Recreational Demand Modelling for Whitewater Kayaking in Ireland

Stephen Hynes
B. Comm. (NUI), M. Econ. Sc. (NUI).

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DESCRIPTION OF THESIS

The primary objective of the thesis is to study the demand for an outdoor recreational pursuit in Ireland. The thesis uses and extends the different travel cost methods of valuation for non-market goods. The vehicle for the research is whitewater kayaking recreation in Ireland. A new method for dealing with the contentious issue of measuring the opportunity cost of time in recreational demand modeling is developed and a number of approaches are adopted to investigate the heterogeneity of tastes and preferences in the Irish kayaking community. Approaches to collecting travel cost data using the internet are also discussed.

The first part of the thesis (*chapter 2*) describes some of the main use and non-use values associated with whitewater river systems. It also reviews the development of the sport of whitewater kayaking in Ireland. *Chapter 3* examines the numerous valuation methodologies (and their applications) that are being used in the field of non-market valuation. Following this, *chapter 4* reviews the single site study on the Roughty river, where the non-market benefits accruing from the preservation of "natural" conditions on one Irish river are estimated. This chapter focuses on one single river and the development threat coming from investments in new hydroelectric plants on Irish rivers.

In *chapter 5* the design and development of the main survey instrument are described. This chapter also gives details on survey administration, procedures, database structure and an analysis of the responses to the survey. *Chapter 6* then investigates the valuation of time in recreation demand models. It uses a RUM model to analyze site choices made by Irish kayaking participants, with emphasis placed on constructing estimates for individuals' opportunity cost of time using secondary data. The idea is motivated by a standard two-constraint model in which people can smoothly trade time for money at the market wage rate.

Chapters 7 and 8 make use of the multi-attribute kayaking data to investigate the heterogeneity of tastes in the kayaking community. *Chapter 7* develops an exogenous approach of incorporating preference heterogeneity using a "clustered" RUM model of whitewater kayaking site choice. In *Chapter 8* two empirical models are used to endogenously take account of individual heterogeneity in analyzing whitewater kayaking site choice decisions. The two models are the random parameter logit model and the latent class model (LCM).

Statement

I declare that the contents of this thesis are entirely my own work.

Signed

Stephen Hynes

10th December 2005

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Chapter 1. Introduction

Whitewater river systems represent natural capital capable of producing a wide range of goods and services for society. If the functional integrity of these whitewater rivers can be maintained, then a flow of environmental services and recreation benefits can be sustained into the indefinite future. Some of the outputs from an environmental good such as a whitewater river, for example certain fish stocks, are freely exchanged in formal markets. Value is determined in these markets through exchange and quantified in terms of price. However, many other outputs such as carbon storage, scenic beauty or acting as a recreational facility contribute to society's quality of life and support the local economy (especially through the tourism trade) but are without formal markets and therefore without prices.

Those land management agencies that are charged with managing wilderness areas and protecting features of the wilderness, such as whitewater rivers, have sharply limited and sometimes politicised budgets and so the resources necessary to perform management tasks may have a very high opportunity cost, both financially and politically (Hackett, 2001). If some value-generating activity must be passed up, for example the development of a small scale hydro scheme on a whitewater river, in order to fund wilderness area maintenance and management, managers may need to assess the benefits generated by the wilderness area. In this thesis I investigate the recreational economic benefits associated with the activity of whitewater kayaking in Ireland. The whitewater rivers in Ireland are a valuable resource in terms of potential hydro-electric energy. They are also valuable for a host of other reasons that will be expanded upon in chapter 2, but this fact is not always considered when it comes to deciding on developments such as a power plant that can potentially destroy the characteristics of a free flowing whitewater river. From a recreational point of view, the whitewater rivers in Ireland are famous around the world for the quality of the fishing experience they offer. What is lesser known is the fact that many of these same river systems are also excellent from the point of view of whitewater kayaking recreation.

Whitewater kayaking refers to the sport of negotiating ones way downstream, through a number of natural obstacles such as waterfalls, rapids, bolder gardens, trees, etc. on a section of river. The ability to create a mental map of the river ahead, coupled with an ability to make split second decisions is required to choose a route down. Kayaking requires considerable kayak (the small craft in which the kayaker sits) handling skills. Precise control, endurance, and sustained power are needed to negotiate the best line down through the rough water and to overcome the frequently changing water conditions. The kayaker chooses and negotiates a route, which is as obstacle free as possible and at the same time utilises the fast current to the best advantage.

Whitewater kayaking is a relatively new form of recreation in Ireland compared to activities such as recreational walking, fishing, and more traditional sporting activities such as Gaelic football and hurling. While some of these other activities have been studied in an Irish context and their economic benefits to the users estimated (see for example Curtis, 2002 for fishing and Curtis and Williams, 2002 for walking), no other studies have estimated the economic benefits of whitewater kayaking in Ireland or the U.K. It is a worthwhile exercise to estimate the economic benefits of whitewater kayaking in Ireland for several reasons.

Firstly, whitewater kayaking has the potential to conflict with other forms of recreation such as fishing and power boating, as these activities often use the same rivers and these conflicts may increase due to the growing popularity of whitewater kayaking. To efficiently allocate resources, managers need information on the relative value of the different activities to recreationalists at multi-activity sites.

Secondly, as policy targets over CO_2 emission reductions are established, the development of more sustainable energy sources such as hydro-power electrical facilities on Irish rivers are likely to be pushed up the political agenda. The building of such hydro plants will have a direct, negative impact on the pursuit of whitewater kayaking on these rivers. Plans to develop hydro schemes have already resulted in intense debates between environmentalists that are concerned about the irreversible environmental impacts of these developments, and industrialists who point at the benefits of diversifying Ireland's energy sources and reducing CO_2 emissions from fossil fuel sourced electricity.

Thirdly, whitewater kayaking can also impose special costs for river and park managers such as repairing damaged banks and marking put-on and take-out points. It is essential to estimate the economic benefits of whitewater kayaking and to understand what kayaking enthusiasts are looking for when they undertake a kayaking excursion in order to assist in whitewater amenity allocation and for use in benefit cost analysis of whitewater specific projects.

The fact that the benefits from pursuing an outdoor recreational pursuit such as whitewater kayaking are not priced does not mean they lack value, only that market indicators of the value do not exist. The service flows provided by whitewater rivers meet the two necessary conditions for generating economic value. First, they are relatively scarce and second, they contribute to people's satisfaction and enhance their welfare (Loomis, 2000). Economists must therefore estimate the non-market benefits of the goods and services jointly produced by a natural resource such as a whitewater river when consumers are unable to express their preferences and willingness to pay via the marketplace. Non-market benefits should be included in the economic analysis used to inform public land management decisions. An economic analysis must account for non-priced benefits and costs, as well as those more readily observed and measured in market prices (Loomis and Walsh, 1992).

Although whitewater rivers provide society with multiple benefits ranging from recreation to providing habitat to wildlife, their value is still debated. The disappearance of whitewater rivers in both Ireland and Scotland can be explained in economic terms by the theory of market failure. As already mentioned, whitewater river benefits such as recreation are 'public goods' and cannot therefore be bought and sold in conventional markets. Consequently, the benefits of developing whitewater rivers for hydro-power are perceived to be more important, or more valuable than conserving the rivers in their natural state. As a result, the market gives wrong signals and incorrect management decisions can be made, even though the preservation of the river may be socially more desirable (Morton, 1999).

To overcome these incorrect market signals and to account for the full array of goods and services generated by an environmental amenity such as a whitewater river, economists have derived the total economic valuation framework (Randall and Stoll, 1983 and Loomis and Walsh, 1992). A total economic valuation framework is the appropriate measure when comparing wilderness benefits to its opportunity costs (Loomis and Walsh 1992). According to Morton (1999) the seven categories of what he refers to as "wildland benefits" are direct use, community, scientific, off-site, biodiversity conservation, ecological services and passive use benefits. Chapter 2 of this thesis will discuss in greater dept the benefits accruing in particular from whitewater river systems.

Morton (1999) sees "wildland recreation" resulting in a variety of individual and social benefits including: personal development (spiritual growth, improved physical fitness, self-esteem, self-confidence and leadership abilities); social bonding (greater family cohesiveness and higher quality of family life); therapeutic and healing benefits (stress reduction helping to increase worker productivity and reduce illness and absenteeism at work); and social benefits (increased national pride). Since this thesis is primarily interested in the direct *recreational* use and *recreational* value of whitewater rivers, Morton's other "wildland benefits" will be ignored. It is important however to be aware of what these other benefits are. The fact that this thesis is focused on just the recreational benefits of the whitewater river resource will also dictate the type of valuation technique that will be utilized in the proceeding chapters.

Among the quantitative valuation approaches there are several econometric methodologies employed in the estimation of the economic value of public goods. Broadly these may be catergorised into stated preference methods and revealed preference methods. In the former, respondents are asked to directly state their Willingness to Pay (WTP) for recreational opportunities in the context of hypothetical changes in the supply or quantity of these opportunities. Revealed Preference (RP) models on the other hand are based upon data drawn from observations of behaviour in real markets from which inferences may be drawn on the value of a related non-market good. The real market acts as a proxy market for the environmental good or service.

Stated preference techniques rely on kayakers's responses to hypothetical scenarios. For example, the researcher might describe a hypothetical whitewater kayaking trip to a kayaker and ask the kayaker whether he or she would take the trip or not. Stated preference techniques have two major classes of elicitation techniques to get kayaker's preferences for whitewater river management. The first type, the Contingent Valuation Method (CVM), measures the value of a change from the status quo to some other state of the world (Mitchell and Carson, 1989). For example, one might ask kayakers to consider their current trip and ask them their willingness to pay to avoid a decrease in water quality or flow in order to quantify the economic loss to this group of recreationalists of, perhaps, a hydro scheme development. The technique could be particularly useful for exploring new management tools or examining willingness to pay in the context of tightening or loosening regulations on river access or usage.

Another stated preference methodology, referred to in the literature as Attribute Based Stated Choice (ABSC) techniques, has been applied to environmental management problems such as rock climbing in Scotland (Hanley et al., 2001) and hunting in Canada (Louviere et al., 2000). ABSC methods include Choice Experiments and other choice based methodologies (Adamowicz et al., 1998) Like CVM, ABSC techniques applied to whitewater river management would gain information about preferences by analyzing responses to hypothetical whitewater kayaking trips. Further, the ABSC method considers a kayaking trip as a bundle of attributes describing a trip.

Using experimental design techniques, kayakers could be given trip choices that require the respondent to make tradeoffs across the different trip attributes simultaneously. Therefore, it is possible to examine how preferences for the value of a management measure such as a river access fee might change as environmental conditions change or as the cost of the trip changes. Additionally, new policy-relevant attributes can be examined; for example, anglers might be asked to consider a trip under the existing management regime and one with a new management tool in place (for example, gear or area restrictions). Like contingent valuation, ABSC techniques are based upon hypothetical, not real behavior. Stated preference models value hypothetical changes, and respondents may not reveal their true preferences in response to hypothetical questions. Consequently, questions must be raised about the reliability of results based upon this type of data.

The two principle revealed preference approaches that are utilised to measure the economic benefit that an individual receives from recreation are the Travel Cost Method (TCM) (subcategories of which are the Count Data Model (CDM) and the Random Utility Model (RUM) approach) and the Hedonic Price Method. In both approaches, the demand curve for the non-market good is estimated by observing behaviour in the market for a related good. The fact that only use-values are considered in the TCM follows from the weak complementarity assumption, i.e. if the individual does not consume the environmental commodity her utility is unaffected by changes in the quality of the commodity[1]. The Travel Cost Method is probably the most utilized of the revealed preference methodologies. It estimates the value of an environmental amenity by using the costs that individuals pay to travel to the site as a proxy for the price of the amenity. With this information, an estimated demand curve for the environmental amenity can be constructed. In 1947, Harold Hotelling wrote a letter to the director of the National Park Service proposing a method for measuring the benefits provided by recreation sites. This letter serves as the foundation upon which the travel cost method is built. Although the suggestion was not used at the time, more than a decade later Trice and Wood (1958) and Clawson (1959) applied Hotelling's suggestions and began a long line of research applying the travel cost model to various non-market valuation problems (Smith, 1989).

While the travel cost method is similar to contingent valuation in the use of survey techniques, it differs in that the travel cost method uses revealed preferences. Individuals' actual behavior and choices reveal the value they place on the environmental amenity. Because the travel cost method uses revealed preferences to measure actual use values it is relatively uncontroversial particularly when compared to contingent valuation techniques (King and Mazzotta, 2002). Traditional travel cost

[1] See section 3.2.2 for a more in depth discussion of the weak complementarity assumption.

methods can be broken into two types of approaches: the zonal travel cost and individual travel cost approaches.

The zonal travel cost approach is the most inexpensive technique because it primarily uses secondary data with just a small amount of simple primary data collected directly from visitors. As with all traditional count data travel cost methods it is most appropriate for valuing a site as a whole instead of valuing changes in the characteristics of a site (King & Mazzotta, 2002). One difficulty of the zonal method is how to treat zones with zero visitation rates. This relates to the more fundamental difficulty of defining the extent of the market for recreation sites (Smith, 1989). If the researcher defines a large market extent, the likelihood may also be high that many of the zones of which the market extent is comprised will have a visitation rate of zero. The individual travel cost approach is similar to the zonal method described above in its basic approach but the one key difference is that it uses individual surveys to collect more detailed information.

The next major innovation in the travel cost method was the random utility model initially used by Morey (1981, 1984) and Hanemann (1984). Random utility models attempt to explain the choice of a particular recreation site as an outcome of a utility maximization problem. The primary advantage of random utility models is their ability to fully capture the value of site characteristics or the effects of variation in site quality on the demand for a recreational site (Freeman, 1993). The random utility model offers a better way of dealing with site characteristics. The random utility model explains choice among various sites is explained as a function of the characteristics of the available sites. The drawback of this approach, aside from its increased complexity, is that unlike the traditional travel cost method the random utility model is unable to explain the total demand for recreational activity at a site, in other words, the total number of visitor days per year (Freeman, 1993).

An important challenge with the travel cost method is the treatment of the opportunity cost of time. With the individual travel cost method it is possible to gather information on annual earnings from which an hourly wage can be derived. This is then assumed to be the opportunity cost of time. Often this wage rate is an unreliable estimate of the individuals actual wage and there is also the issue of deciding what fraction of the wage rate to use as the opportunity cost of time. In chapter 6, a new approach is developed to measure the opportunity cost of time in recreational demand modeling.

Of course the travel cost method of valuation is limited in the fact that it only takes into account use values. Non-use values such as "existence" values and "option" values cannot be taken into account using the travel cost method alone. The fact that only use-values are considered in the TCM follows from the weak complementarity assumption i.e. if the individual does not consume the environmental commodity her utility is unaffected by changes in the quality of the commodity. Existence values, or non-use values, arise from the individual's knowledge that the environmental service exists and will continue to exist independently of any actual or prospective use (Perman et al. 1999). People may appreciate improved environmental quality even if they do not consume the environmental service. That is, their utility may be positively affected (and thus the weak complementarity assumption does not hold). Having said that, if one can reasonably expect non-use values to be relatively small then the travel cost method may be a more suitable method to employ in the valuation process. In a case such as whitewater kayaking recreation where a site has many close substitutes or when damage to a whitewater site is not expected to be permanent, lost non-use value is likely to be small.

Similarly, lost option value may also be small when people have the option of visiting close substitutes. If damage to a site is only temporary and full recovery is expected, then lost existence value may again be small, since people know the site will continue to exist in its natural state for future generations. Lost option value may also be small given that people still have the option to visit the site in its natural state if they wait for recovery (Mitchell and Carson, 1989). In these situations the travel cost method, being a revealed preference technique measuring clearly defined use values is clearly preferred over contingent valuation, since non-use values are not a large concern. The very large number of substitute whitewater sites in Ireland combined with the fact that whitewater rivers are primarily valuable to kayakers as recreational sites (they are generally not valued by kayakers for any endangered species or other highly unique qualities that would make non-use values for the site significant) means that the travel cost method is the ideal valuation technique to employ in order to study the demand for whitewater kayaking recreation. Also the TCM is especially designed for recreational activities, such as kayaking, that require significant travel and attract many participants for repeat visits.

Indeed, the travel cost method has been used extensively to value river recreation. Amirfathi *et al.* (1984) performed a travel cost study to value a 50% reduction of water flows in northern Utah as it affects fishermen. Harris & Meister (1983) used a travel cost approach to value the recreational benefits of Lake Tutira, a small lake in New Zealand highly valued for recreation but also threatened with eutrophication. Ward (1985) used the travel cost method to value instream flows for fishing and white water rafting in rivers near Albuquerque, New Mexico.

Sanders *et al.* (1991) used both the contingent valuation and travel cost methods to estimate the recreation value of sections of 11 rivers in the Colorado Rocky Mountains that had been recommended for protection under the Wild and Scenic Rivers Act. For the travel cost method they used a sub-sample of 122 respondents and the data for all 11 sites was pooled. Although there have been numerous studies that have investigated the non-market value of whitewater recreation from the point of view of fishing and whitewater rafting there is very little evidence in the literature of work specially dedicated to the valuation of whitewater kayaking recreation. A number of studies relating to water based recreation will be discussed in greater detail in chapter 3. It is hoped that the research presented in this thesis will be of use to resource managers, policy makers and other decision makers. It is also hoped that the new approaches developed in this thesis such as using latent class modeling techniques with revealed preference data and the new method for measuring the opportunity cost of time will be of benefit to other researchers in the area of revealed preference/travel cost method analysis.

1.1 Structure of the thesis

The structure of the thesis following this chapter is as follows:

Chapter 2 looks at the origins of the sport of whitewater kayaking and the development of the sport in Ireland. It then reviews some of the main use and non-use values associated with whitewater river systems. The chapter also reviews the many threats to Irish rivers from sources such as pollution and water abstraction from new housing, mining, forestry; hydro-electric schemes; and non-point pollution from farming.

Chapter 3 provides a review of the literature. The review is presented in 3 main sections. In the first, a general overview is given of the numerous valuation methodologies (and their applications) that are being used in the field of non-market valuation. In the second and third section the main stated and revealed preference valuation methodologies are discussed (respectively) in greater depth with particular attention being given to the travel cost methodology. The treatment of travel cost and the opportunity cost of travel time in recreational demand modelling is then reviewed as is the literature relating to heterogeneous preferences in water based recreational studies.

In **chapter 4**, the single site study that was carried out to look at the demand for whitewater recreation on a single river is reviewed. In this chapter the data from the single site study is used to estimate the non-market benefits accruing from the preservation of "natural" conditions for one particular river in Ireland, where the development threat comes from investments in new hydroelectric plants.

This single site study is of methodological interest in that it combines data collected from two different sources; the internet and an on-site survey and uses it in a count data travel cost model. The chapter shows that both data sources can be pooled, thus alleviating the problem of endogenenous stratification that is found when carrying out on-site surveys alone. Through the estimation of a travel cost model, the single site study derives the mean willingness to pay of the average kayaker using the Roughty river in Co. Kerry. The result indicates the high value of the Roughty river as a whitewater recreational resource.

In **Chapter 5** the design and development of the main survey instrument are described. This chapter also gives details on survey administration, procedures, database structure and an analysis of the responses to the survey. **Chapter 6** then investigates the valuation of time in recreation demand models. It uses a RUM model to analyze site choices made by Irish kayaking participants, with emphasis placed on constructing estimates for individuals' opportunity cost of time using secondary data. The idea is motivated by a standard two-constraint model in which people can smoothly trade time for money at the market wage rate. Under this assumption the empirical task undertaken is to identify the market wage rate for each sampled person. Individual level data from the European Community Household Panel is used in an auxiliary regression to parameterize Irish wage rates as a function of socio-economic factors available in both surveys. From the auxiliary regression the wage rate is predicted for each person in the sample, and used to construct the implicit visitation cost of visits to each of 11 whitewater sites. The chapter suggests that instead of asking for wage rates the investigator asks for socioeconomic data in the survey and then uses this data in an auxiliary wage rate function estimated from a secondary data source to forecast wage rates. This gets around the common problem of refusal to divulge such information by respondents. The RUM model is estimated based on site-specific fixed effects, price, and site quality characteristics.

Chapters 7 and 8 make use of the multi-attribute kayaking data to investigate the heterogeneity of tastes in the kayaking community. **Chapter 7** develops an exogenous approach of incorporating preference heterogeneity using a "clustered" RUM model of whitewater kayaking site choice. By separating out the sample of whitewater kayakers into two exogenously identifiable groups (based on their skill level) and running separate conditional logits for each group the fact that kayakers of different skill levels are looking for different characteristics from the whitewater site they choose to visit is taken account of. The results presented in the chapter reveal that not taking into account the differences in the skill of the kayakers and the grade of the river will result in an overestimation of the welfare estimates associated with improvements to lower grade whitewater sites (which are frequented by basic/intermediated proficiency level kayakers) and underestimating welfare estimates associated with changes in the attributes of higher grade whitewater sites (which are frequented by advanced proficiency level kayakers).

In **Chapter 8** two empirical models are used to endogenously take account of individual heterogeneity in analyzing whitewater kayaking site choice decisions. The two models are the random parameter logit model and the latent class model (LCM). The presence of a finite number of 2, 3, 4 and 5 latent preference groups (classes) are assessed and then contrasted with the presence of a continuous distribution of parameter estimates using the random parameter logit model. Welfare estimates associated with changes in the attributes of particular whitewater sites are also presented, and are found to vary considerably depending on the approach taken.

1.2 Outputs from the thesis

A number of papers and presentations have arisen from the research presented in this thesis. Four working papers have been produced for the National University of Ireland, Galway's Department of Economics working paper series. These are:

1. Hynes, S. and Hanley, N., 2004. *Conflict between Commercial and Recreational Activities on Irish Rivers: Estimating the Economic Value of Whitewater Kayaking in Ireland using Mixed Data Sources*. Department of Economics Working Paper No. 75, National University of Ireland, Galway. This paper relates to the results of chapter 4.

2. Hynes, S., Hanley N., and O'Donoghue, C., 2004. *Measuring the opportunity cost of time in recreation demand modelling: an application to a random utility model of whitewater kayaking in Ireland.* Department of Economics Working Paper No. 87, National University of Ireland, Galway. This paper relates to the results of chapter 6.

3. Hynes, S. and Hanley, N., 2005. *Analysing Preference Heterogeneity using Random Parameter Logit and Latent Class Modelling Techniques*. Department of Economics Working Paper No. 91, National University of Ireland, Galway. This paper relates to the results of chapter 8.

4. Hynes, S., Hanley, N. and Garvey, E., 2005. *Accounting for Skill levels in Recreational Demand Modelling using a Clustered RUM Approach.* Department of Economics Working Paper No. 92, National University of Ireland, Galway. This paper relates to the results of chapter 7.

A further 2 papers, based on chapters 4 and 7, entitled "*Preservation versus Development on Irish Rivers: Whitewater Kayaking and Hydro Power in Ireland*" (authors Hynes and Hanley) and "*Up the proverbial creek without a paddle: Accounting for variable participant skill levels in recreational demand modelling* (authors Hynes, Hanley and Garvey) have been accepted for publication in Land Use Policy and Environmental and Resource Economics respectively.

There have also been a number of presentations arising from the research in this thesis. Apart from presentations in the Department of Economics at the University of Stirling and the National University of Ireland, Galway (where I was based for much of the duration of the thesis) 2 other major presentations are worth noting. Firstly, a paper based on the clustered RUM results of chapter 7 entitled "Measuring the Welfare Impacts of Recreational Site Changes Using a Random Utility Choice Model" was presented at the Environmental, Energy and Natural Resource Economic Policy Symposium, in the National University of Ireland, Galway, in March 2005. Secondly, a paper based on the results of chapter 6 entitled "*Measuring the opportunity cost of time in recreation demand modelling: an application to a random utility model of whitewater kayaking in Ireland*" was presented at the 14th Annual meeting of the European Association of Environmental and Natural Resource Economists in Bremen, Germany in July 2005. Although many of the aforementioned papers and presentations have joint authorship the work contained in them is solely my own.

1.3 Summary

Since the value of Irish whitewater river resources are potentially high, a careful assessment of the benefits from this scarce resource is essential in the decision about the efficient and sustainable future use of Irish rivers. Understanding the kayakers decision making process when he or she is deciding on a whitewater site to visit and knowing what site attributes are desirable from a whitewater kayaking perspective are also important as it allows managers to plan the provision of suitable amenities at these sites.

In order to assure equal consideration with marketed costs and benefits, it is also necessary to translate the non-market value of whitewater recreation into monetary units. Decision-making processes that involve monetisation of environmental impacts are relatively new in Ireland but hydro scheme opponents, the Irish kayaking community and the county planning agencies are anxious that whitewater loss is valued equally with financial outcomes of any proposed hydro scheme or other proposed developments that are likely to have an impact on the water flow of Irish whitewater rivers. It is these issues that will be addressed in the following chapters.

Chapter 2. Whitewater kayaking and the Conflicts facing Recreational Pursuits on Irish Rivers

The 1990s have seen growing concern amongst the Irish kayaking and canoeing communities at the rapid change to Ireland's whitewater rivers caused by human impacts. The increased pressure on Ireland's whitewater resources coincides with the success of the Irish economy over the 1990's. The Irish economic boom of the 1990s has attracted enormous attention both at home and abroad. Between 1994 and 1999, per capita income (GNP) grew at an astonishing 7.9% per annum, three times the European average. Unemployment fell from 11% as recently as 1997 to below 5% in early 2001. There are a number of possible explanations given for this growth. The most common are the high levels of foreign investment, the well-educated workforce, huge monetary transfers from the EU and social partnership. The growth rate of income in Ireland over the 1990's significantly exceeded the EU average.

At the same time as Irish income levels were increasing so too was the amount of leisure time available to the average Irish worker. In 1990, the average Irish person worked an average of 1911 hours per year. In 2003 that figure had fallen to 1613 (OECD, 2004). The rapid "Celtic Tiger" economic growth, combined with the increase in leisure time available has led to a substantial increase in the demand for environmental services. Higher water use, hydropower development, algal blooms, catchment changes, the impacts of growing cities and rural housing developments are all a direct result of the massive increase in economic activity in Ireland during the 1990s (Irish Environmental Protection Agency (EPA), 2000). Throughout the course of the 1990s, the volume of industrial production has more than doubled and the country's total primary energy requirement has increased by more than a third. In addition, the total number of vehicles on Irish roads has increased by more than 50 per cent and personal consumption of goods and services has increased by one-third in the five-year period of 1994 to 1999 (EPA, 2000). The director of the Irish Environmental Protection Agency (EPA) warned in the 2000 EPA annual report that "Ireland is in danger of losing the advantage it has of the generally good environmental quality - and will fail to meet its international commitments – unless all economic sectors play their full part in protecting the environment " On the upside, the latest state of the environment report from the EPA in 2004 highlighted that "while the potential pressures on the environment are still growing due to continued strong economic performance....the means to combat them (the pressures) are keeping pace through a widening range of laws and policies" (EPA, 2004).

All the extra pressure on the environment has meant that Irish whitewater rivers that still remain undisturbed and in a relatively natural state are becoming scarcer. In this chapter the values associated with whitewater rivers as a resource, are discussed and a number of conflicts between commercial (and non-commercial) activities and whitewater kayaking recreation on Irish Rivers are analysed. Firstly however, a brief overview is given of the origins of whitewater kayaking and the growth of the sport in Ireland.

2.1. The Origins of Whitewater Kayaking

Whitewater kayaking is a relatively new, dynamic and fast growing sport in Ireland. It is believed that the sport itself started in the United States in the 1930's when it took the step from being a means of livelihood, survival and transport to being a recreational activity (Heath and Arima, 2004). Kayaks were originally developed by the Inuit, the indigenous peoples living in the Arctic regions of North America and Greenland. The word "kayak" itself means "man's boat" which takes account of the fact that kayaks were originally built by the individual who would use them on the water to fish and hunt. The individual would measure the frame for the kayak based on his forearm. According to Heath and Arima (2004) this measurement style confounded early explorers who tried to duplicate the kayak as each kayak was a little different These first kayaks were constructed as a wooden frame covered by an animal skin such as sealskin and were used to hunt on the open waters of the Arctic Ocean.

