Factors Associated with Angling License Purchase Frequency and Fishing Site Choice for BC Anglers

by

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Abstract

A substantial proportion of anglers in British Columbia (BC) are infrequent, meaning that they do not purchase a license every year. Maintaining fishing license sales is an important objective of fisheries management and leads to stable revenue for conservation and management. To sustain participation, we must better understand the characteristics, license-purchasing habits and fishing site preferences of infrequent anglers, as well as differences between infrequent and frequent anglers. We employed a survey distributed to random BC anglers stratified by participation; a follow-up survey was used to assess non-response bias. The results showed that age, fishing skills and centrality of fishing to lifestyle, number of other anglers in household and usual time of license-purchasing influenced the anglers' likelihood to be frequent license-purchasers. Choice modeling identified the differences in fishing site preferences (e.g., expected fish size, amenities) between the two angler groups and revealed what management actions would increase overall angler satisfaction.

Keywords: angler heterogeneity; avidity; fishing license; stated-preference choice; nonresponse

In memoriam Dr. Wolfgang Haider

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Poleg tega pa sem iz srca hvaležna mami in atiju, ki sta brezpogojno verjela vame, me nesebično podpirala v mojih podvigih in me vzpodbujala kadar sem bila na dnu.

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List of Acronyms

AIC   Akaike Information Criterion

ASC   Alternative-Specific Constant

AUC   Area Under the Curve

BC   British Columbia

ROC   Receiver Operating Characteristic

RUT   Random Utility Theory

SPC   Stated-Preference Choice

Chapter 1.

Introduction

1.1. Introduction to Angler Heterogeneity and Fishing Preferences

Management of freshwater fisheries forms a complex interdisciplinary system consisting of both environmental and social components: the fish, the natural habitats, the anglers and other external, human- and nature-driven, factors. Decades of social fisheries research have shown that the human dimensions of fishing too are a complex system within itself. The focus of this research are the recreational fishing license purchasing habits of British Columbia (BC) anglers and the differences between different types of anglers within this jurisdiction.

Over the past couple of decades, a decline in recreational fishing license sales has been observed in BC (Fisheries and Oceans Canada, 2010) and worldwide (Bruskotter & Fulton, 2013); although, some signs of a reversal of this trend have been observed in the United States (U.S. Department of the Interior, U.S. Fish and Wildlife Service, U.S. Department of Commerce, and U.S. Census Bureau, 2018). Declining license sales are challenging from the fisheries management perspective for three main reasons (Dabrowska, Demsar, van Poorten, & Haider, 2018). Firstly, license sales revenue often funds fisheries monitoring, assessment and management, as well as habitat improvements and fish stocking. Secondly, license sales are often used as an index of fishing participation and sometimes even angler satisfaction. And lastly, there is a broader concern that the increasingly urbanized society is becoming progressively more disconnected from the natural environments and the benefits that they directly or indirectly provide (e.g., urbanization and post-modernization was shown to have a negative effect on fishing interest [Arlinghaus, Tillner, & Bork, 2015]). While in BC many anglers purchase their license every single year (and are thus considered frequent anglers), the results from a 2011 province-wide survey of freshwater license holders indicate that the vast majority of BC anglers may be considered infrequent (sometimes also referred to as *lapsed*) anglers, meaning that they do not purchase a license every year (Dabrowska, Haider, & Hunt, 2014).

In the attempt to better understand the drivers of the decline in fishing license sales and to devise approaches to reverse it, much research has focused on investigating angler motivations, barriers to participation, specialization, habits, preferences, and other attributes. Early on, it became evident that anglers are a very diverse recreational group, and consequentially, there is now a substantial literature examining angler heterogeneity in the above-mentioned attributes (e.g., Arlinghaus, Bork, & Fladung, 2008; Bryan, 1977; Dorow, Beardmore, Haider, & Arlinghaus, 2010; Fisher, 1997). Significant effort has been directed towards increasing the understanding of drivers of angler heterogeneity and the interrelationships and systems that link the different ways heterogeneity reveals itself. Yet, it is still often unclear how this heterogeneity affects fisheries surveys and other types of fisheries research. It has been suggested that more specialized, frequent or avid anglers are more engaged in the fishing process and thus more eager to provide feedback to management and to respond to fisheries surveys, and more likely to be intercepted on-site (Thomson, 1991). Thus, fisheries public consultation, surveys, fisheries forums and app data are likely to be overrepresented by these frequent anglers (BC Ministry of Environment, 2007; Jiorle, Ahrens, & Allen, 2016; Venturelli, Hyder, & Skov, 2016). If research typically attracts the same angler profile, then the data collected from these non-representative or convenience samples might not reflect the true opinion of the entire angler population and could thus result in management decisions that would not be supported by the entire angler population (L. M. Hunt, Gonder, & Haider, 2010).

Drawing conclusions on angler's fishing preferences using data from a convenience sample would not be problematic if the survey nonrespondents did not differ from the respondents. However, it is likely that there are substantial differences between the anglers who do and who do not typically respond—specifically, it can be expected that there exist differences in fishing preferences between frequent and infrequent anglers (see for example Dabrowska et al., 2018). If frequent anglers participate in fisheries surveys more often, then the opportunities devised based on those data could be driving infrequent anglers further away from the sport, when their fishing preferences are in contrast with those of frequent anglers. Additionally, managers have long recognized that the key to improving overall fishing participation is to attract and retain those anglers who only buy licenses occasionally (Balsman & Shoup, 2008). Therefore, it is crucial to investigate infrequent anglers' fishing preferences as well as

their characteristics (and compare them to those of frequent anglers), to know how to better serve this angler group, increase their satisfaction and perhaps even entice them to participate in the sport more frequently.

1.2. Research Objectives

The purpose of this research is to gain a better understanding of infrequent anglers, and determine if and how they differ from frequent anglers, both in terms of their sociodemographic and angling-specific characteristics as well as their fishing site preferences. Such an investigation has only become possible recently in BC with the implementation of an electronic license database through which infrequent anglers can be identified and contacted.

The objectives of this research are to:

- investigate the differences between frequent and infrequent anglers, and identify angler characteristics that influence an angler's likelihood to be a frequent license-purchaser;

- determine angler preferences for fishing site attributes, and whether these preferences differ between frequent and infrequent anglers; and

- explore the effects of potential nonresponse bias on survey results.

Chapter 2.

Literature Review

2.1. Understanding Angler Behavior: There Is No Average Angler

Human behavior flows from three main sources: desire, emotion, and knowledge.

(Plato)

The desire for a deeper understanding of leisure participants has been driving empirical and theoretical examinations for many decades (e.g., Burch, 1969). Likewise, recreational fisheries managers and planners have long recognized the importance of a solid understanding of anglers, as discussed earlier. The system of products and its users in the case of recreational fishing is multifaceted. On one hand, fisheries "products" are not simply the fish, but the "specific combinations of fish and the physical, social, and managerial setting in which they are found" (K. M. Hunt & Ditton, 1997, p. 336). And on the other hand, anglers are driven by a multitude of values, desires, needs and motivations, which collectively influence their behavior: "[n]othing is more fundamental to angling behavior than the factors that prompt it" (Fedler & Ditton, 1994, p. 6). Hence, the research field of human dimensions of recreational fishing has substantially expanded since its early stages and now comprises studies that provide crucial insight into both the anglers themselves, together with their preferences for the fisheries products.

In the field of outdoor recreation, Shafer (1969) stipulated that the average camper does not exist except in research reports. Subsequently, an analogous notion has been accepted by the recreational fishing literature: in the same way, the average angler also only exists in research studies and fisheries reports (Aas & Ditton, 1998). This heterogeneity of sport-fishing participants has long been widely recognized on an intuitive level (Fedler & Ditton, 1994). Moreover, significant efforts have been made to empirically evaluate the presumed differences among anglers in their motivations (e.g., Fedler & Ditton, 1994; Schuett, Lu, Ditton, & Tseng, 2010), behavior (e.g., Arlinghaus,

Bork, & Fladung, 2008; Dorow, Beardmore, Haider, & Arlinghaus, 2010), as well as preferences and attitudes (e.g., Aas, Haider, & Hunt, 2000; Beardmore, Haider, Hunt, & Arlinghaus, 2011; Hutt & Neal, 2010).

Angler heterogeneity can stem from the differences between anglers (inter-angler variation) or within an angler (intra-angler variation); the variation can be either observable or unobservable to the researcher (Dabrowska, Hunt, & Haider, 2017). Unobservable heterogeneity cannot be measured directly and needs to be estimated with statistical methods. Observable intra-angler variation causes an angler to behave differently in different contexts; the few studies that have investigated this type of heterogeneity showed that it can have a strong effect on angler behavior and preferences (e.g., Hunt, Boots, & Boxall, 2007). Most research attention has been devoted to the observable inter-angler heterogeneity—anglers demonstrate different preferences and behavior in identical situations, which results from the differences in characteristics among the anglers. Researchers have investigated the heterogeneity of different angler subpopulations as defined by sociodemographic characteristics (e.g., age, gender, income level or ethnicity), residency (e.g., on the gradient from urban to rural; Arlinghaus & Mehner, 2004; Hutt & Neal, 2010), fish species targeted within a given context (e.g., Beardmore et al., 2011; Fedler & Ditton, 1994), or catch preference and consumptive orientation (e.g., Carlin, Schroeder, & Fulton, 2012; Kyle, Norman, Jodice, Graefe, & Marsinko, 2007).

Keeping angler heterogeneity in focus, this section overviews the theoretical concepts related to the human dimensions of recreational fishing. Herein, I explore the various ways of angler segmentation (with an emphasis on the concept of angler specialization), angler preferences and attitudes, motivations and barriers of anglers, and angling participation and avidity.

2.1.1. Exploring Angler Heterogeneity and Segmentation

The predominant approach to angler segmentation employs the concept of recreational (angler) specialization to assess, and attempt to explain, the differences and similarities in motivations, preferences, and behavior between the latent groups of recreational fishers (C.-O. Oh, Sutton, & Sorice, 2013). In this section I provide an in-

depth overview of the concept of angler specialization and related theories, with a focus on the elements that directly relate to my research.

In order to explore recreational group heterogeneity and the underlying processes that drive this inter-group diversity, Bryan (1977) developed a concept of recreational specialization, where he adapted a dictionary definition of specialization to "a continuum of behavior from the general to the particular, reflected by equipment and skills used in the sport and activity setting preferences" (p. 175). The author applied this specialization framework to an example of American trout anglers and identified four angler segment subgroups, arranged along a specialization continuum from general to specialized. Bryan outlined four groups of anglers along the specialization continuum: a) occasional anglers, who fish infrequently because the activity has not become a regular part of their leisure; b) generalists, anglers who have established the sport as a regular activity and use a variety of techniques; c) technique specialists, anglers who specialize in a particular technique to the exclusion of others; and d) technique-setting specialists, highly committed anglers who have a distinct preference for techniques and fishing site types (physical setting).

According to Bryan's (1977) theory[1], an angler is expected to move through these specialization groups with time and progress into higher stages of specialization and involvement the longer he or she participates in the activity, becoming ever-increasingly committed to the sport (as emphasized by Scott and Shafer [2001]). With this developmental progression on the specialization continuum, angler values, preferences, attitudes, personal norms, and finally, behaviors are expected to shift along with intensity of involvement (Bryan, 1977; Ditton, Loomis, & Choi, 1992; Scott & Shafer, 2001). Of particular significance to my research is the notion that the typical behaviors that change along the specialization continuum include fishing participation, or angling avidity. Similarly, Bryan (1977) observed that linked to the progression along the specialization continuum is also an anglers' consumptive orientation and the importance of catching any fish versus catching fish under specific conditions.

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[1] This theory has not yet been confirmed empirically—studies were unable to detect forward movement along the specialization continuum (see, for example, C. Oh, Sorice, Ditton, & Sorice, 2011)

Following Bryan's (1977) development of the theoretical framework of recreational specialization continuum, researchers have adopted various approaches to assessing specialization (e.g., Choi, Loomis, & Ditton, 1994; Ditton et al., 1992; McFarlane, 1994; McIntyre, 1989; McIntyre & Pigram, 1992). Scott and Shafer (2001) emphasized that while Bryan's initial work was less clear upon which aspect of specialization should be the focus of future research, he later proposed that specialization be considered in terms of two underlying measures: behavior (as it is reflected in the length and degree of involvement) and attitudes and values (as they change with increasing centrality of the activity to an individual's identity). Building on Bryan's foundational theoretical concepts, Scott and Shafer (2001) later proposed that an individual's progression along the recreation specialization continuum can be broken down into three elements: "(a) a focusing of behavior, (b) the acquiring of skills and knowledge, and (c) a tendency to become committed to the activity such that it becomes a central life interest" (p. 326).

The focusing of behavior on one leisure activity at the expense of others is arguably directly related to angling participation and avidity, the focal interest of this research project; while the other two elements are of specific relevance to my study due to the way they might be related or have an effect on avidity. In the following two sections I explore the latter two proposed elements of recreation specialization—commitment and skills. Subsequently, I provide an overview of prevalent metrics of recreation specialization.

Angler Commitment and Centrality to Lifestyle

Numerous studies have perused commitment to a leisure activity, along with related constructs such as centrality to lifestyle and enduring involvement, as a means of assessing recreational specialization. Scott and Shafer (2001) summarize these studies as generally taking one of two approaches to mapping the relationships between these constructs. The first approach (attributed to McIntyre [1989]) does not differentiate much between commitment and involvement, and treats centrality as a dimension of involvement. The second approach, adopted more widely, regards commitment and centrality as distinct components of specialization; commitment typically being measured in terms of financial expenses and the amount of equipment owned, and centrality estimated in terms of comparative importance of and percent of time devoted to a

particular leisure activity, aspiration for further skill development, membership in clubs, and subscription to leisure-related magazines (e.g., Kuentzel & McDonald, 1992; McFarlane, 1994).

Buchanan (1985) was among the first researchers to begin formally exploring the links between commitment and leisure behavior. The author proposed that for committed anglers, frequent participation in recreational fishing is crucial for self-expression—he linked high levels of experience with fishing and its centrality to an individual's lifestyle with reducing time, resources and interest an angler makes available for other recreational activities, thus behaviorally and psychologically bonding him or her to the activity of fishing. Similar to Bryan's (1977) two elements of recreation specialization (i.e., behavior, and attitudes and values), Buchanan identified two sub-dimensions of commitment to fishing: consistent or focused behavior over time (which expresses willingness to devote time and effort to the activity and can be measured by estimates of experience levels and avidity) and affective attachment (which captures the personal fulfillment and enjoyment and can be investigated through variables that measure the centrality of the activity to the individual's lifestyle).

Commitment in the context of recreational activities has later also been defined as the "personal and behavioral mechanisms that bind individuals to consistent patterns of leisure behavior" (Kim, Scott, & Crompton, 1997, p. 336). Not unlike Buchanan's (1985) two sub-dimensions of commitment and personal binding mechanisms denote the affective attachment that an individual develops for an activity (Sutton & Oh, 2015), because it is perceived to be personally meaningful, enjoyable, and intuitively worthwhile (Kim et al., 1997). Behavioral binding mechanisms, however, can be either social in nature—namely, shaped by an individual's perceived expectations by other people to continue with the activity; or refer to the costs (monetary or non-monetary, in terms of the actor's own value system) an individual would experience with discontinued participation in the activity (Johnson, 1973), for example, the loss of social connections and friendships within the recreational community, loss of financial investment in equipment, or loss of self-concept (Sutton & Oh, 2015). Similarly, Scott and Shafer (2001) proposed a definition of commitment, which later became largely accepted by other researchers, as "the types of personal and behavioral investments that recreationists may develop over time" (p. 329) and argued that "individuals who evince a high degree of personal and behavioral commitment are likely to regard the activity as a central life interest" (p.

329). In other words, personal and behavioral mechanisms cause an individual to be increasingly bound to an activity, that in turn increases the importance of the activity for the individuals' personal identity, so the individual's leisure needs are progressively more tightly linked to the activity, and thus, the motivation for continued participation in the activity heightens (Scott, Baker, & Kim, 1999).

In the case of recreational fishing, the interplay between the two components of commitment is reflected when participation in fishing becomes progressively more important to an angler: participation in fishing is expected to enable the angler to meet his or her social-psychological needs and needs of self-expression and leisure, as these needs increase when fishing becomes more central to the angler's lifestyle (Sutton & Ditton, 2001). The angler's dependence on fishing to meet their abovementioned needs is increased due to rejection of other leisure activities in favor of fishing that has occurred through increasing commitment to fishing (Sutton, 2006).Therefore, it is reasonable to conclude that a more committed angler is also a more avid one, since commitment to fishing increases an individuals' need and desire to regularly participate in the sport.

A common approach to measure the level of a recreationist's commitment to an activity is through the concept of centrality to lifestyle. Centrality to lifestyle has first been evaluated as a recreational commitment measurement tool in the context of birdwatching by Kim, Scot and Crompton (1997) and has been defined by the authors as "the extent to which a participant's lifestyle and social networks are connected to his or her pursuit of a given leisure activity" (p. 324). The authors also stipulated that since the concept of centrality assumes that the activity is an individual's central life interest, it is implicitly exclusive in its nature and thus indicates a dismissal of alternative leisure activities (similar to Scott and Shafer's (2001) idea of focusing of behavior on one leisure activity at the expense of others). This is in contrast with Bryan's (1977) characterization of recreation specialization, which, in his view, "does not necessarily imply narrowing or restriction of other activities outside the speciality" (p. 186). The researchers established a centrality to lifestyle scale which sought respondents' level of agreement (on a five-point Likert-type scale) with nine statements, all of which were used to estimate one underlying factor—the centrality to lifestyle index.

Centrality to lifestyle has often been used as a measure of psychological involvement and commitment in outdoor recreation, in particular as a proxy for angler

specialization or commitment (e.g., Sutton & Ditton (2001) employed the centrality to lifestyle index to measure the affective attachment component of commitment to fishing). Sutton (2003) later adapted the initial centrality to lifestyle scale developed by Kim et al. (1997) for recreational fishing, which has since been adopted widely (e.g., Beardmore, Hunt, Haider, Dorow, & Arlinghaus, 2015; Dabrowska, Hunt, & Haider, 2017; Li, Sutton, & Tynan, 2010; Sutton & Oh, 2015). In a choice experiment study, this adapted recreation centrality scale had the highest explanatory power among 11 specialization metrics to predict respondent membership in three latent angler specialization classes (Beardmore, Haider, Hunt, & Arlinghaus, 2013). Furthermore, in a different choice experiment study, specialization level (as estimated through the centrality to lifestyle scale) has been shown to be clearly related to the choice the respondents made between two hypothetical fishing sites designed by fish managers: one for novice anglers and the other for expert anglers (Dabrowska et al., 2017). These results indicate that the centrality scale is an appropriate tool for estimating recreation specialization, one of the components of angler heterogeneity.

Fishing Skill and Knowledge Acquisition

As anglers progress along the recreation specialization continuum, their skills and knowledge concurrently evolve (Bryan, 1977); with continuing participation in the activity they gather further experiences from which they can learn and thus advance their skills and knowledge (Scott & Shafer, 2001). Therefore, many researchers used past experience and participation (for example, days of fishing in the past twelve months, or years of fishing experience) as a surrogate measure of specialization, assuming that activity skill and knowledge levels would increase with higher levels of participation[1] (Fisher, 1997). Scott and Shafer (2001) remarked that such an approach would not adequately capture the fact that individuals' desires to advance their skills and expand their knowledge vary substantially. The authors also stipulated that an individual's regular participation in the activity does not necessarily lead to an increase in skills and knowledge, and, *vice versa*, highly skilled and knowledgeable individuals may not necessarily frequently participate in the leisure activity.

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[1] Although the researchers (Ditton et al., 1992; Graefe, 1981) found evidence of an effect of fishing participation on the dependent variables (resource dependency, skill level, and mediate interaction among other anglers), the correlation was not linear and interpretation of the relationship equivocal (Fisher, 1997).

Infrequent participation in recreation can be linked to various constraints that individuals face when navigating their leisure interests, as discussed below (Section 2.1.2.), and the relationship between the constraints and skills is twofold. First, as Scott and Shafer (2001) commented, even highly skilled and knowledgeable individuals (which are presumably closer to the "particular" end of the recreation specialization continuum) may participate infrequently. The explanation for their non-regular partaking in the activity may lie in an unsuccessful navigation of constraints to participation (e.g., lack of leisure time), therefore using past experience as a measure of skills and knowledge would not necessarily reveal the actual level of individuals' skills and knowledge, and consequently their assessed recreation specialization levels. And second, a self-perceived lack of skill can be a constraint to participation itself (Fedler & Ditton, 2001). For example, a concern about their skill level has been used to explain nonparticipation in outdoor recreation among women (Shores, Scott, & Floyd, 2007). On the other hand, skill development can be an important motivational factor for participation to many anglers (see for example Manfredo, Driver, & Tarrant, 1996; Schuett, Lu, Ditton, & Tseng, 2010), and anglers who strive to increase their levels of skills and knowledge are likely to become more interested in the activity over time (Kuehn, Luzadis, & Brincka, 2013).

The relationship between an individual's level of leisure activity skills and knowledge, and his or her participation in and commitment to this activity is evidently complex. However, previous research indicated that, generally, with increased specialization the desire for improved skills and knowledge grows; with this desire the motivation for continuing participation intensifies, which in turn results in higher levels of participation that helps actually develop activity skills and build knowledge. In fact, years of fishing experience and frequency of participation have been found to be the most important contributors to specialization (Chipman & Helfrich, 1988). Nevertheless, while some researchers have operationalized recreation specialization with a single metric (such as level of participation over the past twelve months), this approach has been described as overly simplistic as it does not adequately capture the multi-dimensional nature of specialization (Ditton et al., 1992).

Metrics of Recreation Specialization

Multidimensionality has been a recognized characteristic of recreation specialization since the inception of the theoretical concept (Bryan, 1977). The author suggested that the levels of (angling) specialization were revealed through the following elements, among others: level of participation, preference for a social setting of the activity, fishing site setting preferences, technique preferences and choice of fishing equipment, importance of catching fish, and preference for the style of fisheries management. Consequently, measuring the quantitative or qualitative features of these elements presents itself as a way of determining an individual's level of angling specialization.

