EXPLORING RECREATIONAL ANGLER HETEROGENEITY IN THE OKANAGAN

by

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ABSTRACT

Participation in recreational angling in British Columbia has declined since the early 1990's. Therefore, new fishery management strategies are being designed to attract anglers to the Okanagan region of British Columbia (Region 8). This study used a Discrete Choice Experiment and a Latent Class Model to identify unique groups of anglers within the Okanagan (Region 8), and to evaluate if the new management strategies align with anglers preferences for fishery characteristics. The results of the study identify and describe four heterogeneous segments of fishers, and determine that the new management strategies will provide attractive fishing opportunities for most Okanagan (Region 8) angler segments if they are implemented. These findings are supported by a Decision Support Tool which can be used by fishery managers to evaluate and refine management strategies for small mountain lakes in the Okanagan (Region 8).

Keywords: recreational angling; discrete choice experiment; latent class model; stated preference; fishery characteristics; decision support tool

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1: INTRODUCTION

1.1 Background Information

Participation in recreational angling in British Columbia has declined since the early 1990's; in 1993 approximately 400,000 basic angling licenses were sold in the province, yet by 2005 that number had decreased to 319,400 (approximately a 20% decline). Although license sales have increased modestly since 2005 (approximately 340,000 licenses were sold in 2009), the number of recreational anglers in British Columbia is still far below the desired levels, based on previous angling participation rates in the province (GSGislason & Associates Ltd., 2009). The low rates of participation in recreational angling are a cause for concern due to the impacts they have on British Columbia's economy.

Recreational anglers make a significant contribution to British Columbia's economy. In the year with the fewest recreational angling license sales in recent history (2005), recreational freshwater anglers in British Columbia spent approximately $480 million in fishing related expenditures, contributing $210 million to the province's Gross Domestic Product (GSGislason & Associates Ltd., 2009). Fishing related expenses supported $120 million of wages and benefits, 3875 years of employment and generated $129 million in tax revenue ($76 million Federal and $53 million Provincial) (GSGislason & Associates Ltd.,

2009). According to provincial accounting estimates, recreational fishing in British Columbia supports over 7700 jobs and contributes $288 million in GDP annually (British Columbia Ministry of Environment, 2010).

The British Columbia Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) and the Freshwater Fisheries Society of British Columbia (FFSBC) (a non-profit organization) are the two bodies responsible for managing and improving the freshwater fisheries in British Columbia. Together these two bodies administer fish culture programs, and develop and implement strategies to attract more anglers to the province (Freshwater Fisheries Society of British Columbia, 2010).

In 2009, the FFSBC declared as its goal to increase participation in recreational fishing to 30 percent above the 2005 level, thereby restoring recreational angling activity to 1990 levels. Since 2005, license sales have increased by approximately 20,000. However, in 2009 license sales were still approximately 40,000 short of the FFSBC's goal (GSGislason & Associates Ltd., 2009).

1.2 Research Problem

The FFSBC and the Ministry of Forests, Lands and Natural Resource Operations routinely stock hundreds of lakes and streams in British Columbia to improve the quality of recreational fishing opportunities. Currently the

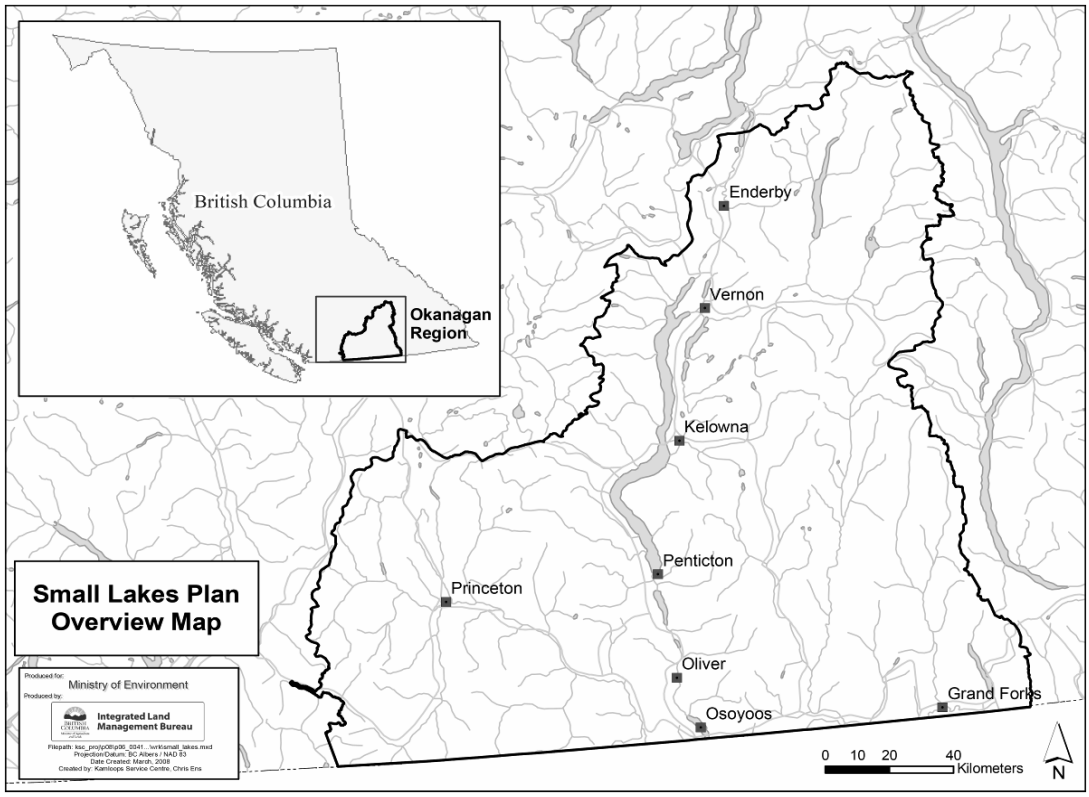
FFSBC and the MFLNRO are establishing guidelines to develop five different types of lakes in British Columbia: trophy lakes, quality lakes, regional lakes, family lakes, and urban lakes (Freshwater Fisheries Society of British Columbia, 2010). The goal of trophy lakes is to develop stocks of larger fish through more restrictive take limits. Quality lakes will be managed to increase overall catch rates on lakes that experience high fishing pressure by employing regulations that reduce individual angler harvest and negative impacts on released fish. Regional lakes will be managed as harvest fisheries where the quality of fishing will be dictated by the biology of lakes. Family lakes will be managed to produce high harvest and catch rates through stocking and will be located in areas with facilities (i.e. washrooms, campgrounds, and picnic areas) and will be easily accessible. Finally, urban lakes will be located near population centres and managed for high harvest and good catch rates (Freshwater Fisheries Society of British Columbia, 2010).

Both the FFSBC and MFLNRO strive to provide fisheries that will satisfy all anglers in the province by developing lakes with different characteristics. Thus fishery managers are developing an experience-based setting management approach to recreational fisheries (Manfredo, Driver & Brown, 1983). However, the lake types described above were developed by a panel of experts, and are not based on quantitative evidence that describes anglers' setting preferences. Therefore, the FFSBC and MFLNRO would like to assess whether the five proposed lake types match the actual recreational fishing demand by the

various anglers. One approach for such an assessment is to better understand the characteristics that influence the choice of fishing sites by anglers (e.g. regulations, travel distance), and to investigate the agreement between angler demand and the already established management strategies.

Currently, the province of British Columbia is divided into eight management regions. Each region has unique ecological and social characteristics, and will eventually be the subject of studies similar to one described in this report. However, the FFSBC and MFLNRO believed it would be valuable to conduct a pilot project; as such, the region of interest to this study is the Okanagan (Region 8) located in south central British Columbia (Figure 1).

Figure 1: Map of the Okanagan (Region 8)



(Jantz and Tarangle, 2010)

1.3 Purpose and objectives

The overarching goal of this project is to determine how well the five lake types defined by the FFSBC and the MFLNRO match the preferences of anglers in the Okanagan region (Region 8). For this purpose it is useful to understand the characteristics of anglers who fish in the Okanagan (Region 8), identify groups within the population of Okanagan (Region 8) anglers with similar characteristics, and evaluate the anglers' preferences for fishery attributes. Then, the five types of lakes which are currently considered by the FFSBC and the MFLNRO will be compared to anglers' responses to a Discrete Choice Experiment (described in section 4.4) which will measure anglers' preferences for small mountain lake characteristics. The comparison of the lake types with

anglers' preferences will illuminate potential alterations to the five lake types that could improve angler utility. Based on the overriding goals of this project, the main research objective is to evaluate the lake types the FFSBC and MLFNRO are considering for implementation in the Okanagan (Region 8). To achieve the principle objective this research project will have to:

- describe the characteristics of Okanagan (Region 8) anglers;
- identify heterogeneous groups within the population of Okanagan (Region 8) anglers; and,
- assess angler preferences for fishery characteristics.

It is important to note that these five lake types are principally designed for small mountain lakes. As such, the focus of this project is on the small mountain lakes in the Okanagan (Region 8) and not on the large valley-bottom lakes which are also present in the region (see section 2.2 for a comparison of small mountain and large valley-bottom lakes).

1.4 Report Organization

This report is organized into six separate chapters including this introductory chapter. Chapter two describes the study area. The third chapter will review the pertinent academic literature regarding human dimensions of recreational fishing research. Chapter four describes the research methods used to explore and compare Okanagan (Region 8) anglers' characteristics, explains the model used to assess anglers' preferences for fishery characteristics, and describes the methods for evaluating the lake types being designed by the FFSBC and MFLNRO. The results of various analyses are provided in chapter five. Finally,

chapter six discusses the key findings of this study on recreational angler research and on fishery management in the Okanagan (Region 8).

2: STUDY AREA

This chapter describes the study area by geographic, recreational, and management characteristics. The chapter concludes with a description of the fishery management strategies currently employed in the Okanagan (Region 8).

2.1 Regional setting of the Okanagan (Region 8)

The Okanagan region (Region 8) covers more than 27,000 square kilometres of south central British Columbia (Jantz & Tarangle, 2010). The region's southern border follows the Canada-United States border for approximately 150 Km, from 120 Km west of Osoyoos, to 30 Km east of Grand Forks. The Okanagan (Region 8) is somewhat triangular with the northern-most point approximately 60 Km north-northeast of Enderby (Figure 1).

2.2 Natural environment

The Okanagan (Region 8) contains a variety of geographic and climatic zones: arid deserts dominate the valley-bottom, and moist forested areas and high alpine regions develop as elevation increases (Jantz & Tarangle, 2010). The region is home to a diversity of lake types, ranging from large valley-bottom lakes (9 lakes greater than 1000 hectares in size) to small, highly productive mountain lakes. Approximately 70 percent (401 of 567) of the small lakes (less

than 1000 hectares in size) are considered manageable for recreational fishing (Jantz & Tarangle, 2010).

2.3 Cultural environment

In 2006 the population of the Okanagan (Region 8) was approximately 320,000, mostly living in eight major population centres: Enderby, Vernon, Kelowna, Penticton, Oliver, Osoyoos, Princeton and Grand Forks. Approximately 60% of anglers in the region are Okanagan (Region 8) residents (Jantz & Tarangle, 2010).

2.4 Recreational environment

Each year the Okanagan (Region 8) receives approximately 10% of the total provincial fishing effort. Resident anglers fish an average of 14 days per year, while anglers from other regions of British Columbia fish six days per year, and anglers from out of province fish three days per year (Jantz & Tarangle, 2010). Most Okanagan (Region 8) anglers target Rainbow Trout. In 2000, 72% of all fish caught were Rainbow Trout, while 8% were Kokanee, Brook Trout, Yellow Perch, Cutthroat Trout, Bass and 'other species' made up the remaining 20% of the catch (Jantz & Tarangle, 2010). Table 1 summarizes basic angler characteristics for the Okanagan (Region 8) gathered during the 1985 and 2000 National Sport Fishing Surveys and highlights the concerns of the FFSBC and the MFLNRO, namely the decline in angler days, and the decline in total direct fishing expenditures.

Table 1: Angler statistics from the National Sport Fishing for 1985 and 2000 for Region 8 (Okanagan)

Recreational Fishing Statistics	1985	2000
Angler days	591,336	422,000
Average number of days fished per angler	11.5	10.7
Average age of licensed male anglers*	44.2	47.9
Average age of licensed female anglers*	41.7	46.8
Average daily direct fishing expenditures	$29	$39
Total direct fishing expenditures	$17.2 million	$16.4 million
Fish caught	1,500,000	900,000
Fish harvested	1,000,000	270,000

*The majority of region 8 anglers are male (77%) which is slightly less than the provincial total of 79%

Source: (Jantz & Tarangle, 2010)

2.5 Management Context

The FFSBC and the British Columbia Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) currently use a variety of fish stocking techniques and regulations to manage lakes in the Okanagan (Region 8). As of 2010, slightly fewer than 350 small lakes in the Okanagan (Region 8) have been stocked with hatchery-raised fish. The FFSBC and MFLNRO currently stock Rainbow Trout and Eastern Brook Trout; both sterile and reproductive fish are stocked depending on the management goals for lakes. Invasive fish species are present in 18 small lakes in the Okanagan (Region 8) (Jantz & Tarangle, 2010).

Fishery managers in the Okanagan (Region 8) enforce a wide variety of regulations. While many lakes are subject to a generic set of regulations, some

may be subject to more or less stringent regulations according to the lakes' specific management goals. Regulations include horsepower (motor size) restrictions, seasonal fishery closures, take limits (number of fish that can be harvested per day), and gear type restrictions. Managers in the Okanagan (Region 8) are currently trying to manage lakes on a large scale, and streamline small lakes regulations to ensure that complex regulations are not a barrier to anglers (Jantz & Tarangle, 2010); however, they are unsure how anglers will respond to changes in fishery regulations.

Research that explores anglers' behaviour in detail, and assesses whether their values align with the expectations of fishery managers could provide additional insights into how fisheries can be managed to maintain fish stocks, while providing satisfying fishing experiences for anglers. Some research to that effect has already been undertaken in south-central British Columbia. However, these studies have focused on the actual behaviour of recreational anglers and their impacts on the biology of lakes (Post et al., 2008). Post et al. (2008) admit that one of the shortcomings of their results is the assumption of a homogeneous population of anglers. Consequently, exploring angler heterogeneity to understand the different types of desired fishing experiences is the logical next step of angler research in the interior lakes of British Columbia.

3: HUMAN DIMENSIONS OF FISHERIES RESEARCH

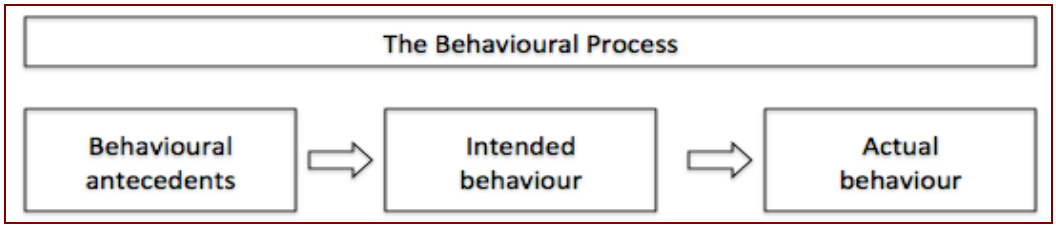
Human dimensions research can contribute valuable insights for the management of a recreational fishery. A well-designed study can evaluate anglers' preferences for fishery characteristics, identify heterogeneous segments of anglers within a population, and provide information that will help create management strategies that produce attractive fisheries. This chapter presents theories and concepts that guide angler research, as well as relevant methods for studying angler behaviour and accounting for heterogeneity within a sample population.

3.1 Studying recreational anglers

Voiland and Duttweiler (1984) suggest that resource management in general and fisheries specifically should by definition be guided by society's needs and values. Since recreational fishing is a voluntary activity, maintaining and enhancing the attractiveness a fishery is of utmost importance. Otherwise, anglers may choose alternative fishing opportunities, or elect to spend their free time on other forms of recreation. As such, fisheries researchers typically try to understand and predict anglers' behaviours so they can anticipate reactions to changes in fishery characteristics, and subsequently design management strategies that produce attractive fisheries.

Figure 2 provides a conceptual overview of the various stages of the human behaviour and decision making process. The first stage of the behavioural process suggests that an individual holds a certain mix of beliefs and values that influence their preferences also referred to as behavioural antecedents. Behavioural antecedents are then thought to influence attitudes, and an individual's predisposition towards behaviour, which reflects their preferences, illustrated in Figure 2 as intended behaviour. Ultimately, an individual's intended behaviour influences their actual behaviour (Ajzen & Fishbein, 1980).

Figure 2: The behavioural process



Adapted from (Parkkila, et al., 2010)

The Theory of Planned Behaviour (TPB) is a commonly used framework for examining the behavioural process. The TPB suggests that exploring the relationship between an individual's behavioural antecedents and actual behaviour can reveal the factors that influence decisions. Subsequently, the knowledge gained can be used to predict how individuals will make decisions about similar situations in the future (Ajzen & Fishbein, 1980).

The utility of studying individuals' behavioural processes to predict human behaviour in a resource management context has been repeatedly verified (Bright & Manfredo 1996; Fulton, Manfredo, & Lipscomb, 1996). For example, behavioural antecedents have been found to significantly influence individuals' support or opposition towards wolf reintroduction in Colorado (Bright & Manfredo, 1996). Similarly, Fulton, Manfredo and Lipscomb (1996) found that individuals' value orientations towards wildlife (a behavioural antecedent) influenced their attitudes, and subsequently their intent to participate in or abstain from wildlife related recreation activities.

Alternatively, researchers can study individuals' intended or actual behaviour by using revealed and/or stated preference approaches. Revealed preference methods are based on observations of actual behaviour (Haider, 2002) and are especially useful for modelling behaviour for products with relatively minor and continuous changes in their characteristics (Timmermans, 1984). Stated preference approaches rely on individuals' evaluations of hypothetical products or product attributes, and are also suitable for the evaluation of individuals' preferences for non-existent products (Haider, 2002).

In the context of behavioural modelling it is important to distinguish between compositional, and decompositional stated preference methods (Timmermans, 1984). Compositional stated preference techniques ask respondents to evaluate independently a number of aspects of a management issue.

Statistical procedures then combine the results of independent evaluations to calculate an overall measure of utility for a management action, such as the analytic hierarchy process (Saaty, 1990; Haider, 2002). In decompositional stated preference choice models researchers create alternative products composed of a set of relevant attributes. Respondents then evaluate sets of hypothetical products and select their most preferred alternative (Haider, 2002; Louviere, Hensher, & Swait, 2000). The results of decompositional stated preference models provide estimates of individuals' preferences for products and product attributes (Louviere, Hensher, & Swait, 2000). While operationalizing compositional stated preference techniques is possible in surveys, many of the questions may not be conducive to the decision context of respondents, and the analysis requires mathematical assumptions about the linkage between attributes (Longland, 2004). Decompositional stated choice methods on the other hand are a more effective method for evaluating hypothetical management scenarios (Timmermans, 1984).

The state-of-the-art in decompositional stated preference modelling is the Discrete Choice Experiment (DCE) (Louviere, Hensher, & Swait, 2000; Hensher, Rose, & Greene, 2005), which provides estimates of consumer preference for the complete suite of product attributes which are included in a DCE. The results of a DCE can subsequently be used to create a Decision Support Tool (DST), to predict respondents' preferences for a set of hypothetical alternatives (Timmermans, 1984). Within a DST the user can

evaluate the demand for a range of possible products or uses, including the null alternative (the option to *not* consume any of the alternatives generated by the user). Therefore, by manipulating the hypothetical products in a DST, users can determine the mix of product attributes that maximize consumer utility (Semeniuk, et al., 2009).

3.2 Attributes of recreational fisheries

Defining the relevant attributes for the product of interest is an important step in designing a decompositional stated preference choice experiment. Attributes (and their associated levels) should include all relevant factors that may influence a person's decision for selecting a good or service. Attributes can be identified from the relevant academic literature, formal and informal interviews, and consultation with relevant experts (Haider, 2002).

In the context of recreational fishing, six product attributes are generally considered to influence anglers' site choice. The attributes typically describe costs, environmental quality, fishing quality, regulations, facility development, and encounter levels (Hunt, 2005). Most of the examples provided below are described in detail by Hunt (2005), and while many of them are taken from revealed preference choice models, each of the attributes has been shown to influence how anglers' select fishing sites, and should therefore be considered when designing a decompositional stated preference choice experiment.

Attributes that describe costs generally transform the travel distance required to access a fishing site into a dollar value (Hunt, 2005). For example, Provencher, Baerenklau and Bishop (2002) assumed that it cost anglers $0.13 (US Dollars) for every mile travelled to access a lake. Additionally, the amount of income foregone by anglers when participating in recreational angling instead of working was included in a travel cost model to calculate an overall cost for an angling trip. Generally, angling research suggests that costs are inversely related to fishing site utility (Adamowicz, 1994; Montgomery and Needleman, 1997).

Another factor that influences recreational angling site selection is the environmental quality of a fishing site. Environmental quality can be described by measures of terrestrial aesthetics (Tay, McCarthy, & Fletcher, 1996; Hunt, 2005) and evaluations of water quality including secci depth (Feather, 1994), and fish advisories (Montgomery & Needleman, 1997). A study of recreational anglers in New York State found that fishers were willing to pay approximately $63 (US) per year to eliminate toxic contaminates present in fisheries (Montgomery & Needleman, 1997), suggesting that anglers prefer sites with high environmental quality.

Independent from environmental quality, the fishing quality of a site is an important factor in how anglers select fishing sites, and can be described in a number of different ways (Hunt, 2005). The fish species in a given lake

(Parsons & Kealy 1992), and the presence of stocked water bodies can be used as proxies for fishing quality (Montgomery & Needleman, 1997). Perhaps a more straightforward evaluation of fishing quality is the expected catch rate (Provencher, Baerenklau, & Bishop, 2002) and size of fish (Adamowicz, 1994), which are usually positively related to site choice (Hunt, 2005).

Regulations are a management tool common to many recreational fisheries. They are designed to alter anglers' behaviour as well as the outcomes of anglers' behaviour (Hunt, 2005). Common regulatory tools include take (or bag) limits, size limits (only fish above, below, or between certain sizes may be retained), gear restrictions, and motor restrictions. Several researchers have shown that anglers have specific preferences for fishery regulations, and that they are a significant factor in how fishers select lakes (Aas, Haider, and Hunt, 2000; Oh and Ditton, 2006).

The presence or absence of facilities also influences an anglers' fishing site choice (Hunt, 2005). For example boat launches (Kaoru, 1995; Montgomery & Needleman, 1997) and campground facilities (Adamowicz, 1994; Morey, Breffle, Rowe & Waldman, 2002) have been used to describe the facilities at fishing sites. The results of several studies suggest that the presence of facilities increases angler utility with a given site (Adamowicz, 1994; Peters, Adamowicz & Boxall, 1995).

Finally, the number of encounters anglers have with other people can influence their utility of a fishing site (Martinson & Shelby, 1992), and should therefore be included in stated preference choice experiments (Hunt, 2005). Congestion at boat launches (Schuhmann & Schwabe, 2004) and numbers of encounters with other anglers (Banzhaf, Johnson & Mathews, 2001 in Hunt 2005) are usually correlated negatively with fishing site choice, suggesting that anglers prefer isolated fishing experiences.

A well-designed DCE, which includes the appropriate attributes, can evaluate the characteristics of recreational fisheries that are important to anglers. The decompositional nature of a DCE also allows researchers to explore the trade offs anglers make between relevant fishery attributes, and to disguise issues that may be primary management concerns within the greater context of fishing site choice (Haider, 2002). Finally, by examining the results of a Discrete Choice Experiment, researchers can prescribe management strategies that will manipulate fishery attributes, such as those described in the preceding paragraphs, in a manner that will maximize angler utility.

3.3 Accounting for heterogeneity in fishery management

While using stated preference methods to evaluate anglers' preferences for fisheries can provide meaningful insight for recreation managers, researchers must be careful to avoid describing the preferences of an average angler.

Shafer (1969) concluded that a population of recreationists might be composed of several unique segments, and that recognizing differences in recreational user groups is imperative. Otherwise, “results will describe a nonexistent *average* [recreationist] who eventually can cause more management problems than [a] study intends to solve” (Shafer, 1969 P. 27).

Though it has long been known that anglers differ, and this fact has been acknowledged in fisheries management, Fisher (1997) was one of the first to state explicitly that a management strategy designed for the ‘average’ angler will satisfy no one. Instead, a suite of lakes designed to satisfy unique angler segments could improve the satisfaction of all anglers. Thus, many researchers have explored recreational angler heterogeneity by employing some form of segmentation.

Segmentation can be undertaken in essentially two ways. Market based (exogenous) segmentations are predicated on differences in behavioural traits, or other variables identified a-priori by researchers. The second form of segmentation uses statistical models to endogenously identify groups of respondents with similar traits (these models are discussed in more detail in section 3.4) (Hunt, Haider & Bottan, 2005). The remainder of this section will focus on how market based, or a-priori segmentations have been used to identify and describe heterogeneous segments of anglers.

Some market-based segmentations rely on well established behavioural theories as the foundation for their segmentations. For example, the concept of recreational angling specialization (Bryan, 1977) has been used to identify heterogeneous groups of anglers and assess differences between groups in terms of their preferences for management actions and physical and social settings (Scott & Shafer, 2001).

Bryan (1977) found that anglers could be categorized into specialization groups according to different choices they make, and are continuously making, such as for certain equipment, their orientation to fish (disposition of catch), their angling history, social setting, distance travelled to recreate, vacation patterns and leisure priority, or their preference for species, type of fishing water, or type of management. Essentially, Bryan was able to examine a variety of angler traits that add up to a more general characterization of angler groups, and describe a recreational angling specialization continuum. Based on his insights he was also able to suggest management strategies that would increase the satisfaction of each specialization group.

Since Bryan's (1977) seminal study, recreational angling specialization theory has evolved. Ditton, Loomis and Choi (1992) reconceptualised the theory of recreation specialization, and used the social worlds perspective (Unruh, 1979)

to describe a more reasoned strategy for studying and explaining recreation specialization. By following the social worlds perspective, Ditton, Loomis and Choi (1992) identified differences between anglers in terms of their resource dependency, levels of mediated interaction and amount of importance attached to activity-specific and activity-general aspects of a fishing experience. Subsequently, researchers have studied the affective (measured by commitment), cognitive (measured by skill and knowledge) and behavioural (measured by frequency of participation) components (Oh & Ditton, 2006) of anglers to identify different specialization segments, and to describe each group's characteristics and preferences for fishery attributes (McFarlane, 2001).

Generally the results of angling specialization studies suggest that specialized anglers are more resource dependent (Ditton, Loomis & Choi, 1992; Chipman & Helfrich, 1988; Graefe, 1980), have higher levels of mediated interactions (Ditton, Loomis & Choi, 1992), and are more concerned with activity-general aspects of fishing experiences (Salz, Loomis & Finn, 2001; Ditton, Loomis & Choi, 1992). Specialized anglers also prefer more conservative management restrictions (Salz, Loomis & Finn, 2001; Chipman & Helfrich, 1988), invest more money in angling related expenditures (Salz, Loomis & Finn, 2001) and fish more often (Graefe, 1980; Salz, Loomis & Finn, 2001) than less specialized anglers.

Though the results of angling specialization studies have provided valuable information to managers (MacFarlane, 2001), some uncertainty regarding the best method for segmenting anglers according to their levels of specialization still exists (Scott & Shafer, 2001). While some researchers have used single item approaches for allocating anglers into specialization segments, such as frequency of participation (Graefe, 1980), many researchers now use multidimensional approaches, which incorporate the affective, cognitive and behavioural aspects of specialization theory (Salz, Loomis & Finn, 2001). Unfortunately, the use of multidimensional approaches requires lengthy surveys (Needham, Sprouse & Grimm, 2009) instead of shorter surveys that minimize impacts on respondents (Vaske, 2008). Thus, Needham, Sprouse and Grimm (2009) generated a series of relatively short statements that include the affective, cognitive and behavioural components of specialization theory (Figure 3). By asking respondents to select the one statement that best describes them, researchers can reduce respondent burden associated with measuring angling specialization while allocating individuals to groups according to specialization theory.