The sport of kayaking continued with low levels of participation from the 1930s until the 1950s when fibreglass (rather than seal skin and/or wood) was introduced as a construction material, making kayaking accessible to the general public. Prior to the 1930s whitewater rivers in Britain, the U.S and Canada were navigated using canoes rather than kayaks but since the canoe is an open vessel it has a tendency to get swamped in turbulent water. Kayaks on the other hand cannot get swamped as the opening where the kayaker sits is very small and a "spraydeck" prevents any water entering the kayak[2]. This advantage meant that kayaks were bound to become a popular choice for whitewater navigation and recreation once their construction became less laborious with the advent of fibreglass. The 1970's saw the explosion of slalom paddling and since the introduction of plastic boats in the 1980's white water kayaking has become a globally practiced recreational activity.

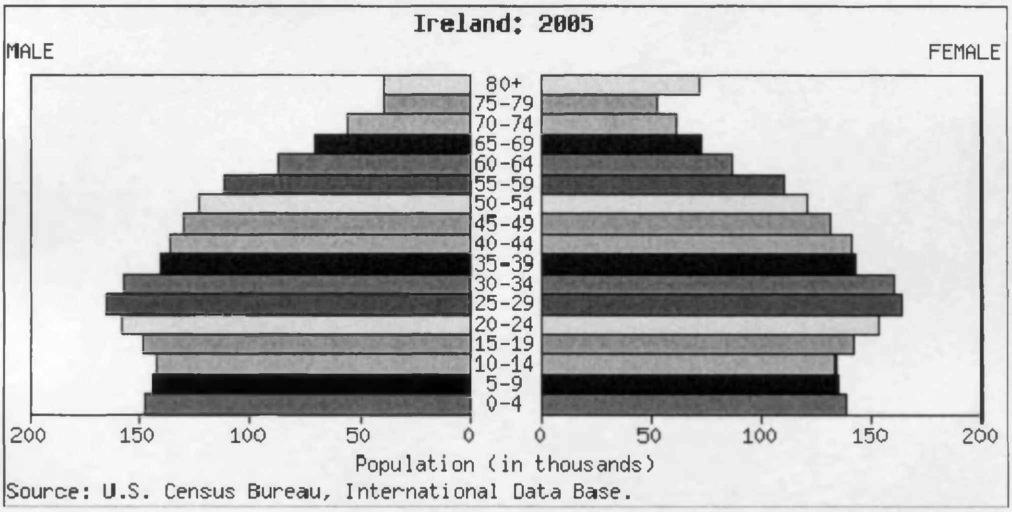
2.2. Whitewater Kayaking in Ireland

The global increase in the popularity of the outdoor pursuit of whitewater kayaking can also be seen in Ireland. As discussed in chapter 1, the rivers of Ireland and the seas around her shores provide excellent possibilities for canoeing and kayaking. Individual canoeists were around for many years in the country but it was only in the late '50s that

[2] A spraydeck consists of a sheet of material (usually neoprene) with an elasticated rim that is worn around the kayaker's waist. The lower rim of the spraydeck covers the opening of the kayak to form a water tight seal which prevents the kayak becoming flooded.

kayaking really started to take off in Ireland. Kayak clubs were formed and soon after, in 1960, a national body for the Republic, the Irish Canoe Union (ICU), was formed. The equivalent body in Northern Ireland is the Canoe Association of Northern Ireland (CANI). Two of the main reasons for the substantial increase in the growth in popularity of outdoor recreational pursuits in Ireland over the last decade are what is referred to as Ireland "demographic dividend" and, as already mentioned in the introduction, increased income levels with the associated increase in the demand for luxury goods and services such as outdoor recreational pursuits.

Figure 2.1. Ireland Population Pyramid for 2005

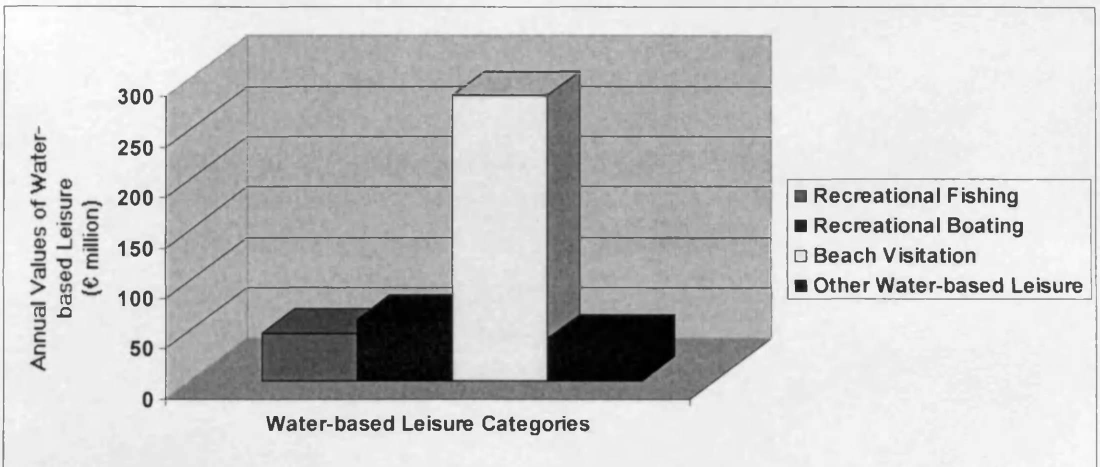


(Source: www.nationmaster.com)

As can be seen from figure 2.1 Ireland has a relatively young population. In fact only 11.5% of the population is currently over the age of 64. The majority of the population is between the ages of 15 and 64 (67.5%) while the other 21% are under the age of 15. This is in sharp contrast to the early eighties when, due to a difficult economic climate and mass emigration, the age dependency ration stood at 69.6%. It is estimated that there will be no worsening of the demographic situation of Ireland until after 2011. Irelands current young, energetic, relatively wealthy and health consciences population has meant a huge increase in the demand for recreational activities and facilities. It is no surprise therefore that the number of individuals participating in the recreational activity of whitewater kayaking in Ireland has increased so noticeably in the last decade.

Although no study has been carried out previously to investigate the demand for whitewater kayaking in Ireland other studies have been carried out that look at other water based leisure activities. Figure 2.1 depicts the results of one recent study that attempted to estimate the value of water-based recreation in Ireland. The study, completed by the Economic and Social Research Institute (ESRI) for the Irish Marine Institute (Williams and Ryan, 2004), analysed water-based leisure activities in Ireland, including those associated with domestic tourism. At the national level, beach visits were found to be highly valued by Irish residents while recreational fishing, boating and aquatic bird watching were also found to be significant economic activities.

Figure 2.2. Estimated National Annual Values of Water-based Leisure in 2003



(Williams and Ryan, 2004)

For the purpose of the ERSI survey, water sports activity was categorised into four main groups, namely: Water skiing/jet skiing; Surfing/sail boarding; Scuba diving/Snorkelling; and "Other Sea Sports". The survey results show both an overall increase in numbers engaging in water sports in general and in the corresponding domestic tourism spend. The report estimated that water sport enthusiasts generated over €35 million in revenue, more than half of which was spent on equipment. A total of 483,200 day trips and 37,000 overnight trips (where the sole purpose of the trip was to undertake a watersport activity) were recorded for 2003.

Over 90 per cent of the total number of overnights attributable to water sports activity were accounted for by those involved in both surfing/sail boarding and scuba diving/snorkelling. As further proof of the growing interest in and awareness of water sports the study found that over 89,000 adults expressed an interest in taking up some water sport activity if facilities improved and a further 9,500 said they would participate more frequently given good facilities. Although this report discussed the demand for water sports in general nowhere in the report is specific mention given to the water sport activity of kayaking.

The present number of whitewater kayakers in Ireland is estimated to be 5000. This figure represents the total number of kayakers that are registered members of the Irish Canoe Union (ICU), the body that represents kayaking interests in Ireland. This figure includes 2500 individually registered members plus an additional estimated 2500 kayakers who are members of the 100 clubs that are registered with the ICU. Not all kayakers are registered with the ICU or an affiliated ICU club so the figure of 5000 can be considered a lower bound estimate of the total whitewater kayaking population in Ireland. An indication of the growth in popularity of the sport is the increasing number of participants on ICU kayak proficiency training courses. Figures from the ICU indicate that participation in these courses has increased by an average of 15% year on year for the 6 years up to and including 2003.

Because of the relatively gentle terrain, Irish whitewater rivers tend to be short in length and "creeky" in character[3]. The average Irish river is much lower volume that the average whitewater river one would find in the United States or mainland Europe but they still offer an exhilarating and technically challenging paddle to kayakers of all proficiency levels. Kayaking on Irish rivers nearly always guarantees solitude, beautiful scenery and in general excellent water quality. Water levels in Irish rivers are directly determined by rainfall. For this reason, winter tends to be the best time of year for whitewater kayaking. Having said that, with the unpredictability of the weather in Ireland there is no definite start or end to the kayaking season.

The annual average amount of rainfall in Ireland is 1100mm. The national average number of rainy days is impressive at 168 (nearly every second day). There is however quite a significant variation in these rainfall figures. As would be expected the localised areas of highest rainfall intensity are the mountains and in particular the western half of the country. Given the mild and wet climate and the rocky terrain all around the edges of the island of Ireland it is not surprising that there are many high quality whitewater rivers available to the whitewater kayaking enthusiast. Neither is it surprising the increasing number of people who are discovering the joys of whitewater paddling in Ireland and how popular the sport of kayaking has become in more resent times.

It is necessary to point out that in Ireland the word "canoe" is used interchangeably to describe both the traditional Canadian canoe, with an open deck (often associated with the American Indians) and the kayak, with closed decks and based on the Inuit design. In Ireland it is the kayak that is most popular, although we usually speak of canoeists. In this thesis we model the demand for closed deck whitewater kayaking only and do not include the handful of individuals in Ireland who participate in whitewater recreation

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[3] A "creeky" river implies a narrow channel, steep in gradient and strewn with boulders.

using an open canoe or rafts. There are, of course special types of each kayak, for flat water, whitewater, surfing, sea kayaking, etc.

2.3. The Value of Whitewater Rivers

From source to ocean, rivers run through and connect our ecological and economic communities. For this reason, river users of all types have long contended that free flowing and conserved whitewater rivers provide a wide variety of benefits to individuals, communities, and society at large. A growing body of international research supports and documents this contention (Porter et al., 2001). Some of the potential benefits of conserved whitewater rivers and whitewater river-related issues that are receiving increased research attention are recreation and tourism experiences, economic impacts and benefits, wildlife habitat, effects on adjacent property values, water quality and in-stream flow (Barmuta et al., 2002). Although this thesis focuses on the recreational value of whitewater rivers, it is important to point out that these rivers are valuable for a host of other (in some cases arguably more important) reasons. The following is a non-exhaustive list of the values associated with whitewater rivers.

Habitat: Whitewater rivers and their catchments are often biologically diverse and productive habitats. They provide habitat for many threatened species of flora and fauna, corridors for wildlife, and refuge habitat for many species in times of drought. For instance, many of the most popular kayaking rivers in Ireland are also famous as salmon and trout spawning grounds, the Roughty and the Boluisce being just two examples.

Ecological systems: Natural river systems are also part of our life support systems, incorporating processes such as nutrient cycling, energy flows, breakdown of toxins, conversion of carbon dioxide to oxygen, recharge of underground water supplies, and water storage.

Conservation: The overall conservation value of whitewater rivers and their catchments derives from their scientific, habitat, ecological and rarity characteristics. Protection of a river system will protect many other inter-related ecological systems and processes as well. Natural whitewater rivers are becoming increasingly scarce on a global scale. As their scarcity increases, their conservation value will also increase.

Water quality protection: Many Irish whitewater rivers supply high quality water for downstream use, including potable water supply, fisheries, aquaculture, and navigation.

Scientific: Whitewater rivers and their catchments can provide baseline data for environmental monitoring and information on the functioning of natural systems. Natural river catchments can provide bio-geographical information, and may contain sites of significance for geology, botany, zoology, archaeology, and other sciences. They also provide a store of genetic stock of the animal and plant species living in them. Whitewater rivers are also important educational resources, particularly for students of the natural sciences. They can be used for learning through field visits, or through recording in print, audio-visual or electronic media.

Intrinsic: Many people believe that species, natural communities and ecosystems have value in their own right, as distinct from having an instrumental value to humans.

Aesthetic: Whitewater rivers have significant aesthetic values to many people because of their characteristics such as waterfalls and boulder gardens, general scenic beauty, solitude, natural or undeveloped qualities.

Social and Cultural: Rivers and river floodplains have long been a focus for human activity (for example, settlement, transport, communications, recreation) and have thus developed significant cultural and social values as a focus for spiritual, political, national or other cultural sentiment.

Historic: Some Irish whitewater rivers and sites on the river floodplains are significant for their association with important eras, battles or events. As a kayaker paddles down the Boyne river for example (one of the rivers analysed in this study), he passes by majestic Slane Castle, the home of The Earl & Countess of Mount Charles. It is renowned worldwide for the annual Rock Concerts held in the natural amphitheatre in front of the Castle. The current Earl, Lord Henry Mount Charles is a direct descendant of the Conynghams, originally a noble Scottish family that first settled in Ireland in 1611. There has been an active association between the Conynghams and the Slane Estate dating back over 300 years, ever since the property was purchased by the family following the Williamite Confiscations in 1701.

Just a couple of miles further down river and about four miles west of Drogheda the kayaker will pass through the site of the Battle of the Boyne, which took place in 1690. No Irish battle is more famous than William III's victory over James II. This battle has had repercussions right up to the present day. Each year hostilities between unionists and republicans in the North of Ireland reach boiling point on the 12th of July when the Orange Order march through the streets to recall King Williams victory.

Recreational: Whitewater rivers and their catchments may be attractive for a number of water-based recreational or tourist activities, including: kayaking, canoeing, rafting, other boating, fishing, swimming, camping, hiking, rock climbing, photography, painting, nature studies, sightseeing, four-wheel driving, picnicking, and hunting. The focus of this thesis is whitewater kayaking recreation but it should be noted that whitewater rivers and their surrounds are of recreational value for a host of other activities, some of which are listed above.[4]

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[4] This thesis concentrates on the recreation value of whitewater kayaking only. Whitewater rivers are generally not valued by kayakers for any endangered species or other highly unique qualities that would make non-use values for the site significant. They are valued for the kayaking experience that the river offers. Of course that kayaking experience is enhanced by the bundle of attributes offered by any given whitewater river. These attributes include things such as scenery, water quality, etc.

Economic: Whitewater rivers, may have economic values for activities including water extraction, mining, forestry and agriculture. A number of Irish whitewater rivers also supply hydro-powered electricity through dams and run of the river hydro schemes. This particular economic activity on Irish rivers will be discussed in greater detail in section 2.4

2.4. The Conflict between Commercial Interests and Recreational Pursuits on Irish Rivers.

At the same time as the sport of kayaking grows in popularity in Ireland, Irish rivers are coming under increasing threat from development of many kinds: pollution and water abstraction from new housing, mining, forestry; hydro-electric schemes; and non-point pollution from farming (Collins, 2000; EPA, 2004; Dunne et al., 2005). The conflicts between the preservation of natural environmental assets such as whitewater rivers and their development have been one of the longest-standing concerns in environmental economics. Early work by Krutilla and Fisher in the late 1960s explored the trade-offs between the market-valued benefits of developments such as hydro power and commercial skiing, relative to the largely non-market benefits of conservation/preservation of sites such as Idaho's Snake River and White Cloud Peaks (Krutilla and Fisher, 1975).

2.5. The Conflict between pollution and water abstraction from new housing, mining, forestry, road construction, non-point pollution from farming and recreational pursuits on Irish rivers.

Disturbances associated with a range of human activities lead directly or indirectly to physical, chemical, or biological impacts that cause a tangible reduction in whitewater river values. In this section, the disturbances that are relevant and impact on the recreational activity of whitewater kayaking is what is of interest. Again, the following list is non-exhaustive of all the possible conflicts that may arise between whitewater kayaking recreation and other entities that have an impact on river systems.

Non-point pollution from farming: Agriculture's contribution to national income remains relatively important in Ireland by EU standards, with agriculture and food processing still accounting for about 8.9% of Gross Domestic Product (GDP) in 2003. Cattle and sheep grazing is the most extensive agricultural and land use activity in Ireland. A high concentration of stock is to be found along Irish river frontages, for water supply and grazing. One potential impact of this agricultural activity from a whitewater recreational point of view is direct contamination of the water. In the broader catchment, reduced vegetation cover due to grazing may lead to greater erosion potential. Accelerated catchment and stream-bank erosion may result in channel widening and alterations to the grade and quality of the whitewater run (O'Grady, 2004).

Baled silage is a popular feedstuff for cattle in Ireland. The illegal dumping of the plastic wrapping from the bales into rivers has been a problem in the past in Ireland, a particularity acute case being the Deel whitewater river in Co. Mayo. With the environmental education of farmers through the Rural Environment Protection Scheme (REPS) and heavier fines being imposed for this type of dumping this aesthetically displeasing activity has been (thankfully) significantly reduced (Emerson and Gilmore, 1999).

Road construction: As the Irish economy has developed there has been a growing consensus that the country needs to greatly improve its relatively basic road infrastructure (Denny and Guiomard, 1997). This view coupled with structural funding from the EU has meant a massive increase in investment on the Irish road network over the 1990s and a 45% increase in public sector funded infrastructure between 2000 and

2004 (Irish Building Industry Directory, 2005). Impacts of roads on whitewater river recreation can include landform disturbance, disturbance of drainage patterns, erosion, siltation, noise pollution and visual intrusion (Robertson, Vang and Brown 1992), all of which will have an effect on the utility of the whitewater kayaker. The significance of the impact will depend on factors such as design of the river crossings, discharge points from drains, level of use, extent and nature of maintenance and time since construction.

Mining Activities: mining activities may cause significant damage, particularly where the river or river valley has been dredged or tailings have been discharged. The potential still exists in Ireland for operating (and non-operating) mines to produce water pollution, which even at low concentrations can exert chronic effects. Such effects include failure of organisms to reproduce and an unusable recreational environment. One example of this conflict situation in Ireland is pollution of the Avoca River by mine water discharging from drainage pipes of abandoned copper and sulphur mines at Avoca, Co. Wicklow, Ireland (Eastern Fisheries Board, 2003). Not only are these discharges aesthetically displeasing, they also pose a significant health risk to kayakers using this river on a regular basis. However, in Ireland there are now stringent mining approval processes which ensure that, if approved, new mining projects are subject to strict environmental management and rehabilitation conditions designed to minimise, amongst other things, pollution of rivers and streams. Licensing of water discharges from mine sites is also now a legislative requirement.

Forestry and housing: Forestry and housing developments are other increasing threats for Irish whitewater sites. The nature and severity of impacts from timber production vary with the stage of the production cycle, topography, logging techniques used and protective measures applied, such as the retention of vegetated buffer strips along drainage lines. Rural housing along whitewater rivers require the same utilities as houses in more urban settings. Pipelines, power transmission lines, telecommunications installations, landfills and sewage systems are an integral part of modern society. Where they are located within a riparian zone[5] or cross a river, impacts can arise from vegetation clearing, associated access tracks, erosion and sedimentation, polluted discharge, and perhaps most relevant for the whitewater kayaking enthusiast, degradation of aesthetic quality.

The Environmental Protection Agency (EPA) produces reports on the quality status of Irish inland waters every year. They estimated that, in the 1998–2000 period, 70 per cent of the total river channels surveyed (13,200 kilometres) was in a satisfactory quality condition, 17 per cent were slightly polluted, 12 per cent were moderately polluted and 1 per cent seriously polluted. This represented a slight improvement compared to the previous two assessment periods, which had shown an increasing spread of slight and moderate pollution and data up to 2002 indicates a reduction in serious pollution levels on Irish inland waterways (McGarrigle *et al.*, 2002).

The Conflict between Hydro-electric Interests and Recreational Pursuits on Irish Rivers.

Hydro-electric schemes are a particularly acute problem from the point of view of whitewater recreational activities as they alter the dynamics of a river. The rise in demand for suitable whitewater sites has coincided with an increasing call on these natural resources for hydro development. The hydropower industry in Ireland has experienced recent strong growth, and this trend is expected to continue, with the emphasis on small-scale run-of-river projects. In the policy document "Renewable Energy: A Strategy for the Future" (1996), targets have been set to secure an additional 13 MW generating capacity from hydropower in Ireland by the year 2010.

[5] A Riparian Zone is the transitional area between the water itself and the surrounding lands. If there is a stream, river, pond, lake, or wetland on a property for even part of the year, it is considered a riparian zone.

The hydro-power available at any site on a river is directly proportional to the fall at that site and to the flow of the river. The quality of a whitewater kayaking site is also directly proportional to the fall and flow at the site. Thus, hydro-electric schemes and whitewater kayaking are in direct hydrological competition. Depending on their mode of operation, hydro-electric schemes are classified as reservoir or run-of-the-river schemes. Run-of-the-river schemes operate in response to the natural variation of river flow: when flow is low, power production is reduced. Because of cost considerations, most recent and planned developments in Ireland are run-of-the-river schemes, employing a low dam or diversion weir of simple construction. This is the mode of operation that has been under consideration for the Roughty river, our case study site in chapter 4.

As a result of the proliferation of small hydro-electric schemes on Irish rivers the number of unspoilt whitewater rivers – rivers with variable and challenging levels of whitewater suitable for kayaking - are being significantly reduced. Table 2.1 highlights the number of rivers in the country that are regarded by the Irish Department of Energy (1985) as having hydro-power potential. Of these 273 rivers, 95 are listed in The Irish Whitewater Guidebook (MacGearailt, 1996) as being of a kayaking quality of grade two or higher.

Table 2.1.The Number of Unspoilt Rivers per County with "Hydro-Power Potential" and the Number of these Rivers that are Classified as Two Star or Higher Whitewater Kayaking Rivers

COUNTY	NO. OF SUITABLE RIVERS	NO. OF THESE RIVERS IN WHITEWATER GUIDEBOOK	COUNTY	NO. OF SUITABLE RIVERS	NO. OF THESE RIVERS IN WHITEWATER GUIDEBOOK
CARLOW	9	2	LONGFORD	3	1
CAVAN	9	4	LOUTH	7	1
CLARE	5	2	MAYO	12	4
CORK	30	5	MEATH	12	3
DONEGAL	29	10	MONAGHAN	8	2
DUBLIN	8	3	OFFALY	5	2
GALWAY	8	5	ROSCOMMON	6	0
KERRY	31	17	SLIGO	11	5
KILDARE	5	2	TIPPERARY	12	3
KILKENNY	9	2	WATERFORD	6	2
LAOIS	5	2	WESTMEATH	5	1
LEITRIM	12	6	WEXFORD	10	1
LIMERICK	7	3	WICKLOW	9	7

Figures adapted from "Small-Scale Hydro-Electric Potential of Ireland" (1985) and "The Irish Whitewater Guidebook" (1996).

Much of the hydropower from small-scale hydro schemes in Ireland is supplied to the Electricity Supply Board (ESB). The growth in utility purchases from private small hydro schemes has increased significantly over the last 20 years. In 1981 3.8GWh of power from this source was supplied to ESB. By 1991 this figure had increased to 22.6GWh and in 2003, 32.4GWh of hydro-electric energy was being purchased by the ESB. Currently there are 16 small hydro-electric schemes in operation on Irish rivers (www.irish-hydro.org).

Some of the hydro-potential outlined in Table 2.1 is being developed through the Alternative Energy Requirement (AER) program - a series of competitions in which prospective renewable energy generators tender for contracts to sell electricity to the ESB. In 1995, 10 proposals for hydropower projects totaling 4 MW capacity were approved under the first of these competitions. The most recent Alternative Energy Requirement competition, AER V, was launched in May 2001 and the results were announced in February, 2002. The target was for 5MW capacity to come from small-scale hydro operations. The main aim of AER V was to ensure that the 500 Megawatt target for renewable based electricity-generating capacity, established in the 1999 Green Paper on Sustainable Energy, was reached by 2005 (Department of the Environment, 1999). To date none of the small hydro scheme projects given the green light under this AER round have gotten off the ground. The reason for this, according to the Irish Hydro Power Association, is that the present maximum price available under the AER is not sufficient for small hydro projects to make a reasonable profit on the investment required. They conclude that improved government policy is required to assist in the development of the remaining small hydro potential in the Republic of Ireland (Miller, 2005).

To make a whitewater kayaking trip worthwhile, a river with numerous rapids with irregular waves and broken water is required. On the other hand, the operation of a small hydro-electric scheme on a river requires only one section of fast flowing water or a single fall of water. For this reason the number of rivers suitable for hydro-electric schemes (273) are far greater than the number suitable for whitewater kayaking. This would seem to suggest that a substantial middle ground is available where hydro electricity and whitewater kayaking can exist without coming into direct conflict. However, in other cases, sites which are attractive from a electricity generation viewpoint will be those most valued by kayakers for recreation.

Of course Ireland is not the only country where the conflicts between the preservation of whitewater resources and their development for hydropower is a major concern. According to the American Whitewater Organisation (AW), "wild river" protection from hydroelectric development is one of the greatest unresolved land management issues in the United States (American Whitewater, 2003). This organisation maintains a complete national inventory of whitewater rivers, monitors threats to those rivers, publishes information on river conservation, provides technical advice to local groups, works with government agencies, and when necessary takes legal action to prevent river abuse. No such organisation exists in Ireland.

Many studies have been carried out in North America that examine this conflict issue. One such study by Daubert and Young (1981) of the Cache la Poudre River in northern Colorado used the contingent valuation method to estimate the value of river flows to recreationalists. The findings indicated that variation in river flows strongly influenced white-water recreation experiences. Lower flow yields resulting from a damming scenario were found to result in less recreational use of the river and lower willingness to pay for recreational uses.

In a more recent case study by Karwacki (2003) the issue of the proposed diversion of the Kipawa River in northwest Quebec from its natural streambed by Hydro-Quebec for the purposes of generating electricity is discussed. Karwacki emphasises that recreational use of white-water habitats, like the Kipawa River are increasingly important engines of economic growth in Canada and around the world and as such need protecting. He also believes that the cost to recreate or simulate a threatened white-water habitat should be factored into the cost of any hydro-project feasibility study. Elsewhere, Norway's national river protection scheme and the complex issues that arise in the debate over natural resource conservation versus economic development in Norway are discussed by Huse (1987). According to Huse, efforts to set aside a number of representative river systems for purposes other than hydropower development have been one of the dominating environmental issues in Norway for many decades.

Recognising the non-market benefits foregone should hydropower development go ahead on a river is essential for efficient management of this potential conflict in the use of this natural resource. Efficient natural resource management would also entail recognising any lost non-use benefits due to development of "wild" rivers for hydropower, since it is the loss in Total Economic Value due to development that is relevant for social cost-benefit analysis. In chapters 5, 6 and 7, the main focus will be on lost recreation benefits and reduced kayaking opportunities brought about by changes in river attributes. It should be stated that the welfare impacts on whitewater kayaking recreationalists from hydro developments is but a small part of the indirect costs of these hydro schemes but it is a part that has received very little attention in the past. This is an issue that will be further addressed in chapter 4.

Other Conflicts facing Whitewater Kayaking on Irish Rivers.

There are a number of other areas where whitewater kayaking comes into conflict on Irish rivers but one of the main ones is with the recreational activity of fishing. We are fortunate in Ireland in that, except for a small number of cases, there is a liberty to navigate any body of water, including whitewater rivers. In contrast, kayakers in England and Wales have public access to only approximately 2% of navigable water. Of course, in Ireland this doesn't mean that the act of access always goes unchallenged. There have been numerous incidents of conflicts between freshwater anglers and kayakers where the fishermen try to prevent kayakers from getting on to the whitewater river.

In contrast to kayaking, angling in Ireland has traditionally been organised around clubs, with individual anglers often being members of more than one club, in order to gain access to different types of fishing. Some anglers believe that in certain situations the presence of kayakers (and other recreational users) can significantly harm the angling experience. Angling clubs in Ireland that restock certain rivers and lakes may also be concerned with protecting the economic value of their investment which, they believe, would be harmed if canoeing and kayaking were to be allowed. One of the most contentious areas between fishermen and kayakers has been this perceived impact of kayakers on fish and fishstocks. In 2000, the British Environment Agency undertook research into this matter using a literature review, a questionnaire survey, and an expert opinion consensus (Pothecary, 2002). The general conclusion was that canoeing and kayaking was not harmful to fish populations and there was no evidence either way that canoes and kayaks disturb fish. In addition, this study found that anglers feel that paddlers have less interest in managing water quality and are largely unaware of the disruption that they cause to angling.

Other conflicts may include landowners objecting to parking, access to the river bank through privately owned land, disturbance to livestock, undressing to don gear, camping, litter and toileting. The first two of these can be discussed in relation to one of the rivers that is analysed in this thesis. In 1999, conflict arose between kayakers on the Boluisce river in Spiddal, Co. Galway and a local farmer who objected to the increased traffic of kayakers putting on to the river through his land. He made complaints to the local police that the kayakers were causing distress to his cattle and were parking in a dangerous manner on the roadside. Matters came to a head in 2000 when the farmer refused to grant permission for kayakers to cross his land to access the upper stretch of the river for a national kayaking competition.

