ESTIMATING THE ECONOMIC VALUE OF TROUT ANGLING IN GEORGIA:

A TRAVEL COST MODEL APPROACH

by

ADRIENNE MICHELLE DORISON

(Under the Direction of Neelam Poudyal)

ABSTRACT

Georgia trout anglers were surveyed to better understand trout angling trip characteristics, trip costs, climate change knowledge, and demographics. Specific objectives included estimating the total economic value of trout anglers in Georgia, understanding factors determining demand for trout angling, and analyzing potential change in economic value of trout angling in response to trout population reductions due to climate change. With the travel cost model as the theoretical basis, the empirical estimation method employed a truncated negative binomial regression. Consumer surplus per trip per person estimates ranged from $60.02 to $164.57 while annual aggregate estimates ranged from $72.7 to $199.5 million, depending upon opportunity costs of time. Behavioral changes related to four hypothetical trout population reductions estimated potential decline in aggregate net economic values of 1.9% to 49%. Results from this study could help policymakers in particular better understand determinants of trout angling demand, and justifying funding initiatives aimed at protecting or managing for this resource.

INDEX WORDS: angling, climate change, consumer surplus, economic value, survey, travel cost model, trout

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ADRIENNE MICHELLE DORISON

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ADRIENNE DORISON

Major Professor: Dr. Neelam Poudyal

Committee: Dr. J. M. Bowker
Dr. Gary T. Green

Electronic Version Approved:

Maureen Grasso
Dean of the Graduate School
The University of Georgia
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DEDICATION

I would like to dedicate this thesis to my father, Lee G. Dorison, as he currently fights a battle much more difficult than mine. His unconditional love, support, and guidance allow me to get through each day with confidence and optimism. I could not have accomplished this significant achievement without him by my side.

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I would also like to thank God for His many blessings.

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CHAPTER 1

INTRODUCTION

Wildlife associated recreation is a significant part of natural resource use in the United States that includes activities such as hunting, fishing, and wildlife viewing. The U.S. Fish and Wildlife Service's 2011 National Survey of Fishing, Hunting, and Wildlife Associated Recreation documented that wildlife recreation in the form of hunting, fishing, and wildlife viewing generated roughly 145 billion dollars in expenditures in 2011 and over 91 million people participated. This expenditure amount was around one percent of the nation's gross domestic product (USDI 2011). In 2011, fishing-related expenditures accounted for 42 billion dollars with over 52% associated to trip-related expenditures (USDI 2011). Without a doubt, fishing is a significant economic component of natural resource use in our nation and state.

In the state of Georgia, fishing is the most popular wildlife-related activity, enjoyed by residents and non-residents of all ages. Estimating and understanding economic value of natural resources would inform management and conservation decisions on future use planning, such as when and where to most effectively to stock trout for anglers.

Outdoor Recreation Demand and Valuation

Recent data indicates that the demand for trout angling is changing both nationwide, and in the state of Georgia. For example, the National Survey of Fishing, Hunting and Wildlife-Associated Recreation (NSFHWAR) is conducted every five years to measure the importance of wildlife-oriented recreation to the American people. Although the study has been conducted since 1955, due to changes in methodology, only estimates of participation and expenditures from the years 1991, 1996, 2001, and 2011 are comparable. Figure 1.1 shows that from 1991 to 2011 angling and more specifically, freshwater angling, participation has experienced a steady decline. Since 2006, participation has shown a healthy increase in both overall angling and freshwater angling. Over the same time span, the expenditures related to those angling and freshwater angling activities, shown in Figure 1.2, have experienced a fluctuating pattern, showing that the number of participants does not necessarily relate to reduced spending. In the most recent 2011 report, while both overall angling and freshwater angling participation have increased since 2006, the expenditures have shown the opposite trend overall, but have increased when focusing on trip-related expenditures only.

It should not be assumed that limited or no growth in participation equates to limited or no growth in related expenditures. Actually, the opposite is occurring. Brown et al. (2000) examined hunting participation rates and related expenditures and found while hunting participation is trending downward, the average expenditure by those who hunt is increasing at a substantial rate. Therefore, rates of participation and expenditures each only tell part of the value story for outdoor recreational pursuits (Fulton et al. 2002).

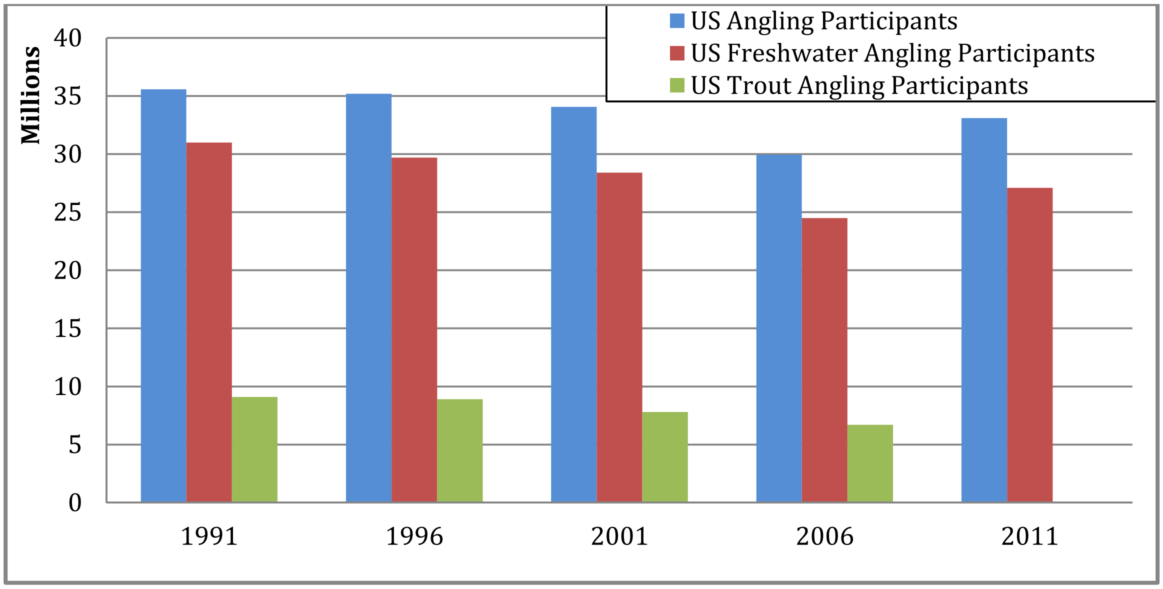

Figure 1.1. United States Angling and Freshwater Angling Participation from 1991-2011

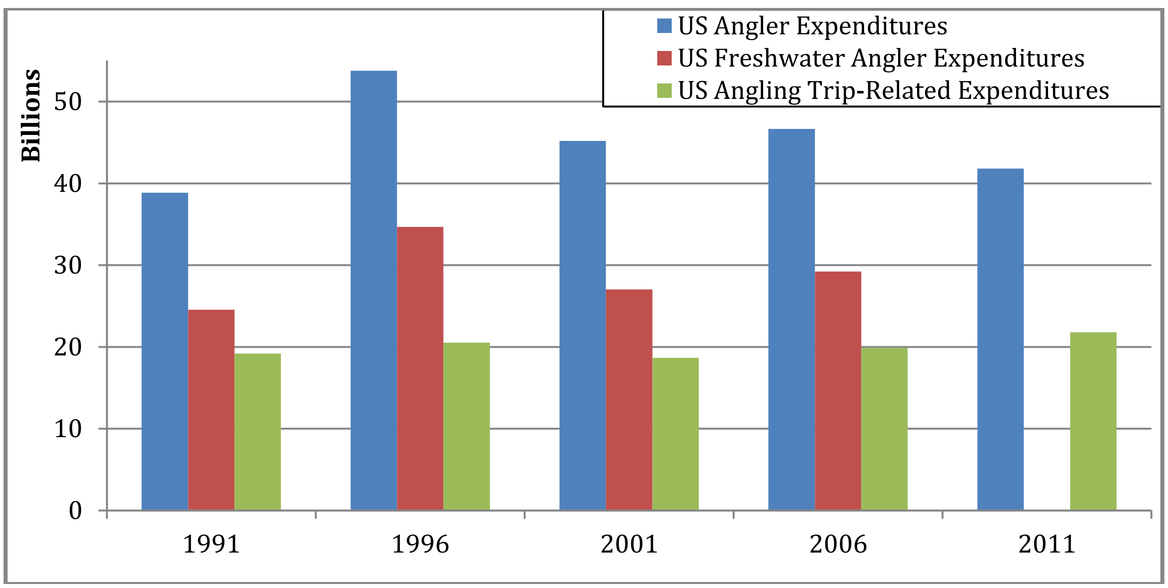

Figure 1.2. United States Angling and Freshwater Angling Overall and Trip-Related Expenditures 1991-2011

Figure 1.1 shows that participation by freshwater anglers declined in the United States by over 6 million over a 15-year time span (1991-2006), and has increased slightly since 2006. With the increase in U.S. population drastically increasing, it raises concern that the American people are becoming less interested in angling as a recreational activity. The number of freshwater anglers may be experiencing fluctuations, but the amount those anglers are spending has not changed much. Fewer anglers could lead to the belief there would be less expenditure, but this has not been the case from 1991 - 2006. When looking at the most recent reports from 2011, there has been an increase in anglers, but a decrease in expenditures (Figure 1.2)[1]. Reports show that participation and expenditure related trends are difficult to predict and explain. The 2011 report is preliminary at this point and does not have completed data. Previous trends related to outdoor recreation participation may be one important indicator of participation patterns in the future (Bowker and Askew 2012).

Angling in Georgia

In the state of Georgia, fishing is the most popular wildlife-related activity, enjoyed by residents and non-residents of all ages. During 2006, each of Georgia's 1.29 million resident anglers fished an average of 14 days in the state's diverse freshwater resources. Anglers spent more than $568 million in 2006 on fishing, which generated more than $1.14 billion in economic impacts and 10,600 jobs (GA DNR 2006). Despite these statistics, Georgia has actually experienced the inverse of what is occurring at the national level. From the years 1991 to 2006, angler participation, number of annual angling trips, and the number of days spent fishing in Georgia increased slightly. Over the same period, angling related expenditures, angling related jobs, tax revenues, and overall economic impacts to Georgia's economy fluctuated greatly (USDI and FWS 1991-2006). The change in Georgia's angling related expenditures and participants is shown below in Figure 1.3 and Figure 1.4, respectively.

1 All monetary values throughout this study have been adjusted for inflation to 2011 U.S. dollars.

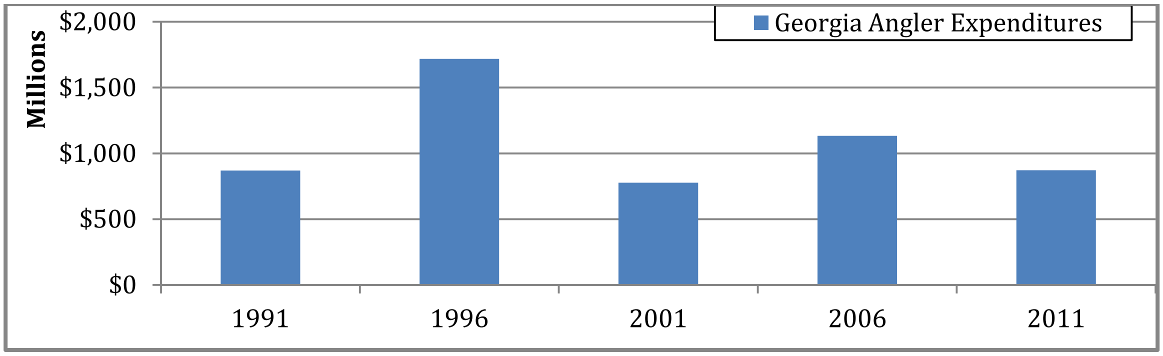

Figure 1.3. Georgia Angler Expenditure 1991-2011

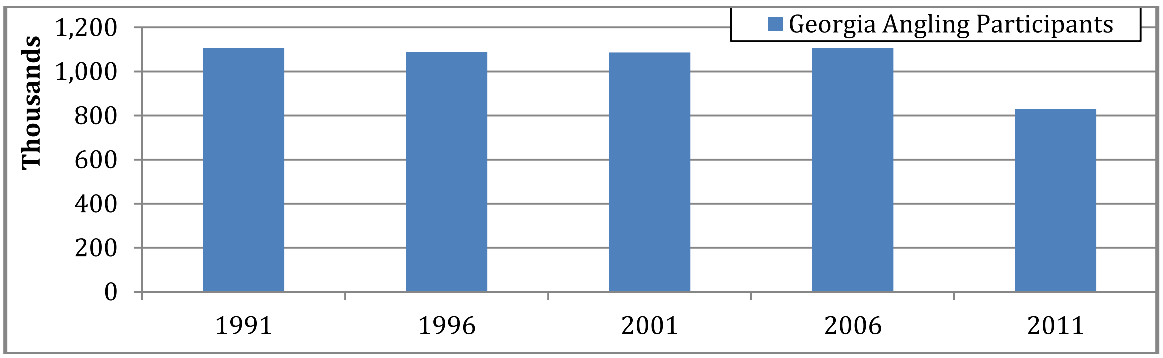

Figure 1.4. Georgia Angler Participants 1991-2011

<u>Trout Angling in Georgia</u>

Approximately 1.3 million Georgia residents choose to fish in the state's diverse freshwater resources. Georgia is home to over 4,000 miles of trout streams, 12,000 miles of warm water streams, and 500,000 acres of impoundments (GA DNR 2012). These public fishing areas have provided great opportunities to many residents and non-residents alike. To provide the state with excellent fishing opportunities, some of these fishing areas are intensively managed and stocked by the Georgia Department of Natural Resources (GA DNR 2012).

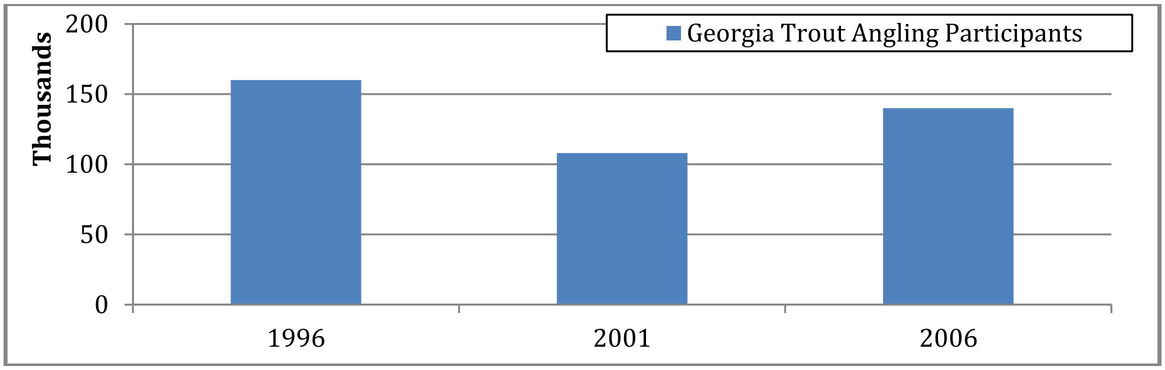

Figure 1.5. Georgia Trout Angling Participants 1996-2006

The NSFHAWR has also reported the number of trout angling participants by state for the past ten years (note: 2011 report not yet available for this level of detail). Trout angling participation in Georgia (Figure 1.5) experienced fluctuations over time, but was home to more than 100,000 trout angling participants from 1996-2006.

Three species of trout reside in Georgia - Brook, Brown and Rainbow. All are species in the salmon family of order Salmoniformes. Each of these species has different characteristics, and varying temperature and habitat tolerances.

Brook Trout, *Salvelinus fontinalis,* are the native trout of the Northeastern United States, the Appalachian highlands, and a large portion of the northern Midwest including parts of Wisconsin, Michigan, Minnesota, Illinois, and Iowa. The Brook trout is the only coldwater game fish native to Georgia's streams. They are generally found in water with temperatures ranging from 32 to 72°F (1 to 22°C). Studies have determined that brook trout cannot tolerate sustained water temperatures exceeding 77°F and prefer water temperatures less than 68°F. Brook trout are less tolerant of warmer water temperatures than Brown or Rainbow trout. *S. fontinalis* prefers clear waters of high purity and a narrow pH range in lakes, rivers, and streams, being sensitive to poor oxygenation, pollution, and changes in pH. Brook trout are known as ecosystem “indicator” species because of their high sensitivities to water quality and temperature (Trout Unlimited 2012). Brook trout can be identified by their light, “worm-like” markings on a dark upper body and vivid white leading edges on the lower fins (GA DNR 2012).

The Rainbow trout, *Oncorhynchus mykiss,* is native to tributaries of the Pacific Ocean in Asia and North America. Due to their ability to thrive in hatcheries, Rainbow trout have been introduced into much of the United States and now inhabit many streams and lakes throughout the country. Rainbow trout generally prefer cool clean streams, lakes, reservoirs, and farm ponds. They are able to withstand a wider range and higher temperatures than most other species of trout, but they do best in areas where the water remains below 70°F. However, for eggs to hatch, temperatures need to reach 55°F. Rainbow trout have a prominent pink-red horizontal stripe on each side of a silvery body and small black dots throughout the body that extend into the caudal fin (GA DNR 2012).

The Brown trout, *Salmo trutta,* is not native to North America; it is a European species whose native range includes the British Isles and most of Europe. The essential requirements for Brown trout to survive are clear, well-oxygenated cool water, and temperatures of 54°F to 68°F are ideal conditions. They can survive in waters up to 75°F, but do best in rivers and lakes below 68°F. Brown trout are olive green to brown on top shading to a creamy, golden-yellow on the sides, black and red-orange spots surrounded by a light halo on the sides, and a square caudal fin with a few spots (GA DNR 2012).

Rainbow and Brown trout were introduced in Georgia in the 1880s and the Georgia Department of Natural Resources (GA DNR) has been stocking streams with both species for over a century. Since they will now also naturally reproduce here, they have been classified by the Georgia Department of Natural Resources as a 'naturalized species.' Both the Brown and Rainbow trout are much more common than the native Brook trout, which prefer tiny headwater streams high in the mountains above barrier waterfalls. Their specialized habitat is used to protect them from being outcompeted by non-native trout (Dallmier 2010).

The Georgia DNR Wildlife Resources Division (GA-WRD) and the U.S. Fish and Wildlife Service (USFWS) stock streams with Rainbow and Brown trout throughout the year. When determining the number of trout to stock and the stocking rate, several factors are taken into consideration, such as fishing pressures, accessibility, and water conditions (GA DNR 2012). Stocking of over one million rainbow and brown trout by the Wildlife Resources Division in Georgia typically takes place between March and Labor Day ("Trout Stocking Season") in streams, rivers and small lakes. Depending on the stream's fishing pressure, public access, and water conditions, some areas are stocked weekly, while others are stocked only once during the entire stocking season. Angling opportunities for anglers of various expertise and skill level include heavily stocked high-use streams, wilderness streams, streams with special regulations, and small impoundments (GA DNR 2012).

For trout to survive and continue to eat and reproduce, water temperatures need to remain cool at less than 72 degrees Fahrenheit. Stream bank and riparian vegetation keep water temperatures cool by providing ample shade and preventing soil erosion through streamside stabilization by way of their root systems. Soil that washes into streams may suffocate aquatic insects and trout eggs, which can further reduce the trout populations

(GA DNR 2012). Warmer water temperatures may begin to cause more issues with trout angling in Georgia in the future.

Unlike other areas around the world, where the majority of trout streams are private, fishing here is open to the public and relatively easy for anglers to access (Burke 2009). Unfortunately, compared to other trout streams found around the country, Georgia's streams are at the extreme southern edge of natural trout water in the Eastern U.S. and are relatively unproductive. Trout productivity is low due to calcium deficient soils and warmer water temperatures, and hence is vulnerable to potential effect of climate change (Dallmier 2010).

Study Rationale

For the past fifty years, economists and environmentalists alike have been concerned with measuring the economic value of recreational uses of the natural environment. Natural resources and the services they provide are critical to the functioning of earth's systems and can be viewed as natural capital. These ecosystem services are not fully captured in commercial markets and are difficult to compare in terms of manufactured capital and economic services (Costanza et al. 1997). This lack of natural resource valuation often leads to inadequate credence in policy decisions. Recreation is just one of the ecosystem services that is provided at minimum or no cost to us by the environment. Legal rules calling for monetary appraisals via benefit-cost analyses of environmental policies and damage assessments in circumstances where environmental damage has occurred have led to this natural resource valuation movement. Resource economists have employed both stated and revealed preference methods to estimate recreational use values (Parsons 2003).

Stated preference methods, also known as direct methods, ask consumers what they would be willing to pay or willing to accept for a change in an environmental amenity. This technique does not require individuals to actually make any behavioral changes; they only need to state how they would behave given certain circumstances. Stated preference methods are hypothetical in nature and have been criticized for lack of observation of actual behaviors. Revealed preference methods use previous behavior reported by the individual to develop models of preference over both market and non-market goods. This type of indirect method has most often been employed through the travel cost model (Adamowicz et al. 1994).

Recreational fishing valuation and participation statistics exist at both the state and national levels. To provide large-scale data, the U.S. Fish and Wildlife Service conduct The National Survey of Fishing, Hunting and Wildlife Associated Recreation every five years (USDI 1991-2011). Data at the state level from anglers and other recreationists is reported on demographics, destinations and expenditures. This survey obtained data from anglers of all types for every state, but the data are confounded and the expenditures represent only a fraction of economic value from a societal viewpoint. While this information is vital, it is somewhat vague and confounded, represents only a portion of the economic impacts from the societal expenditure perspective, and does not address the economic value of the benefits of access to trout angling.

In examining Georgia trout angling more specifically, many gaps are observed in literature regarding economics of recreational fishing. Specifically, existing data, including license sales from GA DNR, fails to provide information on value of coldwater fishing activities like trout fishing. There has been no previous research of statewide scope, in Georgia, to place economic value on recreational trout angling. The scope of this study is to fill this knowledge gap by estimating the economic value of trout angling in Georgia. Moreover, as climate change continues to threaten trout habitat, anglers may decide to substitute sites or even activities to compensate for their losses. This study aims to gain a better understanding of the current economic value (consumer surplus) and potential change in this value under various climate change scenarios to assist in the proper management of this unique resource.

The decreasing quantity demanded, increasing expenditures, and increasing temperatures have generated an interest to estimate the economic benefits of trout angling in Georgia and may be of importance among federal, state, and local agencies. This study offers an in-depth investigation from an economic perspective of the value of a trout-angling trip.

A challenge faced by recreation providers is to understand and respond to the changing characteristics of their clientele. Recreational professionals around the world have emphasized the importance of examining current and future trends, values, and issues. Without effective observations of society's values and issues, we are unable to predict, adapt or innovate to increase recreation in the future. Park recreation planners, administrators, and educators identified issues they expect to have the greatest impacts on their activities' participation. The need to define economic impacts and values of recreational opportunities was ranked number one (Russell 2005).

Natural resource managers are increasingly challenged to meet the needs of a difficult and possibly incompatible mission: to sustain and protect natural resources for future generations, and to supply people with enjoyable recreational experiences in the present. Increased demand for multiple uses of natural resources has placed additional pressure on environmental resources as well as potential conflicts between users. Many public and private resources are threatened by human-induced impacts such as increased population, urban sprawl, greenhouse gas emissions, crowding and congestion, environmental deterioration, and many more issues. A greater understanding of the value placed on these resources by society needs to be evaluated due to the increased pressure on our natural resources (Anderson et al. 1998). It is also critical for natural resource managers to know the value and benefits of non-market resources to be able to justify the cost of providing these resources to the public.

Threats to Trout Angling

Popularity of outdoor recreational activities is different today than it has been in the past. 'Traditional' activities, such as fishing and hunting, have experienced declines and are being replaced by activities such as bird watching and photography (Cordell 2012). As Americans' recreational choices change, growth of activities will likely be spread across a variety of activities. The level of participation for hunting and fishing has remained relatively steady compared to participation levels in 2000. As recreation choices change in the future, hunting and fishing activities are projected to have some of the lowest percentage growth in participant numbers (Cordell 2012). Fishing activities are predicted to decline in per capita adult participation by three to ten percent in the next 50 years (Cordell 2012).

Increasing temperature, drought, and frequent storms are often linked with climate change. Climate change trends may put nature-based outdoor recreation activities, such as trout angling, at risk. Recent surveys of recreation participation have determined that both the number of participants and participation days in all of these activities has steadily declined from 1991 - 2006 (USDI 2006). When considering climate change, per capita fishing participation is expected to drop over the next five decades. With the inclusion of the varying climate change alternatives, the rate of participation has been predicted to decline on average by three percent by the year 2060 (Bowker et al. 2012).

Mendelsohn and Markowski (1999) also reported that climate change is expected to affect future outdoor recreation in a number of ways.

- Climate change may affect the enjoyment of particular outdoor activities due to excessive heat, cold, rain, and other weather extremes
- Warming will shorten winter seasons and lengthen summer ones, altering recreation routines.
- Climate change may alter the ecology of the ecosystem and in turn change the quality of benefits associated with recreating in a given area.

Climate change is a potentially serious threat to Georgia’s trout fishing activities. As air and water temperatures continue to increase, either trout will be forced to adapt to warmer temperatures or they will no longer be able to survive and reproduce in many of their native habitats. Trout Unlimited scientists estimated 58% of Georgia’s subwatersheds, where native brook trout reside, have been extirpated. The number two threat to the disappearing habitat was high water temperatures (Trout Unlimited 2006).

In addition to climate, changes in demographic structure may also cause a reduction in trout angling demand, as preferences and behaviors related to outdoor recreation experience a shift. For instance, there is an increased aging of the population being accompanied by longer life spans and slower population growth. This trend indicates that the distribution of the average age of the population is shifting from younger to older (Dwyer 1994).

Changes in outdoor recreation participation related to an increase in racial and ethnic diversity also exist. An increase in overall population does not constitute a rise in demand for outdoor recreation. As minority populations increase, there are shifts in types of activities that populations prefer (Cordell 2012). This may cause a shift from typical "American" recreational activities, such as hunting and fishing, to move toward historically less popular, but fast-rising, activities, like bird-watching (Cordell et al. 2012).

Urbanization in the form of population growth, increases in minority populations in urban areas, increases in commuting time, and land use changes have all significantly contributed to declines of public participation in both fishing and hunting (Poudyal et al. 2008; Poudyal et al. 2011). Shifts from rural to urban lifestyles are also reflected in outdoor recreation activity choices. Residents of more rural communities participate in hunting and fishing activities at a higher rate, while activities requiring more specialized facilities (i.e. golf and tennis) are more popular among urbanites. These participation patterns reflect availability of the resources and opportunities in these respective areas (Dwyer 1994).

Changes and shifts in demographic characteristics could play a role in the participation in, and valuation of, trout angling in Georgia. It is important to understand how and why the users currently value the resource to be able to manage and plan for the future of trout angling. This study will provide a more comprehensive understanding of economic values associated with trout angling in the state of Georgia. This study will also provide a better understanding of the factors that influence the demand for trout angling.