Operationalization of specialization metrics has not been a straightforward process, however, and a multitude of approaches have been established throughout decades of research without reaching a consensus on the best method of operationalizing this multidimensional construct (Scott & Shafer, 2001). The numerous past recreational fishing studies can be arranged into three groups, each investigating one of the three dimensions of specialization outlined by Scott and Shafer: focusing of behavior; acquiring skills and knowledge (e.g., self-classified skill level; Scott, Ditton, Stoll, & Eubanks, 2005); and psychological commitment.

Behavioral and psychological metrics of specialization are the most commonly used constructs in outdoor recreation research, due to their "activity-general" orientation[1] (Beardmore et al., 2013). For example, frequency of fishing participation has been used in the very first empirical verification of the recreation specialization construct (Graefe, 1981), and, as discussed above, has widely been used as a behavioral metric of specialization, measured as days of fishing in the past year or total years of fishing experience (e.g., Ditton et al., 1992). In this application, frequency of participation can be understood either as a direct indicator of the "focusing of behavior" dimension of specialization, or as a proxy for the skill and knowledge dimension. On the other hand, the centrality to lifestyle construct (Kim et al., 1997; discussed in more detail above) has emerged as an especially widespread metric of recreation specialization with a psychological focus.

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[1] For more information on "activity-general" and "activity-specific" elements of recreational fishing see section 2.1.2.

On the other hand, "activity-specific" correlates of specialization have also been developed and verified for consumptive outdoor activities such as recreational fishing (Beardmore et al., 2013). Catch (or, consumptive) orientation, in particular, often correlates with specialization and commitment—generally, more committed anglers display a stronger consumptive orientation than do less committed anglers (e.g., Beardmore, Haider, Hunt, & Arlinghaus, 2011; Oh & Ditton, 2006), contrary to the early hypothesis and conclusions by Ditton and colleagues (1992). Yet, indicators like catch orientation, angling motives and media use can also be treated as a dependent variable assessed against an angler's degree of specialization (Dorow & Arlinghaus, 2012). Ditton, Loomis and Choi (1992) also point out the potential for a tautological situation, which can arise when using activity-specific metrics, such as use of specific angling equipment, to measure specialization when using Bryan's (1977) definition of specialization as being "reflected by equipment and skills used in the sport and activity setting preferences" (p. 175).

The various specialization metrics have been applied in several ways. In order to capture the multidimensionality of the concept, one approach utilized a combination of several sub-dimensional quantitative metrics to index an angler's degree of specialization (e.g., Fisher, 1997; Hutt & Bettoli, 2007; Oh & Ditton, 2006). Such studies often involve a great number of questions, which tend to place a substantial burden on the respondents—with the intention to lessen this burden, researchers have perused single-metric specialization surrogates, such as years of experience or centrality to lifestyle (Beardmore et al., 2013). As the middle-way between the two aforementioned approaches, a more recent technique captures the aforementioned sub-dimensions of specialization in a narrative way and asks the respondents to self-classify into one of the provided categories of specialization (e.g., Needham, Sprouse, & Grimm, 2009; Scott et al., 2005; see also Beardmore et al., 2013). In some cases, questions examining only a subset of the above-discussed sub-dimensions of specialization are used to cluster respondents into dichotomous groups for the purpose of research, without directly estimating specialization levels (e.g., Ward, Quinn, & Post, 2013).

2.1.2. Angler Motivations and Constraints

Motivations

The fishing experience is multi-layered and involves many other dimensions beside catching fish (Driver & Cooksey, 1977). Two distinct types of elements comprise the overall angling experience: activity-specific and activity-general. Activity-specific elements are those specific to recreational fishing; for example, species of fish targeted, size and quantity of fish, setting in which the fish are caught, and fishing techniques or methods (Graefe, 1981). In contrast, activity-general elements are those that can be found in most other outdoor recreation activities, such as an opportunity for relaxation, spending time with family or friends, being outdoors, or the nature experience (Driver & Cooksey, 1977). Generally, activity-specific elements are within the realm of control of fisheries managers to a larger extent than activity-general elements are; thus good understanding of desirability of specific activity-general elements is crucial for tailoring recreational fishery management to facilitate these experiences (Fisher, 1997). Moreover, knowledge of the activity-general elements, particularly as they relate to motivations for angling participation, can complement the understanding of fishing-specific elements since it provides an insight into the processes that influence angler behavior. The activity-general benefits are of great importance to the experience of fishing for many anglers (Fedler & Ditton, 1994) and have therefore received a lot of research attention regardless of their often indirect connection with managerial decisions.

In a broader sense, it is understood that individuals' engagement in leisure activities is driven by the desire to improve their wellbeing through achieving certain physical and physiological outcomes (Knopf, Driver, & Bassett, 1973). Within this context of motivational theory, individuals engage in recreation as a solution to a problem: for example, daily stress and responsibilities can motivate an angler to go fishing, because it provides a temporary escape from their daily life (Knopf et al., 1973). Yet, researchers have been attempting to find a more detailed answer to the question of why individuals go fishing. Fedler and Ditton (1994) summarize three reasons for why answering this question is important: it helps to explain and predict angling behavior, it allows for exploration of angler heterogeneity, and it assists in development of diverse and balanced types of angling experiences. Interestingly, early studies by Knopf, Driver and

colleagues (e.g., Driver & Knopf, 1976; Knopf et al., 1973), guided by an interest in showcasing the relevance of psychological outcomes and motivations to management decisions (Manfredo et al., 1996), focused on evaluating the importance of activity-general motivational factors, such as experiencing nature, temporary escape, exploration, enjoying time with family, achieving, and maintaining physical fitness. These leisure motivation studies often employed recreation experience preference (REP) scales (for an overview of this method see Manfredo et al., 1996). Following these fundamental explorations, the research focus has been expanded to include activity-specific or catch-related motivations and begun investigating heterogeneity in motivations among angler subpopulations.

Studies have later confirmed the assumptions about differing motivations among anglers—fishing motives were shown to be yet another driver of angler heterogeneity (e.g., Fedler & Ditton, 1994; Schramm & Gerard, 2004; Schuett et al., 2010). For example, Fedler and Ditton (1994) found large differences among angler subpopulations in how interested are individuals in fishing to catch fish for eating or to obtain a trophy fish, yet they saw far fewer group differences in non-catch-related motives. On the other hand, Loomis and Ditton (1987) saw that tournament fishermen placed a higher value to catch-related motives than did sport anglers. A different approach looked at the potential sources of motivational heterogeneity: the dissimilarities in the importance individuals assign to various motivational elements were associated with sociodemographic differences, such as age, gender and income (Schuett et al., 2010). Schramm and Gerard (2004) investigated temporal variation in fishing motivation and, for example, found that the importance of obtaining fish for eating has decreased over time, nevertheless, it still remains one of the primary motivations for fishing to lower-income anglers. These outlined examples show that the differences in fishing motivations have been investigated in three ways: the varying importance of motives on a population level, the variation of importance of motives among subpopulations, and the variation of importance through time.

Recent research (Dabrowska et al., 2018) provided an insight into the dissimilarities in key motivational elements to two distinct angler groups: frequent and infrequent anglers. They found that, although many anglers find it difficult to pick only one main motivation for fishing participation, frequent anglers tended to see fishing as an escape from their daily routine (e.g., enjoying nature, solitude, relaxing, getting out of the

house or away from work), and infrequent anglers were motivated by social factors, in particular spending time with their children or grandchildren. Moreover, catching fish was a primary motivational factor for many infrequent anglers, while frequent anglers either still ascribed high importance to catching fish because it affirmed their good fishing skills, or, with time, begun to see catching fish as a mere "bonus" and were more motivated by the entire fishing experience (which includes, for example, tying their own flies, discovering new locations, learning about the various fish species and their behavior) (Dabrowska et al., 2018).

Constraints

Motivations drive an individual's decision to participate in a leisure activity, but leisure constraints can often restrict this desire and influence leisure participation patterns. Leisure constraints have been defined as the "factors that interfere with individuals' ability and/or desire to participate or their ability to achieve the satisfactions or benefits they seek" (Sutton, 2007, p. 74). Crawford and Godbey (1987) categorized leisure constraints into three groups: intrapersonal, interpersonal, and structural. Intrapersonal constraints are the outcome of an individual's internal psychological processes (e.g., self-perceived skill levels or appropriateness of the activity). Interpersonal constraints are influenced by interactions with other people (e.g., having someone to participate in the activity with). Structural constraints are other elements that directly interfere with participation (e.g., not having sufficient financial resources, lack of time, access or equipment). The type of constraints an individual might experience depends upon personal and situational characteristics, such as age, gender, stage in the life cycle, resource supply and type of recreational activity (Ritter, Ditton, & Riechers, 1992).

Structural constraints have been found to be the chief factors limiting participation in recreational fishing; in particular, anglers reported that lack of time (Aas, 1995), family and work commitments and competing recreational activities most impacted their fishing participation (Fedler & Ditton, 2001). Aas (1995) provided evidence that there are clear differences in constraints experienced by angler subgroups (four groups developed based on a matrix of angling participation and angling interest). Furthermore, low-centrality-to-lifestyle anglers are more likely to report participation in other activities as a constraint on their angling activity, whereas high-centrality anglers are more constricted

by the cost of fishing participation and fishing supplies, confusing regulations, inadequate facilities, and crowded fishing areas (Sutton, 2007). However, it is important to note that fishing constraints have a limited power of predicting fishing participation (Kuehn et al., 2013); higher levels of constraints do not necessarily lead to less participation as recreationists develop negotiation strategies to overcome their constraints (e.g., Jackson, Crawford, & Godbey, 1993; Lyu & Oh, 2014).

In contrast to motivations, frequent and infrequent angler groups experience quite similar constraints (Dabrowska et al., 2018). Dabrowska and colleagues stated that the most frequently reported constraints to both type of anglers were family commitments, work commitments, and other recreational or social interests. Infrequent anglers more often experienced lack of knowledge and skills as a constraint; both types of anglers commented that lack or unavailability of fishing companions is a constraint; and frequent anglers were more constrained by financial concerns (not the direct cost of fishing, but overall budgetary concerns).

2.1.3. Angler Participation and Avidity

Another approach to exploring angler heterogeneity is through angling participation patterns. The entire population of potential anglers is often considered in terms of the following demographic groups according to their fishing participation: non-anglers, occasional anglers, and frequent anglers (Aas, 1996). Frequent anglers are those who participate regularly and typically purchase their fishing license every year. Occasional, or infrequent, anglers purchase a license in some years, but not necessarily every year, and thus only fish occasionally. Non-anglers are those who currently do not fish nor purchase their fishing license. The group of non-anglers can be further divided into two subgroups: those who might be convinced to buy a license and begin fishing, and those who will likely never fish (Dabrowska et al., 2018).

The most common method of quantifying the variability in fishing participation is through examination of individual-level, most commonly demographic, predictor variables and estimation of their effect on angling participation (e.g., Arlinghaus, 2006; Floyd & Lee, 2002; Kuehn et al., 2013). For example, research has revealed positive effects of income, male gender, and fishing site quality and proximity of residence to fishing sites on likelihood of individual's fishing participation; and negative effects of age,

household size, non-white race/ethnicity, and urban residency (for a detailed overview of the demographic and angling-related variables and studies that investigated them, please refer to Table 1 below).

Based on previous research, angling avidity presents itself as an observable source of heterogeneity among anglers, for which predicting factors are possible to estimate. Therefore, my study employed the level of avidity (number of freshwater fishing licenses bought in the past five years) to investigate the differences among frequent and infrequent fishing license purchasing angler groups.

Table 1. **Demographic and angling-related variables and their effect on angling participation**

Variable	Reference	Study	Effect
Age	As age increases	Floyd & Lee, 2002	No effect
		Arlinghaus, 2006	No effect
		Arlinghaus, Tillner, & Bork, 2015	Negative
	≤ 24 years	Thunberg & Fulcher, 2006	Negative
	≥ 65 years	Floyd, Nicholas, Lee, Lee, & Scott, 2006	Negative
		Thunberg & Fulcher, 2006	Negative
Gender	Male	Fedler & Ditton, 2001	Positive
		Floyd & Lee, 2002	Positive
		Arlinghaus, 2006	Positive
		Floyd, Nicholas, Lee, Lee, & Scott, 2006	Positive
		Kuehn, Dawson, & Hoffman, 2006	Positive
		Thunberg & Fulcher, 2006	Positive
		Kuehn et al., 2013	Positive
		Ontario Ministry of Natural Resources, 2013	Positive
		Dabrowska, Haider, & Hunt, 2014	Positive
Income	As income increases	Floyd & Lee, 2002	Positive
		Arlinghaus, 2006	Positive
		Floyd, Nicholas, Lee, Lee, & Scott, 2006	No effect
		Thunberg & Fulcher, 2006	Positive
		Ontario Ministry of Natural Resources, 2013	Positive
Employment status	Full time job	Arlinghaus, 2006	Positive
		Arlinghaus, Tillner, & Bork, 2015	Positive
Education	As education level increases	Floyd & Lee, 2002	No effect
		Arlinghaus, 2006	Negative
		Floyd, Nicholas, Lee, Lee, & Scott, 2006	No effect

Variable	Reference	Study	Effect
		Thunberg & Fulcher, 2006	Negative
		Ontario Ministry of Natural Resources, 2013	Negative
		Dabrowska, Haider, & Hunt, 2014	Negative
Race/ethnicity	Non-white	Fedler & Ditton, 2001	No effect
		Floyd & Lee, 2002	Negative
		Floyd, Nicholas, Lee, Lee, & Scott, 2006	Negative
		Thunberg & Fulcher, 2006	Negative
Language	Non-English	Dabrowska, Haider, & Hunt, 2014	Negative
Household size	As size increases	Fedler & Ditton, 2001	No effect
		Arlinghaus, 2006	Negative
		Arlinghaus, Tillner, & Bork, 2015	Negative
Residency	As population size increases	Floyd & Lee, 2002	Negative
		Arlinghaus, 2006	Negative
		Floyd, Nicholas, Lee, Lee, & Scott, 2006	Negative
		Dabrowska, Haider, & Hunt, 2014	Negative
Urban/rural residency	Urban	Leonard & Aiken, 2015	Negative
Number of adult anglers in household	As number increases	Kuehn et al., 2013	Positive
Level of fishing knowledge	As knowledge increases	Kuehn et al., 2013	Positive
		Ontario Ministry of Natural Resources, 2013	Positive
Access to fishing sites	As distance decreases	Dabrowska, Haider, & Hunt, 2014	Positive

2.1.4. Angler Preferences

Researchers of human dimensions of recreational fishing have long acknowledged the importance of accounting for angler diversity, or heterogeneity in angler behavior, for sustainable fisheries management (e.g., Aas et al., 2000; Fisher, 1997). Therefore, emerging as a major focus in the research field was prediction and evaluation of angler responses to and preferences for management regulations and fishing site characteristics (e.g., Aas & Ditton, 1998; Beardmore et al., 2013; Dabrowska et al., 2017; Hutt & Neal, 2010; Oh, Ditton, Gentner, & Riechers, 2005). It is crucial to

understand this preference heterogeneity, as different anglers obtain different benefits from recreational fishing, and different angling styles can have a varying impact to the resource (Johnston, Arlinghaus, & Dieckmann, 2010). In order to gain a better understanding of how changes to the fisheries resource and sites impact anglers' decisions to select a fishing site and to model angler behavior, researchers most frequently employed a choice modelling approach (see reviews by Fenichel, Abbott, & Huang, 2013; L. M. Hunt, 2005). I provide a more detailed overview of this method in Section 2.2.1.

Researchers have explored anglers' preferences for the following types of fishing attributes: catch expectations and fishing regulations (both within the realm of fisheries management regulatory control) and fishing site characteristics (not necessarily under direct control of fisheries managers). For example, attributes of fishing quality and catch expectations include: fish species, expected catch, expected average size (e.g., Aas et al., 2000; Dabrowska et al., 2017). Typically investigated attributes of fishing regulations are: size limit, bag limit, gear restrictions (e.g., Beardmore et al., 2013; Carlin et al., 2012). For fishing site characteristics, the following attributes were considered: size of the water body, motor restrictions, facility development (e.g., barbecue pits, boat launches, fishing docks), crowding (number of other anglers on site), distance from home (often viewed as a proxy for cost [L. M. Hunt, 2005]), type of access (e.g., paved or unpaved road), and environmental quality (e.g., Balsman & Shoup, 2008; K. M. Hunt & Ditton, 1997).

While most early fishing site preference studies have assumed that anglers have identical preferences, more recent research incorporated the recognition that characteristics of an angler affect his or hers preferences for fishing sites (L. M. Hunt, 2005). These recent research studies adopted one of the three underlying assumptions about heterogeneity in angling preferences: 1) that it arises solely from observable characteristics of individuals, 2) that the source of variation is unknown to the researcher, or 3) that the heterogeneity is a combination of both observable and unobservable characteristics of anglers (for more details see review by L. M. Hunt, 2005; and Section 2.2.1 of this report).

2.2. Relevant Statistical Methods and Concepts

There are multiple different approaches available to researchers for estimating angler heterogeneity, both for eliciting what its drivers are and for evaluating the differences in preferences that arise from it. In this section I expand on the main statistical method used in the analysis of my research data: stated-preference choice models, as well as the statistical concept of nonresponse bias and its implications for social studies surveys.

2.2.1. Stated-preference Choice Methods

Stated-preference choice (SPC) methods were initially developed to better understand human choice behavior and were empirically applied to transportation mode decisions (McFadden, 1974). The SPC methods are now widely accepted as a tool for revealing anglers' choice preferences (L. M. Hunt, 2005). These methods rely on hypothetical choice or *stated* preference (as opposed to *revealed* preference or reported actual choice) data, which provides an opportunity to estimate consumers' preferences when, for example, observational data are expensive or time consuming to collect, or new product features are to be evaluated; the assumption here is that the "[stated-preference] surveys can produce data consistent with economic theory, from which econometric models can be estimated which are indistinguishable from their [revealed preference] data counterparts" (Louviere, Hensher, Swait, & Adamowicz, 2000).

McFadden (1974) defined the three components of a choice behavior study: "(1) the objects of choice and sets of alternatives available to decision-makers, (2) the observed attributes of decision-makers, and (3) the model of individual choice and behavior and distribution of behavior patterns in the population" (p. 106).

Thus, in a SPC survey, the respondents evaluate a number of hypothetical, discrete, alternatives each defined by a common set of attributes and are asked to make a choice between the alternatives (Hensher, 2006), for an example see Figure 1. The term *attribute* denotes "the determinant decision criteria consumers use to evaluate products or services" (Louviere, 1988, p. 4), which are crucial for understanding of the relationship of multiple factors and how they contribute to individuals' preferences and choices. Each attribute is described in terms of levels or ranges. The task of selecting

between two or more alternatives is presented in a form of a *choice set*, and repeated a number of times by varying the attribute levels (Hensher, 2006). The choice set needs to satisfy three conditions (Train, 2003). First, the alternatives presented to the decision-maker must be mutually exclusive (which, in certain situations where alternatives *A* and *B* are not inherently mutually exclusive, might call for an extra alternative defined as, for example, "both *A* and *B*"). Second, all possible options must be included in the choice set, ensuring that it is exhaustive (again, in certain situations where the decision-maker has an option of not choosing any of the alternatives, an additional alternative labelled as "neither/none of the alternatives" can be offered, as in Figure 1 with the alternative of *I will go to a different store*). And third, the choice set must contain a finite number of alternatives.

Figure 1.   **An example of a choice set, where the decision-maker is asked to choose between five alternatives (four different light bulb alternatives and the *I will go to a different store* alternative), each described by up to six attributes (i.e., *brand, power, type, lifetime, daily cost,* and *price*) with multiple levels (e.g., *1,000 h, 3,000 h, 12,000 h,* and *18,000 h*).**

Stated-preference Choice Models

The data obtained by means of SPC procedures are analyzed with discrete choice modelling methods such as conditional logit, multinomial logit, nested logit, random parameters logit and latent class multinomial logit (Hensher, 2006), in which the

stated preference is treated as the dependent variable that is explained as a function of alternative characteristics (Proebstl-Haider & Haider, 2013). I discuss the theoretical foundations of these analyses herein and present the method I employed in my analysis, the conditional logit model.

Discrete choice models arise from utility maximization theory (McFadden, 1974) and random utility theory (RUT) (Manski, 1977). Utility maximization theory stipulates that, when choosing between multiple alternatives, individuals rationally make choices that maximize their overall utility (McFadden, 1974). RUT defines the utility of an alternative as a function of its components (Manski, 1977) and captures the uncertainty of researchers' understanding of different aspects of the choice process (L. M. Hunt et al., 2010). For example, when an angler is choosing a fishing trip location from a set of alternative locations, "utility maximization arises by integrating the attributes of a trip and the angler's individual preferences for those attributes" (Dabrowska et al., 2017, p. 1354).

In RUT models, the level of utility that a decision-maker n obtains from alternative j is U_{nj}, $j = 1, 2,..., J$ (Train, 2003); and since the decision-maker selects an alternative that provides the maximum utility, he or she will choose an alternative i over alternative j if and only if,

$$U_{ni} > U_{nj} \ \forall j \neq i \ . \qquad (1)$$

Since RUT implies that there is a function consisting of attributes of alternatives and characteristics of individuals that denotes an individual's utility for each alternative, equation (1) can be further expanded as follows (Koppelman & Bhat, 2006):

$$U(X_i, S_n) \geq U(X_j, S_n) \ \forall j \quad \Rightarrow i \succ j \ \forall j \in C \ , \qquad (2)$$

where the alternative i is chosen among a set of alternatives, if and only if the utility of alternative i is greater than or equal to the utility of all alternatives, $j,$ in the choice set C. X_i and X_j are vectors of attributes describing alternatives i and j; S_n is a vector of characteristics describing individual n, that influences his preferences among the alternatives.

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RUT models assume that to derive his or hers overall utility for any given alternative, the individual rationally evaluates and totals the expected partial utility of each attribute (or, part-worth utilities) in the alternative, in order to be able to identify and select the alternative with the highest overall utility (Aas et al., 2000). Because the researchers cannot "'peep into the head' of each individual" (Louviere et al., 2000) and observe a decision-maker's choice process fully, the overall utility that an individual derives from the alternative can only be estimated through an indirect utility function consisting of two parts: a deterministic component and a random error component that accounts for researchers' inabilities to fully estimate utility (McFadden, 1974). Typically, this utility function is expressed as:

$$U_{nj} = V_{nj} + \varepsilon_{nj} , \qquad (3)$$

where the utility *U* that an individual *n* derives from alternative *j*, consists of an observable or systematic part V_{nj}, which describes the formal utility that the individual derives from the alternative and is contributed by elements that are observed by the researcher, and a stochastic part ε_{nj} that describes the error. The error term can account for measurement error, part of utility that is individual specific and not common to all individuals in a population, and utility contributed by attributes unobserved by the researcher (Louviere et al., 2000).