An Irish Canoe Union representative stepped in at this point and negotiated a deal with the farmer. In return for a small monetary fee and a promise that kayaking participants would park on a wider stretch of road approximately 200 meters away from the put-on to the river the farmer agreed to allow kayakers to access the river through his land. This Coasian solution to a Coase type problem (Coase, 1960) has meant that kayakers can still access the upper stretches of the Boluisce river and a National competition is still held there every year.

2.6. Summary

Whitewater kayaking activity in Ireland has grown in recent years, partly due to better equipment lengthening the season and partly due to a greater awareness by the general public of the health benefits accruing from engaging in outdoor pursuits. As mentioned in the introduction to this chapter and section 2.2, rising Irish incomes and the demographic structure of the Irish population are the other main factors driving the growth in the sports popularity. It is therefore starting to make a much more significant contribution to the local economy. Continued strong growth in kayaking could result in diminution of enjoyment for the kayakers themselves through overcrowding on the whitewater runs. However, the more immediate dangers relate to the development of whitewater rivers for their hydro-power potential and the possibility of deteriorating relationships with anglers and adjacent landowners to the river. Fishermen can perceive passing kayakers as interfering with their chance to catch fish. There is also the potential for kayaking activities to disturb wildlife and this can be more pronounced at certain times of year. In order to address these and the other issues raised in this chapter it will be important to have an understanding of what the kayaker is looking for from a kayaking excursion and what the economic value of whitewater kayaking recreation is.

Many water sports utilise facilities or resources that are used for non-recreational purposes and that may also provide a habitat for a wide range of flora and fauna. Whitewater kayaking can easily coexist with other recreational and non-recreational uses and can, in fact, enhance the quality of the environment. For example, kayakers on the Lower Corrib that flows through Galway city have for years provided a pleasant backdrop for adjacent apartments and commercial properties. It must be kept in mind however that whitewater kayaking can also cause damage to the environment; increased usage along rivers can lead to soil and bank erosion and may endanger the flora and fauna that inhabit riverbanks especially at put-ins and take-outs of a river.

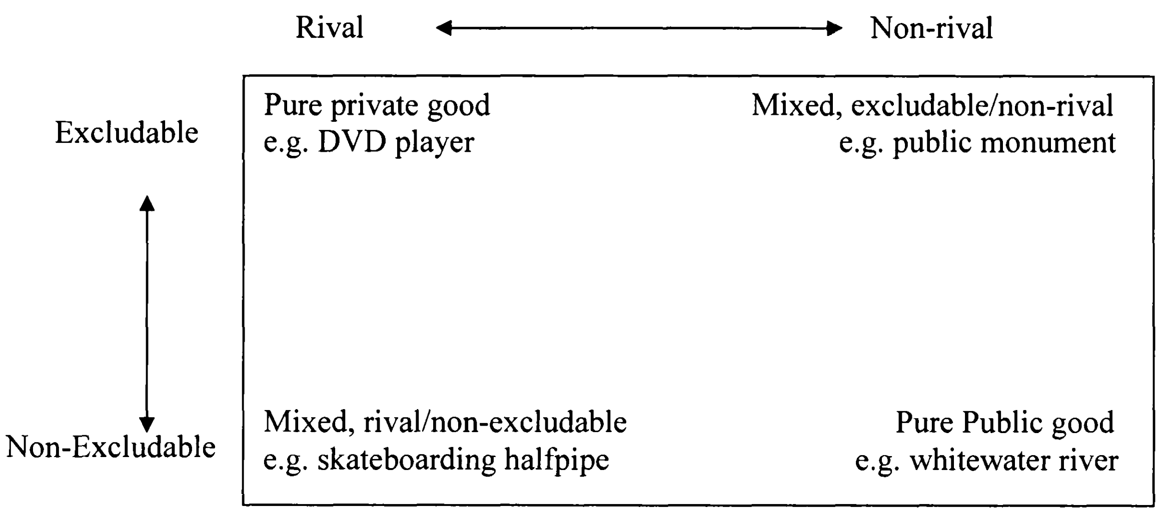
Many of the conflicts discussed in this chapter may increase in the future with the increasing numbers of people participating in the sport of whitewater kayaking. It is for this reason that an objective assessment of the value of whitewater kayaking activity as a form of outdoor recreation should be undertaken. To date no such study has taken place in Ireland. It is hoped that this thesis will fill that gap and be of benefit to policy makers when assessing the costs and benefits of developments on or adjacent to whitewater sites in Ireland.

Chapter 3. The Valuation of Recreational Demand

The valuation of the recreational use of an environmental amenity attempts to estimate the economic value, in monetary terms, which members of society receive from the use of natural resources. These resources cannot be efficiently allocated through markets due to their public good characteristics such as being non-rival (one person's use of a river system to kayak on does not diminish another kayaker's use of the same river, although crowding externalities can complicate this) and non-excludable (once water quality is improved for one kayaker at a particular kayaking site another kayaker cannot be precluded from enjoying this same improved level of water quality). Yet kayaking or canoeing in a river of improved water quality can provide an economic benefit to the kayaker even if a formal market does not exist. It is a benefit for which they would, if they had to, pay some monetary amount, perhaps a riverside parking fee or a kayak launch fee. The fact that they do not have to pay (in most cases) anything, results in the kayaker retaining a ''consumer surplus'' as extra income (Loomis, 2000). Even if a uniform fee was charged for river usage, a consumer surplus would still exist for all but the marginal user.

The problem of measuring the value of the recreational use of environmental amenities has long been of interest to economists due to the way they are demanded. Markets facilitate the allocation of conventional goods because they are, as already mentioned, both excludable and rival (Figure 3.1). In a conventional market situation the price mechanism excludes certain individuals from consuming and given finite availability of most goods one person's consumption may affect another's ability to consume. A public good on the other hand, due to its properties of being non-rival and non-excludable in consumption cannot command a price in a conventional market. Therefore, meaningful measurement of a public good such as whitewater kayaking recreation requires the need for some alternative forms of valuation.

Figure 3.1. Classification of whitewater kayaking recreation.



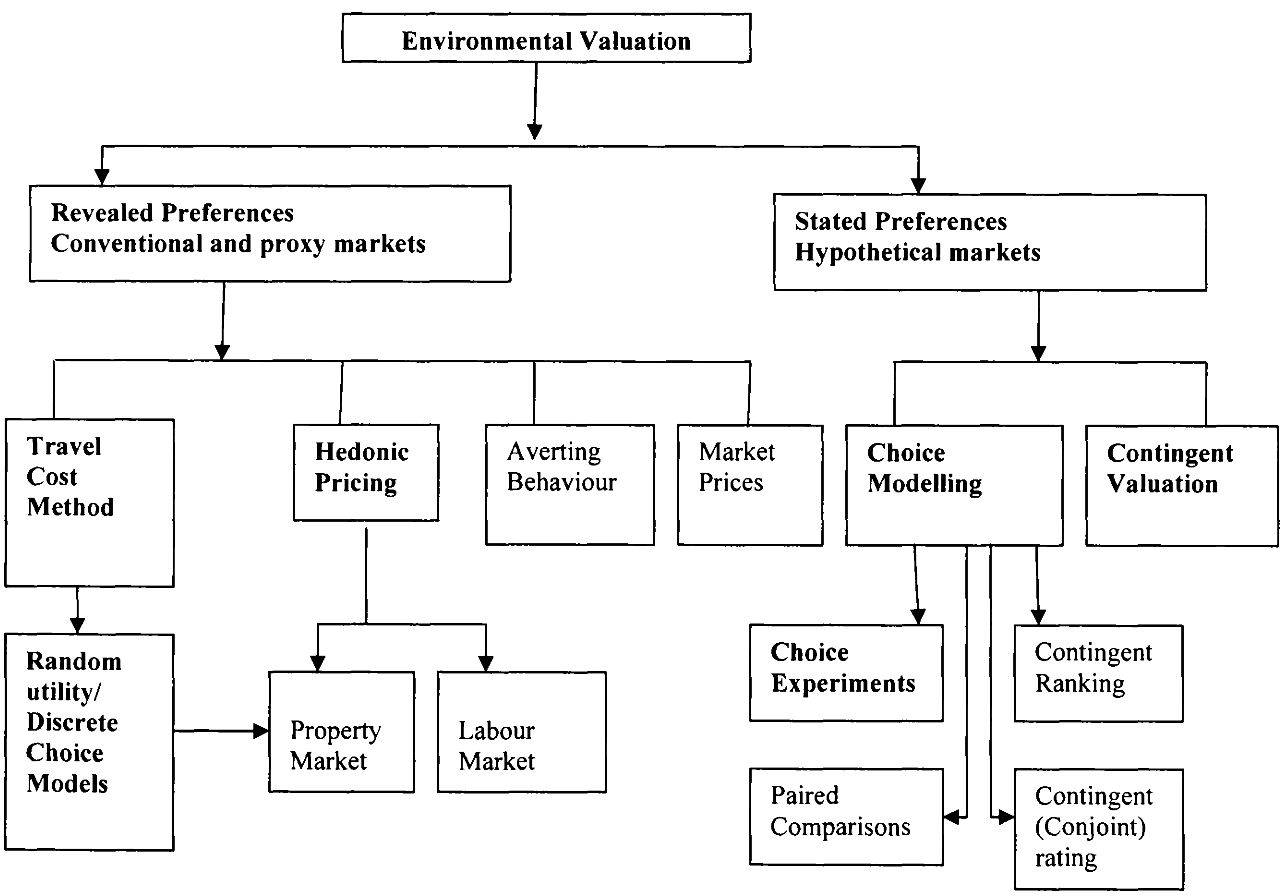
(Source: Whitby, 1997)

Recreation has been widely studied in the past using a variety of non-market valuation techniques. Appendix A provides a short description of 13 different valuation techniques that have been used in the appraisal of environmental resources. The advantages and disadvantages of each method are also presented. In the remainder of this chapter I concentrate on a more limited number of methodologies that could potentially be used to model the demand for whitewater kayaking in Ireland paying particular attention to the actual methodology adopted, the Travel Cost Method.

Methods of valuation are usually categorised into stated and revealed preference approaches. In the former, respondents (usually recreationalists) are asked to directly state their Willingness to Pay (WTP) for recreational opportunities in the context of hypothetical changes in the supply or quantity of these opportunities. Revealed

Preference (RP) models are the main alternative to Stated Preference (SP) techniques for modeling recreation. The RP methods of valuation are based upon data drawn from observations of behaviour in real markets from which inferences may be drawn on the value of a related non-market good. The methodologies most suitable for the modeling of whitewater kayaking in Ireland are shown in Figure 3.2.

Figure 3.2. Classification of environmental valuation methods



Note: Methods in bold type indicate that they are particularly suitable for valuing whitewater kayaking recreation.

3.1. Stated preference techniques

Stated preference methods have two major classes of elicitation techniques that could potentially be used to analyse kayakers preferences for whitewater management. The first type, contingent valuation, measures the value of a change from the status quo to some other state of the world. The second, the Choice Experiment (CE) technique, involves the respondent choosing the preferred option from a number of scenarios in which elements of the attribute bundle describing the good are varied.

3.1.1. The Contingent Valuation Methodology (CVM)

The contingent valuation method, according to Portney (1994), is an economic valuation method that utilises sample surveys or questionnaires to elicit the respondents' willingness to pay for hypothetical projects or programs. The value elicited through this method is dependent on the nature of the hypothetical or simulated market conveyed to the respondents. The CV method normally consists of three major parts namely; (a) the scenario or description of the policy or program by which the good/service is going to be provided; (b) the value elicitation mechanism; and (c) the socio, economic, demographic and environmental factors that could potentially influence the value placed by individuals (Portney, 1994; Mitchell and Carson, 1989).

Many individuals who may never kayak still receive some benefits from just knowing that free flowing whitewater rivers exist (Sanders et al. 1990). The benefits realized by those that never visit the natural environment or never actively participate in on-site use of the whitewater river are known as existence values or non-use values (Olsen et al. 1991). In these cases, many individuals would be willing to pay for the protection of whitewater rivers. These values can be quantified through a hypothetical referendum, where individuals are asked if they would vote in favor of a particular river protection action if it cost them €X. The amount of €X varies across individuals allowing a demand like relationship to be statistically estimated. From this statistical relationship the sample average WTP is calculated. An SP technique such as the contingent valuation method (CVM), which is based on surveys and not actual consumption choices, can be used to value either recreation or existence values. A great many examples exist of the application of the CVM to recreation demand modelling. These include activities such as hunting (Bishop and Heberlain, 1979), boating (Sellar et al., 1985) and kayaking (Munley and Smith, 1976). For a complete literature review of the contingent valuation method and the alternative survey design and econometric approaches used in its implementation see Bockstael et al (2000).

There exists some skepticism regarding the reliability of statements of WTP (Loomis and Walsh, 1997; Hanley et al., 2003). As such, CVM has been subjected to more testing and criticisms than most empirical methods in economics. Nearly every feature of survey design has been tested to determine which approach yields the most reliable results. Summaries of CV studies by different authors reveal that the major criticism of CV studies revolves around two aspects namely (a) validity and (b) reliability (Smith, 1993; Freeman, 1993; NOAA, 1993). In simple terms, validity refers to the "accuracy" and reliability refers to "consistency" or "reproducibility" of the CV results (Kealy et al., 1990). Validity refers to the degree to which the CV method measures the theoretical construct of interest, which is the true economic value of individuals (Freeman, 1993). The reliability of the results of the CV method refers to extent to which the variance of the WTP amounts is due to random sources (Mitchell and Carson, 1989). According to Loomis (1990) "reliability requires that, in repeated measurements, (a) if the true value of the phenomenon has not changed a reliable method should result in the same measurement (given the method's accuracy) and (b) if the true value has changed a reliable method's measurement of it should change accordingly"

3.1.2. The Choice Experiment Methodology

At the same time as CVM was developing other types of stated preference techniques such as choice experiments evolved in both marketing and transport economics (see Louviere, 1993 and Polak and Jones, 1993 for overviews). This technique (some times referred to as the Stated Preference Discrete Choice (SPDC) technique in the literature) has been applied to environmental management problems such as hunting in Canada (Louviere et al. 2000), and rock climbing in Scotland (Hanley et al. 2000). The first study to apply choice experiments to non-market valuation was Adamowicz et al. (1994).

In a choice experiment individuals are given a hypothetical setting and asked to choose their preferred alternative among several alternatives in a choice set. They are usually asked to perform a sequence of such choices. Each alternative is described by a number of attributes or characteristics. A monetary value is included as one of the attributes, along with other attributes of importance, when describing the profile of the alternative presented. Thus, when individuals make their choice, they implicitly make trade-offs between the levels of the attributes in the different alternatives presented in a choice set. Carlsson (2000) gives several reasons for the increased interest in choice experiments. Firstly, it can lead to a reduction of some of the potential biases of CVM. Secondly, more information is elicited from each respondent compared to CVM and thirdly, CE allows for the possibility of testing for internal consistency.

Like contingent valuation, CE techniques applied to whitewater management could gain information about preferences by analyzing responses to hypothetical kayaking trips. Further, CE considers a kayaking trip as a bundle of attributes describing a trip. Using experimental design techniques, kayakers are given trip comparisons that are optimal in the sense that they require the respondent to make tradeoffs across the different trip attributes simultaneously. Therefore, it is possible to examine how preferences for a management measure such as water release limits might change as as environmental conditions change or as the cost of the trip changes. Additionally, new policy-relevant attributes can be examined; for example, kayakers might be asked to consider a trip under the existing management regime and one with a new management tool in place (for example, gear or area restrictions).

Hanley et al. (1998) provide a discussion on the relative merits of the Choice Experiment methodology. They point out that the harsh yes or no response in CVM studies is replaced in CE by a series of choices, which vary by the specification of the separable attributes of the good. The respondent therefore has the opportunity to select those options in which the attributes that conform to his or her preferences are displayed. Also Hanley et al. (1998) contend that the CE technique is sensitive to the scope of the environmental good presented by design. In CE the respondent faces a number of tasks. Each task usually consists of three options, two being variations on the attribute provision of the good and the third a status quo scenario. Because of this setup, Hanley et al. (1998) believe that scope is explicit in CE as the good is presented at two levels of provision in each of the choice tasks.

Although CE is one of the most popular forms of non-market valuation techniques being used by researchers at present it still has a number of drawbacks that need to be considered. Firstly, the repeated dichotomous choice format used in CE raises issues in connection with choice complexity and choice consistency which may be at odds with the economists' assumptions of the behaviour of the respondent (Hyde, 2004). Also Swait and Adamowicz (1996) have found evidence of respondent fatigue and learning effects over repeated choice tasks, which may influence choice making. Respondents may expend increasing effort until the task is learned after which effort is reduced leading to a situation where choice making is no longer conforming to the neo-classical notion of rational, informed decision making. Finally, like contingent valuation, CE is based upon hypothetical, not real behavior. Consequently, questions could again be raised about the veracity of results based upon this type of data.

3.2. Revealed Preference (RP) Techniques

The two principle RP approaches that are utilised to measure the economic benefit that an individual receives from recreation are the Travel Cost Method (TCM) (subcategories of which are the Count Data Model (CDM) and the Random Utility Model (RUM) approach) and the Hedonic Price Method. In both approaches, the demand curve for the non-market good is estimated by observing behaviour in the market for a related good.

3.2.1. The hedonic pricing method

As already mentioned the revealed preference methods basically rely on the information about the individual preferences for the environmental and natural resources that are revealed either through direct market or through surrogate markets. The hedonic pricing method is used to estimate economic values for ecosystem or environmental services that directly affect market prices. It is most commonly applied to variations in housing prices that reflect the value of local environmental attributes. It can be used to estimate economic benefits or costs associated with:

- environmental quality including air pollution, water pollution, or noise
- environmental amenities such as aesthetic views or proximity to recreational sites

The basic premise of the hedonic pricing method is that the price of a marketed good is related to its characteristics or the services it provides. For example, the price of a car reflects the characteristics of that car—transportation, comfort, style, luxury, fuel economy, etc. Therefore, it is possible to value the individual characteristics of a car or other good by looking at how the price people are willing to pay for it changes when the characteristics change.

Noise pollution is a well-known example where the HP method has been employed in the literature (see van Praag and Baarsma, 2005). In general, people would prefer a quiet environment but since no market exists for peace and quiet there is no direct market evidence on how much they value this peace and quiet. However, peace and quiet is implicitly traded in the property market. Individuals can express their preference for a quiet environment through purchasing a house in a quiet area. A measure of the value of peace and quiet could be taken as the extra that is paid for one of two identical houses that is less noisy. This difference is known as a price differential.

The hedonic pricing method is most often used to value environmental amenities that affect the price of residential properties. Whereas this method may be appropriate if the goal of ones research was simply to estimate the value of an improvement in water quality on a whitewater river to the general population, it would be much more difficult to use it to estimate the value of the whitewater river from a recreational point of view. The reason for this is that the property prices in the river catchment area cannot be used as a proxy for the price of whitewater kayaking recreation. Kayaking activity on the river will not be reflected by changes in the value of property along the riverbank. Instead the cost involved to undertake a kayaking trip to the river would be a much more appropriate proxy price to use if the goal of the research is to estimate the value of the whitewater river from a recreational point of view.

3.2.2. The Travel Cost Method (TCM)

- *Weak Complementarity*

Days spent in the pursuit of recreational kayaking do not have a market price, which means that a price must be constructed using an assumption of weak complementarity, which links kayaking activity with marketed goods (see Bockstael and McConnell (1999) and Freeman (1993)). Weak complementarity holds when the individual places no value on the non-marketed good unless they consume some of the marketed goods. To clarify, for a kayaking excursion the marketed goods include the fuel and automobile maintenance required to travel to a kayaking location, the kayaker's time and any entrance fee associated with a site. Weak complementarity implies that if a kayaker does not visit a site (does not consume the marketed goods) then their utility is invariant to changes in the quality of that site[6]. The weak complementarity assumption combined with the assumption that individuals get no utility or disutility from driving, allows one to treat the travel cost as the price of a kayaking trip.

More formally, suppose there exists a utility function where utility depends on the consumption of private market goods and an environmental good E:

$$U = U(X_1 ...., X_j, E)$$

If there exists a commodity X_1 such that U is independent of E if that commodity is not consumed, then that commodity and E are said to be weak complements. This can be shown as:

$$U_E(0, X_2 ...., X_j, E) = 0$$

[6] This excludes so-called \non-use values", which are independent of any observable behavior and measure the value individuals may place on the quality of a location they will never visit.

where U_E is the marginal utility with respect to E. In this expression, X_1 and E are weak complements. When weak complementarity exists, demand models can abstract from E, and assume that utility flows from the consumption of X_1. In a sense, X_1 is a proxy for E. Even though human well-being may not be influenced by X_1, since the consumption of X_1 is systematically related to the consumption of E, for estimating a willingness to pay for E, one can use the "demand" for X_1 instead of the harder to measure "demand" for E. Even when there is a change in the quality, b, of the environmental commodity, E, weak complementarity implies that the utility of individuals who have zero expenditure on X_1, will be unaffected by the change in environmental quality.

$$\frac{\partial U}{\partial b} = 0 | X_1 = 0$$

Therefore under the weak complementarity assumption, the travel cost involved in undertaking a kayaking trip to a river is an ideal proxy price to use to estimate the demand for whitewater kayaking (and/or changes in the demand for whitewater recreation due to changes in the characteristics of whitewater sites).

Travel Cost Methods

The travel cost method is a revealed preference method by which the consumer's preferences for environmental amenities are estimated on the basis of the travel cost incurred in relation to enjoying the benefit of a natural resource. The TCM valuation method known as the Count Data Travel Cost Method (CDM) has been used to estimate the demand for the services of recreation facilities in a wide variety of applications. Examples include Loomis *et al.* (2000) for whale watching; Chakraborty and Keith (2000) for mountain biking; Font (2000) for national park recreation; Curtis (2002) for recreational fishing; Shaw and Jakus (1996) for rock climbing and Hynes and Hanley

(2004) for kayaking. The logic underlying CDM is simple. Taking whitewater kayaking as an example; kayakers at a particular site pay an implicit price for using a river's services through the travel and time costs associated with visiting that particular river. Because kayakers visit a whitewater site from different origins, the relation between differences in implicit price and travel behaviour can be utilized to analyse the demand for the river's services. A kayaker will choose to visit a river if the enjoyment or value of going to that river is at least as high as the travel expense and the opportunity cost of the time spent traveling.

Many of the papers mentioned in the previous paragraph that demonstrate the use of CDM use either a Poisson or Negative Binomial estimation procedure. In these models the number of trips is assumed to be a function of travel costs and characteristics of the recreationalist. These single choice models are relatively easy to construct but oversimplify the choice problem. The major flaws of CDM are its inability to adequately account for substitution among alternative recreational sites and its inability to determine the importance of individual site characteristics. An attempt to compensate for these deficiencies involves estimating multiple-site choice models, which use a series of demand equations to estimate the number of trips taken to alternative sites (Cameron and James, 1987; Morey et al., 1991). However, as Sanderfur et al. (1996) point out, this approach has a number of drawbacks. Firstly these models are difficult to estimate if there are more than five or six sites. Secondly, as with single site models, multiple site models can only estimate a value for the trip as a whole, not the value for an improvement of one specific characteristic of the site.

The other Travel Cost approach, the RUM or random utility site choice (RUSC) model has been developed from earlier single and multiple-site count data travel costs approaches. In the RUM model, recreationalists choices over sites are modelled as being dependent on site attributes (one of which is price), plus an error term. The crucial difference of the RUM model compared to the simple count data approach is that the data is taken from actual choices, using information on which sites respondents have visited over some time period, how far/long it takes them to reach these sites, and other physical attributes of the sites. In comparison to the simpler CDM models this approach takes a more realistic view of the decision making process involved in choosing for example which particular river in a predetermined geographical location a kayaker will visit. A RUM model does not attempt to predict the actual number of trips that a kayaker will take to a whitewater site. Instead, a RUM model estimates the probability that an individual will choose to visit a given river, depending on the characteristics of that river and the characteristics of possible alternative whitewater sites. The better the characteristics of a whitewater site, the higher the probability that the kayaker will choose that site to kayak at and thus the higher the value of the site will be. Using these probability values and the utility level associated with each site it is still possible to calculate the consumer surplus per kayaker associated with changes in access to alternative sites or to site qualities.

For a single whitewater river, which has few potential substitutes, the Count Data TCM is attractive because it is a relatively simple and cost-effective approach. To analyse the demand for whitewater recreation at a number of alternative substitutable sites the Random Utility Site Choice model may be more appropriate. Kayakers' willingness to pay to paddle on the river can be estimated based on the number of trips that they make at different travel costs. This is analogous to estimating peoples' willingness to pay for a marketed good based on the quantity demanded at different prices. Travel cost and experience are expected to reveal themselves as being the critical driving factors behind the demand for whitewater kayaking trips. Demographic factors such as gender and age generally have less dramatic impacts on demand but can be important in explaining why different groups respond differently to changes in price or income (McKean and Taylor, 2000).

Figure 3.3. Kayaking Demand for Kayaker i.

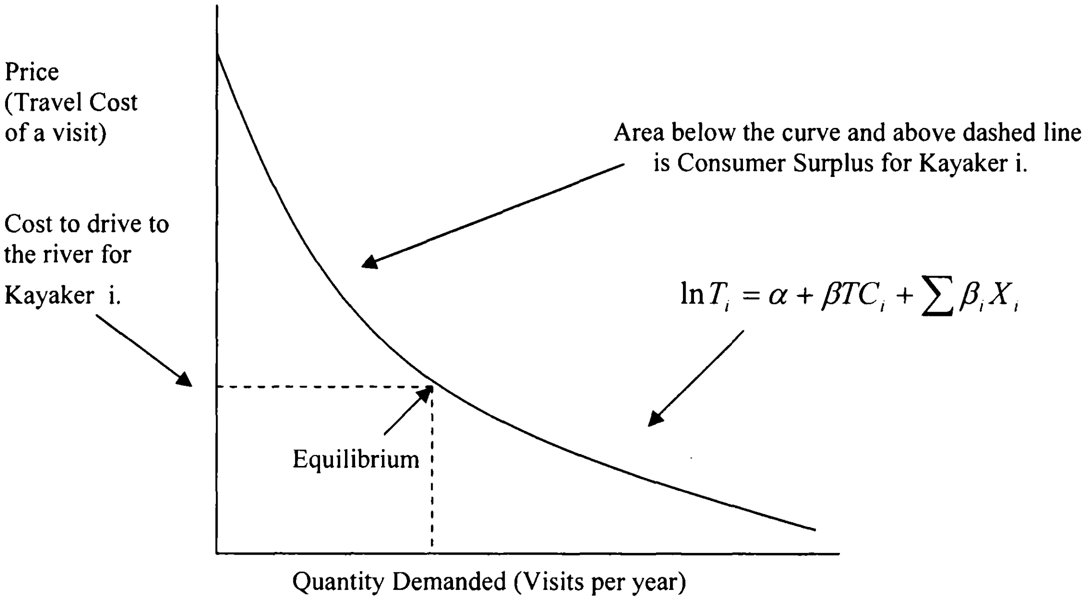


Figure 3.3 describes the demand by a typical kayaker for whitewater recreation. Whitewater recreation demand is negatively sloped indicating that a higher cost or price to visit the recreation site will reduce recreation visits per year. The vertical distance between the kayaker's demand for recreation and the cost of a recreation trip is the net benefit or consumer surplus obtained from a recreation trip. The demand curve shows what the kayaker would be willing-to-pay for various amounts of recreation trips and the horizontal line is their actual cost of a trip. The statistical demand equation that describes this curve is given by:

$$\ln T_i = \alpha + \beta TC_i + \sum \beta_i X_i \tag{3.1}$$

where T is the number of whitewater kayaking trips demanded per kayaker per year, TC is the travel cost per trip, X_i are the series of socioeconomic, skill, and experience variables, and α, β and β_i are coefficients associated with the constant, travel cost, and other non-travel cost variables respectively.