Figure 3: Angler self-classification statements for recreation specialization

Type I: "Fishing is an enjoyable, but infrequent activity that is incidental to other travel and outdoor interests. I am not highly skilled in fishing, rarely read fishing articles, and do not own much fishing equipment beyond the basic necessities."

Type II: "Fishing is an important, but not exclusive outdoor activity. I occasionally read fishing articles and purchase additional equipment to aid in fishing, my participation in fishing is inconsistent, and I am moderately skilled in fishing."

Type III: "Fishing is my primary outdoor activity. I purchase ever-increasing amounts of equipment to aid in fishing, go fishing every chance that I get, consider myself to be highly skilled in fishing, and frequently read fishing articles."

(Needham, Sprouse and Grimm, 2009)

While specialization based segmentations represent market-based groupings based on well-defined theory, other fishery researchers have employed market based segmentations based on angler traits relevant to their research question. For example, Arlinghaus and Mehner (2004) used a segmentation based on fishing location. The authors hypothesized and demonstrated that anglers who fished in urban areas had significantly different characteristics from those who fished in rural areas. Hunt and Ditton (1997) employed a segmentation based on the social group an angler fished with most often, and discovered that each segment had heterogeneous preferences for a number of fishing site attributes, as well as different socio-demographic characteristics. Finally, Fedler and Ditton (1986) were able to identify and describe distinct segments of anglers by exploring whether or not anglers intended to retain or release caught fish.

Another approach for identifying heterogeneity is determining anglers' motivations. Motivation information can also help predict angler behaviour, and allow managers to develop more effective angler programs (Fedler & Ditton, 1994). Motivation theory, based on the work of Driver (1977) and his colleagues, suggests that individuals participate in recreational activities, such as fishing, to achieve a number of psychological and physical goals (Manning, 1999). Therefore, by understanding motivations, managers can design strategies that ensure anglers' desired outcomes are met (Fedler & Ditton, 1994).

The motivational aspects of recreational fishing have traditionally been characterized as falling into two groups: activity-specific and activity-general motivations (Fisher, 1997). Activity-specific motivations include aspects of an experience directly related to fishing, such as catching large fish, catching many fish, and catching fish for eating. Activity-general elements relate to motivations not directly tied to a fishing experience, such as to relax, to be with friends, to be outdoors, and to experience unpolluted natural surroundings. While it would be inappropriate to state that a defined list of motivation items can describe the motivations of *all* anglers, these two categories have traditionally been used to help understand the outcomes anglers desire when fishing (Fisher, 1997).

Many researchers have argued that activity-general motivations are dominant when an entire sample population's motivations are explored (Moeller & Engelken, 1972; Driver & Knopf, 1976, Fedler & Ditton, 1994, Ditton, 2004 in Beardmore et al., in press). However, a recent study suggested that motivations in general, and catch orientation in particular might change when asked in a trip specific, or species specific context (Beardmore et al., in press). Furthermore, some research has shown that angler-reported motivations do not always reflect the aspects of a fishing experience that directly influence their satisfaction (Arlinghaus, 2006). Therefore, while using motivation information to describe the desired outcomes of angler groups identified by market based segmentation may avoid managing for the average angler, there is some uncertainty regarding whether motivation information should be used as the basis for management decisions (Arlinghaus, 2006). Finally, market based segmentations are not without their shortcomings. They have been described as arbitrary and rigid as they impose the criterion of segmentation, and typically do not reveal all sources of heterogeneity among survey respondents (Bhat, 2002). As such, market based segmentations usually do not constitute an optimal segmentation (Hunt, Haider, & Bottan, 2005).

3.4 Using Latent Class Models to study recreational anglers

The previous section demonstrated techniques for identifying heterogeneous groups of anglers by using behavioural antecedents, and actual behaviour to inform market based segmentations. However, the studies described in the previous section made no attempt to segment anglers based on their

preferences for fishery characteristics, which reflect their intended behaviour (Figure 2). This aspect of the behavioural process can be investigated with stated preference techniques and Latent Class Models (LCM) can be used to identify the heterogeneity in respondents' preferences for a product of interest (Train, 2009). Latent Class Models also allow researchers to conduct covariate analyses to further describe the behavioural traits of individuals that populate each group identified by a LCM (Boxall & Adamowicz, 2002). The use of LCMs therefore eliminates the biases associated with market based segmentations identified by Bhat (2002), and allows researchers to describe the attributes of a product that influence choice, instead of basing management decisions on respondents' behavioural antecedents or the results of compositional preference studies.

Boxall and Adamowicz (2002) were the first authors to demonstrate the utility of Latent Class Models (LCM) in a resource management context. They used a LCM to identify groups of respondents with similar preferences for a multi-attribute product, and to suggest management strategies that provided remedies for the product attributes that received unfavourable evaluations. Furthermore, the inclusion of covariates allowed the researchers to describe the respondents in each latent class segment in terms of their motivation for participation in outdoor recreation (Boxall & Adamowicz, 2002).

Similarly, Provencher, Baerenklau and Bishop (2002) used a LCM and discovered heterogeneous segments of anglers with unique preferences for fishing experiences based on the cost and angling quality of a trip, and the amount of time that had elapsed since a respondent's last trip. Additionally, a number of covariates described the respondents in each segment in terms of their ages and experience levels. Ultimately, the authors concluded that Latent Class Models were a valuable tool for evaluating anglers' preferences, explaining heterogeneity within the sample population, and for assessing the effects of recreation site changes on sample populations (Provencher, Baerenklau & Bishop, 2002).

Latent Class Models can also be used in conjunction with market based, or a-priori segmentations. Scarpa and Thiene (2005) described two fundamentally different types of rock climbers based on their frequency of participation, a measure of recreation specialization (Graefe, 1980), and used a LCM to explore the heterogeneity within those two a-priori groups. Study results evaluated the components of a rock climbing experience that were important to the eight groups identified by the LCM, and described how each of the groups would respond to hypothetical changes in the managerial environment (Scarpa & Thiene, 2005).

The information presented in this section demonstrates that Latent Class Models can endogenously identify heterogeneous groups of respondents

within a sample population, without being subject to the researcher imposed bias identified by Bhat (2002). Additionally, covariate analyses can be used to describe members of latent classes in terms of their behavioural antecedents, (Boxall & Adamowicz, 2002), and characteristics (Provencher, Baerenklau, & Bishop, 2002). The use of LCMs therefore allow researchers to evaluate fishery attributes based on respondents' intended behaviour (Figure 2), while incorporating analyses of behavioural traits to enrich the descriptions of the products desired by sample populations. Furthermore, the use of motivation information as a covariate, rather than as the principle factor in describing respondents' desired outcomes avoids the problems associated with anglers' reported motivations as identified by Arlinghaus (2006).

This chapter has demonstrated several techniques for studying and describing anglers and their behaviour. Additionally, the chapter has outlined strategies for identifying sources of heterogeneity within a sample population, and for combining anglers' behavioural traits, and preferences for fishery characteristics into research studies that can improve fishery management. Details on how these strategies and techniques have been used in the present study are described in Chapter 4, following a description of the methods used for data collection.

4: METHODS

In order to achieve the goals of this study we aimed to: describe the characteristics of anglers in the Okanagan (Region 8), identify heterogeneous groups within the population of Okanagan (Region 8) anglers, assess angler preferences for fishery characteristics, and to develop a Decision Support Tool to aid managers in evaluating lake types for implementation in the Okanagan (Region 8). As such, a survey was developed and administered to anglers in the Okanagan (Region 8). The details regarding respondent recruitment, survey design and data analysis are presented in this chapter.

4.1 Recruitment of Survey Respondents

Respondents were recruited through a variety of techniques during the summer of 2010. Beginning in May 2010, British Columbia Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) employees conducting creel surveys in the Okanagan (Region 8) were provided with short intercept surveys (Appendix A) which asked anglers to participate in the 2010 Okanagan Angler Survey. Additionally, one Simon Fraser University (SFU) researcher personally visited small mountain lakes in the Okanagan (Region 8) from the beginning of May to the end of July 2010 to recruit respondents. Lakes were systematically selected based on conversations with MFLNRO and FFSBC employees to ensure a variety of lake types were sampled. The SFU researcher personally delivered intercept surveys to anglers and left intercept

surveys on windshields of unattended vehicles (Appendix B). A number of fly fishing clubs which operate in the Okanagan (Region 8) offered assistance in distributing intercept surveys. Fishing club members were instructed to leave intercept surveys on the windshields of vehicles whenever club members went fishing. Finally, a number of people who had regular contact with anglers in the Okanagan (Region 8) were asked to distribute intercept surveys at their convenience, these people included: MFLNRO employees (Parks area supervisors and their staff), British Columbia forest recreation site operators (located at various locations throughout the Okanagan [Region 8]), fishing resort owners/operators (located at various locations throughout the Okanagan [Region 8]), visitor centre staff (located in Lumby, a location that sold fishing licenses), and tackle shop employees (at Troutwater Supplies in Kelowna, and Kenkraft Fishing Shop on Highway 6, east of Vernon).

The summary of recruitment techniques described above represents the active recruitment techniques used for the 2010 Okanagan Angler Survey. The survey was also advertised on several angling related websites such as ‘www.gofishbc.com’ (the FFSBC’s website), online angling forums, and a number of fishing tackle store websites to increase the sample size. The web advertisements will subsequently be referred to as passive recruitment techniques.

4.2 Delivery of the web-based and mail out survey instrument

All respondents who provided contact information during the recruitment phase of the study were contacted in October 2010. Individuals who provided email addresses were sent personalized messages reminding them of their intent to participate in the full survey (Appendix C). The emails included a link to the web survey and a login ID unique to each respondent. Individuals who had not responded to the survey two or three weeks after the initial contact were sent a reminder email to improve response rates.

Individuals who provided mailing addresses during the recruitment phase were mailed a copy of the full survey with a personalized cover letter and a business reply envelope. The cover letter reminded individuals of their intent to participate, and asked them to return the completed survey in the enclosed prepaid envelope (Appendix D). Respondents who did not return their surveys were sent a personalized postcard two weeks after the initial contact reminding them of the package they had received and asking them to complete and return the survey. Finally, four weeks after the initial contact another complete survey package, including a personalized cover letter, business reply envelope, and survey were sent to any respondents who had still not returned a completed survey (Dillman, 2000).

4.3 Survey design

The main data collection instrument for this study was a self-administered questionnaire. The questionnaire could either be answered online or on paper. The web-based survey (for a link to the web survey see Appendix F) and the paper copy (Appendix E) asked identical questions, though some formatting differences existed. The formatting changes were necessary to ensure questions were easily interpretable in both formats.

The survey was designed to explore anglers' behavioural traits, and to evaluate their preferences for fishery characteristics. The survey consisted of seven sections including:

1. residence information;
2. frequency of recreational angling participation;
3. angler characteristics;
4. importance of lake stocking activity information;
5. motivation for recreational angling participation;
6. small mountain lake selection exercise; and,
7. socio-demographics.

The first section of the survey asked respondents to indicate if they were a resident of the Okanagan (Region 8) and to provide specific residence information including their postal/zip code, country and city of residence. Respondents were then asked a series of questions to determine their frequency of participation in recreational freshwater angling in general, as well as in British Columbia and the Okanagan (Region 8) specifically. The third section of the survey asked a series of questions exploring angler

characteristics including the type of fishing gear used, and the type of vehicles used to access lakes. The third section also asked respondents to classify themselves as one of three ‘angler types’ following Needham, Sprouse and Grimm (2009).

Next, a series of questions that explored the importance of fish stocking information were asked. Respondents were asked if they preferred to fish in artificially stocked or wild (un-stocked) lakes, and to rate the importance of a series of statements relating to knowledge of stocking activities on a five point Likert scale. In the fifth section of the survey, respondents rated the importance of 11 motivation items for fishing trips in the Okanagan (Region 8) on a Likert scale. The motivation items were derived from Sutton (2007), and were selected based on discussions with key informants, MFLNRO and FFSBC staff. Next, the respondents completed the DCE. More details regarding the design of the discrete choice experiment are provided in section 4.4 and 4.5. Finally, respondents were asked a series of socio-demographic questions. Each of the questions contained in sections one through five, and section seven were designed to explore behavioural traits of Okanagan (Region 8) anglers that the researchers believed were relevant to the research questions.

4.4 Discrete choice experiment statistical background

A stated-preference discrete choice experiment (DCE) was used to evaluate respondents’ preferences for fishery attributes. A DCE attempts to estimate the

utility associated with individuals' evaluations of a series of multi-attribute products (Louviere, Hensher & Swait, 2000; Hensher, Rose & Greene 2005). The analysis of a DCE is based on utility maximization theory (Ben-Akiva & Lerman, 1985), which assumes that individuals will select an alternative from a suite of products that maximizes their utility and, random utility theory (McFadden, 1974) which suggests that for each individual there is a deterministic, or observable portion of utility, as well as an unobservable or random component of utility:

$$U_i = V_i + \varepsilon_i, \qquad \text{Eq.1}$$

where U_i is the overall utility of an attribute *i*, V_i is a deterministic parameter vector of attributes, and ε_i is the random component for the non-deterministic component of a respondent's choice. Random utility theory states that an individual will choose alternative *i* if $U_i > U_j$ for all $j \neq i$.

Modeling is conducted as an aggregate stochastic process even though it is assumed that this type of choice is deterministic on the individual level. The probability of choosing alternative *i* is:

$$Prob\{i chosen\} = prob\{V_i + \varepsilon_i > V_j + \varepsilon_j; \forall j \in J\}, \qquad \text{Eq.2}$$

where J is the set of all possible alternatives. The multinomial logit model (MNL) is typically used to produce regression estimates, known as part-worth utility (PWU) parameters for each attribute. The sum of all PWUs represents a respondent's preference as a whole:

$$P(i \mid i \notin J) = \frac{\exp(X_i,\beta)}{\sum_{j=J}\exp(X_i,\beta)}, \qquad \text{Eq.3}$$

where the probability of selecting alternative *i* from all alternatives included (*J*) is equal to the exponent of all measurable components of alternative *i* (i.e. X_i, the vector of explanatory variables, and β, the parameter vector to be estimated) over the sum of the exponent of all measurable elements of all alternatives *J*.

To account for heterogeneity in respondents' choices, the basic MNL model can be expanded to the latent class model (LCM). The LCM assumes that the population of respondents is composed of a finite number of heterogeneous groups of individuals (segments). Each segment is characterized by relatively homogeneous preferences that differ substantially from other segments in their preference structure (Birol, Karouskis, & Koundouri, 2006). Segment membership depends on the unobservable social, attitudinal, and motivational characteristics of the respondents; therefore, the number of segments is determined endogenously by the data. The LCM assumes that a respondent's characteristics affect choice indirectly through their impact on segment membership, and thus combines a choice model with a probabilistic approach for determining the latent (unobservable) class membership of individuals (Boxall and Adamowicz, 2002; Vermunt and Magidson, 2005).

Latent class models assume discrete changes in parameters across different classes that are distinguished by individual heterogeneity (Breffe, Morey, & Thacher, 2005). Therefore, separate part-worth utilities are estimated for each class to account for preference heterogeneity in the choice model. Within a class, the choice probabilities for all alternatives (*J)* are generated by the mixture conditional logit model:

$$P(\text{choice } j \text{ by individual } n \text{ in situation } t) = \frac{\exp(X_{it,j}\beta_c)}{\sum_{j=J}^{ji}\exp(X_{it,j}\beta_c)} \qquad \text{Eq.4}$$

where β is the class specific vector of the j^{th} alternative. An additional summation is added to the beginning of equation four to account for the presence of latent classes:

$$P_n(j) = \sum_{m=1}^{M}\left[\frac{\exp(\alpha\lambda_s Z_n)}{\sum_{s=1}^{S}\exp(\alpha\lambda_s Z_n)}\right]\left[\frac{\exp(X_{it,j}\beta_c}{\sum_{j=J}^{ji}\exp(X_{it,j}\beta_c}\right] \qquad \text{Eq.5}$$

where Z_n is a vector of social, attitudinal and motivational characteristics of individual *n*, and λ_s is a vector of parameters (Boxall & Adamowicz, 2002). Therefore the first summation in equation five suggests that the probability (*P*) that individual *n* selects alternative *j* is equal to the sum of choice probabilities for *j* for each latent class (*M*) weighted by the probability that individual *n* belongs to each class (Hunt & Morgan 2005). Thus researchers can use individuals' characteristics and stated preferences to model choice behaviour by combining an estimation of the probability that an individual belongs to each class with the mixture conditional logit model (Boxall and Adamowicz, 2002)

(see Greene and Hensher, 2003; and Morey, Thacher & Breffe, 2006 for more details of the LCM).

The latent class parameter functions were estimated using Latent Gold Choice Version 4.5 (Statistical Innovations Incorporated, 2010). The maximum likelihood analysis produces PWUs, standard errors, and z-scores for each attribute level, which are compared using the Wald Statistic. Generally, only z-scores significant at the 90% level of confidence (>1.64 or < -1.64) are interpreted as identifying significant PWU estimates (Louviere, Hensher, & Swait, 2000).

4.5 Discrete choice experiment design

The DCE used in the 2010 Okanagan Angler Survey was designed to evaluate anglers' preferences for characteristics of small mountain lakes in the Okanagan (Region 8). The hypothetical lake scenarios were described in terms of several attributes relating to catch expectations, management regulations, physical characteristics, and social characteristics (Table 2) of small mountain lakes in the Okanagan (Region 8).

Table 2: Attributes and levels for small mountain lake selection DCE

Attribute	Levels
Catch Expectations	
Expected catch/four hours effort (Number of fish)	1 fish; 2 fish; 3 fish; 4 fish
Expected catch size (Size of fish)	20-30 cm; 30-40 cm; 40-50cm
Management Regulations	
Motor restriction	No restriction; 10 Hp maximum; Electric motors only
Gear restriction	Single barbless hook, bait ban; Artificial fly only; No restriction
Take limit	0 fish; 1 fish; 2 fish; 5 fish
Physical Characteristics	
Travel distance to lake on paved roads (Paved Travel)	25 Km; 50 Km; 100 Km; 150 Km; 200 Km
Travel distance to lake on unpaved roads (Unpaved Travel)	Less than 2 Km; 15 Km; 30 Km; 45 Km; 75 Km
Required Vehicle	Passenger vehicle; High clearance vehicle; 4WD vehicle
Type of boat launch available at lake (Launch)	Walk-in only; Car-top; Trailer access
Accommodation facilities present at lake (Amenities)	None; Tent/camper sites; RV sites; Fishing Lodge
Social Characteristics	
Number of other boats within 100m (Crowding)	0 boats; 1 boat; 2 boats; 3 or more boats

The attributes for the DCE were determined through a review of relevant literature, as well as discussions with key informants, and FFSBC and MFLNRO staff. Relevant academic studies which explored anglers' preferences for fishery characteristics were consulted and attributes that were commonly found to influence recreational angling site choice were compiled to develop a preliminary list of possible attributes. The researchers then

conducted several meetings with Okanagan (Region 8) fishery managers to refine the list of attributes to factors that were important to fishery management in Region 8, and to the goals of the study. Finally, a series of key informant interviews were held to assess whether the attributes and their associated levels included in the DCE provided enough information for anglers to make informed decisions.

The levels for the expected catch rate, and expected catch size attributes were determined through discussions with Okanagan (Region 8) fishery managers and key informants who had intimate knowledge of the Okanagan (Region 8) small mountain lakes fishery. The levels associated with these two attributes reflect realistic expectations of anglers who fish in the Okanagan (Region 8) and were therefore selected for this study.

The motor restriction, gear restriction, and take limit attribute levels encompass the range of regulations currently used in the Okanagan (Region 8). FFSBC and MFLNRO employees did not anticipate any changes to these management tools in the foreseeable future. Thus, the management restrictions currently employed in the Okanagan (Region 8) were retained as attribute levels for the study.

The highest level for the paved travel attribute was determined by evaluating the greatest linear distance an angler could travel within the Okanagan (Region 8), which is approximately 200 kilometres (the distance from the south west corner to the north east corner of the Okanagan [Region 8]). A series of shorter travel distances were included to account for travel to a lake that did not require a complete traverse of the Okanagan (Region 8). Interviews with key informants, and fishery managers confirmed that the levels for the travel distance on paved roads attribute were reasonable.

A series of discussions with key informants and fishery managers in the Okanagan (Region 8) helped establish the attribute levels for the unpaved travel attribute. The range of unpaved travel distances included in the DCE reflects the potential travel requirements for fishing in the variety of small mountain lakes in the Okanagan (Region 8).

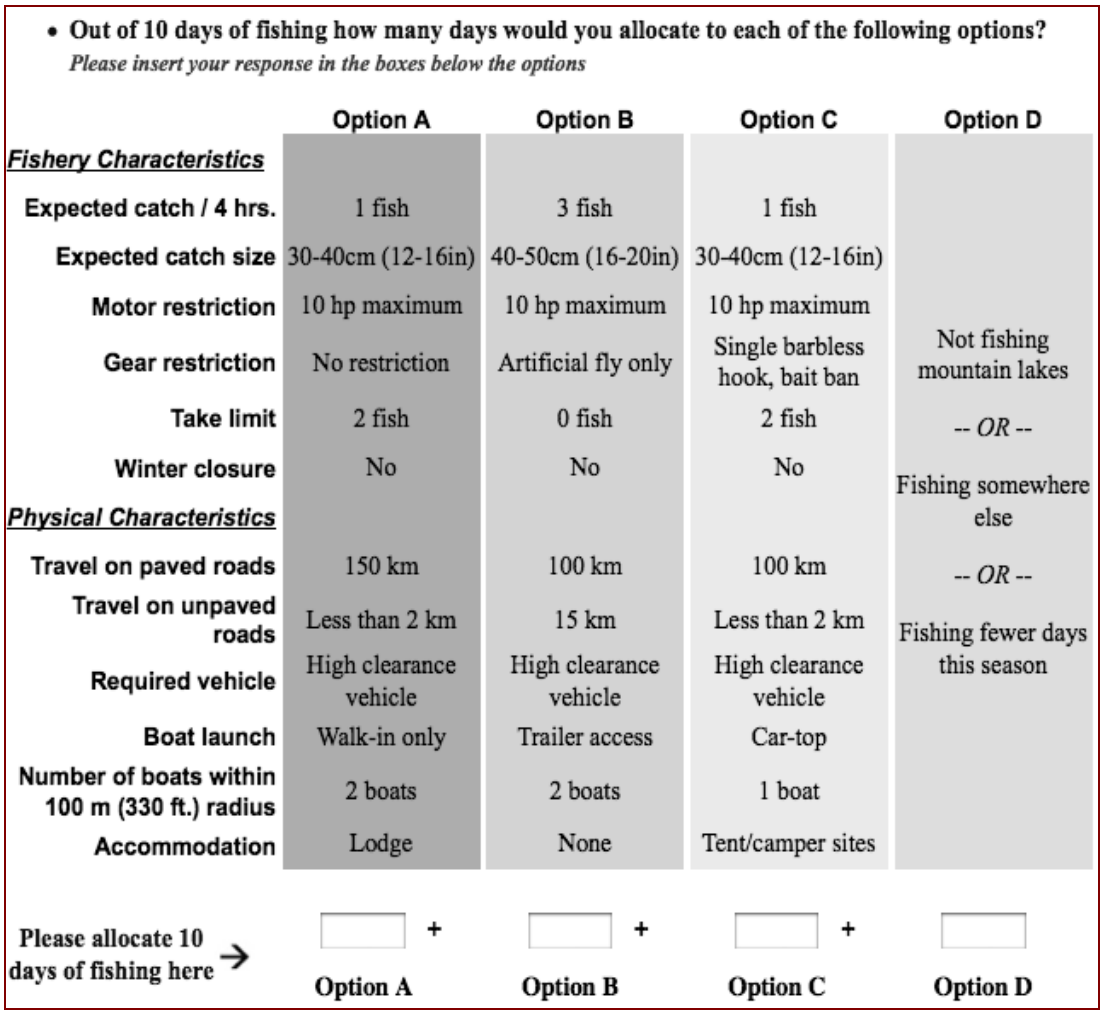
The attribute levels for the required vehicle, boat launch, and amenities attributes were also determined through discussions with key informants and fishery managers. Ultimately the attribute levels used for these fishery characteristics describe the range of access development characteristics of small mountain lakes in the Okanagan.

FFSBC and MFLNRO staff members designed the crowding attribute (the number of other boats within 100 meters). The researchers and fishery managers agreed that the levels associated with the crowding attribute accurately reflected the range of congestion levels an angler could expect when fishing in small mountain lakes in the Okanagan (Region 8). Key informants, and other individuals who tested the survey supported the use of the crowding attribute levels specified in the DCE.

For analysis, the motor restriction, gear restriction, launch type, amenities, and required vehicle attributes were effects coded. Expected catch/four hours effort, expected catch size, take limit, travel distance on paved roads, travel distance on unpaved roads, and number of other boats within 100 meters were linear and quadratic coded (Louviere, Hensher, & Swait, 2000).

The hypothetical alternatives in the small lake selection task were generated using an orthogonal fractional factorial design that permitted the estimation of all main effects. In such a design the levels of all attributes are varied systematically (Ratoke, Hedayat, & Federer, 1981). A total of 204 individual profiles were combined into 68 choice sets in the final design. The instructions with each choice set asked respondents to allocate ten days of fishing to three hypothetical lakes and an option not to fish, or to fish somewhere else. Each respondent evaluated six choice sets; an example choice set (from the web-based survey) is presented in Figure 4.

Figure 4: Example choice set from small mountain lake selection DCE



- **Out of 10 days of fishing how many days would you allocate to each of the following options?**
  Please insert your response in the boxes below the options

	Option A	Option B	Option C	Option D
Fishery Characteristics				
Expected catch / 4 hrs.	1 fish	3 fish	1 fish	
Expected catch size	30-40cm (12-16in)	40-50cm (16-20in)	30-40cm (12-16in)	
Motor restriction	10 hp maximum	10 hp maximum	10 hp maximum	
Gear restriction	No restriction	Artificial fly only	Single barbless hook, bait ban	Not fishing mountain lakes
Take limit	2 fish	0 fish	2 fish	*-- OR --*
Winter closure	No	No	No	Fishing somewhere else
Physical Characteristics				
Travel on paved roads	150 km	100 km	100 km	*-- OR --*
Travel on unpaved roads	Less than 2 km	15 km	Less than 2 km	Fishing fewer days this season
Required vehicle	High clearance vehicle	High clearance vehicle	High clearance vehicle	
Boat launch	Walk-in only	Trailer access	Car-top	
Number of boats within 100 m (330 ft.) radius	2 boats	2 boats	1 boat	
Accommodation	Lodge	None	Tent/camper sites	
Please allocate 10 days of fishing here →	+	+	+	
	Option A	**Option B**	**Option C**	**Option D**

4.6 Analytical Techniques

Data analysis progressed through three stages: data exploration, analysis of the discrete choice experiment, and comparison of the heterogeneous angler segments. Each stage had a unique purpose and analytical techniques; therefore, each stage will be described individually. Latent Gold, version 4.5.0.10328 (Statistical Innovations Inc, 2010) was used to complete the analysis of the Discrete Choice Experiment. All other statistical analyses were

completed using IBM SPSS Statistics 19, Release 19.0.0 (SPSS Incorporated, 2010).

A series of descriptive statistics and frequencies analyses were completed to help the researchers understand the general characteristics of the respondents in the data set. The results of the descriptive statistics were used to help researchers identify potentially relevant a-priori segments of respondents. Relevant a-priori segmentations were noted and incorporated into the analysis of the DCE.

