not Important or Not Applicable

a. Success Rate _____
b. Size of Fish _____
c. Species of Fish_____
d. Fishing Environment_____
e. Number of Anglers (Crowding) _____
f. Proximity to Residence/Place of Work_____
g. Availability of Public Access_____
h. Familiarity with the Area_____
i. Lack of Other Comparable Locations_____
j. Other_____

A.8 What are the three primary species that you are hoping to catch at this location?

1. _____
2. _____
3. _____

A.9 How many fish did you catch today? ___

A.9.1 List the species of fish and the size of fish that you caught today:

a. Coho salmon _____
b. Chinook salmon_____
c. Rainbow trout_____
d. Atlantic salmon_____
e. Brown trout_____
f. Brook trout_____
g. Lake trout_____
h. Rainbow smelt_____
i. Northern pike_____
j. White sucker_____
k. Common carp_____
l. Creek chub_____
m. Brown bullhead (catfish) _____
n. Rock bass_____
o. Pumpkinseed (sunfish) _____
p. Smallmouth bass_____
q. Largemouth bass_____
r. Black crappie_____
s. Yellow perch_____
t. Freshwater drum (sheepshead) _____
u. other_____

A.10 How many fish did you keep today? _____

A.11.1 What is your preferred fishing method at this location?

Fly fishing___
Spin Fishing ___
Float___
Other (please explain)_____

A.11.2 What is your preferred fishing gear?

Artificial Lures or Flies____
Bait____
Other (please explain)_____

A.11.3 What is your preferred location to fish from?

Boat___
Shore___
Wade/Float tube___
Other (incl. ice_____

A.12 Do you usually fish alone? ___ Yes = 1 No = 0

A.12.1 If no, how many of your friends or family do you usually fish with? ___

A.12.2 When you are fishing with others do you usually travel together in one vehicle? ____
Yes = 1 No = 0

A.13.1 What proportion of your angling trips to the Credit River Watershed are day trips? _____%

A.13.2 What proportion of your angling trips to the Credit River Watershed are overnight trips? ___%

A.13.3 Of those trips where you are staying over night, how many days do you typically fish in the Credit River Watershed?_____

A.13.4 Where do you usually stay on overnight trips to the Credit?
Private residence ___ Motel ___ B&B ___ Camp ___ Other ___

A.14 Are you a member of a fishing club? If so, which one? _____

Expenditures

This section of the survey requests some general information regarding your angling expenditures. Please include only your own personal angling expenditures.

B.1 Please indicate how much you have spent over the last 12 months on the following equipment and supplies for all fishing trips everywhere.

B.1.1 Rods, reels, line, hooks and other types of angling gear ____

B.1.2 Clothing used for angling (e.g., boots, vest)____

B.1.3 Other angling materials (e.g., magazines, maps/guides)____

B.1.4 Guided Trips and Charters___

B.2 Please indicate how much you spend each time you go fishing on the Credit. Again, please include only your own personal angling expenditures. For example if you traveled with other anglers include only your portion of the travel expenses.

B.2.1 ____

B.2.2 ____

B.2.3 ____

B.2.4 ____

Demographics

This section requests some general demographic information that is helpful to improve our understanding of the anglers that are fishing the Credit.

C.1 Gender: Male ___ Female ___

C.2 Marital Status: Single ___ Married ___ Other ___

C.3 Age: <14__ 15-24__ 25-34__ 35-44__ 45-64 __ 65-74 __ 75+__

C.4 Number of dependent children ___

C.5 Location of residence: City/Town _____

C.5.1 If you are from a location outside of Ontario, please indicate your home province/state/country (if appropriate) _____

C.5.2 Postal Code/Zip Code _____

C.6 Annual Household Income: <$40,000__ $40,000-$70,000__ $70,100-$100,000__ $100,100-$150,000__ $150,100-$250,000__ >$250,000__

C.7 Highest level of education:
<Grade 9___ Some High School (grade 9-12)___
High School Diploma___ College Diploma___
University Degree: Bachelors___ Masters___
PhD___ Certificate/Diploma___ Other (please specify) _____

C.8 Cultural background:
African ___ Asian (e.g. Chinese) ___ South Asian (e.g. Indian) ___ European ___ Hispanic ___
Middle Eastern ___ Aboriginal ___ Canadian____ Other ___

C.9 If visiting Ontario, what is your planned length of stay _____

Your feedback is important. Please provide us with your thoughts, recommendations, concerns or issues about the Credit fishery.

_____
_____
_____
_____
_____

Thank you for taking the time to answers these questions, your input is going to be very important for the study.

Appendix B – Travel Time and Distance Tables

This appendix contains the travel matrix used to calculate travel costs for each origin/destination combination.