As more recreation trips per year are taken, the benefits per trip decline until the marginal benefit (added satisfaction to the consumer) from an additional trip equals its cost where cost and demand intersect. The kayaker does not make any more visits to the river because the money value to this kayaker of the added satisfaction from another recreation trip is less than the trip cost. The equilibrium number of visits per year chosen by the kayaker is at the intersection of the demand curve and the horizontal travel cost line. Each kayaker has a unique demand curve reflecting how much satisfaction they gain from recreating at the river, their free time available for outdoor recreation, the distance to alternate comparable recreation sites and other factors that determine their likes and dislikes. The critical exogenous variable in the travel cost model is the cost of travel from home to the recreation site (Commons, 1996). Each kayaker has a different travel cost (price) for a recreation trip from home to the river. The distance traveled by each kayaker from home to river and back again multiplied by the cost of fuel is the proxy that is taken for this price.

Variation among kayakers in travel cost from home to recreation site (i.e., price variation) creates the river site-demand function shown in Figure 3.3. Non-monetary factors, such as obligation free time and relative importance of kayaking as an individuals outdoor pastime will also affect the number of river visits per year. The statistical demand curve should incorporate all the factors which affect kayakers' willingness-to-pay for whitewater recreation at the river. The goal of the travel cost demand analysis is to empirically measure the triangular area in Figure 3.3, which is the annual net euro value of satisfaction received or kayaker willingness-to-pay in excess of the costs of the recreation trips. The estimated average net economic value per trip (consumer surplus per trip), derived from the travel cost model, can be multiplied by the total recreation trips from home to the river in a year to find annual net benefits of the river for whitewater recreation.

In summary, each price level along a down-sloping demand curve shows the marginal benefit or kayaker willingness-to-pay for that corresponding output level (number of recreation trips consumed). The gross economic value (total willingness-to-pay) of the whitewater kayaking recreation output of the whitewater site is shown by the area under the statistical demand function. The annual net economic value (consumer surplus) of recreation is found by subtracting the sum of the participants travel costs from the sum of their benefit estimates. This is equivalent to summing the consumer surplus triangles for all kayakers at the river. The econometric model, which is based upon the statistical whitewater recreation demand function, will provide a coefficient for the travel cost variable that can then be used to calculate the consumer surplus values associated with whitewater recreation.

3.2.2.1. Count Data Travel Cost Model

For single site analysis, a count data travel cost model would usually be employed as the econometric model of choice. Count Data models are typically estimated based on either the Poisson or negative binomial distributions. Such an approach is consistent with the discrete nature of the dependent variable, the annual number of trips, which is the focus of the TCM. The number of trips taken in any given year is reported as a discrete, non-negative integer value. Thus, application of the standard distributional assumptions (e.g., normality) is inappropriate because the dependent variable in the TCM cannot take on a continuous range of values. This is evident from the histogram in

Chapter 4 (Figure 4.2) where it can be seen that a discrete probability distribution will result in a better model specification.

Following the work of Creel and Loomis (1990), Grogger and Carson (1991), and Gomez and Ozuna (1993), the most preferred count data model in the revealed preference travel cost literature is estimated under the assumption that the observed number of trips can be described by a negative binomial distribution. This count data distribution is a generalization of the Poisson distribution. The Poisson model has been criticised because of its implicit assumption that the conditional mean of T_i (in this case the expected number of trips to the river demanded) equal the variance (Greene, 1993). This mean-variance equality has proven problematic in applied work since real data frequently exhibits "overdisperion"; that is where the conditional variance is greater than the conditional mean.

For kayaking trips, one event increases the likelihood of another depending on the distance from the river; this is an example of positive contagion. This may result in a greater number of higher and lower counts. Positive contagion increases the variance of the observed counts (overdispersion). But, for the Poisson, E(T) must be equal to Var (T). So, if a Poisson model were fitted to the kayaking data, it would be imposing the mean-variance equality restriction on the estimation. It would effectively be requiring the variance to be less than it really is. As a result, the true variability in the data will be underestimated. This will lead to an underestimation of the standard errors, and thereby an overestimation of the degree of precision in the coefficients (Cameron and Trivedi, 1986).

Shaw (1988) was the first to recognise the non-negative integers, truncation and endogenous stratification nature of on-site sampling recreation data characteristics (expanded upon below) and to assume that the use of common regression linear methods with this type of data sample generate inefficient, biased, and inconsistent estimations. He developed a standard basic Poisson model that corrected for the sampling problems. The basic Poisson model captures the discrete and nonnegative nature of the dependent recreation demand variable and allows inference on the probability of visits occurrence. However the Poisson model estimators are biased downward and Marshallian's CS as calculated by equation 4.13 will be overstated in the presence of over dispersion, a very frequent statistical phenomenon in real data. If the population is over dispersed and the conditional mean is correctly specified as the true mean of the data generating process then the untruncated Poisson model will give consistent estimates of the parameters but downwardly biased estimates of their standard errors (Grogger and Carson, 1984). The truncated Poisson is biased and inconsistent in the presence of overdispersion and similarly the standard Poisson is biased and inconsistent when applied to a truncated sample since the conditional mean is misspecified. As Creel and Loomis (1990) point out the fact that both estimators are inconsistent if the sample is truncated and over dispersed makes the truncated negative binomial estimator an attractive generalization if these conditions are present.

The standard negative binomial model corrects for over dispersion, by allowing the conditional variance to be different from the mean (Grogger and Carson 1991). Subsequent work has extended Shaw's application to include the truncated Poisson model and truncated Negative Binomial distribution as standard poisson and negative binomial estimators are biased and inconsistent in the presence of truncation because the mean function of the count data model is misspecified (Creel and Loomis 1990; Grogger and Carson 1991).

The generalization of the Poisson distribution most often used in the literature on count data models for recreational demand is, as already mentioned, the negative binomial probability distribution (Grogger and Carson, 1991; Englin and Shonkwiler, 1995;

Curtis, 2002) where an individual, unobserved effect is introduced into the conditional mean. This probability distribution, used to develop the negative binomial TCM can be written as:

$$\Pr(T_i) = f(T_i) = \frac{\Gamma(T_i + 1/\alpha)}{\Gamma(T_i + 1)\Gamma(1/\alpha)}(\alpha\lambda_i)^{y_i}(1 + \alpha\lambda_i)^{-(T_i + 1/\alpha)} \qquad (3.2)$$

where there are i = 1, 2, ..., n observations, T_i is the number of trips to the river for individual i and λ_i is some underlying rate at which the number of trips occur, such that we'd expect some number of trips in a particular year i.e. the mean of the random variable T_i ($E(T_i | X_i)$) is given by λ_i and $\lambda_i = \exp(X_i`\beta)$. The exp is an exponential link function that is used to allow the mean to vary according to the set of independent variables. The variance of y_i ($var(T_i | X_i)$) is given by $\lambda_i(1 + \alpha\lambda_i)$.

The vector X_i represents the set of explanatory variables reported for each individual i. It is a 1 by k vector of observed covariates and β is a k by 1 vector of unknown parameters to be estimated. The scaler α and the vector β are parameters to be estimated from the observed sample. Γ in equation (2) indicates the gamma function that distributes λ_i as a gamma random variable. Finally α is a nuisance parameter to be estimated along with β. Larger values of α correspond to greater amounts of overdispersion. The model reduces to the Poisson when $\alpha = 0$ as $E(T_i | X_i)$ is again equal to $var(T_i | X_i)$).

Exclusion of individuals who chose not to make a trip, i.e. only sampling people on-site, implies that the data have been systematically truncated. If this truncation is not recognized, the resulting parameter estimates will be biased. Moreover, this bias will extend to the estimates of consumer surplus that are derived from these parameters. To avoid this problem, one must modify the negative binomial distribution to reflect the fact that T_i is only observed when $T_i > 0$. Following Grogger and Carson (1991), the negative binomial probability distribution is adjusted to account for truncated counts. This probability model can be written as:

$$\Pr(T_i) = f(T_i) = \frac{\Gamma(T_i + 1/\alpha)}{\Gamma(T_i + 1)\Gamma(1/\alpha)}(\alpha\lambda_i)^{T_i}(1 + \alpha\lambda_i)^{-(T_i + 1/\alpha)}[1 - f(0)]^{-1} \qquad (3.3)$$

The truncated probability function differs from the standard probability function by the factor $[1 - f(0)]^{-1}$. Since $f(0)<1$, multiplication of the usual probabilities by $[1 - f(0)]^{-1}$ inflates them, accounting for the unobserved zeros. A truncated Poisson distribution can also be used to model the data generating process that underlies the discrete, nonzero values observed in the sample. Although this model can be somewhat easier to estimate, it once again imposes the restriction that the conditional mean of the dependent variable, λ, is equal to the conditional variance. An unbiased estimator with sample selection and truncation is the Poisson if one uses (trips -1) as the dependent variable. The truncated negative binomial distribution count data model is used in chapter 4 to estimate the demand for whitewater kayaking on the single site study whitewater site, the Roughty river.

3.2.2.2. The Random Utility Model (RUM)

The Random Utility Model (RUM) or random utility site choice (RUSC) model has developed from earlier single and multiple-site count data travel costs approaches. In the RUM model, recreationalists choices over sites are modeled as being dependent on site attributes (one of which is travel costs as a proxy for price), plus an error term. A RUM model estimates the probability that an individual will choose to visit a given river depending on the characteristics of that river and the characteristics of possible alternative whitewater sites. The higher the utility associated with the characteristics of a whitewater site, the higher the probability that the kayaker will choose that site to kayak at and thus the higher the value of the site will be. Using these probability values and the utility level associated with each site it is still possible to calculate the consumer surplus per kayaker associated with alternative sites and with changes in their qualities.

There are numerous examples where the RUM model has been used to analyse the demand for water based recreational amenities; for example, McConnell and Strand (1994) for Atlantic Sports fishing, Parsons and Massey (2003) for beach recreation, Siderelis et al. (1995) for boating and Kaoru and Smith (1995) for saltwater fishing. All of these studies however fail to take account of varying skill levels amongst participants. An early solution to this problem was to interact specific individual variables, such as income or race, with various choice attributes (Adamowicz et al. 1997). Smith (2000) points out that only McConnell et al. (1990) and Adamowicz (1994) have developed formal treatments similar to the habit/addiction models associated with Becker and Murphy (1988). Most other applications have confined their attention to incorporating the years of experience or proficiency level as a determinant of current recreation demand or site choice. One study by Shaw and Jakus (1996), of rock climbing, indicated that general participation, site choice and the amount of use were influenced by the recreationists' ability.

In chapters 6 and 7, the Random Utility Site Choice (RUSC) or Random Utility Model (RUM) approach, first put forward by Bockstael et al. (1986) and later developed by Yen and Adamowicz (1994), is used to model the kayakers' decision-making process in terms of choices over alternative or substitute whitewater sites. Modelling recreation demand with random utility models assumes site selections are made for each choice occasion independently. Choice occasions are single days or weekends and the number of trips is fixed. Because this structure is held constant across individuals neither past history nor future prospects are relevant for models of site decisions. As Smith (1997) points out this has resulted in little attention being given to time constraints in RUM. Of course, using the RUM methodology does not limit the effects of time on actual behavior. Which site to visit on any one choice occasion still involves considering ones opportunity cost of travel time.

The RUM approach models the choice of a recreation site from among a set of alternative sites as a utility-maximizing decision, where utility includes a stochastic component. RUM models emphasize the impact of site quality on recreation demand and are typically estimated using either conditional logit, nested logit or random parameter models (Train, 1998). The consumer chooses from a number of alternatives (e.g. whitewater) sites and picks the one that yields the highest utility level on any given choice occasion. Just like consumer theory assumes that the consumer is rational so does discrete choice theory, the theory on which the RUM model is based (Ben-Akiva and Lerman, 1985). Even though it is possible to derive a demand function from the utility maximisation problem when choices are discrete (Anderson et al., 1989), discrete choice theory usually implies working directly with the indirect utility functions. Assume that a kayaker, *i*, has J possible multi-attribute whitewater sites from which to choose. The model assumes that once kayaker *i* decides on one whitewater site he or she does not care about the quality attributes of the other alternative whitewater sites. The basic choice model for our kayaker is then given by:

$$U_{ij} = V(X_{ij}, y_i - p_{ij}) + \varepsilon_{ij} = V_{ij} + \varepsilon_{ij} \qquad (3.4)$$

U_{ij} is the indirect utility of kayaker i from visiting whitewater site j. $V(.)$ is the deterministic part of the indirect utility function and ε_{ij} is the stochastic part. X_{ij} is a vector of site attributes, y is income and p_{ij} is travel cost. Whenever the utility from visiting site j is greater than the utility from visiting all other sites J, site j will be chosen, i.e. if

$$V(X_{ij}, y - p_{ij}) + \varepsilon_{ij} \geq V(X_{iJ}, y - p_{iJ}) + \varepsilon_{iJ} \quad \forall J \qquad (3.5)$$

then site j will be chosen. The RUM model just described is a utility maximization model attributable to McFadden (1974). Randomness occurs due to omission of explanatory variables, random preferences and errors in measuring the dependent variable. The individual is believed to know her preferences but from the point of view of the investigator, preferences are random variables. The RUM model can be specified in different ways depending on the distribution of the error term. If the error terms are independently and identically drawn from an extreme value type 1 distribution, the RUM model is specified as conditional logit (McFadden, 1974). This implies that the probability of choosing site j is given by:

$$pr_{ij} = \frac{\exp(\mu V_{ij})}{\sum_{k=1}^{J} \exp(\mu V_{iJ})} \qquad (3.6)$$

where pr_{ij} is the probability that site j is chosen and μ is a scale parameter, inversely proportional to the standard deviation of the error distribution.. This specification is known as the conditional logit model. If V_{ij} is written as $V_{ij} = \beta X_{ij}$, where X_{ij} is a vector of characteristics of whitewater site j (parking quality, crowding, star rating, water quality, scenic quality, water reliability and travel costs) and β is the associated parameter vector, then the conditional logit model can be expressed as:

$$pr_{ij} = \frac{\exp(\mu\beta X_{ij})}{\sum_{k=1}^{J} \exp(\mu\beta X_{iJ})} \qquad (3.7)$$

The decision to visit a recreational site, among a number of alternative sites, is mutually exclusive on every choice occasion. Therefore choices can be regarded as discrete, i.e.

the dependent variable takes the value 1 (if a site is chosen) or 0 (otherwise). The model is typically estimated by the method of maximum likelihood. Given the characteristics of the whitewater sites available as options to the kayaker, the model estimates coefficients that maximise the likelihood that one would observe the actual site choices of the sample of kayakers. Once these coefficients have been estimated, the probability of a kayaker choosing any given whitewater kayaking site can be calculated.

The conditional logit model is restricted by the independence of irrelevant alternatives (IIA) assumption (Luce, 1959). IIA assumes that the ratio of probabilities of choosing between 2 alternatives remains constant no matter what happens in the remainder of the choice set. Specifically, the ratio of the probabilities of two alternatives, *j* and *k*, is a function only of the difference in the explanatory variables associated with the two alternatives:

$$\frac{pr(j)}{pr(k)} = \exp[\beta_1(X_j - X_k) + \beta_2(p_j - p_k)] \qquad (3.8)$$

In the recreational context it is often the case that the alternative set violates the IIA property. For example, if the kayaking alternatives available to an individual include a local grade 4 river and a tidal wave, the addition of another whitewater site may not be expected to reduce the probabilities of visiting the first river and tidal wave proportionately, thus producing a violation of the IIA property. The IIA assumption implies that the errors in estimating utility across alternatives are un-correlated. When groups of sites (alternatives) share similar characteristics the IIA assumption is not realistic. The nested multinomial logit model could be used in this case as it allows sites that are similar to form into separate groups (Morey, Rowe and Watson, 1993). Within each group, or nest level, the IIA assumption applies. It does not however apply across nest levels. The error terms in the nested logit model come from a generalised extreme value distribution.

The underlying utility theory allows computation of per trip welfare estimates. Small and Rosen (1981) as well as Hanemann (1982) have described how welfare measures can be obtained from discrete choice models, when the marginal utility of income is assumed constant. Hausmann (1982) used expected utility (V) to estimate the compensating variation associated with a change in prices or quality attributes associated with choices. Thus, measuring a change in welfare associated with a change in some quality attribute in the indirect utility function involves estimating the amount individuals must be compensated to remain at the same utility level as before the change. When there are multiple alternative sites to choose from, the welfare measure involves the expected value (the utility for each alternative times the probability of choosing each alternative) of utility arising from the multiple alternatives. The expected value of the base case is then compared to the expected value of the changed case and the difference is multiplied by 1 over the marginal utility of income to convert the utility difference into a monetary value.

Consider a change in the characteristic b of whitewater site j. The associated change in the consumer surplus per kayaker per trip as measured by compensating variation (CV) can be expressed as:

$$V_j(p_j, b_j^1, y - CV) = V_j(p_j, b_j^0) \tag{3.9}$$

where the superscript 0 (1) denotes the initial (final) level of characteristic b. In the case of a quality improvement, CV is the maximum willingness to pay for the change occurring. The expression for CV is based on the actual utility from visiting site j. The inclusive value index captures the expected utility from visiting the site.

$$IV = \ln\left[\sum \exp(V_j)\right] \quad (3.10)$$

The change in trip utility is converted to money terms by dividing *IV* by the negative of the coefficient on trip cost, β_m. β_m tells us how much a kayaker's site utility would increase if trip cost were to decline for that trip. When the marginal utility of income is constant, the following expression gives a valid measure of the compensating variation (CV) for a change in the characteristics or attributes of one or several of the whitewater sites:

$$CV = -1/\beta_m \left[\ln\left[\sum_i \exp(V_i^1(b_i^1))\right] - \ln\left[\sum_i \exp(V_i^0(b_i^0))\right]\right] \quad (3.11)$$

The above expression can be interpreted as the expected CV for a choice occasion, i.e. the CV for taking a whitewater kayaking trip after a change has occurred in the underlying attributes. In application, the expected value for the change in trip utility is used because its actual value is random and unknown to the researcher. Hanemann (1984) has shown that the marginal utility of income, β_m is equal to the negative of the coefficient of travel cost for a linear in income travel cost model. Thus, the estimated coefficient for travel cost can be used in the calculation of CV. The relative value of each of the expected utilities (V), when different levels of the attributes are included, gives an estimate of the support that each attribute would generate. The value of a marginal change in any of the attributes can be expressed as the ratio of coefficients given in the estimation of (3.7), where β_C is the coefficient on any of the attributes. These ratios are often known as implicit prices:

$$CV = \frac{-\beta_C}{\beta_m} \quad (3.12)$$

3.3. The treatment of travel cost and the opportunity cost of travel time

The standard method of calculating travel cost in recreational demand studies is to multiply the distance to the different sites with a per kilometre price, usually calculated on the basis of marginal vehicle operating costs, petrol price, etc. To this cost, a cost taking into account the opportunity cost of leisure time is often added. Despite the difficulty of extrapolating the simple flexible leisure/work model to many individuals in a recreation data set, the most common practice in the treatment of the opportunity cost of time (in recreational demand modelling) is to value it at the wage rate or some fraction thereof (Train, 1998). There has been and continues to be criticism of this wage-based approach (Smith et al., 1983, Shaw and Feather, 1999), as well as alternative suggestions (e.g. Bockstael et al., 1987 and Feather and Shaw, 1999), but little consensus on how this practice should be replaced.

In much of the travel cost literature the average wage is taken as the upper bound estimate of the opportunity cost of time. According to Parsons et al. (2003), the recreation demand literature has more or less accepted 25% of the hourly wage rate as the lower bound and the full wage as the upper bound. Other approaches have tried to infer values of recreation time from market data in the recreation context (Bockstael et al., 1987); whilst it is also possible to estimate the best-fitting fraction for use in a particular data set (Bateman et al., 1996).

Feather and Shaw (1999) estimate the shadow wage using contingent behavior questions about respondents' willingness to work additional hours. Lew and Larson (2005) followed a similar approach to Feather and Shaw (1999) and used the information to calculate the probability of observing an individual choosing a given recreational site conditional on the probability that the individual falls into a specific labour class. A joint recreational demand model was then estimated by maximizing the product of the likelihood functions for the recreational site choice and the labour supply model. Englin and Shonkwiler (1995) treat the various determinants of site visitation costs as components of a latent variable, which is estimated using distance converted to money travel costs, travel time, and the wages lost in travel as indicator variables.

Both Feather and Shaw's (1999) and Englin and Shonkwiler's (1995) approaches find results close to the simpler strategy of valuing the opportunity cost of time as some fraction of the average industrial wage. With Englin and Shonkwiler, the estimates for opportunity cost of time are close to one-third of the wage rate. For Feather and Shaw the shadow values are closer to the market wage. However both of these approaches are hard to implement in the field. One of the main advantages of the approach developed in chapter 6 for measuring the opportunity cost of time in recreational demand studies is the ease with which it can be implemented. Although, as can be seen from the review above, some progress has been made in estimating individual's opportunity costs of time, Phaneuf and Smith (2004) point out that a compelling replacement for the somewhat dubious strategies that dominate most recreation demand applications is still lacking. In chapter 6 a useful, more reliable framework is presented that researchers can use in future travel cost studies to measure the opportunity cost of leisure time.

3.4. Heterogeneity of Preferences in Water Based Recreational Studies

There are numerous examples where the Random Utility Model (RUM) has been used to analyse the demand for water based recreational amenities; McConnell and Strand (1994) for Atlantic sports fishing, Parsons et al. (2003) for beach recreation, Hynes et al. (2005) for kayaking; Siderelis et al. (1995) for boating and Kaoru and Smith (1995) for saltwater fishing. All of these studies, however, make the assumption that preferences are homogenous across individuals. An early solution to this problem was to interact specific individual variables, such as income or race, with various choice attributes (Adamowicz et al., 1997) or with alternative specific constants. In this manner, heterogeneity was introduced into the basic RUM framework.

Pollack and Wales (1992) summarize this method of using demand parameters interacted with demographic variables. However, as Boxall and Adamowicz (2002) point out, this method is limited in practice because it requires prior knowledge regarding which individual and choice variables to interact in order to distinguish groups with similar preferences. A similar information requirement is involved with another alternative: that of specifying separate MNL models for different groups of recreationalists. For instance, Hanley et al (2000) estimate separate MNL models for summer and winter rock-climbers in Scotland. Hanley et al.'s (2000) approach is implemented in chapter 7 where the sample of whitewater kayakers is separated into two exogenously identifiable groups (based on their skill level) and separate conditional logits are run for each group. This takes into account the fact that kayakers of different skill levels are looking for different characteristics from the whitewater site they choose to visit. However, it should be noted that no objective means exist for knowing whether the sub-divisions imposed by the researcher are the most appropriate given the (unknown) variability in tastes of the sample of recreationalists.

An alternative modelling approach to the basic RUM that allows preferences to vary across respondents with equivalent characteristics is Train's (1998) Random Parameter Logit (RPL) approach. Examples for water-based recreation include studies on Atlantic salmon fishing (Breffle and Morey, 2000), fishing site choice in Montana (Train 1998) and participation and site choice in the Wisconsin Great Lakes region (Phaneuf et al., 1998). Both the Train and Phaneuf et al. studies find that randomizing parameters significantly improves model fit and significantly affects consumer surplus estimates for changes in environmental quality. RPL has also been applied to choice experiments to model demand for a wide array of environmental amenities other than water based ones.

These include rock climbing (Hanley et al., 2001) and Hearne and Salinas (2002) for eco-tourism development.

Another literature investigating heterogeneity that has emerged in the field of recreation demand discrete-choice modeling in the last decade includes latent constructs based on individual attitudes and perceptions. McFadden (1986) initiated work in this area to develop market forecasts. Ben-Akiva *et al.* (1997), Provencher et al. (2002) and Boxall and Adamowicz (2002) are some of the first applications of latent-class models in environmental economics. Provencher et al. (2002) is a latent-class model of site-choice estimated with choice data. The Boxall and Adamowicz (2002) latent-class model is estimated with both attitudinal and choice data. Their model assumes that the probability that an individual belongs to class *c* is a function of his or her answers to the attitudinal questions. This is very similar to the strategy adopted here. Their analysis supported the existence of four classes with homogeneous preferences and consequently affords a much richer interpretation than a conventional multinomial logit model.

A more recent application of the Latent class model in a water based recreation setting is an application by Morey et al. (2003) to preferences over the fishing characteristics of Green Bay, Wisconsin. Their results indicate that Green Bay anglers divide into a small number of distinct groups with respect to preferences over the characteristics of Green Bay and that the probability of belonging to a particular class varies significantly as a function of gender, boat ownership, retirement status, and income. The results allow the authors to broadly characterize each class in terms of their relative preferences over the fishing characteristics of Green Bay such as fish consumption and catch rates by species.

In a more recent paper by the same authors and again looking at the water based activity of fishing, Morey et al. (2005) employ an Expectation-Maximization estimator on responses to Likert-scaled attitudinal questions to segregate a sample of Great Lakes anglers into two to four attitudinal classes. They once more show how membership probabilities obtained using the latent class modeling techniques can be used to estimate structural random utility models. They also compare results to that of the basic multinomial logit model. In yet another fishing recreational study, Provencher and Bishop (2004) model anglers' decisions of recreation participation and evaluate the models' performance on the basis of out-of-sample forecast accuracy. They find similar results are produced from random parameter and latent class logit specifications.

Other papers that compare the LCM to other modeling methodologies but not in a water based recreational setting include Hensher and Greene (2003b) and Scarpa et al. (2003). Hensher and Greene (2003b) looked at the choice of road types in New Zealand and systematically contrasted the merits of a Random Parameter Logit with those of latent class modeling. They concluded that neither one of the models was superior to the other, although they found strong statistical support for the LCM approach with three preference classes. Scarpa et al. (2003) used LCM analysis as an accessory to a more conventional conditional heterogeneity multinomial logit analysis of the choice of piglet breeds, in an effort to value an indigenous pig breed in Yucatan on a sample of households. They found evidence for two distinct preference classes using membership probability equations including various individual specific co-variates. The methodologies underlying the RPL model and the latent class model are discussed in greater detail in chapter 8.

3.5. Summary

Whitewater rivers provide opportunities for a variety of water-based recreational activities in the same way as other natural areas such as mountains, lakes and forests provide other associated recreational benefits. Although the recreational services supplied by whitewater rivers produce value for the consumers of those services, the measurement of recreational value is complicated by the fact that access to most whitewater rivers is non-priced. Because outdoor recreation often competes with commodity uses of rivers, such as hydro-power or mineral extraction, failure to account for the recreational use of whitewater rivers makes it impossible to determine the efficient use of these resources.

Although the recreational benefits of whitewater rivers could be estimated using a number of different valuation techniques it was decided to use the valuation technique known as the travel cost method in this study. Having considered several potential options to estimate the economic value of whitewater kayaking in Ireland (such as choice experiments, contingent valuation and the hedonic price method), which were reviewed above, the travel cost method (TCM) was identified as the most appropriate methodology for estimating consumers' willingness to pay for whitewater kayaking trips and for kayaking in general. The travel cost method was selected for three main reasons:

1. The TCM is well suited for recreational activities, such as kayaking, that require significant travel and attract many participants for repeat visits.

2. Whitewater rivers are primarily valuable to kayakers as recreational sites. There are generally not valued by kayakers for any endangered species or other highly unique qualities that would make non-use values for the site significant.

3. The expenditures for projects to protect natural whitewater rivers are relatively low. Thus, using a relatively inexpensive method like travel cost makes the most sense.

Using survey data collected from individual paddlers, the TCM analyzes the relationship between the costs of travel and the frequency of visits to infer information about the demand for whitewater kayaking. Contingent valuation or contingent choice methods could also have been used in this case. While they might produce more precise estimates of values for specific characteristics of the site and also could capture non-use values, they would be considerably more complicated and expensive to apply. In the following chapters a number of different versions of the travel cost model are used to estimate the demand for whitewater kayaking recreation in Ireland. The model results are then used to look at the impacts on a kayaker's welfare of a number of possible whitewater management changes.

Chapter 4. Modelling Kayaker Participation on the Roughty River

At the outset of this thesis a single site study was carried out to analyse the demand for whitewater recreation on a single river. There were three main reasons for doing this. Firstly and arguably most importantly, the opportunity arose to carry out a quick survey of a group of kayakers who would be in a definite location on a certain date. At the time this survey was being undertaken the Roughty river in Co Kerry was under threat from hydro power development. Since the Roughty is considered by Irish kayakers as one of the classic grade 4 whitewater runs in the country with its huge variety of waterfalls and rapids, there was considerable opposition in the kayaking community to the potential small-scale hydro scheme which would divert the flow of the river and reduce the kayaking potential of the river.