Study Objectives

The objective of this study is to estimate the net economic value of trout angling in Georgia, and analyze the potential change in this value due to possible change in climatic conditions in the future. Objectives of this study were met by employing a travel cost model to trip data collected from a survey of Georgia anglers. The specific objectives are as follows:

1. To estimate the net economic value of trout angling trip in Georgia
2. To understand the factors determining demand for trout angling trips in Georgia
3. To explore the change in economic value (i.e., change in surplus) of trout angling in response to trout population reductions due to climate change.

Organization of Study

This study has been organized into five chapters. This chapter provided background information related to trout angling and recreation demand valuation. It also defined the research objectives and purpose for the study. Chapter two reviews literature on Travel Cost Modeling (TCM) and recreational angling in Georgia and elsewhere. Chapter three provides the methodology for this study. Chapter four presents and discusses the empirical results from the descriptive statistics and TCM model and presents results of potential value decline due to impacts of climate change on trout populations. Finally, chapter five presents the conclusions, policy implications, and study limitations.

CHAPTER 2

REVIEW OF LITERATURE

This chapter reviews empirical studies that establish a literary foundation for the methodology and framework necessary to estimate the economic value of trout angling in Georgia. This chapter begins with a discussion of the travel cost model approach, as a non-market valuation technique. Travel cost modeling is discussed in further depth with a review of studies that applied the travel cost model in recreational valuation. Following travel cost model literature, this chapter presents the potential impacts of climate change on fisheries and trout angling specifically, which will help institute this particular study.

Travel Cost Model Literature

Environmental valuation often deals with taking an environmental change, either positive or negative, (e.g., acres of damaged forest, miles of lost trout streams, increase in populations related to increased temperatures) and estimating a monetary value associated with that change. The valuation process uses a method to place or attach some monetary measure to an environmental good or service. Travel cost modeling (TCM) has generally been accepted as one method (Hotelling 1947) to assess environmental valuations for non-market goods. While analysts and others disagree strongly about the proper method of estimating environmental costs, most will agree that, when applied properly, TCMs offer good approximations of what recreationists would be willing to pay for the improvements in the environment or what their willingness to pay is to avoid damages to the environment (Ward and Beal 2000).

In many recreation demand studies, the travel cost model is used to estimate the relationship between the demand, price and other included variables. This relationship helps to estimate value associated with change in some attribute. It is the most popular and the longest established method for estimating the demand for visits and to value sites used for outdoor recreation (Hotelling 1947; Clawson 1959; Knetsch 1963; Clawson and Knetsch 1966). Hotelling, a Harvard economist, originally developed the travel cost method to calculate the value of the United States' national parks in monetary terms in the late 1940s. He theorized that the costs incurred while traveling to a site reflects a person's willingness to pay for the recreational experience at that site. The price of a visit will increase as travel costs increase, and the number of trips will theoretically decrease (Hotelling 1947).

Clawson (1959), Knetsch (1963) and later Clawson and Knetsch (1966) were later instrumental in further development of the travel cost model. By sequentially adding additional charges to travel costs, Clawson and Knetsch were able to construct a demand curve for the resource itself, unchanged by the benefits that may arise from other recreational activities that users participated in when visiting the site. Their demand curves revealed a negative relationship between price and trips, in agreement with the theory of demand.

Clawson and Knetsch were aware demand for site visits was also constrained by various factors apart from distance. Distance could also be separated further into constraints such as money, time and travel; and money implied additional determinants, travel costs and income. Individuals' employment status and conditions also determined the importance of time. Further, travel could imply either a cost or a benefit. The need to integrate the restriction of travel time led to the next major advancement, opportunity cost of time, in the travel cost methodology (Clawson and Knetsch 1966).

The underlying theory in this method of valuation is the value of a recreational trip derives from the consumer's desire to maximize utility from the recreation experience (Stoll 1983). The value of the recreational experience is a function of market commodities, nonmarket commodities, budget and time constraints (Becker 1965). Since users invest time and money to use the recreational site, the full price of the visit must include the access fee, the monetary travel costs, and the opportunity cost of time used for traveling (Freeman 1993).

The values derived via travel cost models assume a revealed preference in the relationship between the number of trips taken and the participant's costs of traveling to a site. The farther an individual lives from a site, the greater time and monetary costs to visit the site, and as a result, these individuals will make fewer trips over a given time period to the site. If visitors are willing to spend $\$X$ per trip to visit a site Y number of times, the individual must receive satisfaction worth at least $Y * \$X$ from doing so (Wieland and Horowitz 2007).The travel cost model is used to approximate the costs of using a natural resource recreation site. Total travel costs include both trip-related expenditures and the cost of time spent traveling to a recreation site (Williams and Bettoli 2003). Travel cost modeling has been used to estimate economic welfare values (gain or loss) resulting from one or more of the following:

- Changes in access costs for a recreational site
- Elimination of an existing recreational site
- Addition of a new recreational site
- Changes in the environmental quality at a recreational site

The travel cost method is used to estimate demand functions for access to recreation sites with no entry fees (Freeman 1993; Loomis & Walsh 1997). Individuals will perceive and respond to changes in the travel-related components of a recreation trip in the same way they would respond to changes in an entry fee (Freeman 1997). A demand curve can be created through data collection of all trips made to a specific site, which can then be used to calculate the value of that site (Hotelling 1947).

A new form of the travel cost model was later developed by Brown and Nawas (1973) and Gum and Martin (1974). It was based on individual visitors, where the dependent variable, quantity consumed, is the number of trips taken per period by individuals or households (ITCM). This form is able to include both travel time and travel cost and socioeconomic variables as demand shifters, which are often found to be statistically significant.

There are two types of travel cost models, single site and multiple site models. Aside from demand estimation, single site model use is limited to calculation of the total value of access to a specific site. Multiple site models, such as the hedonic travel cost model and the pooled travel cost model, can be used to value the characteristics of sites. The relationship between the number of visits and travel cost is analyzed in standard travel cost models, whereas the hedonic travel cost model can be used to study the relationship between travel cost and site characteristics. Application of the travel cost model has been used to estimate demand for forest use (Starbuck et al. 2006); water quality (Sutherland 1982); hiking and biking (Hesseln et al. 2003); fishing (Morey et al. 2002); and snorkeling (Park et al. 2002).

Demand estimation using the TCM allows for the computation of a measure of welfare known as the consumer surplus. Consumer surplus is a quantitative measure of the net economic benefit derived by the consumer from obtaining a good or service at a given price. It is the difference between the monetary amount an individual is willing to pay for the goods and services purchased and amount the consumer actually has to pay (Wieland and Horowitz 2007). The individual consumer surplus values can be aggregated across all users to determine the total net economic value (Betz et al. 2003). By aggregating the individual consumer surplus across the recreation consumers, the net social benefit of the good can then be estimated (Freeman 1993). This value of aggregate consumer surplus will provide the economic value of the recreational activity.

While researchers in the past using non-market techniques have encountered methodological concerns arising from the use of recreational survey data to calculate demand, the travel cost model technique has become the recent focus of current research due to its reliance on survey data. In contrast to contingent valuation studies, which are based on an individual's stated preferences, revealed preference methods, like the travel cost model, use the actual reported behavior of recreationists (Zawacki et al. 2000). In travel cost studies, demand is usually measured as the number of trips taken to a site for the purpose of recreating (Rockel and Kealy 1991; Zawacki et al. 2000). Since trips, the dependent variable, are measured as discrete, non-negative integers, the ordinary least squares regression is not appropriate. Ordinary least squares regression assumes that the dependent variable is normally distributed (Yen and Adamowicz 1993). There is rarely a normal distribution with count-data, such as the travel cost model. Since demand is measured as a discrete, non-negative integer, Poisson and negative binomial regression models are argued to be more appropriate models in TCM (Yen and Adamowicz 1993).

Numerous researchers have utilized count-data models such as Poisson and negative binomial regression models to determine recreational demand (Yen and Adamowicz 1993, Zawacki et al. 2000, Bowker et al. 2007). An additional common feature of recreational survey data is the presence of truncated data (Shaw 1988). When the survey is administered on-site, information related to non-participants is often not gathered for analysis. Such a dataset is often zero-truncated as only participant information is available. This is usually not an issue with mail-based surveys that collect data from both participants and non-participants. The presence of truncated data can affect welfare estimates such as consumer surplus resulting in often biased and inconsistent estimates (Zawacki et al. 2000).

A methodological concern arises because of endogenous stratification. Due to the on-site gathering of recreational survey data, the likelihood of an individual being surveyed increases with the number of trips the individual takes to the recreational site (Shaw 1988). However, endogenous stratification is usually not an issue if data on trips is collected through an off-site survey, but there are some exceptions dependent upon data collection methodology (e.g., when contact address of mail survey recipients is collected from an earlier on-site survey) (Bowker et al. 1996).

In travel cost studies related to outdoor recreation, the construction of the trip cost variable can often influence demand and consumer surplus estimates. There is no consensus in travel cost models concerning which costs to include in the cost variables (Pearse and Holmes 1993). Because of this, some studies have incorporated both a full and reduced model that includes various cost categories to reflect the different concepts of which travel costs to include (Zawacki et al. 2000; Marsinko et al. 2002). A reduced travel cost variable is a reduced representation of trip costs that often only takes into account the individual's transportation costs and fees (Zawacki et al. 2000; Marsinko et al. 2002). A full version of the travel cost variable may include categories such as food and lodging in addition to the reduced cost variables (Zawacki et al. 2000).

The demand curve generally also takes into account individuals' opportunity costs of time. That is, the value of the time an individual spends on traveling to their fishing site, which could have been used for alternative activities such as working. From an economic standpoint, not including opportunity costs of time has been considered by some studies to undermine the actual economic value of fishing (Cesario 1976; McConnell and Strand 1981; Feather and Shaw 1999).

Measuring the value of time is an essential consideration during application of the travel cost model. It is standard practice when accounting for the opportunity cost of time to use a fraction of the wage rate (Feather 1998). The opportunity cost of time was included in many studies to represent the time costs associated with taking a trip. Opportunity cost of time is often represented as the number of hours spent traveling multiplied by a fraction of the wage rate (Zawacki et al. 2000). Application of a fraction of the wage rate to represent the opportunity cost of time varies throughout the literature. Some researchers use varying multipliers of zero, ¼, and ½ times the wage rate to get a range of estimates (Zawacki et al. 2000). Other studies have used ⅓ the wage rate as standard practice (Cesario 1976) and Bhat et al. (1998) used ¼ of the wage rate in a study of land and water recreation.

Dealing with the concern of including substitute sites or activities remains unsettled in the travel cost literature. The simple travel cost model assumes there are no supplementary recreation sites available. Conversely, research has shown biased consumer surplus estimates will result when there is failure to include relevant substitute sites in the demand equation (Freeman 1993). There is currently no clear consensus on how to deal with substitute sites in the travel cost literature, and while using the cost of substitute sites is preferable, it is not always available and alternative methods such as a binary variable may be utilized (Bowker et al. 2007).

Fisheries-Specific Travel Cost Modeling Literature

Travel cost modeling has been used expansively in recreation to value site access, as well as changes in site quality. For example, it was used by Zawacki et al. (2000) to estimate the demand and value for non-consumptive wildlife-associated recreation in the United States. Park et al. (2002) used the travel cost model to value snorkeling visits to the Florida Keys and Bowker et al. (2007) to used the TCM to estimate the net economic value of the Virginia Creeper Trail (VCT) to its visitors. Shrestha et al. (2007) analyzed demand for nature-based recreation in public Apalachicola River region of Florida using the travel cost model.

There are gaps in current research, as few have explicitly studied demand and consumer surplus associated with recreational trout fishing in the southeast. Below is a summary of many studies related to the application of travel cost modeling in the context of valuing recreational fisheries.

The study by Layman et al. (1996) used a hypothetical travel cost method to develop estimates of economic values related to recreational Chinook salmon fishing on the Gulkana River in Alaska. This methodology is a combination of travel cost and contingent valuation methods. The study took both existing and hypothetical fishery management conditions into consideration in the travel cost model. The estimates of the mean consumer's surplus per day for Alaskan Pacific salmon recreational fisheries ranged from $24.36 to $87.17 depending on the wage rate used. Respondents were then asked how their trips might change to the study area if alternative management practices were imposed. Three hypothetical management scenarios were considered: a doubling of harvest, doubling of daily bag limit, and a season bag limit of five. Each of the hypothetical fishery management scenarios estimated an increase in economic returns to anglers.

Lupi et al. (1996) developed a large-scale spatial model of the demand for recreation angling in Michigan. Seasonal participation was modeled by repeating the site choice logit over the course of a season. The model is a repeated random utility model (RUM) of recreational fishing in Michigan and differs from others in its breadth and scale. The geographic scope is the entire state of Michigan, and the model includes the broad range of fishing activities available across the state. They used one season angler data to establish a relationship between the recreational use of a site and the trip costs and site characteristics. Data was collected over a yearlong period on anglers' site choices and trips through a telephone panel survey from over 1,900 Michigan residents. User day values were estimated at $41 to $50 for trout and salmon fishery scenarios. Hypothetical policy scenarios were also used to illustrate the model's ability to value changes in environmental quality. Great Lake trout and salmon scenarios of a 50% reduction and 50% increase were used estimate benefit changes. A 50% increase in all Great Lake trout and salmon catch rates results in an estimated benefit to Michigan resident anglers of 34.5 million dollars, and the 50% decrease results in an estimated loss of 16.6 million dollars. In this study, it is clear that the estimated gains from increasing catch rates exceed the estimated losses for an equivalent decrease in catch rates.

McKean and Taylor (2000) estimated willingness-to-pay per trip for fishing at the Lower Snake River reservoirs through two mail-based surveys. Consumer surplus was estimated at $38.18 per person per trip. The average number of fishing trips per year from home to the Lower Snake River reservoirs was 20.3 resulting in an average annual willingness-to-pay of $773 per year. The total annual willingness-to-pay by anglers was estimated at over $2.5 million dollars per year.

Count data travel cost models were used by Curtis (2002) to estimate salmon angling demand and economic values in County Donegal, Ireland. The angling demand was found to be affected by angling quality, age, and nationality factors (i.e., Northern Ireland anglers spent the most on fishing expenses compared to other European anglers). Curtis used a truncated negative binomial model and calculated an average consumer surplus value IR £138 ($274.88) and a mean willingness to pay value (consumer surplus + travel costs) of IR£206 ($328.35) per angler per day for salmon angling in Ireland. The results from this survey reveal that salmon resource is of high value. The mean sample travel costs were $136.40 (IR£68) per day compared to the $328.35 (IR£206) total value per day. The difference in these two values explains salmon anglers receive considerable benefits from angling above and beyond their direct angling costs. The consumer surplus value makes up 67% of the total willingness to pay value.

A study by Gillig et al. (2003) estimated the value of recreational red snapper fishing in the Gulf of Mexico. This recreational Red Snapper valuation is decomposed into its direct and indirect components. This study applied a joint truncated travel cost model and contingent valuation model to the Gulf of Mexico recreational Red Snapper fishery, and provides improved estimates of the Red Snapper recreational fishing demand. The contingent valuation yields the highest willingness to pay ($104.77), whereas the truncated travel cost model yields the lowest willingness to pay ($12.04). The willingness to pay estimated by the joint model was $17.73 and falls in between the other models, but is more similar to the truncated travel cost estimate. The results also indicate that the joint model improves the precision of estimated recreational Red Snapper valuation. Given the total cost information, fishery decision makers were then able to evaluate whether the benefits of the policy outweighed the costs, and whether any compensation to the anglers was warranted.

Prado (2006) estimated user's demand for trout angling, visitation rates, and economic efficiency of maintaining the Lower Illinois River trout fishery resource. An on-site creel survey and discrete choice survey was employed to estimate preferences related to three hypothetical management changes and a phone interview gathered information related to travel costs and demographics. A travel cost model was used to measure the demand for angling using a negative binomial count model. The average consumer surplus per angler per day was estimated at $125.04. Anglers also indicated they were willing to pay an additional $11.00 for an increase in size of the stocked trout, and approximately $4.00 for an increase of 20% in the number of trout stocked. Anglers were not willing to pay more for the creation of catch and release areas.

Ojumu et al. (2009) employed the travel cost model to estimate the demand for recreational fishing in Alabama's Black-belt region. The demand for recreational fishing in this study was estimated by using negative binomial approach. Data was obtained through a survey of anglers in Alabama State during the fishing year of 2005/2006. An ideal fishing site that would enhance fishing experience was created in the survey and anglers were asked how much they would pay to visit the ideal site under eight different price scenarios. The travel cost equation was re-specified to include the substitute site. For the purpose of the Alabama study, the sites in the state were assumed to have similar characteristics and the distance and travel cost to the sites would be the differentiating factor. This recreational fishing survey estimated the welfare from the mean number of trips and calculated the consumer surplus to equal $34.78 per trip on average for all the model specifications. By adding this value to the mean expenditures reported in the survey, $226.84, they estimated the total willingness to pay (WTP) to be $261.62 per trip for the 2005/2006 fishing season.

Davis and Moeltner (2010) studied the Truckee/Carson/Walker (TCW) River watershed in northern Nevada. The TCW watershed was under an impending threat of New Zealand mud snail (NZMS) infestations. This aquatic nuisance species has the potential to greatly impair recreational fisheries. The study provided estimates of trip and welfare losses under different types of regulatory control policies. Visitation data for 2004 Nevada fishing license holders was used to estimate a multisite demand model of trip counts to 12 segments of the TCW system. A year-round closure of the fishery would lead to annual expected welfare losses of close to $31 million.

Loomis and Ng (2012) studied Colorado's stocked public reservoirs in 2009, to estimate the economic value of trout and nontrout anglers. It was found that trout anglers' net economic benefits were more than twice those of anglers fishing for species other than trout. Values estimated from the travel cost method produced angler-day consumer surpluses of $200.89 for trout anglers and $64.67 for nontrout anglers. In this stocked reservoir, it was important for managers to defend and justify current management strategies to the anglers who pay most of the stocking costs. One way this study executed this goal was by gaining a better understanding of the benefits received from trout fishing compared to other target species. Nonmarket benefits were about three times higher for trout anglers than for nontrout anglers.

In addition to these more site-based specific studies, comprehensive National Survey of Fishing, Hunting and Wildlife-Associated Recreation (NSFHWAR 2006) provided an addendum to estimate the net economic values associated with angling in the United States through a contingent valuation approach. The study classified each state as a bass, trout, or walleye state. Anglers were then asked to answer a contingent valuation question based on these classifications for their bass, trout, or walleye fishing during 2006. Respondents of the survey were asked a series of valuation questions to determine their willingness to pay for their specified angling activities. Questions were designed to find the respondent's cost per trip in 2006 and at what cost per trip they would not have gone at all in 2006 because it would have been too expensive. The study compared net economic values based on travel costs per angler per day for 19 states in the U.S. The aggregate average economic values for trout angling in these states was $76 per angler per day in 2001, and $62 per angler per day in 2006. Economic value averages ranged from $37 per angler per day in Vermont during 2001, to $108 per angler per day in Alaska in 2001. In 2006, economic values ranged from $32 per angler per day in Vermont, to $97, on average, per angler per day in Arizona.

Welfare Impacts of Climate Change on Trout Angling

While many studies have studied the ecological implications of the changing climate (Roessig et al. 2004; Winder and Schindler 2004; Ficke et al. 2007), few have focused on the socio-economic effects. Measuring the economic value of natural resources brings many complexities to the issue. Fortunately, in the case of freshwater fishing for recreational purposes, there is sufficient information to develop estimates of the impacts on ecosystems related to climate changes and the associated estimates of effects on human welfare. There is a previously well-established direct physical relationship between fish population size and water quality and temperature and natural resource economists have adopted various non-market valuation techniques to measure the change in human welfare associated with fishing experiences or changes in quality of fishing (Pendelton and Mendelsohn 1998; Ahn et al. 2000; and Covich 2009).

Water quality and temperature are major influences on aquatic species, and warmer streams are expected to reduce the current habitat of coldwater fisheries that are available for trout angling opportunities and valued by anglers. Warmer waters and lower stream flows are the result of drier and warmer summers throughout the United States (Covich 2009). These weather patterns could stress many trout and salmon species.

Aquatic ecosystems have been recognized by many researchers as being especially susceptible to climate change effects (Meyer et al. 1999; IPCC 2007). Cold-water species, such as trout, have a high sensitivity to thermal stressors (Eaton and Scheller 1996; Mohseni et al. 2003). The potential effects of anthropogenic climate changes on the distribution of cold-water species have also been studied (Preston 2006). Preston (2006) found that median impacts associated with different temperature distributions suggested cold-water fish habitat loss in 2025, 2050, and 2100 of approximately 10, 20, and 30%, respectively, for the United States. Increased water temperatures, decreased dissolved oxygen levels, increased toxicity of pollutants, eutrophication, altered food webs, and decreased habitat quality and availability will be climate change effects felt by freshwater species (Ficke 2007).

Rahel et al. (1996) examined potential cold-water fish species, brown and rainbow trout, habitat loss in relation to climate changes in the North Platte River drainage in Wyoming. Loss of habitat varied among methods, but all approaches indicated a considerable loss of habitat even for slight increases in temperature. All approaches were based on temperature increases from 1-5°C and estimated losses of thermally suitable cold-water fish species habitat from 7-76%. Habitat loss estimates in Wyoming were 7.5, 13.6, 21.0, 31.4, and 43.3% for 1, 2, 3, 4, and 5 ◦C increases of mean July air temperature, respectively. Habitat loss estimates were represented in terms of reduction of the stream length. Rahel et al. also noted that in addition to habitat loss, population fragmentation would occur as remaining enclaves of cold-water fish are forced to retreat to increasingly isolated headwater streams.

To evaluate the impact of climate change on North American freshwater recreational fishing a study by Pendelton and Mendelsohn (1998) combined an ecological model and the hedonic travel cost method. Their ecological model connected the climate change scenarios for a doubling of CO2 emissions with predicted catch rates that anglers care about. The authors also found global warming could reduce the numbers of cold-water species such as salmon and trout, as well as increase populations of warm water species. Since freshwater fish, like trout, are known to be more sensitive to atmospheric changes, their study offered an attempt to measure combined impacts of climate change on the benefits to northeastern U.S. freshwater anglers (Pendelton and Mendelsohn 1998). The results showed climate change may have detrimental effects on anglers from certain origins, but would be beneficial for anglers from the majority of the 40 origins in the study area. The hedonic travel cost models predict that anglers from more than half of the origins will experience a non-negative change in welfare due to the effects of a doubling of atmospheric carbon dioxide on fish catch rates. A doubling of atmospheric carbon dioxide is predicted to generate between a $7.8 million loss and a $34.7 million net benefit for the Northeast depending on the climate scenario. (Pendleton and Mendelsohn 1998).

While much of the literature covers effects of climate change on tourism trends and freshwater fish's physiology, there is less information on the economic values and impacts associated with loss of trout tolerant habitat. Perceived and actual impacts of climate change on tourist and recreationist destinations are also under researched

Ahn et al. (2000) analyzed the potential economic impact of climate change on recreational trout fishing in the Southern Appalachian Mountains of North Carolina. Like

North Georgia, their study area lies on the extreme margin of trout habitat of the eastern United States, which makes it particularly susceptible to reductions in trout habitat and populations related to climate change. The study's purpose was to estimate the potential welfare loss to trout anglers due to trout habitat and/or population reductions associated with global warming under several different scenarios. Reduction scenarios varied from 7.5% to 82% trout habitat loss. They found that the decrease in thermal habitat for trout (82% of streams would no longer support brook trout) would result in an annual economic loss of US $90 million to $862 million. The median angler's consumer surplus value for a trip occasion is $392. Angler's median welfare loss ranged from $8.31 to $78.49 for per angler per trip occasion depending on the particular trout habitat and population reduction scenario.

Estimates of welfare loss from the previously discussed studies are only indicative of the value of potential effects and may not be appropriate to be used to inform policy makers without further research. Additional research pertaining to recreational fishing valuation and potential effects of climate change would be beneficial to natural resource managers to obtain more accurate assessment for mitigation and adaptation strategies. Surveying North Georgia trout anglers would provide a more comprehensive assessment of economic values of trout angling and the potential impacts of climate change on trout populations. It would be beneficial to better understand angler's behavioral responses to potential trout reductions and how these behaviors may change the net economic value of trout angling in Georgia.

All of these studies may be helpful to provide the baseline knowledge and justification for a travel cost model of Georgia trout angling. These studies also show there is currently a lack of research related to the economic value of trout angling in Georgia. Estimating the economic value of trout angling in Georgia is necessary to better understand if the benefits outweigh the costs associated with conservation and management of the resource. Travel cost modeling with count data models on angler's reported trip data would be one possible, and well-documented approach to angler welfare estimation. Due to Georgia being at the southern edge of trout ranges, the emphasis and information on potential impacts of climate change on cold-water fisheries habitat are critical and should be studied to ensure better planning and adaptive management strategies of the susceptible resource.

The next chapter provides a more in-depth analysis of the travel cost model and the basis for its selection for this study. The survey design, methodology, and the potential impacts of climate change on trout populations are also discussed to provide a better understanding of the entire project.

CHAPTER 3

METHODOLOGY

This chapter's purpose is to describe in detail the research methods used to determine the value associated with trout angling in Georgia. The first section of this chapter introduces the concept of non-market valuation as an economic tool to estimate the value of a non-market good, and provides a theoretical description of the travel cost model (TCM). The second section presents the data collection and analysis procedure adopted in this study. The final section of this chapter discusses welfare calculations related to the travel cost model and potential climate change population reduction scenarios.

Non-Market Valuation

As part of informing regulatory policies and resource management decisions, outdoor recreation demand research is typically motivated by the need to provide measures of the economic values for the services of recreation sites, and the effects of changes in amenities on them.

Recreation resources that nature provides are non-market goods and services, meaning they are not directly sold in the market and therefore their prices cannot be observed. However, economists have developed and used a number of non-market valuation methods, which are based on the theory of welfare economics to place/assign a monetary value on non-market goods or services, like recreational angling in a wilderness stream (Tisdell and Wilson 2004). Some market goods include timber and minerals, which have quantifiable prices. Non-market goods and services may not be paid for directly, but they still provide benefits to their users. In the absence of markets, non-market valuation measures have been developed to estimate consumer demand and consumer surplus.

Demand for a good or service refers to the quantity that people are willing to purchase at a set price per unit of time. In addition to price, demand is affected by several other factors such as related good prices, preferences, substitutes, and socio-economic characteristics. Consumer demand includes the desire to acquire the good/service, the willingness to buy it, and sufficient purchasing power to execute the transaction. Consumer satisfaction can be calculated by estimating the difference between the market price of a good or service and the actual price consumers would be willing to pay. In the case where a consumer is willing to pay more for a good or service than its current market price of that given product, a consumer surplus exists (Willig 1976).