A Principal Components Analysis (PCA) with Varimax rotation was used to explore any underlying relationships or patterns in the responses to the motivation questions. A PCA was also used to explore responses to the importance of stocking information statements. The results of the PCA for the motivation items and the stocking importance statements were ultimately used as covariates in the DCE analysis.

The next stage in data analysis was to explore the data generated by the small mountain lake selection exercise. A number of models were run using different covariates and a-priori segmentations. Initially, responses to all survey questions that revealed significant differences between angler groups (identified by the LCM), and the results of the motivation and importance of

stocking information Principle Components Analyses, were included as covariates in the LCM. After a first assessment, non-significant covariates were removed from analysis and the model was rerun. Only covariates that were significant for at least one of the angler classes were retained in the final model.

It was necessary to examine the results of several a-priori segmentations and LCM's to ensure that the researchers presented results that were based on academically sound logic and were relevant to managers. Log likelihood, Akaike Information Criterion (AIC), and Bayesian Information Criterion (BIC) statistics were all considered when selecting the model which best described the data (Burnham & Anderson, 2002). The researchers also considered several other factors in selecting the final model including the size of each class of respondents, the general characteristics of each segment, and the managerial relevance of the suite of segments. The researchers ultimately selected a model that was statistically robust, and identified groups that were managerially significant.

A number of statistical tests were used to compare the heterogeneous segments' responses to survey questions. Pearson chi-square tests for crosstabulations were used to test for significant differences between groups for questions with categorical variables. Additionally, crosstabulations with a

Bonferroni correction[1] assessed differences between the individual angler groups when a comparison of angler segments revealed a significant difference between all groups. Results significant at the 90, 95, and 99 percent levels of confidence are reported in the results section.

One-way Analysis of Variance (ANOVA) tests were employed to compare responses to questions with continuous variables. Levene's F tests determined if the independent variables had equal variances on the dependent variable for analyses of all questions with continuous variables. Bonferroni statistics were assessed to determine significance when Levene's F tests suggested that equal variances could be assumed; Tamhane's T2 statistics were assessed to determine significance when equal variances could not be assumed (Vaske, 2008).

4.7 Decision Support Tool

Microsoft Excel, version 12.2.8[2] was used to create the computerized Decision Support Tool (DST). The DST allows users to generate profiles of hypothetical lakes by manipulating the attribute levels measured by the DCE. Once the user has created three hypothetical lakes in analogy to the layout of the original choice sets, the DST generates market shares for each heterogeneous angler segment. The market shares, generated based on the results of equation 3,

[1] A Bonferroni correction adjusts p-values to compensate for the effect of multiple comparisons (Vaske, 2008)

[2] Microsoft Excel is copyrighted by the Microsoft Corporation (2007)

provide a measure of support for each of the hypothetical lakes, and the base alternatives (fish somewhere else, or not fish), for each angler segment. The user can then manipulate the attribute levels to see how they influence the market shares, and thus the preferences of each segment for each hypothetical lake.

The first DST configuration (section 5.6.1) presents lakes that will maximize the utilities of each angler segment. The results of the DCE were used to identify the levels that were most preferred by each segment for each attribute. The hypothetical lakes in the DST were then manipulated to reflect the most preferred attribute levels for each angler segment.

The lakes in the second DST configuration (section 5.6.2) are designed to mimic the lake types currently being considered by the FFSBC and MFLNRO. The management guidelines for the proposed lake types supplied by the FFSBC and MFLNRO were used to guide the selection of attribute levels in the second DST configuration. For example, the FFSBC and MFLNRO description of ‘trophy lakes’ provided specific gear restrictions and take limits; therefore these restrictions were used when the researchers constructed the hypothetical ‘trophy lake’ in the second DST configuration. It is important to note that the management guidelines supplied by the FFSBC and MFLNRO did not explicitly describe how every attribute should be manipulated in the DST. Thus, the researchers have manipulated some of the attributes in a

manner they believe is appropriate given the descriptions and management goals of the lakes currently being considered by the FFSBC and MFLNRO. Additionally, the FFSBC and MFLNRO's descriptions of the 'regional' and 'family' lakes were quite similar; thus, they were combined and evaluated as one single hypothetical lake in the second DST configuration.

5: RESULTS

For the results of the 2010 Okanagan Angler Survey response rates are presented first, and then the general demographic characteristics of respondents are summarized. Next, results that pertain to identifying sources of heterogeneity within the sample population are provided. Specifically, the findings of a Principal Components Analysis (PCA) of the motivation for recreational angling questions are described, followed by the outcomes of an a-priori segmentation based on location of fishing activity. The results of the Known Class – Latent Class segmentation that identified additional heterogeneity within the sample population, and sections that describe the preferences of, and differences between the angler segments identified by the study are then provided. Finally, the DST generated for the study is explained and a series of configurations of interest are explored.

5.1 Survey Response Rates

Table 3 summarizes the number of contacts and number of actual respondents for each recruitment process with its respective response rates. Overall, the surveys personally distributed by the SFU researcher achieved the highest response rate (12.9%), followed closely by recruitment surveys distributed in tackle stores (11.4%).

Table 3: Recruitment methods to intercept survey and respective response rates

Distribution method	Number of surveys distributed	Number of surveys returned	Recruitment response rate (%)
Active recruitment techniques			
Personally delivered by SFU researcher	794	102	12.9
*Ministry of Forests, Lands and Natural Resource Operations employees	250	9	3.6
*Visitor's centre	51	1	2.0
*Tackle stores	581	66	11.4
*Fly-fishing clubs	650	60	9.2
*Recreation site operators	324	30	9.3
*Fishing resort owners/operators	459	36	7.8
**Ministry of Forests, Lands and Natural Resource Operations creel surveyors		112	
Total number of actively recruited respondents	3109	416	9.9
Passive recruitment techniques			
Respondents recruited through web advertisements		190	
Total number of potential respondents to full survey		606	

* In these methods all / some surveys were distributed by volunteers, thus the actual number of surveys distributed is unknown
** Creel surveyors did not distribute recruitment surveys but asked anglers who responded to creel surveys if they would like to participate in the 2010 Okanagan Angler Survey.

Nineteen of the 416 potential respondents did not provide contact information on their returned recruitment survey or their email or mailing addresses were illegible; an additional 5 mailing addresses and 26 email addresses were undeliverable. Therefore a total of 366 people (181 contacted via email, 185 contacted via mail) were actively recruited to complete the full survey. Approximately three quarters (76%, 279 individuals) of the 366 people who

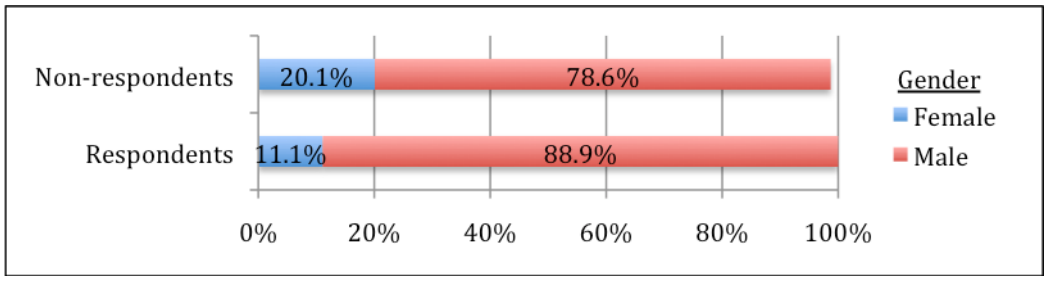
were actively recruited returned a survey (164 web based, 115 paper based). Seventy-one of the 279 returned surveys were incomplete and were therefore removed from analysis resulting in an overall response rate of 56.8 percent.

A link to the web based survey was also posted on various web sites listed in section 4.1, resulting in an additional 190, passively recruited survey responses. Forty of the 190 surveys obtained through web site advertisements were incomplete and were not included in the analysis. The combination of recruitment techniques resulted in a total of 358 usable surveys. Slightly more than one quarter (26.3%) were paper-based surveys, the remaining responses received were web-based surveys (73.7%).

5.1.1 Non-response analysis

The only significant difference between respondents to the full survey and non-respondents (i.e. recruits to the intercept survey who did not complete the full survey) emerged for the gender variable (Figure 5).

Figure 5: Comparison of gender by respondents and non-respondents



(Pearson chi-square: 0.031)
* Due to missing data segment totals do not equal 100%

5.1.2 Comparison of the various recruitment techniques

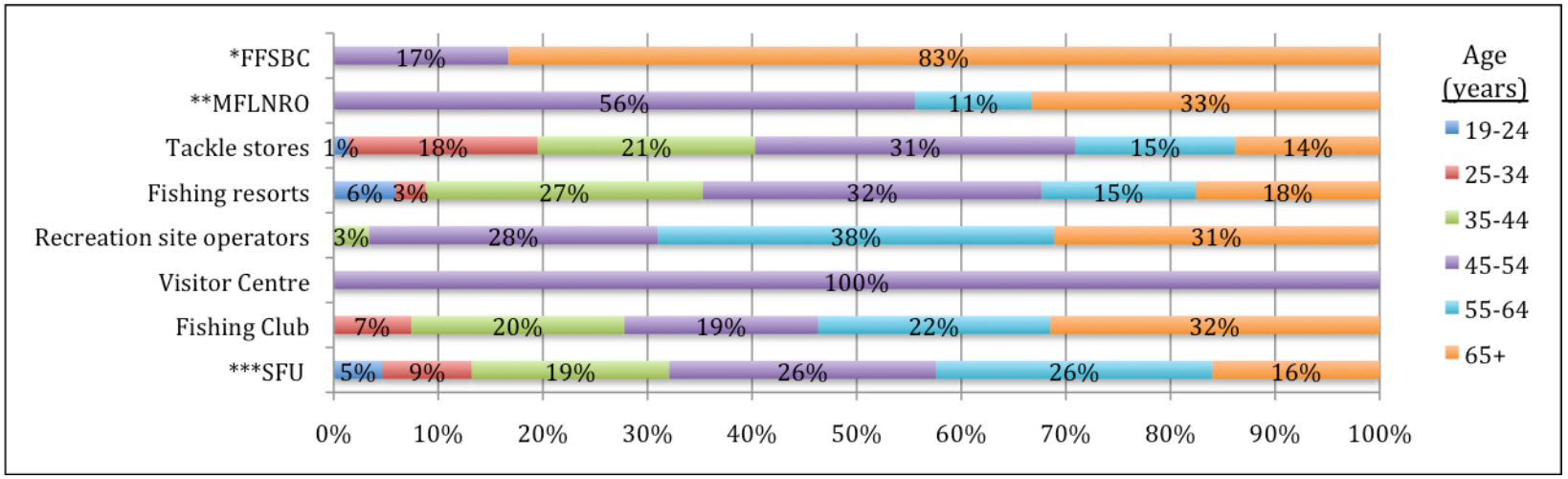
Anglers who were recruited by SFU researchers or tackle store employees were significantly more satisfied with their fishing experience in the Okanagan (Region 8) than individuals who received their recruitment surveys from fishing club members (Table 4). Respondents to the eight recruitment methods also differed significantly by age (Figure 6).

Table 4: Satisfaction with fishing in the Okanagan (Region 8) by recruitment method

	Recruitment type			ANOVA (P-Value)	Tamhane's T2		
	SFU researcher	Tackle stores	Fishing clubs		SFU - Tackle stores	SFU- Fishing clubs	Tackle store-fishing clubs
[X] Mean Satisfaction with Okanagan (Region 8) fishing experience	3.44	3.49	2.96	0.044	1.000	**0.015****	**0.040****

[X] Measured on a scale from 1 (Poor) to 5 (Excellent)

Figure 6: Comparison of respondent age by recruitment method



(Pearson Chi-square: 0.004)

*Freshwater Fisheries Society of British Columbia

**Ministry of Forests, Lands, and Natural Resource Operations

***Simon Fraser University researcher

5.1.3 Comparison of active and passive recruitment techniques

Table 5 describes a number of differences between actively and passively recruited respondents. Actively recruited respondents used trolling gear more often, were less specialized (Figure 7), were more motivated by catching fish for eating, and contained a higher proportion of females (Figure 8) than passively recruited respondents. Passively recruited respondents fished more days in 2010, fished more days in freshwater in British Columbia in 2010, used fly-fishing gear and four wheel drive vehicles more often (Figure 9) than actively recruited respondents. Passively recruited respondents were also more concerned with knowing the species a lake is stocked with, were more motivated by the challenge or sport of fishing, had higher levels of education (Figure 10), and a higher proportion of fishing club members (Figure 11) than actively recruited respondents. The two groups also differed in their age structure (Figure 12), and location of residence (Figure 13).

Table 5: Comparisons of actively and passively recruited respondents

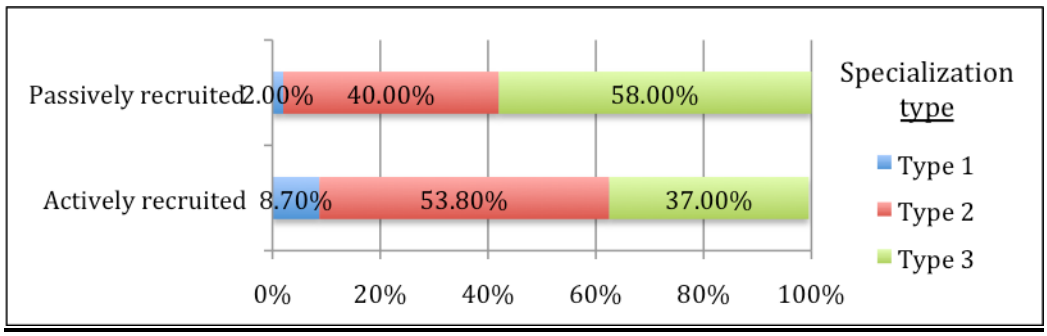
Comparison Item	Group Mean		T-Statistic	P-Value
	Actively Recruited Group	Passively Recruited Group		
Number of days fished in 2010	27.2 days	39.1 days	3.1	**0.002*** **
Number of days fished in freshwater in British Columbia in 2010	26.0 days	37.1 days	2.9	**0.004*** **
Average number of days (out of 10) that fly-fishing gear is used	5.8 days	7.0 days	2.5	**0.013** **
Average number of days (out of 10) that trolling gear is used	4.2 days	1.3 days	-4.5	**<.001*** **
[X] Importance of knowing the size of stocked fish	3.7	4.0	1.7	**0.097***
[XX] To catch fish for eating	2.9	2.3	-4.5	**<.001*** **
[XX] For the 'challenge' or 'sport' of fishing	4.0	4.3	3.9	**<.001*** **

*Sig at 90%, **Sig at 95%, ***Sig at 99%

[X] Responses were measured on a Likert scale from 1 ('Not at all important') to 5 ('Very important)

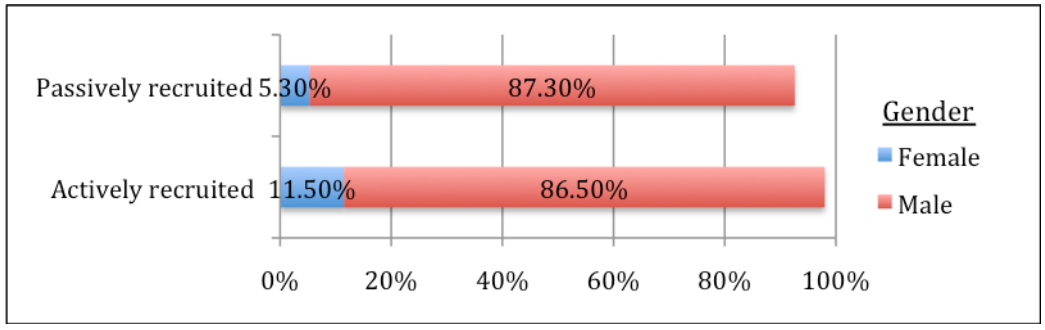
[XX] Motivation items measured on a Likert scale from 1 ('Not at all important') to 5 ('Very important')

Figure 7: Comparison of angler specialization by active or passive recruitment



(Pearson chi-square: <.001)

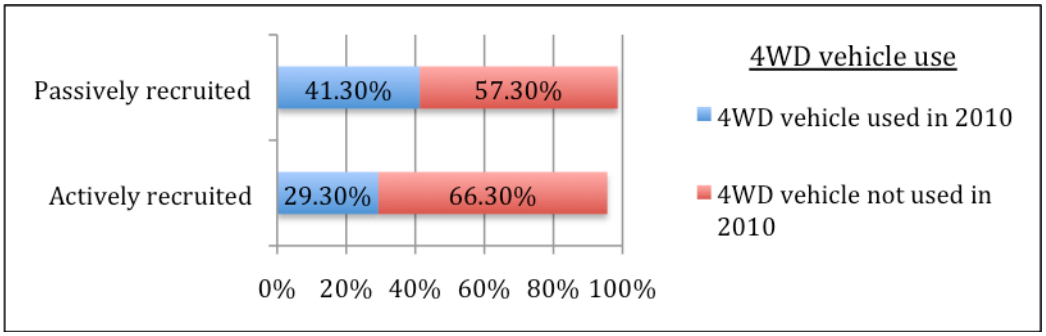
Figure 8: Comparison of respondents' gender by active or passive recruitment



(Pearson chi-square: 0.007)

* Due to missing data segment totals do not equal 100%

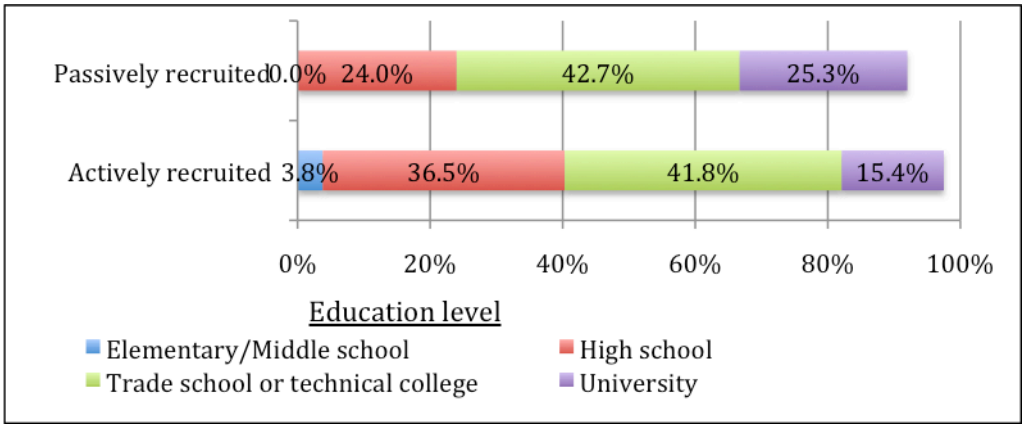
Figure 9: Comparison of four wheel drive vehicle use by active or passive recruitment



(Pearson chi-square: 0.036)

* Due to missing data segment totals do not equal 100%

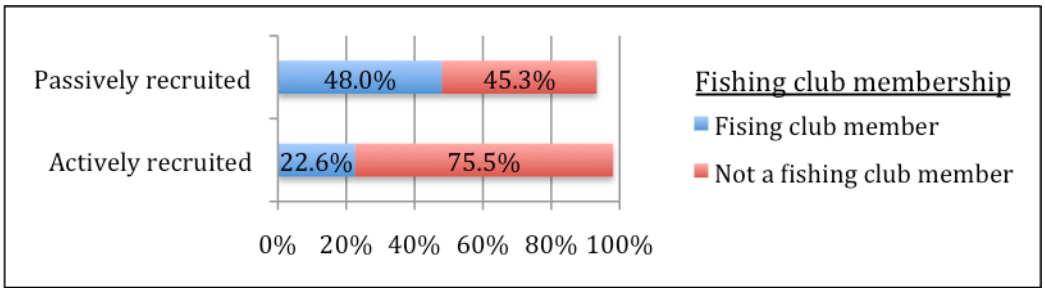
Figure 10: Comparison of education by active or passive recruitment



(Pearson chi-square: <.001)

* Due to missing data segment totals do not equal 100%

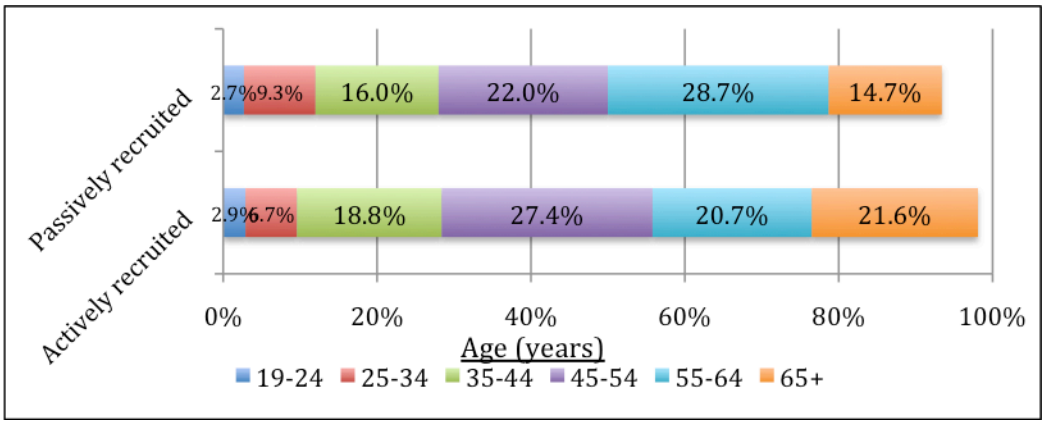
Figure 11: Comparison of fishing club membership by active or passive recruitment



(Pearson chi-square: <.001)

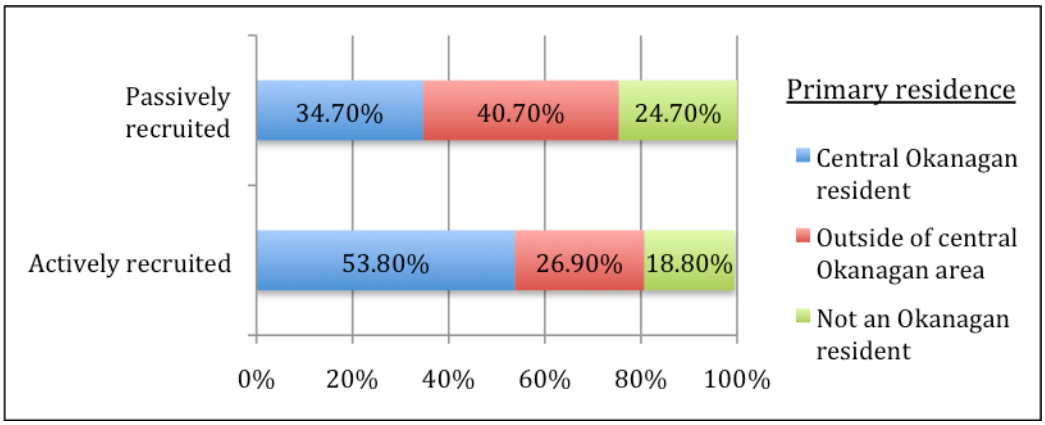
* Due to missing data segment totals do not equal 100%

Figure 12: Comparison of respondent age by active or passive recruitment



(Pearson chi-square: 0.068)
* Due to missing data segment totals do not equal 100%

Figure 13: Comparison of respondent residence by active or passive recruitment



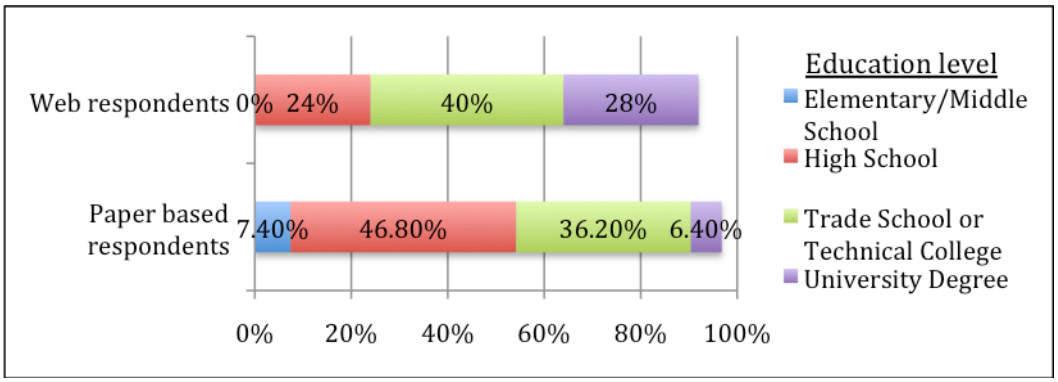
(Pearson chi-square: 0.003)

5.1.4 Comparison of web-based and paper-based survey respondents

Several significant differences emerged between respondents who completed a web-based survey, and those who completed a paper-based survey. Web-based respondents have higher education (Figure 14), used four-wheel drive vehicles more often (Figure 15), spent fewer years fishing in Region 8 (Table 6) and were more motivated by ‘to catch a record or trophy fish’ and ‘to

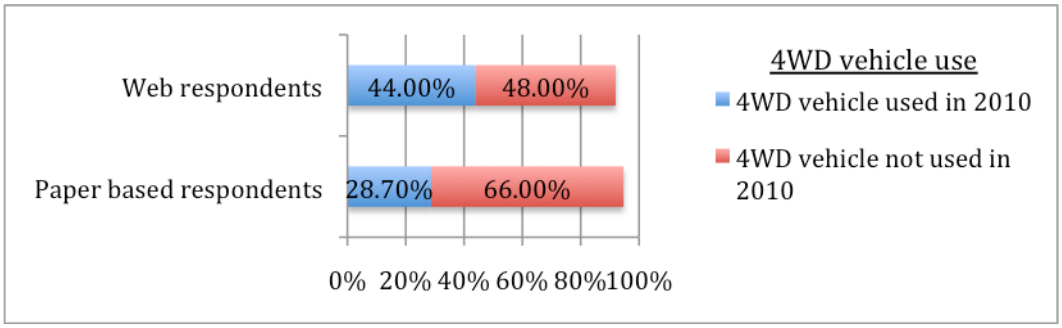
experience adventure and excitement' compared to respondents who completed a paper-based survey (Table 6).