It was for this reason that on the 18th of January 2003 a rally was organised at the river by the Irish Canoe Union (ICU) to highlight the issue. The ICU were also very keen to get their hands on some economic figures in relation to the value of kayaking as an activity. Since a large crowd of whitewater kayakers would be in attendance at the event (and the fact the ICU were behind the survey) I decided to carry out a quick small scale study that would assess the value of the river from a whitewater kayaking perspective. Because of the timeframe involved it was decided to keep the survey short and to focus on kayaker participation rather than the value of potential changes in the rivers characteristics.

The second reason for carrying out the single site study was to allow us to test whether survey data collected via email and an internet kayaking website could be pooled with on-site survey data. It was hoped to use a similar method for the large-scale study as well in order to increase the response rate and save on time and manpower. The single site study should also establish whether the sampling frame and travel cost modelling techniques would be effective in a larger study. Thirdly, the single site study would demonstrate if kayakers were willing to participate in travel cost surveys and was a means of convincing other stakeholders that the main study was worth pursuing and would be supported by this particular recreational group.

It was decided to take the river in county Kerry. This Roughty river was deemed suitable as a single site study site as it was regularly frequented by a large number of kayakers of diverse skill levels. Also, at the time the Roughty was in the media because of strong local (non-kayaker) objections to a proposed hydro-scheme on the river that would greatly reduce the flow on the river affecting fishing, flora and fauna and of course, kayaking[7].

In this chapter the data from the single site study is used to estimate the non-market benefits accruing from the preservation of "natural" river conditions in Ireland, where the development threat comes from investments in new hydroelectric plants. As discussed in chapter 2 such investments are deemed necessary under Irish government targets for increasing the fraction of energy produced from renewable sources. However, hydro developments on some rivers may come at the expense of significant foregone non-market recreation benefits, in terms of the use of "natural" rivers by white-water

[7] Although fishermen led the protests to the hydro-scheme developments on the Roughty, kayakers also held a rally at the river in late February 2003 to protest at the fact that no account was taken by the local county council of the recreational benefits of the river from a kayaking and canoeing perspective.

kayakers. It is therefore the overall aim of this chapter to quantify the non-market costs from a whitewater kayaking perspective of a proposed hydro scheme development on a popular Irish whitewater river, the Roughty, in Co. Kerry using the count data travel cost method.

In what follows, section 4.1 briefly describes the main river under investigation in this study. Section 4.2 briefly outlines the count data travel cost method of valuation and explains the econometric approach taken. Section 4.3 outlines the data source for this single site study and presents summary statistics for the sample dataset. Section 4.4 investigates if the observations from the on-site and on-line surveys can be pooled into one dataset and reviews the empirical estimation process, with particular regard to the zero-truncated negative binomial model. Model results and estimates of consumer surplus from whitewater recreation on the Roughty river are presented in section 4.5. Finally, section 4.6 concludes with a discussion of the policy implications of the results.

4.1. The Roughty River

The river Roughty descends from a high hanging valley in the mountains between Coolea in Cork and Kilgarvan, 10 km east of Kenmare, Co. Kerry. The 6-mile stretch of whitewater below Morley's bridge on the R569, 5 km east of Kilgarvan is the section of the river most often paddled by kayakers. The Roughty runs into Kenmare bay and is one of the few rivers to receive three stars in the Irish Whitewater Guidebook (1996). The Roughty is considered one of the classic grade 4 whitewater runs in the country[8]. It has a huge variety of waterfalls and rapids and is described in The Irish Whitewater

Guidebook as "an excellent paddle with frequent rapids of varying difficulty". At lower levels it is an ideal river to learn on, challenging, yet safe and in flood it becomes a thundering torrent that can test the skill and bravery of the best paddlers.

As discussed in chapter 2, hydro-electric schemes are a particularly acute problem from the point of view of whitewater recreational activities as they alter the dynamics of a river. The hydro-power available at any site on a river and the quality of the kayaking experience at a whitewater site are both directly proportional to the fall and flow at the site. Hydro-electric schemes and whitewater kayaking are therefore in direct hydrological competition. Because of its gradient and the volume of water it carries the Roughty has been considered for development for its hydropower potential. As with most recent and planned developments for hydropower in Ireland, the type of hydro-development considered for the Roughty is a run-of-the-river scheme, employing a low dam or diversion weir of simple construction.

4.2. Choice of Methodology and Model Specification

In this chapter the Travel Cost Model (TCM) method of estimation is used to put a value on the demand for whitewater recreation on the Roughty river. Whitewater kayaking is well suited for the use of the TCM as it is conducted at distinct, identifiable sites and most kayaking trips are single purpose, taken for the sole purpose of recreation at the site (Bergstrom and Cordell, 1991; English and Bowker, 1996; Bowker et al. 1996). Stated preference approaches such as contingent valuation and choice experiments could also be used to estimate the welfare loss to whitewater recreationists from hydro developments. However, these methods are still recognised to be subject to

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[8] Whitewater rivers are graded from 1 to 5, 1 being completely flat, non-moving water to 5 being very fast moving water with many obstacles and potentially very dangerous to kayakers not of the highest skill levels.

hypothetical market bias (Bateman et al, 2002). Using data on actual, rather than stated behaviour, thus has some advantages (see appendix A).

The price faced by whitewater recreationists (in the case of this thesis kayakers) is the cost of access to the recreation site (mainly the time and money costs of travel from home to site), and the quantity demanded per year is the number of recreation trips they make to the Roughty river per year. The count data version of the TCM, which allows for the integer nature of the trips data, has been widely used to estimate demand for recreational amenities (Hanley et al., 2003). Examples include Loomis *et al.* (2000) for whale watching; Chakraborty and Keith (2000) for mountain biking; Font (2000) for national park recreation; Curtis (2002) for recreational fishing; Offenbach and Goodwin (1994) for hunting; and Shaw and Jakus (1996) for rock climbing. No applications have so far been made to whitewater kayaking that this author is aware of.

4.2.1. Poisson and negative binomial distribution models

The number of trips to a whitewater kayaking site taken in any given year is reported as a discrete, non-negative integer value. Following the work of Creel and Loomis (1990), Grogger and Carson (1991) and Gomez and Ozuna (1993), it is assumed that a model of recreational demand can be estimated assuming either a Poisson or a negative binomial distribution for the dependent variable. As discussed in the previous chapter, section 3.2, the Poisson model has been criticised because of its implicit assumption that the conditional mean of T_i (i.e. the expected number of trips to the river per year) is equal to the variance (Greene, 1993). Where the conditional variance is greater than the conditional mean, overdispersion is said to occur (Cameron and Trivedi, 1986).

Take kayakers at the Roughty river for example. The average number of trips taken to the river in one year was 3.24 but the variance was more than double that at 7.27. Those living closest to the river waste no time in checking whether the river is running or not on any particular day. Therefore the number of trips undertaken will be distributed around a lot higher number for these individuals. On the other hand those living further away will only travel to the river if they are reasonably certain of water flow. The count for these individuals will be centered around a relatively low number. This fact suggests that counts of river trips will probably violate the independence assumption, that is the probability of an event occurring is constant within a particular period and independent of other events during the same period.

The Poisson distribution can been generalized to take into account this problem of over dispersion. The generalization most often used in the literature is the negative binomial probability distribution (Grogger and Carson, 1991; Englin and Shonkwiler, 1995; Curtis, 2002) where an individual, unobserved effect is introduced into the conditional mean. This probability distribution, used to develop the current TCM can be written as:

$$\Pr(T_i) = f(T_i) = \frac{\Gamma(T_i + 1/\alpha)}{\Gamma(T_i + 1)\Gamma(1/\alpha)} (\alpha\lambda_i)^{y_i} (1 + \alpha\lambda_i)^{-(T_i + 1/\alpha)} \qquad (4.1)$$

where there are i = 1, 2, …, n observations, T_i is the number of trips to the river for individual i and λ_i is some underlying rate at which the number of trips occur, such that this number of trips would be expected in a particular year i.e. the mean of the random variable T_i ($E(T_i | X_i)$) is given by λ_i and $\lambda_i = \exp(X_i`\beta)$. The variance of y_i ($var(T_i | X_i)$) is given by $\lambda_i(1 + \alpha\lambda_i)$. The vector X_i represents the set of explanatory variables reported for each individual i. It is a 1 by k vector of observed covariates and β is a k by 1 vector of unknown parameters to be estimated. The scaler α and the vector β are parameters to be estimated from the observed sample. Γ in equation (1) indicates the gamma function that distributes λ_i as a gamma random variable. Finally α is a nuisance parameter to be estimated along with β. This parameter is a measure of the ratio of the mean to the variance of the number of kayaking trips taken. Larger values of α correspond to greater amounts of overdispersion. The model reduces to the Poisson when $\alpha = 0$ as $E(T_i | X_i)$ is again equal to $var(T_i | X_i)$).

Problems with the standard poisson and negative binomial distribution models

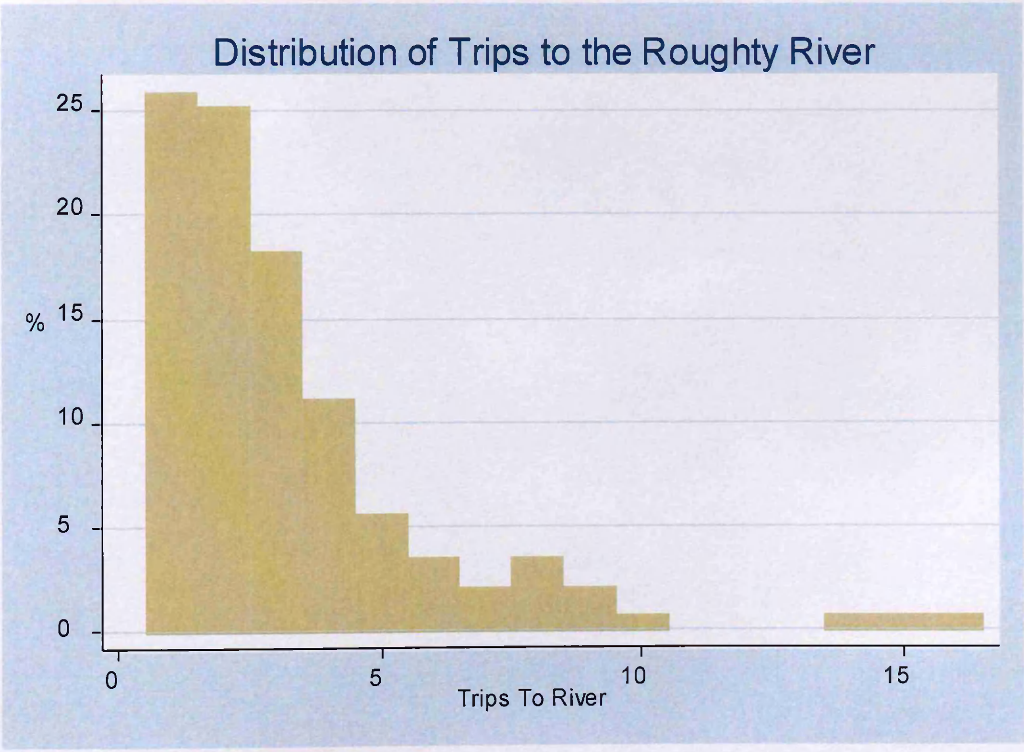
Curtis (2002) points out two possible problems with the standard negative binomial probability distribution, which are relevant for the current study. Firstly, the dataset obtained using on-site sampling contains information on active kayakers only and is therefore truncated at positive demand for kayaking trips (people who take zero trips in the survey period are not observed, even though they may have taken trips in previous years, and may again in the future). Such an occurrence is not uncommon in recreation demand modelling and models to take into account this truncation have been developed (Shaw, 1988).

Secondly, an on-site survey is subject to the problem of endogenous stratification. Due to the method of data collection the likelihood of being sampled depends on the frequency with which an individual visits the river. However, if data from an on-site survey can be pooled with a non-site based survey - in this case, via the internet - then the problem of endogenous stratification may be avoided. Potential solutions to these two problems in relation to the whitewater kayaking dataset are presented in section 4.4.

4.3. Sample characteristics

The data for this analysis was partly collected from a survey distributed to whitewater kayakers in and around the study area on the weekend of the 18^{th} and 19^{th} of February 2003. In addition, the survey was made available on the homepage of the main Irish whitewater kayaking website (www.irishfreestye.com). Kayakers who had used the river in the previous year and who had not already filled out a questionnaire on site were asked to download the questionnaire and return it via email (The questionnaire is contained in Appendix B). A total of 82 surveys were collected at the river, with a further 78 being returned via the internet. Out of a total of 160 returned questionnaires 143 were usable in the analysis. Internet surveys are a useful means of acquiring responses from the general public, although clearly cannot be expected to yield representative samples due to uneven access to the net (Berrens et al, 2004). In Section 5 it is shown that the data collected from the two different sources can be pooled together.

Figure 4.1. Distribution of Whitewater Recreation Trips to the Roughty River



The survey instrument included questions about the frequency and costs of kayaking trips to the Roughty river. Specifically, respondents were asked how many kayaking trips they had taken in the previous 12 months. Focusing on each respondent's most recent trip, additional information was collected about the number of miles traveled, and the time required to complete the trip. Also contained in the survey were questions regarding each kayaker's age, occupational status and income. The question regarding income requested that the respondent indicate which of six categories reflected their before-tax household income. The midpoint of each category was then taken as the best estimate of the respondent's income[9].

Figure 4.1 shows the distribution of trips to the Roughty River in the sample. The average number of trips taken to the river in one year was 3.24 but the variance was more than double that at 7.27, indicating that the dependent variable (trips) was indeed over-dispersed. Table 4.1 summarizes the survey responses for some key variables. A definition of each variable is contained in table 4.2.

Table 4.1.Summary Statistics

Variable	Mean	Std.Dev	Min	Max
Annual Number of Trips to River	3.24	2.70	1	16
Distance Travelled from Home to River	138.37	79.27	15	350
Cost	69.19	39.64	7.5	175
Kayaking Proficiency Level	2.52	0.63	1	3
Discretionary Time (DT) Available	114.33	69.73	12	365
Age	26.00	5.54	16	41
Income	29335.66	23513.84	5000	85000
Experience	7.41	5.14	1	26
Importance of Activity	1.342	0.74	1	4

A definition of each variable is contained in table 4.2.

[9] The questionnaire solicited gross personal income in classes as follows: under €10,000; €10,000 - €19,9994; €30,000 - €49,999; €50,000 - €74,999; €75,000 and over. For the category €75,000 and over, for which there was only 9 observations in the sample, the value of €85,000 was used.

Count data models of recreation demand work by assuming a negative relationship between the costs of trips and the number of trips made to a site. Costs in principle include all the marginal costs of making a visit, comprising both petrol ("out-of-pocket") costs and the costs of travel time. In calculating the travel cost to the Automobile Association (AA) of Ireland's calculations for the marginal costs of motoring for a car of average size of €0.25/mile are used. Lacking adequate data on respondents' labour market situations, any monetary valuation of leisure time in the travel cost calculations is omitted. This likely biases the consumers' surplus estimates downwards (Smith and Kaoru, 1990) so long as people view travel time spend as a cost, rather than a benefit. The issue of how best to measure the opportunity cost of time in recreational demand modeling is an issue that will be addressed in chapter 6.

Table 4.2. Definition of variables

Trips	Annual number of trips from home to the Roughty river (dependent variable).
Miles	Distance traveled from home to the river (one-way)
Cost	Cost of traveling (return journey) to the Roughty river (euros).
Income	Annual income (euros).
Proficiency	Individuals proficiency in handling a kayak, can be basic, intermediate or advanced.
DT	Kayaker's discretionary time available per year (days).
Experience	Kayaker's total number of years kayaking
Age	Age
Importance	Importance of kayaking when ranked against individuals other main interests. 2 indicated kayaking is 2nd most important activity, 3 indicates 3rd most important and 4 indicates that kayaking is just one of many outdoor recreational activities pursued by the respondent.

4.4. Model estimation

Most outdoor pursuits have numerous dedicated websites associated with them. Like-minded recreationists use these sites on a regular basis to communicate with each other and find out the latest news regarding their particular outdoor pursuit. If researchers can use these internet based resources to collect data in conjunction with on site surveys, as was done in this single site study, then not only can the size of the response to a survey be increased with relative ease and at low cost but also the problem of endogenous stratification is reduced by a significant margin. Mehta and Sivadas (1995) set up a study which showed that email could generate high response rates and similar response raters to postal surveys. They also found email surveys to be significantly quicker. They received a half of their email questionnaires within three days compared with three weeks to receive a comparable proportion of postal questionnaires. They found evidence of higher quality of responses and also pointed out the significant cost savings of the method (mainly for convenience of despatch).

4.4.1. Pooling the Datasets

When the observations under study are derived from two different sources (in the current case the on-site survey and the internet based survey, both of which used the same questionnaire), the question arises as to whether or not the datasets can be pooled. To test whether or not the datasets can be pooled a Wald test (Agresti, 1990; Judge et al., 1985) is employed. The Wald statistic is distributed as χ^2 with q degrees of freedom, (where q is the number of variables in the model to be estimated). To test the equality of regression coefficients that are estimated on two different samples one must set up the data and regression model so that one model is nested in a more general model. For example, suppose there are two regressions, one for the on-site dataset and the other for the internet-based sample,

$$y = a1 + b1X \tag{4.2}$$

and

$$t = a2 + b2X \tag{4.3}$$

Firstly, rename t to y and append the second dataset onto the first dataset. Then generate a dummy variable; call it d, which equals 1 if the observation came from the internet dataset and 0 if the data came from the on-site dataset. Next, generate the interaction between x and d, i.e. $w = dX$. Finally, estimate:

$$y = a1 + a2d + b1X + b2w \tag{4.4}$$

One can now test whether $a1$ and $b2$ are separately or jointly zero. This is done using a Wald test. The Wald test is a way of testing the significance of particular explanatory variables in a statistical model. In the whitewater kayaking demand model (the truncated negative binomial model) there is a discrete dependent variable and 11 explanatory variables. For the aforementioned testing procedure there is also 11 dummy variables nested into the more general model. For each explanatory variable in the model there is an associated parameter. The Wald test is one of a number of ways of testing whether the parameters associated with the explanatory variables are zero. If, for the group of dummy explanatory variables, the Wald test is significant, then it can be concluded that the parameters associated with these variables are not significantly different from zero. Therefore the variables should not be included in the model. This would indicate the data from the separate data sources can be pooled. If on the other hand, the Wald test is significantly different from zero then these explanatory variables cannot be omitted from the model. This would indicate that the data from both sources cannot be pooled.

The null hypothesis is:

$$H_0 : Rb = r \tag{4.5}$$

where R is a q x k ($q < k$) matrix of known constants and r is a q x 1 known vector. Testing if the interaction dummy variables are significantly different from zero, i.e.

$r = 0$, is what is relevant in the case of the current dataset.

The Wald statistic is (Judge et al. 1985):

$$W = (Rb - r)'(RVR')^{-1}(Rb - r) \tag{4.6}$$

where the estimated coefficient vector is b and the estimated variance–covariance matrix is V. $Rb = r$ is the set of q linear hypotheses to be tested jointly (the interaction dummies nested into the general model). Given the estimation procedure reports significance levels and confidence intervals using z statistics, the Wald test result is reported using a χ^2 distribution with q degrees of freedom.

$$W \sim \chi^2_q \tag{4.7}$$

Having carried out the testing procedure, a χ^2 statistic (with 10 degrees of freedom[10]), of 15.61 was reported. The significance level associated with the 11 coefficients being zero, is 11.12%. One thus cannot reject the null hypothesis that the two data sets are drawn from the same underlying data generating processes at the 95% level of confidence or at least cannot reject it at any significance level below 11.12%. This indicates that the observations from the two data sources can be pooled.

Assessing the use of the internet and email services in survey collection

The Internet's potential for applied research has recently begun to be acknowledged and assessed. To date, researchers have used Web page-based surveys to study large groups of on-line users and e-mail surveys to study smaller, more homogenous on-line user groups. To date, researchers have used Web page-based surveys to study large groups of on-line users (e.g. Kehoe et al., 1997) and e-mail surveys to study smaller, more homogenous on-line user groups (e.g. Parker, 1992; Smith, 1997). However, it appears that a relatively untapped use for the Internet is to use e-mail to survey broader Internet populations on both a national and international basis and to target specific usr group websites to collect information on a particular group of individuals. This is what was done in this thesis when dedicated kayaking websites and email lists were used to collect survey data on the kayaking population of Ireland.

There are a number of benefits to using on-line survey methods:

1. A web page-based survey can take advantage of the graphic power available through programming languages such as HTML and JavaScript to create an attractive, interesting, and compelling survey that is inviting to respondents.

2. Web page-based surveys have been noted for their ability to generate a high number of responses (Kehoe and Pitkow, 1995). In the single site survey of this chapter approximately half of the total number of surveys collected were from the web-base survey.

3. A high volume of responses can be collected very quickly. For example, in this study 80% of the on-line surveys were returned in the first week. This time factor alone suggests huge benefits over traditional surveying techniques in terms of being able to collect and analyze data quickly, and implement decisions based on the findings.

4. The costs of both data collection and analysis can be greatly reduced by the use of web-based surveys. Outside of high start-up costs for equipment and web page design, the actual implementation of a survey can be almost free, with no costs for paper

[10] The constraint of dummy*y2 was dropped by Stata during the running of the Wald test, hence q is equal

or postage. Data analysis can be simplified by a direct transfer from the form to the analysis software, where limited data cleaning would be necessary (McCullough, 1998).

5. Web page-based surveys allow for anonymity in responses, since the respondent can chose whether to provide his or her name or not. Previous research (Kiesler and Sproull, 1986) has indicated that anonymity may affect response rates positively, as respondents may be more willing to respond without fear that their answers may be identifiable to them.

6. Since respondents type in their answers directly to a form on a web page, there is no need for an interviewer to have contact with the respondents (Schillewaertet al., 1998). Therefore, survey responses will be free from biases caused by interviewers, resulting in cleaner data.

As I discovered through the conducting of the on-line kayaking surveys there are a number of key limitations unique to the internet and e-mail that must be considered when planning an on-line survey. First, researchers must recognize that unsolicited surveys may be considered aggressive by respondents and not in keeping with Internet culture (Mehta and Sivadas, 1995). Minimizing a perception of intrusiveness should help to address this problem. Second, the changing nature of the Internet suggests that it is possible that e-mail addresses may become out-of-date fairly quickly. For the email lists used in the large scale kayaking study over 10% of the email addresses resulted in delivery failures due to those addresses no longer being in use. Addressing this issue early on can prepare the researcher for dealing with delivery failures. Some other limitations that researchers must recognize when they are considering web-based surveys are:

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to 10 rather than 11.

1. Web page-based surveys must attract respondents to the web page with messages posted in news groups, links on other web pages, banner ads, and other types of methods. As a result, all segments of population may not be represented in the sample. All Internet users do not use the same browsers, and different browsers may not present images and text on web pages in the same manner. For example, some users (such as those subscribing to freenets) use only a text-based web browser (such as Lynx), and may not be able to respond to the survey.

2. Internet surveys are a useful means of acquiring responses from the general public but clearly cannot be expected to yield representative samples due to uneven access to the net (Coomber, 1997). For the kayaking survey I used a usenet newsgroup. If kayakers are not a frequent visitor to the newsgroups, they may not be aware of the survey announcement posted in newsgroups, and thus may not have the opportunity to complete the survey.

3. Web page-based surveys generally allow for multiple responses from a single individual, as well as responses from individuals outside of the population of interest. This could also bias the results. Respondents to the kayaking survey were asked to fill out the survey once and once only. For the on-site survey kayakers were also asked not to fill out the survey if they had previously filled it out on line.

4. One way to validate a method is to compare it to other methods that are accepted within the research community. Since it is almost impossible to develop response rates to web page-based surveys it is difficult to compare web page-based survey methods to traditional survey data collection methods such as postal mail and on-site surveys. This leads to another generalisability issue. Without an understanding of the size of the respondent pool in comparison to the size of the universe and the

sampling pool, it is difficult to generalize research findings beyond the universe of those responding to the survey (Coomber, 1997).

Based on the results of my internet surveys it appears that e-mail can successfully be used to survey recreationalists nationwide. An e-mail survey may have higher response rates and speeds compared to traditional on site methods. However, as discussed above certain limitations apply to this method. Most importantly it would not be possible to generalize results for recreational demand for both Internet users and non-Internet users based on knowledge attained solely from on-line respondents. Another challenging limitation is the changing nature of the Internet. The composition of the Internet changes daily with new individuals logging on and others adding or switching Internet service providers. Thus, some directories may contain information that is out of date or incomplete. This was found to be a problem in administering the online kayaking surveys used in this thesis. Additionally, "spam" technology allows individuals to set up mail filters, which delete messages from those senders not on the receiver's 'approved' list. This deletion may or may not be reported to the sender. As use of mail filters grows, response rates may be affected.

While e-mail surveying will probably never replace completely onsite recreational demand surveys and postal mail surveys, I have shown that it can provide additional data to supplement an on-site survey and give 'hard to reach' individuals an opportunity to respond thus providing a richer dataset on the recreational group.

The full dataset in this chapter that includes the respondents from the on-line survey contains information on individuals other than those present on the survey weekend and the likelihood of being sampled does not depend on the frequency with which an individual visits the river. Thus, even though part of the sample used in this chapter involved an on-site survey, endogenous stratification was not found to be a problem in this case. This important result clearly illustrated that Internet data collection can produce results that are very similar to those from more conventional on-site travel cost surveys. Also by utilising data collected via the internet with data collected on-site, researchers can avoid some of the pitfalls associated with on-site surveys alone, save time and resources on data collection and perhaps most importantly widen the sample in terms of representativeness.

4.4.2. The truncated negative binomial model

The other major problem to be tackled with site survey-based recreation demand data is that no observations exist for individuals who made zero trips to the river during the sampling period. Exclusion of individuals who chose not to make a trip implies that the data have been systematically truncated. If this truncation is not recognized, the resulting parameter estimates will be biased in terms of inferences drawn about the population of potential beneficiaries from conserving the river for kayaking in the future. This bias will extend to the estimates of consumer surplus that are derived from these parameters. To avoid this problem, one must modify the negative binomial distribution to reflect the fact that T_i is only observed when $T_i > 0$. Following Grogger and Carson (1991), the negative binomial probability distribution is adjusted to account for truncated counts. This probability model can be written as:

$$\Pr(T_i) = f(T_i) = \frac{\Gamma(T_i + 1/\alpha)}{\Gamma(T_i + 1)\Gamma(1/\alpha)}(\alpha\lambda_i)^{T_i}(1 + \alpha\lambda_i)^{-(T_i + 1/\alpha)}[1 - f(0)]^{-1} \tag{4.8}$$

The truncated probability function differs from the standard probability function by the factor $[1 - f(0)]^{-1}$. Since $f(0)<1$, multiplication of the usual probabilities by $[1 - f(0)]^{-1}$ inflates them, accounting for the unobserved zeros. Estimation of the resulting truncated negative binomial model relies on standard maximum likelihood techniques. The log-likelihood function for the truncated model can be written as follows:

$$\ln L = \sum_{i=0}^{N} \ln\Gamma(T_i + 1/\alpha) - \ln\Gamma(1/\alpha) + T_i \ln(\alpha\lambda_i) - (T_i + 1/\alpha)\ln(1+\alpha\lambda_i) \\ - \ln[1-(1+\alpha\lambda_i)^{-1/\alpha}] \quad (4.9)$$

where N corresponds to the size of the truncated sample. The conditional mean and variance of this model is given by:

$$E(T_i \mid X_i, T_i > 0) = \lambda_i[1 - f(0)]^{-1} \quad (4.10)$$

and

$$\mathrm{var}(T_i \mid X_i, T_i > 0) = \frac{E(T_i \mid X_i, T_i > 0)}{f(0)^{\alpha}}\{1 - [f(0)]^{1+\alpha} E(T_i \mid X_i, T_i > 0)\}. \quad (4.11)$$

For comparison purposes, the demand model was also estimated under the less restrictive assumptions imposed by use of the truncated poisson distribution. A truncated Poisson distribution can also be used to model the data generating process that underlies the discrete, nonzero values observed in the sample. Although this model can be somewhat easier to estimate, it once again imposes the restriction that the conditional mean of the dependent variable, λ, is equal to the conditional variance.

4.5. Results

Parameter estimates for the kayaking TCM are presented in Table 4.3 (a definition of the variables used can be found in Table 4.2). Several alternative specifications of the demand equation were estimated. These included the standard and truncated Poisson models and the standard negative binomial model. Although these alternative models gave results similar in magnitude and with the same signs, they were rejected in favour of the truncated negative binomial model, as this was found to best fit the data in terms of the log likelihood value. This model's estimate of the mean number of whitewater recreation trips demanded is 2.83. This is a slight underestimate of the actual mean of 3.24 trips observed in the sample. In the preferred model, α, the overdispersion parameter is quite small at 0.242. It is however positive and significant, indicating that the data is overdispersed. In order to test the hypothesis that $\alpha = 0$ (and therefore indicating that the Poisson model would be more appropriate) a likelihood ratio-test was performed. The χ^2 value of 51.66 implies that the probability that one would observe these data conditional on $\alpha = 0$ is virtually zero.