Trout angling may be considered a rival good in some instances where crowding or catching a trout, limits the use of others, but commonly has the characteristics of a nonrival and exclusive good. While trout angling in public areas is not theoretically limited by use of others, there is a fee for use of streams through park entrance fees and license costs, making the good/service exclusive to some potential users. Fishing areas on privately owned land are exclusive and accessibility is based on the discretion of the owner. If use in public areas continued to increase and congestion became a problem, these characteristics may change. Entering parks and streams from areas other than major access points and streams passing through private property also have the potential to change the goods' characteristics.

Theoretical Travel Cost Model

For many recreational sites and activities, like trout angling in Georgia, indicators of value through market clearing prices are unavailable. Alternative valuation techniques such as the travel cost model have been developed for these goods and services that are not priced (Bowker et al. 2007). To model visitor behavior and estimate the average individual net economic value, consumer surplus, for recreational access to trout angling in Georgia, this study utilized the travel cost model (Haab and McConnell 2002). The travel cost model relies on the relationship establishment between the number of trips taken and the round-trip costs incurred by travelers. This relationship can then be exploited to derive the individual consumer surplus for recreational access to a site (Hof 1993). The travel cost method is a revealed preferences approach as the actual behavior of recreationists is reported (Zawacki et al. 2000). The travel cost method is based on reported behaviors along with many assumptions.

Hotelling suggested the travel cost incurred by individuals when visiting a recreation site could be an implicit price for the services offered by that site. It is assumed that individuals perceive and respond in the same way to changes in the cost of traveling to visit a recreation site, as they would respond to changes in admission prices (Freeman 1993). Exploring the empirical relationship between increased travel distances and associated declining visitation rates would allow for the estimation of the demand relationship. In this way, the Marshallian demand curve for the recreation service can be estimated and appropriate consumer surplus measures calculated. Welfare values can be estimated, and thus provide a basis for comparing benefits with the cost of their supply. This study of Georgia trout angling is not a single site TCM, but rather a multiple site model. This means that fishing does not occur at a single site, but multiple streams. However, the variation in distance from the residence of many anglers to fishing sites of their choice creates enough variation in travel cost and frequency of trips to allow for the derivation of a demand function.

The theoretical basis of the travel cost method centers on the economic concept of utility maximization (Parsons and Kealy 1995). The basic concept is that economic utility maximization is subject to budget and time constraints of an individual (Betz et al. 2003). Equation (1) expresses a basic utility function (Freeman 1993).

$$U_i = f(x) \tag{1}$$

Where U_i is an individual's utility that is a function of a set of variables (X; income, employment, free time, etc.). The travel cost method assumes that increasing trip costs will decrease the number of trips a participant can afford to take to their site of choice, all else equal (Pearse and Holmes 1993). As a result, a participant maximizes utility by taking a number of trips that reflects his or her budgetary capabilities and appreciation for the activity or site selection.

Concerning recreation, the travel cost method attempts to ascertain a value for access to the recreational experience. In theory, the travel costs incurred by recreationists to a site can be used to determine a proxy price for access that they would be willing to pay (Pearse and Holmes 1993). The two most frequent ways the travel cost method is applied in valuation are the zonal, or aggregate approach, and the individual approach. The zonal travel cost model (ZTCM) is based on the establishment of the relationship between the travel costs incurred from the origin zone to the specific recreation site and the per capita participation rates at a recreation site from a set of geographic origin zones (Loomis and Walsh 1997).

The individual travel cost model (ICTM) is analogous to the zonal approach in concept, but uses only individual observations. With the individual approach, the dependent variable is the number of trips an individual or household makes while, with the zonal approach, the dependent variable is either per capita or total visitation rates for a specific geographic area or zone (Pearse and Holmes 1993). Similarly, explanatory variables associated with the individual approach include individual demographics and costs incurred by the individual while the zonal approach utilizes costs and characteristics associated with the zone as a whole (Pearse and Holmes 1993). It is difficult to apply the ZTCM to multi-site models because the exact distance between the zone or the visitor's origin and the actual site is unknown. Due to the structure of the data source and its focus on individual participation and expenditures, the travel cost method technique utilized for this research was the individual approach.

Demand is typically modeled at either the individual or household level through surveys that are implemented on-site or mail-based (Freeman 1993). Demand functions and consequent consumer surpluses can then be estimated at the per-trip and per-person level. With the appropriate estimate of total visits or visitors, the estimates can be aggregated to obtain the total annual site value (Leeworthy and Bowker 1997; Betz et al. 2003).

The individual travel cost model (ICTM) estimates individual demand for a recreation site based on individuals travel costs, socioeconomic characteristics, and tastes and preferences. The ICTM has been shown to provide: 1) statistical efficiency in estimation, 2) theoretical consistency in modeling individual behavior, 3) avoidance of arbitrary zone definitions, and 4) increased heterogeneity among zonal populations (Bowker and Leeworthy 1998).

The individual travel cost approach involves collection of data on the costs incurred by each individual while travelling to the recreational site. This 'price' paid by visitors is unique to each individual, and is calculated by summing the travel costs from each individual's original location to the recreational site. A demand curve can be estimated by aggregating the reported travel costs associated with a number of individuals accessing the amenity. As demonstrated by previous researchers (Rockel and Kealy 1991; Zawacki et al. 2000), the travel cost method can be further exploited to estimate measures of welfare and to establish a lower bound for the value of the good.

The general individual travel cost demand function for trout angler behavior is presented in equation (2) (Bowker et al. 1996).

$$TRIPS_i\colon \quad f = (TC, SUB, INC, SE, TP) + u \tag{2}$$

For the *ith* individual, $TRIPS_i$ is the annual trips taken to the recreation site for the primary purpose of trout angling; *TC* is the travel cost per trip; *SUB* is the cost of recreating at a substitute site; *INC* in the annual income; *SE* are socio-economic variables such as age, race, gender, education and employment; and *TP* is a vector of individuals tastes and preferences. The term *u* is included to account for random sources of error. Further explanation of variables selected in the final demand model can be found later in the chapter.

A common practice in travel cost modeling has been to combine results experienced by different people at different sites. Estimation of recreational values across different sites simultaneously can be readily accomplished using an econometric multiple-site travel cost model. The multiple-site model is a logical extension of the traditional travel cost model. Rather than focusing on recreational demand at a single site, the multiple-site framework allows for simultaneous estimation of a multitude of demand equations (Samples and Bishop 1985). This feature has proven particularly useful in the past at measuring the combined benefits associated with geographically dispersed, yet substitutable recreation sites (Burt and Brewer 1971; Cicchetti et al. 1976). Vaughan and Russell (1982), and Smith and Desvousges (1986) used a varying parameter model. This model assumes the parameters of individual site demand models are functions of site characteristics. Regional demand models have also been used in the literature (Loomis et al. 1986). This type of model pools recreation trip information from multiple sites and a simple demand model is estimated (Phaneuf and Smith 2002). This study will employ a form of the regional demand model, as individuals will provide data from many different trout angling sites across the state of Georgia.

Survey Instrument Design

Survey design procedures require inputs from researchers who will conduct the survey and from those who will use the data. The data users should identify the variables to be measured, the estimates required, the reliability and validity needed to ensure the rigors of the estimates, and any resource limitations that may exist pertaining to the conduct of the survey (Vaske 2008).

This survey was designed to obtain information needed to estimate net economic value of trout angling in Georgia as well as to gain information related to angler's knowledge and behavioral responses to climate change impacts. Development of the survey addressed who Georgia trout anglers are, what they prefer, travel and angling expenditures, views on climate change, perceptions of climate change on trout, and many other questions to get a well-rounded perspective on the population knowledge, preferences and perspectives. The survey instrument is provided in Appendix A. The survey was separated into three sections:

1. Current and Past Trout Fishing in Georgia,
2. Perspectives about Sport Fishing, Nature and Climate Change, and
3. Demographics.

This survey was designed and modified by a committee of three researchers with extensive expertise in survey design and construction. The survey instrument was initially developed based on literature. Furthermore, several scale construction options were also examined. After several revisions, pre-testing, and adjustments based on a pre-test, a final survey was designed. Suggestions and feedback from GA DNR staff were also utilized to improve the survey. Some questions were taken directly or adapted from other surveys, such as the National Survey on Recreation and the Environment (USDA Forest Service 2000). Questions related to travel information were created based on previous travel cost model literature and previously included variables (Ahn et al. 2000; Zawacki et al. 2000; Bowker et al. 2007). The research committee also created additional questions to meet the current needs of this research.

Thirty-two questions appeared in the first section related to trout angling trips. Thirteen were multiple-choice questions, one used a semantic scale, eight were open response, and ten were statements using a five-point Likert scale. The second section of the survey was related to perspectives about sport fishing, nature and climate change. This section contained sixty-seven questions in total, with three multiple-choice questions and six questions with 64 statements using a Likert scale. For this study, two of these Likert scale questions were utilized for analysis (Appendix A, Questions B4 and B5). The third and final section of this survey contained questions ten questions related to individuals socio-demographics.

Questions related to climate change perceptions were based on a five point Likert scale. The Likert scale was balanced on both sides of a neutral option, creating a less biased measurement. Likert (1932) proposed a summated scale for the assessment of survey respondents' attitudes. Individual items in Likert's sample scale had five response alternatives: strongly disapprove, disapprove, undecided, approve, and strongly approve. The Likert scale is a very useful tool to obtain an overall measurement of a particular topic, opinion, or experience. The five point Likert scale was used throughout the survey due to the importance of not mixing scales and similarly to Likert (1932) ranges from strongly disagrees to strongly agree. Using this as a standard will reduce potential confusion and will allow for comparisons within and between questions.

The survey question related to site characteristics used a semantic differential to measure anglers' level of importance of particular site characteristics (Appendix A, Question A20). A semantic differential is a type of a rating scale designed to measure the connotative meaning of concepts. The connotations are used to derive the attitude towards the given concept. The semantic differential is one of the most widely used scales used in the measurement of attitudes (Himmelfarb 1993). The respondent is asked to choose where his or her position lies, on a scale between two bipolar adjectives. The bipolar adjectives used in this survey question ranged from not important to very important on a five-point scale.

Questions were designed by the researchers to be both valid and reliable. Validity in this case refers explicitly to construct validity. The construct validity is the extent to which an observed measurement reflects the underlying theoretical construct the researcher has intended to measure with the question (Cronbach and Meehl 1955). The basic strategy to improve construct validity in this survey was to select several important concepts and then to add a few additional related items in a way that multiple questions refer to the same core concept, thus improving the reliability and validity of responses (Andrews 1984). Estimates of reliability for Likert-type and semantic questions were measured for all respondents using Cronbach's alpha coefficient. Cronbach's alpha coefficient is a measurement of internal consistency and is often used to measure reliability (Cronbach 1951). All tests were conducted using STATA (StataCorp, Version 12.1). Cronbach's alpha coefficients greater than 0.7 are considered acceptable (Kline 1999). Two questions used in this study, with six and seven individual statements respectively, required the measurement of reliability through Cronbach's alpha coefficient and are reported in Table 3.1.

Two statements used in question A20 reported inverse signs and lowered the reliability measurement. These statements were removed from the analysis and the Cronbach's alpha test was performed a second time. The overall alpha value increased after removal of these two statements. This may suggest that the question was not entirely clear and may be removed or altered in future surveys to improve reliability. The Cronbach's alpha coefficient measurement was still very close to acceptable and the question should not be ruled and unreliable. Questions B4 and B5 were both considered to be reliable according to the Cronbach's alpha coefficient reported.

Table 3.1. Survey Question Reliability Assessment using Cronbach's Alpha Coefficient

Question A20: Importance of Site Characteristics	**Alpha**
Catching many trout	0.539
Catching trophy trout	0.605
Catching native trout	0.595
Avoiding crowds	0.521
Site accessibility	0.436
Familiarity with site	0.442
Being with family/friends	0.491
Nature and scenery	0.498
Short driving distance	0.465
Other kinds of recreation nearby	0.488
Test Scale	0.539
Question B4: General Climate Change	
Human activity contributes to the increase in greenhouse gases, adding to climate change.	0.745
Climate change is primarily natural and humans have little effect.	0.764
There is some evidence that climate change is occurring and some action should be taken.	0.753
We don't know enough about climate change, and more research is necessary.	0.884
Concern about climate change is unwarranted.	0.796
If we reduce our fossil fuel use now, then climate change will be reduced in the future.	0.782
Test Scale	0.822
Question B5 : Perceived Impacts of Climate Change on Trout	
Rising stream temperature due to climate change is negatively affecting trout habitat in Georgia now.	0.719
Rising stream temperature due to climate change will negatively affect trout habitat in Georgia in the future.	0.696
Rising stream temperatures will eventually destroy trout fishing in Georgia streams.	0.692
Rising stream temperatures will hurt some species of trout in Georgia, but not others.	0.821
Trout in Georgia will eventually adapt to higher stream temperatures.	0.758
Rising stream temperatures will have minimal impacts on any species of trout in Georgia.	0.727
Rising stream temperatures will decrease the streams available for trout stocking in Georgia.	0.728
Test Scale	0.768

Following numerous revisions of the survey, the instrument was assessed through a pre-test by the study collaborators and a peer group of individuals with knowledge in the topic area. The mail-based survey was administered to a sample of 3000 individuals who had purchased a trout stamp as part of a trout specific, larger fishing or combination license in the state of Georgia for the year 2011.

Sample/Population

Sample selection depends on the population size, its homogeneity, the sample media and its cost of use, and the degree of precision required (Salant and Dillman 1994). The people selected to participate in the sample must be selected at random; they must have an equal (or known) chance of being selected.

Because a trout stamp is required when fishing for trout in Georgia, information collected by the Georgia Department of Natural Resources upon purchase of the trout stamp provided the basis for the sampling frame for this research. With over 380,000 license holders of different types carrying a trout privilege in Georgia, a random sample needed to be administered for the survey process. The research team used a modified version of a stratified random sample to select 3,000 names and addresses from the Georgia Department of Natural Resources license database (GA DNR 2012). The modified stratified random sample first determined the percent of each license type out of the total population. The number of individuals selected for the sample was proportional to the total population by each license type. The variation of license type was incorporated into the randomization of the sample to ensure the inclusion of all license types in a proportional manner.

The Dillman (2007) method was used to determine if the sample size used was appropriate for this study. The necessary sample size was calculated with equation (3).

$$N_s = \left(\frac{(N_p)(p)(1-p)}{(N_p^{-1})\left(\frac{B}{C}\right)^2 + (p)(1-p)} \right) \tag{3}$$

Where, N_s is the sample size needed; N_p is the population size; P is the proportion expected to answer in a certain way; B is the acceptable sampling error level (0.05); C is the Z statistic associated with confidence interval (1.96 = 95%).

Table 3.2. License Types: Population and Sample Allocations

License Description	# in Population	% in Population	Proportional Allocation	# in Sample	% of Sample
Disability Honorary H/F	9,574	3.05%	92	150	5.00%
Disability Honorary Fishing	4,408	1.41%	42	150	5.00%
Honorary Veteran 1-Time Fishing	37	0.01%	0	0	0.00%
Honorary Veteran 1-Time H/F	203	0.06%	2	0	0.00%
Lifetime Adult H/F	8,888	2.83%	85	129	4.30%
Lifetime Nonresident Grandchild	1	0.00%	0	0	0.00%
Lifetime Senior Card	6,709	2.14%	64	123	4.10%
Lifetime Senior Discount H/F	6,203	1.98%	59	114	3.80%
Lifetime Veteran H/F	468	0.15%	4	0	0.00%
Lifetime Youth H/F	157	0.05%	2	0	0.00%
Nonresident 3-Day Trout Fishing	5,597	1.78%	54	300	10.00%
Nonresident Trout Fishing	5,886	1.88%	56	200	6.67%
Resident 3 Day Trout Fishing	958	0.31%	9	100	3.33%
Resident Trout Fishing	130,708	41.67%	1,250	802	26.73%
Resident Sportsman Combination	51,669	16.47%	494	500	16.67%
Resident Trout Fishing 2-Year	9,789	3.12%	94	86	2.87%
Senior (65+) Lifetime H/F	71,710	22.86%	686	330	11.00%
SR (65+) Lifetime H/F w/ Card	728	0.23%	7	16	0.53%
Total Licenses	313,693		3,000	3,000	

The following license types include a trout angling privilege and were thus selected from for the sample: Disability Honorary Hunting and Fishing (H/F), Disability Honorary Fishing, Honorary Veteran 1-Time Fishing, Honorary Veteran 1-Time H/F, Lifetime Adult H/F, Lifetime Nonresident Grandchild, Lifetime Senior Card, Lifetime Senior Discount H/F, Lifetime Veteran H/F, Lifetime Youth H/F, Non-Resident 3-Day Trout Fishing, Non-Resident Trout Fishing, Resident 3-Day Trout Fishing, Resident Trout Fishing, Resident Sportsman Combination, Resident Trout Fishing 2-Year, Senior Lifetime H/F, and Senior Lifetime H/F with Plastic Card.

The number of anglers selected from each license type was proportionally representative of the overall percentage of each license type. However, some license types were oversampled based on the expected response rates. Table 3.2 shows the number of license types in the population, the percent of each license type, the proportional allocation of licenses for the sample, the number actually allocated in the sample, and the percent of each license type allocated in the sample. For example, when looking at the 'Resident Trout Fishing' license type, dividing the number of 'Resident Trout Fishing' licenses sold (130,708) by the total number of licenses sold, (313,693) the proportion of that license type can be estimated (0.417). To calculate how many licenses of that type should be included in the sample, the proportion (0.417) was multiplied by the sample size (3,000) to obtain the number of individuals to be included in the sample (1,250).

Implementation Process

On-site sampling is generally the preferred way of gathering data for recreation demand analyses. While this format of sampling is popular, on-site data collection can be very expensive, and also generally leaves the researcher with a zero-truncated and endogenously stratified sample (Shaw 1988). For reasons related to ease and cost efficiency, mail surveys are more frequently used than face-to-face or telephone interviews in the field of social science research (Dillman 1991). A randomly drawn mail survey sample identifies current site users and potential users and allows data collection from both the participants and nonparticipants; data are neither endogenously stratified nor zero-truncated.

The survey used in this study was administered following a modified Dillman Method (1991). The Dillman method suggests an initial mailing, a postcard reminder one week later, and then a second questionnaire mailing, if necessary, two weeks after the postcard. This study employed the two survey mailings and the postcard reminder that was later followed by an email and online version of the same survey. Only a portion of the sample had email addresses available through their license information. The large survey envelope included a cover letter, survey, and a business-reply prepaid return envelope. The second round of surveys included a follow up letter in exchange for the cover letter.

The first survey was mailed out during the third week of March 2012. Those who did not respond to the initial survey were sent a follow up by a post-card reminder a few weeks later. A few weeks after the post-card mail out, a third correspondence was sent out, along with a follow up letter and a copy of the survey to those whom had not yet responded. Due to the low response rate and many undeliverable addresses, individuals who had not yet responded at this stage were contacted by email addresses, if available. Non-respondents with valid email addresses were contacted via email to complete an online version of the survey. The online version of the survey was created and employed through Survey Monkey (Surveymonkey 2012).

Study Area

Trout are very temperature sensitive species and occupy only a limited geographic range in cooler streams in the North Georgia Mountains. Georgia has approximately 4,000 miles of trout streams that are relatively unproductive when compared to other trout streams across the country. To meet the demands of over 150,000 trout anglers, stocking and special regulations are used on some streams to maintain acceptable catch rates. The GA DNR Wildlife Resources Division and the U.S. Fish & Wildlife Service stock streams with rainbow, brown and brook trout from early April through mid-September. Stream fishing pressure, accessibility, and water conditions determine the number of trout stocked and the stocking frequency. In general, streams on public lands are stocked more often and with greater numbers of trout. Trout fishing opportunities vary and include heavily stocked high-use streams (better for beginners), wilderness streams, streams with special regulations, and small impoundments (Georgia Department of Natural Resources 2012).

This study was conducted in the state of Georgia. While anglers across the entire state and even non-resident anglers were surveyed for this study, their trout angling activities likely occurred in a more specific region. North Georgia is the only region in Georgia with trout ecosystems and cool enough water temperatures to support trout populations. Georgia's Department of Natural Resources provided a list of counties where trout populations and angling are known to occur. Figure 3.1 below displays locations of counties with possible trout fishing opportunities in the state of Georgia. This map was included in the survey. Individuals were able to report how many trips were made for the primary purpose of trout angling in each of the counties with possible trout angling opportunities.

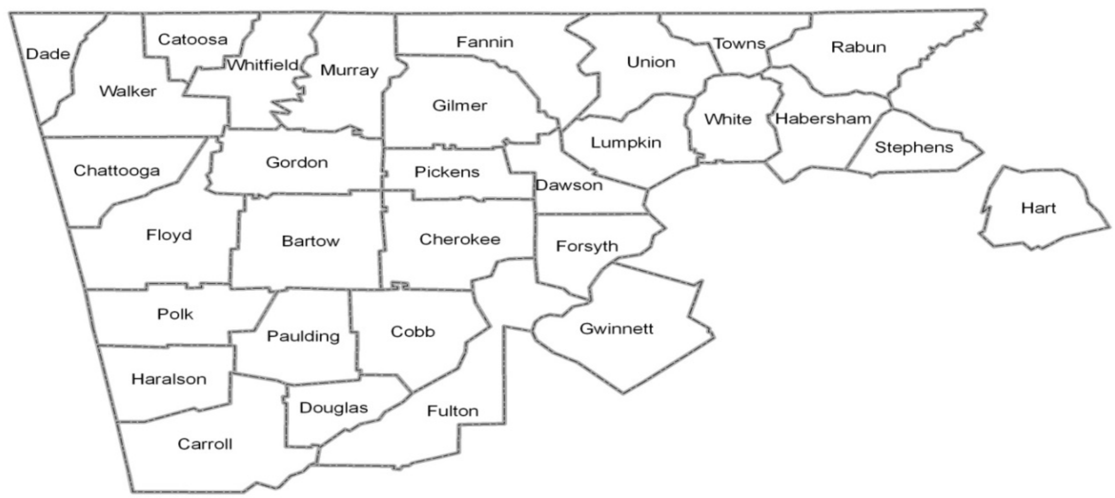

Figure 3.1. Map of Georgia Counties with Trout Angling Streams

<u>*Data Analysis*</u>

Data were first entered into an excel spreadsheet as surveys were returned and coded accordingly. Following data coding, data were imported into the STATA program for further analysis. Data analysis was performed using STATA (Statistical/Data Analysis Software, Version 12.1).

The Ordinary Least Squares (OLS) regression is not appropriate because trips occur in non-negative quantities leading to bias (Creel and Loomis 1990; Hellerstein and Mendelsohn 1993; Du Preez and Hosking 2010). The OLS regression method is inapplicable due to trips occurring in positive integer quantities. Ordinary least squares

(OLS) regression assumes that the dependent variable is normally distributed (Yen and Adamowicz 1993). Data is rarely normally distributed when dealing with count-data. To account for the bias, a count data model should be applied to TCM (Bowker et al. 1996). Recognition of the dependent variable as a non-negative integer, rather than a continuous variable, has improved statistical efficiency in recreation trip demand modeling (Betz et al. 2003).

Count data models are standard in recreation demand studies and account for the integer nature of trips by modeling the number of trips as a result of discrete and nonnegative choices (Hellerstein 1991). These estimators account for the fact that random dependent variable, Y_i, follows a discrete probability distribution rather than a continuous one, like those used in OLS (Betz et al. 2003). Many recent studies estimating recreation demand have used count data models (Bowker and Leeworthy 1998; Zawacki et al. 2000; Betz et al. 2003; Du Preez and Hosking 2010; etc.).

The count data models also are able to account for heteroskedasticity and the skewed distributions of non-negative data (Windelmann 1994). Two models are typically used to analyze TCM data, the Poisson Model, and the Negative Binomial (NB) model (Greene 2000). The conditional variance and conditional mean of the distribution are equal with Poisson regression models (Yen and Adamowicz 1993).

$$\mathrm{E}(y_i|x_i) = \mathrm{Var}(y_i|x_i) = \mu_i \tag{4}$$

As a result, the distribution does not exhibit over-dispersion. Conversely, if the conditional variance is greater than the conditional mean, over-dispersion does exist within the distribution. This over-dispersion will likely cause the Poisson model to produce biased parameter estimates of the standard errors (Yen and Adamowicz 1993).

The Poisson distribution can be generalized by compounding the Poisson and Gamma distributions, allowing over-dispersion of the data. The result of this compound is the negative binomial distribution. The Poisson probability distribution is as follows (Yen and Adamowicz 1993):

$$\Pr(Y = y|\lambda) = \frac{e^{-\lambda}\lambda}{y!} \tag{5}$$

When over-dispersion does exist within the distribution, use of a negative binomial regression model is favored over a Poisson regression model (Zawacki et al. 2000). The use of the Negative Binomial model allows for the testing of over-dispersion, which is not an available option with the Poisson model. This tends to be a frequent occurrence in TCM studies because many respondents make only a few trips, and a few respondents will make many trips. A function called the "trip generating function" can be generated by way of the NB model to estimate a demand curve for the typical site visitor. Integrating under the demand curve and estimating the area above the price line can then calculate a consumer surplus value.

For recreational trip data, the variance is always greater than the mean and this shows the over-dispersion of the count data (Haab and McConnell, 2002). The distribution of the count data for this study shows that as well and further justifies the use of negative binomial that does not assume equality of the conditional mean and variance. Gourieroux et al. (1984) explains that the negative binomial model provides a consistent estimator even when the dependent variable exhibits over dispersion, a form of heteroscedasticity.

Truncation and endogenous stratification are two essential issues of relevance for data collected on-site and the associated count data models. Truncation refers to the fact that on-site data contains information on active visitors only and is therefore truncated at positive demand for trips to the site (Shaw 1988; Englin and Shonkwiler 1995). Endogenous stratification is an issue with on-site data when individuals who visit the site more frequently are subsequently more likely to be included in the sample. The likelihood of being sampled depends on the frequency with which an individual visits the site

Since demand for trout angling was measured as a discrete, non-negative integer, the Poisson and negative binomial regression models were theoretically more appropriate models for this study. Accounting for truncation and endogenous stratification is dependent on the sample and should be looked at on a case by case basis. The sample in this study included potential non-participants and trip frequency did not increase the probability of being sampled. However, during the data collection phase it became clear that many of the license holders were either unaware or uninterested in the trout angling privilege that accompanied their license. Nonusers will never visit a site, even if the price is sufficiently low. The observed overlap in license-types has provided data from non-participants who are not part of the trout angling population at large. Because of this, multiple models were estimated to study demand relationships and changes between the different observed respondent groups. Several different models were estimated to test for accuracy and robustness: Negative Binomial, and Truncated Negative Binomial.