Following utility theory, an individual will choose alternative *i* over alternative *j* if $U_i > U_j$. Thus, arriving from equations (1) and (3), an individual *n* will chose an alternative *i* when,

$$(V_{ni} + \varepsilon_{ni}) > (V_{nj} + \varepsilon_{nj}) . \qquad (4)$$

Rearranging the above equation to move observable (deterministic) parts on one side and unobservable (error) parts on the other leads to the following form:

$$(V_{ni} - V_{nj}) > (\varepsilon_{nj} - \varepsilon_{ni}) . \qquad (5)$$

The researcher cannot determine exactly if the above equation holds true, because the $(\varepsilon_{ni} - \varepsilon_{nj})$ component is not observed by the researcher. Thus, the researcher can only calculate the probability that $(\varepsilon_{ni} - \varepsilon_{nj})$ will be less than $(V_{ni} - V_{nj})$,

or the probability that the individual will chose an alternative *i* over alternative *j* (Louviere et al., 2000):

$$P(i) = P((V_{ni} + \varepsilon_{ni}) \geq (V_{nj} + \varepsilon_{nj})) \; i \in C, \; \forall j \in C . \qquad (6)$$

Assuming that the stochastic utility terms ε_{nj} are type I extreme values and are independently and identically distributed, the probability of an individual *n* choosing alternative *i* from a set of alternatives *j* (*j = 1, 2,..., J*) in a choice set *C* is (Ben-Akiva & Lerman, 1985; McFadden, 1974):

$$P_{in} = \frac{e^{(V_i)}}{\sum_{j=1}^{J} e^{(V_j)}}, \; i \in C, \; \forall j \in C , \qquad (7)$$

where the probability of alternative *i* being chosen is the exponent of all measurable attributes of alternative *i* over the sum of the exponent of all measurable attributes of all alternatives. This way, we arrive to a form of a multinomial (conditional) logit model. The multinomial model relies on three hypotheses about the unobserved utilities (error terms): 1) independence of errors, 2) type 1 extreme value distribution, and 3) identically distributed errors (McFadden, 1974).

The model in Equation 7, known as conditional logit model, is an extension of the multinomial logit model, and requires the satisfaction of three assumptions (McFadden, 1974): 1) independence from irrelevant alternatives (IIA), which requires that the ratio of choice probabilities between two alternatives is unaffected by the inclusion of a third alternative (Ben-Akiva & Lerman, 1985), 2) positivity, where the probability that an alternative is chosen is greater than zero for all possible alternative sets, and 3) irrelevance of alternative set effect, which assumes without replications on each individual the 'alternative choice set effect' cannot be identified, so the choice sets need to be designed in a way that "alternatives can plausibly be assumed to be distinct and weighted independently in the eyes of the decision maker, and that there is, across replications, one alternative set (the present choice alternatives)" (Hensher & Johnson, 2018, p. 39). In contrast with the better known multinomial logit model, in the conditional logit model "a choice among alternatives is treated as a function of the characteristics of the alternatives, rather than (or in addition to) the characteristics of the individual making the choice" (Hoffman & Duncan, 1988, p. 415). The conditional logit model does not inherently account for heterogeneity in preferences for the attributes and their levels

among individuals (Dabrowska et al., 2017), so those need to be included in the model in indirect ways.

The conditional logit model can be expanded to include the components of the observable utility V_i : all attributes or known characteristics, X_{in}, of an alternative i and individual n (Dabrowska et al., 2017). This gives a standard logit expression

$$P_{in} = \frac{e^{(X_{in}\beta\prime)}}{\sum_{j=1}^{J} e^{(X_{jn}\beta\prime)}},\qquad (8)$$

where β parameters are estimated preferences (weights), that individuals place on the attributes X_i of the alternative, expressed in a scaled form—a scale factor is inversely related to the variance in stochastic utility and thus a scaled form reflects this variance (Train, 2003). Model in Equation 8 is an improvement over model in Equation 7 since it allows for incorporation of observed (or known) characteristics of individuals to account for heterogeneity in preferences (Train, 2003).

2.2.2. Survey Errors

Nonresponse Bias

The literature on social science survey research defines four types of systematic errors that can compromise the accuracy of survey results: coverage error, sampling error, nonresponse error, and measurement error (Dillman, Smyth, & Christian, 2014). Of particular interest to my study is the nonresponse error, which Dillman and colleagues (2014) define in the following way:

> Nonresponse [e]rror is the difference between the estimate produced when only some of the sampled units respond compared to when all of them respond. It occurs when those who do not respond are different from those who do respond in a way that influences the estimate. (p. 3)

While the challenge of non-response is common to most social surveys, it becomes a more serious problem for the surveyors when non-respondents (defined as units within a sample that are selected for a study but for which data are not obtained for any reason) exhibit different characteristics in a way that is relevant to the study results and provide different survey responses than respondents (Carkin & Tracy, 2015), thus introducing a nonresponse bias in the survey results. When survey respondents are not

representative of the target population, disregarding this nonresponse error can lead to bias in the sample (Fisher, 1997), and therefore limit the representativeness of extrapolations derived from survey results (Lew, Himes-Cornell, & Lee, 2015). Nonresponse bias can have an effect on estimated means, percentages, totals, variances, associations and temporal changes in parameters (Peytchev, 2013); for example, nonresponse bias can lead to substantial over- or underestimates of the means.

Sometimes researchers assume that a high response rate (i.e., low non-response) of the survey guarantees a low or non-existent nonresponse error—for example, some studies have adopted a response rate of 65 % as sufficient to achieve representativeness of the sample (e.g., Dolsen & Machlis, 1991; Margenau & Petchenik, 2004). However, many researchers warn that response rate should not be used as the sole measure for evaluating the potential presence of non-response bias and survey success (e.g., Dillman et al., 2014; Groves, 2006; Lew, Himes-Cornell, & Lee, 2015). A commonly accepted formula for estimating nonresponse bias in the mean, as presented in Groves (1989), is a product of response rate and the difference between the respondent and non-respondent means. A formula where nonresponse bias is defined as the ratio of the covariance between the response propensity and the survey variable, and the mean response propensity—where the response propensity is the likelihood of participating in the survey—has been proposed by Bethlehem (2002). In practice, survey response rates can be increased by directing more effort to data collection, or enticing the remaining non-respondents with techniques that increase their response propensities, for example reducing the task or providing incentives (Peytchev, 2013).

In the field of recreational fishing, nonresponse bias is of particular importance, due to the high heterogeneity of sports fishers (as discussed in Chapter 2). More specifically, it is expected that highly specialized anglers will be more likely to respond to recreational fishing related surveys and provide feedback to fisheries management (Fisher, 1997). Under this supposition—empirically explored in several studies (e.g., Beardmore, Hunt, Haider, Dorow, & Arlinghaus, 2014; L. M. Hunt et al., 2010)—angling surveys will have a disproportionate representation of avid anglers compared to novice anglers, resulting in what has been labelled as avidity bias and characterized as a key source of nonresponse bias (Thomson, 1991).

Generally, two main approaches to reducing nonresponse bias exist in the literature: increasing survey response rate and using post-survey statistical correction modelling methods. There has been an extensive effort devoted in the literature to the evaluation of different response rate increasing approaches, for example, Dillman and colleagues (2014) provide a comprehensive overview of methods available for increasing the response rate of social science surveys. Some methods, like multiphase survey designs and mixed-mode survey designs, can be used for either reducing non-response (and through it, the potential for nonresponse bias) or obtaining measures of nonresponse bias (Peytchev, 2013). When non-response is not sufficiently reduced, researchers often rely on statistical modelling to estimate and stratify sample members' probability of responding to the survey and use weighting class and response propensity models to adjust the survey responses (e.g., Fisher, 1996).

Protest Responses

In the field of SPC surveys, respondents sometimes do not exhibit utility-maximizing behavior, do not respond to the given task rationally and refuse to engage in the evaluation of hypothetical alternatives to reveal their preferences (Meyerhoff, Mørkbak, & Olsen, 2014). When respondents always choose one of the provided alternatives (e.g., alternative *A, B,* or "none of the alternatives"), regardless of the changing attribute levels throughout the entire series of choice sets, then those responses are often seen as *protest responses* (Dabrowska et al., 2017) and are associated with respondents who "refuse to play the game" (Mitchell & Carson, 1989, p. 166) of attribute evaluation. While it is common practice to omit the protest responses from the analysis, it is sometimes difficult to delineate the protest responses from responses that reflect respondents' preferences (Meyerhoff & Liebe, 2006). In the data processing stage, these responses are typically removed, therefore, it is important to correctly identify protest responses, since the decision on their inclusion or omission in the subsequent analysis can affect modelled preference estimates (Halstead, Luloff, & Stevens, 1992).

Chapter 3.

Methods

Experience without theory is blind, but theory without experience is mere intellectual play.

(Immanuel Kant)

With the goal of learning more about the different types of BC anglers, their license-purchasing habits and their fishing preferences, my study aimed to survey licensed anglers from across the province. The main research instrument of my study was an online survey, consisting of two parts—a questionnaire, and a stated-preference choice model (SPC). With the purpose of assessing potential non-response bias, I supplemented the online survey with a telephone follow-up questionnaire. This chapter explains the three research tools in detail, after first discussing the theoretical concepts behind the research mechanisms.

3.1. Survey Distribution

The survey was distributed to a random sample of BC resident anglers, who had purchased a freshwater fishing license at least once over a five year period (2012–2016) and had consented to be contacted via email for research and other purposes. The potential participants' contact information was obtained from the freshwater angler license database maintained by the British Columbia Ministry of Forests, Lands and Natural Resource Operations (MFLNRO). The database contains contact information (including a residential address, an email address and a phone number) for each individual angler along with the years in which they had purchased a freshwater fishing license, which can be used to determine frequency of license purchasing. This characteristic of the database allowed me to stratify the random sample according to license purchasing history into frequent and infrequent anglers strata. Frequent anglers were deemed those anglers who have purchased an annual freshwater fishing license four or five times over the past five years. Those anglers who have obtained a fishing license three times or less over the past five license years were considered infrequent. I have only collected data from anglers with a residential address within BC who had

consented to be contacted by email or phone for research and other purposes at the time of purchasing their license.

In the first phase of the study, the randomly selected participants were contacted with an email message, which contained an invitation to fill out the online survey. The email invitation was sent by a staff person from the British Columbia Ministry of Environment. The goal was to obtain a balanced respondent sample from both angler strata. Drawing on my advisors' previous experience with recruiting anglers for participation in online surveys, I was expecting a lower response rate from the infrequent group. In order to attract these anglers, I modified the content of the invitation email sent to this angler group by including a statement stipulating how my particular interest lied in learning more about habits of anglers who do not purchase their licenses regularly. To account for the lower expected response rate of infrequent anglers, the number of randomly selected infrequent anglers to receive the email invitation was higher than the number of selected frequent anglers (10,651 invites sent to the infrequent angler stratum; 5,389 invites sent to the frequent angler stratum).

Initial email invitations were sent between July 24 and July 26, 2016. Since every invited angler was assigned an individual code, I was able to identify those who had not yet participated in the survey or had stopped before completion. These participants were sent a reminder email approximately one week later, between August 2 and August 4, 2016.

In the second phase, I pooled the anglers who were invited to participate in the online survey but had not submitted their responses, and drew a simple random sample from this pool of non-respondents. In the process, I maintained the stratification by license purchasing history. These randomly selected anglers were contacted again on October 10, 2016, and invited to participate in a short telephone follow-up survey. The telephone survey was administered by a professional market research company; the calls were made between 4 p.m. and 8 p.m. on weekdays.

3.2. Research Instruments

3.2.1. Online Survey: Questionnaire

The questionnaire, distributed as a part of the online survey, consisted of 25 questions that were developed to help me understand whether there are differences in fishing experiences, license-purchasing habits, and demographics between frequent and infrequent anglers.

After a comprehensive review of previous studies that have assessed the effect of different angler characteristics on recreational fishing participation (see Section 2.1.3 and Table 1), I developed questions that examined an angler's:

- early fishing experiences (at what age and by whom were they initiated to fishing);

- species preferences;

- the types of fishing they engage in most often (e.g., trolling, drifting, still fishing, ice fishing);

- the water body types they visit most often (e.g., urban lakes, lakes, rivers, streams, ocean);

- the number of single- and multi-day fishing trips taken in the 2015–2016 license year;

- license-purchasing habits (when and how they purchase licenses);

- satisfaction with fishing experiences in the 2015–2016 license year;

- the centrality of fishing to their lifestyle and perceived fishing skills (for more details see section Centrality to Lifestyle Scale and Self-perceived Fishing Skills Scale);

- history of providing catch information and feedback regarding fishing regulations; and

- demographics (e.g., age, gender, income, whether they spent most of their life in urban or rural areas, and the size of their household and the number of anglers in their household).

For a full list of survey questions and answers provided (where applicable) please see Appendix A.

The questions were predominantly framed as closed-ended, multiple choice type, where I asked the respondents to choose one or more answers among provided options. The exceptions were six open-ended questions, where the format of the answer was numerical (e.g., questions inquiring about respondent's age at the time of their first fishing experience [Question 1], or the number of single and multi-day fishing trips a respondent has taken in the previous license year [Question 9]), as well as one open-ended question where the respondents were asked to write a short answer using their own words (a question regarding respondent's most frequently targeted fish species [Question 3]).

As part of the questionnaire, I also included three questions that employed a five-point Likert-style scale. These questions were:

- about how often does a respondent fish different water body types, with response categories ranging from "Never" to "Always" (Question 4),

- about centrality of fishing to respondent's lifestyle, with response categories ranging from "Strongly agree" to "Strongly disagree" (Question 11), and

- about respondent's perceived fishing skills, with response categories ranging from "Strongly agree" to "Strongly disagree" (Question 11).

The following section briefly discusses two of the abovementioned scales: the centrality to lifestyle scale and the perceived fishing skills scale. These two scales are related to recognized angler behavior constructs and therefore it is appropriate to inspect them more closely.

Centrality to Lifestyle Scale and Self-perceived Fishing Skills Scale

Centrality to lifestyle is a well-recognized metric of outdoor recreation involvement and commitment (Beardmore et al., 2013); therefore, I have incorporated the centrality scale adapted to recreational fishing (Sutton, 2003) in my questionnaire. For more information on the theoretical background of angler specialization and centrality, please refer to Section 2.1.1. The centrality scale (Question 11) consisted of the following nine questions:

1. If I stopped fishing, I would probably lose touch with a lot of my friends.

2. If I couldn't go fishing, I am not sure what I would do with my time.

3. Because of fishing, I don't have time to spend participating in other leisure activities.

4. Most of my friends are in some way connected with fishing.

5. I consider myself to be somewhat expert at fishing.

6. I find that a lot of my life is organized around fishing.

7. Others would probably say I spend too much time fishing.

8. I would rather go fishing than do most anything else.

9. Other leisure activities don't interest me as much as fishing.

Similarly to centrality to lifestyle, the level of fishing skills has also been linked to angler specialization and commitment (Bryan, 1977). The relationship between skills and specialization is discussed in more detail in Section 2.1.1 Previous studies have inspected the relationship between angler specialization and either revealed fishing skills as derived from catch per unit effort (CUE) estimates (Beardmore et al., 2013) or self-perceived skill assessment (Beardmore et al., 2013; Sutton & Ditton, 2001, 2005). In these examples, the self-perceived skill levels were assessed through one single question (e.g., "How would you judge your angling skills compared to other anglers?" [Beardmore et al., 2013, p. 277]). However, I intended to obtain an estimate of an individual's fishing skills by employing a more rigorous metric, derived from multiple questions addressing the same underlying concept of fishing skills. These different questions assess several aspects of fishing skills, without directly asking for a self-assessment. Based on input and advice from BC fisheries managers and government scientists, I developed the following seven sub-questions to assess a respondent's self-perceived fishing knowledge and skills (Question 12):

1. I find it difficult to know where/when to go fishing.

2. I don't have the proper equipment to go fishing.

3. I find it difficult to understand fishing regulations.

4. There is a skill to fishing that I don't understand.

5. When I go fishing I feel intimidated by other anglers.

6. I'm not sure how to properly handle fish.

7. I wish I could learn new types of fishing.

3.2.2. Online Survey: Stated-preference Choice Model

In the second part of the online survey, respondents were presented with a stated-preference choice model (SPC). The SPC examined respondents' stated preferences for a fishing site by employing an allocation task: respondents were asked to distribute a total of ten fishing days among three alternatives: two hypothetical fishing sites (Site A and Site B) and opting to fish somewhere else. The two hypothetical fishing sites were described with nine attributes in three categories:

- fishing site characteristics,

- catch expectations, and

- fishing regulations.

The attributes (characteristics of a fishing site) were chosen based on their capacity affect individual's likelihood to visit a fishing site. As noted earlier, SPC is a common tool used to estimate anglers' fishing preferences and I was therefore able to build on knowledge gathered by other researchers to choose attributes that have been shown to have an effect on anglers' fishing choices. Based on examples from the literature, I identified the following attributes for the purpose of my study: travel distance (e.g., Beardmore et al., 2013; Carlin et al., 2012; K. M. Hunt & Ditton, 1997), site congestion (e.g., Beardmore et al., 2013; Dabrowska et al., 2017), facilities and amenities (e.g., Balsman & Shoup, 2008; K. M. Hunt & Ditton, 1997), fish species (Balsman & Shoup, 2008), number of fish caught and average fish size (e.g., Beardmore et al., 2013; Oh et al., 2005), and harvest restrictions—fish size limit and daily catch limit (e.g., Beardmore et al., 2013; Carlin et al., 2012; Oh et al., 2005).

In order to gain a deep understanding of the differences in anglers' preferences, I could have used a larger number of attributes, anticipating this would aid me to define the two hypothetical fishing sites in more detail. However, a longer list of attributes would increase the complexity of the final experimental design (Louviere et al., 2000). Furthermore, it has been suggested that when faced with complex choices, such as between sets of alternatives with many attributes, individuals change their decision strategies in a way that defeats theoretical assumptions of the SPC method, thus negatively influencing researchers' ability to detect the differences in preferences (Swait & Adamowicz, 2001). Therefore, I limited the number of attributes to nine. These

selected attributes describe a fishing site based on characteristics that tend to influence anglers' decisions to visit a particular fishing site, and that can be manipulated by fisheries management decisions. I determined three levels of each of the nine attributes (see Table 2).

Table 2. **Attributes and their levels used in the stated-preference choice model**

	Attribute	Description	Levels
Fishing Site	Distance	The distance travelled to reach the fishing site	1. 30 km 2. 100 km 3. 300 km
	Access	The type of access to the fishing site	1. Paved road 2. Well-maintained gravel road 3. Hike-in (20 minutes)
	Congestion	The number of other anglers encountered at the fishing site	1. No other anglers in sight 2. 1-5 other anglers in sight 3. 6 or more other anglers in sight
	Amenities	The type and quantity of amenities and facilities available at the fishing site	1. No amenities on site 2. Some amenities on site (boat access ramp, fishing docks, restrooms, picnic tables) 3. Many amenities on site (boat access ramp, fishing docks, restrooms, picnic tables, camping sites, playground equipment, barbecue pits, fishing lodge)
Catch Expectations	Species	The number of fish species caught	1. 1 fish species 2. 2 fish species 3. 3 fish species or more
	Catch	The expected number of fish caught	1. 1 fish per 2 days 2. 1 fish per day 3. 5 fish per day
	Average size	The expected size of fish caught	1. Average 2. Below average 3. Trophy
Fishing Regulations	Size limit	The fish size limit regulation for the fishing site	1. No size limit 2. Minimum size limit 3. Slot limit
	Daily bag limit	The daily bag limit for the fishing site	1. Catch and release only 2. 2 fish 3. 10 fish

The SPC part of the online survey began with a brief introduction of the exercise. Afterwards, each respondent was asked to complete six choice sets, by allocating ten fishing days among the three alternatives: *Site A*, *Site B*, and *Fish somewhere else* (see Figure 2 below for an example of a choice set). The alternative to "fish somewhere else" remained unchanged throughout the six choice sets an individual was asked to evaluate. The levels of attributes for each of the two fishing site options within a choice set were determined based on a fractional factorial design that allowed for independent estimation of the effects of each attribute. After removing improbable alternatives and choice sets, the final survey design consisted of 81 choice sets. Upon starting the survey, each respondent was randomly assigned one of the predetermined combinations of six choice sets; the order in which these six choice sets were presented to the respondent was randomized as well.

1. **Out of 10 days of fishing, how many would you allocate to each of the following options?**
   [Please, insert the numbers in the boxes below the options.]

	Site A	Site B	Fish somewhere else
FISHING SITE			
Distance needed to travel	30 km	30 km	
Access to the site	Paved road	Well-maintained gravel road	
Site congestion	No other anglers in sight	6 or more other anglers in sight	
Amenities	No amenities on site	Some amenities on site (boat access ramp, fishing docks, restrooms, picnic tables)	Fish somewhere else
CATCH EXPECTATIONS			
Number of targeted fish species	3 fish species or more	2 fish species	
Expected number of fish caught	1 per 2 days	1 per 2 days	
Expected average size of fish	Below average	Trophy	
REGULATIONS			
Size limit	Minimum size limit	No size limit	
Daily bag limit	Catch and release only	3 fish	
NUMBER OF DAYS (out of 10):	_____ days	_____ days	_____ days

Figure 2. **An example of a choice set in which the respondents had to allocate 10 fishing days between three options.**

3.2.3. Telephone Follow-up Survey

I incorporated the telephone follow-up survey in my study with an intent to capture any non-response bias in the initial online survey. Thus, the short telephone survey included a subset of questions from the initial survey. The questions covered:

- license-purchasing history in the last five years;

- satisfaction with fishing experiences in the 2015–2016 license year;

- whether the respondent has a regular fishing partner;

- history of providing catch information and feedback regarding fishing regulations;

- demographics (education and age); and

- whether or not the respondent recalls receiving an invitation to the initial online survey.