Table 4.3.Parameter Estimates for the Different Specifications

Parameter	Poisson	NB	Truncated Poisson	Truncated NB
Constant	0.578	0.583	0.298	0.199
	-1.37	-1.26	-0.57	-0.32
Income	0.00002	0.00002	0.00002	0.00002
	(2.54)*	(2.23)*	(2.87)**	(2.37)*
Travel Cost	-0.009	-0.009	-0.011	-0.012
	(6.70)**	(5.75)**	(7.20)**	(5.65)**
Discretionary Time Available	0.003	0.003	0.004	0.004
	(4.78)**	(4.07)**	(5.21)**	(4.08)**
Intermediate Proficiency	0.768	0.737	1.02	0.987
	(2.71)**	(2.39)*	(2.61)**	(2.16)*
Advanced Proficiency	0.872	0.838	1.126	1.093
	(2.81)**	(2.46)*	(2.71)**	(2.21)*
Importance of Activity to Individual	-0.093	-0.1	-0.14	-0.195
	-1.13	-1.08	-1.42	-1.45
Years Experience	0.081	0.084	0.122	0.149
	-1.83	-1.69	(2.27)*	(2.08)*
Age	-0.018	-0.018	-0.024	-0.026
	-1.58	-1.41	-1.86	-1.61
Income Squared	0	0	0	0
	(2.58)*	(2.22)*	(2.86)**	(2.30)*
Years of Experience Squared	-0.003	-0.003	-0.005	-0.007
	-1.6	-1.49	(2.06)*	-1.91
α		0.096		0.242

Absolute value of z statistics in parenthesis.** indicates significance at 5%, * indicates significance at 1%. For definition of variables, see Table 4.2.

NB stands for the Negative Binomial model. Notice that there are very little differences between the coefficients and the standard errors of the Poisson and Negative Binomial model and similarly between the coefficients and the standard errors of the Truncated Poisson and Truncated Negative Binomial model. The zero-truncated Negative Binomial model (last column in the table) does however display the lowest value for the maximum log-likelihood.

The marginal effect of covariates on mean whitewater trips taken is given by:

$$\frac{\partial E(T \mid X)}{\partial x_i} = (1+\alpha)\lambda_i \beta_j \qquad (4.12)$$

For every €20 increase in the travel cost of a trip, the number of whitewater trips demanded falls by 0.84 or approximately 29%. The estimated coefficients for both travel costs and discretionary time available (DT) are of the expected sign and significant at the 95 percent level of confidence. For each additional day of discretionary time available to kayakers, 0.014 more trips to the Roughty river are demanded. The income coefficient is also significant and has the expected positive sign but is very small at .0000271. While this result may appear strange it is not uncommon to encounter small (and in some cases negative) income effects in recreational travel cost demand models (Chakraborty and Keith, 2000 and Curtis, 2002).

The variable denoting income squared (Y2) is significant at the 1% level but is very small in magnitude. Its significance shows a quadratic relationship between trips to the Roughty river and income. The variable denoting the relative importance of kayaking as a recreational pursuit (Importance) was found to be insignificant, even though it had the anticipated sign. Kayaking experience has a significant (at the 1% level) impact on the demand for whitewater kayaking trips, showing that the number of whitewater trips demanded increases by 0.52 or 18.5% for each additional year of experience. A priori, this is what one would expect considering the somewhat technical nature of the Roughty river. This agrees with the result obtained by Munley and Smith (1976), who also concluded that experience had a positive impact on the willingness to pay for whitewater recreation.

The dummy variables measuring proficiency level in a kayak indicate whether a respondent classifies him/herself as being a basic, intermediate or advanced kayaker. This is an excellent indicator of the skill level of each kayaker. Compared with basic proficiency level kayakers, intermediate kayakers are predicted to make 3.47 more trips to use the Roughty river, with advanced proficiency level kayakers likely to demand 3.83 more trips than their basic proficiency counterparts. Very few basic proficiency kayakers would consider kayaking on a river with a difficulty rating of greater than grade 3. Considering the Roughty is classified as a grade 4 river the coefficients on the dummy variables measuring proficiency level are of the expected sign and magnitude. The other variable in the model, age, is insignificant but of the expected sign. As kayakers get older fewer trips are demanded.

Consumers' surplus was estimated following McKean and Taylor (2000) and Hellerstein and Mendelsohn (1993), for consumer utility maximization subject to an income constraint, and where trips are a nonnegative integer. Hellerstein and Mendelsohn show that the conventional formula to find consumer surplus for a semi-log model also holds for the case of the integer constrained quantity demanded variable. They show that the expected value of consumer surplus, *E(CS)*, derived from count models can be calculated as:

$$E(CS) = E(T_i|x_i)/\beta_p = \hat{\lambda}_i/(\beta_p) \tag{4.13}$$

where $\hat{\lambda}_i$ is the expected number of trips, and β_p is the price (*i.e.*, travel cost) coefficient. The per-trip *E(CS)* is simply equal to $1/\text{-}\beta_p$. In the preferred model, this implies that consumers' surplus per trip is €83.3. The population estimate of per-trip consumer surplus is estimated with 95% confidence to be between €62.5 and €125. The estimated average whitewater trips per year in the full 143-person sample were 2.83. Total consumer surplus per kayaker per year is average annual trips multiplied by surplus per trip or 2.83 x €83.3 = €235.74 per year. This implies that the annual whitewater value of the Roughty river for the sample of kayakers or willingness-to-pay by those in the sample of 143 kayakers is 143 x 235.74 = €33,711 per year.

Since this study on whitewater recreation is one of the first of its type done in Europe, the comparisons here are with similar studies on whitewater recreational sites carried out in the United States[11]. Johnson et al. (1990), in a contingent valuation study, obtained estimates of mean willingness to pay for a permit for access to a controlled whitewater river in Oregon of €39.73 and €64.39, depending on the question format used. Bergstrom and Cordell (1991) estimated much lower values for consumer surplus per trip at €24.01 for canoeing and kayaking. English and Bowker (1996) obtained estimates of per-trip surplus for commercial rafting in Northern Georgia of €131.90. In a more recent study on whitewater recreation on the Gauley river in West Virgina by Ready and Kealage (1998) consumer surplus per trip estimates of €84.42 were calculated. However, such simple comparisons are somewhat hard to interpret, since methodology and context vary greatly between these earlier studies and that reported here.

4.6. Summary

This chapter has attempted to highlight the conflict between commercial interests and recreational pursuits on Irish rivers using the Roughty river as a single site study. With regard to the estimation of the travel cost model, the study found that the mean consumer surplus of the average kayaker using the Roughty river in Co. Kerry was €235 per year. In a recent poll looking at river usage in Ireland carried out on the internet site, www.irishfreestyle.com, it was found that 43% of the respondents had paddled the Roughty river. Taking this as an estimate of the proportion of the population of intermediate or advanced kayakers in the country that paddle the Roughty river an

[11] All figures have been converted into 2003 euros.

estimated average of 2.83 times per year, this would mean an estimated 3,042 trips in aggregate to the Roughty river per year[12]. This indicated a total consumer surplus figure of €0.715 million for the kayaking population using the Roughty river in Co. Kerry. This result indicates the high value of the Roughty river as a whitewater recreational resource, even ignoring non-use values from preservation.

This single site study is limited in the sense that the sample size is quite small. Also, since it is focused on one site only, the opportunity cost of hydro developments on the Roughty will be over-estimated. Given the scope of the single site study, a very basic approach was taken to the specification of the TCM. For example, substitution among sites within the Kerry area was not considered as it was assumed that within the region of Kerry, the Roughty river offers unique kayaking opportunities. If this assumption is incorrect, and substitution to other sites does play an important role in determining the demand for kayaking trips to the Kerry region, then the TCM will tend to overstate actual willingness to pay.

Given the small sample size and the method by which the sample was self selected it would be wise to take a cautious view as to how representative the single site study sample is of the population of Irish kayakers. Estimating the preferences of kayakers for alternative whitewater rivers as a function of site characteristics and kayaker characteristics is an obvious extension of this single site study. It would also be interesting to investigate the impacts on welfare and trips of a rationing mechanism such as the imposition of car-parking fee (Shaw and Ozog, 1999 and Hanley et al. 2002) and the impacts on welfare and trips of changes in the characteristics of one or more rivers.

[12] An ICU representative estimated that half of their 5000 members were of intermediate proficiency level or higher. Therefore, 43% of 2500 multiplied by 2.83 results in the figure of 3,042 trips per year.

The rest of the thesis will attempt to answer these questions using data from a larger survey that analyses whitewater trips to 11 alternative whitewater sites.

In the debate on using the natural flows of rivers such as the Roughty for hydro-electric power much emphasis is placed on the value of electrical power that will be generated. Losses to society are often put in terms of the loss in the scenic value of the river, loss in terms of a fishing resource, the impacts on the indigenous flora and fauna and perhaps the impacts on local residents. Little if anything is said in terms of the whitewater recreational value of such a river system at the planning application stage for such hydro-electric schemes[13]. Though we do not comment on the value of the Roughty from a hydro-electric viewpoint, the welfare estimates presented here confirm the significant opportunity costs of allowing such developments on popular kayaking rivers.

For a single whitewater river such as the Roughty, the Count Data TCM is attractive because it is a relatively simple and cost-effective approach. This was the main reason it was used in this preliminary small scale study of the Roughty river. Having said this, there are 2 major issues that cannot be addressed by the count data model used in this chapter. These are its inability to adequately account for substitution among alternative recreational sites and its inability to determine the importance of individual site characteristics. A simple count data model can only estimate the number of trips taken to a single site. To analyse the demand for whitewater recreation at a number of alternative substitutable sites the Random Utility Site Choice model is more appropriate.

[13] Prior to the completion of this study An Bord Pleanála refused planning permission (on appeal, since it was initially granted by Kerry county council – planning registration reference number: 3566/01) for development of a small hydro-power scheme, the design of which would have incorporated a river intake, pipeline and powerhouse building (at Morleys bridge) on the Roughty river. In its final decision it was deemed that "The Roughty River is an important salmonid habitat of considerable value in terms of fish spawning, angling and tourism. The proposed development would, therefore, seriously injure the amenities of the area and be contrary to the proper planning and development of the area." No mention was made in An Bord Pleanála written decision, to the value of the Roughty river as one of the best whitewater recreational resources in the country.

A RUM model does not attempt to predict the actual number of trips that a kayaker will take to a whitewater site. Instead, a RUM model estimates the probability that an individual will choose to visit a given river, depending on the characteristics of that river and the characteristics of possible alternative whitewater sites. The better the characteristics of a whitewater site, the higher the probability that the kayaker will choose that site to kayak at and thus the higher the value of the site will be. Using these probability values and the utility level associated with each site it is still possible to calculate the consumer surplus per kayaker associated with changes in access to alternative sites or to site qualities.

The simple single choice count data model used in this chapter is relatively easy to construct but oversimplifies the choice problem. Although it was effective in determining the value of the Roughty river as a whitewater kayaking recreational resource it cannot offer the researcher any indication of which attributes attract a kayaker to the river in the first place or what value is associated with changes in the attributes of the river. To answer these questions a large survey would be needed that would collect information covering a number of substitute sites and random utility type models would need to be employed to calculate the welfare change associated with changes in access to alternative sites or to site characteristics. It is for these reasons that on completing the single site survey on the Roughty I set about designing and implementing a larger scale survey of the kayaking population of Ireland. This large scale survey, the RUM models developed from the collected data and the welfare estimates associated with changes in access to alternative whitewater sites and to whitewater site characteristics are topics to be discussed in the proceeding chapters. Accounting for substitution among alternative recreational sites and the determination of the importance of individual site characteristics are questions that could not be dealt with in the simple count data model utilized in this chapter but are issues that will be addressed in the remainder of this thesis.

Chapter 5. Study design and sample characteristics

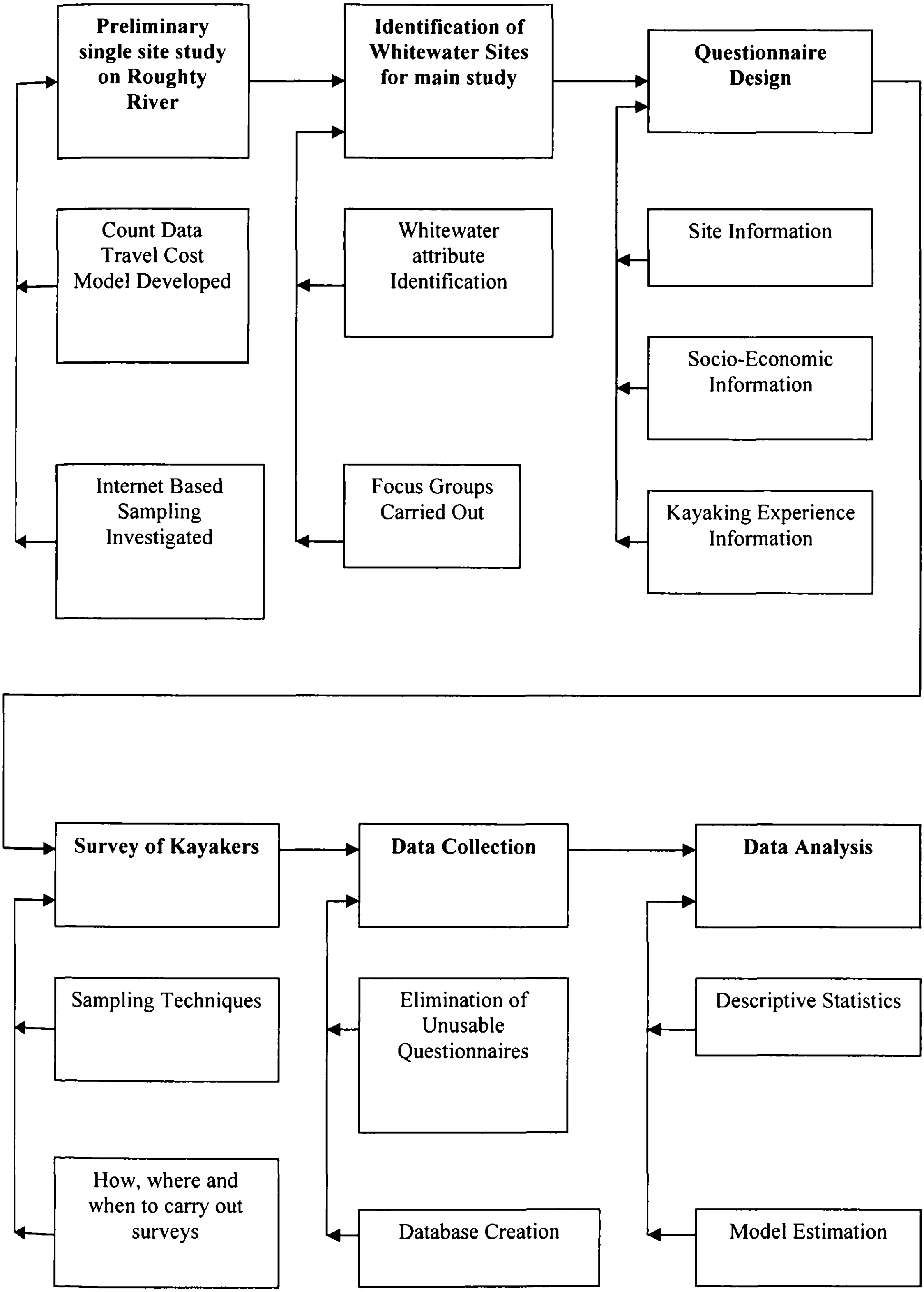
Having completed the single site study the next step in this study was to identify the choice sets and their relevant attributes in order to model site choice. The study was subdivided into six main steps as summarised below.

1. Preliminary investigation: a detailed analysis of kayaking recreation enthusiasts was carried out to obtain basic knowledge of the main issues to be investigated;

2. Identification of whitewater sites: this activity was based on the information provided by preliminary focus groups and respondents on an Irish kayaking internet discussion forum. Three main criteria were used in deciding suitable whitewater sites: (i) the grade of the whitewater kayaking; (ii) the approximate frequency of visits to the whitewater site; and (iii) the geographical location of the whitewater site.

The next phase of the study, as can be seen in Figure 5.1, was the preparation of the questionnaire: the questionnaire has been designed according to the guidelines proposed by Mitchell and Carson (1989) and Carson et al. (1995). Particular care has been devoted to: (i) identification of the variables required for the valuation models (e.g.; socioeconomic data, travel costs, etc.); (ii) design of the questions in a manner that facilitates the completion of the questionnaire by the respondents with the least amount of hassle and mental strain possible; and (iii) designing the questionnaire in a manner that allowed techniques used for revealing preferences of the visitors to be employed.

Figure 5.1. Study Design



3. Survey Distribution: the survey was distributed by email. The sample of respondents was made on a random basis using two emailing lists of Irish whitewater kayakers. Face-to-face interviews were also carried out on site at one whitewater kayaking meet on the river Liffey according to a pre-defined plan of action which took into account the risks of biases that could derive from an uneven distribution of interviews during the survey period (see section 5.2 for an expanded discussion on how the survey was distributed via email and on-site).

4. Collection of data and validation of the questionnaires: at this stage invalid questionnaires were eliminated and a database was created with the data collected. Invalid questionnaires amounted to less than 1% of the whole sample.

5. Data analysis: the analysis of data was mainly aimed at describing the behaviour of specific variables and checking for any mistakes in entering the data from the hardcopy surveys to the excel spreadsheets.

Each of the steps described above will be discussed in greater detail in the remainder of this chapter.

5.1. Survey Instrument Design

In designing the survey instrument, which is included in Appendix C, it was hoped to learn about several aspects of whitewater kayakers in addition to the frequency of trips to the whitewater sites. To accomplish this, focus groups were conducted with kayakers from the university kayak club in Galway and a second group consisting of 7 kayakers who had no affiliations with any particular kayak club[14]. Discussions with the Irish Canoe Union (ICU) and my own kayaking experience also helped in this process. A discussion thread was also set up on the discussion forum of the Irish Freestyle Kayaking website at www.irishfreestyle.com. Having conducted the focus groups and taken on board the comments of participants on the message board of the Irish Freestyle Kayaking website the survey was written up and broken down into the following seven sections:

1. Introduction and Aims of the Study

2. Kayaking Activity and Choice of Kayaking Sites over the last 12 Months

3. Evaluation of Kayaking Sites in Ireland

4. Relative Influence of Factors

5. Personnel Expenditure on Kayaking

6. Kayaking Experience

7. Classification Questions

Part 1 simply gave a definition of whitewater kayaking, outlined the aims of the study, discussed who was undertaking the study and outlined the manner in which the respondent should complete the questionnaire. Part 2 asked respondents to indicate how many days they had kayaked at each of 11 different whitewater sites in Ireland in the previous 12 months. Part 3 then asked respondents to evaluate the 11 kayaking sites (in terms of 9 attributes which are reviewed in section 5.3) they have visited throughout their kayaking experience but instructed them not to comment on the sites they had never visited. Part 4 then asked the respondents to rank the 8 attributes from 1 to 8, according to their importance in the respondents decision to choose a kayaking site to paddle at, e.g. 1

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[14] Much of the kayaking population in Ireland are not affiliated with any particular club. Individuals have their own equipment and paddle rivers in groups of three or four. As such, it was felt necessary to get the opinions of non-club affiliated kayakers as well as club affiliated ones.

= most important among the set of attributes listed when choosing a paddling destination or 8 = least important among the set of attributes listed when choosing a kayaking site to paddle at. In parts 5 through 7, the respondents were asked questions to solicit information on the amount of money being spent by kayakers on their sport, the kayakers socio-economic characteristics and their skill and experience at kayaking. These questions included yes or no questions, open ended questions concerning occupation, years kayaking, nearest town to where they live, etc and categorical questions where respondents were asked to indicate if they were for example male or female or to indicate the income bracket that they belonged to.

5.2. Sampling Procedure

The sampling frame was provided by two Irish kayaker email lists obtained from the Outdoor Adventure Store (one of the main kayak equipment outlet stores in Ireland) and the Irish kayaking instruction company, H2O Extreme. A random sample of these email addresses was selected, and questionnaires were emailed to these individuals, who were asked to complete and return the questionnaire via email. As an incentive to get people to return the questionnaires a raffle was organized with €500 worth of kayaking equipment as prizes. Everyone who returned a completed questionnaire had their names entered into the draw. To widen the sample in terms of representativeness and increase the number of completed surveys, the questionnaire was also administered at an organized kayaking meet on the Liffey river in January 2004 and the questionnaire was also posted up on the homepage of the Irish Canoe Union website (www.irishcanoeunion.com).

5.2.1. The Internet based Sample

The Internet provides access to a wealth of information on countless topics contributed by people throughout the world. As such, the Internet is a very valuable research resource. There are also many e-mail discussion groups or Usenet newsgroups. These groups cover a wide variety of topics. You can ask questions of the experts and read the answers to questions that others ask. Belonging to these groups is somewhat like receiving a daily newspaper on topics that interest you. These groups provide a good way of keeping up with what is being discussed on the Internet about your subject area. In addition, they can help you find out how to locate information (both online and offline) that you want. There are a host of these email discussion groups dedicated to outdoor recreational activities. In Ireland there are dedicated email discussion forums for whitewater kayaking (www.irishfreestyle.com), sea kayaking (www.irishseakayakingassociation.com), mountaineering (www.mountaineering.ie) and fishing (www.angling-in-ireland.com), to name but a few.

E-mail discussion groups for recreational activities could potentially be utilised by researchers as a cheap and reliable method to collect survey data. Individuals who frequent these sites tend to be very enthusiastic about their particular outdoor pursuits and are more likely to be willing to fill out questionnaires and return them to the researcher quickly and completed. Following the success of this internet based approach in the single site study it was decided to adopt a similar strategy for the main survey as well. For a full discussion of the advantages and potential biases and pitfall of using the internet and email lists as a surveying tool see section 4.4.1. The questionnaire was posted up on the homepage of the Irish Canoe Union website (www.irishcanoeunion.com) and a link created to it from the Irish freestyle kayaking website discussion forum. Although it is not known how many of the email responses were a result of direct contact via the email lists or from individuals who happened upon the link message on the kayaking discussion forum, in total 161 surveys were returned via the internet. All of the 161 completed questionnaires returned via the internet in this study, had been returned within 2 weeks.

5.2.2. The On-site Sample

The data from the onsite survey and used in this analysis was collected from a survey distributed to whitewater kayakers in and around the put-in to the Lower Liffey on the weekend of the 27th and 28th of January 2004. A similar approach was used in the carrying out of the on-site survey as was used in the single site study. Survey recipients were once again provided with a copy of the survey and an outline of what the study was designed to achieve. Respondents were asked to read the descriptive outline and answer all relevant sections in the survey. They were also asked to complete the survey only if they had not already returned a survey via email. Completed surveys were to be placed in a box in the car park at the put-in to the river. Thus, as with the single site study it was possible both to discern who returned the survey and to maintain confidentiality. A sample of 118 useable responses from kayakers was acquired from the on-site survey. Combining the samples from the onsite survey and the internet based sample resulted in an overall sample of 279 individual kayakers or 3069 kayaker-whitewater site observations.

5.3. Whitewater sites and their attributes

Eleven principal whitewater sites were identified (see also figure 5.2)[15]. These were:

- The Liffey in Co. Dublin

- Clifden Play Hole in Co. Galway

[15] The shaded sections of the rivers represent the portion of the river system that is utilised by whitewater kayaking enthusiasts.

- Curragower wave on the Shannon in Co. Limerick

- The Boyne in Co. Meath

- The Roughty in Co. Kerry

- The Clare Glens in Co. Tipperary

- The Annamoe in Co. Wicklow

- The Barrow in Co. Wexford

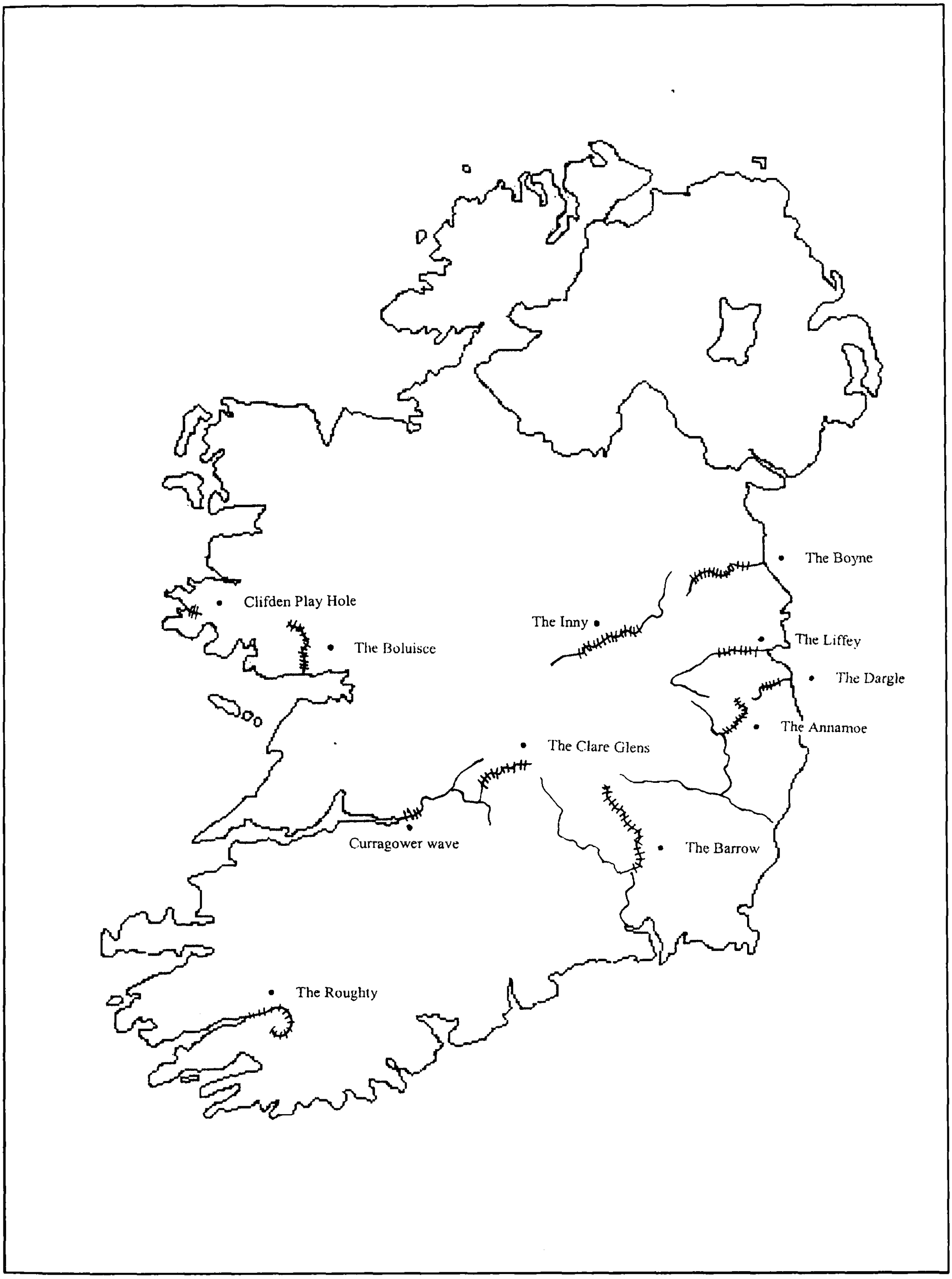
- The Dargle in Co. Wicklow

- The Inny in Co. Longford

- The Boluisce in Co. Galway

In regards to the site attributes we had to decide whether to use a subjective or an objective measure of each characteristic. Objective measures value characteristics using external sources of data whereas subjective measures allow the respondent themselves to place a value on the attributes of each alternative site. Following the approach adopted by Hanley et al. (2001) we use the respondents' perceived or subjective measure for all attributes other than travel cost. This approach is in contrast to that used in much of the random utility literature where attribute measures are sourced externally from the respondents. For example, Parsons and Massey (2003) use a variety of external data sources such as travel guides, field trips, interviews with resource managers and geological maps to compile a dataset of characteristics in relation to 62 beaches in the mid-Atlantic region of the USA.