The negative binomial regression model is used for modeling count variables, usually for over-dispersed count outcome variables. Count-data is over-dispersed when the conditional variance exceeds the conditional mean (Long and Freese 2006). The equation for the negative binomial regression is as follows (Yen and Adamowicz 1993):

$$P(y_i|x_i) = \frac{\Gamma(y_i + \alpha^{-1})}{y_i!\,\Gamma(\alpha^{-1})}\left(\frac{\alpha^{-1}}{\alpha^{-1} + \mu_i}\right)^{\alpha^{-1}}\left(\frac{\mu_i}{\alpha^{-1} + \mu_i}\right)^{y_i} \tag{6}$$

where, the negative binomial distribution has three parameters: μ, α and Γ. The parameter, μ, is the mean or expected value of the distribution, α, is the over dispersion parameter, and Γ is the gamma function. When α = 0 the negative binomial distribution is the same as a Poisson distribution.

The truncated negative binomial regression model is used to model count data for which the value zero cannot occur and for which the conditional means are not equal to the conditional variances. The data in this model also exhibit over dispersion (Long and Freese 2006). Equation (7) shows the truncated negative binomial regression equation with conditional probability (Yen and Adamowicz 1993).

$$P(y_i = 0|x_i, z_i) = (1 - F_i)\frac{\Gamma(y_i+\alpha^{-1})}{y_i!\Gamma(\alpha^{-1})}\left(\frac{\alpha^{-1}}{\alpha^{-1}+\mu_i}\right)^{\alpha^{-1}} \times \left(\frac{\mu_i}{\alpha^{-1}+\mu_i}\right), y_i > 0 \tag{7}$$

Construction of Variables

There is a tradeoff between the cost of travel and site access implied within the travel cost theory. The cost spent on travel will vary amongst sites and users, which will create the variation required to approximate the demand for recreation trips (Freeman 1993). Estimation of the ordinary demand curve for recreational activities is allowed because of the variation in trip costs and the weak complementary relationship between the travel cost and site access (Freeman 1993). Travel consumer surplus and resources consumer surplus are considered equivalent based on a condition created by the complimentary relationship between the site access and travel costs (Hof 1993). When the demand for a market good is zero, the marginal utility for a nonmarket also equals zero, this implies that there is a weak complimentary relationship between the market and nonmarket good (Freeman 1993).

Variable specification was based on economic theory and the previous literature related to recreation trips using similar modeling techniques. The ICTM allows for the construction of an ordinary demand curve where trips demanded are a function of individual travel costs, substitute prices, income, socioeconomic characteristics, and anglers' tastes and preferences. If an ordinary demand curve can be estimated, the value of site access can be measured. The site access value estimated is the net willingness to pay (WTP), otherwise known as the consumer surplus. Integration of the ordinary demand curve from the average travel cost to the choke price will provide a measurement of ordinary consumer surplus (Freeman 1993). After the survey data were entered into Excel and the dataset was compiled, a number of transformations were made to facilitate data analysis.

Dependent Variable

The definition of the term "trip" may vary in terms of the type of recreation activity. Typically, the individual is used as the observational unit in the ITCM; for this reason, trips by individuals are combined with individual travel costs, income and other variables to estimate the demand model.

Other alternative methods for constructing the dependent variable consumption unit have also been utilized. Bowker et al. (1996) used an alternative, coined as the person-trip. Their white-water rafting study acknowledges that defining trips solely on a per household basis could be misleading. This is due to the nature of rafting, as one raft may hold several members of the household. The trip definition should be multiplied by the members of the household that visited the site to account for all participants on all trips. Therefore, a household in which three individuals visited a rafting site three times in that given year, would yield a total number of nine purchased trips (Bowker et al. 1996). The person-trip approach is not necessary for this study of trout anglers. Bowker et al. (1996) noted that the individual unit observation structure works well for recreational activities where costs and participation are individual in nature and individuals can be explicitly focused on during the sampling process; e.g., hunting, fly-fishing, or hiking.

The fisheries and recreation literature is fairly consistent in the way this variable is defined. Du Preez and Hosking (2010) used the number of trips undertaken to the Rhodes site by the individual in the past year. Curtis (2002) used the number of fishing days demanded per fishing trip as the dependent variable. Kerkvliet and Nowell (2000) defined the dependent variable used in their modeling as the number of days the angler spent fishing in the specified location. Kealy and Bishop (1986) used the individual's total number of days spent fishing in the Wisconsin portion of Lake Michigan.

For this study, the dependent variable is the number of trips taken in 2011 by the individual for the primary purpose of trout angling in Georgia. The annual trips question, filled out by Georgia trout angler survey respondents, appeared in the survey (Appendix A, Question A12).

The previous question was used in the survey to further identify the number of trips for anglers according to several limitations. Trips had to occur in the year 2011, trips had to occur within the state of Georgia, and trips had to occur for the primary purpose of trout angling. Making all of these factors specific in the question allowed the measurement of number of trips to be clear and precise.

The general specification of demand for recreation trips is presented below (Bowker et al. 1996).

$$Y_i = f(C_i,\ S_i\,, D_i) \tag{8}$$

where Y_i is the number of trips by the ith individual for the purpose of trout angling, C_i is the cost of ith individual's trip including time cost, S_i is the ith individual's substitute variables, and D_i is a vector of socioeconomic variables for individual i.

Independent Variables

The choice of independent variables for model estimation is the most subjective and controversial factor in travel cost modeling (Betz et al. 2003). Economic theory has provided guidance and commonly agreed on the inclusion of variables such as price, substitutes, and income (Freeman 1993). Unfortunately, there is still considerable debate about the creation of price variables in previous travel cost studies.

As previously discussed, outdoor recreation on public land generally has characteristics that make the resource nonexclusive and in some cases, nonrival, and unable to be traded in the marketplace. There is a lack of traditional markets for outdoor recreation and user fees for many resources are insignificant or zero. Therefore, a proxy for price must be created to estimate an ordinary demand curve. Freeman explains the price variable consists of the full price of a recreation trip. This full price includes the admission fees, out of pocket travel costs to the site, and the time costs of traveling to and from the site. (Freeman 1993).

This study uses a transportation cost related to the reported vehicle used for the trout-angling trip to estimate the out of pocket costs of a recreational trout-angling trip. These costs were reported in the 2011 edition of AAA's *Your Driving Costs* (AAA Association Communication 2011), and represent the operating cost for vehicles per mile. The cost represents the average per mile driving costs for the 2011 model year. This cost varies by individual, dependent on their response to the question of 'what vehicle type do you typically use when traveling to fish for trout in Georgia'. The AAA operating cost includes the cost of gas, maintenance, and tires. Table 3.3 shows the 2011 driving cost values used for each vehicle size.

Table 3.3. AAA 2011 Driving Costs by Vehicle Type

Operating Costs	Small Sedan	Medium Sedan	Large Sedan	Average Sedan	4WD SUV	Minivan
Gas	0.101	0.128	0.142	0.123	0.170	0.151
Maintenance	0.041	0.043	0.049	0.044	0.048	0.045
Tires	0.006	0.011	0.011	0.100	0.011	0.076
Cost Per Mile	0.148	0.182	0.202	0.177	0.229	0.203

Note: All values are provided in U.S. dollars.

The round trip mileage for each respondent was multiplied by the operating costs for their reported vehicle per mile to derive the out of pocket travel cost for each trip; small sedan (0.148), medium sedan (0.182), large sedan (0.202), SUV/pick-up (0.229), small size pick-up used the minivan rate of (0.203). The distance traveled and time spent traveling to the trout angling site was reported by respondents in question A8. This produced a one-way mileage and travel time estimate. To get the round trip mileage and travel time estimate the one-way estimates were doubled.

The opportunity cost of time is an important part of the cost of a recreation trip and is often incorporated into travel cost models. Cesario (1976) was one of the first authors to examine the opportunity cost of time. To value time, he used a fixed ratio of the wage rate. Cesario tentatively concluded, with respect to non-work travel, the value of time is between one-fourth and one-half of the wage rate. This approach was later generalized by McConnell and Strand (1981); they estimated the implicit value of time directly from the data rather than assuming a fixed proportion. Bockstael et al. (1987) later acknowledged in cases where respondents face fixed workweeks, the wage rate might not provide sufficient information about an individual's opportunity cost of time. Larson (1993) examined conditions under which the full wage rate was an appropriate value of time. Despite recognizing its importance, no consensus has been reached as to the appropriate method of dealing with travel time.

Freeman (1993) contends both on-site and travel costs should be included, but addresses several issues related to the topic. One issue for a large portion of the sample is it may be difficult, or even impossible, for them to substitute working increased hours at their regular (or overtime) wage rate for leisure time. The discretionary time constraint variable has been used in previous studies for persons in a disequilibrium labor market who cannot substitute time for income at the margin (Bockstael et al. 1987; McKean et al. 1995; McKean et al. 1996). Restrictions on free time are likely to reduce the number of fishing trips taken. This study also acknowledges the issue of disequilibrium labor markets amongst individuals that are employed, unemployed, retired, military and students. Those individuals who are retired, students, unemployed do not possess the same opportunity cost of time as those in the labor market. Freeman also notes studies elicit a pretax income measure, but a more realistic wage rate should be derived from a post-tax reported income.

Failure to include travel time results in biased consumer surplus estimates (Forster 1989). Since time costs need to be measured in a manner consistent with out of pocket costs and access fees, a justifiable proxy price of time must be used to convert time to a monetary value (Freeman 1993). Use of some fraction of an individual's or household's wage rate has been the most commonly used approach; one-third of the wage rate is a frequently used ration (McConnell and Strand 1981). This method is used as a shadow price to value time as a function of travel time and an individual's time value (Betz et al. 2003). While there is no consensus on the appropriate fraction of the wage rate to use, valuation of time costs as a function of the wage rate and travel time was seen throughout the literature. Cesario (1976) valued individual time at one-third the wage rate in his article estimating benefits of recreation at parks in the Northeast. To measure economic benefits of sport fishing in the Chesapeake Bay, McConnell and Strand (1981) used a value of ⅓ the wage rate. Bergstrom et al. (2004) also used a time value of ⅓ the wage rate to estimate recreational fishing benefits on Louisiana's Gulf Coast. Travel time costs ranging between ¼ and ½ of the wage rate are commonly thought to be appropriate (Bateman 1993). Bowker et al. (1996) and Zawacki et al. (2000) used three different fractions (0, ¼ and ½) as wage rate multipliers. Parsons et al. (2003) observed the recreation demand literature has more or less accepted ¼ of the wage rate as the lower bound and the full wage rate as the upper bound, although neither value has gained full support (Hynes et al. 2004).

Following Freeman (1993), using the entire wage rate as a measure of time cost is inappropriate since some individuals may not have the opportunity to work additional hours at that wage rate. Instead, the common practice is to multiply trip time by a fraction of the wage rate (Wilman and Pauls 1987, Rockel and Kealy 1991, Layman et al. 1996, Zawacki et al. 2000). Trip times were obtained through individual survey responses of one-way travel time. Wage rate estimates were obtained by dividing individual income by a full time 2,080-hour work year.

This study uses several model specifications related to different opportunity costs of time to account for some of the issues previously discussed. Consistent with other studies (Zawacki et al. 2000, Marsinko et al. 2002), a fraction of the wage rate was utilized in the calculation of fixed opportunity cost of time estimates. Similar to Bowker et al. (1996) and Zawacki et al. (2000), this study uses the wage rate multipliers of zero, ¼, ½, and a mixed model. The mixed opportunity cost model uses ¼ of the wage rate multiplier for those individuals, who reported full-time/part-time employment status, and a zero wage rate multiplier for individuals who reported their employment status as unemployed, retired, military, or student. These individuals do not have the same opportunity cost of time as individuals who participate in the labor market. The results of the model including no travel time should be considered the lower bound of travel cost values if one considers the opportunity cost of time to be positive. Conversely, the measures without travel time costs could be considered an upper bound if the utility gained during the time spent traveling to the site was a positive experience (i.e. a scenic drive) (Greene et al. 1997). Opportunity cost of onsite time was not included in this model because onsite time in this study was seen as endogenous component of the trip cost. A recreationist is able to first decide the optimal length of time to recreate at a site, and then is able to decide how many trips of that optimal length to take (Kealy and Bishop 1986).

Rate of travel is another assumption made in many travel cost studies. The rate chosen in the literature varies. For example, Layman et al. (1996) used 60 mi/hr, Englin et al. (1996) used 50 km (31 mi) per hour, Rockel and Kealy (1991) used 45 mi/hr, Casey et al. (1995) and Boxall et al. (1996) and Zawacki et al. (2000) used 80 km (50 mi) per hour. This study uses the 50 miles per hour rate of travel conversion to obtain the travel cost estimates because the majority of transportation corridors in Georgia have speed limits similar to this specification.

Travel costs can then be estimated through use of the above information and specifications of transportation costs, round-trip mileage, rate of travel, and opportunity cost of time, travel time and trout stamp costs. Trip costs were calculated by multiplying the number of reported round-trip miles by the operating costs for their reported vehicle type, and then adding this value to the number of roundtrip hours multiplied by the opportunity cost. The following equation was used to calculate trip costs for each individual:

$$\mathrm{TC_i} = (\mathrm{RTmiles_i} \times \mathrm{OC_i}) + (\mathrm{RTtime_i} \times \mathrm{OPC_i}) \tag{9}$$

where, TC_i is the trip cost of *ith* individual; $RTmiles_i$ is the number of roundtrip miles of the *ith* individual; OC_i are the operating costs (gas, maintenance, tires) for the *ith* individual for their specific reported vehicle type; $RTtime_i$ is the roundtrip travel time of *ith* individual in hours; and OPC_i is the calculated opportunity cost of the *ith* individual related to their reported income (Gill et al. 2004). It is expected the demand for recreation will decrease with increasing travel cost.

Socioeconomic Variables

Socioeconomic variables are necessary in a demand model to control for underlying differences in tastes, preferences and opportunities among individuals. Important determinants of demand include income, age, education, race, gender, number of children (Loomis and Walsh 1997). The literature indicates no standard of what should be included in every travel cost model, but this study uses precedent set in other studies for guidance.

Many of the variables were transformed into dummy variables. A dummy variable is a numerical variable used in regression analysis to represent subgroups of the sample. A dummy variable is often used to differentiate numerous treatment groups. In the simplest case, a dichotomous variable is used (1, 0) where an individual is given a value of 0 if they are in the control group or a 1 if they are in the treated group. Dichotomous variables are useful because they enable us to use a single variable to represent more than one group. This means there is no need to write out separate equation models for each subgroup. The dummy variables are able to turn various parameters on and off in an equation.

The following socioeconomic variables were transformed into dummy variables for the purpose of data analysis in this study, but it should be noted all were not used in the final model due to lack of significance and correlation: gender (1 = male, 0 = otherwise), household with children (1 = 1 or more children, 0 = otherwise), education (1 = post bachelor's degree, 0 = otherwise), employed (1 = full or part time employed, 0 =

otherwise), retired (1 = retired, 0 = otherwise), rural (1 = resides in a designated rural county, 0 = otherwise), overnight (1 = took an overnight trip, 0 = otherwise), trout unlimited member (1 = member of trout unlimited, 0 = otherwise) and wilderness angler (1 = anglers who fish in wilderness streams, 0 =otherwise).

Gender can be an important demand determinant in recreational models (Loomis and Walsh 1997). There is little direction provided in the angling literature regarding the determinant of inclusion of a gender variable. A variable for gender was not used in Layman et al. (1996), Siderelis and Moore (1995), or Fix and Loomis (1998). Greene et al. (1997), Lupi et al. (1996), and Du Preez and Hosking (2010), all included gender to estimate demand, but in all cases it was not significant. A gender variable was also included in this model to determine a potential relationship with demand for trout angling trips. Englin and Shonkwiler (1995) noted the likelihood of trips decreased if the respondents were female. Demand for trout angling from female respondents is expected to be lower than the demand for male users.

The effect of the education variable (EDUC) is expected to be negative as many studies in the literature have found those respondents belonging to higher education classes were less likely to make angling trips compared to those in lower education groups (Layman 1996; Lupi et al. 1996; Ojumu et al. 2009). It is expected that individuals with higher education potentially have a higher opportunity cost of time. Many recreational angling models exclude the education variable altogether (Greene et al. 1997; Carson et al. 2009; Du Preez and Hosking 2010)

Continuous variables were utilized to model age (AGE), years of trout angling experience (YRSEXP) of each individual, and the number of participants (PARTYSIZE) on a typical trout-angling trip. Trout angling experience is expected to have a positive and significant relationship with the demand for trips. Individuals who have trout angled for a longer period of time have most likely become more specialized and are predicted to take more trips than beginners. The party size (i.e. number of participants) is expected to have a negative and significant relationship with the demand for trips. Even though some level of companionship may be desired, trout angling is an individual sport and many anglers are assumed to seek solitude, away from crowds when taking a trout-angling trip.

Income (INC) was defined as annual household income from all sources before taxes. Survey results related to household income were presented on an ordinal scale. For example, respondents were able to indicate if their household income fell within a range of $0-25,000, $25,001 to $50,000, $50,001 to $75,000, $75,000 to $100,000, and more than $100,001. To transform household income a continuous variable, the midpoints of the abovementioned ranges became the value for an individual's response. For example, for the income ranges referenced above, responses became $12,500, $37,500, $62,500, $87,500, and $112,500 respectively.

Many travel cost studies have found income to have a negative or non-significant influence (Liston-Heyes and Heyes 1999; Sohngen et al. 2000; Loomis 2003; Du Preez and Hosking 2010). However, income was included for theoretical reasons. The demand for a commodity is based on own price, substitute prices, income, and socioeconomic characteristics. To determine the amount of recreation trips in a household's consumption bundle, the amount of household income should be taken into consideration. The budget constraint is shifted outward if household income increases. Because of this, if recreation trips are a normal good, trips demanded can be expected to increase (Gill et al. 2004).

Although recreation may be considered a normal good, often the influence of income is found to be weak in travel cost studies (Creel and Loomis 1990; Sohngen et al.2000; Loomis 2003). Higher income is expected to have a positive relationship with the trout angling demand, as individuals with more dispensable income will have fewer constraints on the amount of trips they can take.

Substitutes and Preferences

The demand equation in early travel cost studies neglected the "cross prices" of alternative sites (Agnello and Han 1993). The failure to include potential substitute and complement prices has now been recognized as leading to biased estimates of important demand parameters for the primary site and thus its economic value (Samples and Bishop 1985; Rosenthal 1987).

While inclusion of the substitute has been acknowledged as important, the choice of the substitution variable still remains arbitrary and unresolved in terms of whether to select a site or activity substitution variable. Following Bowker et al. (1996), the substitution variable in this study is represented by a binary variable. Respondents were asked a hypothetical site and activity substitution question to determine what they would do in exchange if their trout angling site was no longer available. Respondents were asked to choose between the following substitutes: go somewhere else in Georgia to trout fish, go somewhere else in Georgia for an alternative activity, go out of state to trout fish, stay home, go to work. The binary variable (GATROUTSUB) used a value of one for all individuals who would ‘go somewhere else in Georgia to trout fish’, and all other substitution options; ‘choose another activity in Georgia,’ ‘trout fish in another state,’ ‘go to work’, and ‘stay home’ were given the value of zero.

Satisfaction of individual respondents was estimated with a binary variable. Respondents were asked to rate the quality of trout angling in Georgia now compared to when they first began trout angling here. Individuals who responded with a rating of worse or much worse were given a dummy value of zero. Those who responded the quality of trout angling had stayed the same, gotten better, or gotten much better, all received a dichotomous value of one. It is expected individuals who are satisfied with the quality of trout angling in Georgia will demand more trips; the coefficient is expected to be positive for this variable.

Site and experience preferences of individual anglers were also examined with dummy variables. Anglers were asked how important the following characteristics were when selecting a place to trout fish in Georgia: catching many trout, catching trophy trout, catching native trout, avoiding crowds, site accessibility, familiarity with site, being with family/friends, nature and scenery, short driving distance to site, and other forms of recreation nearby site. The question, A20 in Appendix A, provided a scale of one to five, from not important to very important, respectively. To transform these questions into dummy variables, responses of a one, two, or three were recorded as zero to signify not important to neutral, and responses of four and five were recorded as one to signify important to very important during site selection.

Final Model Specification

After variable and data transformations were made, a sample of the data was constructed to carry out data analysis. Following construction of all variables, and running many different preliminary models, the following function (10) was selected to best model trout angling demand in Georgia in 2011, where X_i is the number of trips:

$$X_i = \beta_0 + \beta_1(TravelCost) + \beta_2(Age) + \beta_3(Gender) + \beta_4(PartySize) + \beta_5(YearsExp) + \beta_6(Income) + \beta_7(GATroutSub) + \beta_8(TUMember) + \beta_9(PreferTrophy) + \ error \quad (10)$$

All data were entered into a database file, necessary calculations and formatting adjustments were made, and dummy variables were created where necessary. The database file was then imported into the STATA program to determine descriptive statistics and perform all estimation procedures. Table 3.4 provides a full description of each variable used in the final model, and the expected signs of estimated coefficients.

Table 3.4: Definitions of Explanatory Variables and Expected Coefficient Signs (Dependent Variable: Number of Georgia Trout Angling Trips in 2011)

Variable	Explanation	Expected coefficient
TCOST	Approximate cost of round-trip travel for trout angling trip	-
AGE	Continuous variable for individual's age in years	-
GENDER	Dummy variable; 1 if individual is male, 0 otherwise.	+
PARTYSIZE	Continuous variable for number of anglers traveling on average fishing trip	-
YEARSEXP	Continuous variable for number of years of trout angling experience	+
INCOME	Continuous variable for annual household income before taxes (in thousands)	+
GATROUTSUB	Dummy variable; 1 if trout angling in Georgia at a substitute site, 0 otherwise.	+
TUMEMBER	Dummy variable; 1 if individual is a member of Trout Unlimited, 0 otherwise.	+
PERFERTROPHY	Dummy variable; 1 if individual ranked 'catching trophy trout' as important to very important, 0 otherwise.	+

Pearson Correlations

A pair-wise correlation matrix was used in this study to determine if multicollinearity was present in the model. A good "rule of thumb" when using a correlation matrix to determine if multicollinearity exists in a model is removing variables that have a Pearson correlation value of 0.7 or higher (AcaStat 2012). The sign of the correlation coefficient determines whether the correlation is positive or negative. The magnitude of the correlation coefficient determines the strength of the correlation. Although there are no established rules for describing correlational strength, the guidelines in Table 3.5 were used as a general framework.

Table 3.5. Interpretation of Pearson Correlation Coefficients

Value	Descriptive Terms
$0 < \lvert r \rvert < 0.3$	Weak Correlation
$0.3 < \lvert r \rvert < 0.7$	Moderate Correlation
$\lvert r \rvert > 0.7$	Strong Correlation

Note: r = Pearson correlation coefficient value

While removing one of the correlated explanatory variables will correct for multicollinearity in a model, dropping a variable can often lead to biased and inconsistent parameter estimates (Gujarati 1988). If the variable in question is theoretically relevant, removal can become a problem. When a relevant variable is omitted from the regression model, that variables effect is captured by the error term. The assumptions of the classic linear regression model state that this error term has a constant variance and the mean of the error term is zero (Gujarati 1988). Omitting a relevant variable can lead to violations of these assumptions and result in biased parameter estimates and misleading conclusions related to confidence intervals and significance tests, this is referred to as the "omitted variable bias" (Gujarati 1988).

Marginal Effects

The marginal effects measure how much the dependent variable is expected to change when an independent variable (X_i) changes by one unit, holding other explanatory variables constant. Since the model is in logarithmic function, the equation (11) below can be used to calculate the marginal effects.

$$\frac{dE(Y_i)}{dX_i} = \beta Y_i \tag{11}$$

Reporting the marginal effects are important in economic disciplines because they provide a good approximation to the amount of change in the dependent variable (number of trout angling trips) that will be produced by a one-unit change in the independent variables (i.e. age, party size, years experience, etc.) (Long and Freese 2006).

Price Elasticity

Elasticity is defined as the responsiveness of the quantity demanded to small changes in the price. The estimated demand model is able to derive an important economic policy measure: price elasticity (ζ). This is a unitless measure of demand response to changes in a good or service's price. The percentage change in quantity demanded is divided by the percentage change in the price to obtain the elasticity measure. Price elasticity is typically defined as the percentage change in quantity (i.e. recreation trips) resulting from a one-percentage change in price (i.e. travel costs) (Rosenberger and Stanley 2007). Due to the inverse relationship between price and quantity, the price elasticity is a negative value. A price and quantity change in the same proportion is implied through a unitary elasticity.

Demand is more responsive to changes in price with higher price elasticity, in absolute terms. Demand is “elastic” when elasticity is greater than one whereas it is called inelastic when elasticity is less than one. Demand is unit elastic when the elasticity is equal to one. Table 3.6 provides the interpretation of price elasticity of demand.

Table 3.6. Interpretation of Price Elasticities of Demand

Value	Descriptive Terms
$E_d = 0$	Perfectly inelastic terms
$-1 < E_d < 0$	Inelastic or relatively inelastic demand
$E_d = -1$	Unit elastic, unit elasticity, unitary elasticity, or unitarily elastic demand
$-\infty < E_d < -1$	Elastic or relatively elastic demand
$E_d = -\infty$	Perfectly elastic demand

Note: E_d = elasticity of demand

The equation (12) for price elasticity (ε_p) is the price coefficient (β_{cost}) times the average travel cost ($\overline{TC}$) in a truncated negative binomial model (Gill et al. 2004):

$$\varepsilon_p = \beta_{TravelCost} \times \overline{TC} \tag{12}$$

Elasticity estimates are known to be affected by several different factors including presence of substitutes, income effects, necessity of the good, time dimensions of price changes and scope of the affected resource. Variation in elasticity estimates arises related to these aforementioned factors. For example, a demand model that evaluates price changes for a specific angling site with substitutes will estimate a more elastic demand than a model that evaluates the demand for fishing in general, where substitution across multiple sites holds demand fairly constant at the activity level with price changes at a particular site (Smith and Kaoru 1990; Rosenberger and Stanley 2007).With micro level data, there is likely to be great variability in the estimated demand elasticities due to individual heterogeneity in tastes and opportunities. The estimated elasticity increases as the distance or travel cost increases.

Consumer Surplus

Welfare associated with Georgia trout angling was calculated for all the estimated models for comparison purposes. The travel cost model allows for the construction of the ordinary demand curve where the trips demanded are a function of individual travel costs, and other relevant explanatory variables. The measure of the net willingness to pay (WTP) for the recreational activity is also known as the consumer surplus (CS). WTP represents the maximum sum of money an individual would be willing to pay rather than having to do without a good (Freeman 1993).

The demand curve reflects marginal willingness to pay (WTP), while the area below the demand curve represents total WTP. This concept is illustrated in Figure 3.2, which depicts a simple demand curve. At the price paid and quantity demanded, total expenditures are represented by the “total “revenue area (i.e. total expenditures = price X quantity). However, analyses that consider only expenditures do not capture the extra value implied by the consumer surplus. Consumer surplus can be thought of as the amount that consumers are WTP over and above the amount they actually pay for the resource. Consumer surplus is obtained by integrating the demand function, over the relevant price range, usually between the average price or travel cost, and the choke price.