A full list of questions is enclosed in Appendix B. These questions were selected based on the preliminary analysis of the initial online questionnaire—only the variables that were shown to affect angler's avidity were included in the follow-up survey.

3.3. Analyses

A separate analysis was performed on each of the above-discussed survey components. In this section, I explain the different steps and methods of data analyses involved in the study.

Unless where noted otherwise, the data were prepared using computer program Microsoft Excel and the statistical analyses were performed using R (R Core Team, 2017), an open-source language for statistical computing, in the RStudio (RStudio Team, 2016) environment. I used the following R packages to conduct the analyses and prepare graphic representation of data: ggplot2 (H. Wickham, 2009), ggpubr (Kassambara, 2017), pscl (Jackman, 2017), MKmisc (Kohl, 2018), ResourceSelection (Lele, Keim, & Solymos, 2017), survey (Lumley, 2014), mfx (Fernihough, 2014), ROCR (Sing, Sander, Beerenwinkel, & Lengauer, 2005), dplyr (Hadley Wickham, Francois, Henry, & Müller, 2017), qwraps2 (DeWitt, 2018), mlogit (Croissant, 2013), and mclogit (Elff, 2018).

3.3.1. Questionnaire Analysis

Data Preparation and Cleaning

As noted earlier, the purpose of the questionnaire part of the online survey was to investigate which characteristics influence an angler's likelihood to be a frequent license-purchaser. Thus, I considered the 25 questions of the online questionnaire as separate independent variables in the analysis of factors that influence an angler's fishing avidity. The questionnaire data were treated in three steps:

First, I inspected the responses for completeness; only complete questionnaire responses were included in the subsequent analysis (n = 1526). I excluded those survey responses where the respondents exited the survey before completing the questionnaire part of the survey, or chose the "prefer not to say" response where applicable (e.g., questions regarding age, gender, education). In total, 544 responses were removed.

Second, based on the number of times the respondent has purchased an annual freshwater fishing license in the past five years (Question 8), I assigned the respondents into one of the two avidity categories. Those respondents who had purchased a recreational fishing license four times or more were deemed frequent, whereas those respondents who had purchased a license less often (three times or less) were categorized as infrequent.

Third, I merged each respondent's answers to the sub-questions about centrality to lifestyle and self-perceived fishing skills (Question 11 and Question 12) into two single-value metrics. While statistical analyses of questions with responses on a Likert scale are typically complex, this study's use of Likert scale served the purpose of evaluating an angler's overall level of importance of fishing to his or hers lifestyle, and the general level of his or hers self-perceived fishing skills. Each of the two sets of questions covered a single concept from different perspectives. Thus, I assigned numerical values to each Likert-scale level (e.g., "Strongly agree" was coded as 1, "Strongly disagree" as −1) and estimated the means of the two separate sets of Likert-type questions and used these calculated means as two independent variables in the subsequent analysis.

Model Estimation

The objective of the questionnaire analysis was to describe and explain variance in license-purchasing habits of freshwater anglers. More specifically, my goal was to determine which predictor variables had an effect on the outcome of the dependent variable—an individual's avidity, expressed as a binary category ("Frequent" and "Infrequent"). Furthermore, I wanted to explore how anglers differed in variables that cannot reasonably be used as predicting factors as the relationship between the cause and effect is not intuitively clear; for example, it is difficult tell whether an angler who purchases his or hers fishing license every year and normally does so online is more likely to be a frequent angler because of the method of purchasing the license, or does the method itself depend on the individual's avidity.

Logistic regression (Agresti, 1996) was used to model anglers' avidity category as a function of demographic, socioeconomic, fishing participation and experience variables, as collected *via* questionnaire responses. Table 3 contains a complete list of independent variables that were considered in logistic regression model estimation. As a stepwise procedure (forward selection or backward elimination) in model selection does not necessarily yield a meaningful mode and thus many researchers warn to use it with caution (see Agresti, 1996), my choice of model terms was guided by intuitive expectations and outcomes of other studies (see Table 1). Among the estimated models, the best model was selected based on information theoretic-approach (Burnham & Anderson, 2003). The models were assessed with Akaike's information criterion (AIC), which formally examines the models for the relative loss of information—the best model exhibits the lowest loss of information (Akaike, 1974). Alongside with the AIC and the differences in AIC between a given model and the model with lowest AIC (ΔAIC), the probabilities (Akaike weights, *w*) that a given model *i* is the best among the examined models *J* was computed based on the following equation (Beardmore et al., 2013):

$$w_i = \frac{e^{-\frac{1}{2}\Delta_i}}{\sum_{j=1}^{J} e^{-\frac{1}{2}\Delta_j}} \qquad (9)$$

Furthermore, a McFadden R^2 statistic was computed for each model. These statistics are summarized in Table 10 in Appendix C.

The predictive ability of the selected model was inspected with a receiver operating characteristic (ROC) curve, which plots the true positive rate against the false positive rate at various threshold settings and illustrates the predicative power of the model (Agresti, 1996). The area under the curve (AUC) was estimated to further assess the predictive ability of the model; a higher AUC of ROC (maximum is 1.0) signifies a better predictive power of the model (Agresti, 1996). For results of these assessments refer to Appendix C, Table 10.

Table 3. **List of independent variables used in logistic regression model estimation predicting license purchasing frequency**

Variable	Code	Type
Age at first fishing experience	age_firstfishing	numerical
Who introduced the individual to fishing	how_introduced	categorical
Types of fishing the individual participates in	types_fishing_icefishing types_fishing_shorefishing types_fishing_boat	categorical
Typical time of licence purchase	when_purchase	categorical
Centrality to lifestyle mean	centrality	numerical
Perceived level of skills mean	skills	numerical
Membership in fishing organization	member_fo	categorical
Age	age	categorical
Gender	gender	categorical
Education level	education	categorical
Household size (under and above 16 years of age)	householdsize_under16 householdsize_over16	numerical
Number of individuals in household who fish	householdsize_fish	numerical
Having a regular fishing buddy	fishing_buddy	categorical
Number of fishing sites that the individuals knows well	fishing_sites_knowenough	numerical
Types of areas the individual has lived in (urban, rural, or mix)	areas_lived	categorical

Variable	Code	Type
Household income	income	categorical
Amount of leisure hours available in a week	leisure_hours	numerical

The parameter estimates obtained with logistic regression were then transformed to an odds ratio for easier interpretation of the size of the effect of each parameter. Odds ratios were presented for a one-unit increase and computed by exponentiation of the parameter estimates.

Following the logistic regression analysis, I investigated how frequent and infrequent anglers differed in their responses to other questionnaire questions that were not used in the model estimation. Table 4 contains a list of variables that I compared against respondent avidity levels. More specifically, I performed Pearson's chi-squared (x^2) tests (Agresti, 1996) to test for differences in the proportions of levels of categorical variables amongst the angler groups, and Welch's unequal variance t-tests (Welch, 1947) to test the null hypothesis that the two population means of numerical variables are equal. Type-I error rate (α) was set at 0.05 for all tests.

Table 4.   **List of variables tested for differences amongst angler groups**

Variable	Code	Type
Frequency of fishing at different water body types	waterbodies_urbanlakes waterbodies_lakes waterbodies_river waterbodies_ocean	categorical
Typical method of licence purchase	how_purchase	categorical
Level of satisfaction with fishing in previous licence year	how_satisfied	categorical
Provided fishing regulation feedback, catch info, responded to survey	provided_catchinfo provided_regulationsinfo responded_survey	categorical
Number of fishing trips taken	trips_singleday_fishing trips_multiday_fishing trips_singleday_other trips_multiday_other	numerical

3.3.2. Stated-preference Choice Analysis

Data Preparation and Cleaning

Incomplete responses to the SPC exercise were excluded from the analysis (i.e., only the responses where the respondents completed all six choice set tasks were used in model estimation). Additionally, protest responses were excluded. Protest responses cases were identified by observing respondents' choice patterns: where the respondents refused to consider their preferences for different attribute levels and always chose same alternative, regardless of the attribute levels (e.g., allocating 10 days of fishing to *Site A* in each of the six choice sets), I deemed the responses as protest and excluded the respondents' data from model estimation. In total, 237 responses were removed.

Furthermore, avidity category variable, as estimated in the questionnaire data preparation (see Chapter 3.3.1), was included in the SPC dataset.

Model Estimation

The purpose of using the SPC task was to determine anglers' preferences for various aspects of fishing sites. Additionally, I wanted to investigate the differences in preferences between the frequent and infrequent angler groups.

Therefore, I used the SPC data to estimate the conditional logit model, with the purpose of estimating the effects of the fishing site attributes on the likelihood of a fishing site with those attributes being selected as the preferred option. The model included all attributes of fishing sites. Additionally, it incorporated the Alternative-Specific Constant (ASC), which in SPC modelling is used to capture the average effect on utility of all factors within an alternative that are not included in the model, relative to other alternatives (Train, 2003). The observed heterogeneity among anglers, expressed in the form of avidity category, was included in the model as well. This binary avidity variable was transferred from the questionnaire data.

As the format of specifying the conditional logit model required by the statistical software used did not allow for accounting for allocation task within the choice sets, the number of days allocated to each alternative was incorporated in the model by transforming the data—each individual response was multiplied by the number of days the respondents allocated to that choice.

In the same way that the parameter estimates obtained with logistic regression were then transformed to an odds ratio for easier interpretation, the results of the conditional logit model were transformed as well. Odds ratios were presented for a one-unit increase and computed by exponentiation of the parameter estimates.

3.3.3. Follow-up Survey Analysis

The analysis of the follow-up survey served the purpose of testing for nonresponse bias; hence, I compared the responses from the follow-up sample with the responses to the initial questionnaire. Specifically, I used a series of Pearson's chi-squared (χ^2) tests (Agresti, 1996) to test for differences in proportions of sets of categorical data. The tests were performed on variables listed in

Table 5.

Table 5.   List of variables tested for differences amongst questionnaire and follow-up survey

Variable	Code	Type
Avidity	CATEGORY	categorical
Level of satisfaction with fishing in previous licence year	how_satisfied	categorical
Having a regular fishing buddy	fishing_buddy	categorical
Provided fishing regulation feedback or responded to survey	provided_feedback	categorical
Education level	education	categorical
Age	age	categorical

Herein, the variable "Provided fishing regulation feedback or responded to survey" was determined by pooling the sub-variables of providing regulation feedback and responding to fisheries surveys.

Chapter 4.

Results

4.1. General Findings

4.1.1. Response Rates

In total, 2,070 online survey responses were collected. Of that, 1,241 respondents were from the frequent stratum (5,389 invitees) and 829 from the infrequent stratum (10,651 invitees); uncorrected response rate of 23.0% and 7.8%, respectively. After adjusting for 1,512 undeliverable survey invitations, the adjusted response rates were estimated at 25.4% for the frequent and 8.6% for the infrequent angler groups.

As not every respondent completed the SPC exercise of the online survey, and due to the need to exclude protest responses, the final number of responses used in the analysis of the SPC component was 1,833 (1,111 from frequent and 722 from infrequent anglers).

In the telephone follow-up survey, a total of 314 responses were collected (189 from the frequent stratum and 125 from the infrequent stratum; 9% and 14% response rate, respectively).

4.1.2. Descriptive Statistics

Despite the efforts to obtain a balanced sample, the percentage of frequent anglers was higher (60.0%) than the percentage of infrequent anglers (40.0%) in the sample. Descriptive statistics of demographic and socio-demographic characteristics of survey respondents are presented in Table 6 below.

Table 6.   Socio-demographic caracteristics of questionnaire respondents per angler category

Characteristics	Frequency (Percent in category)		
	Frequent Category n = 1,241 (60.0)	Infrequent Category n = 829 (40.0)	Total Sample n = 2,070 (100.0)
Gender (n = 2,054)			
Female	125 (10.1)	146 (17.6)	271 (13.1)
Male	1,111 (89.5)	672 (81.1)	1,783 (86.1)
No response	5 (0.4)	11 (1.3)	16 (0.8)
Age (n = 2,053)			
19 to 24 years	17 (1.4)	22 (2.7)	39 (1.9)
25 to 34 years	108 (8.7)	104 (12.5)	212 (10.2)
35 to 44 years	207 (16.7)	162 (19.5)	369 (17.8)
45 to 54 years	247 (19.9)	158 (19.1)	405 (19.6)
55 to 64 years	324 (26.1)	204 (24.6)	528 (25.5)
65 years or more	333 (26.8)	171 (20.6)	504 (24.3)
No response	5 (0.4)	8 (1.0)	13 (0.6)
Education (n = 2,013)			
Some high school	54 (4.4)	25 (3.0)	79 (3.8)
High school	300 (24.2)	148 (17.9)	448 (21.6)
College, university or trade school	708 (57.1)	484 (58.4)	1,192 (57.6)
Post graduate degree	147 (11.8)	147 (17.7)	294 (14.2)
No response	32 (2.6)	25 (3.0)	57 (2.8)

Characteristics	Frequency (Percent in category)		
	Frequent Category n = 1,241 (60.0)	Infrequent Category n = 829 (40.0)	Total Sample n = 2,070 (100.0)
Income (n = 1,568)			
$0 to $20,000	14	14	28
	(1.1)	(1.7)	(1.4)
$20,001 to $50,000	117	72	189
	(9.4)	(8.7)	(9.1)
$50,001 to $80,000	216	132	348
	(17.4)	(15.9)	(16.8)
$80,001 to $110,000	221	131	352
	(17.8)	(15.8)	(17.0)
$110,001 to $140,000	155	98	253
	(12.5)	(11.8)	(12.2)
$140,001 or more	232	166	398
	(18.7)	(20.0)	(19.2)
No response	286	216	502
	(23.0)	(26.1)	(24.3)

4.2. Questionnaire Results

Results of the logistic regression analysis that tested for the effects of a series of independent variables on anglers' avidity levels are presented in Table 7 below.

Table 7. **Results of the logistic regression analysis to test for significant effects on an individual's likelihood of being a frequent angler**

Parameter	df	Estimate	Standard error	z-value	p-value	Odds ratio	95 % CI for odds ratio
(Intercept)	1	0.48	0.44	1.11	0.2684		
age2	5	0.38	0.44	0.88	0.3792	1.47	(0.62, 3.46)
age3	5	0.55	0.42	1.32	0.1882	1.74	(0.76, 3.98)
age4	5	0.75	0.42	1.79	0.0743	2.12	(0.93, 4.84)
age5	5	0.87*	0.42	2.09	0.0370	2.40	(1.05, 5.49)
age6	5	0.96*	0.42	2.27	0.0230	2.61	(1.15, 6.03)
skills	1	0.32*	0.12	2.60	0.0093	1.37	(1.08, 1.75)
centrality	1	0.72*	0.11	6.75	< 0.0001	2.06	(1.68, 2.56)
householdsize_fish	1	0.16*	0.05	3.10	0.0020	1.17	(1.07, 1.30)
when_purchase2	5	−0.82*	0.22	−3.80	< 0.0001	0.44	(0.29, 0.68)
when_purchase3	5	−1.90*	0.20	−9.44	< 0.0001	0.15	(0.10, 0.22)
when_purchase4	5	−1.46*	0.12	−11.87	< 0.0001	0.23	(0.18, 0.30)
when_purchase5	5	−3.01*	0.32	−9.48	< 0.0001	0.05	(0.03, 0.09)
when_purchase6	5	−1.83*	0.38	−4.77	< 0.0001	0.16	(0.07, 0.34)
skills*centrality	1	−0.32*	0.11	3.04	0.0024	0.72	(0.59, 0.89)

Note. An asterisk (*) indicates a significant value (α = 0.05). Odds ratio for a one-unit increase. Odds ratio for an X unit increase = $e^{X(estimate)}$. Only significant variables have been included in the final model. Model McFadden R^2 = 0.246; AIC = 1569, χ^2 = 600.24, df = 14, p-value < 0.0001.
Levels of age: 1) 19 to 24 years; 2) 25 to 34 years; 3) 35 to 44 years; 4) 45 to 54 years; 5) 55 to 64 years; 6) 65 years or more
Levels of when_purchase: 1) At the beginning of a new license year (around April 1st); 2) When the weather starts to improve; 3) Before a planned (summer) vacation; 4) Before a first planned fishing trip; 5) When someone invites me to go fishing; 6) Other

Of the series of independent variables tested, age, skills, centrality to lifestyle, number of people in the household who fish, typical time of year to that a license was purchased, and interaction between skills and centrality, were related to an individual's likelihood of belonging into the frequent angler group. Age and centrality were the strongest predictors of avidity, with odds ratios of 2.40 (p-value = 0.0361, 95% CI [1.05, 5.49]) and 2.61 (p-value = 0.0221, 95% CI [1.15, 6.03]) for age groups between 55 and 64 years, and 65 years or more, respectively, and an odds ratio of 2.06 (p-value = 0.0092, 95% CI [1.68, 1.75]) for a one unit increase in centrality to lifestyle. On the other hand, the regression model failed to find evidence of significant relationship of age and angler avidity for age levels 25 to 34 years, 35 to 44 years, and 45 to 54 years,

compared to age between 19 to 24 years. One additional member of the household who fishes increased the odds ratio of an individual to be a frequent angler by 17 percent (*p*-value = 0.0014, odds ratio 95% CI [1.07, 1.30]), isolating the effect by holding all other independent variables constant. Similarly, with an increase in one unit of mean perceived skill level, the individual was 1.37 times more likely to belong in the frequent group (*p*-value = 0.0092, 95% CI [1.08, 1.75]), all other parameters held constant. The analysis showed strong evidence (*p*-value < 0.0001) of the negative effect of typical time of licence purchase for all levels different from "at the beginning of a new license year"; the sizes of the effect measured in odds ratio varied from 0.05 (95% CI [0.03, 0.09]) to 0.44 (95% CI [0.29, 0.68]. The largest effect, odds ratio 0.05 (*p*-value < 0.0001, 95% CI [0.03, 0.09]), on likelihood to be a frequent angler, was observed for anglers who typically purchased their license only after someone invited them to fish. Furthermore, the results of the model failed to find evidence against the null hypothesis of no interaction between skills and centrality: the odds ratio of interaction between skills and centrality, all other parameters held constant, was estimated at 0.72 (*p*-value = 0.0024, 95% CI [0.59, 0.89]). This interaction can be interpreted as follows: as the measure of skills for an individual increased by one unit, the effect of centrality on likelihood of being a frequent angler was reduced by 28% (or 0.72, expressed in odds ratio); thus, the lower the individual's skill value, the higher was the effect of centrality, and *vice versa*, the higher the individual's centrality value, the lower was the effect of skills on individual's likelihood of being a frequent angler.

The logistic regression model was followed by the analysis of the differences between frequent and infrequent anglers (see Table 4), the results of which are summarized in the following paragraphs.

From chi-squared tests, there were different proportions in frequency of fishing at various water body types among frequent and infrequent angler groups. The results showed a different proportion in frequency of fishing in urban lakes (χ^2 = 28.91, df = 4, *p*-value < 0.0001), other lakes (χ^2 = 197.53, df = 4, *p*-value < 0.0001), rivers and streams (χ^2 = 79.09, df = 4, *p*-value < 0.0001), and ocean (χ^2 = 23.31, df = 4, *p*-value = 0.0001). These differences in proportion of how often anglers fish in the abovementioned water bodies can also be observed in the mosaic plot in Figure 3, where the differences are most pronounced for lakes, and least for ocean. As expected, frequent anglers indicated that they had fished more often, for all water body types; overall, more than 50% of

anglers (both frequent and infrequent) said that they "rarely" or "never" fished in urban lakes and ocean. Both groups of anglers most often fished in non-urban lakes, followed by rivers and streams; infrequent anglers fished in lakes and rivers with a similar frequency, whereas frequent anglers tended to visit lakes more often than rivers. The largest observed difference among angler categories was between the proportion of anglers who "always" or "often" fish in lakes; a similar pattern can be observed for rivers.
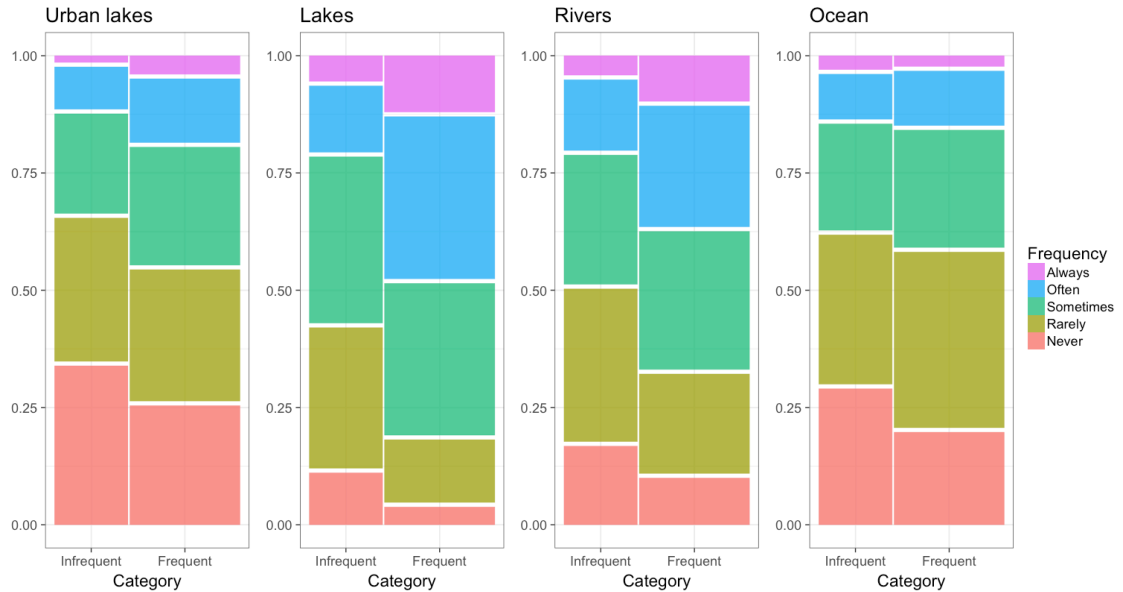
Figure 3.   **Mosaic plots showing proportions of frequency of fishing at different water-body types by angler category**

Note.   Urban lakes χ^2 = 28.91, df = 4, *p*-value < 0.0001
Lakes χ^2 = 197.53, df = 4, *p*-value < 0.0001
Rivers χ^2 = 79.09, df = 4, *p*-value < 0.0001
Ocean χ^2 = 23.31, df = 4, *p*-value = 0.0001

I also found evidence against the null hypothesis of independence between angler avidity and the preferred method of purchasing a fishing license (χ^2 = 22.03, df = 1, *p*-value < 0.0001). As can be inferred from the mosaic plot (Figure 4), a higher proportion of infrequent anglers purchased their licence in person, compared to frequent anglers.
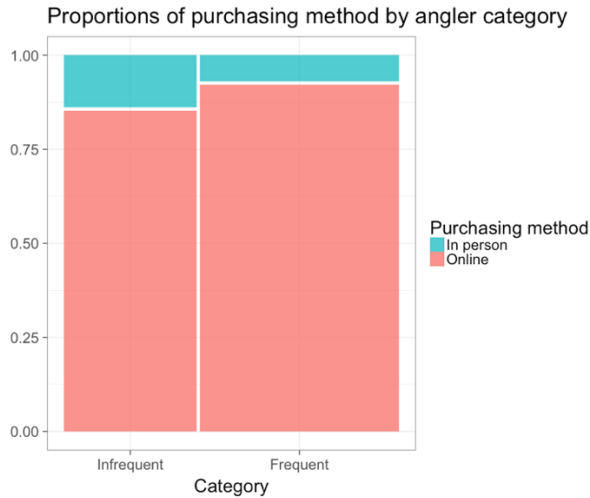
Figure 4. **Mosaic plot showing proportions of preferred license purchasing method by angler category**

Note. χ^2 = 22.03, df = 1, *p*-value < 0.0001

Additionally, the analysis found evidence against the null hypothesis of independence between angler avidity and the satisfaction level with fishing experience in the past license year (χ^2 = 64.50, df = 4, *p*-value < 0.0001). The mosaic plot in Figure 5 shows that overall, frequent anglers were more satisfied with their fishing experience: frequent anglers more often indicated that they were "very satisfied", whereas a larger proportion of infrequent anglers stated that they were "neither satisfied nor dissatisfied".