Figure 5.2. Geographical Location of the Whitewater Sites



However, we assume most kayakers have, through personal experience, a good knowledge of major whitewater kayaking sites and therefore allow them to use their own judgment to rank each alternative site in terms of the following attributes:

- Average quality of parking at the site (measured on a Likert scale, from 1 to 5 where 1 indicates poor safety and quality of parking to 5 indicating excellent safety and quality of parking).

- Average crowding at the paddling site which indicates how many other kayakers are expected on the water where and when the respondent is paddling (measured on a Likert scale, from 1 to 5 where 1 means very crowded to 5 meaning uncrowded).

- Average quality of the kayaking site as measured by the star rating system used in The Irish Whitewater Guidebook (where no stars is the lowest quality and 3 stars is the highest).

- Average quality of the water (measured on a Likert scale, from 1 to 5 where 1 means extremely polluted to 5 meaning unpolluted).

- Scenic quality of the kayaking site (measured on a Likert scale, from 1 to 5 where 1 means not at all scenic to 5 meaning very scenic).

- Reliability of Water Information (measured on a Likert scale, from 1 to 5 where 1 indicates that before visiting the site, a kayaker is completely unsure of the water level at the site and 5 indicates that the kayaker has no uncertainty about water level at the site prior to the commencement of the journey).

- Number of other kayaking sites within 10 miles proximity of this site (measured on a Likert scale, from 1 to 5, where 1 is none and 5 is many)[16]

- Travel Distance to whitewater site (measured in miles).

- Travel Time (minutes taken to get from home to whitewater site).

5.4. Database Design

The whitewater kayaking dataset was inputted manually from the returned onsite and online surveys into a Microsoft Excel spreadsheet. This was a time consuming endeavor due to the extensive information returned in each survey[17]. Because the statistic packages of Limdep and Stata were to be used in this analysis it was important to take into account the structure of the database. Both packages are quite specific about how the data must be organized if one wishes to run multinomial logit type models. This meant that the dataset had to be organized quite differently from usual data sets. Initially, the kayaking survey data was entered as follows:

Observation	Trips to Liffey	Trips to Clifden	Liffey-distance	Clifden-distance	Age
1	6	2	10	160	28

Here observation 1's trips and views on the whitewater site attribute of distance traveled are all on the one line. Stacking the kayakers in the dataset, one has 279 lines for 279 observations. To run multinomial logit type model requires that the dataset be converted into a "panel" dataset structure as follows:

Observation	Trips	Distance Travelled	Age	River
1	6	10	28	1
1	2	160	28	2

[16] This attribute was not included in the final estimation as it was assumed that the value of other sites near by was already captured in the RUM model through the travel cost variable and the site dummy variables.
[17] I must acknowledge the help of my brother Martin in inputting the data into the Excel Spreadsheet. He selflessly gave up hours of his time to help in the data entry process.

It is structured in this manner as Stata and Limdep treat each whitewater site destination's trips as a frequency for one of the choices. Therefore the choice alternatives must be stacked for each kayaker, even when the choice includes taking no trips. Also, variables such as age, which remain constant over each whitewater site alternative, must appear on each line if one wishes to use the variable in the modelling process. Therefore rather than having 279 observations or lines in our dataset we now have 279 times 11 whitewater site observations or 3069 lines. The restructuring of the dataset was a very important step prior to model building process that will be discussed in subsequent chapters.

5.5. Descriptive statistics for the sample

Some 43% of all kayakers questioned were in the 16-25 years age bracket, which was the largest percentage of any of the age groups. 37% and 9% of the kayakers were in the age brackets 25-35 years and 35-45 years respectively. Only 3% of the kayakers questioned were aged over 45 years. The majority of responded were male (78%). 70% of the sample were single, whilst 13% of those interviewed had children. The majority of kayakers (75%) were either degree/diploma holders or were presently attending a third level institution, while 23% had left the education system on completion of secondary level. The mean income before tax was €27,634[18]. Table 5.1 presents some further summary statistics of the respondents in the survey.

[18] This figure includes average student income of €5000

Table 5.1. Summary Statistics of Respondents in Kayaking Survey

	Mean	Std. Dev.	Min	Max
Age	27.06	7.20	16	52
Education	1.27	0.48	1	3
Income	27554.35	21891.34	5000	90000
Importance of Kayaking*	1.26	0.71	1	4
Travel Cost	55.59	37.64	1.15	274.79
Obligation Free Days	102.88	70.71	0	365
Number of Years Paddling	7.22	6.27	0.5	36

***1 indicates that kayaking is the respondents most important outdoor activity whereas 4 indicates that kayaking is but one of many outdoor pursuits participated in by the respondent.**

Table 5.2.Mean Visits to Each Whitewater Site Last Year and Total Sites Visited Last Year as a Whole

Kayaking Site	Mean visits per annum	Std. Deviation
The Liffey	16.59	42.32
Clifden Play Hole	2.63	5.54
Curragower Wave	3.34	6.46
The Boyne	5.65	14.73
The Roughty	0.82	2.00
The Clare Glens	1.00	2.14
The Annamoe	3.42	5.30
The Barrow	1.01	6.12
The Dargle	1.28	3.78
The Inny	1.07	1.82
The Boluisce	1.01	2.52
All Sites	37.83	47.16

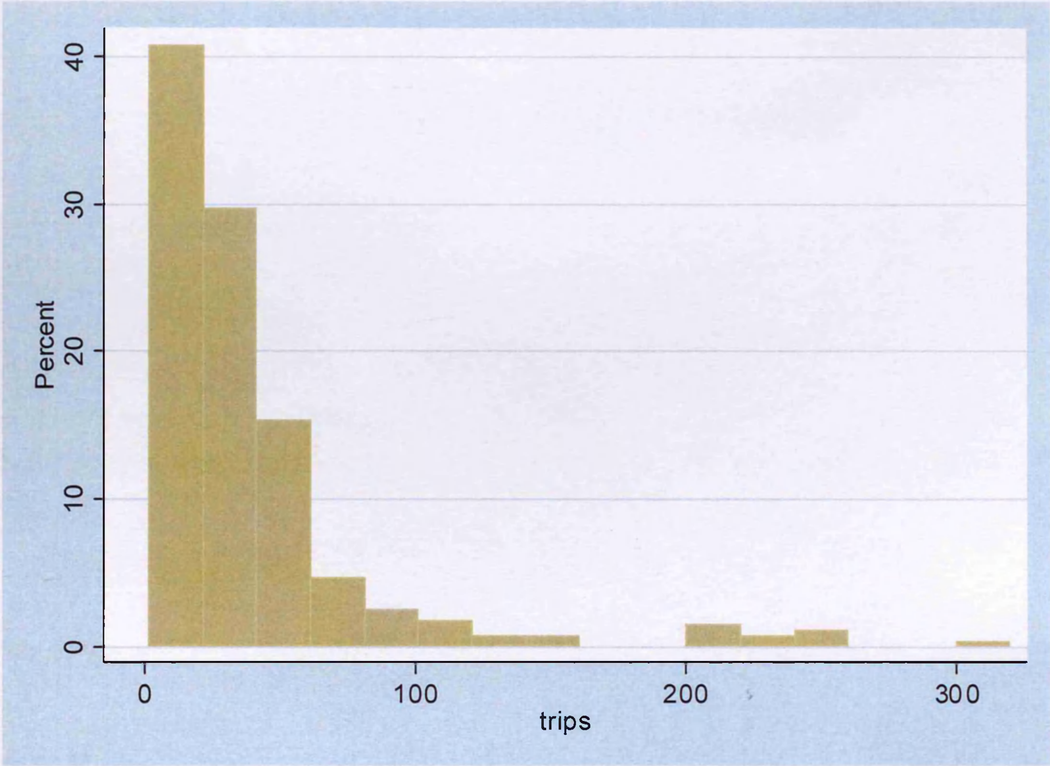
Over 44% of kayakers had been paddling for 5 years or less, with another 15% and 19% indicating they had been kayaking for between 5 and 10 years and between 10 and 20 years respectively. Overall respondents had been kayaking for a minimum of 0.5 years, a maximum of 36 years with the mean at 7.4 years. In terms of participation, 39% of all respondents completed 20 kayaking trips or less in a year, with the next largest group being 23% of respondents, completing from 30 to 50 kayaking trips in the year. Overall the mean number of kayaking trips completed in the previous year was 38, with the median at 26. Table 5.2 gives a picture of kayaking activity during the 12 months prior to the completion of the survey.

Table 5.3. Visits to Kayaking Sites in Ireland Anytime in the Past

Kayaking Site	No.of Respondents	% of repondents
The Liffey	225	80.65
Clifden Play Hole	146	52.33
Curragower Wave	158	56.63
The Boyne	196	70.25
The Roughty	116	41.58
The Clare Glens	128	45.88
The Annamoe	175	62.72
The Barrow	102	36.56
The Dargle	102	36.56
The Inny	160	57.35
The Boluisce	137	49.10

Kayakers were also asked how many of a sample of the eleven key Irish kayaking sites they had visited at any time in the past. As indicated in table 5.3, the kayaking site visited by most respondents at some point in the past was the river Liffey, followed by the Boyne, the Annamoe and then Curragower wave on the Shannon. The Barrow and the Dargle were the two least visited sites with only 36% of respondents having visiting either at any time in the past. Figure 5.2 shows the distribution of total trips in the previous 12 months. It is obvious from the histogram that the majority of the sample has made less than 20 trips to all the rivers in the sample in the previous year.

Figure 5.2. Distribution of Total Trips over the Previous year



Respondents, as mentioned above, were also asked both to (i) rank attributes in terms of importance; and (ii) score each of the 11 whitewater kayaking sites on these attributes. The relevant information is given in Tables 5.4-5.6. As indicated in table 5.4, the majority (60%) of respondents ranked the star rating of the whitewater site as the most important attribute. Scenic quality of the kayaking site was ranked the least important attribute by 32% of respondents.

Table 5.4.Factors Ranked 1st and Last in Importance with Regard to Choosing a River to Kayak

Factors	% of kayakers ranking attribute 1st in Importance	% of kayakers ranking attribute Least in Importance
Quality of parking	2.87	18.28
Crowding at the paddling site	1.43	4.66
Quality of the kayaking site (stars)	60.22	3.58
Water Quality	5.73	2.51
Scenic quality of the kayaking site	3.58	31.54
Reliability of Water	15.05	2.51
Number of other sites within 10 miles	2.87	22.94
Travel Time (one way from home to site)	7.53	10.75

Many respondents identified further factors which they considered important. These included, the weather and the personality, skill and experience of the people they were kayaking with. As one respondent put it in relation to the weather; "tonnes of rain while driving to the river followed by glorious sunshine while on the river are the ideal conditions for a good paddle". The length of the whitewater run was also considered an important characteristic by a number of respondents. Finally, remoteness of the whitewater site and the kayaking experience was also a plus factor for some respondents. Tables 5.5 and 5.6 give the mean attribute scores by whitewater site.

Table 5.5.Mean Ranking of Attribute by Whitewater Site

Factor	Liffey	Clifden	Curragower	Boyne	Roughty
Average quality and safety of parking at the site (on a scale from 1 to 5 where 1 indicates poor safety and quality of parking to 5 indicating excellent safety and quality of parking)	3.35	2.99	3.08	2.36	3.06
Average crowding at the paddling site (measured from 1 to 5 where 1 means very crowded to 5 meaning uncrowded)	2.76	2.74	2.92	3.22	3.94
Average quality of the kayaking site (no. of stars)	1.66	2.37	2.64	1.64	2.72
Average quality of the water (measured from 1 to 5 where 1 means extremely polluted to 5 meaning unpolluted)	1.93	4.15	2.61	3.27	4.57
Scenic quality of the kayaking site (measured from 1 to 5 where 1 means not at all scenic to 5 meaning very scenic)	2.63	4	2.37	3.97	4.41
Reliability of Water (measured from 1 to 5 where 1 indicates that before visiting the site, a kayaker is completely unsure of the water level at the site and 5 indicates that the kayaker is positive about water level	3.33	4.52	3.34	3.2	2.62
Number of other kayaking sites within 10 miles proximity of this site (measured on a Likert scale, from 1 to 5, where 1 is none and 5 is many)	2.37	2.05	2.66	1.64	3.8
Travel Time (minutes taken to get from home to whitewater site)	85	195	123	91	225

The Dargle and the Inny have the highest average ranking when it comes to parking facilities whereas the Boyne has the lowest ranking. This result was not unexpected as both the Dargle and Inny have excellent parking at the put ins and take out points while the Boyne has been notorious in recent years for cars being broken into while kayakers are on the river at both the put in and take out points. In regards to crowding, Clifden has the worst average ranking whilst the Clare Glens has the best at 4.03. The Clare Glens is technically very challenging and is in a remote location that is difficult to reach so solitude is almost always guaranteed. Clifden on the other hand is a park and play site that tends to get extremely crowded on the weekends. Because this is a tidal feature water levels are guaranteed so people can make plans to visit the site well in advance once they have a set of tide time-tables.

The Clare Glens and the Barrow receive the highest average star rating of all sites and the Dargle receives the lowest. This is a somewhat surprising result as the Barrow is only a grade 2 run whereas the Dargle is a grade 4/5 run. It may be that basic and intermediate proficiency kayakers are indicating their preferences for the less technical runs and giving the most difficult runs in the survey that they are unlikely to kayak on a lower star rating. In regards to water quality it is interesting (but not unexpected) to find that the remotest runs, the Roughty, Clare Glens and Boluisce have the highest average quality ranking and the most urban whitewater sites, the Liffey and the Curragower wave on the Shannon, have the lowest average water quality rankings. A similar rural/urban split is seen for the ranking of scenic quality. This holds true for all rivers except the Inny. The Inny is in a rural setting but still gets a low average scenic quality ranking. This fact may be explained by the fact that the Inny is the only river in the sample located in the relatively flat and scenically uninspiring midlands of the country (see Figure 5.1).

Table 5.6.Mean Ranking of Attribute by Whitewater Site...continued

Factor	Clare Glens	Annamoe	Barrow	Dargle	Inny	Boluisce
Average quality and safety of parking at the site (on a scale from 1 to 5 where 1 indicates poor safety and quality of parking to 5 indicating excellent safety and quality of parking)	3.55	3.16	2.58	3.88	3.65	2.85
Average crowding at the paddling site (measured from 1 to 5 where 1 means very crowded to 5 meaning uncrowded)	4.03	2.98	3.65	4.13	3.51	3.6
Average quality of the kayaking site (no. of stars)	2.89	2.11	2.88	1.32	1.57	2.04
Average quality of the water (measured from 1 to 5 where 1 means extremely polluted to 5 meaning unpolluted)	4.43	4.13	4.13	3.43	3.67	4.26
Scenic quality of the kayaking site (measured from 1 to 5 where 1 means not at all scenic to 5 meaning very scenic)	4.73	4.02	4.38	3.68	2.84	3.43
Reliability of Water (measured from 1 to 5 where 1 indicates that before visiting the site, a kayaker is completely unsure of the water level at the site and 5 indicates that the kayaker is positive about water level	2.48	3.02	2.56	3.13	2.71	2.98
Number of other kayaking sites within 10 miles proximity of this site (measured on a Likert scale, from 1 to 5, where 1 is none and 5 is many)	2.57	4.07	3.2	2.15	1.5	1.85
Travel Time (minutes taken to get from home to whitewater site)	143	111	102	145	127	134

In relation to prior information on water levels, the tidal features of Clifden playhole and Curragower wave on the Shannon have the highest average ranking. This was expected, as one knows with almost certainty prior to visiting these sites whether they will be “up” or not by examining the heights and times of the tide in a set of tide tables. The quick to rise and quick to fall rivers of the Roughty and Clare Glens have as expected the lowest average ranking when it comes to this attribute. The greatest average time to get to any of the rivers is for the remote Roughty while it takes the least amount of time to get to the Liffey, which flows through the capital city of Dublin. The last attribute “number of other whitewater sites in a 10 mile proximity” was not used in the final analysis but information was collected on it in the survey. For this attribute, the Annamoe fairs best and the Inny worst. Again this is to be expected, the Annamoe is situated in the Wicklow mountains which is the home of many other quality whitewater runs while the Inny is one of only a handful of whitewater rivers to be found in the low lying midlands of Ireland.

Finally, table 5.7 outlines respondents' personal expenditure on kayaking over the previous 12 months. The high proportion of expenditure that is spent on travel cost (petrol expenses), food, accommodation and socialising in the area of the whitewater sites is an indication of the economic contribution that is made by the Irish kayaking community in what are usually rural, sparsely populated areas. There has been an increasing and considerable interest in EU member states in rural development over recent years. This concern for rural development was encapsulated in the Cork Declaration (European Conference on Rural Development, 1996), which announced a 10-point Rural Development programme for the EU. It asserted that sustainable rural development must be put at the top of the agenda of the EU and defined its aims as reversing rural out-migration, combating poverty, stimulating employment and equality of opportunity and responding to growing requests for more health, safety and leisure facilities.

With increasing recognition that rural development in Ireland is no longer synonymous with agricultural development (Department of Agriculture and Food, 1999), the development of local amenities to facilitate kayakers and other outdoor recreationalists could go a long way in sustaining vibrant rural populations in remote areas with valuable but under-utilised recreational resources such as whitewater rivers and mountain trails.

Table 5.7.Personal Expenditure on Kayaking over Previous 12 Months.

Category of Expenditure	Total Spend (€) in Previous 12 months	Average Spend per Kayaker (€)	% Spend in the Kayaking Area
Travel Cost	112465	403.10	63
Food	62480	223.94	72
Magazines/Guides/Books	6594.5	23.64	16
Kayaking Equipment	268260	961.51	20
Kayaking Courses/Tuition	24723	88.61	21
Socialising	109995	394.25	71
Accommodation	44685	160.16	73
Miscellaneous	8026	28.77	6

5.6. Summary

The survey instrument used included questions about the frequency and costs of kayaking trips to the 11 different kayaking sites. Specifically, respondents were asked how many paddling trips they had taken in the previous 12 months to each of the 11 areas; to score each area in terms of the 9 attributes used; to provide a ranking of attributes; to provide information on spending related to kayaking and to provide information on their kayaking abilities, experience and standard socio-economic information such as before tax income levels, employment status, age, etc.

Great care was taken with the structure of the collected data in the dataset. In order to use multinomial type models, whitewater site alternatives were stacked for each kayaker in the base excel database. The descriptive statistics from the data revealed a wealth of information in relation to the preferences of whitewater kayakers. Firstly, it is obvious from the data that the star rating of the whitewater site is seen as the most important attribute by the majority of respondents and that scenic quality of the kayaking site is viewed as the least important attribute. What was also interesting is that only 5.6% of respondents viewed water quality as the most important attribute of a whitewater site. In chapters 6, 7 and 8 the preferences of the kayaking population of Ireland will be analysed further using Conditional Logits, Random Parameter Logits and Latent Class models.

Chapter 6. Measuring the opportunity cost of time in recreation demand modelling: an application to a random utility model of whitewater kayaking in Ireland

The treatment of travel cost and travel time in recreational demand modelling has been a contentious issue for many decades. The problems, which arise when dealing with the issue of time in recreation demand modelling, were first discussed by Clawson and Knetsch (1966). Ward and Loomis (1986) later emphasized the need for continued research on the valuation of travel time in order to evaluate the effects of different assumptions and to establish greater consensus on best practices. Shaw (1992) and Feather and Shaw (1999) also raised the question of the appropriate monetary value of leisure time. Eighteen years after Ward and Loomis's paper these same sentiments are still being expressed by Lew and Larson (2005) and Phaneuf and Smith (2004), the latter believing that "time, its opportunity costs, and its role in the demand for trips remain unresolved questions in recreation modeling". This chapter addresses one aspect of the problem of time valuation, namely the appropriate opportunity cost to be used for travel time. This is done in the context of an application of the random utility site choice model, using data from a survey of kayaking trips to whitewater sites in Ireland. The method of estimating time costs utilises information from a secondary micro level data set, the European Community Household Panel (ECHP).

In the next section a formulation of the demand for a kayaking site's services using a household production framework is developed and is designed to consider the opportunity cost of time. Section 6.2 is a critique of the use of the opportunity cost of time in the literature and section 6.3 reviews the secondary panel dataset used in the analysis, the European Community Household Panel (ECHP) dataset. The empirical estimation process for the wage equation is reviewed in section 6.4 while section 6.5 discusses the Random Utility Site Choice (RUSC) model and the treatment of travel cost. Model results are presented in section 6.6 while section 6.7 presents estimates of consumer surplus from whitewater recreation on Irish rivers and a discussion of the policy implications of the results. Finally, section 6.8 summarises and concludes the chapter.

This chapter adds to the literature by (i) outlining a new approach to measuring the opportunity cost of travel time that has a distinct advantage over the approaches used in most other travel cost studies in regards to its ease of implementation and (ii) by comparing three RUSC models which differ in their treatment of travel cost. The study is also the first application of the Random Utility Model to any outdoor recreation pursuit in Ireland. The standard conditional logit model, reviewed in chapter 3, is used in this chapter to estimate recreational benefits, mainly because no obvious division of groups could be found for the 11 chosen whitewater sites (see section 6.6 for IIA test results).

6.1. Theoretical Framework

Two questions are central to the value of leisure time in recreation demand models: What is the price of time given up, and what fraction of this should be used as the value of leisure time? The household production approach provides an appropriate microeconomic framework for analysing these issues and was first introduced by Gary Becker (1965). He postulated that the utility a household obtains is generated by commodities that are produced by combining market goods and "auxiliary" goods with time in a household production function. The outputs of this production process are the utility generating commodities. The striking feature of the model is that a consumer's demand for market goods is a derived demand, in the same manner that firms have a derived demand for the factors of production. In what follows, the household production framework is extended in order to model kayak recreation decisions. The model outlined below is based on the earlier work of Dekay and Smith (1977) and Smith et al. (1983).

To begin with, two groups of inputs are introduced into the kayaker production process that yields commodities. One group of inputs, denoted I_k, refers to a kayaking commodity (or what can be thought of as the service flows of kayaking activity). Kayakers may utilise the inputs of time, market goods such as kayaking equipment, transport vehicles, petrol, etc. and the services of the river being visited in producing kayaking service flows. The quantities of market goods used in producing kayaking service flows are expressed by $q=(q_1,q_2,q_3,...,q_K)$. Each input alternative, q, is characterized by the pecuniary price P_k.

Another group of inputs consists of non-kayaking related consumption goods traded in markets. I_c denotes this non-kayaking composite commodity. The quantities of these inputs are expressed by $x \equiv (x_1,x_2,x_3,...,x_C)$. Each good is traded at the price P_c, and its consumption activity takes the time t_c. The consumption time, t_k, represents the time it takes, in hours, to get to and from the whitewater kayaking site[19]. Every kayaker is assumed to produce both the kayaking and composite types of commodities.

[19] In much of the travel cost literature opportunity cost is separated out into the components of travel time and on-site time (Smith et al., 1983, Shaw, 1992 and McConnell, 1992) but for the purposes of this chapter the latter is ignored and the framework concentrates solely on travel time. Having said this, the general conclusions of the theoretical framework would still be applicable if the analysis was extended to include on-site time. A whitewater kayaking trip also requires carrying out a car shuttle where one car is left at the take out of the river and the other car is left at the top. Since Irish rivers are very short in character, the travel time involved in a shuttle is usually only in the region of 15 to 20 minutes. For this reason it was decided not to include this portion of travel time in the study but it could be a significant consideration for whitewater kayaking in countries such as the U.S. or Canada where the whitewater runs are much longer and a shuttle could take anything up to 1.5 hours of additional travel time.

The production function of the kayaking commodity, denoted by F_k, is then expressed as:

$$I_k = F_k(q_k, t_k, S_k) \tag{6.1}$$

where S_k is the characteristics of the kayaking site, such as scenery quality, water quality, level of crowding, star rating of the whitewater, etc. The production function of the composite commodity, denoted by F_c, is expressed as:

$$I_c = F_c(x_c, t_c) \tag{6.2}$$

A kayaker is assumed to be a utility maximiser satisfying the following three conditions:

1. The kayaker's utility is a function of commodity bundles I_k and I_c, and is strictly concave and differentiable with respect to the quantities of I_k and I_c consumed.

$$U = U(I_k, I_c) \tag{6.3}$$

2. The commodity bundles consumed are produced under constraints on monetary income and available time. The constraint for the pecuniary income is:

$$\sum_k P_k q_k + \sum_c P_c x_c = M_0 = A + wT_w \tag{6.4}$$

where M_0 is monetary income, A is non-labor income, w is the net wage rate, and T_w is working time. It should be noted that identity 6.4 is an equality rather than an inequality. In order to simplify matters it will be assumed that non-labour income is zero (also no information was collected in the kayaker dataset in relation to unearned income). Therefore:

$$\sum_k P_k q_k + \sum_c P_c x_c = M_0 = wT_w \quad (6.5)$$

The constraint for the available time is:

$$T_A = \sum_k t_k q_k + \sum_c t_c x_c = T_o - T_w \quad (6.6)$$

where T_o refers to total time available for all activities. For example, T_o is 24 hours, if the period is 1 day and only one kayaker is involved. Typically T_o discounts sleep and eating hours, so is about 100 hours per week.

3. The kayaker makes earnings at the wage rate w without any binding constraint on working hours T_w. This assumption ensures that the marginal value of time is equal to the wage rate. It is restrictive in that it assumes that the individual is able to optimise, i.e. reach an interior solution, rather than being at a corner solution (e.g. an individual working a fixed number of hours).

The choice decision problem of a kayaker is now formulated in terms of the Lagrangian, denoted by:

$$\begin{aligned} L_0 \equiv & \max U(I_k, I_c) + \lambda_1 (wT_w - \sum_k P_k q_k - \sum_c P_c x_c) \\ & + \phi_1 (I_k - F_k(q_k, t_k, S_k)) + \phi_2 (I_c - F_c(x_c, t_c)) \\ & + \lambda_2 (T_o - T_w - \sum_k t_k q_k - \sum_c t_c x_c) \end{aligned} \quad (6.7)$$

where $\lambda = (\lambda_1, \lambda_2)$ and $\phi = (\phi_1, \phi_2)$ are non-negative Lagrange multipliers.

By condition 3, the working hour, T_w, is an independent decision variable for the kayaker. With respect to this variable, the first order condition of the kayaker's lagrangian maximization problem yields $w\lambda_1 = \lambda_2$. Therefore, the two constraints in equations (6.5) and (6.6) can be merged into one equation:

$$\sum_k (p_k + wt_k)q_k + \sum_c (p_c + wt_c)x_c = \sum_k mc_k q_k + \sum_c mc_c x_c = wT_w \quad (6.8)$$

The assumption that the marginal value of time spent kayaking or consuming goods is linearly proportional to the wage rate *w,* and the modified constraint of equation 6.8 implies the relationships in equations 6.9 and 6.10. Accordingly, the marginal price of a kayaking trip, mc_k, to whitewater site *i* is:

$$mc_k = p_k + wt_k \quad (6.9)$$

Similarly, the marginal price, mc_c, of a composite good, *c*, is:

$$mc_c = p_c + wt_c \quad (6.10)$$

Equation 6.9 illustrates that there are two major components that contribute to the cost of a kayaking excursion. Firstly, there is the monetary (marginal) cost of consumption of kayaking related products for the whitewater trip; the main ones being the vehicle-related travel costs (i.e. petrol for the trip, operating costs of the vehicle, etc). Secondly, there is the opportunity cost of travel time, which is proportional to the wage rate *w*.

6.2. The opportunity cost of time

Central to modeling of demand for recreation has been the problem of how to handle the time people spend in the enjoyment of the recreational activity at a site. Spending more time at a site enhances the benefits of recreational activity, so time should be a positive argument in the utility function. On the other hand the time it takes to get to and from the site may be considered a negative argument in the utility function. It should also be noted that time is also costly and hence should be treated as component of the cost of the trip. Traditionally, in the travel cost literature, time has been exogenously imposed as a constraint and becomes a part of the price. Two questions in particular are central to the value of leisure time in recreation demand models. What is the price of (working) time given up, and what fraction of this should be used as the value of leisure time?

The standard method of calculating travel cost in recreational demand studies is to multiply the distance to the different sites with a per kilometre price, usually calculated on the basis of marginal vehicle operating costs, petrol price, etc. To this cost, a cost taking into account the opportunity cost of leisure time is often added. Despite the difficulty of extrapolating the simple flexible leisure/work model[20] to many individuals in a recreation data set, the most common practice in the treatment of the opportunity cost of time (in recreational demand modelling) is to value it at the wage rate or some fraction thereof (Train, 1998). There has been and continues to be criticism of this wage-based approach (Smith et al., 1983, Shaw and Feather, 1999), as well as alternative suggestions (e.g. Bockstael et al., 1987 and Feather and Shaw, 1999), but little consensus on how this practice should be replaced.