Consumer surplus, a measure of social welfare, is the difference between an individual’s willingness to pay for access to a good or service and the actual expenditures he or she has to pay to obtain it (Zawacki et al. 2000). By using the demand component of the estimation technique utilized, individual per trip and aggregate consumer surplus estimates can be acquired. To estimate an individual's consumer surplus in the count-data regression model, a point estimate used to calculate the negative reciprocal of the cost coefficient (Yen and Adamowicz 1993). This is the integral below the demand curve and above market price. Since recreational trout angling is a non-market good, a measure of market price does not exist and is replaced with average trip expenditure (Freeman 1993). Individual consumer surplus estimates can then be aggregated to ascertain values of aggregate social value.

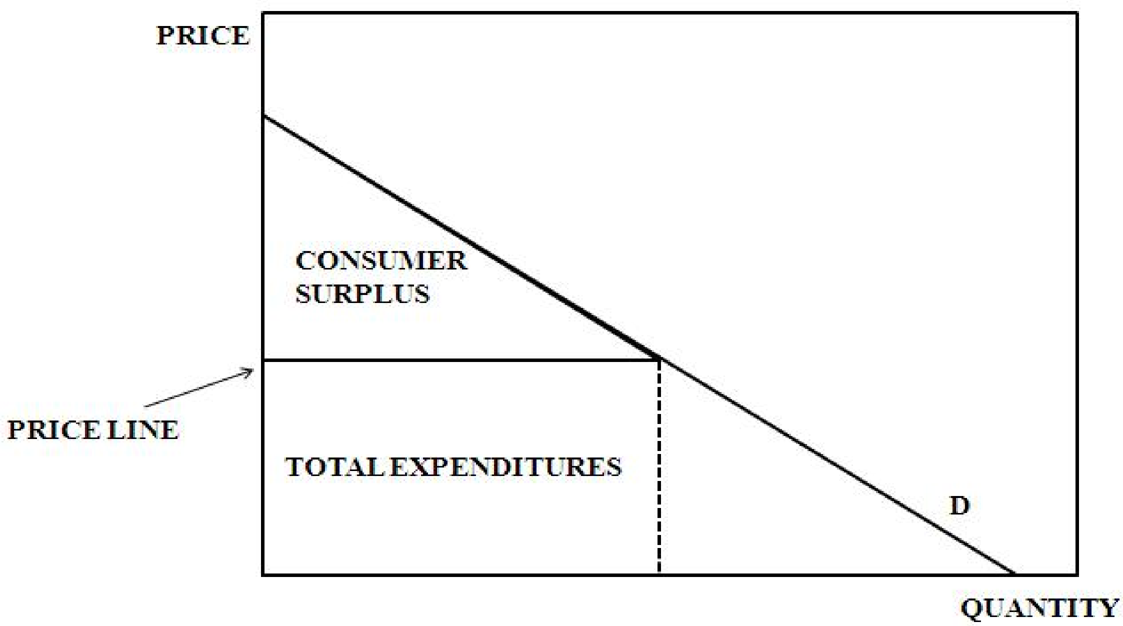

Figure 3.2. The Relationship between the Demand Curve and Consumer Surplus

To calculate the welfare measure for each count data model, the estimated coefficients of the respective travel cost covariate can be used. The average consumer surplus per visit estimates are calculated by the negative inverse of the travel cost coefficient (Creel & Loomis 1990). The use of the count-data models allows this particular method of calculating consumer surplus per visit estimates (Loomis et al. 2001). Individual per-trip consumer surplus estimates were obtained using the following equation (13) (Yen and Adamowicz 1993):

$$CS = \frac{-1}{\beta_{TC}} \tag{13}$$

where, β_{TC} is the coefficient for the trout angling trip cost variable.

Following Zawacki et al. (2000), aggregate consumer surplus estimates were calculated by multiplying the individual consumer surplus estimates by the number of Georgia license holders with a trout angling privilege (GA DNR 2011).

Climate Change Perceptions

Individuals were asked questions to assess their understanding, views, and perceptions related to climate change and its possible relation to trout angling. Climate change questions can be found in Section B of Appendix A. Anglers were initially asked to state their level of agreement to the following statements related to general climate change concerns. Following the general questions, anglers were asked questions related to climate change impacts on trout angling in Georgia.

Anglers were asked to state their level of agreement with each of the following climate change statements on a five point Likert scale (one = strongly disagree, five = strongly agree) (Appendix A, Question B3).

1. Human activity contributes to the increase in greenhouse gases, adding to climate change.
2. Climate change is primarily natural and humans have little effect.

3. There is evidence that climate change is occurring and some action should be taken.
4. We don't know enough about climate change, and more research is necessary.
5. Concern about climate change is unwarranted.
6. If we reduce our fossil fuel use now, then climate change will be reduced.

Following generic questions related to climate change, respondents were asked to focus more specifically on climate change and trout in Georgia. Anglers were asked if they had ever seen or heard of trout in Georgia streams that were dying due to increased water temperatures (Appendix A, Question B2).

Anglers were also asked questions related to climate change and its potential effects on trout habitat and populations in Georgia. The following three statements on a five likert point scale, (one = strongly disagree, five = strongly agree) was used to determine if trout anglers believed climate change would have effects on trout habitat (Appendix A, Question B4).

1. Rising stream temperature due to climate change is negatively affecting trout habitat in Georgia <u>now</u>.
2. Rising stream temperature due to climate change will negatively affect trout habitat in Georgia in the <u>future.</u>
3. Rising stream temperatures will eventually destroy trout fishing in Georgia streams.
4. Rising stream temperatures will hurt some species of trout in Georgia, but not others.
5. Trout in Georgia will eventually adapt to higher stream temperatures.

6. Rising stream temperatures will have minimal impacts on any species of trout in Georgia.
7. Rising stream temperatures will decrease the streams available for trout stocking in Georgia.

For the previous statements, all responses with a value of three were considered to be neutral to avoid researcher bias. Individuals who responded with a value of one or two disagreed with the respective statement, and individuals who responded with a value of four or five agreed with the respective statement.

Potential Change in Trip Behavior due to Hypothetical Climate Change Scenarios

To predict behavioral changes of anglers, individuals were asked how they would respond to changes in trout populations and subsequent changes in catch rates associated with rising stream temperatures. Anglers were asked how their demand for trips to their most frequented Georgia angling site may change should the trout population decline by certain amounts due to rising stream temperatures; Appendix A, Question B5. At each of the trout population reduction scenarios (i.e. 10%, 25%, 50%, and 75%), anglers were able to respond with one of the following:

- My number of trips there probably wouldn't change
- I would make somewhat fewer trips
- I would make many fewer trips
- I would stop fishing there completely

To assess possible implications of rising stream temperatures on future demand for trout angling trips, the "stop fishing" response was used to estimate aggregate consumer surplus values at each percentage reduction scenario. For each percentage reduction scenario, respondents who chose to stop taking trips to their site were coded with a value of one and respondents who reported they would continue to take trips were coded with a value of zero.

CHAPTER 4

RESULTS

This chapter presents the results of the sampling procedure adopted in this study. The descriptive statistics are reported for each of the different respondent groups used for analysis. The results of the travel cost model are presented with descriptions of the variables used in the model, variable outcomes, marginal effects, and elasticities. This section also provides estimates of the individual and aggregate consumer surplus values for each of the models. Respondents' views on general climate change and climate change impacts on trout populations in Georgia are also reported. Anglers' reported change in trips related to trout population reductions associated with rising stream temperatures are reported in the final section of this chapter. These behavioral changes are then used to highlight the potential change in aggregate net economic values of trout angling under the various climate change and population decline circumstances.

Sampling Results

The survey sample contained 3,000 individuals, both residents and non-residents, with any license including trout angling priveledges in the state of Georgia. Of the total 3,000 surveys mailed out, 453 were returned as undeliverable. The survey yielded 631 responses overall, 32% of those respondents indicated they were not trout anglers, while others provided information related to demographics, trout angling participation, trips taken, trip costs, experience level, climate change impacts knowledge and perceptions for the year 2011. The breakdown of responses by the individual correspondence types can be found in Table 4.1.

Table 4.1. Survey Responses Breakdown by Each Mailout/Version

	Mailout 1	Mailout 2	Email	Total
Returned	231	305	95	631
Response Rate (Cumulative)	9.08%	21.04%	24.77%	24.77%
Undeliverable	278	106	69	453
Not Trout Angler	77	113	11	201

The first mailout yielded 231 responses for a 9.08% response rate. The second mailout was slightly better with 305 surveys returned for cumulative response rate of 21.04%. The email version of the survey, yielded 95 reponses. This brought the total number of returned surveys to 631 and when taking undelivered surveys into account, our final response rate was 24.77%. Because some surveys had incomplete information (item non-response), were missing key information, refusal to participate, multi-purpose trips, potentially inaccurate responses, such as an excessive number of household individuals, they were not included in the final data analysis.

Thirty-two percent of the 631 respondents reported they were not trout anglers any longer, or had never been trout anglers and did not know the trout angling privilege came with their license type. Therefore, only 68% of all 631 respondents were self-reported trout anglers. Fifteen percent of the 631 respondents also reported although they would consider themselves to be trout anglers, they did not take a trip specifically for trout angling in 2011. Twenty-two percent of the trout angler group reported to not take trips in 2011. To better understand the sample and help organize data analysis, respondents were divided into three separate categories (Figure 4.1). The groups were defined as follows; all respondents, trout anglers, and trip takers.

The first group, “all respondents,” included 615 individuals. The second group, “trout anglers,” included 416 survey respondents. This group eliminated respondents who reported they were not trout anglers. There were 201 indviduals who carried a trout privilege with their license, but did not consider themselves to be trout anglers in the past, presently or in the near future. The third group, “trip takers,” included only respondents who had reported taking trips in 2011. From the original 615 responses, individuals who reported they were not trout anglers, and individuals who reported they did not take trout angling trips in 2011 were removed to reach the “trip-taker” group. This group yielded 326 surveys and was ultimately used to estimate the final travel cost model.

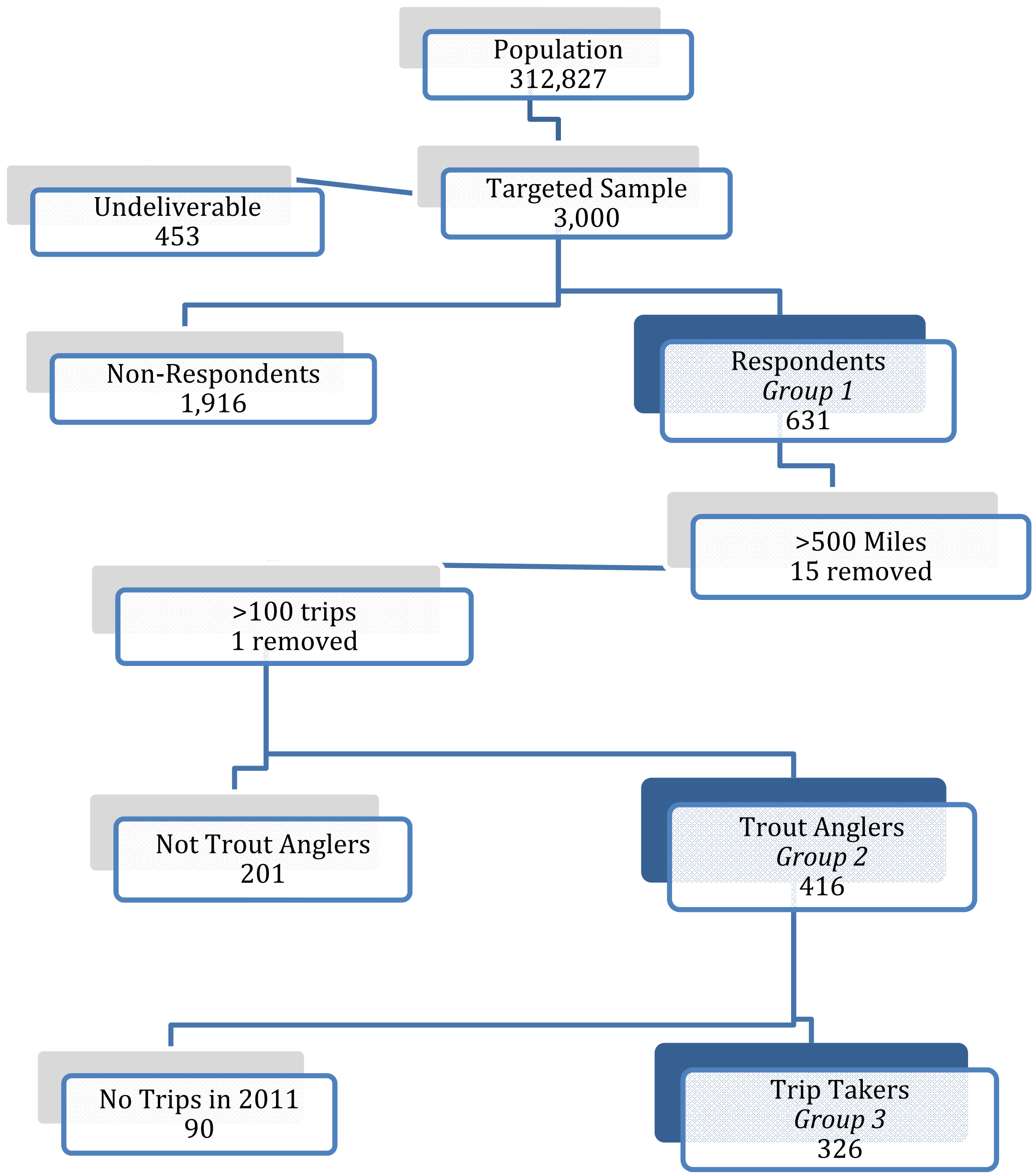

Figure 4.1. Respondent Categories: All Respondents, Trout Anglers, Trip Takers

Data Cleaning and Assumptions

Data cleaning required making some assumptions. Some of the observations in the data set had missing values due to non-responses. Efforts were made to impute values if possible for some of the variables. For example, many respondents did not include their age, gender, or zip code but we already had this information in the Georgia Department of Natural Resources (2011) license database. To avoid forcing fishing trip costs on individuals who do not trout fish, those who reported themselves as not trout anglers or not trip takers in 2011 were separated into different groups.

Elimination of some responses was also necessary due to missing responses to key questions. When possible, missing key information was calculated or estimated using reasonable assumptions. If income data were missing for a particular respondent, the median income in that specific respondent's county of residence was used as a proxy. Earlier, Greene et al. (1997) adopted this method to calculate missing income information. The distance traveled to the trout-angling site had to be estimated in instances where distances were not reported to estimate the travel costs associated with that respondent. For example, if the respondent reported six trips, but did not specify how far he traveled or in which county he fished, the weighted average for miles traveled by respondents from the same county was calculated and used as a proxy for the estimated one-way distance for the individuals trips. The weighted average assigns a weight to individual quantities to ensure an accurate average is calculated. The weight is related to the number of trips taken by the individuals in the county that is being used for the distance estimation. This weighted average distance estimation was used for trout anglers and trip takers who did not report one-way distance or time traveled to their trout-angling site. The weighted average for the estimated distance to site was calculated by taking the sum product of the number of trips in the specified county, and then dividing by the sum of the number of trips taken in the same county.

The original sample was also trimmed to include only those anglers within 500-mile radius of their Georgia trout-angling destination. Long haul travelers are often not well described by recreation demand models (Beal 1995; Bowker et al. 1996; Bin et al. 2005). This is based primarily on the premise of avoiding visitors who are trout angling on long multipurpose trips, rather than for the primary purpose (Hellerstein 1991; Bowker et al. 1996). Multipurpose trips incur joint costs; these joint costs cannot be properly apportioned to each individual purpose (Freeman 1993). Bowker et al. (1996) employed a similar trimming technique, 1,000-mile radius, to limit their sample to primary purpose, single destination whitewater trips.

One individual also reported their 125 trips were a result of their profession, a trout-angling guide, and not necessarily for recreation. This particular respondent was removed from the dataset. Prado (2006) eliminated all individual observations who reported over 100 fishing trips per year to the trout fishery from the sample because of the excessive reported number of recreational trips. The U.S. Department of Interior National Park Visitation Statistics also removes park staff visits, lodge employee visits, and through traffic from the total trips to estimate total recreation visits (U.S. Department of Interior, National Park Service 2010).

Due to the elimination of different respondents within each of the three groupings, the characteristics of each group are slightly varied. Demographics, trip information, and angling preferences based on the detailed surveys are reported separately to better understand each respondent group. While these groups are very similar, it is important to note there were variations.

Trout Angler Characteristics

Descriptive statistics related specifically to each of the "all respondent," "trout angler," and "trip taker," groups are explained below and are reported in Table 4.2.

Table 4.2. Descriptive Statistics for Each Respondent Group

Variable	All Respondents n = 615	Trout Angler Respondents n = 416	Trip Taker Respondents n = 326
Age	52.04	49.95	49.11
White %	87	90	86
Male %	86	87	86
Employed %	53	64	58
Retired %	23	25	27
Undergraduate Degree %	44	41	49
Graduate Degree %	19	17	20
Income	65,393	69,694	70,326
Household Size	2.23	2.57	2.7
More than 1 Child in HH %	23	25	25
TU Member %	11	15	18
Conservation Org Member	25	29	32
Organization Member %	40	45	46
NRA Member %	25	28	25

While the demographic data shows participants and non-participants are similar, they do have minor, but noticeable differences. Overall, group 1 was slightly younger, had more retirees, higher levels of education, higher incomes, and larger household sizes than groups 2 and 3. Group 2 had a slightly higher proportion of employed persons, males and white respondents than group 1 or 3. Groups 3 had higher levels of group involvement and more were members of organizations in general, members of conservation related organizations and members of Trout Unlimited. Group 2 had the most respondents who were members of the National Rifle Association (NRA), while groups 1 and 3 had the same amount of NRA members.

Table 4.3. Mean Comparisons of Trout Anglers; Trip Takers and Non-Trip Takers

Variable	Trip Takers N=326	Non-Trip Takers N=90
Average Age*	49.1	52.9
Gender – Male	87%	90%
Average Party Size	2.35	2.12
Years Experience	17.9	18.6
GA Trout Substitute	52%	46%
TU Member **	18%	5%
Prefer Trophy **	27%	16%
One Way Miles **	89.0	76.3
Income	70,326	$67,406
Employed	57%	52%
Average Travel Cost (Mixed Opp Cost) ***	56.2	44.5

Note: ** denotes significance at 5%; and * denotes significance at 10%.

To better understand if trip takers were different from non-trip takers who still considered themselves to be trout anglers, these two groups were compared. Table 4.3 compares the means of each group and reports if they are significantly different from each other. The non-trip taker group was slightly older, had more males, and more years of experience than the trip taker group. Trips takers had higher incomes, higher rate of employment, traveled with larger party sizes, preferred trophy trout when selecting a site, and had a larger number of Trout Unlimited members than the non-trip taker group. The average miles and travel costs were calculated for the non-trip takers by using reported trip information and missing distances were estimated using the weighted average estimation. Those who reported trip information likely took trips in an earlier year and provided information based on the previous trip, albeit they reported taking no trips in the year 2011.

Trout Angling Trips

Table 4.4. Trip Profile Information for Georgia Trout Angling Trip Takers in 2011

Variable	Mean	Std. Dev	Min	Max
Number of Trips	7.31	10.94	1	100
Overnight Trip Takers (%)	53	0.49	--	--
Number of Overnight Trips	1.64	3.01	1	28
Nights Spent per Overnight Trips	3.28	2.75	0	21
One-way Miles	88.6	106.78	0	500
One-way Time (hrs)	1.77	2.14	0	10
Party Size	2.35	1.04	1	8
Years of Trout Fishing Experience	17.44	15.64	1	63
Operating Costs Per Mile	0.216	0.018	0.148	0.229

Descriptive statistics related to trip information was not provided for all respondents. The ‘all respondents’ group and the ‘trout angler’ respondent group included many individuals who were not trout anglers, and many that did not fish in 2011. The information was skewed by zeros and provided a misrepresentation of trip information. Descriptive statistics related to trip information are provided in above in Table 4.4 for the trip taker respondent group only because it includes exclusively individuals that reported taking at least one trout-angling trip in 2011.

Respondents were also asked questions related to their trips taken in 2011 for the primary purpose of trout angling in Georgia. Trip takers took an average of 7.3 trips in 2011 and 53% took at least one overnight trip. For those individuals who took overnight trips, they took on average 1.64 overnight trips per year and spent 3.28 nights away on average. Anglers traveled an average of 88.6 miles one way to their preferred trout-angling site and spent an average of 1.75 hours traveling one-way to this site. The number of average participants on a trout-angling trip was 2.35 and trips takers had an average of 17.4 years of trout angling experience.

Preference for Site Characteristics

Respondents were asked to rate the importance of different site characteristics to them when choosing a site for a trout-angling trip in Georgia. Preferences related to site characteristics are reported below in Figure 4.2 for all respondents in the form of averages from the likert scale statements.

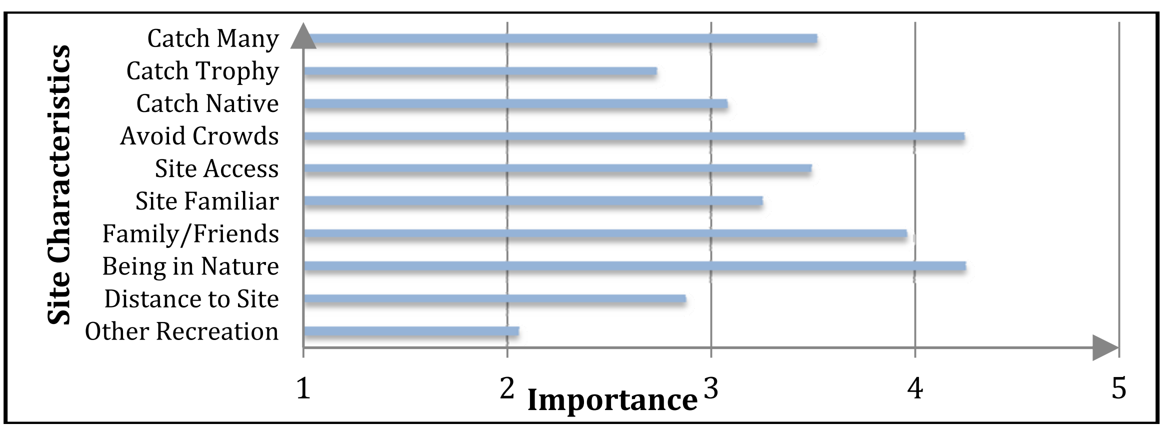

Figure 4.2. Georgia Trout Anglers' Average Likert Scale Importance of Site Characteristics when Selecting an Angling Site

Overall, the most important characteristics when selecting a site for trout angling was avoiding crowds, being with friends and family, and just being out in nature. Availability of other forms of recreation at their angling site was indicated as the least important by respondents when selecting a site.

Travel Cost Model

Travel cost model noted for all respondents, and trout anglers were estimated using the negative binomial count regression models. The third group only included "trip-takers" and was therefore estimated by using the truncated negative binomial count regression model variable, due to only non-zeros in the dependent variable. The models from now on will be called model 1 for "all respondents," model 2 for "trout-angler respondents," and model 3 for "trip-takers" only. Three additional variations of model 3 were also run using the trip taker specifications with different opportunity costs of time of mixed, zero, 25%, and 50%; these models are referred to as model 4, model 5, and model 6 respectively.

Table 4.5. Descriptions of All Models used for Travel Cost Model Analysis

Group	Label	Count Regression Model	Opportunity Cost
All Respondents	Model 1	Negative Binomial	Mixed
Trout Anglers	Model 2	Negative Binomial	Mixed
Trip Takers	Model 3	Truncated Negative Binomial	Mixed
Trip Takers	Model 4	Truncated Negative Binomial	No Opportunity Cost
Trip Takers	Model 5	Truncated Negative Binomial	25% Opportunity Cost
Trip Takers	Model 6	Truncated Negative Binomial	50% Opportunity Cost

The mixed opportunity cost of time uses 25% of the wage rate for individuals who are employed and zero opportunity cost of time for individuals who reported themselves as unemployed, retired, or as students and do not have the same ability to exchange recreation for work. Table 4.5 provides descriptions and details of each model used for analysis.

Table 4.6. Regression Estimates for Travel Cost Model for Georgia Trout Angling in 2011 (Models 1-3) (Dependent Variable: Number of Trout Angling Trips)

Variable	Model 1: NB Mixed OC	Model 2: NB Mixed OC	Model 3: TNB Mixed OC
Intercept	1.042*** (0.381)	2.706*** (0.356)	2.963*** (0.416)
TravelCost	-0.001 (0.001)	-0.003*** (0.001)	-0.004*** (0.000)
Age	-0.029*** (0.005)	-0.018*** (0.005)	-0.018*** (0.006)
Gender	-0.006 (0.200)	-0.247 (0.195)	-0.265 (0.225)
PartySize	0.289*** (0.072)	-0.171*** (0.060)	-0.305*** (0.723)
YearsExp	0.035*** (0.005)	0.020*** (0.004)	0.025*** (0.005)
GATroutSub	0.521*** (0.144)	0.218* (0.128)	0.258* (0.149)
TUMember	1.038*** (0.219)	0.728*** (0.183)	0.572*** (0.204)
PreferTrophy	0.558*** (0.175)	0.464*** (0.148)	0.458*** (0.170)
Income (1000's)	0.001 (0.002)	-0.003 (0.002)	-0.003 (0.003)
n	615	416	326
Log likelihood	-1270.736	-1112.208	-889.879
Pseudo R^2	0.075	0.036	0.043
Likelihood ratio α	0	0	0

Note: *** denotes that the coefficient is statistically significant at the 1% level; ** denotes significance at 5%; and * denotes significance at 10%. Numbers in parentheses are standard errors.

Table 4.7. Regression Estimates for Travel Cost Model for Georgia Trout Angling in 2011 (Models 4-6) (Dependent Variable: Number of Trout Angling Trips)

Variable	Model 4: No Opp Cost	Model 5: 25% Opp Cost	Model 6: 50% Opp Cost
Intercept	3.115***	2.989***	2.944***
	(0.415)	(0.412)	(0.413)
TravelCost	-0.007***	-0.004***	-0.003***
	(0.002)	(0.001)	(0.001)
Age	-0.017***	-0.018***	-0.018***
	(0.005)	(0.005)	(0.005)
Gender	-0.336	-0.304	-0.289
	(0.229)	(0.226)	(0.225)
PartySize	-0.301***	-0.301***	-0.302***
	(0.073)	(0.073)	(0.073)
YearsExp	0.024***	0.025***	0.025***
	(0.005)	(0.005)	(0.005)
GATroutSub	0.259*	0.262*	0.262*
	(0.149)	(0.149)	(0.149)
TUMember	0.621***	0.614***	0.613***
	(0.202)	(0.202)	(0.202)
PreferTrophy	0.447***	0.446***	0.446***
	(0.168)	(0.169)	(0.169)
Income (1000's)	-0.004	-0.003	-0.002
	(0.003)	(0.003)	(0.003)
n	326	326	326
Log likelihood	-887.964	-887.851	-888.024
Pseudo R^2	0.046	0.046	0.045
Likelihood-ratio α	0	0	0

Note: *** denotes that the coefficient is statistically significant at the 1% level; ** denotes significance at 5%; and * denotes significance at 10%. Numbers in parentheses are standard errors.