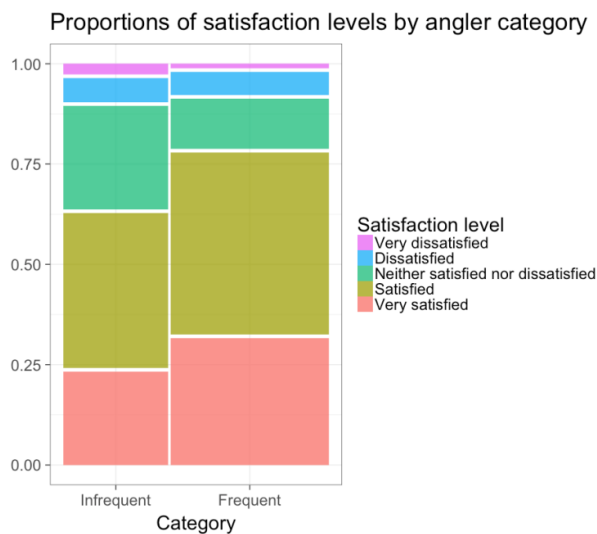**Figure 5.** **Mosaic plot showing proportions of fishing satisfaction levels by angler category**

Note. χ^2 = 64.50, df = 4, *p*-value < 0.0001

The results of chi-squared tests showed evidence of a difference in past research participation (providing catch information, management or regulations feedback, or responding to surveys). Among frequent and infrequent anglers, there was a difference in proportions of anglers who have in the past shared catch information (χ^2 = 96.29, df = 1, *p*-value < 0.0001), provided regulations feedback (χ^2 = 31.95, df = 1, *p*-value < 0.0001), and responded to fisheries surveys (χ^2 = 57.94, df = 1, *p*-value < 0.0001). Overall, frequent anglers more often interacted with fisheries managers (see mosaic plots in Figure 6); the differences between the groups were largest for catch information.
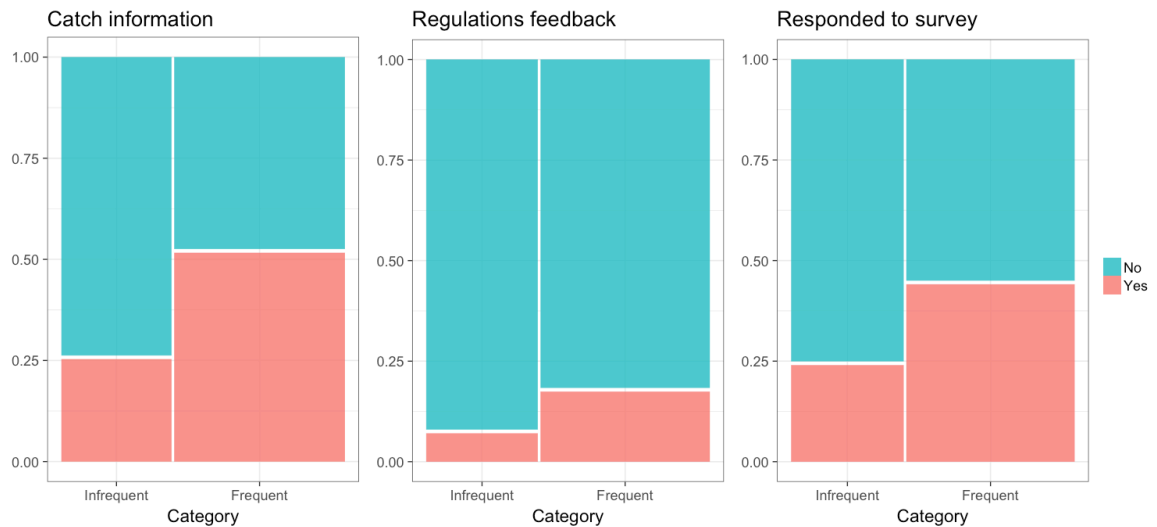
Figure 6. **Mosaic plots showing proportions of anglers who have provided catch information, regulations feedback or responded to survey, by angler category**

Note.   Catch information χ^2 = 96.29, df = 1, *p*-value < 0.0001
Regulations feedback χ^2 = 31.95, df = 1, *p*-value < 0.0001
Responded to survey χ^2 = 57.94, df = 1, *p*-value < 0.0001

Frequent and infrequent anglers, on average, took different numbers of fishing trips in the past licensing year (2015–2016), as the results of Welch's two sample t-tests demonstrated (see Table 8). The largest observed difference between the mean number of fishing trips was for single-day trips where fishing was the primary activity (*p*-value < 0.0001, 95% CI [–8.02, –5.87]). On the other hand, the differences for other types of trips were observed, yet smaller. For example, the mean number of multiday trips where fishing occurred but was not the primary activity was more similar among the groups (*p*-value = 0.0003, 95% CI [–1.05, –0.31]). The same was observed for single day trips where fishing was not the primary activity (*p*-value < 0.0001, 95% CI [–1.21, –0.55]).

Table 8. **Results of unequal variance tests of differences in mean numbers of trips taken by angler category**

Variable	Sample mean	95% CI for difference in means	df	t-value	p-value
Single-day trips (other)					
Frequent	1.44	(−1.21, −0.55)	1473.5	−5.22	< 0.0001*
Infrequent	0.57				
Single-day trips (fishing)					
Frequent	9.98	(−8.02, −5.87)	1494.5	−12.66	< 0.0001*
Infrequent	3.03				
Multiday trips (other)					
Frequent	1.20	(−1.05, −0.31)	1308.1	−3.65	0.0003*
Infrequent	0.52				
Multiday trips (fishing)					
Frequent	2.10	(−1.80, −1.21)	1318.5	−9.97	< 0.0001*
Infrequent	0.60				

Note. An asterisk (*) indicates a significant value ($\alpha = 0.05$).

Additionally, the questionnaire asked the respondents to list their three favourite fish species targeted. Overall, *trout, general* (n = 713), and *rainbow trout* (n = 750) were most commonly listed as first favourite fish species. *Trout, general* was the first favourites fish species for 40.5% of frequent anglers and 25.5% of infrequent anglers; and *rainbow trout* for 31.7% of frequent anglers and 42.9% of infrequent anglers. Other popular fish species listed as the first favourite were *salmon, general* (n = 158), *sockeye salmon* (n = 58), *cutthroat trout* (n = 59), and *walleye* (n = 50). Popular second favourite species were *salmon, general* (n = 221), *sockeye salmon* (n = 169), *trout, general* (n = 151), *rainbow trout* (n = 127), *steelhead trout* (n = 106), *cutthroat trout* (n = 99), *bull trout* (n = 98), and *bass* (n = 97). *Salmon, general* was the second favourite fish species for 11.1% of frequent anglers and 10.0% of infrequent anglers; *sockeye salmon* for 9.7% of frequent anglers and 5.9% of infrequent anglers; and *trout, general* for 6.4% of frequent anglers and 8.6% of infrequent anglers.

4.3. Stated-preference Choice Model Results

The results of the conditional logit model are presented in Table 9 below.

Table 9. Results of the conditional logistic model estimated to test the effects of parameter levels on anglers' preferences

Attribute	Estimate	Standard error	z-value	p-value	Odds ratio
ASC1	−0.0972*	0.0362	−2.68	0.0073	0.9073
distance	−0.1671*	0.0077	−21.63	< 0.0001	0.8461
species	0.0191*	0.0077	2.48	0.0130	1.0193
catch	0.0898*	0.0077	11.61	< 0.0001	1.0940
access_paved	0.2400*	0.0156	15.35	< 0.0001	1.2713
access_gravel	0.2257*	0.0157	14.36	< 0.0001	1.2532
congestion_none	0.3057*	0.0152	20.09	< 0.0001	1.3576
congestion_1-5	0.1221*	0.0161	7.61	< 0.0001	1.1299
amenities_none	−0.0518*	0.0154	−3.36	0.0008	0.9495
amenities_some	0.0208	0.0151	1.37	0.1694	1.0210
avg_size_belowavg	−0.1919*	0.0154	−12.46	< 0.0001	0.8254
avg_size_average	−0.0887*	0.0152	−5.84	< 0.0001	0.9151
size_limit_none	0.0495*	0.0152	3.25	0.0012	1.0508
size_limit_min	−0.0255	0.0153	−1.67	0.0956	0.9748
daily_bag_catchrelease	−0.2570*	0.0158	−16.21	< 0.0001	0.7734
daily_bag_2fish	−0.0192	0.0148	−1.30	0.1946	0.9810
F_ASC1	0.2410*	0.0471	5.12	< 0.0001	1.2726
F_distance	0.0179	0.0100	1.79	0.0729	1.0181
F_species	−0.0030	0.0100	−0.30	0.7645	0.9970
F_catch	0.0460*	0.0100	4.58	< 0.0001	1.0471
F_access_paved	−0.0537*	0.0204	−2.63	0.0085	0.9477
F_access_gravel	0.0447*	0.0204	2.19	0.0283	1.0457
F_congestion_none	−0.0570*	0.0198	−2.88	0.0040	0.9446
F_congestion_1-5	−0.0085	0.0207	−0.41	0.6794	0.9915
F_amenities_none	0.0614*	0.0200	3.08	0.0021	1.0633
F_amenities_some	0.0229	0.0197	1.16	0.2459	1.0231
F_avg_size_belowavg	−0.1458*	0.0200	−7.30	< 0.0001	0.8643
F_avg_size_average	−0.0725*	0.0196	−3.70	0.0002	0.9301
F_size_limit_none	0.0171	0.0199	0.86	0.3891	1.0173
F_size_limit_min	0.0778*	0.0199	3.91	< 0.0001	1.0809
F_daily_bag_catchrelease	0.0600*	0.0205	2.94	0.0033	1.0619
F_daily_bag_2fish	−0.0058	0.0194	−0.30	0.7649	0.9942

Note. An asterisk (*) indicates a significant value (α = 0.05). Odds ratio for an X unit increase = $e^{X(estimate)}$. F_ indicates frequent group. Model AIC = 220127.7.

The model included as independent variables all of the attributes that define the choice alternatives. While the majority of the variables were categorical with three levels, three of the variables were treated as continuous in linear terms: catch expectations, distance travelled, and number of species. Furthermore, the angler category was included in the model to investigate the differences in variable estimates between frequent and infrequent anglers.

The analysis showed that all variables and their levels, except for three (amenities: some, size limit: minimum, and daily bag limit: 2 fish), had a significant effect on the likelihood of the hypothetical fishing site being selected. Among the continuous variables, distance had the largest effect on site selection (it is important to note that the size of the effect is conditional on the way the attributes and attribute levels were defined in the experimental design). Distance needed to travel to a fishing site had a negative effect: all other variables held constant, with each unit increase in distance it was 0.8461 times less likely that the fishing site was chosen (p-value < 0.0001). On the contrary, catch expectations had a positive effect on the likelihood of choosing the site, expressed in odds ratio as 1.0940 (p-value < 0.0001). Species diversity also has a slight positive effect on the likelihood of a fishing site being selected, odds ratio 1.0193 (p-value = 0.0130).

Low congestion had the greatest effect on how likely anglers chose a hypothetical fishing site (again, this assessment of effect size is conditional on the attributes and attribute levels used in the study design). Compared to the level of "more than 6 other anglers" on site, seeing "no other anglers" substantially increased the utility of the fishing site, the odds of a fishing site with no other anglers being selected was 36% higher than the most congested level (odds ratio 1.3576, p-value < 0.0001). Even seeing "1-5 other anglers" at the fishing site had a relatively strong positive effect compared to the most congested level (odds ratio 1.1299, p-value < 0.0001). The second largest effect of site preferences was observed for the type of access to the site. Relative to the level of a 20-minute hike-in, a paved road had the highest a part-worth utility, with odds ratio of 1.2713 (p-value < 0.0001), whereas a well-maintained gravel road was slightly less preferable than a paved road, but still greatly more preferable than the hike-in level, with odds ratio of 1.2532 (p-value < 0.0001). A very stringent take limit—catch-and-release only—at the fishing site decreased the odds ratio of it being selected by 23% (odds ratio 0.7734, p-value < 0.0001), compared to take limit of 10 fish,

all other attributes held constant. The level of a daily bag limit of 2 fish was not significantly more or less preferred than the level of 10 fish. The trophy size of fish was the most preferred level: compared to the trophy level estimates of both other levels had a negative sign, and the average size reduced the odds of selecting the fishing site by 8% (odds ratio 0.9151, *p*-value < 0.0001), while the below-average size reduced the odds by 17% (odds ratio 0.8254, *p*-value < 0.0001). Anglers have a slight preference to have many or some amenities at a fishing site, as opposed to no amenities; compared to a fishing site with many amenities, the absence of amenities decreased the odds ratio of selecting the site by 5% (odds ratio 0.9495, *p*-value = 0.0008), but there was no evidence of a difference in the preferences for a site with only some amenities. Fish size-limit regulations had a small overall effect on site preferences; the level "no size limit" was the most preferred—compared to the slot size limit it increased the odds by 5% (odds ratio 1.0508, *p*-value = 0.0012), while "minimum size limit" did not have an effect on site selection.

The preferences for fishing sites differed between frequent and infrequent anglers in the following attributes: fish size, size limits, amenities, daily bag limits, congestion, access and catch expectations (listed in order of the size of the effect). The estimates for the interaction between the angler category and attributes can be interpreted as an additional level to the population estimates; angler category has either a moderating or a magnifying effect on the population estimate. Herein, I interpret the results from the perspective of frequent anglers (e.g. positively influenced by an increase in attribute level), yet, the exactly opposite is true for the infrequent angler group (e.g. negatively influenced by an increased level of the same attribute).

The largest difference in preferences between frequent anglers and infrequent anglers arose from the preference for the fish size attribute. Frequent anglers were much more positively influenced by the expectation of catching a trophy-sized fish; compared to this level the below-average fish size decreased the odds of a frequent angler selecting the hypothetical fishing site by 14% (odds ratio 0.8643, *p*-value < 0.0001), whereas the expectation of average-sized fish decreased the odds by 7% (odds ratio 0.9301, *p*-value = 0.0002). Moreover, preferences of frequent anglers were more positively influenced by a minimum-size limit at the fishing site, odds ratio 1.0809 (*p*-value < 0.0001), compared to the level of slot size limit, but they did not exhibit a higher preference for no size limit. Compared to infrequent anglers, frequent anglers preferred

to have no amenities at the fishing site, compared to many amenities, with an odds ratio of 1.0633 (*p*-value = 0.0021). Furthermore, frequent anglers were less negatively influenced by catch-and-release regulations, with an odds ratio of 1.0619 (*p*-value = 0.0033), compared to daily bag limit of 10 fish. Additionally, the preference to see no other anglers at the fishing site was less pronounced among frequent anglers, with an odds ratio of 0.9446 (*p*-value = 0.0040). Frequent anglers had a higher preference for fishing sites that can be accessed by a well-maintained gravel road, with an odds ratio of 1.0471 (*p*-value = 0.0283), and a lower preference for fishing sites with a paved road, with an odds ratio of 0.9477 (*p*-value = 0.0085), than infrequent anglers. And lastly, frequent anglers were slightly more positively influenced by catch expectations—each unit increase in catch expectations increased a frequent angler's odds to choose a fishing site, everything else held constant, by 5% (odds ratio 1.0471, *p*-value < 0.0001).

Overall, anglers were more likely to have chosen the alternative of fishing somewhere else (base level of the hypothetical alternatives) as opposed to one of the two proposed hypothetical fishing site alternatives, as reflected by the negative sign of the ASC variable estimate (odds ratio of choosing either *Site A* or *Site B* 0.9073, *p*-value = 0.0073). Nevertheless, frequent anglers had a weaker preference for the alternative *Fish somewhere else*; the odds of a frequent angler selecting either *Site A* or *Site B* were higher than the odds of a frequent angler selecting neither of the alternatives (odds ratio 1.2726, *p*-value < 0.0001).

4.4. Follow-up Survey Results

The results of the follow-up survey showed that only 30% of respondents recalled receiving an email invitation to the online survey. The remainder of the analysis of the follow-up survey investigated the differences and similarities in characteristics between individuals who did respond to the initial online survey and respondents to the follow-up telephone survey.

It was my aim to obtain a balanced sample from both angler categories, for both phases of the survey. The chi-squared test failed to find evidence against the null hypothesis of equal proportions of angler categories in the online questionnaire and in the follow-up survey (χ^2 = 0.0004, df = 1, *p*-value = 0.9849), which confirmed that I successfully surveyed equal proportions of frequent and infrequent anglers in both

phases. The analysis also failed to find an evidence of a difference in the proportions of anglers who have a regular fishing buddy and those who do not, among the two survey phases (χ^2 = 0.48, df = 1, p-value = 0.4884).

Anglers in the follow-up survey expressed a different level of satisfaction with their fishing experience than anglers in the online questionnaire (χ^2 = 25.50, df = 4, p-value < 0.0001); this difference can be observed in the first mosaic plot in Figure 7. In the follow-up survey, more anglers indicated that they were "very satisfied" or "satisfied", compared to the questionnaire. On the other hand, a slightly higher proportion of respondents to the follow-up survey was either "very dissatisfied" or "dissatisfied". Chi-squared test failed to find evidence of a difference in the distribution of satisfaction levels among the two angler categories in the follow-up survey (second mosaic plot in Figure 7). In the questionnaire survey, frequent anglers were overall more satisfied with their fishing experience (third mosaic plot in Figure 7).

Figure 7.   Mosaic plots of proportions of satisfaction levels among survey phases and among angler categories

Note.   Follow-up vs. Questionnaire χ^2 = 25.50, df = 4, p-value < 0.0001
Satisfaction follow-up χ^2 = 4.22, df = 4, p-value = 0.3771
Satisfaction questionnaire χ^2 = 64.50, df = 4, p-value < 0.0001

The analysis showed that the proportion of anglers who have previously provided fisheries management feedback or responded to surveys differed among the follow-up survey and the questionnaire (χ^2 = 37.56, df = 1, p-value < 0.0001). As the first mosaic plot in Figure 8 shows, more respondents to the questionnaire have previously provided some form of feedback, compared to the respondents to the follow-up survey. In both

survey phases, a higher proportion of frequent anglers than infrequent anglers have provided feedback (second and third mosaic plots in in Figure 8).