Table B-1 – Travel Distance and Time between Origins and Destinations

	Destination																			
	1		2		3		4		5		6		7		8		9		10	
	Island Lake CA		Upper CR CA		Grange Property		Sauriol CA		Forks C A		Brimstone Rd.		Belfountain CA		Hillsburgh		Trout Unlimited		Whillans RMA	
Origin	km	min	km	min	km	min	km	min	km	min	km	min	km	min	km	min	km	min	km	min
AcG	42	41	37	37	35	35	29	29	24	24	24	24	24	24	19	19	32	34	34	36
Bo	36	35	43	40	41	38	39	41	34	36	34	36	34	36	44	46	30	30	32	32
Br	105	108	97	105	95	103	120	95	118	95	115	90	115	90	110	85	121	93	123	95
Br1	42	42	41	41	39	39	39	41	34	36	34	36	34	36	42	44	31	29	33	31
Br2	36	36	35	35	33	33	33	35	28	30	28	30	28	30	37	39	24	24	26	26
Ca	25	25	22	22	20	20	15	19	13	16	16	19	16	19	26	29	13	12	15	14
Ce	110	99	107	96	105	94	116	103	121	108	111	98	111	98	121	108	107	96	109	98
Cm	76	75	68	72	66	70	61	64	56	59	56	59	56	59	51	54	68	71	70	73
Co	69	69	75	71	77	73	89	85	84	80	94	90	94	90	99	95	83	79	85	81
Ha	85	87	97	84	95	82	89	85	94	90	84	80	84	80	79	75	91	74	93	76
Lo	175	140	167	137	165	135	161	162	159	162	156	157	156	157	151	152	170	139	172	141
Mi1	57	53	56	52	54	50	43	46	48	51	38	41	38	41	48	45	45	41	47	43
Mi2	57	54	54	51	52	49	53	51	46	44	48	46	48	46	57	53	44	40	46	42
Mi3	71	64	70	63	68	61	63	61	57	54	53	48	53	48	48	43	59	52	61	54
Mi4	50	52	49	51	47	49	42	41	40	43	36	36	36	36	38	37	42	40	44	42
Ml	56	50	48	47	46	45	41	40	36	35	36	35	36	35	31	30	44	45	46	47
Ne	55	51	62	56	60	54	71	65	66	60	66	60	66	60	76	70	63	56	65	58
No	336	239	324	232	326	234	327	236	330	239	332	241	332	241	335	244	332	241	334	243
Oa	75	76	67	68	65	66	60	57	65	62	55	52	55	52	50	47	67	56	69	58
Or	15	17	21	19	23	21	27	29	29	31	32	34	32	34	37	39	30	27	32	29
Ot	502	342	499	339	497	337	495	335	500	340	490	330	490	330	500	340	489	330	491	332
StC	145	110	137	107	135	105	129	98	127	98	124	93	124	93	119	88	130	96	132	98
To1	60	61	58	61	56	59	62	57	57	52	57	52	57	52	67	62	49	51	51	53
To2	78	63	76	63	74	61	70	60	65	55	65	55	65	55	75	65	65	51	67	53
To3	93	74	91	74	89	72	86	74	81	69	81	69	81	69	91	79	80	63	82	65
To4	62	52	60	52	58	50	56	52	51	47	51	47	51	47	61	57	49	41	51	43
Tr	237	168	234	165	232	163	229	163	234	168	224	158	224	158	234	168	224	158	226	160
Wh	124	97	121	94	119	92	115	95	115	100	110	90	110	90	120	100	109	90	111	92

	Destination															
	11		12		13		14		15		16		17		18	
	Mid Credit River		Silver Creek		Terra Cotta CA		Fairy Lake		Norval		Lake Aquitaine		Erindale Park		LO Waterfront	
Origin	km	min	km	min	km	min	km	min	km	min	km	min	km	min	km	min
AcG	17	17	7	7	17	17	0	0	18	20	28	32	36	35	46	44
Bo	25	27	33	38	27	29	40	45	37	37	60	51	52	46	45	42
Br	101	79	98	82	101	79	91	75	90	66	88	65	80	60	81	59
Br1	27	28	22	27	27	28	29	34	17	22	32	26	32	26	37	34
Br2	21	23	15	18	21	23	22	25	8	10	30	27	30	27	28	31
Ca	15	14	20	23	17	16	27	30	27	25	51	43	43	38	42	44
Ce	108	103	136	142	110	105	143	149	122	93	130	95	122	90	117	90
Cm	71	58	52	52	71	58	45	45	62	46	62	49	70	52	75	62
Co	99	91	113	103	101	93	113	103	111	103	124	117	132	120	156	120
Ha	71	59	68	62	71	59	61	55	60	46	55	44	47	39	49	40
Lo	170	123	151	116	170	123	144	109	160	112	178	125	170	120	170	120
Mi1	30	32	25	25	30	32	32	32	14	16	16	16	8	11	13	19
Mi2	41	39	34	33	41	39	41	40	22	22	19	20	11	15	10	15
Mi3	40	38	33	28	40	38	40	35	29	24	20	24	12	19	14	15
Mi4	24	25	15	16	24	25	22	23	11	13	5	5	15	15	26	26
Ml	30	29	22	22	30	29	15	15	38	35	41	31	49	39	55	51
Ne	63	63	85	66	65	65	92	73	71	55	84	62	76	57	72	55
No	309	243	358	252	311	245	358	252	337	235	358	245	350	240	337	233
Oa	40	42	42	44	40	42	35	37	33	28	31	28	23	23	19	21
Or	45	41	59	54	47	43	59	54	57	51	69	67	77	67	75	73
Ot	579	262	477	317	581	264	484	324	465	310	508	335	500	330	465	303
StC	111	82	107	84	111	82	100	77	99	68	94	66	86	61	90	63
To1	48	43	46	39	50	45	53	46	32	28	41	35	33	30	27	26
To2	55	46	53	40	57	48	60	47	41	33	52	38	44	33	35	27
To3	71	57	68	52	73	59	75	59	57	44	53	43	45	38	44	41
To4	40	36	37	31	42	38	44	38	26	23	33	30	25	25	14	14
Tr	214	149	211	143	216	151	218	150	200	136	208	137	200	132	194	130
Wh	101	77	98	72	103	79	105	79	87	64	94	67	86	62	80	59