Regression estimates are presented in Table 4.6 and Table 4.7. Overall, seven out of nine variables were consistently significant throughout the travel cost models. While the sample size was reduced from the all-respondent group model to the trout angler group model and then further reduced in the trip taker group model, the log likelihood increased. This improved the robustness of the model and helped to justify the reduction of sample size. The pseudo R-squared value was very low for all models, but due to the nature of the data, these values cannot be interpreted as one would interpret an OLS R-squared value (Long and Freese 2006). Negative binomial and truncated negative binomial regression does not have an equivalent to the R-squared measure found in OLS regression because count R-Squared does not approach goodness of fit in a way comparable to any OLS approach. It transforms the continuous predicted probabilities into a binary variable on the same scale as the outcome variable (0-1) and then assesses the predictions as correct or incorrect. For this reason, count-data model R-squared values are not typically used for interpretation (Long and Freese 2006).

The likelihood ratio test is a test of the over-dispersion parameter alpha. When the over-dispersion parameter is zero the negative binomial distribution is equivalent to a Poisson distribution. In this study, all alpha values were significantly different from zero thus indicating that the Poisson distribution is not appropriate. See Appendix B for STATA program outputs for all estimated models.

Table 4.6 shows the results of the travel cost estimations for the three different groups of respondents using the travel cost variable with “mixed” opportunity costs. Table 4.7 shows the results for the trip taker respondent group only, using three different rates of opportunity cost of time; 0, 25%, 50%. The variable coefficients and standard errors are shown for all models in Table 4.6 and 4.7.

The standard error is an estimate of the standard deviation of the coefficient, the amount it varies across cases. It can be thought of as a measure of the precision with which the regression coefficient is measured. If a coefficient is large compared to its standard error, then it is probably different from 0. The standard errors for all independent variables in all models are provided in Tables 4.6 and 4.7 above. Pearson correlations among explanatory variables were estimated and analyzed to check for multicollinearity. Multicollinearity was not found amongst any variables in the travel cost models. The Pearson correlation matrix can be found in Appendix C.

Best Fit Model

The truncated negative binomial model, model 3, was selected as most appropriate because it was unclear whether non-users have the same demand functions as users (Hellerstein 1991; Martinez-Espineira and Amoako-Tuffour 2008). Since many respondents explicitly reported they did not use the trout stamp privilege that came with their license, model 1 was determined to be inappropriate to assign consumer surplus values to these individuals. Similarly, model 2 was also considered inappropriate since many individuals did not take trout angling trips, and it cannot be inferred when or if they will take trout angling trips in the future. Both of these models would result in higher per-person consumer surplus values.

Log likelihood values reported for each model were also compared during model selection. The log likelihood value is considered an important criterion in selecting the best fitting model (Long and Freese 2006). All models using the truncated negative binomial regression of trip taker respondents (models 3-6) provided maximized log likelihood estimates that were all very similar.

The trip taker respondent models estimated with the truncated negative binomial regression and incorporating different rates of opportunity cost of time can be used as lower and upper bounds for the travel cost models. From this point on, welfare calculations and interpretations will be primarily based on the results from model 3, the truncated negative binomial regression model using trip taker respondents only and the mixed opportunity cost of time. This is because it was the most appropriate measure of a cost variable. Models 4-6 using the varying opportunity costs of time will also be reported and should be interpreted in the same way as model 3.

Table 4.8. Marginal Effect of Independent Variables in All Travel Cost Models (Dependent Variable: Number of 2011 Trout Angling Trips)

Variable	Model 3	Model 4	Model 5	Model 6
TravelCost	-0.018***	-0.032***	-0.018***	-0.012***
Age	-0.082***	-0.078***	-0.079***	-0.080***
Gender	-1.330	-1.726	-1.543	-1.458
PartySize	-1.382***	-1.363***	-1.362***	-1.366***
YearsExp	0.115***	0.110***	0.111***	0.112***
GATroutSub	1.164*	1.169*	1.179*	1.179*
TUMember	3.164**	3.492***	3.442**	3.437**
PreferTrophy	2.331**	2.264**	2.256**	2.252**
Income	-0.001	-0.002	-0.001	-0.009

Note: *** denotes that the coefficient is statistically significant at the 1% level; ** denotes significance at 5%; and * denotes significance at 10%.

The marginal effects, or elasticities, were also estimated and reported for all models in Table 4.8 at the means of all the independent variables included in the travel cost models. The marginal effect provides a good approximation of how much the dependent variable (number of trout angling trips) will change with a one-unit increase in the independent variable, holding all other variables constant.

Size of the marginals for each independent variable provides the size of the effect that variable has on the dependent variable (number of trout angling trips in 2011), and the sign on the marginals (positive or negative) gives the direction of the effect. For example, to interpret the marginal effect of "party size," on average, a party with one additional member would mean the party would have 1.382 less trips, *ceteris paribus*. Marginal effects were interpreted based on model 3 with the mixed opportunity cost of time and trip takers only.

The cost of the trip in all models was negatively related with the number of trips, (the demand is downward sloping) but not always significant. The travel cost variable for model 1 was negative, but not significant at any of the specified levels. The travel cost variable for all other models (2, 3, 4, 5, and 6) was negative and significant at the 1% level. As the cost of trips increased, there was demand for fewer trips. The marginal effect for the travel cost variable illustrated on average, if the cost increased by $1, the demand was reduced by 0.018 trips.

The age coefficient was negative and significant at the 1% level in all of the travel cost models. This was the predicted outcome, because as individuals get older, they are expected to demand fewer trips. The result is consistent with Ojumu et al. (2009), who found the number of recreational fishing trips was reduced when anglers were 50 years or older. In this study, the marginal effect shows demand for trips decreased by 0.082 on average, as anglers' age increased by one year.

Both the gender and income variables were negative and insignificant in all models. Other travel cost fisheries studies have also reported gender to be insignificant (Prado 2006; Du Preez and Hosking 2010). The negative and insignificant income coefficient contradicts theory. However, many travel cost studies have found negative or insignificant income coefficients (Greene et al. 1997; Zawacki et al. 2000; Loomis 2003;

Du Preez and Hosking 2010). One possible explanation for this result is individuals with higher incomes will likely be working more or have many alternative time commitments and have less time to engage in recreation. The marginal effects of both gender and income were found to be insignificant.

The number of individuals per trout angling trip was reported as the party size. The party size variable was negative and significant at the 1% level for all models, indicating as the number of participants in the group increased, the demand for trips decreased. This was the expected coefficient for this variable as trout angling is typically thought to be an individual sport. Loomis and Ng's (2012) travel cost study of trout anglers in Colorado also reported the party size coefficient to be negative and significant. To interpret the marginal effect, as anglers in Georgia added one more participant to their angling group, the demand was reduced by 1.382 trips on average.

The years of experience variable was positive and significant at the 1% level for all models. This was the expected coefficient for this variable, as the longer anglers have been involved in trout angling, the more likely they were to demand trips. Bowker et al. (1996) and Ojumu et al. (2009) also found individuals with previous experience were likely to demand more trips. This variable was not included in many other studies, but could be valuable to future studies as it was significant and predicted a higher demand for trips. The estimated marginal effect indicates that for each additional year of trout angling experience, the demand for trips increased by 0.115.

The coefficient for Georgia trout substitute was positive and significant, which accords with *a priori* expectations. Trout anglers who had substitutes of trout angling in Georgia at a different site, if their preferred site were no longer available, were likely to demand a higher number of trips. Due to the nature of the binary substitution variable created in this model, it is difficult to compare to other studies, but the interpretation is logical. It was significant in all models, but at various significance levels. For model 1, the variable was significant at the one percent level, and in all other models, Georgia trout substitute is significant at the ten percent level. Interpretation of the marginal effects is slightly different for a binary variable such as substitute. In this case, those with access to substitute sites in Georgia demand 1.164 more trips, on average, than those without access to substitute sites for trout angling in Georgia.

This coefficient for the TU member coefficient was positive and significant at the one percent level in all tested models. Respondents who were members of the Trout Unlimited organization were likely to demand more trips than their non-member counterparts. This is the expected outcome as members of Trout Unlimited are more likely to be avid trout anglers. Marginal effects in Table 4.8 show anglers who were reported members of Trout Unlimited were predicted to demand 3.163 more trips, on average, than anglers who were not members of the TU organization.

The prefer trophy variable had a positive and significant coefficient. The coefficient was significant at the one percent level for all models in the analysis. When selecting sites for trout angling, anglers who indicated that “catching trophy trout” was important to very important were also likely to demand a greater number of trout angling trips. If catching trophy trout was an important part of site selection for anglers, they were predicted to demand 2.331 more trips per year.

The truncated negative binomial regression was used to estimate the travel cost model for the trip taker respondent groups. The truncated negative binomial model accounts for trout angling participants only and does not allow for zeros associated with the dependent variable, number of trips.

Price Elasticity

The price elasticity estimates were consistent with economic theory. Recreation demand studies have encountered price elasticities ranging from about - 0.2 to - 2.0 (Loomis & Walsh 1997).

Table 4.9. Price Elasticities for Travel Cost Variable with Truncated Negative Binomial Models using Varying Opportunity Costs of Time

Model	Opportunity Cost of Time	Price Elasticity of Demand
Model 3	Mixed	-0.222
Model 4	0	-0.271
Model 5	25%	-0.271
Model 6	50%	-0.264

Price elasticities for models 3, 4, 5, and 6 are reported in Table 4.9 above. These results range from -0.222 to -0.271 and indicate relative inelasticity. McKean and Taylor (2000) found a similar price elasticity of -0.28 for recreational trout angling trips. With respect to travel cost modeling, an increase in cost of ten percent associated with traveling to a trout angling site (i.e. distance, gas, etc.) will reduce the demand for trips by approximately two percent (Buchholz 1996).

Consumer Surplus

Table 4.10 shows the consumer surplus values related to all truncated negative binomial regression models using varying opportunity cost models (models 3-6). Models 3, 4, 5, and 6 included 2011 trip-takers only. The travel cost variable was significant at the highest (1%) level, and the coefficient was negative for all reported models.

Table 4.10. Average Per Group and Per Person Per Trip Consumer Surplus using Travel Cost Variable and Varying Opportunity Costs of Time		
	Consumer Surplus: Average Per Group Per Trip	Consumer Surplus: Average Per Person Per Trip
Model 3 (Mixed OC)	$252.54	$107.46
Model 4 (No OC)	$141.05	$60.02
Model 5 (25% OC)	$259.30	$110.34
Model 6 (50% OC)	$386.74	$164.57
Note: Average party size was 2.35.		

The consumer surplus on average per group per trip for model 3 was $252.54, and $107.46 on average per person per trip. The average group size used to calculate per person consumer surplus values was 2.35. In model 4, the consumer surplus value was $141.05 on average per group per trip and $60.02 on average per person per trip. With the inclusion of a 25% opportunity cost of time for all trip-takers regardless of their employment status, the consumer surplus was $259.30 on average per group per trip and $110.34 on average per person per trip. When as high as 50% opportunity cost of time for all trip-takers regardless of their employment status was considered, the estimated consumer surplus was $386.74 on average per group per trip and $164.57 on average per person per trip.

Several recreational fisheries valuation studies are compared in Table 4.11. Other fisheries studies using the travel cost model have found consumer surplus per person per trip to be similar to this study, while geographic location and site differences should be taken into consideration during consumer surplus comparison. Consumer surplus values were adjusted for inflation to the year 2011 and compared to the estimates produced by this study. Consumer surplus estimates for recreational angling ranged from $5.09 for Tampa Bay recreational angling (Greene et al.1997) up to $1029 for angling in Yellowstone National Park (Lowe 1998). Prado's 2006 trout fishery study was the most similar to the results of this study. He estimated the consumer surplus value of the Lower Illinois trout fishery to be $125.04 per angler per day.

Table 4.11. Comparison of Consumer Surplus Values from Recreational Angling Travel Cost Model Literature

Study	Species	Location	Model	CS person/trip
Layman et al. 1996	Salmon	Alaska	Tobit & OLS	87.17
Lupi et al. 1996	Trout	Michigan	RUM	45.50
Greene et al. 1997	General	Tampa Bay	RUM	5.09
Lowe 1997	Trout	Yellowstone	OLS	1029.70
McKean & Taylor 2000	Trout	Idaho	NB	49.96
Ahn et al. 2000	Trout	North Carolina	RUM	392.00
Curtis 2002	Salmon	Ireland	TNB	274.88
Gillig et al. 2003	Snapper	Gulf of Mexico	TNB	17.73
Prado 2006	Trout	Oklahoma	NB	125.04
Ojumu et al. 2009	General	Alabama	NB	34.78
Du Preez & Hosking 2010	Trout	South Africa	TNB	312.16
Loomis & NG 2012	Trout	Colorado	TESP	200.89
Dorison 2012	Trout	Georgia	TNB	107.46

Aggregate Consumer Surplus

The demand models estimated using the truncated negative binomial regression allow for the calculation of individual consumer surplus for a trout-angling trip. Estimating the total consumer surplus requires estimating the average consumer surplus across all individuals in the population of trout-license holders in Georgia. However, multiplying this average consumer surplus value by all license holders with a trout privilege would result in biased overestimations. From the sample population it was observed that 32% of respondents are not trout anglers, so using all license holders would be inappropriate.

To account for non-trout anglers and non-trip takers in the aggregate consumer surplus estimates, the proportions of each respondent group related to the number of all license holders were used to obtain more accurate measures. The proportion of reported 'trout anglers' and 'trip takers' in the sample was used to estimate the number of proportional 'trout anglers' and 'trip takers' in the license holder population. The average individual consumer surplus values were then multiplied by the calculated proportion of license holders who took trips to estimate the aggregate net economic value.

Table 4.12. Net Economic Value using Travel Cost Variable in All Significant Models

Specified Model	Proportional Licenses	Net Economic Value
Model 2 (Trout Anglers; Mixed OC)	211,603	$198,695,300
Model 3 (Trip Takers; Mixed OC)	165,824	$130,264,550
Model 4 (Trip Takers; No OC)	165,824	$72,754,646
Model 5 (Trip Takers; 25% OC)	165,824	$133,751,216
Model 6 (Trip Takers; 50% OC)	165,824	$199,487,378

Table 4.12 shows the proportion of license holders considered for each respondent group and the per trip and annual aggregate consumer surplus (i.e. net economic value) associated with each. While the truncated negative binomial models using trip takers only and varying opportunity costs of time as lower and upper bounds have been selected as the most appropriate for this analysis, estimations for all significant models (models 2-6) are presented in this section for comparison and model selection justification purposes.

The average consumer surplus per person per trip for model 2 was $164.74. Since model 2 only takes into account individuals who were reported trout anglers, the sample proportion was calculated and used to estimate the proportion of trout anglers from the entire license holder population. By dividing the number of observations from model 2 by the number of observations from model 1, the proportion of reported "trout anglers" in the sample was estimated to be 67.7% of the total sample. This proportion was used to estimate the amount of license holders in the population who were also trout anglers. By multiplying the total number of licenses (312,827) by the calculated proportion (.676), the estimated proportion of license holders who can be assumed to be trout anglers was 211,603. To estimate the aggregate consumer surplus the average individual consumer surplus was multiplied by the proportional number of licenses and the number of average trips. The same technique was used with model 3 to estimate the proportion of all license holders that were Georgia trout angling trip takers in 2011. The number of observations in model 3 was divided by the number of observations in model 1 to estimate the proportion of trip takers from the sample. This proportion (.53) was then multiplied by the number of total licenses (312,827) to reach the number of trip takers in the total population. The number of trip takers from the entire population was estimated to be 165,824.

To estimate the aggregate net economic value, the number of proportional license holders (165,824) was multiplied by the average individual consumer surplus values at different opportunity costs of time. Annual estimates were calculated by multiplying the per trip value by the average number if trips per year, 7.3. For example, to estimate the aggregate consumer surplus for model 3 we can then multiply the average individual consumer surplus ($107.46) by the proportional number of licenses and the average number of trips. This method was used to calculate the net economic value for models 3-6 using the varying opportunity costs of time, and the same proportional number of anglers for both the per trip and per year estimations.

For model 3, the aggregate consumer surplus associated with trout angling in Georgia was estimated at $130,264,500 annually. This estimate has been selected as the most appropriate. This value indicates the net economic value of trout angling in Georgia.

Respondents' Views on Climate Change in General

Individuals were asked questions to express their understanding and views on general climate change and their perceived impact of climate change on trout habitat and their fishing activities. All respondents were included in the reported results of this section, because their perceptions and beliefs about climate change are not contingent upon whether they took a trout-angling trip in 2011. Anglers were initially asked to state their level of agreement to statements related to general climate change concerns (Appendix A, Question B3).

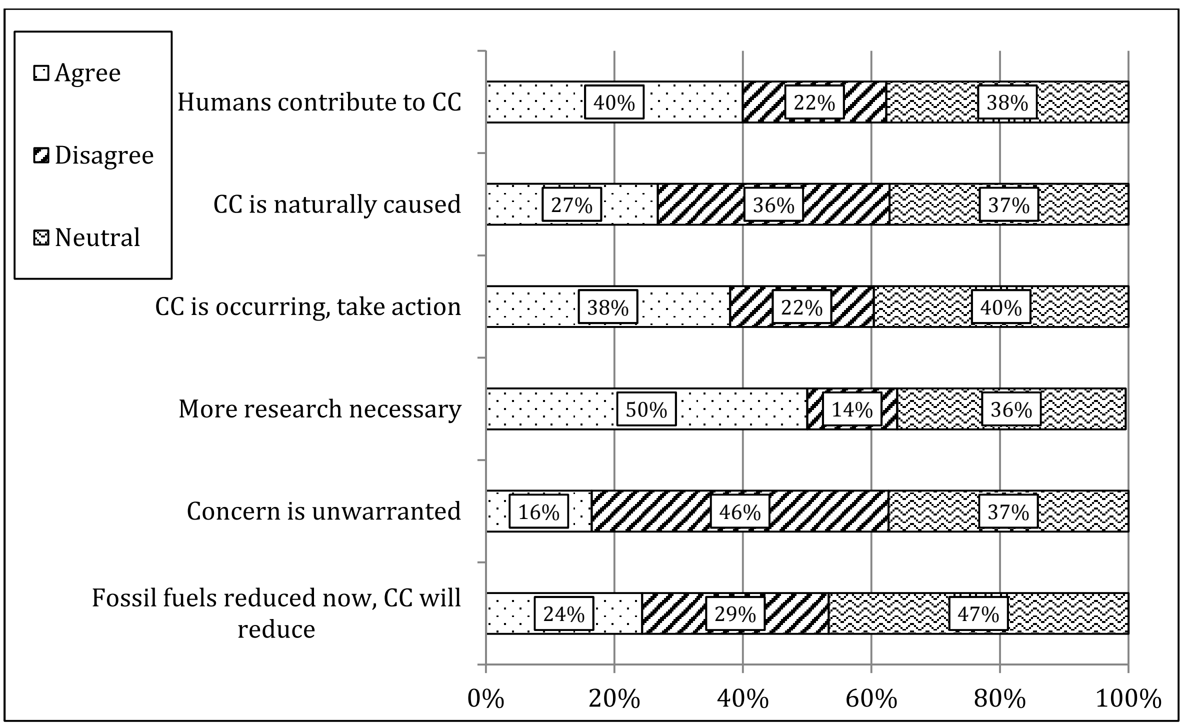

Figure 4.3. Respondents' Agreement to General Climate Change Statements

Results from questions regarding angler's responses to general climate change are shown above in Figure 4.3. The statements used a five point likert scale (one = strongly disagree, five = strongly agree) to better understand respondents perceptions of climate change. Responses with a value of three were coded as neutral to separate them from those individuals who agreed or disagreed with statements. Responses that were ranked as agree to strongly agree were coded as one, and responses that were ranked as disagree to strongly disagree were labeled as zero.

While many statements had a high percentage of neutral responses, 40% of respondents agreed human activity has contributed to climate change, and 27% agreed climate change is naturally caused. Thirty-eight percent of respondents agreed climate change is occurring and action should be taken. Half of respondents agreed that we don't know enough about climate change and more research should be conducted. Only a small portion of respondents, 16%, agreed that concern related to climate change is unwarranted. If fossil fuel use is reduced now, 24% of respondents agreed climate change will also be reduced.

Angler's Beliefs Regarding Climate Change Impacts on Trout in Georgia

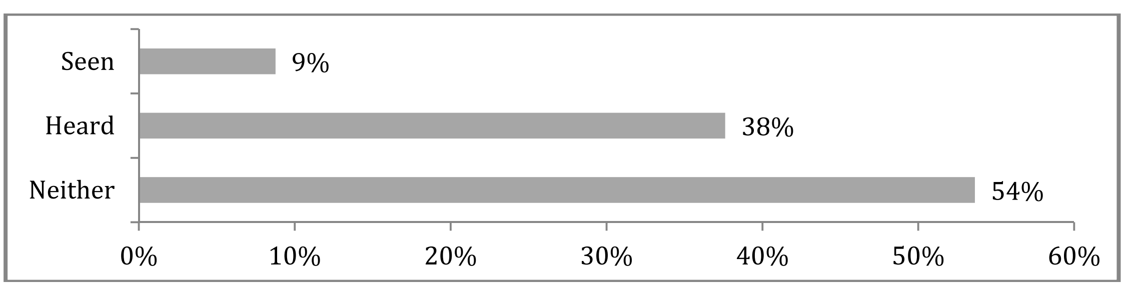

Figure 4.4. Respondents who have seen or heard of Trout Dying in Georgia due to Increased Stream Temperatures

Following generic questions related to climate change, respondents were asked to focus more specifically on climate change and trout in Georgia (Appendix A, Question B2). Respondents were asked if they had ever seen or heard of trout in Georgia streams that were dying due to increased water temperatures. The responses to this question are shown above in Figure 4.4. The majority, 54%, of respondents had never seen or heard of trout dying due to increased temperatures. A small proportion reported they have actually seen dying trout, 9%, and 38% have heard of trout dying due to increased stream temperatures.

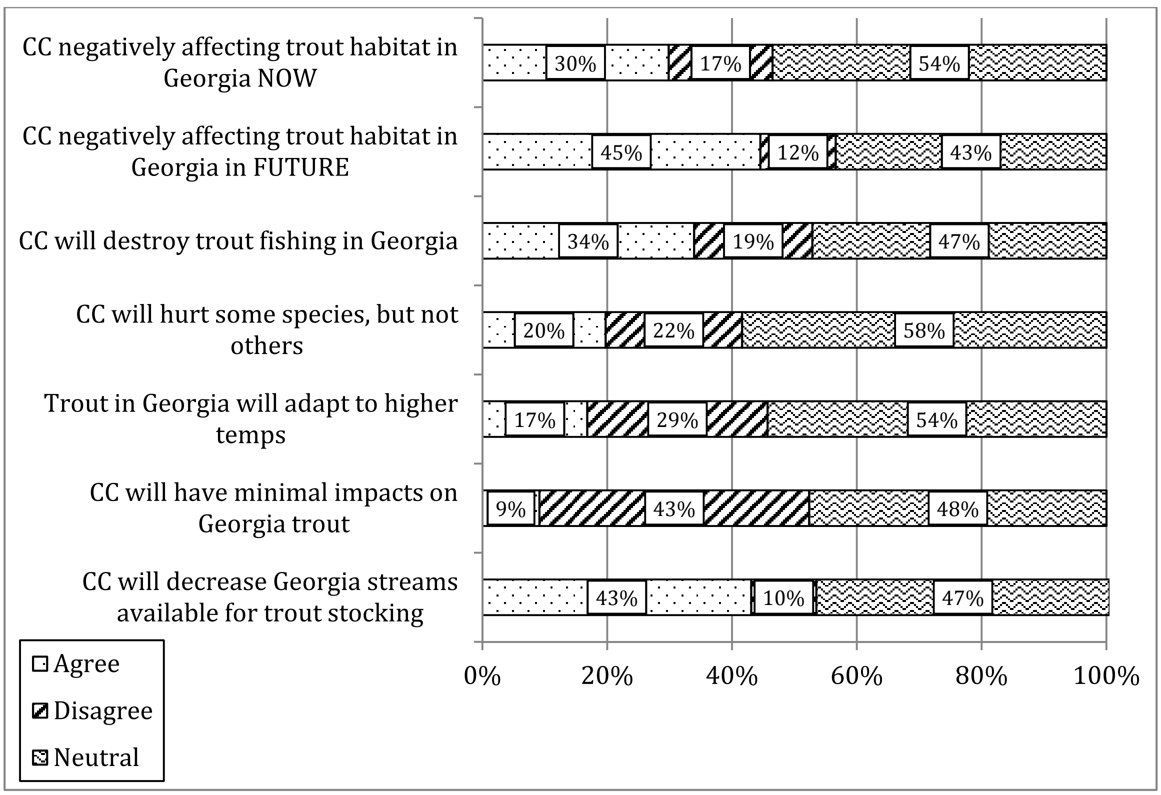

Figure 4.5. Respondents' Agreement to Statements Related to Potential Climate Change Impacts on Trout Habitat and Populations in Georgia

Anglers were then asked questions related to the potential impacts of climate change on trout habitat in Georgia (Appendix A, Question B4). The statements also used the same five point likert scale (one = strongly disagree, five = strongly agree) as the general climate change questions. Results related to angler's beliefs on climate change impacts on trout habitat and populations in Georgia are shown above in Figure 4.5.

Respondents were asked if rising stream temperatures would hurt some species of trout in Georgia, but not other species. This question has the potential to be interpreted in two different ways. By disagreeing, respondents may have been reporting that they believe rising stream temperatures will not hurt any species of trout, or they may have been reporting that it would hurt all species and not just some, as stated in the question.

A second question asked anglers for their level of agreement to whether rising stream temperatures would have minimal impacts on any trout species in Georgia could also be interpreted in two different ways. Those who disagreed may believe that trout would not be impacted by rising stream temperatures, or they may have disagreed because they think trout species will be impacted more than minimally by rising stream temperatures in Georgia. Forty-three percent of respondents disagreed that rising stream temperatures in Georgia would minimally impact trout species.

Overall, it was observed through responses there was concern from respondents related to the impacts of rising stream temperatures on trout habitat and populations in Georgia. Almost one-third of respondents agreed trout habitat is being negatively affected now, and close to half believed rising stream temperatures will negatively affect trout habitat in the future. Thirty-four percent agreed trout fishing in Georgia would eventually be destroyed due to rising stream temperatures. As stream temperatures increase, 29% of respondents disagreed trout in Georgia will be able to adapt to the higher temperatures.

There is also concern from 43% of respondents due to rising stream temperatures, trout stocking in Georgia will no longer be available in some areas.