Figure 14: Education by survey type



(Pearson chi-square: <.001)
* Due to missing data segment totals do not equal 100%

Figure 15: Use of four wheel drive vehicles by survey type



(Pearson chi-square: <.001)
* Due to missing data segment totals do not equal 100%

Table 6: Comparisons of web-based and paper-based survey respondents

Comparison item	Group Mean		T-statistic	P-value
	Paper based survey respondents	Web based survey respondents		
Number of years fishing in the Okanagan (Region 8)	26.2	17.2	2.5	**0.020****
[X] To catch a 'record' or 'trophy' fish	2.8	3.6	-2.7	**0.009*****
[X] To experience adventure and excitement	4	4.4	-2.3	**0.020****

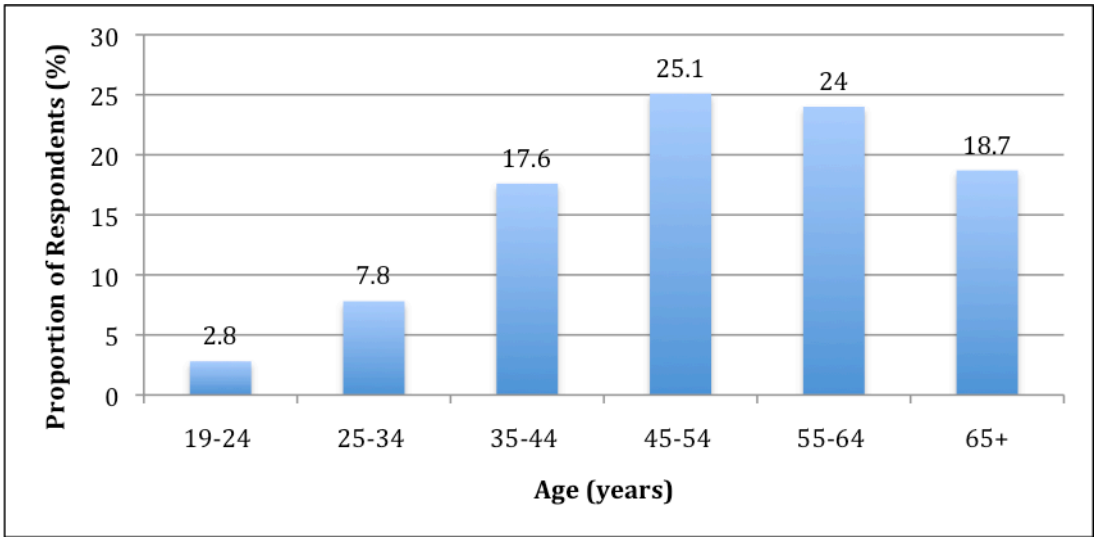
*Sig at 90%, **Sig at 95%, ***Sig at 99%

[X]Motivation items measured on a Likert scale from 1 ('Not at all important') to 5 ('Very important')

5.2 Demographic characteristics of respondents

The majority of respondents (86.9%) to the 2010 Okanagan Angler survey were males and most were more than 45 years of age, with one-quarter (25.1%) of respondents between the ages of 45 and 54 years, one-quarter of the sample (24%) between the ages of 55 and 64 years, and about one-fifth (18.7%) of respondents greater than 64 years of age. Respondents in the 19 to 24, and 25 to 34 year age classes made up small proportions of the sample (2.7% and 7.8%, respectively). Respondents between the ages of 35 and 44 constituted slightly less than one-fifth (17.6%) of the sample (Figure 16).

Figure 16: Complete sample age distribution (N=358)

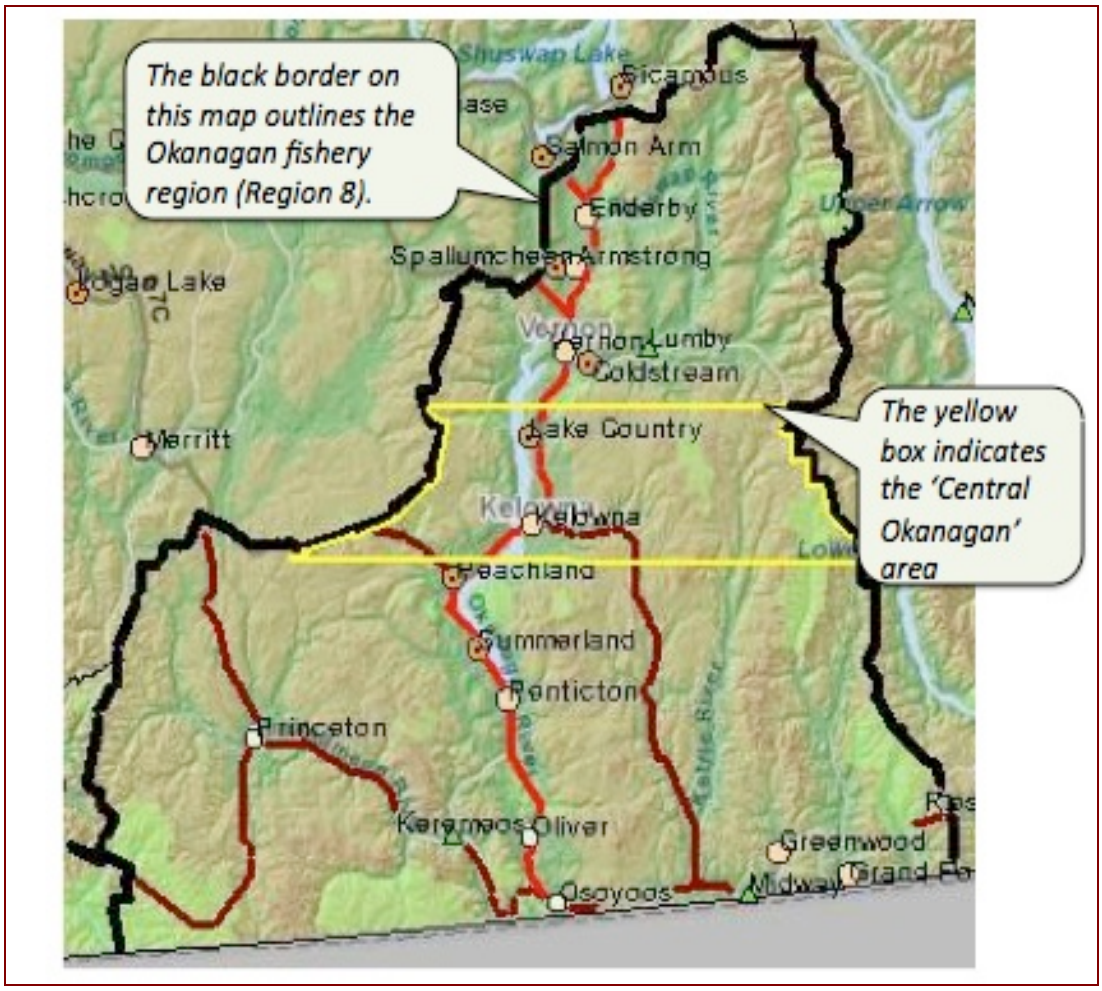


Approximately two-fifths of respondents (42.2%) had obtained a degree from a trade school or technical college, while one-fifth of respondents (19.6%) had completed a university degree. Slightly less than one-third (31.3%) had completed high school, but not participated in higher education. Only a small proportion of the sample (2.2%) had only completed elementary school.

Most survey respondents (98.9%) currently reside in Canada, however individual respondents originated from the United States, Australia, and Denmark (for a total of 0.9% of the sample). The vast majority (96.4%) of survey respondents lived in British Columbia, and almost half of all respondents (45.8%) reside within the 'Central Okanagan Area' described in Figure 17. Approximately one-third of respondents (32.7%) lived within the Okanagan (Region 8), but outside of the central area (to see the regional setting on the Okanagan [Region 8] within British Columbia refer to Figure 1).

The remaining one-fifth (21.2%) of respondents lived outside of the Okanagan (Region 8), either in other areas of British Columbia or outside of the province.

Figure 17: Central and non-central Okanagan (Region 8) areas



5.3 Principal component analysis of motivation items

A PCA of the 11 motivation items was undertaken for the entire sample of respondents. Initially all components with Eigenvalues greater than one were retained, which resulted in a three component solution. However, one motivation item was poorly represented in all three components (the factor

loadings for ‘to catch fish for eating’ were less than .215 for each of the three factors). Therefore, a four-component solution was estimated (Table 7), which explained 64.1 percent of the total variance for Eigenvalues greater than 0.983 (Table 8), and resulted in improved component loadings for all items, and four highly interpretable components. The discovery of four motivation components suggests that Okanagan (Region 8) anglers’ motivations can be grouped into four categories, outdoor/relaxation motivations, social motivations, motivations relating to catching fish, and consumptive motivations. While a cluster analysis was employed to identify groups of similarly motivated anglers, the results did not reveal a meaningful segmentation. As such, the researchers elected to use the results of the PCA of motivation information to inform the Latent Class Model (results of the LCM are described in Section 5.4.2).

Table 7: Principal component analysis of motivation for recreational angling

Motivations	Varimax rotated factor loadings by factor			
	1	2	3	4
Outdoors / Relaxation Dimension				
To be outdoors	0.759	0.062	0.071	0.086
For relaxation	0.696	0.274	0.037	-0.184
To experience unpolluted natural surroundings	0.662	0.111	-0.012	0.233
To experience adventure and excitement	0.551	0.279	0.466	-0.034
Social Dimension				
To be with friends	0.108	0.889	0.098	0.029
To be with others who enjoy the same things you do	0.084	0.802	0.091	0.097
To do something with family	0.234	0.733	-0.043	0.049
Catching Fish Dimension				
To catch a ‘record’ or ‘trophy’ fish	-0.132	0.047	0.869	0.021
For the challenge or sport of fishing	0.415	0.057	0.618	-0.364
To experience new and different things	0.362	-0.014	0.45	0.396
Fish Consumption Dimension				
To catch fish for eating	0.06	0.143	-0.061	0.836

Table 8: Total variance explained

Component	Initial Eigenvalue	Final Eigenvalue	Cumulative Percent (%)
1	3.3	2.2	20.0
2	1.6	2.2	39.8
3	1.2	1.6	54.1
4	1.0	1.1	64.1

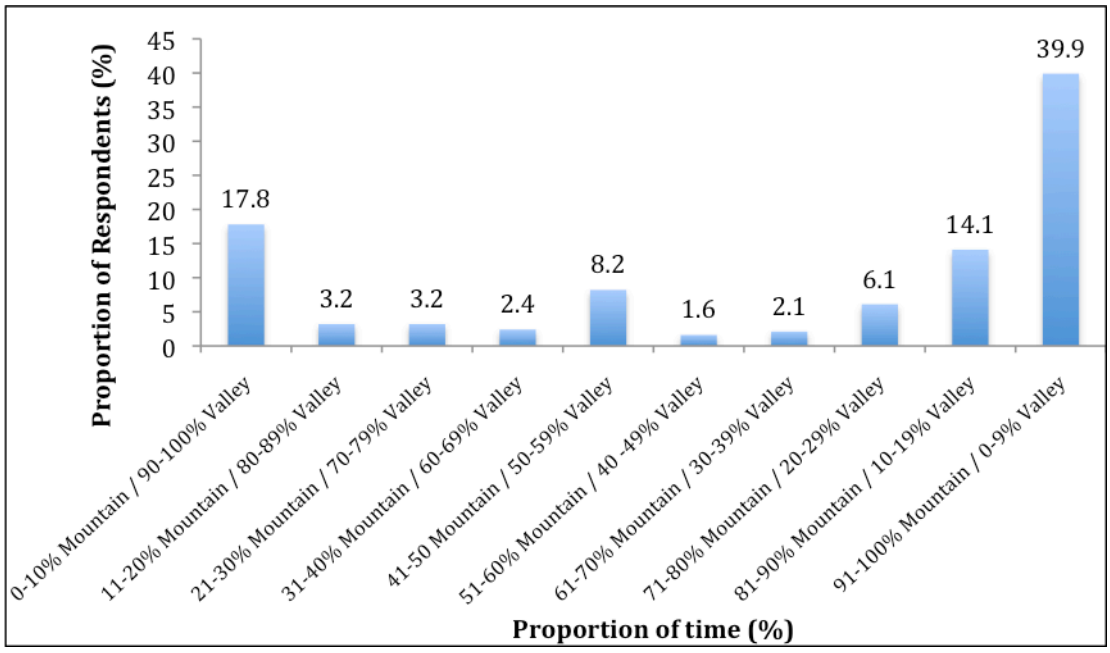
5.4 Identifying Angler Heterogeneity

5.4.1 A-priori segmentation

Figure 18 shows that only a small proportion of respondents (9.8%) distributed their time evenly between the small mountain and valley-bottom lakes in the

Okanagan (Region 8) (i.e. between 40 and 60 percent of their time in both mountain and valley lakes). Most anglers (90.2%) spent a majority of their time fishing in either mountain or valley lakes, as illustrated by the bimodal distribution in Figure 18. Given the obvious disparity in the preferred fishing locations one needed to assume a number of fundamental differences between these two groups of respondents. Therefore, respondents were segmented into two groups: mountain anglers (fishing 50% or more of their time in mountain lakes N=261 or 72.9% of the total sample) and valley anglers who spent less than 50 percent of their time fishing in mountain lakes (N=97 or 27.1% of the total sample), for further analysis.

Figure 18: Allocation of fishing effort between mountain and valley lakes (N=358)



5.4.2 The discrete choice experiment

Given the above defined a-priori segmentation the researchers decided to treat the valley-bottom anglers as one homogenous group, and to explore the heterogeneity of small mountain lake anglers further in a latent class analysis. By modelling jointly, the researchers were able to obtain comparable part-worth utility estimates for the valley angler group as a whole and to explore heterogeneity within the mountain angler group.

Several Latent Class Models were tested to determine the most appropriate number of segments for the mountain anglers. The model summary statistics (Table 9) are not completely conclusive as the AIC suggests a five class model (four mountain angler segments and one valley angler segment), while the BIC statistic suggests a three class model (two mountain angler segments and one valley angler segment). Given the fact that two classes of mountain lake anglers were mostly distinguished by their responses to the intercept (one group is very committed to fishing, while the other one is not), it was deemed important to retain at least three segments of mountain lake anglers to obtain more differentiated insights. Additionally, since the BIC increased substantially, and the AIC decreased minimally for the five segment model, the researchers elected to retain the four class model for analysis. Furthermore, these four classes provided a highly interpretable solution. Figure 19 graphically displays how the a-priori segmentation and the Known Class - LCM combined for the identification of four heterogeneous angler segments.

Table 9: Model statistics for combined known class / latent class segmentations

Model	Number of Segments	[a]LL	[b]*BIC (LL)	[c]*AIC (LL)	[d]Npar	[e] L^2
1	2 segments	-9850.1	20008.4	19808.2	54	19488.7
2	3 segments	-9634.1	**19764.7**	19442.1	87	19054.3
3	4 segments	-9575.4	19835.7	19390.8	120	18943.9
4	5 segments	-9541.9	19956.9	**19389.8**	153	18881.1

Table 9 describes the statistical tests used to select most appropriate number of segments

* Information criteria used to evaluate the quality of the latent class models

[a] Log likelihood at convergence

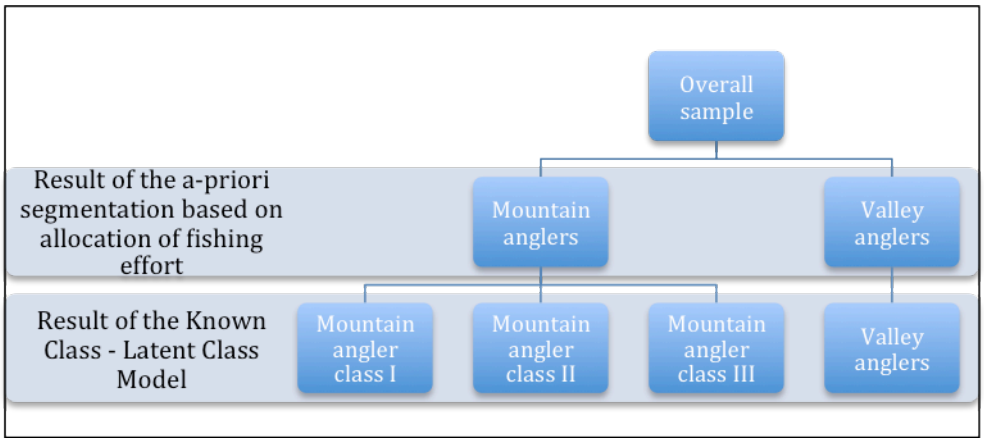
[b] Bayesian Information Criterion

[c] Akaike Information Criterion

[d] Number of parameters

[e] Likelihood squared

Figure 19: Segmentation flow chart



5.4.2.1 Segment Preferences

Among the mountain lake anglers, class I comprised the largest segment of the sample population (36%), followed by class II and class III (21% and 16% of the sample, respectively). The *valley angler* class contained the second largest number of respondents (27% of the sample). Each class has been assigned a name based on their preferences for small mountain lake attributes, and their

unique characteristics determined by their responses to questions in sections one through five and seven of the survey (significant differences to the questions in these survey sections are described in section 5.5 below). Class I has been labelled *dedicated anglers*, class II has been named s*ocial anglers*, and class III is referred to as the *less committed anglers*. The fourth class, determined via the a-priori segmentation, will still be referred to as the *valley anglers*.

Table 10 and Figure 20 present the results of the DCE. The columns on the left side of Table 10 present the attributes, and attribute levels evaluated by the DCE. The two columns directly below each angler segments title display the coefficients and standard errors for each segment. The column furthest to the right presents the Wald= statistic, testing for significant differences of estimates between segments.

Continuous variables were coded as linear and quadratic terms. Quadratic terms were removed from the analysis when not significant and the model was re-run with only linear terms. The covariates included in the model, and their parameter estimates are shown at the bottom of Table 10. Most attribute coefficients point to the intuitively correct direction, and all of the attributes were deemed to be of relative importance by most of the four angler segments (indicated by the magnitude of the coefficients for each angler group).

Generally, all four segments exhibited similar patterns in their evaluation of the fish stocking and regulation attributes. Each angler segment had a positive coefficient for the attribute number of fish, indicating they prefer to catch more fish per unit of effort. However, the *social* and *less committed anglers'* evaluations of the number of fish attribute only became positive when the expected catch rate was more than two fish per four hours of effort. *Social* and *less committed anglers'* evaluations of expected number of fish caught also resulted in a steeper slope (see Figure 20) than the *dedicated or valley anglers'*, indicating that *social* and *less committed anglers* placed relatively more importance on catching more fish than the *dedicated* or *valley angler* segments. The expected catch size (size of fish) attribute was also important to each of the segments. However, the *less committed anglers* exhibited greater utility for larger fish (greater that 35 cm) than the other three segments, this relationship is demonstrated by the steep slope of the *less committed anglers* part worth utility line for 'Number of Fish' in Figure 20.

Dedicated anglers displayed significant preferences for almost all of the attributes describing management restrictions; they preferred an 'electric only' motor restriction, disliked both 'no restriction' and '10 Hp maximum', preferred the most stringent gear restriction ('artificial fly only'), and disliked 'no restriction'. *Dedicated, less committed* and *valley anglers* all exhibited a preference for a take limit of two fish and declining utility as the take limit increased past this point. S*ocial anglers* displayed continuously increasing

utility as the take limit increased. Though the four segments' evaluations of the take limit attribute are interesting from a management perspective, they are not significantly different from each other.

The results of the DCE indicate that the physical characteristics of lakes also influence how anglers selected small mountain lakes. The *social anglers* actually exhibited increasing utility as required travel on paved roads increased. The three other segments displayed decreasing utility as travel distance on paved roads increased. Another significant source of heterogeneity was the groups' preferences for the required vehicle attribute. *Social, less committed,* and *valley anglers* have a tendency to prefer lakes that do not require a 4WD vehicle for access. Conversely, *dedicated anglers* exhibited a significant preference for lakes that required a 4WD vehicle, and a strong disutility for lakes that could be accessed with a passenger vehicle. *Dedicated anglers* were also the only segment to display a strong utility for the 'car-top only' boat launch. *Social* and *valley anglers* significantly preferred lakes with a 'trailer access' boat launch, and all four angler segments exhibited a significant disutility for 'walk-in only' lakes. Only the *social* and *less committed anglers* demonstrated a significant preference for the number of other boats within 100 meters. *Social anglers* preferred to have one or two other boats nearby, while *less committed anglers* preferred no other boats, but would tolerate one other boat within a 100-meter radius.

Table 10: Combined Known Class - Latent Class Model - Four class solution

Attributes		*Dedicated anglers*		*Social anglers*		*Less committed anglers*		*Valley anglers*		[c] Wald = (p-value)
Attribute	**Attribute Level**	[a]Coef	[b]St.Er	[a]Coef	[b]St.Er	[a]Coef	[b]St.Er	[a]Coef	[b]St.Er	
Intercept	Lake A, B, or C	13.7[X]	3.15	1.30[X]	0.25	-0.99[X]	0.17	-0.11	0.07	3.8[E-22X]
	Option D	-13.7[X]	3.15	-1.30[X]	0.25	0.99[X]	0.17	0.11	0.07	
Fishery Characteristics										
Number of fish	Linear term	0.10*	0.06	0.12[X]	0.08	0.30[X]	0.12	0.08	0.07	0.310
Size of fish	Linear term	0.28[X]	0.10	0.47[X]	0.15	0.89[X]	0.20	0.37[X]	0.11	0.073*
Gear restriction	[D]Single barbless hook	-0.04	0.09	-0.08	0.16	-0.03	0.20	-0.03	0.10	0.001[X]
	Artificial fly only	0.57[X]	0.12	-0.12	0.17	0.22	0.23	-0.11	0.12	
	No restriction	-0.53[X]	0.13	0.20	0.17	-0.19	0.21	0.14	0.12	
Motor restriction	No restriction	-0.18*	0.12	-0.30*	0.16	-0.14	0.22	0.15	0.12	0.001[X]
	10 Hp maximum	-0.31[X]	0.09	0.12	0.13	0.09	0.18	0.05	0.10	
	Electric only	0.50[X]	0.10	0.17	0.15	0.06	0.21	-0.20	0.12	
Take limit	Linear term	0.13	0.12	0.33*	0.18	0.57[X]	0.29	0.33[X]	0.12	0.310
	Quadratic term	-0.31[X]	0.12	-0.13	0.21	-0.44	0.30	-0.41[X]	0.13	0.710
Physical Characteristics										
Paved travel	Linear term	-0.27*	0.14	0.18	0.19	-0.46*	0.27	-0.15	0.15	0.220
Unpaved travel	Linear term	0.09	0.10	-0.11	0.16	-0.30	0.33	-0.02	0.12	0.520
	Quadratic term	-0.14	0.13	-0.43[X]	0.19	-0.53*	0.32	-0.01	0.16	0.270
Required vehicle	Passenger	-0.36[X]	0.11	0.004	0.15	0.11	0.21	0.07	0.12	0.092*
	High clearance	0.12	0.09	0.09	0.13	0.23	0.18	0.10	0.10	
	4 WD	0.23[X]	0.11	-0.09	0.17	-0.33	0.21	-0.17	0.12	
Boat Launch	Car-top	0.29[X]	0.11	0.16	0.15	0.31	0.22	-0.04	0.13	0.057*
	Trailer access	0.11	0.09	0.4[X]	0.14	0.13	0.18	0.54[X]	0.10	
	Walk-in only	-0.40[X]	0.13	-0.56[X]	0.19	-0.43*	0.26	-0.50[X]	0.14	
Amenities	None	-0.22*	0.12	0.07	0.18	-0.06	0.30	-0.13	0.14	0.640
	Tent/camper sites	0.36[X]	0.12	0.28*	0.17	0.50[X]	0.25	0.20	0.13	
	RV sites	0.15	0.12	-0.19	0.19	0.05	0.24	0.29[X]	0.12	
	Lodge	-0.30[X]	0.13	-0.16	0.19	-0.49[X]	0.24	-0.36[X]	0.15	

Table 10 (continued)

Attributes		*Dedicated anglers*		*Social anglers*		*Less committed anglers*		*Valley anglers*		[c] Wald = (p-value)
Attribute	**Attribute Level**	[a]Coef	[b]St.Er	[a]Coef	[b]St.Er	[a]Coef	[b]St.Er	[a]Coef	[b]St.Er	
Social Characteristics										
Crowding	Linear term	-0.12	0.09	-0.05	0.14	-0.42[X]	0.19	-0.12	0.10	0.420
	Quadratic term	0.10	0.13	-0.52[X]	0.21	-0.02	0.32	-0.09	0.13	0.120
Covariates										**P-Value**
Motivation components	Outdoors/ Relaxation	0.50[X]	0.18	-0.38*	0.20	0.17	0.17	-0.30[X]	0.14	0.036[X]
	Social	-0.01	0.15	0.24	0.21	-0.53[X]	0.15	0.30*	0.16	0.005[X]
	Catching fish	0.39[X]	0.18	-0.50[X]	0.24	-0.07	0.23	0.18	0.16	0.027[X]
	Fish consumption	-0.24*	0.15	0.20	0.17	0.30*	0.16	-0.26*	0.15	0.034[X]
Importance of stocking information		0.05	0.16	0.12	0.12	0.17	0.18	-0.34[X]	0.16	0.190
Age		0.05[X]	0.01	-0.03*	0.02	0.01	0.01	-0.03[X]	0.01	0.003[X]
Use of 4WD to access lakes		-0.86[X]	0.01	-0.43	0.34	0.29	0.35	0.99[X]	0.35	0.001[X]
Amount of fishing compared to previous years		-0.5[X]	0.22	0.28	0.24	-0.08	0.21	0.33*	0.20	0.097*
Fly-rod gear use		0.05[X]	0.02	0.03*	0.02	0.05[X]	0.02	-0.13[X]	0.04	0.002
Spin-casting gear use		-0.04	0.06	0.01	0.02	0.01	0.02	0.02	0.02	0.650
Trolling gear use		-0.10*	0.05	-0.03	0.07	-0.02	0.05	0.14[X]	0.04	0.003[X]

[*]Sig at 95%, [X]Sig at 99%

[a] Coefficient

[b] Standard error

[c]Wald = (p-value): a significant p-value indicates that the four angler segments had significantly different preferences for the corresponding attribute

[D] Single Barbless Hook, Bait ban attribute level

Figure 20: Part Worth Utility for combined Known Class - Latent Class Model by segments