Appendix C – Angling Product Demand Function Statistics

This table provides the demand functions estimated for each of the angling products.

Table C-1 – Demand Functions Estimated for Angling Products

Season	Code	Demand Functions	SE[1]	F stat	R^2
Spring	SPb1	Q1=22.294-0.139P1-105.176/P1	5.60	1.95	0.57
	SPb2	Q2=1223.773/P2-0.07P2	19.09	16.02	0.065
	SPb3	Q3=29.496-0.5P3-152.63/P3+0.35P5	19.27	1.18	0.18
	SPr1	Q4=25.313-0.15P4-329.386/P4	8.96	0.65	0.10
	SPr2	Q5=14.05-0.26P5+323.5/P5+0.21P3	24.09	1.33	0.18
	SPw1	Q6=0.022P6+153.272/P6	1.06	10.88	0.91
Summer	Sb3	Q1=16.351-0.28P1+21.722/P1+0.22P8	13.58	2.40	0.32
	Sb4	Q2=12.7-0.19P2+96.8/P2+0.06P5+0.1P10	8.44	1.49	0.30
	Sr1	Q3=-5.9-0.69P3-42.1/P3+1.2P4	18.68	0.77	0.70
	Sr3	Q4=-0.555-0.009P4+538.05/P4	10.57	0.54	0.21
	Sr4	Q5=-16.96-0.16P5-540.7/P5+0.16P8	2.21	5.90	0.95
	Sw2	Q6=36.55-1.12P6-253.6/P6+0.83P1	34.53	0.67	0.22
	Sw4	Q7=3.624-0.256P7-71.352/P7+0.069P8+0.247P10	5.19	4.54	0.67
	Sm1	Q8 = 23.06-0.096*P8-333.3/P8	-	-	-
	Sm2	Q9=-12.4-0.29P9+376.3/P9+0.31P4	10.29	11.33	0.69
	Sm4	N/E	-	-	-
Fall	Fb2	Q1=-0.42P1+9.8/P1+0.68 P3	2.99	6.70	0.95
	Fb3	Q2=-0.023P2+115.17/P2+0.029P5	2.26	8.63	0.76
	Fb4	Q3=-0.041P3+334.98/P3+0.038P8	5.58	8.25	0.71
	Fr1	N/E	-	-	-
	Fr2	Q5=12.47-0.256P5-113.07/P5+0.104P2	8.59	0.22	0.18
	Fr3	Q6=83.82-1.16P6-1049.3/P6+0.51P2	25.33	1.88	0.23
	Fr4	Q7=-11.433-0.028P7+263.435/P7+0.194P8	0.15	799.00	1.00
	Fw4	Q8=269.3-3.18P8-4687.4/P8	19.01	6.70	0.30
	Fm4	N/E	-	-	-
Winter	Wr1	Q1=2.038-0.238P1+102.08/P1+0.166P2+0.141P3	4.37	2.73	0.46
	Wr2	N/E	-	-	-
	Wr3	N/E	-	-	-
	Wr4	Q4=-79.06-87.35/P4-0.11P4+0.13P2+0.34P5	0.00	-	1.00
	Ww4	Q5=-7.7+399/P5-0.048P5+0.096P2+0.001P4	1.43	1.33	0.97

The general form of the equations is constant among products, where for example in the first equation for product SPb1:

Q1 is the number of fishing trips taken in the spring for product *SPb1*;
P1 is the price of a fishing trip to enjoy product *SPb1*.

[1] This is the standard error for the standard coefficient.