Potential Change in Net Economic Value under Hypothetical Climate Change Scenarios

Following the estimation of net economic values associated with trout angling in Georgia for the year 2011, it was important to estimate potential changes in trip taking behavior due to rising stream temperatures. It should be noted one angler reported to stop taking trips at 10%, but reported to continue taking trips at 25%, 50%, and 75%. This observation was removed from the calculations due to ambiguity.

Table 4.13. Angler and Trip Changes Related to Trout Population Reduction Scenarios

	Current	10% Reduction	25% Reduction	50% Reduction	75% Reduction
# Anglers	326	321	315	261	152
# Anglers Lost	0	4	10	64	173
# Trips	2384	2328	2290	2001	1157
Average Trips	7.31	7.25	7.27	7.67	7.61
Person-Trips	5171	4894	4814	4072	2284
Average Persons Per Trip	2.16	2.10	2.10	2.03	1.97
% Reduced Anglers	0	1%	3%	20%	53%
# Proportional Licenses	165,824	163,856	160,903	133,840	77,253

Table 4.13 shows the calculations of anglers, trips, and proportions at the current level and at each reduction scenario. The first estimate calculated the new number of anglers for each reduction scenario after removing anglers who reported they would ‘stop fishing.’ The number of trips taken and reported by these specific anglers for each

reduction scenario was summed. The reduced number of trips was then divided by the reduced number of anglers for each reduction scenario to calculate the average number of trips during each reduction. The proportion of anglers lost during each reduction scenario was calculated by dividing the number of anglers lost by the original number of anglers. The previously calculated number of trip takers in the license population then multiplied this proportion to reach the reduced number of anglers in the population related to the results of the sample. The average trips for each reduction scenario was then multiplied by the proportional number of anglers in the population for each reduction scenario and then multiplied by the consumer surplus value calculated in the travel cost model.

For example, when interpreting the 75% reduction scenario, the first row shows the number of anglers (152) that will still be taking trips to their site even with a 75% reduction of the trout population. The number of anglers who reported they would stop taking trips at the 75% reduction was 173. The number of trips at the 75% population reduction (1157) is simply the sum of 2011 trips by anglers who reported they would still take trips. By dividing the number of trips that would still be taken (1157) by the number of anglers who would still fish (152) the average trips for the 75% reduction scenario was obtained (7.61).

Following individual estimates, person-trip calculations were also performed to account for reductions at the group level. The person-trip calculation multiplied the number of participants in each group, by the number of trips taken by each group who would continue fishing (2284) person-trips remain at the 75% reduction. The average persons per trip was calculated by dividing the number of person-trips (2284) by the number of trips taken in that reduction (1157) to obtain the average participants per trip respective to the particular reduction. There was an average of 1.97 participants per group in the 75% reduction scenario. The percent reduction in anglers was calculated by dividing the number of anglers lost (173) by the number of anglers at the current level (325). The 75% reduction scenario results in a 53% reduction in anglers. To extrapolate the calculations of anglers lost from the sample to the population, the number of trip takers in the license population (165,824) was multiplied by the proportional loss of anglers (.53) to reach the number of current trip takers who would potentially stop taking trips at the 75% reduction (87,886). Subtracting the lost anglers (87,866) from the current number of trip takers (165,824) provides the new number of trip takers related to the 75% reduction scenario (77,253).

Table 4.14. Potential Net Economic Value for each Trout Population Reduction Scenario using Varying Opportunity Costs of Time (in millions)

Opportunity Cost (OC)	Current	10% Reduction	25% Reduction	50% Reduction	75% Reduction
Mixed OC	$130.3	$127.6	$125.6	$109.7	$63.4
No OC	$72.7	$71.3	$70.1	$61.3	$35.4
25% OC	$133.8	$131.1	$128.9	$112.7	$65.1
50% OC	$199.5	$195.5	$192.3	$168.0	$97.2

Table 4.15. Potential Net Economic Decline for each Trout Population Reduction Scenario using Varying Opportunity Costs of Time (in millions)

Opportunity Cost (OC)	Current	10% Reduction	25% Reduction	50% Reduction	75% Reduction
Mixed OC	$0	$2.6	$4.7	$20.5	$66.8
No OC	$0	$1.5	$2.6	$11.5	$37.3
25% OC	$0	$2.7	$4.8	$21.1	$68.6
50% OC	$0	$4.0	$7.2	$31.5	$102.3

The net economic values were calculated using the different consumer surplus values associated with varying opportunity costs of time to provide an upper and lower bound. Table 4.14 shows the net economic value estimates (in millions), and Table 4.15 shows the potential decrease in value (in millions) for each reduction scenario. The aggregate net economic value for each reduction scenario was estimated by extrapolating the proportion of trips lost to the trip taker proportion of the population of license holders. The average number of trips was multiplied by the consumer surplus value, and then multiplied by the proportional number of trip takers in the license population to reach the net economic values.

The potential decrease in total value was calculated by subtracting the new economic value at each reduction scenario from the current net economic value. Net economic values and value decreases were estimated using individual consumer surplus values calculated through the travel cost model at all opportunity costs of time.

It should be noted the same consumer surplus values were used in calculating net economic value under various population reduction scenarios. The assumption was made for the purpose of this research, that consumer surplus per trip was invariant to resource quality. Due to this assumption, the potential welfare loss estimates are very conservatively biased. Only counting individuals who would stop fishing altogether in the potential trout population reduction scenario, and not including those who would just take fewer trips was another assumption that may lead to conservative estimates of the potential welfare loss.

The trout population reduction scenarios show that the net economic values were initially reduced minimally at the 10% and 25% reductions, and then considerably reduced at the 50% and 75% population reduction. The aggregate net economic value with current trout populations was estimated at $130.3 million using the mixed opportunity cost of time. When the trout populations were hypothetically reduced by 10%, the estimated value was $127.6 million. When applying the largest reduction scenario of 75%, the aggregate net economic value was reduced to $63.4 million. These estimates represent a potential reduction in value ranging from 1.9% to 49%, dependent on the scenario, from the current state.

Table 4.16. Potential Net Economic Value at the Person-Trip Level for each Trout Population Reduction Scenario using Varying Opportunity Costs of Time (in millions)

Opportunity Cost (OC)	Current	10% Reduction	25% Reduction	50% Reduction	75% Reduction
Mixed OC	$281.4	$268.0	$263.7	$222.7	$124.9
No OC	$157.2	$149.7	$147.3	$124.4	$69.8
25% OC	$288.9	$275.2	$270.7	$228.7	$128.3
50% OC	$430.9	$410.5	$403.8	$341.1	$191.4

Table 4.17. Potential Net Economic Decline at the Person-Trip Level for each Trout Population Reduction Scenario using Varying Opportunity Costs of Time (in millions)

Opportunity Cost (OC)	Current	10% Reduction	25% Reduction	50% Reduction	75% Reduction
Mixed OC	$0	$13.3	$17.7	$58.6	$156.4
No OC	$0	$7.4	$9.9	$32.8	$87.3
25% OC	$0	$13.7	$18.2	$60.2	$160.6
50% OC	$0	$20.4	$27.1	$89.8	$239.5

The net economic value and subsequent decrease in total value related to each reduction scenario was also calculated for the person-trip level. To estimate the net economic value at the group level, the individual net economic value was multiplied by the number of average participants per trip during each reduction scenario. Table 4.16 and 4.17 above, respectively provide the estimates of net economic value and net economic declines at the person-trip level.

At the person-trip level, the aggregate net economic value using the mixed opportunity cost of time was estimated at $281.4 million for the trout fisheries current state. When incorporating the potential trout population reduction scenarios, the person-trip net economic value at the 10% reduction was $268 million and dropped to a net economic value of $124.9 million at the 75% reduction. The potential net economic value at the person-trip level declines by 44% of the current value.

CHAPTER 5

CONCLUSIONS

This chapter presents the conclusions and recommendations related to the research conducted in this study. The first section provides a brief summary of the research. The consumer surplus, net economic value estimations, trout population reduction scenarios, and other related findings are discussed in the context of management and policy implications. This chapter concludes with limitations of the study and suggested direction for future research.

Summary

This study sought to determine the economic value associated with trout angling in the state of Georgia and the expected change in value because of potential climate change effects. The state of Georgia is home to over 4,000 miles of trout angling streams, and hosts more than 300,000 license holders with a trout angling privilege.

Trip frequency and travel cost data from a random sample of Georgia trout anglers was used to estimate the economic value of trout angling in Georgia. The Individual Travel Cost Model (ITCM) was employed as the method. A truncated negative binomial model was selected as the most appropriate to estimate the per person consumer surplus of a trout angling trip in Georgia.

In the most valid models, consumer surplus per trip per person estimates ranged from $60.02 to $164.57 depending upon inclusion of varying opportunity costs of time.

The annual net economic value associated with trout angling in Georgia was estimated at $130.3 million using the mixed opportunity cost of time. Estimates of the potential decrease in economic value associated with hypothetical trout population reductions ranged from $2.6 to $66.8 million dollars, which could be as high as 49% reduction from the current value.

Policy and Management Implications

The primary implication of this research is the estimated economic value trout angling in Georgia provides to users. The estimated value of trout angling in Georgia could be used to evaluate the total benefit associated with trout habitat management or trout stocking programs in the state.

The value associated with a trout-angling trip in Georgia was found to be $107.46 per person when applying a reasonable opportunity cost of time for anglers with current employment status. Value estimates ranged from $60.02 to $164.57 with the application of no opportunity cost of time and 50% opportunity cost of time respectively. The varying opportunity costs of time may be used as upper and lower bounds of consumer surplus values since the travel cost literature has yet to define the most appropriate measure of time cost.

The aggregate consumer surplus per year for trout angling in Georgia was estimated between $72.7 to $199.5 million when using the varying opportunity of costs of time as upper and lower bounds. The best estimate of the value of trout angling in Georgia from this study is $130.3 million dollars annually. The NSFHAWR reported 140,000 Georgia trout angling participants in 2006. Using their participation estimate, the estimated economic value of trout angling in Georgia is $109.9 million dollars per year.

The economic value estimates are the potential amount of welfare that may be lost if Georgia trout angling disappears. It should be noted that welfare would not likely drop to zero, as anglers have alternatives and substitutes for trout angling in Georgia, but welfare may be reduced if substitutes are not equal to the original experience. If the cost of maintaining trout angling in Georgia is equal to or below the consumer surplus value, continuing the trout fishery operation would be justifiable. Non-use benefits and economic impacts associated with trout angling have not been addressed in this study, but should be considered during the benefit-cost analysis.

Further, this research can help GA DNR in particular better understand determinants of trout angling participation and frequency. For example, it may be more beneficial for GA DNR to improve delayed harvest streams where anglers are able to catch trophy trout because this is an important site characteristic for anglers who generally demand more trips.

The trout angling experience as suggested by this research was inelastic in price, with elasticities of demand related to cost ranging between -.2 and -.3. Therefore, the demand for trout angling trips was determined to be fairly insensitive to the costs. Increasing costs will produce a less than proportionate decline in demand. If there was a 10% increase in cost of accessing trout angling (i.e. distance traveled), trips demanded by anglers would be reduced by approximately 2%. The inelasticity shows people may still take the same number of trips, regardless of minor cost increases, possibly because there are very few substitutes that are similar to the trout fishing experience.

Catch rate has been one proxy used to assess the demand related to quality in previous recreational fishing travel cost literature. Catching many trout was found to be insignificant in the early version TCM models; therefore, it is not possible to assume that the number of angler trips was influenced by catch rate. However, catching trophy trout was significant and positive in the final version TCM models. One possible assumption for this relationship is trout anglers are interested in catching larger trout and delayed harvest programs are important to anglers in the state of Georgia.

When looking at the map or trout counties in Georgia, the majority of trips were taken in counties with a higher number of delayed harvest areas. This shows and supports the assumption that Georgia anglers are very interested in the delayed harvest program and the benefits it provides. The GA DNR may see benefits in promoting the delayed harvest program to meet the demands of anglers interested to catching trophy trout. The annual trout angler benefits may be higher than it would have been without any stocking or with decreased stocking. A detailed analysis of how much (or whether) stocking affects angler catch rate, annual trips, and angler benefits would be valuable to managers and a meaningful topic for exploration by future studies.

This study also offers some perspective on potential effects of climate change on trout fishing in Georgia. Trout population declines may result in a decline of trips, causing an overall decrease in the value of trout angling in Georgia. Depending on the climate change and the hypothetical trout population reduction scenario, the economic value of trout fishing could decrease from the $130.3 million baseline to $127.6, $125.6, $109.7, and $63.4 million in the 10%, 25%, 50%, and 75% scenarios, respectively. These are potential reductions of 1.9%, 3.6%, 15.7% and 49% of the current value.

While these reported behavioral changes in trip demand were related to trout population reductions potentially caused by rising stream temperatures, the same application could be applied relative to trout stocking efforts in Georgia. However, the cause of the trout population decline may be viewed as arbitrary for certain management purposes. If trout populations were reduced because of decreased stocking, similar behavioral changes in trip demand may occur. The population decline due to climate change may be viewed as something more permanent, whereas associating the decline to changes in trout stocking could be temporary. Trout stocking planners could potentially use the suggested reductions to stock less trout in exchange for accepting a certain amount of decline in value. Due to the temporary nature of stocking reductions, changes in the stocking effort could be easily altered in the next period.

GA DNR might use some of the information presented here to inform their trout stocking planning. If stream temperatures increase and trout populations are possibly reduced, stocking efforts could be increased as a way to compensate for the loss of trout. While trout population reductions due to climate change could be compensated with increased stocking in some areas, while that may not be an option in others. Many anglers fish in wilderness streams or other areas where no trout stocking occurs, and climate change may have greater effects or even complete loss in these areas. Management decisions would require additional research to ensure stream temperatures are low enough to support the stocked trout.

The reduction scenarios estimated loss of potential economic value, but when looking at the number of trout anglers who would stop taking trips based on trout population reductions, many anglers were not affected by the reduced quality of the site. Findings suggest even when trout populations were reduced by 75%, close to half of the trout-anglers alleged that they would continue to take trips to that particular site.

Therefore, trout angling may be relatively inelastic to negative quality changes. It could be assumed there are some other amenities, besides catch rate, which anglers are seeking through this recreational activity. Respondents are very interested in avoiding crowds, just being outdoors in nature and are likely to demand fewer trips as the number of participants in the group increases. Hence, it may be assumed the amenity sought after by trout anglers is not solely catching trout, but they may be seeking seclusion in the outdoors during their trout angling trips.

The costs of accessing trout angling sites are also related to the potential rising stream temperatures and climate change. If stream temperatures increase, trout habitat may be threatened and the population range shifts north. Georgia is already at the southern edge of trout habitat and could be at risk in the future for losing the trout populations which exist in the state. Trout angling was found to be relatively inelastic, and trout anglers are not very affected by the travel costs associated with trips. Therefore, as trout habitat shifts further north, anglers may be forced to drive further north to reach trout habitat that may no longer exist in Georgia in the future. Trout anglers will travel to other states, such as Tennessee and North Carolina, offering trout angling opportunities. This may potentially reduce the number of trout angling licenses purchased in Georgia, and thus reduce the revenue associated with license sales in Georgia.

The potential loss of trout habitat and populations in Georgia may also be of concern to anglers. As anglers have to travel further for trout angling trips, they will likely have to take more costly overnight trips, pay higher non-resident license fees to trout fish in other states, and spend more time traveling which may also reduce onsite time for some anglers. All of these implications may reduce angler’s current welfare.

Local economies may also be negatively affected by the loss or reduction of trout angling in Georgia as anglers spend money while traveling to sites and in local communities during their trout angling trips.

Management decisions are often oversimplified by focusing only on economic values. Managers should exercise caution when using economic benefits as justification to favor trout anglers and their recreational preferences when divergence of management interests arises between trout anglers and non-trout anglers. The information provided in this study is a starting point to evaluate whether or not the benefits of trout angling in Georgia are worth the costs of stocking and habitat maintenance and to get a sense of how trout anglers will be impacted by natural threats such as climate change. This study is also an important addition to the recreational demand literature by estimating the individual consumer surplus of a Georgia trout angling trip as well as the net economic value. A number of natural resource agencies at the federal and state level can use these values through the "benefit-transfer" approach to make informed decision in their respective locations.

Limitations and Suggestions

This section discusses some of the possible limitations associated with this study. As survey responses were received, it was very apparent many of the generic license holders were unaware their license even carried a trout angling privilege. They responded to the survey providing information stating that not only were they not trout anglers, but also they did not even know they were allowed to trout fish with their respective license type. Of the 631 survey responses received, 32% of these individuals reported that they were not trout anglers. Many of the surveys were likely not returned due to a high percentage of the sample including individuals who were not interested in the topic, because they were not trout anglers. This may also introduce a potential non-response bias and a sample representation that has higher demand for trout angling trips than the population at large.

There are also potential limitations related to the economic modeling. The travel cost model has some intrinsic methodological concerns. Issues arising consistently with travel cost modeling include, but are not limited to; multi-purpose recreation trips, discretionary expenditures, handling of substitutes, use of proxies and missing information, recollection error, and selection of the opportunity cost of time (Randall 1994).

In the travel cost model used in this study, the substitute variable could be a potential limitation. Ideally, individuals should identify a specific substitute site. The survey used in this study asked if anglers would trout fish somewhere else in Georgia, change activities but remain in Georgia, trout fish out of state, stay at home, or go to work in lieu of trout fishing at their typical Georgia site. However, 4% reported more than one response to this question and 32% did not respond at all because they were not trout anglers. Selecting a single choice for these respondents would have created researcher bias. An overwhelming 30% reported they would either stay home or go to work and 54% reported they would stay in Georgia to trout fish. For this reason, a binary variable was created instead; those who chose to stay in Georgia and trout fish, and those who chose otherwise. This variable was found to be positive and significant in all the models used in this study. In future demand studies, it may prove beneficial to use specific price proxies for substitute sites and substitute activities versus the more simplistic binary variable.

Another issue that consistently arises in travel cost modeling is the measurement of time costs. There has been little consensus on how to measure costs of travel time. This study followed precedence set in the literature by using a range of wage rate portions as a measure of the time cost associated with a trout-angling trip. In some instances, work cannot be equally traded for leisure and a fixed portion of the wage rate may not be the appropriate time cost measurement. To address the issue of time inequality amongst the unemployed, student and retired respondents a “mixed” opportunity cost of time was applied in this study. Only individuals who reported themselves as employed received time cost allocations in this model specification. Even with the application of the mixed time cost measurement, there may be discrepancies related to trading work for leisure that should be addressed at the individual level for increased accuracy. Some studies have directly asked respondents whether or not they are able to trade work for leisure hours. This could prove helpful in future studies to better determine how to include time costs in the travel cost model.

Bias associated with non-response is another limitation associated with this study. Even in well-designed surveys, the unknown opinions of individuals who fail to respond cannot contribute to estimates of population preferences. If there is a difference between the preferences of the nonrespondents and those of the respondents of which the estimates were based, nonresponse bias has occurred. People who feel strongly about the issues in a survey are more likely to respond (Pearl and Fairley 1985). In this study, 32% of respondents were not trout anglers and therefore had limited interest in the survey. The proportion of the sample that were not trout anglers could be even larger due to this nonresponse bias theory. Many who do not trout fish, may not have even sent the survey back to notify us about this information.

While it would be difficult to know if the preferences of the nonrespondents differed from those who did respond, basic demographic comparisons were assessed.

Table 5.1. Demographic Descriptives to Compare Population, Sample, Respondents, Nonrespondents and Undeliverable Surveys

Group	Average Age	% of Females	% of Males
Population	48.37	16.45	83.55
Sample	47.97	17.37	82.63
Respondents	49.72	17.27	82.73
Nonrespondents	47.64	17.69	82.30
Undeliverable	47.06	16.11	83.89

Table 5.1 above shows the average age, and percent of males and females of the population, sample, respondents, nonrespondents, and undeliverable. Respondents were slightly older than the other groups. When comparing the demographics of each, the average age and percent of each gender are very similar to the other groups and no significant differences were observed.

The hypothetical population reduction scenarios also presented a limitation. The consumer surpluses per trip per person values were held constant in the reduction scenario net economic value calculations. The assumption was made, for simplicity purposes that consumer surplus values do not change with quality. The net economic value estimations would likely change based on the reductions in quality. The National Resource Economics Handbook (USDA NRCS 1995) explains that quality improvements could shift the demand curve to the right, causing an increase in the consumer surplus.

The inverse of this relationship could be applied to quality reductions, and the demand curve should theoretically shift to the left. This could cause a decrease in consumer surplus as quality of the resource is reduced. Further investigation into this theory is suggested, as well as exploring how the supply curve may shift with quality changes.

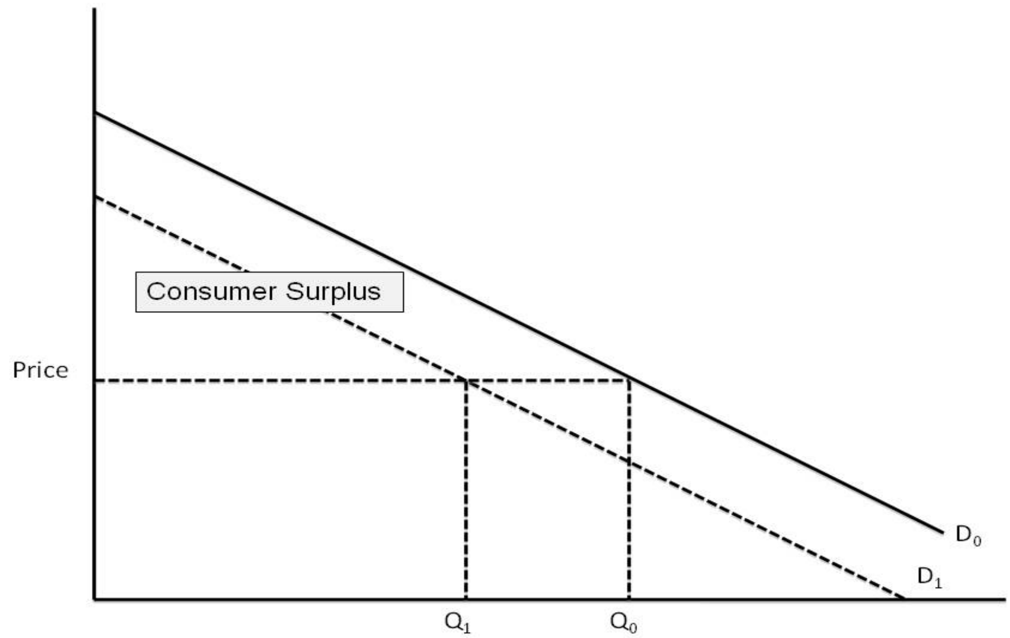

Figure 5.1. Demand Curves and Consumer Surplus Areas with a Reduction in Quality

Figure 5.1 above shows the original demand, D_0, and the likely demand, D_1, after a reduction in quality, and the corresponding consumer surplus areas. Future studies may benefit from further research related to the actual changes in consumer surplus values related to reductions of resource quality to provide more accurate estimates of net economic values.

Estimates of the potential decline in value due to hypothetical population reduction scenarios were very conservatively biased. This study was limited to calculating decline related only to anglers who would stop fishing completely, but was not able to estimate decline associated with anglers who would take fewer trips. Future studies would benefit from estimating the potential decline in value related to anglers who would take fewer trips, but may not stop fishing completely. Calculating both of these values would provide a more complete estimate of the potential decline in value associated with trout population reductions.

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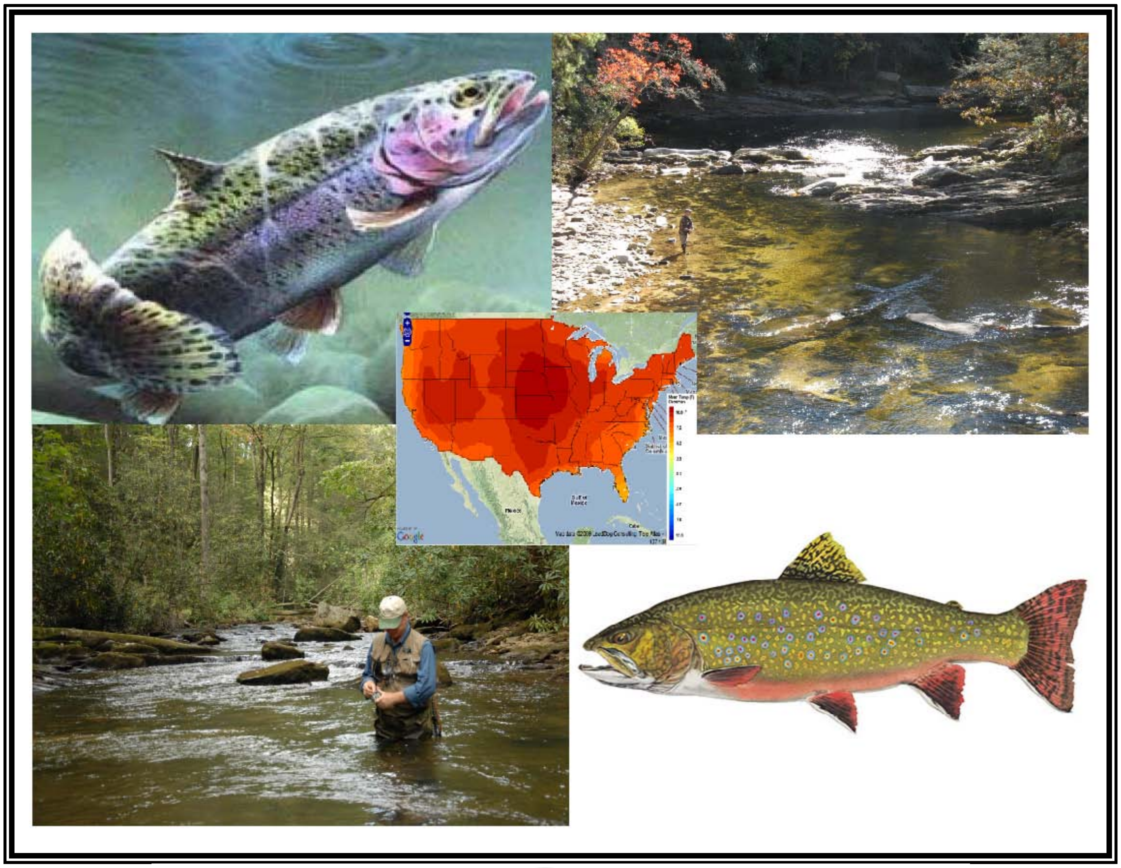
APPENDIX A

Georgia Angler Survey
Climate Change & Trout Fishing in Georgia



1785

The University of Georgia

Warnell School of Forestry and Natural Resources

2012

You have been randomly selected as a Georgia trout stamp holder to participate in this survey. The survey is intended to help managers better understand Georgia trout anglers' knowledge and opinions of climate change and its potential impact on trout fishing. If you are less than 18 years old, please do not complete the survey.