Figure 8. **Mosaic plots of proportions of anglers who provided feedback among survey phases and among angler categories**

Note. Follow-up vs. Questionnaire χ^2 = 37.56, df = 1, *p*-value < 0.0001
Feedback follow-up χ^2 = 9.29, df = 1, *p*-value = 0.0023
Feedback questionnaire χ^2 = 57.13, df = 1, *p*-value < 0.0001

Respondents to the follow-up survey also differed from respondents to the questionnaire in sociodemographic characteristics, in particular, education (χ^2 = 15.06, df = 3, *p*-value = 0.0017) and age (χ^2 = 52.68, df = 5, *p*-value < 0.0001). The follow-up survey had a higher proportion of respondents with a higher level of education (first mosaic plot in Figure 9); there was no evidence of a difference in proportions of education levels for angler categories in the follow-up survey (second mosaic plot in Figure 9); and infrequent anglers had a higher level of education than frequent anglers in the questionnaire phase (third mosaic plot in Figure 9). Overall, the respondents to the follow-up survey were younger than the respondents to the questionnaire (first mosaic plot in Figure 10). In the follow-up survey, approximately 50 % of the respondents were younger than 44 years, whereas in the questionnaire survey, approximately 50% of respondents were younger than 54 years. In both the follow-up and questionnaire phases, there was a higher proportion of younger anglers among the infrequent angler group compared to the frequent group; the difference was most pronounced in the follow-up survey, where the age level of 25 to 34 years was overrepresented, and the age level of 55 to 64 years was underrepresented in the infrequent angler group (second and third mosaic plots in Figure 10).
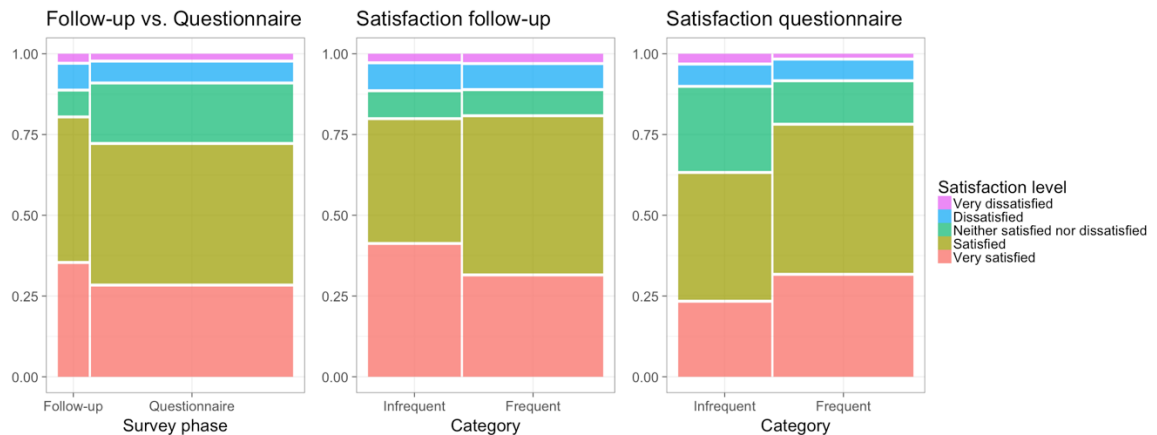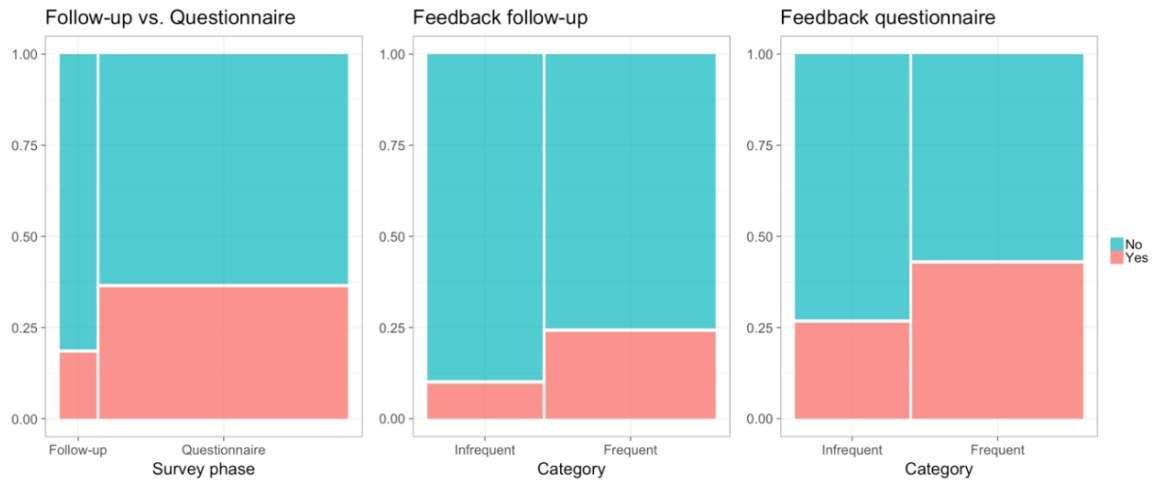
Figure 9.   Mosaic plots of proportions of education levels among survey phases and among angler categories

Note.   Follow-up vs. Questionnaire χ^2 = 15.06, df = 3, p-value = 0.0017
Education follow-up χ^2 = 5.22, df = 3, p-value = 0.1561
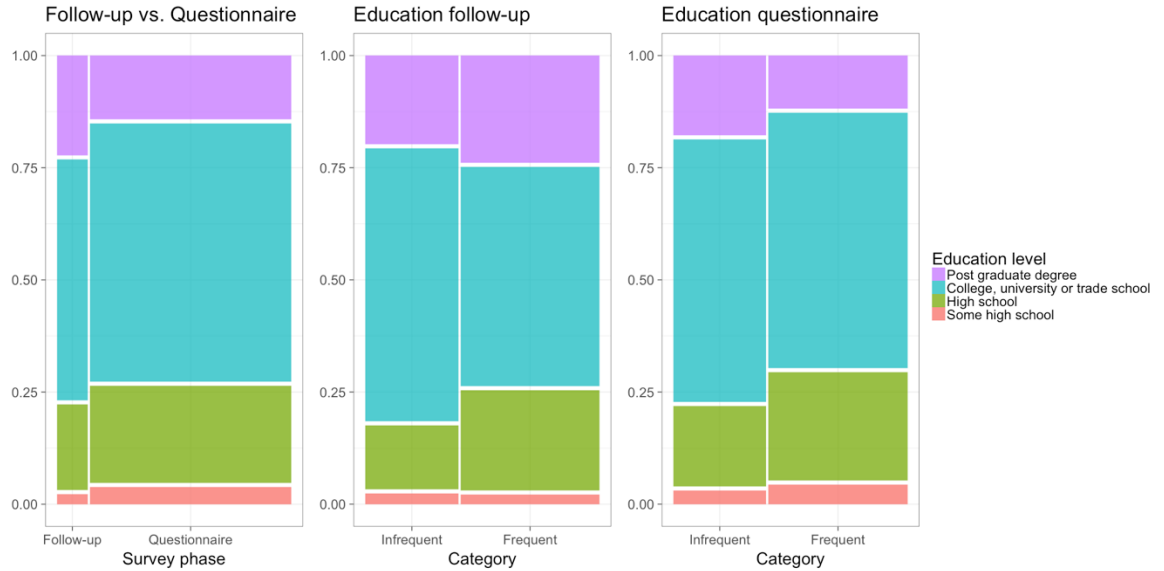Education questionnaire χ^2 = 23.79, df = 3, p-value < 0.0001
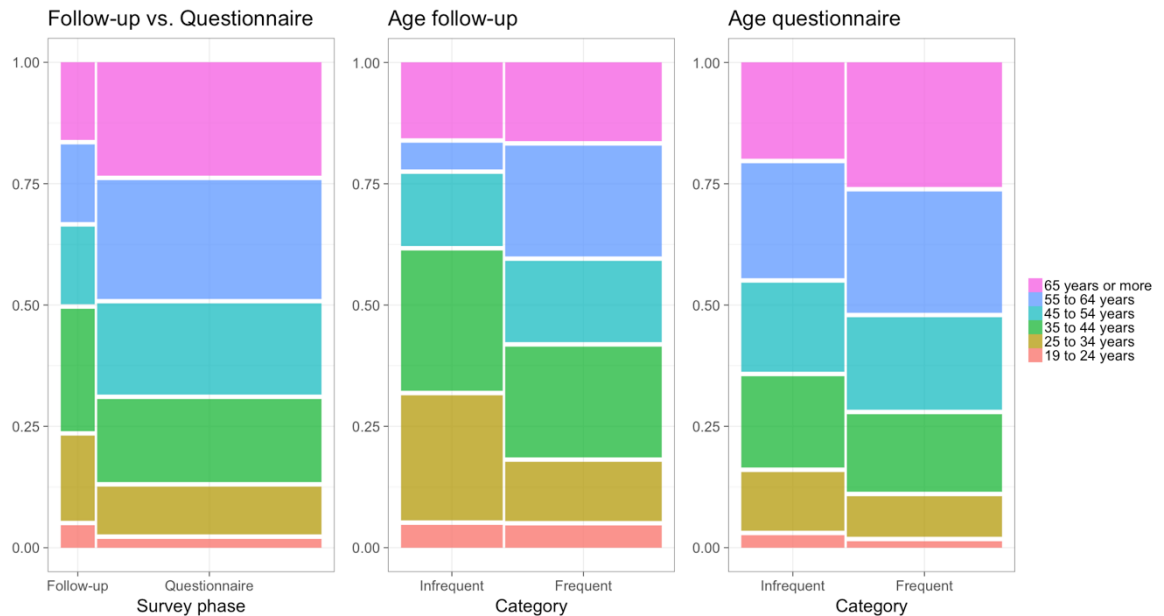

Figure 10.   Mosaic plots of proportions of age levels among survey phases and among angler categories

Note.   Follow-up vs. Questionnaire χ^2 = 52.68, df = 5, p-value < 0.0001
Age follow-up χ^2 = 24.15, df = 5, p-value = 0.0002
Age questionnaire χ^2 = 22.29, df = 5, p-value = 0.0005

Chapter 5.

Discussion and Conclusions

Against that positivism which stops before phenomena, saying "there are only facts," I should say: no, it is precisely facts that do not exist, only interpretations.

(Friedrich Nietzsche)

Angler heterogeneity reveals itself in different ways, and the focus of this research was to investigate the differences between two disparate angler groups: frequent and infrequent fishing license purchasers. Specifically, the purpose of this research was twofold. On one hand, the research aimed to examine the differences in angler sociodemographic and angling-specific characteristics between the two angler groups. And, on the second hand, the research sought to study the differences in angler fishing site preferences between the two angler groups. Thus, this chapter is organized as follows: first, I discuss the factors that influence an angler's likelihood to be a frequent license-purchaser, and present suggestions for improving license sales; second, I discuss the overall angler preferences for attributes of fishing sites and the differences in these preferences between frequent and infrequent anglers, and implications for fisheries management; third, I discuss the implications of the follow-up survey results to nonresponse bias and, consequently, the findings of this study; fourth, I address the limitations of this research effort; and fifth, I close the chapter with general conclusions of this research.

5.1. Who Are Frequent Anglers and How to Increase the Size of This Segment

In the field of human dimensions of recreational fisheries research, various individual-level characteristics have been used to quantify the effects on variability in fishing participation (e.g., Arlinghaus, 2006; Floyd & Lee, 2002; Kuehn et al., 2013). In my research, I investigated the effects of 17 sociodemographic and angling-specific angler characteristics on licence-purchasing habits. I found that the model that best described anglers' likelihood of belonging into the frequent group included the following

factors: age, skills, centrality to lifestyle, number of people in the household who fish, typical time of year to purchasing a license, and interaction between skills and centrality.

Specifically, among sociodemographic characteristics, my study showed that older age (55 to 65 years, and 65 years or more; compared to the age group 19 to 24 years) had the highest positive effect on anglers' likelihood of being a frequent license-purchaser. This is somewhat contrasting to previous research, which generally found negative effects of age on angler avidity (e.g. Arlinghaus et al., 2015), especially for the age group of 65 years or more (Floyd et al., 2006; Thunberg & Fulcher, 2006). Lack of time has repeatedly been reported as one of the most important constraints on anglers of various heterogeneous groups (e.g., Aas, 1995; Freudenberg & Arlinghaus, 2009; Shores et al., 2007), and it could be intuitively theorized that anglers aged 55 years or more are more likely to have more time available for leisure activities due to less working hours on average. In this research, however, the number of leisure hours an individual has available in a typical week was not among the factors that predicted angling avidity. Indeed, the effect of weekly working hours has been shown to even have a positive effect on participation rate, indicating moderate amounts work does not prohibit individuals from engaging in fishing (Arlinghaus et al., 2015). Therefore, this work suggests that the positive effect of older age on fishing avidity relates to a set of motivators or constraints different from solely availability of time to go fishing.

Targeting infrequent anglers is often seen as a low-hanging fruit for increasing license sales as they are the most easily recruited market segment (Balsman & Shoup, 2008). In an Ohio pilot project, specifically designed direct-marketing materials directed towards infrequent anglers has resulted in a 23 to 36 percent increase in renewal rates (as cited in Dann, Alvarado, Palmer, Schroeder, & Stephens, 2008). Coupling this approach with targeting the population younger than 54 years of age could provide a further improved return on advertising investment.

In the literature, there is a well-established knowledge of disproportional representation of males and higher-income individuals among (frequent) recreational fishing participants (e.g., Arlinghaus, 2006; Floyd & Lee, 2002; Thunberg & Fulcher, 2006), however, the results of my research failed to provide further support for these notions, since including the gender and income variables in the model did not significantly improve its predictive capacity. Similarly, while other research suggested a

negative effect of household size on angler avidity (Arlinghaus, 2006; Arlinghaus et al., 2015), I found no support for inclusion of this factor in the predictive model.

Conversely, this research showed that the number of household members who are anglers was among the best determinants of angler avidity; its effect was positive. The interpretation of this finding is two-sided. First, frequent anglers are probably more likely to recruit other people (in this case family members) to the fishing activity. And second, the availability of a fishing partner within an individual's household enables that individual to pursue fishing more often. In fact, social aspects of fishing are often the main motivation of frequent anglers; and frequent anglers are more confident in their knowledge of fishing opportunities and fishing skills (Dabrowska et al., 2018); it is reasonable to expect that both the social motivation and fishing knowledge contribute to increased initiation of family members to the sport. Hence, increased availability of family-friendly fishing sites and continuing delivery of programs such as Learn to Fish and Rod Loan (Freshwater Fisheries Society of BC, n.d.) have the potential to, not only initiate new individuals to fishing, but also to create the environment in which existing anglers can be motivated to fish more regularly.

Regarding the influence of angling-specific characteristics on the likelihood of anglers to be frequent, my research indicated that time of year when an individual purchases their fishing license, along with self-perceived fishing skills and centrality of fishing to lifestyle, were the remaining three key factors. I found evidence that individuals who typically purchase their fishing licenses at the beginning of a license year (around April 1st) were more likely to belong into the frequent angler group. The opposite was true for those individuals who purchase their licenses at any other point during a license year, especially those individuals who only purchase a license after being invited to go fishing by someone else. These results replicate previous research findings, which indicated that frequent anglers expect to go fishing at some point during the season, so they tend to purchase their license at the beginning of the season in order to be ready when the opportunity arises (Dabrowska et al., 2018). Furthermore, the abovementioned research found that infrequent anglers deliberate more before purchasing a license, in order to assess the potential use they might derive from it. Thus, increased advertising efforts during the license-renewal period could result in formation of a lasting habit of purchasing a license early. Besides, emphasizing the larger potential value an angler can get from a fishing license if purchased early in the season, could encourage

infrequent anglers which might otherwise be reluctant to buy a license if they considered purchasing it later in the season (after being invited to go fishing) due to less time left available to make use of the license.

Additionally, this research showed support for the positive relationship between angler specialization levels (as operationalized by centrality to lifestyle scale) and fishing skills (as measured by a self-perceived skill scale), and angling avidity. This is consistent with Bryan's (1977) concept of recreation specialization, which is, according to the author, revealed through the level of participation and the level of skills and knowledge, among other ways. Angler specialization (which includes the elements of centrality and commitment) is expected to progress on the continuum from general to specialized with continued participation, and consequently so are individual's angling skills and knowledge (Bryan, 1977). More recent research also found support for operationalization of recreation specialization through centrality to lifestyle scale (e.g., Beardmore et al., 2013). My research showed support for this notion, since skills and centrality, as well as interaction between the two, were among the selected predictors of angling avidity. Interestingly, there was a negative relationship between the effects of the level of fishing skills and the effects of centrality of fishing to lifestyle on angling avidity; the effect of skills was lower for those individuals with higher centrality and *vice versa*, indicating that the lack of one the aspects of specialization can be partially compensated with another aspect to still achieve the same level of participation, as measured by license-purchasing habits.

Angler specialization is a multifaceted concept, its processes largely internal, and thus difficult to influence solely through fisheries programs. Though, there is a potential for fisheries programs to improve anglers' fishing skills and thus facilitate the circumstances for increasing fishing avidity. For example, expanding programs like Learn to Fish (Freshwater Fisheries Society of BC, n.d.) to more readily include adult learners and to provide advanced-skill learning, as well as facilitating opportunities for knowledge-sharing, could increase anglers' self-perceived fishing skills, making these individuals more likely to become frequent anglers. Additionally, better fishing knowledge and increased skills has the potential to improve the confidence of anglers to initiate friends and family members to the sport—generating further positive influence on anglers' avidity levels.

5.2. Preferences of Frequent and Infrequent Anglers and Management Implications

Freshwater fisheries managers have long observed a spectrum of preferences for fishing sites and attitudes towards management actions among recreational anglers (Aas & Ditton, 1998). This research effort sought to investigate the preferences for various attributes of fishing site among BC freshwater anglers, as well as the differences in fishing site preferences between the two heterogeneous groups: the frequent and the infrequent anglers.

Overall, I found that anglers preferred fishing sites that were located a short distance from their starting point, that could be accessed by a paved road or at least by a well-maintained gravel road, that had a low number of other anglers at the site (or, better yet, no other anglers), and that had at least some amenities available for use. With regards to catch expectations, high daily catch expectations were greatly positively associated with site choice and anglers showed a slight preference for sites with higher fish species diversity, and preferred sites with trophy- (most preferred level) or average-sized (second most preferred level) fish. Fishing regulations had the following effect on anglers' preferences: catch-and-release only was less preferred than the regulations that allowed at least some fish to be taken, and, compared to a slot-size or minimum-size limits, no size limit was the most preferred level. On average, BC anglers preferred a comfortable and isolated fishing experience. It appears that the importance of catch and keeping fish to angler utility was relatively high, as catch-related attributes indicated a preference for many, big, and diverse fish, that did not need to be released, regardless of their size.

While the above-discussed findings can provide meaningful insights for future fisheries management decisions, they are based on the assumption that BC anglers are a homogenous group. And in the light of past decades' research on angler heterogeneity, it would be short-sighted to accept the idea that all BC anglers are seeking the same fishing experience and are attracted to the same type of fishing sites. Thus, the investigation of the different preference patterns between frequent and infrequent anglers was the principal interest to my fishing site preference research.

Compared to infrequent anglers, frequent anglers preferred more rudimentary fishing sites: they had a higher preference for fishing sites with no amenities, as well as for those that had to be reached by a gravel road (yet, a paved road was still preferred over the hike-in option). Additionally, frequent anglers had a lesser preference for complete solitude at the fishing site as they were less negatively influenced by seeing other anglers while fishing.

Moreover, frequent anglers had different preferences for catch-related attributes. They exhibited a much higher importance of expected fish size—preference for trophy-sized fish, as well as a slightly higher preference for fishing sites where they could expect to catch a higher number of fish. This observation was in contrast with my expectations, which relied on the original propositions of recreation specialization that described more specialized (or in the case of this study, frequent) anglers as less motivated by catch-related elements of fishing (Ditton et al., 1992). However, other researchers observed similar catch-related preferences of more avid or specialized anglers (e.g., Beardmore et al., 2013; Dabrowska et al., 2017; Dorow et al., 2010); the researchers attempted to explain these preferences within specific fishery contexts. Within the framework of my study, I theorize that the catch-related preferences of frequent anglers can be interpreted as relative to their fishing skills: the expectations for catching trophy-sized fish would have a higher influence on an individual who is confident in his or hers ability and skills to catch fish of this size.

In my research, frequent anglers were also more tolerating of fishing regulations: compared to infrequent anglers, they were less negatively influenced by catch-and-release restrictions and were more accepting of minimum size limits. This result was expected and consistent with recreation specialization theory (Ditton et al., 1992) and with previous research which investigated the differences in preferences among anglers of varying specialization levels (e.g. Dabrowska et al., 2017; Dorow et al., 2010).

The results of my research provided further support for the fisheries management approaches that take angler heterogeneity into account, realizing that only providing opportunities that entice the average angler (who does not exist) to participate in fishing would not result in optimal benefits to the overall angler population, and instead call for approaches that determine regulations and management objectives based on the composition of the angler population in terms of angler types (Johnston et al., 2010). My

research has shown that frequent anglers have different preferences for fishing site characteristics from infrequent anglers, and thus providing a range of fishing sites that satisfy both groups of anglers is essential to keeping the frequent anglers engaged and to motivate infrequent anglers to participate in the sport more often. For example, fishing sites accessed by gravel roads, with no or only basic amenities, where anglers could expect to catch either large or many fish, and with more stringent fishing regulations (e.g., catch-and-release only, or minimum size limits) would more likely attract frequent anglers. On the other hand, fishing sites accessed by paved roads, with a medium level of amenities, little to no crowding, with average sized fish and more lenient fishing regulations would be more appealing to infrequent anglers. Unfortunately, various fishing site preferences are not always compatible with each other, for example, a water body cannot contain a large number of trophy-sized fish, or, a paved road enables easy access to the site and therefore attracts more anglers and increases crowding levels. In these cases, knowing the relative effects an attribute level has on the likelihood of that fishing site to be chosen is helpful to find a compromise between competing management goals that satisfies a larger percentage of a targeted angler group.

5.3. Considering Nonresponse Bias

In this study, I observed a very low response rate to the initial online survey. In case of a low response rate, it is implied that respondents are somewhat self-selected into the sample (Brick, 2013), which breaches the statistical assumptions of selecting a random sample. Self-selection is of concern to researchers because it decreases the representativeness of the sample (Petrovčič, Petrič, & Manfreda, 2016) and using a non-representative or convenience sample introduces the representation bias, which might skew study findings away from the actual angling population means, perspectives or preferences (L. M. Hunt et al., 2010). Avid or highly specialized anglers, for example, are more likely to respond to fisheries surveys and are therefore often overrepresented in such surveys, thus introducing the avidity bias into the study results (Barrett, van Poorten, Cooper, & Haider, 2017; Thomson, 1991).

In this study, the analysis of the follow-up survey indicated that a type of avidity bias was present in the initial online survey. The results showed that the respondents in the initial survey phase were more likely to have had responded to fisheries surveys or

provided feedback before than the respondents to the follow-up survey—the initial survey attracted more of the individuals who typically participate in angling public participation opportunities. Furthermore, I found that both in the initial and the follow-up surveys frequent anglers were more likely to have had participated in fisheries outreach opportunities before than infrequent anglers were. This finding further confirms that avidity bias is a valid concern to fisheries researchers. Interestingly, the overall differences between frequent and infrequent anglers in the follow-up survey were less pronounced than in the initial survey.

The follow-up survey also showed that the non-respondents to the initial online survey were on average more satisfied with their fishing experience in the previous license year. Perhaps this could be explained by assuming that the less satisfied (especially infrequent) anglers were more likely to respond because they hoped that the survey would provide them with an opportunity to express their dissatisfaction or concerns. Moreover, the follow-up survey revealed that as an individuals' education levels increased, their propensity to respond to the initial survey decreased—in particular, the individuals with a post graduate degree were less likely to respond than individuals with a lower level of education. Similarly, the respondents within higher age groups were more likely to respond to the initial survey. And while it would be challenging to correct the survey data to reflect the true population averages better, it is important to take these findings into account when considering the results of the initial survey.