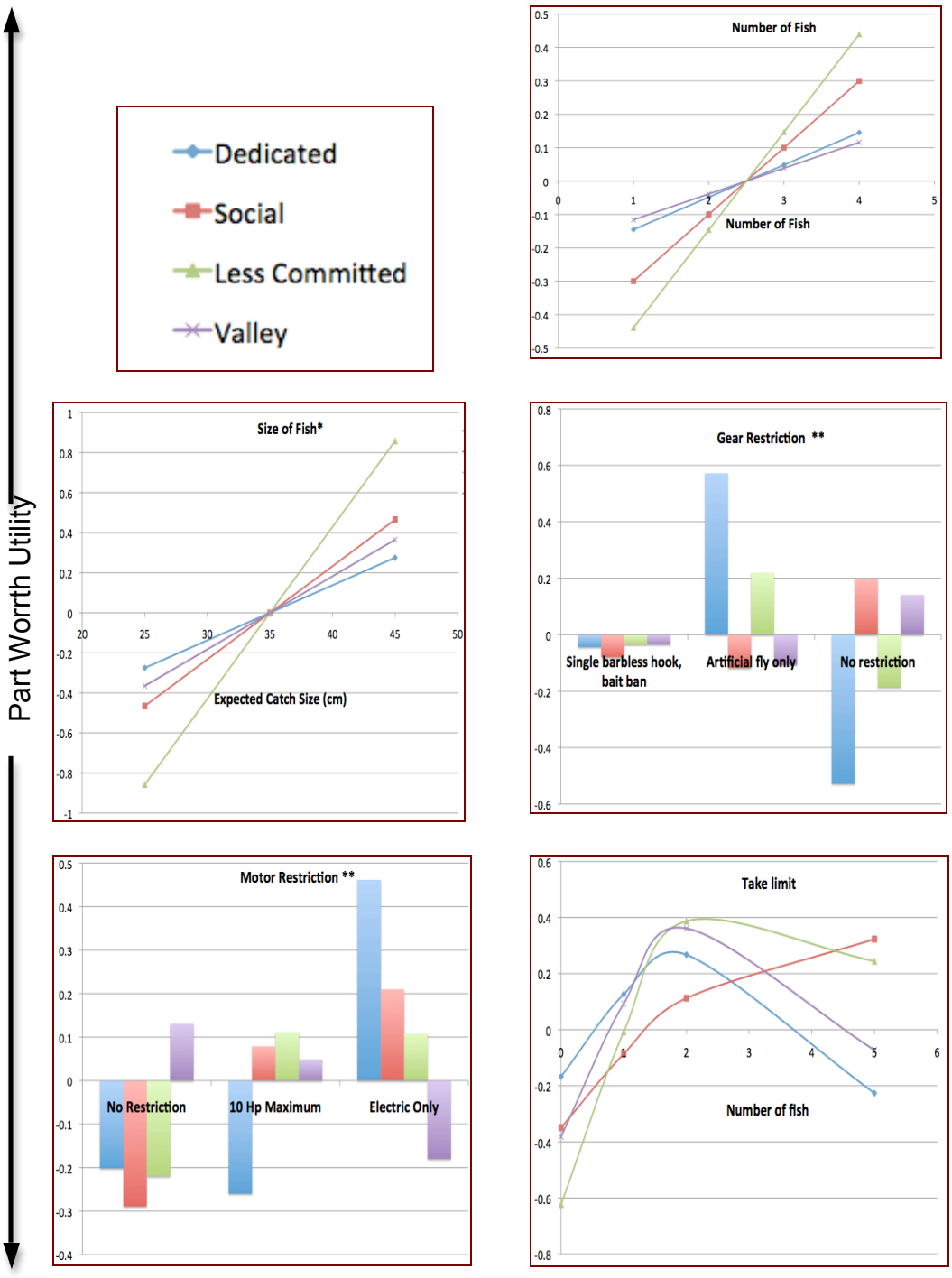
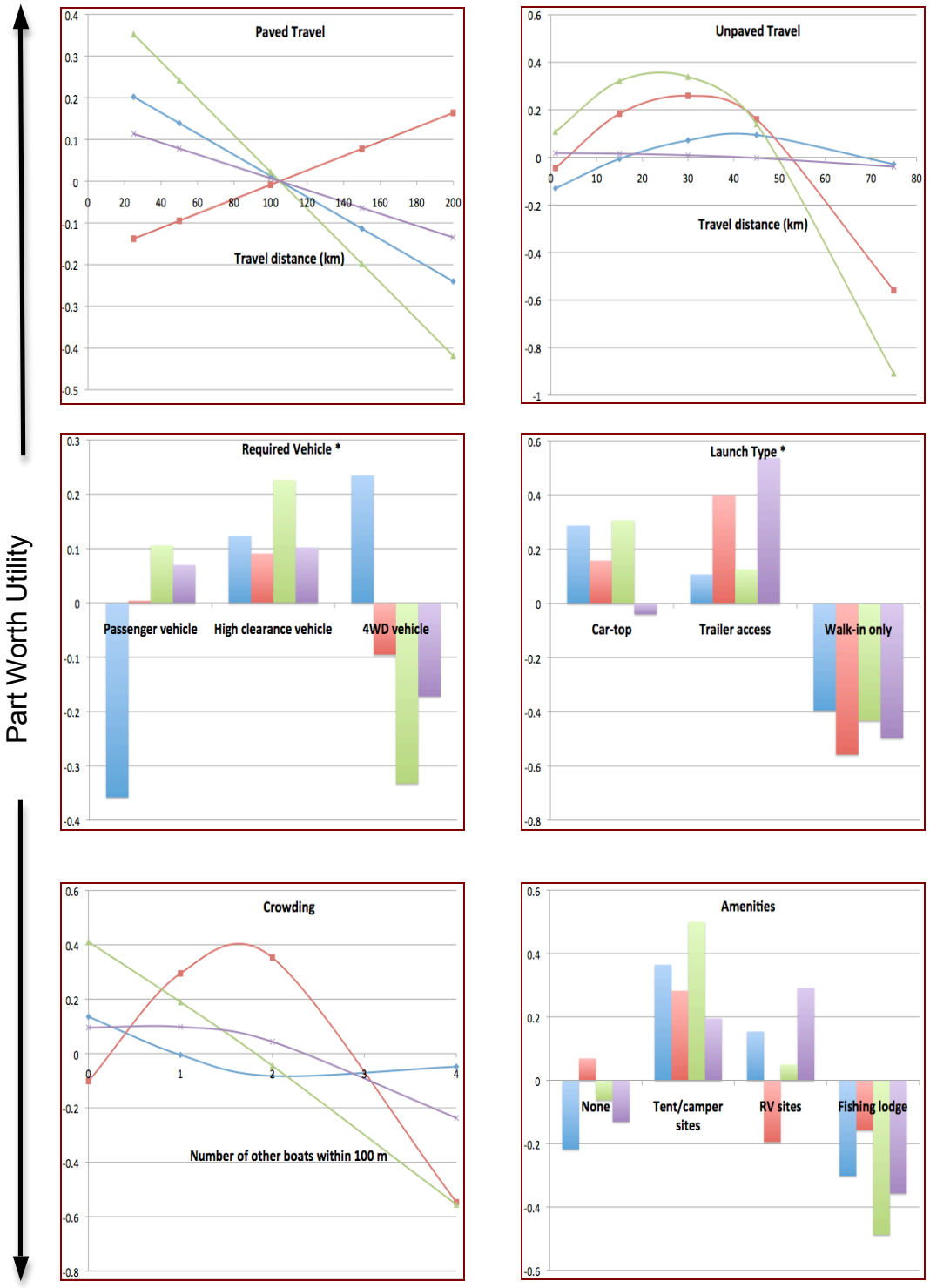


Figure 20 (continued)



* Indicates that the four groups have different evaluations of the attribute (significant at the 95% level of confidence)

** Indicates that the four groups have different evaluations of the attribute (significant at the 99% level of confidence)

The intercepts provide an interesting insight into the *less committed angler* segment. These coefficients measure how the respondents allocated their fishing days to each of the options in the DCE ('Lake A', 'Lake B', 'Lake C', and 'Option D'). The first three options ('Lakes A – C') all indicate that the respondents would participate in recreational fishing, i.e. they would visit one of the three lakes. 'Option D' allowed the respondents to fish somewhere other than mountain lakes or to not fish. Only the *less committed anglers* had a positive and significant coefficient for 'Option D' and negative and significant coefficients for 'Lake A - C', suggesting that *less committed anglers* would elect not to fish in small mountain lakes in the Okanagan (Region 8) if none of the three lakes presented in a choice set were appealing.

Finally, the covariates described at the bottom of Table 10 test if the characteristics and behavioural antecedents of anglers differ between classes, i.e. contribute to describing these classes. The results of the motivation covariate will be described in the following section. Other significant differences between the characteristics of anglers (which were used as covariates) will be described in section 5.5.

5.4.2.2 Motivation covariate

Table 11 compares each segment's mean responses to the individual motivation items. Each respondent was asked to rate 11 statements relating to their motivation for recreational angling on a 5-point likert scale (1- *'Not at all important'*, 3 – '*Somewhat important',* 5- '*Very important'*). The Bonferroni

statistic was used to assess differences between each segments' motivations as equal variances could be assumed for each group. *Dedicated anglers* were less motivated by the statements 'to catch fish for eating' and 'to catch a record or trophy fish'; but were more motivated by 'the challenge or sport of fishing' than the *social anglers*. *Dedicated anglers* were also significantly less motivated by the statement 'to catch fish for eating' than the *valley anglers*, and significantly more motivated by 'the challenge or sport of fishing' than the *less committed anglers*. V*alley anglers* were significantly more motivated by the statement 'to catch a record or trophy fish' than the *social anglers,* and *dedicated anglers* were more motivated by 'experiencing adventure and excitement' than *less committed anglers*. The *less committed anglers* were significantly less motivated by the statement 'to be with others who enjoy the same things you do' than the three other segments. Additionally, *less committed anglers* were less motivated by the statement 'to be with friends' than the *social* and *valley anglers*. In the experiencing nature dimension, *dedicated anglers* ranked the motivation statements 'to be outdoors' and 'to experience unpolluted natural surroundings' significantly higher than the *valley anglers*. Finally, the *less committed anglers* were more motivated by 'experiencing unpolluted natural surroundings' than the *valley anglers*.

Table 11: Angling motivation by classes

Motivation Item	Segment Mean [a]D	[b]S	[c]LC	[d]V	ANOVA (p-value)	Bonferroni D - S	D-LC	D – V	S – LC	S – V	LC - V
Catching Fish Dimension											
To experience new and different things	3.8	3.6	3.7	3.6	.254	.914	1.000	.467	1.000	1.000	1.000
To catch a 'record' or 'trophy' fish	3.0	2.5	2.9	3.1	.042	**.088***	1.000	1.000	.850	**.043****	1.000
For the challenge or sport of fishing	4.3	3.8	3.9	4.1	.001	**.001*****	**.043****	.561	1.000	.159	1.000
Outdoors/Relaxation Dimension											
For relaxation	4.6	4.5	4.4	4.5	.130	1.000	1.000	1.000	1.000	1.000	1.000
[xx] To be outdoors	4.8	4.6	4.7	4.6	.036	.219	.807	**.070***	.939	1.000	.918
[xx] To experience unpolluted natural surroundings	4.7	4.5	4.8	4.3	<.001	.575	.909	**.002*****	.202	.546	**<.001*****
To experience adventure and excitement	4.3	4.0	3.9	4.1	.053	.484	**.069***	.716	1.000	1.000	1.000
Fish Consumption Dimension											
To catch fish for eating	2.3	3.0	2.8	2.8	.005	**.007*****	.255	**.094***	1.000	1.000	1.000
Social Dimension											
[xx] To be with others who enjoy the same things you do	4.0	4.2	3.1	4.0	<.001	.405	**<.001*****	1.000	**<.001*****	.488	**<.001*****
To do something with family	3.7	4.0	3.5	4.0	.045	.361	1.000	.478	.169	1.000	.197
[xx] To be with friends	4.0	4.3	3.6	4.1	.001	.139	.136	.853	**.002*****	.830	**.021****

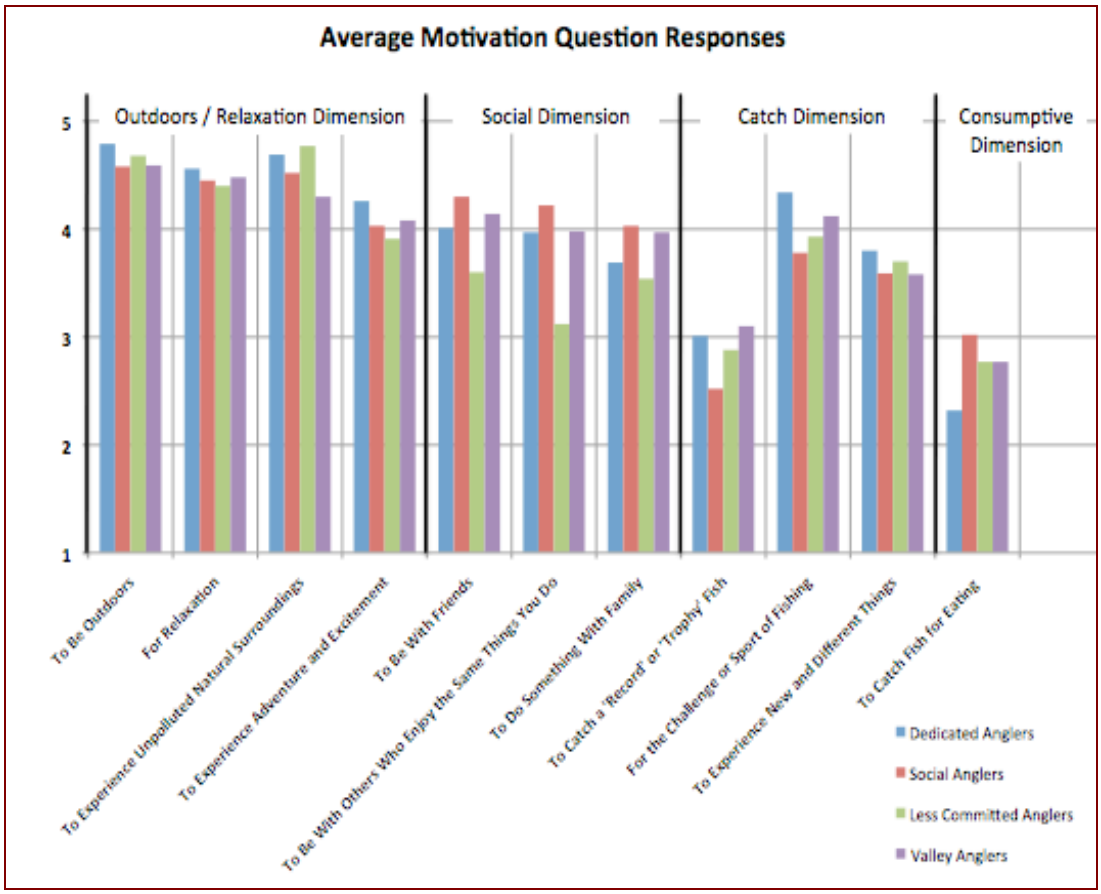
Responses were measured on a Likert scale from 1('Not at all important') to 5 ('Very important)
*Sig at 90%, **Sig at 95%, ***Sig at 99%
[xx] The variances for this item were not equal therefore Tamhane's T2 stats are presented.
[a] Dedicated Anglers, [b] Social Anglers, [c] Less committed Anglers, [d] Valley Anglers

The coefficients for each motivation component presented in Table 10 also demonstrate that each of the four angler segments are motivated to participate in recreational fishing by a different suite of motivation statements. *Dedicated anglers* are motivated by the outdoors/relaxation and catching fish dimensions, but not by consuming fish. S*ocial anglers* are not motivated by the outdoors/relaxation or the catching fish dimensions. The motivation covariate did not reveal any significant motivation dimensions for the *social anglers*. *Less committed angers* are motivated by the fish consumption dimension, but not the social dimension. Finally, *valley anglers* are motivated by the social dimension, but not by the outdoors/relaxation or fish consumption dimensions. Figure 21 displays the angler segments mean responses to the motivation items in the four motivation dimensions (or components) identified by the PCA.

5.5 Differences between heterogeneous angler segments

The differences in angler characteristics between the four groups are compared in the following section. Only information regarding significant differences between groups will be presented. Tables displaying analyses of non-significant differences are presented in Appendix G.

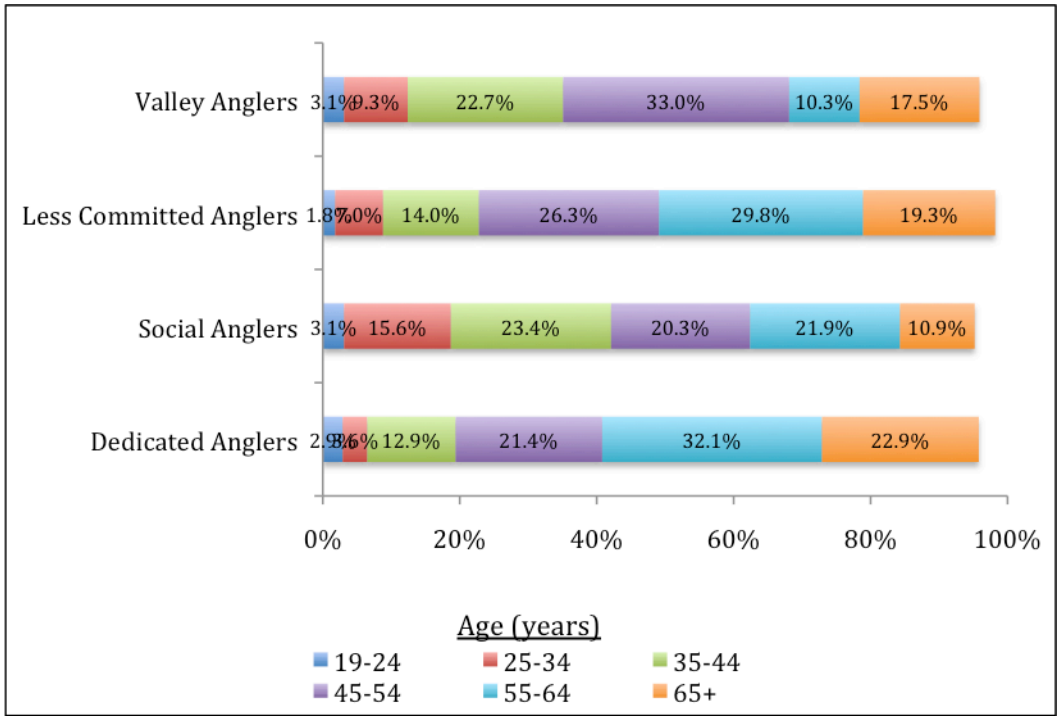
Figure 21: Angler segments' mean responses to motivation items



5.5.1 Angler segment age distribution

Dedicated anglers were significantly older than both the *social,* and *valley anglers* (Table 12). Figure 22 presents information regarding the age distributions in each of the four angler segments. One notable point is that the majority (50 % or more) of anglers in all four segments are at least 45 years old.

Figure 22: Respondent age by angler segment



(Pearson chi-square: 0.012)

Table 12: Chi-square tests of age differences between segments

	Between group comparisons†					
	Dedicated / Social	Dedicated / Less committed	Dedicated / Valley	Social / Less committed	Social / Valley	Less committed / Valley
P-value	**0.01***	0.84	**0.001*****	0.323	0.227	0.093

*Sig at 90%, **Sig at 95%, ***Sig at 99%

†To account for multiple comparisons, a Bonferroni correction has been used to identify significant differences (P-Value / 6). Therefore a P-value ≤0.017 is significant at the 90% level of confidence, a P-value ≤0.008 is significant at the 95% level of confidence, and a P-value ≤.002 is significant at the 99% level of confidence.

5.5.2 Frequency of angling participation

At least two of the angler segments had significantly different responses to each of the frequency of angling participation questions (Table 13).

Table 13: Frequency of angling participation by segment

	Segment Mean				ANOVA	Tamhane's T2					
	[a]D	[b]S	[c]LC	[d]V	(p-value)	D-S	D-LC	D-V	S-LC	S-V	LC-V
Days fished in 2010	31.2	23.8	30.4	40.4	.022	0.226	1.000	0.481	0.488	**0.023****	0.433
Days fished in the Okanagan (Region 8) in 2010	23.5	16.1	13.6	24.4	.057	0.315	**0.027****	1.000	0.933	0.191	** **0.011**
Days fished in freshwater in British Columbia in 2010	30.1	23.3	27.3	38.7	.030	0.309	0.980	0.557	0.890	**0.044****	0.284
[†]Years fishing in the Okanagan (Region 8)	26.8	21.9	17.5	19.6	<.001	0.259	**0.002*****	**0.005*****	0.822	1.000	1.000
Number of Lakes fished in the Okanagan (Region 8) in 2010	6.5	4.7	5.2	3.2	<.001	0.131	0.570	**<.001*****	0.984	0.**047****	** **0.022**

*Sig at 90%, **Sig at 95%, ***Sig at 99%

[†] Bonferroni Post Hoc tested used to compare groups because equal variances are assumed

[a] Dedicated Anglers

[b] Social Anglers

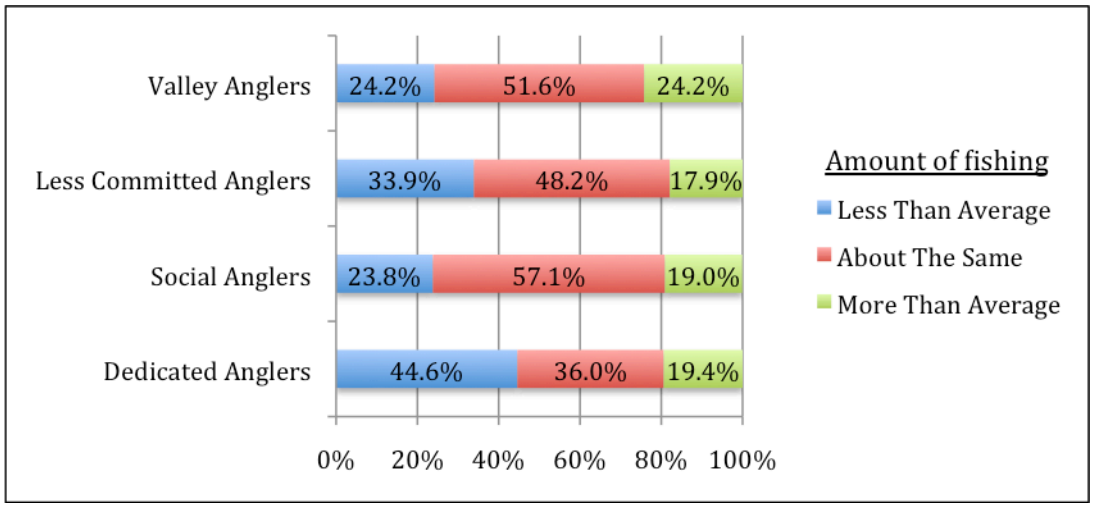
[c] Less Committed Anglers

[d] Valley Anglers

Social anglers fished significantly fewer days in 2010 (23.8 days) than the *valley anglers* (40.4 days), and the *less committed anglers* spent fewer days fishing in the Okanagan (Region 8) in 2010 (13.6 days) compared to the *dedicated anglers* (23.5 days). *Social anglers* also spent significantly fewer days fishing in freshwater in British Columbia in 2010 (23.3 days) than the *valley anglers* (38.7 days), and *dedicated anglers* have spent significantly more years fishing in the Okanagan (Region 8) (26.8 years) than both the *less committed* (17.5 years) and *valley anglers* (19.6 years). The *dedicated, social,* and *less committed anglers* all fished in more lakes in 2010 (6.5, 4.7 and 5.2 lakes respectively) than the *valley anglers* (3.2 lakes). The difference in the number of lakes fished can probably be attributed to the fact that there are only nine valley-bottom lakes for the *valley anglers* to choose from, and more than 500 lakes that the mountain anglers could potentially visit in the Okanagan (Region 8).

Approximately two-fifths (44.6%) of *dedicated anglers* indicated that they fished less often in 2010 than in previous years (Figure 23), which amounts to a significantly higher proportion than either the *social* (23.8%) or the *valley angler* (24.2%) segments (Table 14).

Figure 23: Amount of fishing compared to previous years by segment



Pearson chi-square: (0.015)

Table 14: Chi-square tests of change in angling participation between segments

	Between group comparisons†					
	Dedicated / Social	Dedicated / Less committed	Dedicated / Valley	Social / Less committed	Social / Valley	Less committed / Valley
P-Value	**0.009***	0.264	**0.006****	0.465	0.713	0.382

*Sig at 90%, **Sig at 95%, ***Sig at 99%

†To account for multiple comparisons, a Bonferroni correction has been used to identify significant differences (P-Value / 6). Therefore a P-value ≤0.017 is significant at the 90% level of confidence, a P-value ≤0.008 is significant at the 95% level of confidence, and a P-value ≤.002 is significant at the 99% level of confidence.

5.5.3 Gear use differences between groups

Each respondent indicated the number of days (out of 10) that they used fly-fishing, spin casting, and trolling gear (Table 15). *Valley anglers* used fly-fishing gear less often, and trolling gear more often than each of the mountain angler segments. *Dedicated anglers* also used spin-casting gear less than the *valley anglers.*

Table 15: Gear use by segments

(out of 10 days of fishing)	Segment Mean†				ANOVA	Tamhane's T2					
	[a]D	[b]S	[c]LC	[d]V	(p-value)	D-S	D-LC	D-V	S-LC	S-V	LC-V
Fly-fishing days	8.4	6.9	6.8	2.4	<.001	.101	.117	**<.001*** **	1	**<.001*** **	**<.001*** **
Spin casting days	1.3	1.8	1.5	3.0	.004	.788	.991	**.02** **	.997	.357	.149
Trolling days	1.2	1.8	1.9	6.4	.<.001	.776	.693	**<.001*** **	1	**.002*** **	**.002*** **

*Sig at 90%, **Sig at 95%, ***Sig at 99%

†Due to respondent error, segment means do not = 10

[a] Dedicated Anglers

[b] Social Anglers

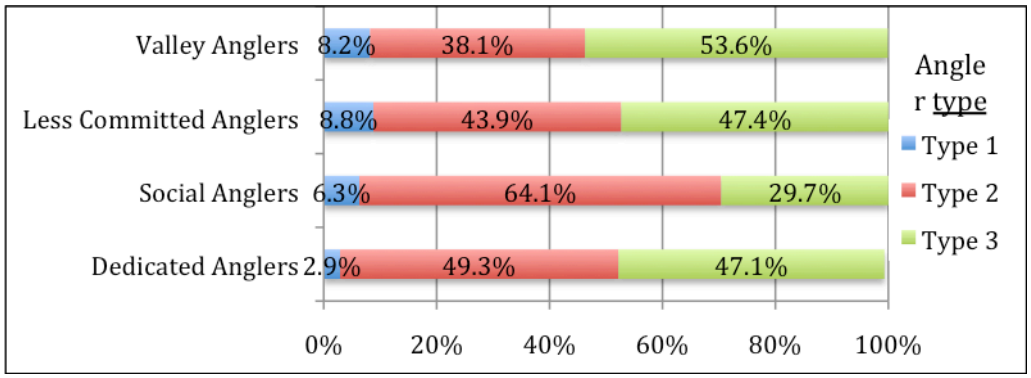
[c] Less Committed Anglers

[d] Valley Anglers

5.5.4 Self classified angler types

Each respondent self classified into one of three 'angler types' to indicate their individual level of angling specialization. 'Type 1' anglers are the least specialized, and 'Type 3' anglers are the most specialized (for a complete discussion of angler specialization please see section 3.3). *Social anglers* generally indicated that they were less specialized than *valley anglers* (Table 16). Figure 24 presents additional information regarding the self-classifications of respondents in each of the four angler segments.

Figure 24: Angler type (based on self – classification) by segment



Pearson chi-square: (0.064)

Table 16: Chi-square tests of angler type differences between segments

	Between group comparisons†					
	Dedicated / Social	Dedicated / Less committed	Dedicated / Valley	Social / Less committed	Social / Valley	Less committed / Valley
P-Value	0.081	0.289	0.109	0.082	**0.005****	0.75

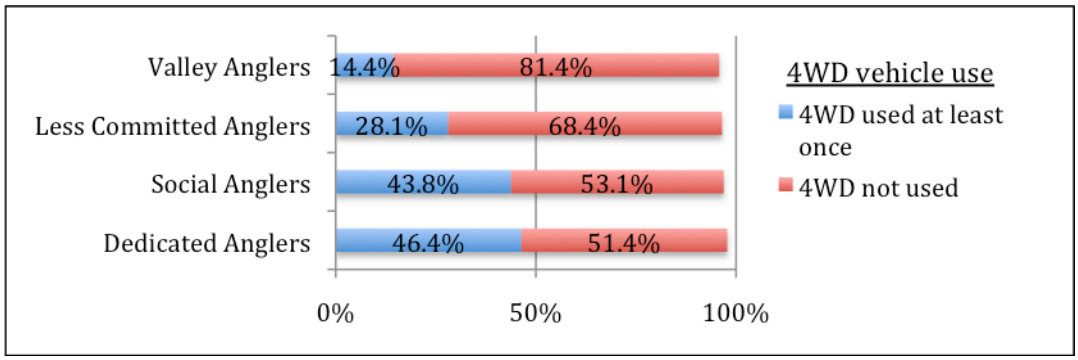
*Sig at 90%, **Sig at 95%, ***Sig at 99%

† To account for multiple comparisons, a Bonferroni correction has been used to identify significant differences (P-Value / 6). Therefore a P-value ≤0.017 is significant at the 90% level of confidence, a P-value ≤0.008 is significant at the 95% level of confidence, and a P-value ≤.002 is significant at the 99% level of confidence.

5.5.5 Use of 4 wheel-drive vehicles

Figure 25 presents information regarding whether or not anglers in each segment used four wheel-drive vehicles to access a fishing site in 2010. Significantly more *dedicated* and *social anglers* used four wheel-drive vehicles to access lakes for fishing in 2010 (46.4% and 43.8%, respectively) than *valley anglers* (14.4%) (Table 17). It is also interesting to note that the majority of anglers in each segment did not use 4 wheel-drive vehicles to access lakes in 2010.

Figure 25: Comparison of four wheel-drive vehicle use



Pearson chi-square: (<.001)
* Due to missing data segment totals do not equal 100%

Table 17: Chi-square tests of difference in four wheel-drive vehicle use between segments

	Between group comparisons†					
	Dedicated / Social	Dedicated / Less committed	Dedicated / Valley	Social / Less committed	Social / Valley	Less committed / Valley
P-Value	0.936	0.119	**<.001*** **	0.359	**0.001*** **	0.235

*Sig at 90%, **Sig at 95%, ***Sig at 99%
†To account for multiple comparisons, a Bonferroni correction has been used to identify significant differences (P-Value / 6). Therefore a P-value ≤0.017 is significant at the 90% level of confidence, a P-value ≤0.008 is significant at the 95% level of confidence, and a P-value ≤.002 is significant at the 99% level of confidence.