Section A: Current and Past Trout Fishing in Georgia

A1. For which species of trout do you fish? (*Check ALL that apply*)

☐ Brook ☐ Brown ☐ Rainbow ☐Other (specify)_____________

A2. If you fish in streams, what type of streams do you fish? *(Check ALL that apply)*

☐ Year-round ☐ Seasonal

☐Tailwater ☐ Wilderness

☐ Heavily stocked ☐ Special regulation (i.e., delayed harvest, trophy)

A3. What do you typically do with your catch? *(Check ONE)*

☐Eat ☐Release

☐Trophy ☐ Other (please specify)______________

A4. Did you fish for trout in Georgia in 2011?

☐ Yes, go to question **A7**. ☐ No, go to question **A5**.

A5. Which best describes your reason for answering 'No'?

☐ I usually go every year, but 2011 was an exception; go to question **A7**.

☐ I quit trout fishing altogether; go to question **A6.**

☐ I don't use the trout stamp that comes with my license **(SKIP TO B1)**

A6. Which of the following best describes the reasons you do not trout fish? *(Check ALL that apply)*

☐Crowding ☐Not enough trout

☐Lack of time ☐ Too expensive

☐Long commute ☐Unfavorable weather

☐No fishing partners ☐I only fish trout outside of Georgia

A7. Where do you typically begin your Georgia trout fishing trips?

☐Permanent residence (zip code) ___________ ☐Non-permanent residence (zip code)__________

A8. Approximately, how far is the place in A7 from the place in Georgia you trout fish most often?

one-way distance ________________miles AND/OR one-way commute time ____________hours

A9. What type of vehicle do you typically use when traveling to fish for trout in Georgia. *(Check ALL that apply)*

☐Full-size Pick-up/SUV ☐Small Pick-up/SUV ☐Small Car ☐Medium Car ☐ Large Car/Van

A10. When do you take your trout fishing trips in Georgia? *(Check ALL that apply)*

☐Winter (Dec-Feb) ☐ Spring (Mar-May) ☐Summer (June-Aug) ☐Fall (Sept-Nov)

A11. How many people usually travel in the same vehicle with you during a typical Georgia trout-fishing trip?

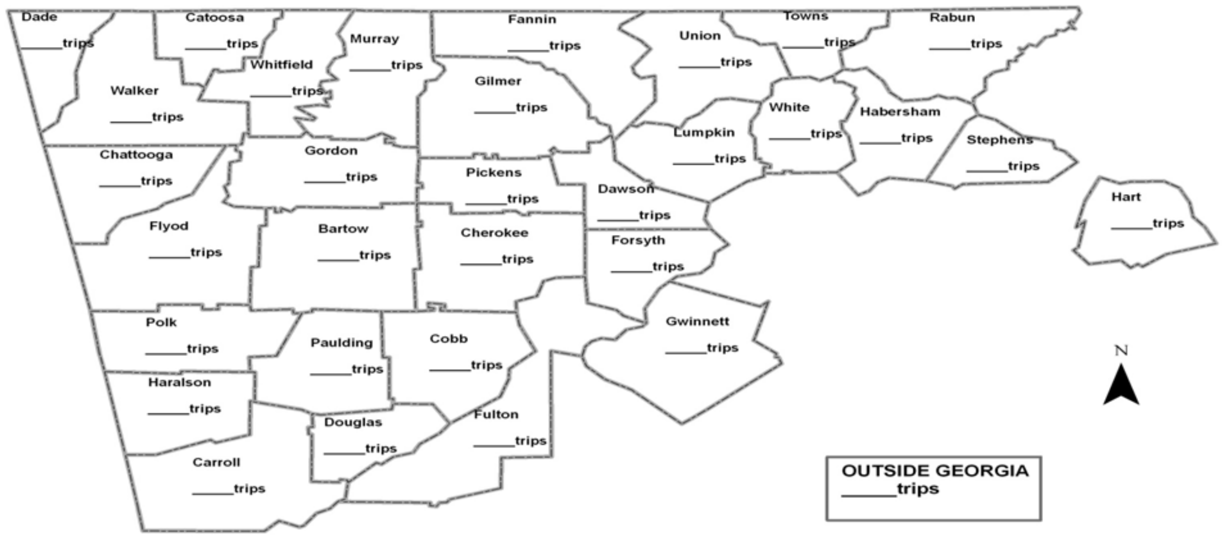
__________________ # people in vehicle INCLUDING MYSELF

A12. How many trips in total did you take for the primary purpose of trout fishing in Georgia in 2011?

____________________# trips

A13. Please indicate on the map the number of trips you made in 2011 to any Georgia counties shown below or outside Georgia for the primary purpose of trout fishing.

Map 1: Trout Counties in Georgia



A14. How many of your trout fishing trips indicated in **A12** above were overnight trips?

☐ ___________________# trips

☐No overnight trips (Go to **A17**)

A15. On your last overnight trout-fishing trip in Georgia, how many total nights were you away from home?
_______________# nights

A16. During your last trout fishing **OVERNIGHT TRIP** in 2011, how much did you personally spend on the following items both INSIDE and OUTSIDE the 31 Georgia counties shown in Map 1?

Items related to your last trout fishing OVERNIGHT TRIP	Amount spent **WITHIN** 31 Georgia counties named in Map 1	Amount spent **OUTSIDE** 31 Georgia counties named in Map 1
Fees/Stamps/Entrance	$	$
Transportation expenses (gas, etc.)	$	$
Restaurants/bars	$	$
Groceries	$	$
Fishing equipment and supplies	$	$
Lodging (hotel, campground)	$	$
Guide services	$	$
Souvenirs/Gifts/Apparel	$	$
Entertainment	$	$
Miscellaneous other expenses	$	$

A17. During your last trout fishing **DAY TRIP** in 2011, how much did you personally spend on the following items both INSIDE and OUTSIDE the Georgia counties shown in Map 1?

Items related to your last trout fishing DAY TRIP	Amount spent **WITHIN** 31 Georgia counties named in map 1	Amount spent **OUTSIDE** 31 Georgia counties named in map 1
Fees/Stamps/Entrance	$	$
Transportation expenses (gas, etc.)	$	$
Restaurants/bars	$	$
Groceries	$	$
Fishing equipment and supplies	$	$
Lodging	$	$
Guide services	$	$
Souvenirs/Gifts/Apparel	$	$
Entertainment	$	$
Miscellaneous other expenses	$	$

A18. What gear do you use when trout fishing? *(Check ALL that apply)*

☐ Fly ☐ Bait (worms, corn, etc.) ☐ Lure

A19. Which of the following times do you most prefer to fish? *(Please check ONE)*

☐Opening day ☐First three days after stocking

☐Stocking day ☐Other (e.g., when I have time, when less crowded)

A20. How important are following to you when selecting a place to trout fish in Georgia? *(Check ONE box per ROW)*

	Not Important 1	2	3	4	**Very Important** 5
Catching many trout	☐	☐	☐	☐	☐
Catching trophy trout	☐	☐	☐	☐	☐
Catching native trout	☐	☐	☐	☐	☐
Avoiding crowds	☐	☐	☐	☐	☐
Site accessibility	☐	☐	☐	☐	☐
Familiarity with site	☐	☐	☐	☐	☐
Being with family/friends	☐	☐	☐	☐	☐
Nature and scenery	☐	☐	☐	☐	☐
Short driving distance	☐	☐	☐	☐	☐
Other kinds of recreation nearby	☐	☐	☐	☐	☐

A21. How long have you been trout fishing in Georgia?

______________# years ☐ 1st year (Go to**A23**)

A22. How would you rate the quality of trout fishing in Georgia now compared to when you first began trout fishing here?

☐Much Worse ☐ Worse ☐ Same ☐ Better ☐ Much Better

A23. If the place you most often trout fish in Georgia is not available on a typical fishing day, what would you do instead? *(Check ONE)*

☐Go somewhere else in Georgia to trout fish ____________________# one-way miles from residence
☐Go somewhere else in Georgia for another activity ____________________# one-way miles from residence
☐Go out of state to trout fish ____________________# one-way miles from residence
☐Stay home
☐Go to work

A24. On most days, which would you rather catch? *(Check only ONE)*

☐8 trout/9 inches each
☐ 6 trout/10 inches each
☐ 4 trout/12 inches each
☐2 trout/16 inches each

Section B: Perspectives about Sport Fishing, Nature and Climate Change

NOW, WE WOULD LIKE TO LEARN ABOUT YOUR PERSPECTIVES ON NATURE, AND YOUR UNDERSTANDING OF CLIMATE CHANGE AND ITS POSSIBLE RELATION TO TROUT FISHING.

B1. Please indicate your level of disagreement/agreement with each of the following statements.

	Strongly Disagree ◄ 1	2	3	4	► Strongly Agree 5
Nature's primary value is to provide things that are useful to people.	☐	☐	☐	☐	☐
Sport fishing is a valuable food source.	☐	☐	☐	☐	☐
Sport fishing is important for human well-being.	☐	☐	☐	☐	☐
Sport fishing helps develop social ties.	☐	☐	☐	☐	☐
Sport fishing is important for jobs and income.	☐	☐	☐	☐	☐
Sport fish are a valuable part of nature.	☐	☐	☐	☐	☐
Protecting the environment is more important than providing sport fishing opportunities.	☐	☐	☐	☐	☐
Humans have a right to change the natural world to suit their needs.	☐	☐	☐	☐	☐
Fish have as much right as people to exist.	☐	☐	☐	☐	☐
Management should focus on doing what is best for nature instead of what is best for people.	☐	☐	☐	☐	☐

B2. Have you seen or heard that trout in Georgia streams are dying from increased water temperatures?

☐Seen ☐Heard ☐Neither seen nor heard

B3. Please indicate your level of disagreement/agreement with each of the following statements.

	Strongly Disagree ◄ 1	2	3	4	► Strongly Agree 5
Human activity contributes to the increase in greenhouse gases, adding to climate change.	☐	☐	☐	☐	☐
Climate change is primarily natural and humans have little effect.	☐	☐	☐	☐	☐
There is evidence that climate change is occurring and some action should be taken.	☐	☐	☐	☐	☐
We don't know enough about climate change, and more research is necessary.	☐	☐	☐	☐	☐
Concern about climate change is unwarranted.	☐	☐	☐	☐	☐
If we reduce our fossil fuel use now, then climate change will be reduced.	☐	☐	☐	☐	☐

CLIMATE CHANGE MAY LEAD TO INCREASED STREAM TEMPERATURES RESULTING IN LOWER TROUT POPULATIONS AND CATCH RATES. THIS SECTION FOCUSES ON HOW TROUT ANGLERS PERCEIVE IMPACTS OF CLIMATE CHANGE ON TROUT ANGLING IN GEORGIA.

B4. Please indicate your level of disagreement/agreement with each of the following statements.

	Strongly Disagree ◄ 1	2	3	4	► Strongly Agree 5
Rising stream temperature due to climate change is negatively affecting trout habitat in Georgia <u>now</u>.	☐	☐	☐	☐	☐
Rising stream temperature due to climate change will negatively affect trout habitat in Georgia in the <u>future</u>.	☐	☐	☐	☐	☐
Rising stream temperatures will eventually destroy trout fishing in Georgia streams.	☐	☐	☐	☐	☐
Rising stream temperatures will hurt some species of trout in Georgia, but not others.	☐	☐	☐	☐	☐
Trout in Georgia will eventually adapt to higher stream temperatures.	☐	☐	☐	☐	☐
Rising stream temperatures will have minimal impacts on any species of trout in Georgia.	☐	☐	☐	☐	☐
Rising stream temperatures will decrease the streams available for trout stocking in Georgia	☐	☐	☐	☐	☐

B5. If the trout population and your catch rate at the places in Georgia you fish the most were reduced by the following amounts due to rising stream temperatures. Indicate how your trips to those places would change.

	My number of trips there probably wouldn't	I would make somewhat fewer trips there	I would make many fewer trips there	I would stop fishing there completely
10% reduction in trout	☐	☐	☐	☐
25% reduction in trout	☐	☐	☐	☐
50% reduction in trout	☐	☐	☐	☐
75% reduction in trout	☐	☐	☐	☐

B6. If you spent less time trout fishing at the place in Georgia you fish the most, in which of the following activities would you spend more time? *(Check ALL that apply)*

☐Fishing in other states/countries for trout
☐ Fishing in other streams in Georgia for trout
☐ Fishing in Georgia for saltwater species
☐ Fishing in Georgia for warm water species
☐ Hunting
☐ Bicycling
☐ Camping
☐Outdoor team sports
☐ Motor boating
☐ Off-road ATV/4-wheeling
☐ Bird/Nature viewing
☐ Indoor activities
☐ Canoeing/Kayaking/Swimming/Sailing
☐Hiking/Walking/Running
☐ Golf
☐Target Shooting

B7. Where do you typically obtain your climate information? (*Check ALL that apply*)

☐AM Talk Radio
☐The Weather Channel
☐National Public Radio (NPR)
☐North Georgia Trout Online
☐ Fox News
☐ Other Internet Fishing Bulletin/Website
☐ ABC/CBS/NBC
☐ Family/Friends
☐ Other cable news (MSNBC, CNN, etc.)
☐ Surfing Internet
☐ Newspapers/Magazines
☐ Trout Unlimited

THE FOLLOWING TWO QUESTIONS LIST ITEMS RELATED TO TROUT MANAGEMENT PROGRAMS, INITIATIVES, AND OTHER ISSUES. IN B8, PLEASE INDICATE HOW IMPORTANT EACH ITEM IS TO YOU, AND IN B9, INDICATE HOW WELL YOU THINK EACH ITEM IS BEING PERFORMED IN GEORGIA.

B8. How important are the following to your trout angling in Georgia?

Trout Fishing	**Not Important ←** **1**	**2**	**3**	**4**	**→ Very Important** **5**
Publishing of stocking report/schedule	☐	☐	☐	☐	☐
Reports on water quality/conditions	☐	☐	☐	☐	☐
Mitigation/restoration	☐	☐	☐	☐	☐
Accessibility to streams	☐	☐	☐	☐	☐
Stocking appropriate waters	☐	☐	☐	☐	☐
License pricing	☐	☐	☐	☐	☐
Maintaining wild trout population	☐	☐	☐	☐	☐
Hatchery supported streams	☐	☐	☐	☐	☐
Bait restrictions	☐	☐	☐	☐	☐
Special regulation streams	☐	☐	☐	☐	☐
Scientific research on trout species	☐	☐	☐	☐	☐
Enforcement of fishing regulations	☐	☐	☐	☐	☐
Recruitment of new anglers	☐	☐	☐	☐	☐
Retention of current anglers	☐	☐	☐	☐	☐

B9. How well do you think the following are currently being done in Georgia?

Trout Fishing	**Not Important ◄ 1**	**2**	**3**	**4**	**► Very Important 5**
Publishing of stocking report/schedule	☐	☐	☐	☐	☐
Reports on water quality/conditions	☐	☐	☐	☐	☐
Mitigation/restoration	☐	☐	☐	☐	☐
Accessibility to streams	☐	☐	☐	☐	☐
Stocking appropriate waters	☐	☐	☐	☐	☐
License pricing	☐	☐	☐	☐	☐
Maintaining wild trout population	☐	☐	☐	☐	☐
Hatchery supported streams	☐	☐	☐	☐	☐
Bait restrictions	☐	☐	☐	☐	☐
Special regulation streams	☐	☐	☐	☐	☐
Scientific research on trout species	☐	☐	☐	☐	☐
Enforcement of fishing regulations	☐	☐	☐	☐	☐
Recruitment of new anglers	☐	☐	☐	☐	☐
Retention of current anglers	☐	☐	☐	☐	☐

B10. Some factors that could threaten statewide trout habitat are listed below. Please indicate the threat level you believe these factors pose on trout populations in Georgia.

	No Threat ◄ **1**	**2**	**3**	**4**	► Very High Threat **5**
Disposal of storm water runoff	☐	☐	☐	☐	☐
Fishing pressure (too many anglers)	☐	☐	☐	☐	☐
Illegal fishing practices	☐	☐	☐	☐	☐
Reduction of shoreline vegetation	☐	☐	☐	☐	☐
Rising water temperature	☐	☐	☐	☐	☐
Industrial/residential pollutants	☐	☐	☐	☐	☐
Agricultural runoff	☐	☐	☐	☐	☐
Land development (sprawl)	☐	☐	☐	☐	☐
Forestry practices	☐	☐	☐	☐	☐

Section C: Demographics

These questions will help us to ensure that the people we are surveying are representative of all trout anglers in Georgia. **All answers will be kept strictly confidential.**

C1. What is your age? _____________years

C2. What is your gender? _______Male _______Female

C3. Are you of Hispanic, Latino, or Spanish origin? _______Yes _______No

C4. Which of the following category best describes your race/ethnicity? *(Check ALL that apply)*

☐ Caucasian
☐ Asian or Pacific Islander
☐ African American
☐ American Indian
☐ Other

C5. How many people live in your household?

☐________# total
☐________# under 18years
☐________# trout anglers

C6. What is your highest level of education?

☐High school not completed
☐ High school completed
☐Some college or technical school
☐ College degree completed
☐ Post Bachelor's education

C7. What is your current employment status? (*Check ALL that apply*)

☐Full-time job ☐Part-time job ☐Unemployed ☐Student ☐ Retired ☐ Military

C8. Did you vote in the most recent presidential election? _______Yes _______No

C9. Are you a member of any of the following outdoor sporting associations/groups? *(Check ALL that apply.)*

☐Trout Unlimited
☐The Sierra Club
☐ Ducks Unlimited
☐The Wildlife Society
☐Quail Unlimited
☐National Rifle Association
☐ North Georgia Trout Online
☐ Other (please specify)

C10. In 2011, in what range was your annual household income from all sources before taxes?

☐ $ 25,000 or less
☐ $ 75,001 to 100,000
☐ $ 25,001 to 50,000
☐ $ 100,001 or more
☐ $ 50,001 to 75, 000

Please use the space provided below for any additional comments.

Please return this survey in the enclosed postage-paid envelope. If you have misplaced the envelope, please return the survey to:

Dr. Neelam Poudyal
Warnell School of Forestry and Natural Resources
University of Georgia
180 East Green Street
Athens, GA 30602

Additional questions or problems regarding your rights as a study participant should be addressed to The Chairperson, Institutional Review Board, University of Georgia, 612 Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411; Telephone (706) 542-3199; E-Mail Address irb@uga.edu

APPENDIX B

STATA OUTPUT

```
Negative binomial regression                      Number of obs   =        615
                                                  LR chi2(9)      =     205.99
Dispersion     = mean                             Prob > chi2     =     0.0000
Log likelihood = -1270.7364                       Pseudo R2       =     0.0750
```

trips	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
tc_mixedoppcost	-.0009313	.0011834	-0.79	0.431	-.0032508	.0013882
age	-.0292501	.0051795	-5.65	0.000	-.0394017	-.0190985
gender	-.0061181	.2001988	-0.03	0.976	-.3985006	.3862644
partysize	.2895367	.0719683	4.02	0.000	.1484815	.430592
yearsexp	.0349959	.0045848	7.63	0.000	.0260099	.0439819
gatroutsub	.5213713	.1434819	3.63	0.000	.240152	.8025907
tumember	1.038131	.2191728	4.74	0.000	.6085603	1.467702
prefertrophy	.5576238	.1748308	3.19	0.001	.2149617	.9002859
income	.0011449	.0024393	0.47	0.639	-.0036361	.0059258
_cons	1.043074	.3804406	2.74	0.006	.2974244	1.788724
/lnalpha	.7523935	.0813704			.5929105	.9118765
alpha	2.122073	.1726739			1.809247	2.488989

```
Likelihood-ratio test of alpha=0:  chibar2(01) = 2843.26 Prob>=chibar2 = 0.000
```

```
Negative binomial regression                      Number of obs   =        416
                                                  LR chi2(9)      =      82.07
Dispersion     = mean                             Prob > chi2     =     0.0000
Log likelihood = -1112.2081                       Pseudo R2       =     0.0356
```

trips	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
tc_mixedoppcost	-.0025831	.0009025	-2.86	0.004	-.004352	-.0008143
age	-.0178109	.0047934	-3.72	0.000	-.0272059	-.008416
gender	-.2468357	.1946649	-1.27	0.205	-.6283719	.1347005
partysize	-.1707641	.0603077	-2.83	0.005	-.2889651	-.0525631
yearsexp	.0200777	.0040852	4.91	0.000	.0120708	.0280846
gatroutsub	.2180419	.1282734	1.70	0.089	-.0333693	.4694532
tumember	.728456	.1826786	3.99	0.000	.3704125	1.086499
prefertrophy	.4641675	.1480751	3.13	0.002	.1739457	.7543893
income	-.0026864	.0022408	-1.20	0.231	-.0070783	.0017055
_cons	2.706209	.3549987	7.62	0.000	2.010424	3.401993
/lnalpha	.2856684	.0837248			.1215709	.4497659
alpha	1.330651	.1114085			1.129269	1.567945

```
Likelihood-ratio test of alpha=0:  chibar2(01) = 2196.80 Prob>=chibar2 = 0.000
```

Truncated negative binomial regression
Truncation point: **0**
Dispersion = **mean**
Log likelihood = **-889.96437**

Number of obs = **326**
LR chi2(**9**) = **80.57**
Prob > chi2 = **0.0000**
Pseudo R2 = **0.0433**

trips	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
tc_mixedoppcost	-.0039598	.0009987	-3.96	0.000	-.0059172	-.0020024
age	-.0181021	.0055119	-3.28	0.001	-.0289052	-.0072991
gender	-.2646204	.2245697	-1.18	0.239	-.7047688	.1755281
partysize	-.3046602	.0727849	-4.19	0.000	-.4473159	-.1620044
yearsexp	.0254558	.0048188	5.28	0.000	.0160112	.0349004
gatroutsub	.2577347	.1498353	1.72	0.085	-.0359372	.5514066
tumember	.5724036	.2041785	2.80	0.005	.172221	.9725862
prefertrophy	.4581888	.1701698	2.69	0.007	.1246621	.7917155
income	-.0028839	.0026706	-1.08	0.280	-.0081181	.0023504
_cons	2.959699	.4161111	7.11	0.000	2.144136	3.775262
/lnalpha	.4031283	.1802156			.0499123	.7563442
alpha	1.496499	.2696924			1.051179	2.130473

Likelihood-ratio test of alpha=0: chibar2(01) = **1583.49** Prob>=chibar2 = **0.000**

Truncated negative binomial regression
Truncation point: **0**
Dispersion = **mean**
Log likelihood = **-888.11495**

Number of obs = **326**
LR chi2(**9**) = **84.26**
Prob > chi2 = **0.0000**
Pseudo R2 = **0.0453**

trips	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
tc_nooppcost	-.0070895	.0016031	-4.42	0.000	-.0102314	-.0039475
age	-.0173356	.0054813	-3.16	0.002	-.0280788	-.0065925
gender	-.3344068	.2299636	-1.45	0.146	-.7851273	.1163136
partysize	-.3010456	.0727739	-4.14	0.000	-.4436798	-.1584113
yearsexp	.0244183	.004813	5.07	0.000	.0149849	.0338516
gatroutsub	.2595631	.1485329	1.75	0.081	-.031556	.5506822
tumember	.6216944	.2016785	3.08	0.002	.2264117	1.016977
prefertrophy	.4478927	.1684307	2.66	0.008	.1177745	.7780108
income	-.0039589	.0025999	-1.52	0.128	-.0090546	.0011368
_cons	3.108034	.414934	7.49	0.000	2.294778	3.92129
/lnalpha	.3815669	.1784547			.0318021	.7313318
alpha	1.464578	.2613608			1.032313	2.077846

Likelihood-ratio test of alpha=0: chibar2(01) = **1572.91** Prob>=chibar2 = **0.000**

```
Truncated negative binomial regression            Number of obs   =        326
Truncation point: 0                               LR chi2(9)      =      84.56
Dispersion      = mean                            Prob > chi2     =     0.0000
Log likelihood = -887.96887                       Pseudo R2       =     0.0454
```

trips	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
tc_25oppcost	-.0038566	.0008628	-4.47	0.000	-.0055476	-.0021656
age	-.0175617	.0054789	-3.21	0.001	-.0283002	-.0068232
gender	-.3032248	.2264284	-1.34	0.181	-.7470164	.1405668
partysize	-.3011539	.072574	-4.15	0.000	-.4433963	-.1589114
yearsexp	.0247026	.004806	5.14	0.000	.015283	.0341223
gatroutsub	.2620403	.148824	1.76	0.078	-.0296494	.55373
tumember	.614627	.2021002	3.04	0.002	.218518	1.010736
prefertrophy	.4464221	.1686953	2.65	0.008	.1157854	.7770588
income	-.002505	.0026639	-0.94	0.347	-.0077262	.0027163
_cons	2.984452	.4123447	7.24	0.000	2.176272	3.792633
/lnalpha	.3820384	.178435			.0323124	.7317645
alpha	1.465268	.2614551			1.03284	2.078745

```
Likelihood-ratio test of alpha=0:  chibar2(01) = 1573.79 Prob>=chibar2 = 0.000
```

```
Truncated negative binomial regression            Number of obs   =        326
Truncation point: 0                               LR chi2(9)      =      84.24
Dispersion      = mean                            Prob > chi2     =     0.0000
Log likelihood = -888.12702                       Pseudo R2       =     0.0453
```

trips	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
tc_50oppcost	-.0025857	.0005833	-4.43	0.000	-.0037289	-.0014426
age	-.017716	.0054825	-3.23	0.001	-.0284614	-.0069705
gender	-.2883904	.2252843	-1.28	0.201	-.7299396	.1531588
partysize	-.3019427	.0725303	-4.16	0.000	-.4440996	-.1597859
yearsexp	.0248648	.0048065	5.17	0.000	.0154443	.0342853
gatroutsub	.2618751	.1490196	1.76	0.079	-.0301979	.5539481
tumember	.6138043	.2024006	3.03	0.002	.2171064	1.010502
prefertrophy	.4457188	.1689155	2.64	0.008	.1146506	.7767871
income	-.0020516	.0026985	-0.76	0.447	-.0073406	.0032374
_cons	2.940066	.4126676	7.12	0.000	2.131252	3.748879
/lnalpha	.3846612	.1786305			.0345518	.7347705
alpha	1.469116	.262429			1.035156	2.085003

```
Likelihood-ratio test of alpha=0:  chibar2(01) = 1575.59 Prob>=chibar2 = 0.000
```

APPENDIX C

Variable	TC Mix	Age	Gender	Party Size	Yrs Exp	GA Sub	TU Member	Prefer Trophy	Income
TC Mixed	1.000								
Age	0.105	1.000							
Gender	-0.025	0.055	1.000						
Party Size	0.077	-0.111	-0.064	1.000					
Yrs Exp	-0.069	0.201	0.072	0.026	1.000				
GA Trout Sub	0.040	0.033	-0.099	0.057	0.198	1.000			
TU Member	0.017	0.069	0.108	-0.097	-0.006	0.018	1.000		
Prefer Trophy	-0.015	-0.125	0.133	0.112	0.072	-0.023	0.087	1.000	
Income	0.203	0.075	0.088	-0.132	-0.075	0.006	0.272	0.070	1.000

Table A.1. Pearson Correlation Matrix for All Independent Variables Included in Travel Cost Model