5.4. Study Limitations

The most pronounced limitation of this research was the low response rate of the initial survey: as discussed above, the low response rates decrease the statistical validity and representativeness of the results. While reasonable attempts were made to increase the response rate (such as multiple contacts and personalized invitation emails), other methods could have been employed to further improve the response rate (e.g., providing a monetary incentive for responding or including a different survey mode in the study design; for examples see Dillman et al., 2014).

The second limitation of the study was that fact the follow-up survey also received a low response rate: there was a large proportion of non-respondents from

whom no data were collected. Therefore, any consideration of non-response bias was influenced by any remaining non-response bias in the follow-up survey. Further research should incorporate a more vigorous study of non-response bias, as it was shown to have a considerable effect on survey results but the size of the effect was hard to discern within this research.

The third limitation of the study was that there is a large segment of the overall BC resident angler population which had not consented to be contacted via email for research and other purposes and was therefore excluded from the pool of individuals from which the initial random samples were drawn. While these anglers could have been contacted by regular mail, extra funds would have been required as mail surveys tend to be more costly than online surveys (Carrozzino-Lyon, McMullin, & Parkhurst, 2013).

Another limitation of this research arose from the unavailability of the population estimates for the majority of the variables investigated in the study. Had these estimates been known and the non-response bias more successfully assessed, the initial survey estimates could have been corrected to better reflect the true population differences between frequent and infrequent anglers and their fishing site preferences.

5.5. Conclusions

To conclude, the findings of this study confirmed the assumption that frequent and infrequent BC freshwater recreational anglers differ from each other—both in their characteristics, as well in their fishing site preferences. On one hand, there are several demographic and angling-specific variables that influence an angler's likelihood to be a frequent license-purchaser. Understanding these characteristics is important from the fisheries-management perspective: it is crucial for managers to know which groups of anglers (as defined by the characteristics identified in this research) are more likely to purchase their fishing license every year, especially as this knowledge can improve and expand on existing license marketing tactics and recruitment efforts. On the other hand, the frequent and the infrequent anglers had different preferences for several attributes of fishing sites, which has implications for fisheries-management approaches—the preference insights revealed through this research indicated what attributes of fishing opportunities were most desired by the two different angler groups, and management approaches that provide a diverse set of fishing sites which address those preferences

could potentially increase angler participation. However, this research effort was impacted by low response rates, which could have diminished the validity of the results. Therefore, further research is needed to collect more representative samples that will provide researchers with greater confidence in the validity of the results and will improve the understanding of the differences between frequent and infrequent anglers and the implications for sustainable fisheries management.

References

Aas, Ø. (1995). Constraints on Sportfishing and Effect of Management Actions to Increase Participation Rates in Fishing. *North American Journal of Fisheries Management*, *15*(3), 631–638. http://doi.org/10.1577/1548-8675(1995)015

Aas, Ø. (1996). Recreational fishing in Norway from 1970 to 1993: trends and geographical variation. *Fisheries Management and Ecology*, *3*, 107–118. http://doi.org/10.1111/j.1365-2400.1996.tb00135.x

Aas, Ø., & Ditton, R. B. (1998). Human dimensions perspective on recreational fisheries management: implications for Europe.

Aas, Ø., Haider, W., & Hunt, L. M. (2000). Angler Responses to Potential Harvest Regulations in a Norwegian Sport Fishery: A Conjoint-Based Choice Modeling Approach. *North American Journal of Fisheries Management*, *20*, 940–950. http://doi.org/10.1577/1548-8675(2000)020<0940:ARTPHR>2.0.CO;2

Agresti, A. (1996). *An introduction to categorical data analysis* (Vol. 135). Wiley New York.

Akaike, H. (1974). A new look at the statistical model identification. *IEEE Transactions on Automatic Control*, *19*(6), 716–723.

Arlinghaus, R. (2006). Understanding Recreational Angling Participation in Germany: Preparing for Demographic Change. *Human Dimensions of Wildlife*, *11*(4), 229–240. http://doi.org/10.1080/10871200600802889

Arlinghaus, R., Bork, M., & Fladung, E. (2008). Understanding the heterogeneity of recreational anglers across an urban-rural gradient in a metropolitan area (Berlin, Germany), with implications for fisheries management. *Fisheries Research*, *92*(1), 53–62. http://doi.org/10.1016/j.fishres.2007.12.012

Arlinghaus, R., & Mehner, T. (2004). A management-orientated comparative analysis of urban and rural anglers living in a metropolis (Berlin, Germany). *Environmental Management*, *33*(3), 331–344. http://doi.org/10.1007/s00267-004-0025-x

Arlinghaus, R., Tillner, R., & Bork, M. (2015). Explaining participation rates in recreational fishing across industrialised countries. *Fisheries Management and Ecology*, *22*(1), 45–55. http://doi.org/10.1111/fme.12075

Balsman, D. M., & Shoup, D. E. (2008). Opportunities for Urban Fishing: Developing Urban Fishing Programs to Recruit and Retain Urban Anglers. *Urban and Community Fisheries Programs: Development, Management, and Evaluation*, *67*, 31–40.

Barrett, B. N., van Poorten, B., Cooper, A. B., & Haider, W. (2017). Concurrently Assessing Survey Mode and Sample Size in Off-Site Angler Surveys. *North American Journal of Fisheries Management*, *37*(4), 756–767. http://doi.org/10.1080/02755947.2017.1324543

BC Ministry of Environment. (2007). *Freshwater Fisheries Program Plan*. Retrieved from http://www.env.gov.bc.ca/fw/docs/fisheries_program_plan.pdf

Beardmore, B., Haider, W., Hunt, L. M., & Arlinghaus, R. (2011). The importance of trip context for determining primary angler motivations: Are more specialized anglers more catch-oriented than previously believed? *North American Journal of Fisheries Management*, *31*(5), 861–879. http://doi.org/10.1080/02755947.2011.629855

Beardmore, B., Haider, W., Hunt, L. M., & Arlinghaus, R. (2013). Evaluating the Ability of Specialization Indicators to Explain Fishing Preferences. *Leisure Sciences*, *35*(3), 273–292. http://doi.org/10.1080/01490400.2013.780539

Beardmore, B., Hunt, L. M., Haider, W., Dorow, M., & Arlinghaus, R. (2014). Effectively managing angler satisfaction in recreational fisheries requires understanding the fish species and the anglers. *Canadian Journal of Fisheries and Aquatic Sciences*, *72*(4), 500–513. http://doi.org/10.1139/cjfas-2014-0177

Beardmore, B., Hunt, L. M., Haider, W., Dorow, M., & Arlinghaus, R. (2015). Effectively managing angler satisfaction in recreational fisheries requires understanding the fish species and the anglers. *NRC Research Press*, *513*(November 2014), 500–513.

Ben-Akiva, M. E., & Lerman, S. R. (1985). *Discrete choice analysis: theory and application to travel demand* (Vol. 9). MIT press.

Bethlehem, J. G. (2002). Weighting nonresponse adjustments based on auxiliary information. In R. M. Groves, D. A. Dillman, J. L. Eltinge, & R. J. A. Little (Eds.), *Survey nonresponse*. New York, NY: Wiley.

Brick, J. M. (2013). Unit nonresponse and weighting adjustments: A critical review. Versita.

Bruskotter, J. T., & Fulton, D. C. (2013). The future of fishing: an introduction to the special issue. *Human Dimensions of Wildlife*, *18*(5), 319–321.

Bryan, H. (1977). Leisure value systems and recreational specialization: The case of trout fishermen. *Journal of Leisure Research*, *9*(3), 174–187.

Buchanan, T. (1985). Commitment and leisure behavior: A theoretical perspective. *Leisure Sciences*, *7*(4), 401–420. http://doi.org/10.1080/01490408509512133

Burch, W. R. (1969). The social circles of leisure: Competing explanations. *Journal of Leisure Research*, *1*(2), 125.

Burnham, K. P., & Anderson, D. R. (2003). *Model selection and multimodel inference: a practical information-theoretic approach*. Springer Science & Business Media.

Carkin, D. M., & Tracy, P. E. (2015). Adjusting for Unit Non-Response in Surveys Through Weighting. *Crime and Delinquency*, *61*(1), 143–158. http://doi.org/10.1177/0011128714556739

Carlin, C., Schroeder, S. A., & Fulton, D. C. (2012). Site Choice among Minnesota Walleye Anglers: The Influence of Resource Conditions, Regulations and Catch Orientation on Lake Preference. *North American Journal of Fisheries Management*, *32*(2), 299–312. http://doi.org/10.1080/02755947.2012.675952

Carrozzino-Lyon, A. L., McMullin, S. L., & Parkhurst, J. A. (2013). Mail and Web-Based Survey Administration: A Case Study With Recreational Users of Virginia's Wildlife Management Areas. *Human Dimensions of Wildlife*, *18*(3), 219–233. http://doi.org/10.1080/10871209.2013.761298

Chipman, B. D., & Helfrich, L. A. (1988). Recreational specializations and motivations of Virginia river anglers. *North American Journal of Fisheries Management*, *8*(4), 390–398.

Choi, S., Loomis, D. K., & Ditton, R. B. (1994). Effect of social group, activity, and specialization on recreation substitution decisions. *Leisure Sciences*, *16*(3), 143–159. http://doi.org/10.1080/01490409409513227

Crawford, D. W., & Godbey, G. (1987). Reconceptualizing barriers to family leisure. *Leisure Sciences*, *9*(2), 119–127.

Croissant, Y. (2013). mlogit: multinomial logit model. Retrieved from https://cran.r-project.org/package=mlogit

Dabrowska, K., Demsar, T., van Poorten, B., & Haider, W. (2018). Does a misunderstanding of occasional anglers prevent us from increasing angler participation?

Dabrowska, K., Haider, W., & Hunt, L. M. (2014). Examining the impact of fisheries resources and quality on licence sales. *Journal of Outdoor Recreation and Tourism*, *5–6*, 58–67. http://doi.org/10.1016/j.jort.2014.03.005

Dabrowska, K., Hunt, L. M., & Haider, W. (2017). Understanding how Angler Characteristics and Context Influence Angler Preferences for Fishing Sites. *North American Journal of Fisheries Management*, *37*(6), 1350–1361. http://doi.org/10.1080/02755947.2017.1383325

Dann, S. L., Alvarado, A., Palmer, D., Schroeder, B., & Stephens, M. (2008). Angler participation, recruitment, and retention in Michigan, 1995-2004: Using data-mining techniques for customer relationship management. Research Report 2088., 54.

DeWitt, P. (2018). qwraps2: Quick Wraps 2. Retrieved from https://cran.r-project.org/package=qwraps2

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2014). *Internet, phone, mail, and mixed-mode surveys: the tailored design method*. John Wiley & Sons.

Ditton, R. B., Loomis, D. K., & Choi, S. (1992). Recreation specialization: re-conceptualization from a social worlds perspective. *Journal of Leisure Research*.

Dolsen, D. E., & Machlis, G. E. (1991). Response rates and mail recreation survey results: how much is enough? *Journal of Leisure Research*, *23*(3), 272–277.

Dorow, M., & Arlinghaus, R. (2012). The Relationship between Personal Commitment to Angling and the Opinions and Attitudes of German Anglers towards the Conservation and Management of the European Eel Anguilla anguilla. *North American Journal of Fisheries Management*, *32*, 466–479. http://doi.org/10.1080/02755947.2012.680006

Dorow, M., Beardmore, B., Haider, W., & Arlinghaus, R. (2010). Winners and losers of conservation policies for European eel, Anguilla anguilla: An economic welfare analysis for differently specialised eel anglers. *Fisheries Management and Ecology*, *17*(2), 106–125. http://doi.org/10.1111/j.1365-2400.2009.00674.x

Driver, B. L., & Cooksey, R. W. (1977). Preferred psychological outcomes of recreational fishing. In R. A. Barnhart & T. D. Roelofs (Eds.), *Catch-and-reiease fishing as a management tool* (pp. 27–40). Arcata, California: Humboldt State University.

Driver, B. L., & Knopf, R. C. (1976). Temporary escape: one product of sport fisheries management. *Fisheries (USA)*.

Elff, M. (2018). mclogit: Mixed Conditional Logit Models. Retrieved from https://cran.r-project.org/package=mclogit

Fedler, A. J., & Ditton, R. B. (1994). Understanding Angler Motivations in Fisheries Management. *Fisheries*, *19*(4), 6–13. http://doi.org/10.1577/1548-8446(1994)019<0006:UAMIFM>2.0.CO;2

Fedler, A. J., & Ditton, R. B. (2001). Dropping Out and Dropping In: A Study of Factors for Changing Recreational Fishing Participation. *North American Journal of Fisheries Management*, *21:1*(July 2015), 135–146. http://doi.org/10.1577/1548-8675(2001)021

Fenichel, E. P., Abbott, J. K., & Huang, B. (2013). Modelling angler behaviour as a part of the management system: Synthesizing a multi-disciplinary literature. *Fish and Fisheries*, *14*(2), 137–157. http://doi.org/10.1111/j.1467-2979.2012.00456.x

Fernihough, A. (2014). mfx: Marginal Effects, Odds Ratios and Incidence Rate Ratios for GLMs. Retrieved from https://cran.r-project.org/package=mfx

Fisher, M. R. (1996). Estimating the effect of nonresponse bias on angler surveys. *Transactions of the American Fisheries Society*, *125*(1), 118–126.

Fisher, M. R. (1997). Segmentation of the Angler Population by Catch Preference, Participation, and Experience: A Management-Oriented Application of Recreation Specialization. *North American Journal of Fisheries Management*, *17*(2), 413–428. http://doi.org/10.1577/1548-8675(1997)017

Fisheries and Oceans Canada. (2010). *2010 Survey of Recreational Fishing in Canada*. Retrieved from http://www.dfo-mpo.gc.ca/stats/rec/can/2010/index-eng.htm

Floyd, M. F., & Lee, I. (2002). Who Buys Fishing and Hunting Licenses in Texas? Results from a Statewide Household Survey. *Human Dimensions of Wildlife*, *7*(2), 91–106. http://doi.org/10.1080/10871200290089364

Floyd, M. F., Nicholas, L., Lee, I., Lee, J.-H., & Scott, D. (2006). Social Stratification in Recreational Fishing Participation: Research and Policy Implications. *Leisure Sciences*, *28*(4), 351–368. http://doi.org/10.1080/01490400600745860

Freshwater Fisheries Society of BC. (n.d.). Fishing Programs. Retrieved April 12, 2018, from https://www.gofishbc.com/How-to-Fish.aspx#fishing-programs

Freudenberg, P., & Arlinghaus, R. (2009). Benefits and Constraints of Outdoor Recreation for People with Physical Disabilities: Inferences from Recreational Fishing. *Leisure Sciences*, *32*(1), 55–71. http://doi.org/10.1080/01490400903430889

Graefe, A. R. (1981). The relationship between level of participation and selected aspects of specialization in recreational fishing. *Dissertation Abstracts International, A*, *41*(10).

Groves, R. M. (1989). *Survey errors and survey costs*. New York, NY: Wiley.

Groves, R. M. (2006). Nonresponse rates and nonresponse bias in household surveys: What Do We Know about the Linkage between Nonresponse Rates and Nonresponse Bias? *Public Opinion Quarterly*, *70*(5), 646–675. http://doi.org/10.1093/poq/nfl033

Halstead, J. M., Luloff, A. E., & Stevens, T. H. (1992). Protest bidders in contingent valuation. *Northeastern Journal of Agricultural and Resource Economics*, *21*(2), 160–169.

Hensher, D. A. (2006). Revealing differences in willingness to pay due to the dimensionality of stated choice designs: An initial assessment. *Environmental and Resource Economics*, *34*(1), 7–44. http://doi.org/10.1007/s10640-005-3782-y

Hensher, D. A., & Johnson, L. W. (2018). *Applied discrete-choice modelling* (Routhledge). New York, NY: Routledge.

Hoffman, S. D., & Duncan, G. J. (1988). Multinomial and conditional logit discrete-choice models in demography. *Demography*, *25*(3), 415–427.

Hunt, K. M., & Ditton, R. B. (1997). The Social Context of Site Selection for Freshwater Fishing. *North American Journal of Fisheries Management*, *17*, 331–338.

Hunt, L. M. (2005). Recreational fishing site choice models: insights and future opportunities. *Human Dimensions of Wildlife: An International Journal*, *10*(3), 153–172. http://doi.org/10.1080/10871200591003409

Hunt, L. M., Boots, B. N., & Boxall, P. C. (2007). Predicting Fishing Participation and Site Choice While Accounting for Spatial Substitution, Trip Timing, and Trip Context. *North American Journal of Fisheries Management*, *27*(3), 832–847. http://doi.org/10.1577/M06-079.1

Hunt, L. M., Gonder, D., & Haider, W. (2010). Hearing Voices from the Silent Majority: A Comparison of Preferred Fish Stocking Outcomes for Lake Huron by Anglers from Representative and Convenience Samples. *Human Dimensions of Wildlife*, *15*(1), 27–44. http://doi.org/10.1080/10871200903360080

Hutt, C. P., & Bettoli, P. W. (2007). Preferences, specialization, and management attitudes of trout anglers fishing in Tennessee tailwaters. *North American Journal of Fisheries Management*, *27*(4), 1257–1267.

Hutt, C. P., & Neal, J. W. (2010). Arkansas Urban Resident Fishing Site Preferences, Catch Related Attitudes, and Satisfaction. *Human Dimensions of Wildlife*, *15*(2), 90–105. http://doi.org/10.1080/10871200903443316

Jackman, S. (2017). pscl: Classes and Methods for R Developed in the Political Science Computational Laboratory. Sydney, New South Wales, Australia: United States Studies Centre, University of Sydney.

Jackson, E. L., Crawford, D. W., & Godbey, G. (1993). Negotiation of leisure constraints. *Leisure Sciences*, *15*(1), 1–11. http://doi.org/10.1080/01490409309513182

Jiorle, R. P., Ahrens, R. N. M., & Allen, M. S. (2016). Assessing the Utility of a Smartphone App for Recreational Fishery Catch Data. *Fisheries*, *41*(12), 758–766. http://doi.org/10.1080/03632415.2016.1249709

Johnson, M. P. (1973). Commitment: A conceptual structure and empirical application. *The Sociological Quarterly*, *14*(3), 395–406.

Johnston, F. D., Arlinghaus, R., & Dieckmann, U. (2010). Diversity and complexity of angler behaviour drive socially optimal input and output regulations in a bioeconomic recreational-fisheries model. *Canadian Journal of Fisheries and Aquatic Sciences*, *67*(9), 1507–1531. http://doi.org/10.1139/F10-046

Kassambara, A. (2017). ggpubr: "ggplot2" Based Publication Ready Plots. Retrieved from https://cran.r-project.org/package=ggpubr

Kim, S.-S., Scott, D., & Crompton, J. L. (1997). An Exploration of the Relationships Among Social Psychological Involvement, Behavioral Involvement, Commitment, and Future Intentions in the Context of Birdwatching. *Journal of Leisure Research*, *29*(3), 320–341. http://doi.org/10.1080/00222216.1997.11949799

Knopf, R. C., Driver, B. L., & Bassett, J. R. (1973). Motivations for fishing. In *Transactions of the North American Wildlife and Natural Resources Conference* (Vol. 38, pp. 191–204).

Kohl, M. (2018). MKmisc: Miscellaneous functions from M. Kohl.

Koppelman, F. S., & Bhat, C. (2006). *A Self Instructing Course in Mode Choice Modeling: Multinomial and Nested Logit Models*.

Kuehn, D. M., Dawson, C. P., & Hoffman, R. (2006). Exploring Fishing Socialization Among Male and Female Anglers in New York's Eastern Lake Ontario Area. *Human Dimensions of Wildlife*, *11*(2), 115–127. http://doi.org/10.1080/10871200600572490

Kuehn, D. M., Luzadis, V., & Brincka, M. (2013). An Analysis of the Factors Influencing Fishing Participation by Resident Anglers. *Human Dimensions of Wildlife*, *18*(5), 322–339. http://doi.org/10.1080/10871209.2013.820370

Kuentzel, W. F., & McDonald, C. D. (1992). Differential effects of past experience, commitment, and lifestyle dimensions on river use specialization. *Journal of Leisure Research*, *24*(3), 269.

Kyle, G., Norman, W., Jodice, L., Graefe, A., & Marsinko, A. (2007). Segmenting anglers using their consumptive orientation profiles. *Human Dimensions of Wildlife*, *12*(2), 115–132. http://doi.org/10.1080/10871200701196066

Lele, S. R., Keim, J. L., & Solymos, P. (2017). ResourceSelection: Resource Selection (Probability) Functions for Use-Availability Data.

Leonard, J., & Aiken, R. (2015). *Fishing and hunting recruitment and retention in the U.S. from 1990 to 2005: Addendum to the 2011 national survey of fishing, hunting, and wildlife-associated recreation*.

Lew, D. K., Himes-Cornell, A., & Lee, J. (2015). Weighting and imputation for missing data in a cost and earnings fishery survey. *Marine Resource Economics*, *30*(2), 219–230. http://doi.org/10.1086/679975

Li, O., Sutton, S. G., & Tynan, L. (2010). Communicating scientific information to recreational fishers. *Human Dimensions of Wildlife*, *15*(2), 106–118. http://doi.org/10.1080/10871200903366939

Loomis, D. K., & Ditton, R. B. (1987). Analysis of Motive and Participation Differences between Saltwater Sport and Tournament Fishermen. *North American Journal of Fisheries Management*, *7*(4), 482–487. http://doi.org/10.1577/1548-8659(1987)7<482:AOMAPD>2.0.CO;2

Louviere, J. J. (1988). *Quantitative applications in the social sciences: Analyzing decision making*. Thousand Oaks, CA: SAGE Publications Ltd. http://doi.org/10.4135/9781412983365

Louviere, J. J., Hensher, D. A., Swait, J. D., & Adamowicz, W. (2000). *Stated Choice Methods : Analysis and Applications*. Cambridge, United Kingdom: Cambridge University Press.

Lumley, T. (2014). survey: analysis of complex survey samples.

Lyu, S. O., & Oh, C.-O. (2014). Recreationists' Constraints Negotiation Process for Continual Leisure Engagement. *Leisure Sciences*, *36*(5), 479–497. http://doi.org/10.1080/01490400.2014.920702

Manfredo, M. J., Driver, B. L., & Tarrant, M. a. (1996). Measuring leisure motivation : A meta-analysis of the recreation experience preference scales. *Journal of Leisure Research*, *28*(3), 188–213.