5.5.6 Importance of stocking information

Several significant differences between segments emerged for the responses of stocking information (Table 18). *Social anglers* rated 'the importance of knowing the species a lake is stocked with' significantly lower than both the *dedicated* and *less committed anglers.* All three mountain angler segments rated the 'importance of knowing how often a lake is stocked and the 'importance of knowing the size of stocked fish' significantly higher than the *valley anglers. Dedicated anglers* rated the 'importance of knowing when a lake was last stocked' significantly higher than the *valley anglers*, and the 'importance of knowing if a lake is stocked with triploids' significantly higher than the *social* and *valley anglers*; the *less committed anglers* also rated this item significantly higher than the *valley anglers*. Generally, all of the angler segments rated each of the five importance of stocking question at least '*moderately important'* with the exception of the *less committed anglers'* ratings of the 'importance of knowing when a lake was last stocked,' and the *social anglers'* ratings of the 'importance of knowing if a lake is stocked with triploids.'

Table 18: Importance of stocking information by segment

Importance of knowing…	Segment Mean				ANOVA (p-value)	Bonferroni					
	[a]D	[b]S	[c]LC	[d]V		D-S	D-LC	D-V	S-LC	S – V	LC-V
[XX] the species a lake is stocked with	4	3.5	4.1	3.7	.008	**.036****	1	.155	**.098***	.95	.35
how often a lake is stocked	3.2	3.1	3.2	2.5	.001	1	1	**.001*****	1	**.071***	**.02****
when a lake was last stocked	3.14	3	2.9	2.5	.008	1	1	**.005****	1	.157	.544
the size of stocked fish	3.2	3.2	3	2.5	<.001	1	1	**<.001*****	1	**.007*****	**.099***
if the lake is stocked with triploids	3.3	2.7	3.1	2.5	<.001	**.046****	1	**<.001*****	.878	1	**.059***

Responses were measured on a Likert scale from 1('Not at all important') to 5 ('Very important)

*Sig at 90%, **Sig at 95%, ***Sig at 99%

[XX] The variances for this item were not equal therefore Tamhane's T2 stats are presented

[a] Dedicated Anglers

[b] Social Anglers

[c] Less committed Anglers

[d] Valley Anglers

5.6 Decision Support Tool

The Decision Support Tool (DST) for this project was created using the results from the four segment Known Class - Latent Class Model for anglers in the Okanagan (Region 8) (Table 10). The DST simulates the behaviour of anglers in the Okanagan (Region 8) (mountain lake and valley anglers), when selecting mountain lakes. The DCE did not explicitly offer the option of angling in a valley lake.

The small mountain lake DST allows the user to construct hypothetical mountain lakes by selecting any combination of attribute levels in the DST for each of the four lakes (four lakes were generated in the first DST configuration to compare each of the four angler segments' most preferred lake characteristics, while three lakes were compared in the second DST configuration to evaluate three hypothetical lake types designed by the FFSBC and MFLNRO). The DST then calculates and displays the proportion of each angler segment that would visit the specified alternatives; the probability estimates represent a market share for each hypothetical lake. For the purpose of this study the DST will be used to develop lake types that maximize the utility of each angler segment. Thereafter, the DST will be used to assess how each angler segment would allocate their fishing effort if the small mountain lakes in the Okanagan (Region 8) were managed according to the management regimes currently being devised by the FFSBC and MFLNRO (described in section 1.2).

5.6.1 DST configuration 1

Figure 26 presents the first DST configuration in which each hypothetical lake reflects a situation that maximizes the utility of one of the angler segments; that pattern is clearly apparent in the market shares displayed at the bottom of Figure 26. Each of the attribute levels in 'Lake A' were set to the most desired levels of the *dedicated anglers*, 'Lake B' attribute levels were chosen to reflect the preferences of the *social anglers,* 'Lake C' was designed to maximize the utility of the *less committed anglers*, and 'Lake D' reflects the preferences of *valley anglers*. Interestingly, only few differences emerged between 'Lake A' and 'Lake C,' which implies a strong similarity between the *dedicated* and *less committed anglers.* The only differences in the attribute settings between 'Lake A' and 'C' are motor restriction, amount of travel on unpaved roads, and the type of vehicle required to access the lake. The relationship between *dedicated* and *less committed anglers* is also demonstrated by the market shares for 'Lake A' and Lake C'. Even though 'Lake C' was not specifically designed for the *dedicated anglers* it still attracted approximately one-quarter (25.3%) of *dedicated anglers*. The opposite is also true for 'Lake A', which attracted one-quarter (23.5%) of the *less committed anglers*.

Figure 26: DST configuration 1

	Lake A	Lake B	Lake C	Lake D	Option E
Fishery Characteristics					
Expected catch / 4 hours	4 Fish	4 Fish	4 Fish	4 Fish	
Expected catch size	40 - 50 cm	40 - 50 cm	40 - 50 cm	40 - 50 cm	
Motor restriction	Electric only	Electric only	10 Hp maximum	No Restriction	Not fishing mountain lakes
Gear restriction	Artificial fly only	No restriction	Artificial fly only	No restriction	--OR--
Take limit	2 Fish	5 Fish	2 Fish	2 Fish	Fishing somewhere else
Physical Characteristics					--OR--
Travel on paved roads	25 Km	200 Km	25 Km	25 Km	Fishing fewer days this season
Travel on unpaved roads	45 Km	30 Km	30 Km	Less than 2 Km	
Required vehicle	4WD vehicle	High clearance vehicle	High clearance vehicle	High clearance vehicle	
Boat launch	Car-top	Trailer access	Car-top	Trailer access	
Number of other boats within 100 meters	0 boats	2 boats	0 boats	0 boats	
Accomodation	Tent/camper sites	Tent/camper sites	Tent/camper sites	RV sites	

Market Shares	Lake A	Lake B	Lake C	Lake D	Option D
Dedicated anglers	**64.4%**	**4.9%**	**25.3%**	**5.3%**	**0.0%**
Social anglers	**11.1%**	**67.4%**	**15.1%**	**7.3%**	**0.2%**
Less Committed anglers	**23.5%**	**7.1%**	**58.6%**	**11.6%**	**6.1%**
Valley anglers	**10.5%**	**15.3%**	**35.7%**	**50.1%**	**6.3%**

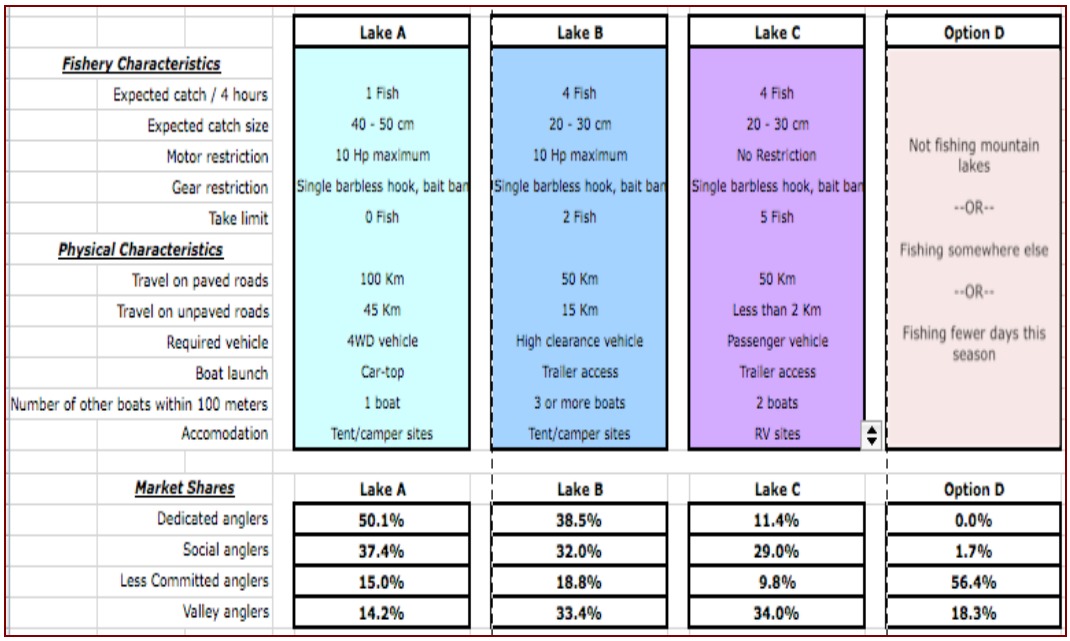
In this scenario each lake is designed to maximize one of the angler segments' utility

The first DST configuration also shows that the *social anglers* are unique when compared to the two other mountain angler segments. ‘Lake B’, which was designed to attract *social anglers*, has a relatively liberal management regime (no gear restrictions and a high take limit) and provides a trailer access boat launch. Additionally, travel required on paved roads to reach ‘Lake B’ is set to the highest level measured by this experiment, indicating that *social anglers* prefer to travel farther to access a lake for fishing compared to the other two mountain angler segments. The first DST configuration also demonstrates that *social anglers* prefer to have other anglers nearby (i.e. the number of other boats within 100 meters in ‘Lake B’: preferred level is 2 boats). Finally, the market share for ‘Lake B’ documents that a lake designed to attract anglers in the *social* segment will not appeal to many *dedicated, less committed* or *valley anglers* (attracting only 4.9%, 7.1% and 15.3% respectively).

The hypothetical lake that would attract the largest proportion of *valley anglers,* ‘Lake D,’ has very liberal management restrictions (no gear or motor restrictions), requires relatively short travel on any type of road, and provides more developed amenities (RV sites) than the lakes that maximize the utility of the mountain angler segments. Interestingly, very few *dedicated anglers* (5.3%), *social anglers* (7.3%), or *less committed anglers* (11.6%) are attracted to ‘Lake D’ which suggests that a lake designed to attract *valley anglers* to small mountain lakes would not attract many anglers from the mountain angler segments.

5.6.2 DST configuration 2

Figure 27: DST configuration 2



	Lake A	Lake B	Lake C	Option D
Fishery Characteristics				
Expected catch / 4 hours	1 Fish	4 Fish	4 Fish	
Expected catch size	40 - 50 cm	20 - 30 cm	20 - 30 cm	
Motor restriction	10 Hp maximum	10 Hp maximum	No Restriction	Not fishing mountain lakes
Gear restriction	Single barbless hook, bait ban	Single barbless hook, bait ban	Single barbless hook, bait ban	--OR--
Take limit	0 Fish	2 Fish	5 Fish	
Physical Characteristics				Fishing somewhere else
Travel on paved roads	100 Km	50 Km	50 Km	--OR--
Travel on unpaved roads	45 Km	15 Km	Less than 2 Km	
Required vehicle	4WD vehicle	High clearance vehicle	Passenger vehicle	Fishing fewer days this season
Boat launch	Car-top	Trailer access	Trailer access	
Number of other boats within 100 meters	1 boat	3 or more boats	2 boats	
Accomodation	Tent/camper sites	Tent/camper sites	RV sites	

Market Shares	Lake A	Lake B	Lake C	Option D
Dedicated anglers	**50.1%**	**38.5%**	**11.4%**	**0.0%**
Social anglers	**37.4%**	**32.0%**	**29.0%**	**1.7%**
Less Committed anglers	**15.0%**	**18.8%**	**9.8%**	**56.4%**
Valley anglers	**14.2%**	**33.4%**	**34.0%**	**18.3%**

In this scenario each hypothetical is designed to reflect one of the lake types currently being developed by the FFSBC and MFLNRO

In the second DST configuration (Figure 27) the hypothetical lakes reflect the characteristics of the lakes currently being designed by the FFSBC and the MFLNRO. The attribute levels in ‘Lake A’ represent a ‘trophy lake’ (i.e. a lake with large fish and very restrictive take limits). The FFSBC and MFLNRO also describe ‘trophy lakes’ as having poor to good access (reflected in the travel on paved and unpaved roads, as well as the required vehicle attributes), and gear restrictions designed to minimize the negative impacts to released fish (a single barbless hook - bait ban gear restriction). ‘Lake B’ represents the goals of a ‘quality lake’. The FFSBC and MFLNRO describe ‘quality lakes’ as having high catch rates, low harvest rates, average to good access, and high use

levels; these characteristics have been manifested in the expected catch/four hours of effort, take limit, travel distances, required vehicle, and crowding attributes. The third lake, ‘Lake C’, represents two of the FFSBC and MFLNRO lake types (‘regional’ and ‘family’ fisheries), which were combined because their characteristics in terms of the DCE attributes are similar. The ‘regional/family lake’ is managed to have: high harvest rates, liberal take limits, relatively easy access, and little management intervention; these characteristics have been reflected in the attribute levels in ‘Lake C’. The final lake type being considered by the FFSBC and MFLNRO, the ‘urban fishery’, was not included in this simulation because it is not a feasible fishery for a small mountain lake, but rather for valley-bottom lakes in close proximity to urban centres. It is worth noting that the lake types being considered by the FFSBC and MFLNRO did not include information regarding each attribute included in the DCE used in this study. Therefore, the researchers have manipulated the attribute levels that were not explicitly described by the FFSBC and MFLNRO in a manner that logically follows from the management intent for each lake type. For example, the FFSBC and MFLNRO state explicit goals for catch rates in lakes managed as ‘trophy lakes’; however, it is unlikely that a lake would be able to produce very large fish (40-50 cm) and have high catch rates. Therefore, the expected catch/four hours of effort has been set to a relatively low level.

The second DST configuration provides fishery managers with an estimate of the demand for each lake type relative to one another. The market shares presented in Figure 27 demonstrate how each angler segment would allocate their fishing time if the three lake types presented in the second DST were the only lakes available for fishing. For example, most *dedicated* and *social anglers* would visit the 'trophy lake' and the largest proportion of *valley anglers* would visit the 'regional/family lake'. Another notable point regarding the market shares presented in Figure 27 is the number of anglers who selected 'Option D' (to not fish or to fish somewhere other than mountain lakes). Very small proportions of the *dedicated* and *social anglers* (0% and 1.7% respectively) market shares were allocated to 'Option D' indicating that very few of these anglers would not visit any small mountain lakes in the Okanagan (Region 8) if the lake types presented in the second DST were the only lakes available. Conversely, more than half (56.4%) of the *less committed anglers* market share was allocated to 'Option D', suggesting that the lake types designed by the MFLNRO and the FFSBC presented in the second DST may not provide many fishing opportunities that are attractive to the *less committed anglers*.

5.6.3 Sensitivity of the angler segments to individual attributes

By manipulating the attribute levels within the DST, some trends regarding the most influential attributes for each angler segment become evident. For example, *dedicated anglers* seem to be most influenced by the expected catch size, motor restriction, and gear restriction attributes. *Social anglers* seem to

be most sensitive to changes in the type of vehicle required to access lakes and the expected catch size of fish. *Less committed anglers* are also quite sensitive to the expected catch size, are very sensitive to the take limit attribute, and dislike lakes with high crowding levels. Finally, *valley anglers* seem to be most sensitive to changes in the expected catch size of fish, and are relatively indifferent to changes in the other attributes.

6: DISCUSSION

Chapter 6 begins by presenting the profiles of each angler segment and the results of the Decision Support Tool as they relate to fishery management in the Okanagan (Region 8). Thereafter, the results of the Discrete Choice Experiment are examined in the context of previous academic research on the topic. Next, the benefits of using a Latent Class Model to identify sources of angler heterogeneity are summarized. Finally, the limitations of the study are presented, and the results as they pertain to fishery management in the Okanagan (Region 8) and to the future of human dimensions of fisheries research are discussed.

6.1 Angler preferences and the FFSBC and MFLNRO lake types

The results of the second DST configuration (Figure 27, section 5.6.2) suggest that for small mountain lakes the lake types which have been defined recently by the FFSBC and MFLNRO align well with three of the segments emerging from our study, the *dedicated, social,* and *valley anglers.* However, more than half (56.4%) of the *less committed anglers* market share was allocated to 'Option D,' (to not fish, or to fish somewhere other than small mountain lakes) in second DST configuration. Therefore, one can assume that the lake types evaluated in the second DST configuration do not satisfy these *less committed anglers'* preferences to the same extent. The remainder of this section

presents profiles of each angler segment identified by this study, and discusses the lake types currently being considered by the FFSBC and MFLNRO in relation to each segments' preferences.

6.1.1 Dedicated anglers

Dedicated anglers have fished in the Okanagan (Region 8) for an average of 26.8 years (Table 13), they use fly-fishing gear more than fourth-fifths of the time (Table 15) and the majority classified themselves as more specialized anglers (Figure 24). The results of the PCA of motivation information and the Known Class - Latent Class Model (LCM) suggest that *dedicated anglers* are motivated by outdoors/relaxation aspects and catching fish, but not by 'catching fish for eating' (Table 10).

When fishing in small mountain lakes *dedicated anglers* are particularly interested in catching many larger fish, and prefer strict management regimes, including an artificial fly only gear restriction, and an electric only motor restriction. *Dedicated anglers* exhibited a strong disutility for weaker management guidelines, such as no motor restrictions, a ten horse power maximum, and no gear restrictions. *Dedicated anglers* preferred lakes that required a 4WD vehicle for access, and lakes that only had a car-top boat launch, demonstrated a disutility for lakes that were walk-in only, and preferred lakes with simple tent/camper sites. Finally the intercept coefficient indicates that *dedicated anglers* are very committed to recreational fishing and will

continue to participate even if the lakes available for fishing do not exactly reflect their specific preferences for small mountain lakes (Table 10).

The ‘trophy lake’ (‘Lake A’ in the Figure 27) which attracted most (50.1%) of the *dedicated anglers’* market share in the second DST configuration (Figure 27), and the *dedicated anglers* ideal lake (exemplified in ‘Lake A’ in the first DST configuration, Figure 26) have several similar qualities. Both lakes employ conservative management restrictions, are relatively difficult to access, and both have high expected catch sizes. However, the expected catch rate of the ‘trophy lake’ in the second DST configuration (Figure 27) is much lower than the *dedicated anglers* preferred catch rate of four fish per four hours effort (Figure 20). Regardless of the minor differences between the two hypothetical lakes, it seems that the ‘trophy lake’ satisfies the *dedicated anglers’* preferences for small mountain lakes.

The ‘quality lake’ (‘Lake B’ in Figure 27) also attracted almost two-fifths (38.5%) of the *dedicated anglers*. Though the ‘quality lake’ employs a relatively conservative management regime, it is more developed, and easier to access than the ‘trophy lake,’ which may account for the ‘quality lake’s’ lower market share for *dedicated anglers* compared to the ‘trophy lake’. However, both the ‘trophy lake’ and the ‘quality lake’ described in the second DST configuration (section 5.6.2) seem to satisfy the *dedicated anglers* preferences for small mountain lake characteristics.

6.1.2 Social anglers

S*ocial anglers* have an average of 21.9 years of fishing experience in the Okanagan (Region 8) (Table 13), they use fly-fishing gear more often than spin casting or trolling equipment (Table 15) and more than two-thirds of this segment classified themselves as 'type 2' or moderately specialized anglers (Figure 24). *Social anglers* were not significantly motivated by any of the components measured in this study, but the results of the motivation covariate revealed that *social anglers* are not motivated by the outdoors/relaxation or the catching fish components (Table 10).

Social anglers prefer a take limit of at least two fish, and lakes where they can catch many large fish. *Social anglers* also preferred lakes that required between 20 and 45 kilometres of travel on unpaved roads, exhibited increasing utility as the amount of travel on paved roads increased, and preferred lakes with a trailer access boat launch. *Social anglers* disliked lakes that were walk-in only, and preferred lakes where there are tent/camper sites and only one or two other boats within a 100-meter radius (Table 10).

The *social angler's* ideal lake, personified by 'Lake B' in the first DST configuration (Figure 26) is quite different from any of the lake types evaluated in the second DST configuration (Figure 27). However, the *social angler's* market shares in the second DST configuration suggest that the *social anglers* would fish in the 'trophy lake,' the 'quality lake,' and the 'regional/family lake' if

they were the only lakes available for fishing. Therefore, the results of the second DST configuration (section 5.6.2) suggest that the *social anglers* are quite committed to fishing in the small mountain lakes in the Okanagan (Region 8), and will continue to do so if the FFSBC and MFLNRO decide to implement the new lake types they are currently considering.

6.1.3 Valley anglers

Respondents in the *valley angler* segment have spent an average of 19.6 years fishing in the Okanagan (Region 8) (Table 13). Generally, the *valley anglers* indicated that they were highly specialized (Figure 24), and that they used trolling gear most often (Table 15). More than four-fifths of v*alley anglers* did not use a 4WD vehicle to access lakes in 2010 (Figure 25), which may reflect the relatively easy access to valley-bottom lakes.

Valley anglers exhibited increasing utility as the expected size of fish increased, and preferred a take limit of two fish. They also preferred lakes with a trailer access boat launch and RV campsites, exhibited a disutility for lakes that were walk-in only, and disliked lakes where a fishing lodge was present (Table 10). The results of the motivation covariate indicated that *valley anglers* are significantly motivated by the social component, and were not motivated by the outdoors/relaxation or the fish consumption components (Table 10) suggesting that they participate in recreational fishing to spend time with friends and family.

The *valley anglers'* ideal lake ('Lake D' in the first DST configuration, Figure 26), has very liberal management restrictions and relatively easy access. Therefore, it is not surprising that the *valley anglers* were most attracted to the 'regional/family lake' ('Lake C') in the second DST configuration (Figure 27), which is the easiest lake to access, and employs a relatively relaxed management regime. Another third (33.4%) of the *valley anglers'* market share was also allocated to the 'quality lake' in the second DST configuration (Figure 27), which suggests that more than one of the lake types currently being designed by the FFSBC and MFLNRO are somewhat attractive to the *valley anglers*.

Two scenarios may explain why approximately one-fifth (18.3%) of the *valley anglers* chose not to fish in the small mountain lakes presented in the second DST configuration (Figure 27). First, it is evident that none of the lake types designed by FFSBC and MFLNRO exactly reflect the *valley anglers'* preferences. Therefore, if the FFSBC and MFLNRO want to attract more *valley anglers* to small mountain lakes in the Okanagan (Region 8), they should alter the lake types they are currently considering, or design a new lake type to satisfy the *valley anglers'* unique preferences. Second, the *valley anglers* intercept (Table 10) suggests that they are not very committed to fishing in small mountain lakes in the Okanagan (Region 8). Therefore, even if the FFSBC and MFLNRO design a new type of lake specifically to attract *valley anglers*, many *valley anglers* may still elect to spend some time fishing in

valley-bottom lakes. Thus, the FFSBC and MFLNRO must decide how much effort they want to expend attracting *valley anglers* to small mountain lakes, and adjust the lake types they are designing accordingly.

6.1.4 Less committed anglers

Less committed anglers fished an average of 13.6 days in the Okanagan (Region 8) in 2010 (Table 13) and spent an average of 17.5 years fishing in the Okanagan (Region 8) (Table 13). Like the *dedicated* and *social anglers*, *less committed anglers* primarily use fly-fishing gear (Table 15), and the majority of *less committed anglers* classified themselves as 'type 2' or 'type 3' anglers (Figure 24). Finally, more than two-thirds of the *less committed anglers* reported not using a 4WD vehicle to access a lake for fishing in 2010 (Figure 25).

Less committed anglers prefer lakes with high catch rates and large fish. Additionally, the slopes of the utility lines for the catch size and catch rate attributes are steeper for the *less committed anglers* than any of the other segments (Figure 20), indicating that these two attributes were relatively more important to them. The *less committed anglers* also preferred little travel on paved and unpaved roads, and demonstrated a significant disutility for lakes where a fishing lodge was present and lakes that were walk-in only. *Less committed anglers* preferred to fish at lakes with only tent/camper sites, and with no other boats within a 100-metre radius. Finally, the motivation covariate

indicates that *less committed anglers* are the only group that are significantly motivated by the fish consumption component, and that they are not motivated by the social component (Table 10), suggesting that *less committed anglers* prefer to be alone and appreciate being able to catch and keep fish.

Perhaps the most significant result of the second DST (Figure 27) in terms of the *less committed anglers* is their market share for 'Option D,' to not fish, or to fish somewhere other than small mountain lakes in the Okanagan (Region 8). More than half (56.4%) of the *less committed anglers'* market share was allocated to 'Option D' which suggests that the lake types currently being considered by the FFSBC and MFLNRO do not adequately satisfy these *less committed anglers*. Two reasons may explain why a high proportion of the *less committed anglers'* market share was allocated to 'Option D' in the second DST configuration. First, the results of DST configuration one (Figure 26) show that *less committed anglers* prefer lakes with high catch rates, high expected catch sizes, relatively easy access, and low crowding levels. Clearly, creating lakes that reflect the *less committed angler's* preferences may be very difficult from a management perspective. Therefore, the lake types being designed by the FFSBC and MFLNRO, which reflect lakes that managers believe can be implemented in the Okanagan (Region 8), may not be able to be manipulated in a way that satisfies the *less committed anglers'* preferences, thus they may choose to participate in a different recreation activity.

It is also possible that *less committed anglers* would rather fish in streams, than small mountain lakes. Thus, the *less committed anglers'* large market share allocated to 'Option D' in the second DST configuration (Figure 27) would suggest that when there are no small mountain lakes available which meet their specific preferences, *less committed anglers* may elect to fish in streams. If l*ess committed anglers* did prefer to fish in streams, their high intercept coefficients for 'Option D' in the DCE, (Table 10) would be explained. However, the results of this study do not allow the researchers to test this assumption.

In light of the results of the second DST configuration as they relate to the *less committed anglers*, Okanagan (Region 8) fishery managers will have to decide if they want to alter one or more of the lake types they are designing to attempt to satisfy the *less committed anglers.* Alternatively, the FFSBC and MFLNRO could accept that they might not be able to satisfy *less committed anglers'* preferences. Subsequently, the FFSBC and MFLNRO could implement the lake types they are currently considering which seem to satisfy the other mountain lake anglers described by this study.

The profiles of each angler segment identified by this study demonstrate that the Okanagan (Region 8) fishery is rather heterogeneous and should be managed accordingly. Additionally, the results of the DCE show that each of the angler segments has different preferences for small mountain lake

attributes. Finally, the results of the Decision Support Tool scenarios show that the lake types currently being designed by the FFSBC and MFLNRO satisfy most Okanagan (Region 8) angler types identified by this study.

6.2 Evaluation of the Discrete Choice Experiment results

The results of the DST discussed above exemplify the usefulness of decompositional stated preference analyses to evaluate angler preferences for hypothetical management scenarios. However, in order to develop an effective DST the Discrete Choice Experiment (DCE) used in the 2010 Okanagan (Region 8) Angler Study had to include fishery attributes that influenced anglers' site choices (Haider, 2002). As such, the DCE included many of the fishery characteristics described by Hunt (2005) that have been proven to influence angling site choice, including fishing quality, regulations, facility development, and encounter levels. The DCE also included some attributes that were considered important for understanding lake selection in the Okanagan (Region 8), specifically, the required travel distance on paved and unpaved roads, and the type of vehicle required to access a lake.

6.2.1 Fishing quality

The fishing quality of the hypothetical small mountain lakes in the Okanagan (Region 8) was represented by the expected catch rate and expected catch size attributes in the DCE. Both of these measures of fishing quality have been found to influence angling site choice in previous academic research (Provencher, Baerenklau & Bishop, 2002; Adamowicz, 1994). Additionally,

several studies have found that angling site choice is positively correlated with the expected catch rate (Jakus & Shaw, 2003; Whitehead & Haab, 2000) and expected catch size of fish (Oh et al., 2005; Hunt, 2005). Therefore, the results of the present study, which found that each angler segments' utility increased as the expected catch size and expected catch rate of fish increased (Figure 20) are plausible.

As creating lakes that provide high catch rates and large fish is not possible in all circumstances, it is important to note that these are only two of eleven attributes measured by the DCE in this study. Therefore, each respondent made tradeoffs which forced them to consider the expected catch rate and size of fish in conjunction with other small mountain lake characteristics. Therefore, the DST should be used to explore the tradeoffs anglers made when choosing small mountain lakes in the DCE. Doing so will allow managers to develop lakes that provide anglers with a high level of utility, even if the catch rate and catch size of fish can not be maximized in every instance.

6.2.2 Regulations

Regulations also influence how anglers select lakes for fishing (Oh & Ditton, 2006; Hunt, 2005) and some researchers have found that this can be a source of heterogeneity within a sample population (Aas, Haider & Hunt, 2005). Each angler segment's lake choice was significantly influenced by the management restrictions evaluated by the DCE. The *dedicated* and *social anglers* had a

significant preference for the motor restriction attribute, and only the *dedicated anglers* had a significant preference for the gear restriction attribute (Table 10). Responses for the take limit attribute were more uniform, as the *dedicated, less committed* and *valley anglers* all preferred a take limit of two fish, while the *social anglers* preferred a take limit of five fish (Figure 20).

The diversity in anglers' preferences for regulations can be used to explain some of the characteristics of each group. For example, the *dedicated, less committed and valley anglers'* preference for a take limit of two fish suggests that these anglers understand the consequences of liberal take limits, and prefer regulation regimes that maintain the ecological integrity of fisheries. Similar conclusions have been reached by other recreational fishing studies (Oh et al., 2005), and suggest that a diverse suite of fishery regulations may be required to satisfy all anglers. Thus, the fact that each angler segments had different preferences for management restrictions is not surprising, and represents one of the sources of heterogeneity identified by the Known Class - Latent Class Model (LCM).

6.2.3 Travel distance

Attributes that describe costs generally transform the amount of travel required to access a lake into a dollar value (Hunt, 2005). However, the researchers and Okanagan (Region 8) fishery managers believed that estimates of the distance an angler was willing to travel to access a lake were more important

to fishery management in the Okanagan (Region 8) than the amount of money an individual was willing to spend. Therefore, the travel distance required to access a site was used to assess anglers' preferences for small mountain lakes in the Okanagan (Region 8).

Angling research generally suggests that travel distance is inversely related to site attractiveness (Adamowicz, 1994; Peters, Adamowicz & Boxall, 1995; Hunt, Boots & Boxall, 2007). However, the *social anglers* identified by this study exhibited increasing utility as the amount of travel on paved roads increased (Figure 20) similar to the results of Beardmore et al. (Forthcoming). Perhaps *social anglers* see fishing as an opportunity to go on a trip, and therefore prefer to travel far from their primary residence when fishing in the Okanagan (Region 8). Each of the other angler segments exhibited decreasing utility as the amount of travel on paved roads decreased, in agreement with trends in recreational angling research (Figure 20).

The DCE also evaluated anglers' preferences for the amount of travel on unpaved roads required to access a small mountain lake. Though a review of academic literature did not reveal any studies that explicitly examined how the amount of travel on unpaved roads affected angling site choice, some angling research has explored the effect of road quality of fishing site choice. Hunt, Boots and Boxall (2007) found that poor quality roads (roads with one lane and some type of maintenance problem) were a deterrent to some, but not all

northern Ontario anglers. Therefore, anglers' preferences for lake access characteristics may be a source of heterogeneity within a sample population of anglers.

In the present study, the three mountain angler segments preferred to visit lakes that required at least some travel on unpaved roads, while the *valley anglers* preferred very little or no travel on unpaved roads (Figure 20). However, most small mountain lakes in the Okanagan (Region 8) require at least some travel on unpaved roads. Therefore, mountain anglers may have inherently accepted some amount of unpaved travel when selecting lakes in the DCE.

Alternatively, mountain anglers may believe that lakes with difficult access provide higher quality fishing experiences. Kaufman et al. (2009) found that anglers who chose to visit lakes that were difficult to access only selected lakes with high fishing quality. Therefore, one can assume that some anglers are willing to visit lakes that are difficult to access if the fishing quality in that lake is high. Therefore, Okanagan (Region 8) mountain anglers may select lakes with difficult access in the hope of having a better angling experience.

6.2.4 Required vehicle

In this study, the type of vehicle required to access a lake was used as an additional measure of lake accessibility. Only the *dedicated anglers*

significantly preferred the use of four wheel drive vehicles. Each of the other segments tended to prefer lakes that required a high clearance vehicle for access. The *dedicated anglers* may prefer visiting lakes that require a four wheel-drive vehicle for access because they believe these lakes will provide a higher quality fishing experience (Kaufman et al., 2009). Conversely, the *social, less committed and valley anglers* preference for lakes with easier access seem to agree with angling research which suggests that lakes which are difficult to access are less attractive to recreational anglers (Hunt & Dyck, In Press). It is also possible that the *social, less committed* and *valley anglers* do not own four wheel drive vehicles, which would eliminate the possibility of visiting lakes requiring a four wheel drive vehicle for access.

6.2.5 Launch type

Two measures of facility development were included in the DCE: launch type and amenities (the amenities attribute will be discussed in section 6.2.6). The launch type attribute evaluated anglers' preferences for three types of boat launches: walk-in only lakes, trailer access boat launches, and car-top boat launches. *Dedicated anglers* significantly preferred car-top boat launches. The *social* and *valley angler* segments preferred trailer access boat launches. All four angler segments exhibited a significant disutility for lakes that were walk-in only.

Though a review of academic literature did not reveal any studies which evaluated anglers' preferences for specific types of boat launches, several studies found that anglers generally prefer to fish at lakes where a boat launch is provided (Montgomery & Needleman, 1997; Karou, 1995; Jakus & Shaw, 2003). Additionally, Hunt, Boots and Boxall (2007) found that lakes which were only accessible by trails were a deterrent to anglers, suggesting that the results of the present study regarding walk-in only lakes are similar to other research studies.

While the unanimous disutility associated with walk-in only lakes in this study does not mean Okanagan (Region 8) anglers who prefer walk-in only lakes do not exist, it does suggest that respondents to this survey preferred the other boat launch types evaluated in DCE. It is also possible that anglers are only willing to visit a walk-in lake if it provides a very high quality fishing experience, which may relate to the findings of Kaufman et al. (2009) described above.

6.2.6 Amenities

The evaluations of the amenities attribute revealed that the *dedicated, less committed* and *valley angler* segments all dislike lakes with a fishing lodge, perhaps because they associate lakes with fishing lodges with high levels of crowding and overuse, resulting in an unattractive fishery. All three mountain angler segments demonstrated a preference for lakes with tent/camper sites, and the *valley anglers* significantly preferred to fish at lakes where RV sites

were provided. The differentiation between the campsite preference of mountain and *valley anglers* might be due to the type of camping equipment they use. However, the unanimous preference for lakes with campsites agrees with other recreational angling research that describes a positive correlation between the presence of campsites and fishing site selection (Adamowicz, 1994; Morey et al., 2002; Peters, Adamowicz & Boxall, 1995).

6.2.7 Crowding

Angling research generally suggests that encounters with other anglers are negatively correlated with site selection (Banzhaf, Johnson & Mathews, 2001 in Hunt, 2005). However, contrary to other recreational fishing studies, the *social anglers* significantly preferred having two other boats within a 100-meter radius, perhaps so they can share their fishing experience with others. The three other angler segments tended to prefer lower levels of crowding (having one or no other boats within a 100 meter radius) in accordance with other recreational fishing studies (Hunt, 2005).

The results of the DCE are generally consistent with other recreational fishing studies with a few minor exceptions noted above. Additionally, the anglers' evaluations of attribute levels that were relevant to the small mountain lakes fishery in the Okanagan (Region 8) revealed several sources of heterogeneity between the mountain and *valley anglers*, as well as within the subpopulation of mountain anglers. The heterogeneity established within the sample

population suggests that the a-priori segmentation and the Latent Class Model (LCM) used in this study were effective methods for identifying heterogeneous segments of anglers within the sample population.

6.3 Identifying Okanagan (Region 8) angler heterogeneity

The discussion of the Decision Support Tool scenarios, and the respondents' evaluations of the DCE attributes provided above highlights several sources of heterogeneity within the population of Okanagan (Region 8) anglers identified by the Known Class - Latent Class Model. Additionally, the differences between the mountain and *valley anglers* demonstrate the effectiveness of the a-priori segmentation used in this study. The subsequent sections will discuss the use of the a-priori segmentation and the LCM.

6.3.1 A-priori segmentation

The a-priori segmentation (Hunt, Haider & Bottan, 2005) used in this study is quite similar to the segmentation employed by Arlinghaus and Mehner (2004). They demonstrated the utility of using an a-priori segmentation for a research question focused on distinct fishery products. This distinct product differentiation became evident in the Okanagan (Region 8) when the researchers compared the large valley-bottom lakes to the small mountain lakes. Valley-bottom lakes provide a substantially different fishing experience than the small mountain lakes, and were not the principle focus of this research project. Thus, anglers who primarily fished in valley lakes were separated from those who fished in mountain lakes to ensure mountain anglers' preferences

for small mountain lake characteristics could be described in detail. The results of the subsequent analysis showed that mountain anglers have significantly different preferences for small mountain lake characteristics than *valley anglers*. Therefore, the a-priori segmentation was a useful method of identifying heterogeneity within the population of Okanagan (Region 8) anglers.

Though only one a-priori segmentation was ultimately used, several were tested. Segmentations based on angling specialization (Fisher, 1997; Bryan, 1977), motivation, location of residence, and fishing club membership were all explored. However, the analysis of group preferences for fishery characteristics based on these segmentations did not reveal many significant differences. In other words, little heterogeneity between the groups could be established. With the exception of the separation of mountain and *valley anglers*, the a-priori segmentations tested in this study were probably unsuccessful for the sample population as a whole, as well as within the mountain angler segment, due to many of the shortcomings of market based segmentations described by Bhat (2002), namely that they are arbitrary, and rigidly imposed.

It is surprising that the segmentation based on angler specialization did not reveal significant preference heterogeneity between Okanagan (Region 8) anglers, as many other researchers have demonstrated the utility of this form of segmentation (Bryan, 1977; Fisher, 1997; Oh & Ditton, 2006). Initially the researchers believed that the methods used to identify anglers with different

levels of specialization (based on Needham, Sprouse & Grimm, 2009) might not have been appropriate. An alternative segmentation based on other factors theoretically tied to angling specialization including various behavioural traits, cognitive factors, or affective components (McFarlane, 2001) measured by the study was explored. However, a multiple regression comparing the number of days anglers fished in 2010, the overall importance of stocking information, and fishing club membership, to self reported angler specialization (Appendix H) supported the use of the self-identification methodology described by Needham, Sprouse and Grimm (2009). Therefore, the researchers determined that the a-priori segmentation based on angler specialization was not an effective method for identifying angler heterogeneity within the sample population of Okanagan (Region 8) anglers.

While the finding that anglers' levels of specialization were not associated with relevant preference heterogeneity is rare, it is not unheard of. Provencher, Baerenklau, and Bishop (2002) used a LCM to study a population of Lake Michigan anglers and discovered that none of the angler segments identified in their study were dominated by more experienced anglers. Their findings agree with the present study which suggest that angler specialization may not be an appropriate segmentation variable in all circumstances. Additionally, the fact that the specialization based segmentation failed to reveal relevant heterogeneity highlights the fact that rigidly imposed segmentations may not reveal all sources of heterogeneity (Bhat, 2002). Therefore, the researchers

used a Latent Class Model to endogenously explore heterogeneity with the population of Okanagan (Region 8) anglers.

6.3.2 The Latent Class Model

The previous section demonstrated that only one of a number of a-priori segmentations revealed heterogeneity relevant to the study. However, simply describing the differences between *mountain* and *valley anglers* did not satisfactorily answer all of the research questions set out at the beginning of this study. Other researchers have demonstrated that combining an a-priori segmentation with a decompositional stated preference analysis and a LCM can identify additional sources of heterogeneity within a subpopulation of interest (Scarpa & Thiene, 2005). Thus, a Latent Class Model (LCM) was used to explore heterogeneity within the subpopulation of mountain anglers.

The use of a LCM served three important functions. First, by grouping mountain anglers into three unique segments according to respondents' preferences for fishery characteristics, the LCM allowed researchers to avoid describing the preferences of an average mountain angler (Shafer, 1969). Second, the LCM identified unique groups of respondents based on their preferences for small mountain lake fishery attributes (Train, 2009). Thus, the heterogeneity between the groups highlights angler preferences that are relevant to fishery management. Third, the LCM included a number of covariates (Boxall & Adamowicz, 2002) that have been used to describe each

of the segments. Therefore, the researchers were able to study several stages anglers' behavioural processes (Figure 2) simultaneously, and to provide detailed profiles of each angler segment.

The result of the Principle Components Analysis (PCA) of anglers' motivations (Section 5.3) is perhaps the most interesting covariate from a fisheries research perspective. The PCA identified two activity-general motivation components (outdoors/relaxation and social) and two activity specific motivation components (catch and consumptive) (Table 7), in accordance with motivation theory (Fisher, 1997) and similar to the components found in other studies. For example, Sutton (2007) identified five motivation components: catching fish, relaxation, excitement, socializing and experiencing nature. Similarly, Mostegl (Forthcoming) analyzed a sample of British Columbian anglers' motivations, and identified four motivation components: nature, catch, social and eat. In both studies the motivation items within each component were very similar to the corresponding components identified by the PCA in this study.

While the results of the PCA of motivations for recreational angling are interesting when they are examined independently, namely the identification of four motivation domains (outdoors/relaxation, social, catching fish and consumption), they became much more revealing when included as a covariate in the LCM. For example, the covariates showed that *social anglers*

were not significantly motivated by the catching fish component, yet they exhibited increasing utility as the expected catch rate increased, and preferred a take limit of two fish. Similarly, the *valley* and *dedicated anglers* indicated a significant preference for a take limit of two fish, though both segments were not motivated by the consumption component. The results of the motivation covariate suggest that there is some disagreement between anglers reported motivations and their stated preferences for fishery characteristics, similar to the findings of Arlinghaus (2006). For example, a segmentation based solely on motivation information would have suggested that managers should focus on improving the activity-general aspects of the Okanagan (Region 8) fishery, and employ a more conservative management regime. However, the results of the Known Class – Latent Class Model demonstrate that both activity-specific and activity-general elements need to be managed to provide an attractive fishery. Thus, the use of motivation information as a covariate avoided the shortcomings of basing management decisions solely on behavioural antecedent research (Arlinghaus, 2006), and instead used anglers' behavioural antecedents (motivations) to provide more robust descriptions of the anglers who populated each segment identified by the LCM.

The other covariates used in the LCM revealed additional sources of heterogeneity that support the a-priori segmentation, and illuminate differences between all four angler segments. The three covariates which describe anglers' gear use (fly-rod gear use, spin casting gear use, and trolling gear

use) show that mountain anglers primarily use fly-fishing gear, while *valley anglers* use trolling equipment most often (Table 10). The differentiation in equipment use is similar to the results of Aas, Haider, and Hunt (2000) who found that anglers who used different types of gear had unique preferences for fishery characteristics.

Similarly, as Hunt (2005) states that the presence of stocking activities might be interpreted as an indicator of environmental quality, the importance of stocking information as a covariate suggests that mountain anglers are generally more concerned with the environmental quality of lakes than *valley anglers* (Table 10). Thus, the inclusion of the gear use, and importance of stocking information covariates allowed the researchers to describe additional sources of heterogeneity between the mountain and *valley anglers*.

The remaining covariates which described the respondents' ages, use of four wheel-drive vehicles, and amount of fishing compared to previous years, revealed additional sources of heterogeneity between all of the angler segments. For example, the age covariate suggests that older anglers are more likely to belong to the *dedicated angler* segment, while younger anglers are more likely to be members of the *social* or *valley angler* groups (Table 10). Interestingly, the general demographic trends show that fewer individuals aged 25-34, and 35-44 responded to the survey than older anglers (Figure 16). This

may suggest that anglers in this age group are too busy with other commitments to participate in recreational angling.

The four wheel drive covariate suggests that anglers who regularly use four wheel drive vehicles to access lakes for fishing more likely belong to the *dedicated angler* segment, and anglers who rarely or never use four wheel drive vehicles likely belong to the *valley angler* group (Table 10). Finally the previous years fishing comparison covariate suggests that anglers who fished less in 2010 than they have in previous years are more likely to belong to the *dedicated angler* group, than any of the other segments identified by the LCM (Table 10).

The results of this study show that the Latent Class Model was a useful means of identifying sources of heterogeneity in the Okanagan (Region 8) anglers' preferences for small mountain lake characteristics (see section 6.1 for a detailed description of each angler segments' preferences). Furthermore, the covariates explained sources of heterogeneity in anglers' behavioural antecedents and behavioural traits. Thus, this study explored anglers' entire behavioural process (Figure 2) and allowed the researchers to provide a comprehensive description of the unique angler groups that fish in the Okanagan (Region 8).

6.4 Respondent recruitment

The researchers used a variety of techniques to recruit respondents to the 2010 Okanagan (Region 8) Angler Survey. The intercept surveys personally distributed by the SFU researcher were the most effective method of recruiting respondents (measured by the proportion of intercept surveys returned) (Table 3). Distribution of intercept surveys by tackle stores, fishing clubs, recreation site operators, MFLNRO staff, FFSBC staff, and fishing resort operators were also valuable methods of contacting potential respondents (Table 3). However, it is difficult to know how many recruitment surveys were actually distributed via each of these means.

The comparison of recruitment survey responses revealed few significant differences between respondents who were contacted by the various recruitment techniques (section 5.1.2). The lack of significant differences between recruitment techniques suggests that little bias was introduced by the use of a variety of sampling strategies. However, it should be noted that the use of tackle stores and fishing clubs for distribution may have resulted in more avid anglers being sampled. Additionally, anglers who fished more often were more likely to be sampled by the SFU researcher.

The use of passive recruitment techniques (advertisements on angling websites) also contributed to the overall sample size. However, the use of angling media to recruit respondents may have introduced some bias into the

sample. For example, the comparison of actively and passively recruited respondents (section 5.1.3) suggests that passively recruited respondents are more specialized than actively recruited respondents. This finding is logical, as specialization theory states that more specialized anglers have higher levels of interaction with fishing related media (Ditton, Loomis & Choi, 1992). As such, specialized anglers were more likely to see advertisements for the 2010 Okanagan (Region 8) Angler Survey on fishing related websites than less specialized anglers.

Finally, the comparison of respondents who answered the survey online and those who answered paper based surveys revealed few significant differences (section 5.1.4). However, one notable difference was that respondents who completed the online version of the survey had more education than those who completed paper based surveys. Therefore, more educated individuals may be more likely to answer online surveys. In future studies researchers should ensure that a variety of survey media are available so no one is excluded from responding to a survey.

6.5 Limitations

Though the sampling techniques used for the 2010 Okanagan (Region 8) Angler Survey provided a diverse sample of anglers, some shortcomings may be associated with the sampling strategy. Perhaps the most important limitation is that the sampling techniques may not have provided a

representative sample of all Okanagan (Region 8) anglers. As such, the relative sizes of the four angler segments (section 5.4.2) may not reflect the proportions of Okanagan (Region 8) anglers present in the actual population. In future studies researchers could obtain a more representative sample by using the province wide fishing license database to recruit respondents. The use of the fishing license database would require an angling study to be conducted on a province wide basis so anglers from each management region in British Columbia could be identified, and their preferences for fishery characteristics could be applied to the appropriate regions.

Another limitation of this study was the method researchers used to select attribute levels for the hypothetical lakes in the second Decision Support Tool (DST) configuration (section 5.6.2). The researchers made a number of assumptions regarding the specific attribute levels that should be used to represent each hypothetical lake type. Therefore, the hypothetical lakes in the second DST configuration may not exactly reflect the lake types currently being considered by the FFSBC and MFLNRO. However, Okanagan (Region 8) fishery managers can personally manipulate the attribute levels in the DST to provide more accurate evaluations of the lake types they are considering.

The design of the 2010 Okanagan (Region 8) Angler Survey incorporated at least two weaknesses. First, the 2010 Okanagan (Region 8) Angler Survey only evaluated the type of campsites that anglers preferred when selecting

lakes for fishing. However, recreational angling research suggests that the number of encounters anglers have with other individuals affects the overall attractiveness of a fishing site (Banzhaf, Johnson & Mathews, 2001 in Hunt, 2005). As such, subsequent studies should include a variable that accounts for the size of campgrounds (number of campsites present at a fishing site) to determine if it influences lake selection.

Second, the *less committed anglers'* preferences and characteristics suggest that they are not overly satisfied by any of the lake types being designed by the FFSBC and MFLNRO. However, it is possible that these anglers prefer to fish in streams rather than small mountain lakes. Unfortunately no variables were included in the survey that could affirmatively state that anglers in the *less committed* segment prefer to fish in streams. Future studies exploring anglers' preferences for fishery characteristics in British Columbia should assess whether anglers prefer to fish in streams or small mountain lakes.

6.6 Conclusions

The results of this study showed that the lake types currently being designed by the FFSBC and MFLNRO align with most Okanagan (Region 8) angler segments' preferences for small mountain lake characteristics. The study identified four unique groups of Okanagan (Region 8) anglers, and described them in terms of their motivations for recreational fishing, their behavioural traits, and their preferences for small mountain lake fishery characteristics. The

profiles of each of the angler segments will be useful to fishery managers in the Okanagan (Region 8) when considering new management regimes.

The identification of four heterogeneous segments of anglers suggests that an experience-based approach to fishery management (Manfredo, Driver & Brown, 1983) in the Okanagan (Region 8) may lead to increased angler satisfaction. By creating a suite of lakes that satisfies the unique preferences of each angler segment, fishery managers can ensure all anglers have rewarding fishing experiences. However, the FFSBC and MFLNRO should carefully examine the results of this study that describe aspects of fisheries they have direct control over to ensure anglers' preferences are considered when developing new management regimes.

Though the methods used in the 2010 Okanagan (Region 8) Angler Survey did not explicitly evaluate anglers' preferences for stocking strategies, the DCE indirectly evaluated their preferred stocking outcomes (Lewin, Arlinghaus & Mehner, 2006). Generally the DCE results suggest that anglers prefer stocking strategies that increase the expected catch size and catch rate. However, the results of the Decision Support Tool (DST) show that each angler segment weighs the expected catch size and catch rate of fish relative to other fishery characteristics differently. Therefore, fishery managers should use the DST to evaluate anglers' preferences for stocking outcomes in relation to other fishery characteristics that influence site choice. By doing so fishery managers will be

able to design attractive lakes even if the expected catch rate and size of fish cannot be maximized in every instance.

The results of the DCE that describe anglers' preferences for fishery regulations are also pertinent to fishery management in the Okanagan (Region 8). Jantz and Tarangle (2010) reported that the FFSBC and MFLNRO are currently attempting to streamline regulations to reduce barriers to anglers. However, the results of the present study found that Okanagan (Region 8) anglers do not have homogeneous preferences for regulation regimes (Table 10). As such, the FFSBC and MFLNRO should consider developing regulatory regimes for each of the hypothetical lake types they are currently designing. Doing so would make regulations easier for the public to understand, while still accounting for heterogeneity in anglers' preferences.

In addition to providing fishery managers in the Okanagan (Region 8) with a description of the anglers who frequent the region, this study demonstrated a powerful combination of social science survey techniques. First, the results of the DCE in the form of a LCM show that studying anglers' intended behaviour can provide meaningful insights into angler preferences for fishery characteristics. Additionally, the study supports the findings of other studies which suggest that properly designed decompositional stated preference choice analyses can be a useful means for predicting anglers' responses to hypothetical management scenarios (Hunt, 2005; Haider, 2002; Timmermans,

1984). However, the selection of fishery product attributes and their associated levels is important and should be guided by previous academic research (such as the review provided in Hunt, 2005), and consultation with fishery managers and key informants (Haider, 2002).

Finally, this study contributes to a larger body of fishery research being conducted to improve fishery management in south-central British Columbia. The results of this study can be used in conjunction with other research that describes the biological impacts that anglers have on lakes (e.g. Post et al., 2008) to inform fishery management planning in the Okanagan (Region 8). Ultimately, a management strategy informed by both biological and human dimensions research will produce a healthy and attractive fishery.

APPENDICES

Appendix A – Recruitment script for Ministry of Forests, Lands and natural Resource Operations staff

Interviewer: _____ Interview #: _____
Date (Day/ Month / Year): _____
Location: _____

We are also assisting a researcher from Simon Fraser University; would you mind answering a few additional questions if you have not already participated in the study?

1. *On a scale from 1 to 5 where 1 is Poor and 5 is Highly Satisfactory, how would you rate today's trip?*

Poor				Highly Satisfactory
1	2	3	4	5

2. *Have you fished in freshwater in BC in the last year?*
[ ] Yes (If yes, proceed to question 3)
[ ] No (If no, proceed to question 2.B)

2.B. *Why not?* (Record response and proceed to question 5)

_____
_____

3. *Approximately how many days did you spend fishing in the Okanagan last year?*
_____ (Number of days per year)

4. *Approximately how many days did you spend fishing in freshwater last year?*
_____ (Number of days per year)

5. *Where are you from*?
Country: _____
Province/ State (if Can/US): _____
City/Town: _____
Postal Code (At least first 3 digits): _____

The SFU research team will also be conducting an Internet survey in the late summer and early fall. By completing the online survey you will be helping to shape the fishery management policies for the Okanagan region.

As a reward for completing the online survey you will be entered in a draw for a fishing rod and reel package. Do we have your permission to contact you by email to complete the Internet survey? <u>All personal information will be used for the purposes of this study only, and will not be released to any outside agency.</u>

Full Name: _____
Email Address: _____[**Please Double check**]

Thank you for your time. You can expect to receive an email from Simon Fraser University in the late summer. Have a nice day.

Appendix B – Intercept survey

2010 Recreational Angler Survey
Okanagan (Region 8)

Conducted by:

The School of Resource and Environmental Management

Simon Fraser University

The Freshwater Fisheries Society of British Columbia

Hello, we hope that you had a great fishing trip!

Researchers from *Simon Fraser University* and the *Freshwater Fisheries Society of British Columbia* are conducting a study of recreational fishers in the Okanagan region. The goal of the study is to better understand the different types of recreational anglers and their preferences for management strategies. This is your opportunity to share your insights and opinions about freshwater fishing in this region.

If you choose to participate any information you provide will be kept strictly confidential. There are no risks to you as a participant and your participation is strictly voluntary. Any concerns or complaints about this research can be directed to Dr. Hal Weinberg, Director, Office of Research Ethics at: hal_weinberg@sfu.ca or 778-782-6593.

Once you have completed this survey please place it in the attached prepaid envelope and drop it in mail.

If you have already completed this survey please recycle this copy, and thank you for your participation!

If you have not previously completed this survey please answer the questions below:

1. Have you fished in freshwater in BC in the last year (2009)?

[ ] Yes *(If yes proceed to Question 2)*
[ ] No *(If no please answer Question 1.B)*

1.B. Why not? *(Please use the space provided below for your answer)*

_____

_____

2. Approximately how many days did you spend fishing in freshwater last year (2009)?

____ Number of days

3. Did you fish in the Okanagan region last year (2009)?

[ ] Yes *(If Yes, please answer Question 3.B)*
[ ] No *(If No, please proceed to Question 4)*

3.B. Approximately how many days did you spend fishing in the Okanagan last year (2009)?

___ Number of days

4. How would you rate your recreational fishing experience in the Okanagan region? (*Check one*):

[ ]	[ ]	[ ]	[ ]	[ ]
Excellent	Very Good	Good	Fair	Poor

5. Please indicate your gender:

[ ] Female [ ] Male

6. Please indicate which age category you fall into:

[ ] 19-24
[ ] 25-34
[ ] 35-44
[ ] 45-54
[ ] 55-64
[ ] 65+

7. Where are you from?

Country: _____
Province / State (if Can/USA): _____
Town / City: _____
Postal / Zip Code: _____

We will be conducting a full survey in the late summer and early fall of this year, which will provide you with more opportunity to share your opinions about fishing in BC. When you complete that survey you will be eligible to enter a draw to win one of several prize packages.