Manski, C. F. (1977). The structure of random utility models. *Theory and Decision*, *8*(3), 229–254. http://doi.org/10.1007/BF00133443

Margenau, T. L., & Petchenik, J. B. (2004). Social Aspects of Muskellunge Management in Wisconsin. *North American Journal of Fisheries Management*, *24*(1), 82–93. http://doi.org/10.1577/M02-045

McFadden, D. (1974). Conditional logit analysis of qualitative choice behavior. In P. Zarembka (Ed.), *Frontiers in Econometrics* (pp. 105–142). New York: Academic Press. http://doi.org/10.1108/eb028592

McFarlane, B. L. (1994). Specialization and motivations of birdwatchers. *Wildlife Society Bulletin (1973-2006)*, *22*(3), 361–370.

McIntyre, N. (1989). The personal meaning of participation: Enduring involvement. *Journal of Leisure Research*, *21*(2), 167.

McIntyre, N., & Pigram, J. J. (1992). Recreation specialization reexamined: The case of vehicle-based campers. *Leisure Sciences*, *14*(1), 3–15.

Meyerhoff, J., & Liebe, U. (2006). Protest beliefs in contingent valuation: explaining their motivation. *Ecological Economics*, *57*(4), 583–594.

Meyerhoff, J., Mørkbak, M. R., & Olsen, S. B. (2014). A meta-study investigating the sources of protest behaviour in stated preference surveys. *Environmental and Resource Economics*, *58*(1), 35–57.

Mitchell, R. C., & Carson, R. T. (1989). *Using surveys to value public goods: the contingent valuation method*. Resources for the Future.

Needham, M. D., Sprouse, L. J., & Grimm, K. E. (2009). Testing a self-classification measure of recreation specialization among anglers. *Human Dimensions of Wildlife*, *14*(6), 448–455. http://doi.org/10.1080/10871200903032580

Oh, C.-O., & Ditton, R. B. (2006). Using recreation specialization to understand multi-attribute management preferences. *Leisure Sciences*, *28*(4), 369–384. http://doi.org/10.1080/01490400600745886

Oh, C.-O., Ditton, R. B., Gentner, B., & Riechers, R. (2005). A Stated Preference Choice Approach to Understanding Angler Preferences for Management Options. *Human Dimensions of Wildlife*, *10*(3), 173–186. http://doi.org/10.1080/10871200591003427

Oh, C.-O., Sutton, S. G., & Sorice, M. G. (2013). Assessing the Role of Recreation Specialization in Fishing Site Substitution. *Leisure Sciences*, *35*, 256–272. http://doi.org/10.1080/01490400.2013.780534

Oh, C., Sorice, M. G., & Ditton, R. B. (2011). Exploring Progression along the Recreation Specialization Continuum Using a Latent Growth Approach Exploring Progression along the Recreation Specialization Continuum Using a Latent, *33*(1), 15–31. http://doi.org/10.1080/01490400.2011.533104

Ontario Ministry of Natural Resources. (2013). *2013 Ontario Fish and Wildlife Consumer Research Survey: A report on trends in fishing, hunting and wildlife related interests in Ontario*.

Petrovčič, A., Petrič, G., & Manfreda, K. L. (2016). The effect of email invitation elements on response rate in a web survey within an online community. *Computers in Human Behavior*, *56*, 320–329.

Peytchev, A. (2013). Consequences of Survey Nonresponse. *Annals of the American Academy of Political and Social Science*, *645*(1), 88–111. http://doi.org/10.1177/0002716212461748

Proebstl-Haider, U., & Haider, W. (2013). Tools for measuring the intention for adapting to climate change by winter tourists: some thoughts on consumer behavior research and an empirical example. *Tourism Review*, *68*(2), 44–55. http://doi.org/10.1108/TR-04-2013-0015

R Core Team. (2017). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Retrieved from https://www.r-project.org/

Ritter, C., Ditton, R. B., & Riechers, R. K. (1992). Constraints to sport fishing: Implications for fisheries management. *Fisheries*, *17*(4), 16–19.

RStudio Team. (2016). RStudio: Integrated Development for R. Boston, MA: RStudio, Inc.

Schramm, H. L., & Gerard, P. D. (2004). Temporal changes in fishing motivation among fishing club anglers in the United States. *Fisheries Management and Ecology*, *11*(5), 313–321. http://doi.org/10.1111/j.1365-2400.2004.00384.x

Schuett, M. a., Lu, J., Ditton, R. B., & Tseng, Y. P. (2010). Sociodemographics, Motivations, and Behavior: The Case of Texas Anglers 1989–2004. *Human Dimensions of Wildlife*, *15*(4), 247–261. http://doi.org/10.1080/10871209.2010.490973

Scott, D., Baker, S. M., & Kim, C. (1999). Motivations and commitments among participants in the Great Texas Birding Classic. *Human Dimensions of Wildlife*, *4*(1), 50–67.

Scott, D., Ditton, R. B., Stoll, J. R., & Eubanks, T. L. (2005). Measuring specialization among birders: Utility of a Self-Classification measure. *Human Dimensions of Wildlife*, *10*(1), 53–74. http://doi.org/10.1080/10871200590904888

Scott, D., & Shafer, C. S. (2001). Recreational specialization: a critical look at the construct. *Journal of Leisure Research*, *33*(3), 319–343. http://doi.org/10.1017/CBO9781107415324.004

Shafer, E. L. (1969). *The average camper who doesn't exist*. Northeastern Forest Experiment Station, Upper Darby, Pennsylvania.

Shores, K. a., Scott, D., & Floyd, M. F. (2007). Constraints to Outdoor Recreation: A Multiple Hierarchy Stratification Perspective. *Leisure Sciences*, *29*(3), 227–246. http://doi.org/10.1080/01490400701257948

Sing, T., Sander, O., Beerenwinkel, N., & Lengauer, T. (2005). ROCR: visualizing classifier performance in R. *Bioinformatics*, *21*(20), 7881.

Sutton, S. G. (2003). Personal and Situational Determinants of Catch-and-Release Choice of Freshwater Anglers. *Human Dimensions of Wildlife*, *8*(2), 109–126. http://doi.org/10.1080/10871200304300

Sutton, S. G. (2006). Understanding Recreational Fishers' Participation in Public Consultation Programs. *Human Dimensions of Wildlife*, *11*(5), 329–341. http://doi.org/10.1080/10871200600894969

Sutton, S. G. (2007). Constraints on Recreational Fishing Participation in Queensland , Australia Restriciones en la Participación de Actividades de Pesca Recreativa en Queensland , Australia. *Fisheries*, *32*(2), 73–83.

Sutton, S. G., & Ditton, R. B. (2001). Understanding catch-and-release behavior among U.S. atlantic bluefin tuna anglers. *Human Dimensions of Wildlife*, *6*(1), 49–66. http://doi.org/10.1080/10871200152668698

Sutton, S. G., & Ditton, R. B. (2005). The Substitutability of One Type of Fishing for Another. *North American Journal of Fisheries Management*, *25*(2), 536–546. http://doi.org/10.1577/M04-059.1

Sutton, S. G., & Oh, C.-O. (2015). How Do Recreationists Make Activity Substitution Decisions? A Case of Recreational Fishing. *Leisure Sciences*, (July 2015), 1–22. http://doi.org/10.1080/01490400.2015.1016195

Swait, & Adamowicz, W. (2001). The Influence of Task Complexity on Consumer Choice: A Latent Class Model of Decision Strategy Switching. *Journal of Consumer Research*, *28*(1), 135–148. http://doi.org/10.1086/321952

Thomson, J. (1991). Effects of the Avidity Bias on Survey Estimates of Fishing Effort and Economic Value. *American Fisheries Society Symposium*, *12*, 356–366.

Thunberg, E. M., & Fulcher, C. M. (2006). Testing the Stability of Recreational Fishing Participation Probabilities. *North American Journal of Fisheries Management*, *26*(3), 636–644. http://doi.org/10.1577/M05-122.1

Train, K. E. (2003). *Discrete choice methods with simulation*. New York: Cambridge University Press.

U.S. Department of the Interior; U.S. Fish and Wildlife Service; U.S. Department of Commerce; and U.S. Census Bureau. (2018). *2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation*. Retrieved from

Venturelli, P. A., Hyder, K., & Skov, C. (2016). Angler apps as a source of recreational fisheries data: Opportunities, challenges and proposed standards. *Fish and Fisheries*, 1–18. http://doi.org/10.1111/faf.12189

Ward, H. G. M., Quinn, M. S., & Post, J. R. (2013). Angler Characteristics and Management Implications in a Large, Multistock, Spatially Structured Recreational Fishery. *North American Journal of Fisheries Management*, *33*, 576–584. http://doi.org/10.1080/02755947.2013.785991

Welch, B. L. (1947). The generalization of "Student's" problem when several different population variances are involved. *Biometrika*, *34*(1–2), 28–35. http://doi.org/10.1093/biomet/34.1-2.28

Wickham, H. (2009). ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York.

Wickham, H., Francois, R., Henry, L., & Müller, K. (2017). dplyr: A Grammar of Data Manipulation.

Appendix A.
Full List of Questions Used in the Online Questionnaire

1. How old were you when you first went fishing? [Please fill in the blank below. If you do not remember the exact age, please provide an estimate.]

     _____ years old

2. How were you introduced to fishing? [Please select one.]
     ☐ By a parent(s)
     ☐ By another family member
     ☐ By a friend/spouse
     ☐ During an organized activity (for example a school or community trip or event)
     ☐ By the media (for example TV, radio, or magazine etc.)
     ☐ By no one or nothing in particular/started on my own
     ☐ Other [please, specify]

3. What are the species or types of freshwater fish you target most frequently? [Please, list up to 5 species in order from most frequently to least frequently targeted.]
     1. _____
     2. _____
     3. _____

4. How often do you fish at the following water bodies? [Please, choose one answer for each water body type.]

	Never	Rarely	Sometimes	Often	Always
Urban Lakes (within 15 km of a town)					
Lakes further away					
Rivers/Streams					
Ocean					

5. What types of fishing do you partake in? [Please select all that apply.]
- ☐ Ice fishing
- ☐ Shore fishing

  Boat fishing:
  - ☐ float tube
  - ☐ kayak
  - ☐ canoe
  - ☐ small boat
  - ☐ trailer boat

6. When do you usually purchase a freshwater fishing license for British Columbia (BC)? [Please select one.]
- ☐ At the beginning of a new license year (around April 1st)
- ☐ When the weather starts to improve
- ☐ Before a planned (summer) vacation
- ☐ Before a first planned fishing trip
- ☐ When someone invites me to go fishing
- ☐ Other [please, specify]

7. How do you usually purchase a freshwater fishing license for BC? [Please select one.]
- ☐ Online
- ☐ In person at a license vendor

8. How many times did you purchase the following freshwater fishing licenses in BC in the last five years? [Please, enter the number. If you did not purchase the license type, leave blank.]

One Day Angling License: _____ times
Eight Day Angling License: _____ times
Annual Angling License: _____ times

9. How many single and multi-day freshwater fishing trips did you take in the last year that you were licensed to fish in BC? [Please, enter the approximate number. If you did not take any trips of a type, enter 0.]

_____ of single-day fishing trips
_____ of single-day trips for another purpose where fishing also occurred
_____ of multi-day fishing trips
_____ of multi-day trips for another purpose where fishing also occurred

10. How satisfied were you with your fishing experiences in BC in the last year that you have purchased a license? [Please select one.]

        ☐ Very satisfied
        ☐ Satisfied
        ☐ Neither satisfied nor dissatisfied
        ☐ Dissatisfied
        ☐ Very dissatisfied

11. Please, indicate your level of agreement with the following sentences. [Please, choose one level for each statement.]

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
If I stopped fishing, I would probably lose touch with a lot of my friends.					
If I couldn't go fishing, I am not sure what I would do with my time.					
Because of fishing, I don't have time to spend participating in other leisure activities.					
Most of my friends are in some way connected with fishing.					
I consider myself to be somewhat expert at fishing.					
I find that a lot of my life is organized around fishing.					
Others would probably say I spend too much time fishing.					
I would rather go fishing than do most anything else.					
Other leisure activities don't interest me as much as fishing.					

12. Please, indicate your level of agreement with the following sentences. [Please, choose one level for each statement.]

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I find it difficult to know where/when to go fishing.					
I don't have the proper equipment to go fishing.					
I find it difficult to understand fishing regulations.					
There is a skill to fishing that I don't understand.					
When I go fishing I feel intimidated by other anglers.					
I'm not sure how to properly handle fish.					
I wish I could learn new types of fishing.					

13. Have you ever provided catch information to fisheries staff ('creel officers') when fishing? [Please select one answer.]
        ☐ Yes.
        ☐ No.
        ☐ I do not remember.

14. Have you ever provided feedback regarding regulations (e.g. attended a meeting or an open house, or wrote an email as an response to a poster posted at the subject water bodies)? [Please select one answer.]
        ☐ Yes.
        ☐ No.
        ☐ I do not remember.

15. Have you ever responded to an online or mail survey regarding your fishing experience? [Please select one answer.]
      ☐ Yes.
      ☐ No.
      ☐ I do not remember.

16. Are you a member of a fishing organization? [Please select one answer.]
      ☐ Yes. (Which one? _____)
      ☐ No.

17. To which age group do you belong? [Please select one answer.]
      ☐ 19 to 24 years
      ☐ 25 to 34 years
      ☐ 35 to 44 years
      ☐ 45 to 54 years
      ☐ 55 to 64 years
      ☐ 65 years or more
      ☐ I prefer not to answer

18. What is your gender? [Please select one answer.]
      ☐ Male
      ☐ Female
      ☐ Other
      ☐ I prefer not to answer

19. What is the highest level of education you have completed? [Please select one answer.]
      ☐ Some high school
      ☐ High school
      ☐ College, university or trade school
      ☐ Post graduate degree (e.g. Master's or PhD)
      ☐ I prefer not to answer

20. Including yourself, how many people live in your household?   [Please, enter the number of people including yourself. If no people under 16 years of age live in your household, enter 0.]
      _____ under 16 years of age
      _____ over 16 years of age

Including yourself, how many of those people have fished in the past 5 years? [Please, enter the number of people including yourself.]

_____ people

21. Do you have a regular fishing buddy or buddies? [Please select one answer.]
☐ Yes
☐ No
☐ I prefer not to answer

22. How many fishing locations do you feel you know well enough to fish on your own or bring others to? [Please enter the number.]

_____ sites

23. What best describes the areas where you have lived most of your life? [Please select one answer.]
☐ Mostly urban areas
☐ Mix of urban and rural areas
☐ Mostly rural areas
☐ I prefer not to answer

24. What is your total household income level? ($CAD)   [Please select one answer.]
☐ $0 to $20,000
☐ $20,001 to $50,000
☐ $50,001 to $80,000
☐ $80,001 to $110,000
☐ $110,001 to $140,000
☐ $140,001 or more
☐ I prefer not to answer

25. In a typical week, how many hours do you have available for leisure activities? [Please enter the approximate number.]

_____ hours

Appendix B.
Questions and Script Used in the Follow-up Telephone Survey

INTRODUCTION:

Hello, may I please speak with [NAME ON LIST]?

IF GATE KEEPER ASKS WHAT THIS IS REGARDING:

We are conducting a survey about fishing license purchasing habits of BC anglers on behalf of British Columbia Ministry of Environment.

TO RESPONDENT:

Hello, my name is _____ and I'm calling from [SUPPLIER], a market research company. We are conducting a three minute survey on behalf of British Columbia Ministry of Environment and researchers at Simon Fraser University. Please let me assure you, we are not trying to sell you anything and no sales call will be generated from our conversation.

IF THE REPONDENT ASKS WHO ARE THE RESEARCHERS:

The researchers at Simon Fraser University are a master's student Tjaša Demšar [*tiasha demshar*] and her supervisor Dr. Sean Cox.

TO RESPONDENT:

We have 7 quick questions we would like to ask you about your fishing habits and experiences in British Columbia. Your participation in this study is voluntary and your answers will be kept strictly confidential.

Are you older than 19 years and would you have a couple of minutes to help us?
       ☐ Yes.
       ☐ No.

[IF **NO**, THANK & TERMINATE. IF **YES**, CONTINUE WITH THE QUESTIONS BELOW.]

QUESTIONNAIRE:

1. How many times did you purchase the following **freshwater fishing licenses in BC** in the **last five years**?

    One Day Angling License: _____ times
    Eight Day Angling License: _____ times
    Annual Angling License: _____ times

[RECORD NUMBER OF PURCHASES: IF RESPONDENT IS UNSURE, ASK FOR BEST ESTIMATE. IF RESPONDENT SAYS HE/SHE DID NOT BUY ANY LICENSES IN THE PAST FIVE YEARS, RECORD "0" IN ALL THREE CATEGORIES.]

2. How **satisfied** were you with your fishing experiences in BC **in the last year** that you have purchased a **license**?
    ☐ Very satisfied.
    ☐ Satisfied.
    ☐ Neither satisfied nor dissatisfied.
    ☐ Dissatisfied.
    ☐ Very dissatisfied.

3. Do you have a **regular fishing buddy**? [That is someone you regularly go fishing with and is usually the first person you contact if you want to go fishing.]
    ☐ Yes.
    ☐ No.
    ☐ I prefer not to answer.

4. Have you ever provided **feedback** regarding **fishing regulations** or responded to a **survey** regarding your **fishing experiences**?
    ☐ Yes.
    ☐ No.
    ☐ I do not remember.

5. Do you remember receiving an **email invitation** to the "Improving Fishing Experiences and Increasing Angler Participation in British Columbia" **survey** from Simon Fraser University and British Columbia Ministry of Environment earlier this year?

    [IF RESPONDENT ASKS WHEN EXACTLY WAS THE EMAIL SENT, TELL: "LATE JULY/EARLY AUGUST".]
    ☐ Yes.
    ☐ No.

6. What is the highest **level of education** that you have **completed**?
    ☐ Some high school.
    ☐ High school.
    ☐ College, university, or trade school.
    ☐ Post-graduate degree (e.g. Master's or PhD).
    ☐ I prefer not to answer.

7. And the last question, what is your **age**?
    ☐ 19 to 24 years.
    ☐ 25 to 34 years.
    ☐ 35 to 44 years.
    ☐ 45 to 54 years.
    ☐ 55 to 64 years.
    ☐ 65 years or more.
    ☐ I prefer not to answer.

[IF RESPONDENT RESPONDS WITH EXACT AGE IN YEARS, SELECT THE CORRESPONDING CATEGORY]

Those were all of my questions for today. Thank you for your help. Have a great day/evening.

Appendix C.
Logistic Regression Model Selection and Assessment

Table 10. Selection of logistic regression model

Model	Npar	R²	AIC	Δᵢ AIC	wᵢ AIC
age + when_purchase + householdsize_fish + skills*centrality	6	0.25	1569	0	100%
age + gender + education + householdsize_fish + how_satisfied + skills*centrality	8	0.15	1764	195	0%
age + gender + education + how_satisfied + skills*centrality	7	0.14	1782	213	0%
gender + age + education + fishing_buddy + skills*centrality	7	0.14	1789	220	0%
centrality*skils	3	0.12	1796	227	0%
age + gender + education + how_satisfied + centrality	5	0.12	1832	263	0%
age + gender + education + how_satisfied + skills	5	0.10	1876	307	0%
skills	1	0.06	1916	347	0%
age + gender + education + how_satisfied	4	0.06	1952	383	0%
age*gender + education + how_satisfied	5	0.06	1953	384	0%
age*gender+education	4	0.03	2012	443	0%
age*gender + education + areas_lived	5	0.03	2012	443	0%
age*gender	3	0.02	2017	448	0%
age + gender + education + income	4	0.03	2017	448	0%
age*gender + education + income	5	0.03	2019	450	0%
gender	1	0.01	2022	453	0%
age	1	0.01	2031	462	0%
age*areas_lived	3	0.02	2039	470	0%
age*education	3	0.02	2050	481	0%

Note. All models were limited to responses with no missing values.

Npar – number of parameters, AIC – Akaike Information Criterion, R² – McFadden's R², Δᵢ AIC – difference in AIC, wᵢ AIC – AIC weight

Table 11. **Wald-test estimates for individual paramaters included in the model (CATEGORY ~ age + skills * centrality + householdsize_fish + when_purchase)**

Parameter	df	F-value	p-value
age	5	2.81	0.0155*
skills	1	6.77	0.0093*
centrality	1	45.54	< 0.0001*
householdsize_fish	1	9.60	0.0020*
when_purchase	5	45.39	< 0.0001*

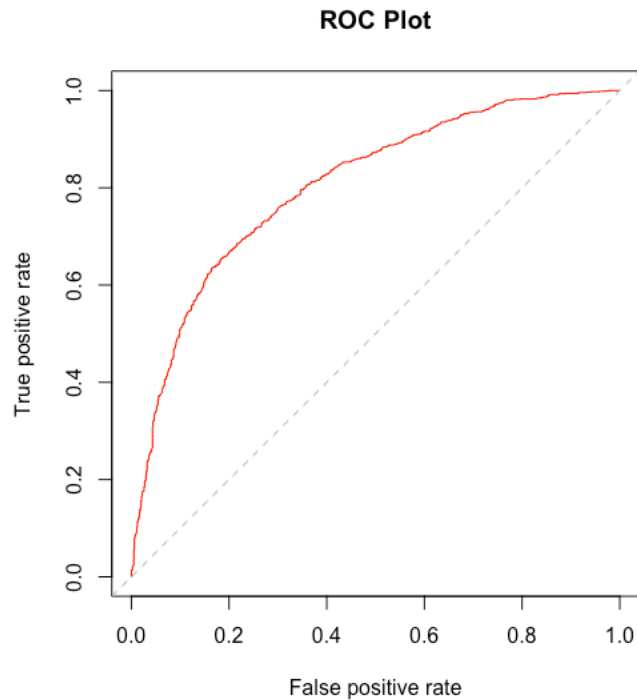Note. Hosmer-Lemeshow goodness of fit test: χ^2 = 11.33, df = 8, p-value = 0.1383.

Figure 11. **Selected logistic regression model was assessed with a ROC plot of the true positive rate against the false positive rate at various threshold settings.**

Note. Area under the curve (AUC) was estimated at 0.805. A higher AUC (max = 1) signifies a better predictive power of the model (Agresti, 1996).