To participate in the full survey please provide us with your mailing address and/or email address (below). All personal information will be used for the purposes of this study only, and will not be released to any outside agency.

You may participate in this survey either online or by mail; please indicate which method you prefer (*Check one*):

[ ] Please e-mail me the link to the survey
[ ] Please send the survey by mail

Name: _____

_____

Email Address: _____

_____

And/Or,

Mailing Address: _____

_____

_____

Thank you for your time!

Once you have completed this survey please return it in the attached business reply envelope.

We will be administering the full survey in the late summer.

Appendix C – Contact email for potential respondents

Dear «Respondent_name»,

Earlier this summer, you participated in a short angling survey conducted by Simon Fraser University and the Freshwater Fisheries Society of British Columbia. On the survey, you indicated that you be would interested in receiving our complete survey this fall.

To access the online survey, please click on the link below and sign in using the login ID:

'«LoginID»'

http://www.okfishingstudy.rem.sfu.ca/index.php?lg=y

We are interested in learning about your fishing activities in the Okanagan fishery (Region 8). The survey will help us to understand the regional distribution of anglers, and provide insights into the factors influencing anglers' decisions.

We hope that you will participate in this study. If you have any additional comments or questions please contact the research assistant Adam King (adamk@sfu.ca), or the principal investigator, Dr. Wolfgang Haider (whaider@sfu.ca).

As an added incentive you will have the option to enter a prize draw once you have completed the survey.

Sincerely,
Adam King, Master's Candidate, School of Resource and Environmental Management
Simon Fraser University

By filling out this questionnaire, you are consenting to participate. Your participation in this survey is voluntary, and you may choose not to respond to any question or terminate the survey at any time. All information that you provide in this survey will be kept strictly confidential in accordance with Simon Fraser University's research ethics guidelines. Any personal identifying information you provide will be used only to contact you in the event that you win one of the prizes. Your response will be stored offline in a secure password-controlled cache. Individual records will be identified using a code for data analysis and all records will be destroyed once the data analysis is complete. Your responses will be analyzed in aggregate and will not be identifiable in any publications. If you have any concerns, you may contact Dr. Hal Weinberg, hal_weinberg@sfu.ca.

Appendix D – Contact letter for potential respondents

SFU

school of resource & environmental management
faculty of environment

Tel: 778-782-4659
Fax: 778-782-4968
www.rem.sfu.ca

address
TASC 1, room 8405
Simon Fraser University
8888 University Drive
Burnaby BC V5A 1S6
Canada

<Address>
<address>
<address>

<Name>,

Earlier this summer, you participated in a short angling survey conducted by Simon Fraser University and the Freshwater Fisheries Society of British Columbia. On the survey, you indicated that you be would interested in receiving our complete survey this fall. Please find the survey enclosed; we truly appreciate you taking your time to support our research.

We are interested in learning about your fishing activities in the Okanagan fishery (Region 8). The survey will help us to understand the regional distribution of anglers, and provide insights into the factors influencing anglers' decisions.

We hope that you will participate in this study. If you have any additional comments or questions please contact the research assistant Adam King (adamk@sfu.ca), or the principal investigator, Dr. Wolfgang Haider (whaider@sfu.ca). Once you have completed the survey please return it in the pre-paid envelope provided.

As an added incentive, your name will be entered in a prize draw once we have received your completed survey.

Sincerely,

Adam King,
Master's Candidate, School of Resource and Environmental Management
Simon Fraser University

By filling out this questionnaire, you are consenting to participate. Your participation in this survey is voluntary, and you may choose not to respond to any question or terminate the survey at any time. All information that you provide in this survey will be kept strictly confidential in accordance with Simon Fraser University's research ethics guidelines. Any personal identifying information you provide will be used only to contact you in the event that you win one of the prizes. Your response will be stored in a locked cabinet in the Centre for Tourism Policy and Research at Simon Fraser University. Individual records will be identified using a code for data analysis and all records will be destroyed once the data analysis is complete. Your responses will be analyzed in aggregate and will not be identifiable in any publications. If you have any concerns, you may contact Dr. Hal Weinberg, hal_weinberg@sfu.ca.

Appendix E – Complete mail out survey

2010 Okanagan Angler Survey

By filling out this questionnaire, you are consenting to participate. Your participation in this survey is voluntary, and you may choose not to respond to any question or terminate the survey at any time. All information that you provide in this survey will be kept strictly confidential in accordance with Simon Fraser University's research ethics guidelines. Any personal identifying information you provide will be used only to contact you in the event that you win one of the prizes. Your response will be stored offline in a secure password-controlled cache. Individual records will be identified using a code for data analysis and all records will be destroyed once the data analysis is complete. Your responses will be analyzed in aggregate and will not be identifiable in any publications.

This survey pertains only to your fishing activities in the Okanagan (Region 8), as outlined on the map on the next page

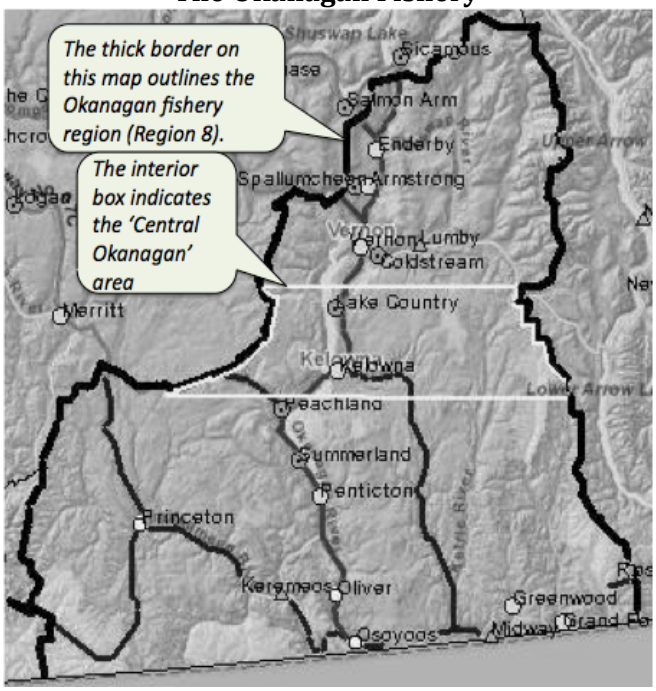
The School of Resource and Environmental Management

Simon Fraser University

The Freshwater Fisheries Society of British Columbia

1

The Okanagan Fishery



1. Please indicate if you are:
(Please check only one)

[ ] A 'Central Okanagan' resident
[ ] A resident of the Okanagan (outside of the 'Central Area')
[ ] Not an Okanagan resident

1.B If you answered '<u>Not an Okanagan resident</u>,' is fishing usually your primary reason for travelling to the Okanagan?

[ ] Yes
[ ] No

1.C If you answered '<u>No</u>', please specify your primary reason for visiting the Okanagan:

_____

_____

2. Where are you from?

Country: _____
Province / State: _____
City / Town: _____
Postal / Zip Code: _____

3. In total how many days have you spent fishing in any freshwater in 2010?

_____ Day(s)

4. How many days did you spend fishing in the study area (Okanagan, Region 8) in 2010?

_____ Day(s)

5. How many days did you spend fishing in freshwater in British Columbia in 2010?

_____ Day(s)

6. For how many years have you been fishing in the Okanagan (Region 8)?

_____ Year(s)

7. How does the number of days that you fished in the Okanagan (Region 8) this year compare to previous years (lakes only)?
(Please check only one)

[ ] This year I fished more than average
[ ] This year I fished about the same
[ ] This year I fished less than average

8. Out of 10 days of fishing how many days do you typically use each of the following types of equipment? *(Total must equal 10 days):*

_____ Day(s) Fly rod
_____ Day(s) Spin casting
_____ Day(s) Trolling equipment

9. At how many different lakes did you fish in the Okanagan (Region 8) this season (2010)?

_____ Lake(s)

10. Did any of the lakes you fished in the Okanagan (Region 8) in 2010 require a 4 - Wheel Drive Vehicle for access?

[ ] Yes
[ ] No

11. Which of the following statements best describes you as an angler? *(Please check only one)*

[ ]	Type I	Fishing is an enjoyable, but infrequent activity that is incidental to other travel and outdoor interests. I am not highly skilled in fishing, rarely read fishing articles, and do not own much fishing equipment beyond the basic necessities.
[ ]	Type II	Fishing is an important, but not exclusive outdoor activity. I occasionally read fishing articles and purchase additional equipment to aid in fishing, my participation in fishing is inconsistent, and I am moderately skilled at fishing.
[ ]	Type III	Fishing is my primary outdoor activity. I purchase ever-increasing amounts of equipment to aid in fishing, go fishing every chance I get, consider myself to be highly skilled in fishing, and frequently read fishing articles.

12. When fishing in the Okanagan (Region 8), do you prefer to fish in stocked lakes, or lakes with natural recruitment (unstocked)?
(Please check only one)

[ ] I prefer to fish in stocked lakes
[ ] I prefer to fish in lakes with natural recruitment
[ ] I like both

13. How important are each of the following statements when selecting a lake for fishing in the Okanagan (Region 8):

	Not at all important		*Somewhat important*		*Very important*
Knowing the species of fish the lake is stocked with	[ ]	[ ]	[ ]	[ ]	[ ]
Knowing how often the lake is stocked	[ ]	[ ]	[ ]	[ ]	[ ]
Knowing when the lake was last stocked	[ ]	[ ]	[ ]	[ ]	[ ]
Knowing the size of the stocked fish	[ ]	[ ]	[ ]	[ ]	[ ]
Knowing if the lake is stocked with sterile (triploid) fish	[ ]	[ ]	[ ]	[ ]	[ ]

14. Please indicate the importance of each of the following statements for your fishing trips in the Okanagan (Region 8) in 2010:

	Not at all important		*Somewhat important*		*Very important*
To catch fish for eating	[ ]	[ ]	[ ]	[ ]	[ ]
To experience new and different things	[ ]	[ ]	[ ]	[ ]	[ ]
To be with others who enjoy the same things you do	[ ]	[ ]	[ ]	[ ]	[ ]
To be outdoors	[ ]	[ ]	[ ]	[ ]	[ ]
To catch a 'record' or 'trophy' fish	[ ]	[ ]	[ ]	[ ]	[ ]
For the challenge or sport of fishing	[ ]	[ ]	[ ]	[ ]	[ ]
For relaxation	[ ]	[ ]	[ ]	[ ]	[ ]
To experience adventure and excitement	[ ]	[ ]	[ ]	[ ]	[ ]
To do something with family	[ ]	[ ]	[ ]	[ ]	[ ]
To be with friends	[ ]	[ ]	[ ]	[ ]	[ ]
To experience unpolluted natural surroundings	[ ]	[ ]	[ ]	[ ]	[ ]

15. When you fished in the Okanagan this season, how did you allocate fishing time between the valley bottom lakes (Lake Okanagan, Wood Lake, Mable Lake, Sugar Lake, Kalamalka, Skaha, Osoyoos Lake and Christina Lake) and the many mountain lakes?
(Total for valley bottom and mountain lakes must equal 100%)

I fish in the **valley bottom** lakes _____ % of the time
I fish in the **mountain** lakes _____ % of the time

If your response was '0%' for either **valley bottom** or **mountain** lakes, don't answer the questions regarding that type of lake in questions **16-19**

16. When you fished in the *valley bottom* lakes this season, what percentage of your time was spent fishing for each of the following species?
(Total for all species must equal 100%)

Rainbow Trout _____ % of the time
Kokanee _____ % of the time
Bass _____ % of the time
Other (please specify below) _____ % of the time

17. When you fished in the *mountain* lakes this season, what percentage of your time was spent fishing for each of the following species: *(Total for all species must equal 100%)*

Rainbow Trout _____ % of the time
Kokanee _____ % of the time
Bass _____ % of the time
Other (please specify below) _____ % of the time

Below, you may ignore the questions about fish species you did not fish for.

List of angling motivations for questions 18-19

1. To catch fish for eating
2. To experience new and different things
3. To be with others who enjoy the same things you do
4. To be outdoors
5. To catch a 'record' or 'trophy' fish
6. For the challenge or sport fishing
7. For relaxation
8. To experience adventure and excitement
9. To do something with family
10. To be with friends
11. To experience unpolluted natural surroundings

18. When fishing in *valley bottom* lakes for …

	My ***primary*** motivation is:	My ***secondary*** motivation is
… Rainbow trout	#:	#:
… Kokanee	#:	#:
… Bass	#:	#:
… Other	#:	#:

19. When fishing in *mountain* lakes for …

	My ***primary*** motivation is:	My ***secondary*** motivation is
… Rainbow trout	#:	#:
… Kokanee	#:	#:
… Bass	#:	#:
… Other	#:	#:

Next, we are interested in your preferences for <u>individual lake characteristics</u>

20. What is your most preferred catch rate?
(Please check only one)
[ ] 1 fish / 4 hours
[ ] 2 fish / 4 hours
[ ] 4 fish / 4 hours

21. What is your most preferred catch size?
(Please check only one)
[ ] 20-30cm (8-12 inches)
[ ] 30-40cm (12-16 inches)
[ ] 40-50cm (16-20 inches)

22. What is your most preferred motor restriction?
(Please check only one)
[ ] No restriction
[ ] 10 Hp maximum
[ ] Electric only

23. What is your most preferred gear restriction?
(Please check only one)
[ ] Single barbless hook, bait ban
[ ] Artificial fly only
[ ] No restriction

24. What is your most preferred take limit?
(Please check only one)
[ ] 0 fish
[ ] 1 fish
[ ] 2 fish
[ ] 5 fish

Next we are interested in your preferences for <u>lake access characteristics</u>

25. What is your most preferred travel distance on paved roads?
(Please check only one)

[ ] 0 km
[ ] 25 km
[ ] 50 km
[ ] 100 km
[ ] 150 km
[ ] 200 km

26. What is your most preferred travel distance on unpaved roads?
(Please check only one)

[ ] Less than 2 km
[ ] 15 km
[ ] 30 km
[ ] 45 km
[ ] 75 km

27. What type of access vehicle do you prefer?
(Please check only one)

[ ] Passenger vehicle
[ ] High clearance vehicle
[ ] 4 WD vehicle

28. What is your most preferred type of lake access?
(Please check only one)

[ ] Car-top boat launch
[ ] Trailer access boat launch
[ ] Walk-in only

On each of the following pages you will see 3 descriptions of mountain lakes. Imagine that each set characterizes the only fishing opportunities of mountain lakes. *(Please evaluate each set independently of the others)*

29. Out of 10 days of fishing how many days would you allocate to each of the following options?

Please insert your response in the boxes below the options

	Option A	Option B	Option C	Option D
Fishery characteristics				
Expected catch / 4 hours	4 fish	2 fish	1 fish	
Expected catch size	20-30cm (8-12in)	30-40cm(12-16in)	40-50cm(16-20in)	
Motor restriction	No restriction	10 hp maximum	Electric only	
Gear restriction	Single barbless hook, bait ban	Artificial fly only	No restriction	
Take limit	1 fish	2 fish	5 fish	Not fishing mountain lakes
Winter closure	Yes	No	No	
Physical characteristics				Fishing somewhere else
Travel on paved roads	150 km	50 km	100 km	
Travel on unpaved roads	0 km	50 km	75 km	Fishing fewer days this season
Required vehicle	High clearance vehicle	4 wd	Passenger car	
Boat launch	Walk in access only	Trailer access	Car-top launch	
Number of boats within 100m (330 ft.) radius	3 or more boats	0 boats	1 boat	
Accommodation	Lodge	Tent/camper sites	RV sites	

Insert response here → *Total must equal 10 days*	[ ] + **Option A**	[ ] + **Option B**	[ ] + **Option C**	[ ] **Option D**

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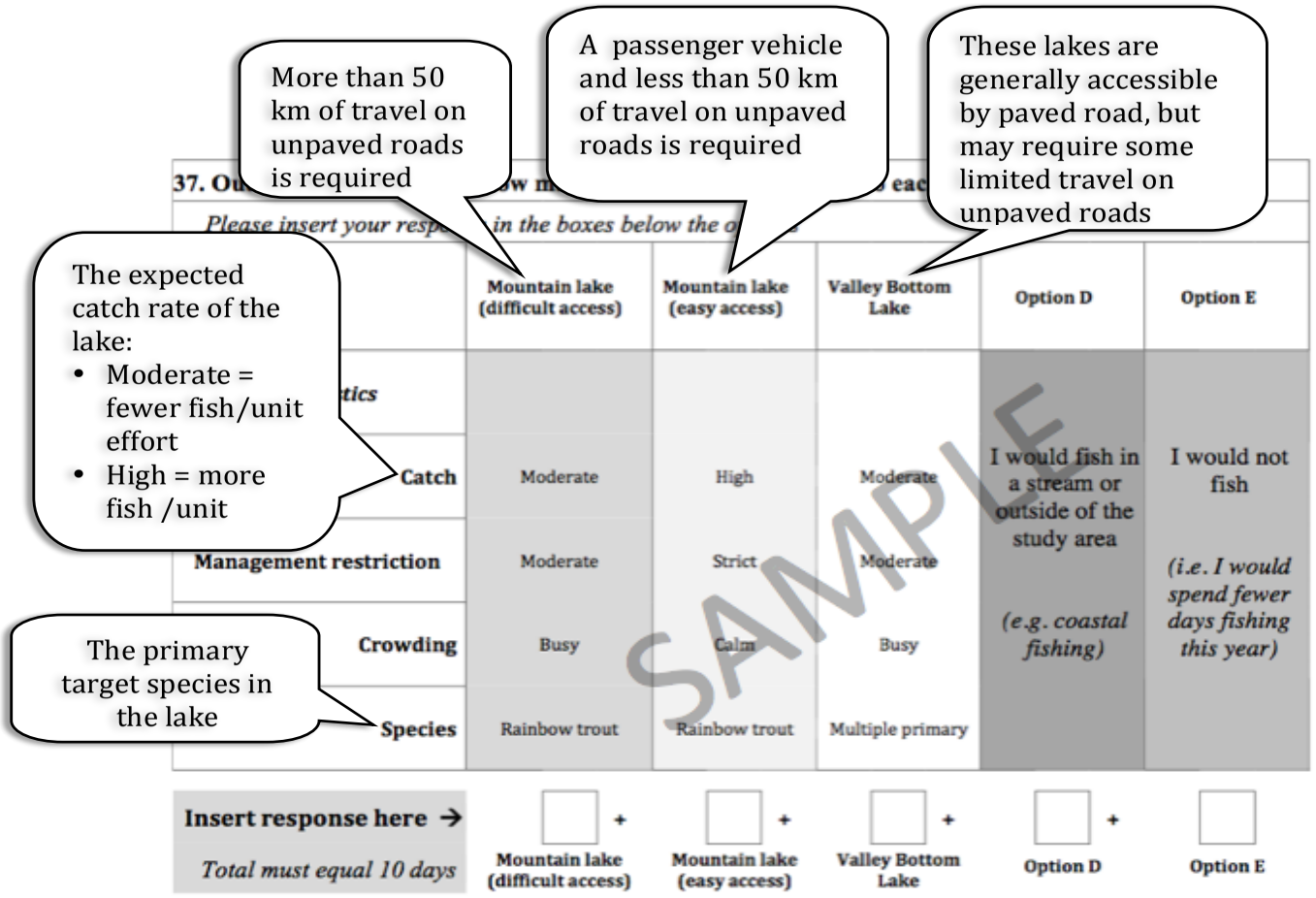
N.B. To save paper, only one choice set from this DCE has been presented in this appendix. However, each personalized survey included six unique choice sets.

The next set of questions describes the three types of lakes in the Okanagan: 1. Difficult access mountain lakes, 2. Easy access mountain lakes, and 3. Valley bottom lakes.



37. Out of 10 days of fishing how many days would you allocate to each of the following options?

Please insert your response in the boxes below the options

	Mountain Lake (difficult access)	Mountain Lake (easy access)	Valley Bottom Lake	Option D	Option E
Lake Characteristics				I would fish in a stream or outside of the study area *(e.g. coastal fishing)*	I would not fish *(i.e. I would spend fewer days fishing this year)*
Catch	Moderate	High	Moderate		
Management restriction	Moderate	Strict	Moderate		
Crowding	Busy	Calm	Busy		
Species	Rainbow trout	Rainbow trout	Multiple primary		

Insert response here → *Total must equal 10 days*	☐ +	☐ +	☐ +	☐ +	☐
	Mountain Lake (difficult access)	**Mountain Lake (easy access)**	**Valley Bottom Lake**	**Option D**	**Option E**

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N.B. To save paper, only one choice set from this DCE has been presented in this appendix. However, each personalized survey included four unique choice sets.

41. How often do you use each of the following types of accommodation while fishing in the Okanagan?

	Never	*On one, or part of a trip*	*On two or more trips*	*Every trip*	*Unsure*
At home (day trips only)	[ ]	[ ]	[ ]	[ ]	[ ]
Provincial park campground	[ ]	[ ]	[ ]	[ ]	[ ]
Forest service campground	[ ]	[ ]	[ ]	[ ]	[ ]
Other crown land camping	[ ]	[ ]	[ ]	[ ]	[ ]
Private campground	[ ]	[ ]	[ ]	[ ]	[ ]
Full service resort	[ ]	[ ]	[ ]	[ ]	[ ]
Basic resort (housekeeping only)	[ ]	[ ]	[ ]	[ ]	[ ]
With a friend/relative	[ ]	[ ]	[ ]	[ ]	[ ]
Hotel/Motel	[ ]	[ ]	[ ]	[ ]	[ ]
Other (please specify):	[ ]	[ ]	[ ]	[ ]	[ ]

_____

42. What is your gender?

[ ] Female
[ ] Male

43. What age category do you fall into?

[ ] 19 - 24
[ ] 25 - 34
[ ] 35 - 44
[ ] 45 - 54
[ ] 55-64
[ ] 65 +

44. Please indicate the highest level of education you have completed:
(Please check only one)

[ ] Elementary / middle school (grades 1 – 8)
[ ] High school (grades 9 – 12)
[ ] Trade school or technical college
[ ] University degree

45. Are you a member of a fishing club?

[ ] No
[ ] Yes (*if yes please answer question* **45.A**)

45.A Which fishing club do you belong to?

[ ] Penticton Fly fishers
[ ] Princeton Fish and Game Club
[ ] Lonely Loon Fly fishers Society
[ ] Peachland Sportsmen's Association
[ ] Otter Valley Fish and Game Club
[ ] Keremeos - Cawston Sportsmen Association
[ ] Kalamalka Fly Fishers Club
[ ] Enderby Fish and Game
[ ] Oceola Fish and Game Club
[ ] British Columbia Wildlife Federation (BCWF)
[ ] Other (Please specify):

_____

Thank you very much for filling out the survey!
Your answers will provide very important information for the improvement of the freshwater fisheries in the Okanagan

Please provide your contact information so that we can enter your name in the prize draw

(Please cut this section out and return it in the same envelope and as the survey!)

Name:

Email address:

Mailing address:

Appendix F – Link to online survey

To view the online survey please visit:

http://www.okfishingstudy.rem.sfu.ca/

Appendix G – Non-significant comparisons between segments

This appendix presents the results of comparisons that did not reveal significant differences between the four angler segments.

Socio-Demographics†

	Total sample		Dedicated		Social		Less Committed		Valley		Chi Square (p-value)
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	
Gender											
Female	32	8.9%	10	7.1%	10	15.6%	7	12.3%	5	5.2%	**7.556 (0.272)**
Male	311	86.9%	124	88.6%	51	79.7%	49	86%	87	89.7%	
Education											
Elementary / middle school	8	2.2%	1	0.7%	3	4.7%	0	0%	4	4.1%	**13.419 (0.339)**
High school	112	31.3%	37	26.4%	20	31.3%	17	29.8%	38	39.2%	
Trade school or technical college	151	42.2%	65	46.4%	25	39.1%	26	45.6%	35	36.1%	
University degree	70	19.6%	29	20.7%	13	20.3%	13	22.8%	15	15.5%	

†Due to missing data, total sample sizes differ for each characteristic
*Sig at 90%, **Sig at 95%, ***Sig at 99%

Residence Information†

	Total sample		Dedicated		Social		Less Committed		Valley		Chi Square (p-value)
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	
Central Okanagan Resident?											
Central Okanagan Resident	164	45.8%	71	50.7%	27	42.2%	25	43.9%	41	42.3%	**7.584 (0.577)**
Resident of the Okanagan outside of the central area	117	32.7%	42	30%	24	37.5%	22	38.6%	29	29.9%	
Not an Okanagan Resident	76	21.2%	27	19.3%	13	20.3%	10	17.5%	26	26.8%	
Is fishing your primary motivation for visiting the Okanagan?											
Yes	41	11.5%	18	12.9%	6	9.4%	3	5.3%	14	14.4%	**5.903 (0.434)**
No	34	9.5%	9	6.4%	7	10.9%	7	12.3%	11	11.3%	

†Due to missing data, total sample sizes differ for each characteristic
*Sig at 90%, **Sig at 95%, ***Sig at 99%

Fishing Club Member†											
	Total sample		Segments								Chi Square (p-value)
			Dedicated		Social		Less Committed		Valley		
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	
Yes	119	33.2%	51	35.7%	21	32.8%	16	28.1%	32	33%	**2.228 (0.898)**
No	225	62.8%	84	60%	40	62.5%	40	70.2%	61	62.9%	

†Due to missing data, total sample sizes differ for each characteristic

*Sig at 90%, **Sig at 95%, ***Sig at 99%

Stocked or wild lakes preferred†											
	Total sample		Segments								Chi Square (p-value)
			Dedicated		Social		Less Committed		Social		
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	
Stocked	34	9.5%	15	10.7%	10	15.6%	4	7%	5	5.2%	**16.543 (0.168)**
Wild	23	6.4%	6	4.3%	1	1.6%	4	7%	12	12.4%	
I like both	297	83%	117	83.6%	53	82.8%	48	84.2%	79	81.4%	

†Due to missing data, total sample sizes differ for each characteristic

*Sig at 90%, **Sig at 95%, ***Sig at 99%

Appendix H – Results of multiple regression evaluating angler specialization

	Descriptive Statistics	
Specialization characteristic	Mean	Standard Deviation
Days fished in 2010	31.41	32.869
*Sum of importance of stocking information scores	15.44	5.572
**Fishing club member	1.65	0.477

* Sum of five importance of stocking information questions (1 – Not at all important, 5- Very important)
** Dummy variable coded as 1- fishing club member, 2 – not a fishing club member

		X Coefficients				
		Unstandardized coefficients		Standardized coefficients		
Model		Beta	Standard Error	Beta	T-value	P-Value
1	(Constant)	2.166	0.041		52.23	<.001***
	Days fished in 2010	0.008	0.001	0.415	8.260	<.001***
2	(Constant)	1.848	0.090		20.46	<.001***
	Days fished in 2010	0.007	0.001	0.410	8.342	<.001***
	Y Sum of importance of stocking information scores	0.021	0.005	0.194	3.939	<.001***
3	(Constant)	2.081	0.140		14.89	<.001***
	Days fished in 2010	0.007	0.001	0.368	7.704	<.001***
	Y Sum of importance of stocking information scores	0.021	0.005	0.197	4.035	<.001***
	Z Fishing club member	-0.137	0.063	-0.109	-2.177	0.03**

X Dependent variable: Angler Type
Y Sum of five importance of stocking information questions (1 – Not at all important, 5- Very important)
Z Dummy variable coded as 1- fishing club member, 2 – not a fishing club member
* Sig at 90%, ** Sig at 95%, *** Sig at 99%

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