For people in full time employment, most studies calculate an hourly wage using annual income. Reported annual income is then divided by the number of hours worked in a year, a number usually in the range of 2000 to 2080. Another approach is to calculate respondents hourly wage using a simple wage regression over the subset of individuals in the sample earning an hourly wage (Smith, et. al. (1983)). In this case, the wage rate is regressed on income and a vector of individual characteristics such as age, gender, and education. The fitted regression is then simulated over non-wage earners to impute

[20] In theory, an individual increases the number of hours worked until the wage at the margin is equal to the value of an hour in leisure. Multiplying the hourly wage times travel time, in this case, is a fair estimate of the opportunity cost of time. Unfortunately, the simple leisure/work trade off does not apply to individuals working a fixed 35-hour week job for a salary. These individuals do not have the flexibility to shift time in and out of work in exchange for leisure. The tradeoff is also implausible for retired individuals, homemakers, students, and the unemployed.

a wage[21]. As already mentioned, it is also common to see some fraction of the imputed wage used to value time, anywhere from 1/4 of the wage to the full wage. According to Feather and Shaw (1999), this practice stems from early transportation literature wherein analysts had imputed the time cost in empirical travel studies in this range.

Cesario (1976) is credited with first suggesting approximating the opportunity cost (value) of time as a fraction of an individuals wage rate. Despite the evident problems with so doing it remains, for practical reasons, the most popular approach. The appropriate fraction to choose is, as already mentioned, the subject of much debate. Thirty-three percent has probably been the most often chosen (Coupal et al. (2001) and Englin and Cameron (1996), being just two examples). In other travel cost studies Benson and Willis (1992) and Garrod and Willis (1992) used 43% of the hourly wage rate in calculating the opportunity cost of time. This was the figure recommended by the British Department of Transport at the time. In other studies Hanley (1989) and Bateman *et al.* (1996) found that using 0% and 0·025% provided them with the 'best' fit for their data. Indeed, Ward and Beal (2000) also consider the use of 0% appropriate. They considered the opportunity cost of time to be irrelevant because individuals were assumed to travel for leisure and recreation during their holidays when there is no loss of income.

According to Parsons et al. (2003), the recreation demand literature has more or less accepted 0.25 as the lower bound and the full wage as the upper bound but neither is really on a firm footing. As an example, Parsons et al. cites Feather and Shaw (1999) who show that, in theory, for those on a fixed work schedule it is possible for the value of time to be greater than the wage. It should also be noted that there have been other

[21] This regression-based approach can also be found in a report by McConnell and Strand (1994). Here the authors demonstrate a methodology for estimating a factor of proportionality between the wage rate and the unit cost of time within the travel cost model.

approaches used that infer values of time from market data (Bockstael et al., 1987 and Feather and Shaw, 1999).

Feather and Shaw (1999) estimate the shadow wage by using contingent behaviour questions about respondents' willingness to work additional hours along with actual working decisions. The relationship between the wage and shadow wage is determined by categorizing each individual's work schedule. With flexible work schedules, hours are adjusted until the shadow wage is equal to the market wage. The relationship between the shadow and actual wages is then translated to a probability statement and with contingent choice data, it is possible to use a maximum likelihood estimator to recover the structural parameters of the shadow wage equation. Feather and Shaw use predictions for each individual's hourly opportunity cost of time to construct the time cost component of prices to recreation sites.

Another study by Englin and Shonkwiler (1995) treat the various determinants of site visitation costs as components of a latent variable. The latent cost variable is estimated using distance converted to money travel costs, travel time and the wages lost in travel as indicator variables. The approach uses factor analysis to estimate travel costs. Englin and Shonkwiler are one of the few in the literature to provide evidence empirically that using a fraction of the hourly wage (in their case 33%) may be appropriate in measuring the opportunity cost of time. Shaw (personal correspondence) uses this fact to point out that using the "fractional" wage rate is an ad hoc approach and recommends instead the use of the full hourly wage in calculating the opportunity cost of time.

A recent study by Lew and Larson (2005) developed a discrete-choice recreation demand model that explicitly accounts for the stochastic shadow value of leisure time. Using data from a survey of San Diego beach users, the stochastic shadow value of time, labour supply, and beach choice are jointly estimated. To classify people into labour supply categories, respondents were asked several questions similar to those used by Feather and Shaw (1999). Once categorised, the probability of observing an individual choosing a given recreational site was made conditional on the probability that the individual falls into a specific labour class. The joint model was then estimated by maximizing the product of the likelihood functions for the recreational site choice and the labour supply model. Results from this joint estimation approach were compared with the usual approach that estimates labour supply first and uses predicted values of time in the recreational site choice model. Lew and Larson find that their approach produces markedly different welfare measures compared to the simpler model, which does not account for unobserved variability of time values.

Both Feather and Shaw's (1999) and Englin and Shonkwiler's (1995) approaches find results close to the simpler strategy of valuing the opportunity cost of time as some fraction of the average industrial wage. With Englin and Shonkwiler, the estimates for opportunity cost of time are close to one-third of the wage rate. For Feather and Shaw the shadow values are closer to the market wage. However both of these approaches are hard to implement in the field. One of the main advantages of the approach developed in chapter 6 for measuring the opportunity cost of time in recreational demand studies is the ease with which it can be implemented. Although, as can be seen from the review above, some progress has been made in estimating individual's opportunity costs of time, Phaneuf and Smith (2004) point out that a compelling replacement for the somewhat dubious strategies that dominate most recreation demand applications is still lacking. In this chapter a useful, more reliable framework is presented that researchers can use in future travel cost studies to measure the opportunity cost of leisure time.

The theoretical model in the previous section suggests that an empirically desirable approach for the treatment of travel costs is to use each individual's actual hourly wage rate as the appropriate measure of the opportunity cost of leisure time within the travel cost calculation, rather than a fraction thereof. In much of the travel cost literature the average wage is taken as the upper bound estimate of the opportunity cost of time. According to Parsons et al. (2003), the recreation demand literature has more or less accepted 25% of the hourly wage rate as the lower bound and the full wage as the upper bound. Other approaches have tried to infer values of recreation time from market data in the recreation context (Bockstael et al., 1987); whilst it is also possible to estimate the best-fitting fraction for use in a particular data set (Bateman et al., 1996).

Feather and Shaw (1999) estimate the shadow wage using contingent behavior questions about respondents' willingness to work additional hours. Lew and Larson (2005) followed a similar approach to Feather and Shaw (1999) and used the information to calculate the probability of observing an individual choosing a given recreational site conditional on the probability that the individual falls into a specific labour class. A joint recreational demand model was then estimated by maximizing the product of the likelihood functions for the recreational site choice and the labour supply model. Englin and Shonkwiler (1995) treat the various determinants of site visitation costs as components of a latent variable, which is estimated using distance converted to money travel costs, travel time, and the wages lost in travel as indicator variables.

This thesis argues that the use of the "fractional" wage may be underestimating the true opportunity cost of leisure time. There are 2 main reasons for this. Firstly, in a world of incentive-based pay structures such as overtime, piece-work and performance related pay regimes an individual's opportunity cost of time may actually be higher than his or her basic net hourly wage[22]. For those individuals who work a basic number of hours per week and who have the choice of working additional hours at a higher rate of pay

[22] It is apparent that the use of incentive programs is becoming more commonplace. The National Association of Manufacturers in America surveyed 4,500 companies examining the skill level of workers and common human resource practices. They found that 54% of these companies offered some type of bonus plan and another 35% offered some type of gainsharing or pay for performance program (Micco, 1997).

due to an incentive based pay system, the opportunity cost of leisure time will in fact be greater than their average wage rate (or what will be referred to here as their potential wage rate), w. Estimating this wage rate from a secondary data source is one key element of the empirical work of this thesis and reported in this chapter.

The "fractional" wage method may have been appropriate in the seventies and eighties but the movement towards incentive based pay structures in the past two decades means that this is no longer the case. This is particularly true for a country such as Ireland where incentive based pay schemes have recently increased in popularity due to a rapidly changing economic environment under globalisation, a tight labour market and the high influx of foreign direct investment in the sectors of electronics and pharmaceuticals. The possibility that the wage rate may be a lower (rather than an upper) bound estimate of the opportunity cost of travel time is an issue that has not been considered in the literature up until this point. Only Feather and Shaw (1999) highlight the possibility that the value of time may be greater than the wage for those individuals on a fixed work schedule.

Secondly, there is evidence that there may be corner solutions in the labour market where individuals are forced to work more hours than they would wish. For example, Feather and Shaw (1999) report that almost 50% of their respondents stated that they were "over-employed" while 19% of Lew and Larsons (2005) respondents reported a similar status. Schor (1991) also supplies evidence that the average American may be, as he puts it, "over worked". In the Irish case, a recent survey by the Economic and Social Research Institute (O'Connell et al., 2004) found that 47% of Irish employees "agreed or strongly agreed that they often have to work extra time over and above their formal hours to get through the job or help out". Furthermore, 38% of those in the survey indicated that their work took "too much of their family time".

If it is indeed the case that individuals are spending more time in work than they would like, (if they were free to choose), then the marginal value of leisure is actually higher than the marginal value of working (the wage rate). Once again this suggests that each individual's actual hourly wage rate should be used as the appropriate measure (or even the lower bound measure) of the opportunity cost of leisure time within the travel cost calculation rather than a fraction thereof. Ultimately however, unless one carries out a detailed survey of each respondent's labour market situation, one is forced to make ad hoc assumptions about what fraction of the wage rate to use.

For people in full time employment, most travel cost studies calculate an implied hourly wage using self-reported *annual* income. Reported annual income is then divided by a notional number of hours worked in a year, a number usually in the range of 2,000 to 2,080. One practical issue with this is that surveys often experience high item non-response rates for income questions, whilst household or individual income is typically only provided within a range (e.g. "€20,000 - €25,000 per annum"). Another approach, much less used, is to calculate a respondent's hourly wage using a simple wage regression over the subset of individuals in the sample earning an hourly wage, using self-reported values for this wage rate (Smith et al., 1983). The fitted regression is then simulated over non-wage earners to impute a wage: however, this approach also suffers from the tendency of respondents to be reluctant to disclose their income (as noted above). In any case, self-employed respondents and those who earn salaries will be unlikely to know what their implied hourly wage is anyway.

In this chapter, a value for w is estimated for each person in the sample using a secondary data source, the European Community Household Panel. The estimated wage is related to respondents using survey questions regarding their socio-economic status. This procedure is followed separately for male and female workers. 100% of this estimated wage is then attributed as the cost of leisure time (i.e. the standard assumption of the human capital literature that the opportunity cost of other activities equals the marginal wage rate is made), in order to calculate marginal trip costs, and compare welfare measures and demand models fitted with those arising from more standard treatments of time valuation. By estimating a wage rate for each respondent using a large panel data set of individuals in the Irish labour market, it highlights the fact that instead of participating in the recreational activity of kayaking, the respondents could be working in the job they already have or alternatively they could be doing alternative work suitable to their education, age, etc.

This method of calculating the opportunity cost of time is superior to the usual method of dividing gross earnings by 2,000 hours, or some such figure, (referred here to as the derived hourly wage) for a number of reasons. Firstly, survey respondents are often unwilling to divulge their earnings or wage rates but will usually have no problem discussing related socio-economic data. For example, Chakraborty and Keiths' (2000) travel cost study on mountain biking in Utah resulted in 22% of surveys being returned incomplete, the majority of which, according to the authors, related to missing data on earnings. Indeed, for the sample of kayakers, 18 of the 26 unusable returned surveys contained missing data on income. By using a wage equation from a secondary dataset the necessity of having to solicit any information on actual earnings in the survey is avoided. This could greatly increase the number of usable completed responses in travel cost modelling or indeed any other survey based non-market valuation technique.

Secondly, even if the respondent does supply information on his earnings, survey designers have a tendency to use earnings bands that are very wide in order to encourage the respondents to divulge information on their annual income. This ad hoc approach results, at best, in an a vague estimate for an individuals earnings even before one divides this number by some other arbitrary figure such as 2,000. Also, some survey respondents cannot be asked directly what their hourly wage rate is as those on a salary would have very little idea. Thirdly, using this derived hourly wage only supplies a potential wage rate for those respondents in an employed state. Respondents who are in full-time education but who could potentially work part-time and respondents who are not in education but still working part-time, are not supplied with potential wage rates using this method[23]. In addition, simply using a derived hourly wage calculated from respondents' gross earnings does not take into account individuals' unique circumstances or the fact that different individuals work different hours and could potentially work in alternative employment during their free time. Finally, since the use of environmental services such as kayaking on a river, or hill walking, are considered luxury goods it would be expected that those individuals from the labour force who participate in these outdoor activities are on a higher than average income. Indeed, for the sample of kayakers, those who declared themselves "employed" had an average gross income of €39,827 compared to the average Irish annual industrial wage of €29,574[24].

In summary, because (a) individuals are reluctant to respond to questions about pay in surveys of this kind, (b) because they tend to mis-report the pay they receive and the hours they work, (c) because they tend not to report the "true" opportunity cost of pay which may include bonus and other types of payment methods and (d) in order to predict potential hourly pay for those who are not in work such as students, this study utilises externally estimated hourly wage variables from a dedicated income survey, which relies upon pay slip information, in this case the European Community Household Panel Survey. By using a potential hourly wage for each respondent predicted with an earnings model from a secondary dataset of the general Irish labour force and basing this upon each respondent's actual socio-economic characteristics, I

[23] Dividing the gross earnings of part-time workers by 2,000 hours or some similar figure will greatly underestimate these individuals' hourly wage rates.

hope to demonstrate that the wage estimates used in the random utility site choice model are a truer reflection of each respondent's actual opportunity cost of time.

6.3. The ECHP Dataset

As discussed in chapter 5, respondents to the kayaking survey were asked to indicate, amongst other things, their age, education level, what part of the country they live in and what their main occupation was (if they were not currently in full time education). This socio-economic information allows one to use a potential hourly wage rate estimated using data on the Irish labour force from the European Community Household Panel dataset (ECHP) to predict an hourly wage rate for each respondent. The ECHP is a comparative household panel data set covering European Union Member States. It contains sampled micro-data at individual and household level. The survey includes information on personal demographics, income, employment status, education, health, social relations, migration and satisfaction. In addition, at the household level it contains information on the financial situation of the household, accommodation, durables and children. The ECHP is a household-level survey and therefore collects information on all members of responding households.

The data set for Ireland extracted from the ECHP and used to estimate a potential hourly wage rate for the survey respondents consists of 2,090 individuals for the year 1999. The hourly earning figures in the ECHP for this year have been adjusted to 2003 earnings using the Central Statistics Office (CSO) Irish industrial earnings index. The estimation procedure for the potential hourly wage rate and how it is then used in estimating travel costs to the whitewater sites in the survey will be expanded upon in the next section.

[24] This average Irish industrial earnings figure for 2003 and was taken from the Irish Central Statistics

6.4. The Random Effects Wage Model

As already mentioned in this chapter, a potential hourly wage function (equation 6.11) is estimated from the Irish ECHP panel dataset. A Mincerian earnings equation was derived and estimated with the log of the net hourly wage rate as the dependent variable and schooling dummies, occupation dummies, experience, experience squared, a public sector worker dummy and a region dummy as explanatory variables. This is a standard type wage equation in the earnings estimation literature (Barret et al., 2002; Blackaby et al., 1996; Casey, 2004). The results of this estimation process can be found in table 6.1. Four hourly wage functions are estimated, one for full-time men, one for full-time women, one for men who are working part time but are in full-time education and finally one for women who are also working part time but are in full-time education.

The wage equation used is based on Mincer's (1974) earnings function. The study of the effects of investment in schooling and on-the-job training on the level, pattern and interpersonal distribution of life-cycle earnings was first pioneered by Becker (1964) and Mincer (1962). The Mincer equation captures four important empirical regularities. The first is that earnings increase with schooling. Secondly, there is concavity of log earnings in experience. Thirdly, there is parallelism in log earnings experiences profiles for different education groups (i.e. the ratio of earnings for persons with education levels differing by a fixed number of years is roughly constant across schooling levels) and fourthly there is U-shaped interpersonal variance in earnings. Following Mincer's example, an Experience variable that is equal to Age minus Schooling minus 5 is used $(E=A-S-5)$ to capture the interaction between schooling and experience. Since the ECHP is a panel dataset that follows the same individuals over time, a random effects cross-sectional time-series regression model is fitted. The potential wage equation is therefore as follows:

Office (CSO) website http://www.cso.ie/schools/earnings.html.

$$\ln w_{it} = \beta_0 + \beta_1 Univ_{it} + \beta_2 upsec_{it} + \beta_3 E_{it} + \beta_4 E_{it}^2 + \beta_5 Occ_{it} + \beta_6 Year_{it} + \beta_7 Public_{it} + \beta_8 Region + \mu_i + \upsilon_{it}, \quad (6.11)$$

where $\ln w_{it}$ is the log of the hourly wage for individual *i* in year *t*, *Univ* is a dummy variable indicating whether the individual is a university graduate, *Upsec* is a dummy variable indicating if an individual's highest level of educational achievement is upper secondary level, *E* is experience, E^2 is experience squared, O*cc* is an occupational dummy, *Year* is a dummy variable indicating the actual years in the ECHP dataset[25], *Public* is a dummy variable indicating if an individual is a public sector worker, region indicates where in Ireland the individual is from and ε is a random error reflecting unmeasured factors that affect *w*.

In the Random Effects wage model, ε is made up of two parts, the component μ_i is the random disturbance characterising the ith individual and is constant through time (called the permanent effect). υ_{it} is the random component that varies both across individuals and across time (called the transitory effect). When equation 6.11 is used to predict hourly wages for the sample of kayakers the coefficients for all the year dummies are set to 0 as the kayaking dataset is a cross-sectional dataset for 2003. The wage rate for all years in the ECHP have been adjusted to reflect 2003 prices using the average industrial hourly wage index from the Irish Central Statistics Office (http://www.cso.ie/schools/earnings.html).

Almost all empirical studies find that schooling has a positive and significant effect on earnings. It would therefore be expected that $\beta_1 > 0$ and $\beta_2 > 0$. It would also be expected that earnings are a concave function of labour market experience (i.e. $\beta_3 > 0$

[25] There are 8 years of information in the ECHP, 1994 to 2001. The year dummies pick up any significant changes in the wage rate unique to any one year. When using the wage equation to predict an hourly wage for our sample of kayakers the year dummies drop out as our sample of kayakers are from the year 2004.

and $\beta_4 < 0$). As already stated the wage equation includes a dummy variable for occupation. This could pose a problem of endogeneity if the goal of the wage equation was to explain the variation in the wage rate for the sample, but this is not the objective here.

Statistical endogeneity of occupation in the wage function may result from (1) unobserved determinants of occupation that also influence wages and/or (2) measurement error. However, since the wage function is being used to predict a potential wage rate for the sample of kayakers and not for the explanation of the variation in their earnings, the inclusion of the occupation dummies as explanatory variables is not seen to be a problem. In any case the schooling variables are more likely to be endogenous than the occupational variable. Because of the significance of the unobserved effects (as found by using the Breusch-Pagan Lagrange Multiplier Test) the random effects model was chosen over the pooled cross-section model. Although the random effects model is rejected by the Hausmann test, it was still decided to use the random effects model rather than the fixed effects model as the goal of the analysis is to predict earnings for another sample. In any case, the size, sign and significance of the coefficients in the random effects model are very similar to the pooled cross-sectional model.

6.5. The Whitewater Recreation Demand Model

Following the estimation of the opportunity cost of time, the Random Utility Site Choice (RUSC) model or what is more commonly referred to as simply the RUM (Random Utility Model) model is now used to model the kayakers' decision-making process in terms of choices over alternative, substitute whitewater sites. Modeling recreation demand with the RUM model assumes site selections are made for each choice occasion independently. Choice occasions are single days or weekends. The

RUM approach models the choice of a recreation site from among a set of alternative sites as a utility-maximizing decision, where utility includes a stochastic component. RUM models emphasize the impact of site quality on recreation demand and are typically estimated using either multinomial, nested logit or random parameter models (Train, 1998). Since the RUM has already been discussed in chapter 3, it is not formally presented again in this chapter. Instead this discussion of the recreational demand model focuses on the measurement of the travel cost variable.

In the literature, the opportunity cost of travel time is usually assumed to be a fixed proportion, ω, of an individuals predicted potential hourly wage. Clear guidance does not exist for choosing a value of ω, though other studies have used values in the range of 0.25 (Needelman and Kealy, 1995) to 0.333 (Loomis etal.,1995) to 0.43 (Garrod and Willis, 1992). Lower values of ω tend to give more conservative estimates of the value of a site. However, having reviewed the criticisms of this approach in the literature and the already discussed impacts of incentive based pay structures it was decided to use the full wage rate rather than a fraction thereof, for this study. Once the opportunity cost of leisure time has been calculated, the total travel cost is then given by:

$$TC_{ij} = ((2 * (distance * €0.25))/2.3) + ((travel\ time/60) * HW_i) \qquad (6.12)$$

Where TC_{ij} is the travel cost of kayaker *i* to whitewater site *j* and HW_i is the predicted potential hourly wage rate of kayaker *i*. In calculating the travel cost to each whitewater site the Automobile Association (AA) of Ireland's calculations for the marginal costs of motoring for a car of average size of €0.25/mile[26] is used. It is usual for the petrol expenses of a kayaking trip to be divided amongst all the participating passengers in the vehicle traveling to the whitewater site. In a recent poll looking at river usage in Ireland

[26] Due to the fact that the distance variable in the dataset is only for the "one way trip to the river or whitewater feature" it is multiplied by the number 2 to take account of the fact that the kayaker makes a

carried out on the internet site www.irishfreestyle.com, online users were asked how many kayakers travelled in the vehicle they were in, on the last river trip they were on. It was found that the average number of kayakers per vehicle was 2.3 individuals. A similar figure of 2.5 individuals per vehicle was used in another travel cost study that looked at whitewater recreation on the Gauley river in West Virginia (Ready and Kemlage, 1998). Given this finding, the round trip petrol expense portion of equation 6.12 is divided by 2.3 making the assumption that kayakers share the petrol cost of a kayaking excursion. To the extent that this estimate is too high (low), the per-trip consumer surplus will be underestimated (overestimated).

This approach to measuring the opportunity cost of travel time has a distinct advantage over most other travel cost studies. Whereas most of these other studies simply use a fractional wage rate extracted from the gross income variable for the sample population in calculating the opportunity cost of travel time (see for example Cesario and Knetsch, 1976 and Loomis et al., 1995), in this study each individuals potential hourly wage as predicted by the earnings model from the ECHP dataset and based upon that persons actual socio-economic characteristics is used. This should give a much better indication of the true opportunity cost facing each and every kayaker in the sample when they are deciding on which whitewater site to visit, assuming of course that the full wage rather than a fraction thereof is the correct opportunity cost figure to use. Also, since large panel data sets with excellent labour market information have become much more available in recent times, the approach adopted in this chapter (and used in all the further whitewater kayaking demand analysis in this thesis), can be replicated in

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return journey from his or her place of origin and the costs associated with this return journey are what influence the choice of site to kayak at.

recreation travel cost studies for almost any site in all developed (and some less developed) countries[27].

Following the calculation of the opportunity cost of time, the next stage of the analysis involves modeling the kayaker's decision-making process in terms of choices over alternative, substitute whitewater sites. The valuation of the recreational use of an environmental amenity attempts to estimate the economic value, in monetary terms, that members of society receive from uses of natural resources that cannot be efficiently allocated through markets due to their public good characteristics. To illustrate the effects of different treatments of travel time on welfare estimates, the change in consumers surplus for a number of site quality changes is calculated using the Hanemann formula already discussed in chapter 3:

$$CS = -1/\beta_m \left[\ln\left[\sum_i \exp(V_i^1(b_i^1))\right] - \ln\left[\sum_i \exp(V_i^0(b_i^0))\right]\right] \qquad (6.13)$$

In a political context policy makers could use the calculated change in consumer surplus as measured in 6.13 to predict the kayaking community's support generated by different policy options. Some of the potential policy options in regards to Irish whitewater kayaking are discussed in section 6.7. In section 6.6 the results of the wage estimation procedure are presented and three RUM models are compared, one where the opportunity cost of time is not included in the travel cost calculation, one where the opportunity cost of time is included and calculated as outlined above using the secondary dataset and the potential hourly wage and one where the opportunity cost of time is measured using the annual income information provided in the survey.

[27] The ECHP dataset contains data on individuals in twelve member states: Germany, Denmark, Belgium, the Netherlands, Luxembourg, the UK, France, Ireland, Italy, Greece, Spain and Portugal. Other countries have joined the survey since 1994: Austria in 1995, Finland in 1996 and Sweden in 1997. Also, Britain has the New Earnings Survey and the British Household Panel Study. In Germany they also have the German Socio-Economic Panel, Canada has the Statistics Canada Tax Database maintained by Revenue Canada and in the United States there are numerous panel datasets, one such being the US Study of Income Dynamics started in 1968.

6.6. Model Estimation and Results

6.6.1. Potential wage model estimation and results

Table 6.1 contains the results of the estimated Random Effects wage equations (which uses a generalized least squares estimator) from the ECHP dataset. For comparison purposes a Fixed Effects (using the within regression estimator), a pooled cross-sectional and a first differenced wage equation are also estimated (tables 6.2 and 6.3). On the whole the Random Effects and the pooled cross-sectional models provide results that are much more significant that either the Fixed Effect or first differenced models. Indeed, the latter two models have goodness of fit statistics ranging between only 4% and 11%. Furthermore, the coefficients in these later two models are mostly insignificant, the worst example being in the female student first-differenced wage equation where only 4 variables have coefficients that are significant at the 5% level.

Table 6.1.Random Effects Hourly Earnings Regressions from European Community Household Panel (ECHP) Irish Dataset

ln W	Men (Employed)	Women (Employed)	Men (Students)	Women (Students)
University level education achieved	0.436	0.399	0.65	0.757
	(20.77)**	(15.89)**	(8.83)**	(9.87)**
Upper Secondary level education achieved	0.151	0.177	0.331	0.464
	(10.98)**	(9.51)**	(5.97)**	(7.03)**
Experience	0.051	0.03	0.088	0.079
(Age minus years of education minus 5)	(25.08)**	(12.41)**	(6.83)**	(6.81)**
Experience Squared	-0.001	-0.001	-0.002	-0.002
	(16.97)**	(9.45)**	(3.40)**	(3.29)**
Working Part-time	0.441	0.31		
(0 - part time worker, 1 - full time worker)	(10.38)**	(13.50)**		
Public Sector Worker	0.171	0.204		
(0- private sector, 1 - public sector)	(10.44)**	(11.70)**		
Professionals	0.1	0.157	0.072	0.266
	(4.06)**	(4.81)**	-0.73	(2.91)**
Technicians and associate professionals	0.037	0.045	0.062	0.229
	-1.61	-1.38	-0.63	(2.37)*
Clerks	-0.052	-0.004	-0.087	0.073
	(2.02)*	-0.12	-0.84	-0.79
Service workers and shop and market sales workers	-0.085	-0.186	-0.01	0.087
	(3.35)**	(5.99)**	-0.1	-0.93
Skilled agricultural and fishery workers	-0.194	-0.449	-0.386	-0.612
	(4.69)**	(2.88)**	(2.03)*	-1.39
Craft and related trade workers	-0.046	-0.046	0.026	-0.057
	(2.01)*	-0.85	-0.27	-0.28
Plant and machine operators and assemblers	-0.103	-0.054	-0.067	0.015
	(4.45)**	-1.51	-0.66	-0.14
Elementary occupations	-0.158	-0.15	-0.208	-0.03
	(6.65)**	(4.09)**	(2.10)*	-0.25
Armed forces	-0.068	-0.044	-0.086	0.373
(0 is legislators, senior officers and senior managers)	-1.38	-0.16	-0.5	-1.13
1995	0.037	0.06	0.058	0.042
	(3.48)**	(4.26)**	-0.98	-0.83
1996	0.014	0.062	0.009	0.086
	-1.26	(4.24)**	-0.15	-1.66
1997	0.028	0.087	0.175	0.052
	(2.42)*	(5.73)**	(2.86)**	-0.92
1998	0.045	0.104	0.125	0.052
	(3.75)**	(6.73)**	(2.12)*	-0.95
1999	0.078	0.11	0.249	0.046
	(6.21)**	(6.81)**	(4.13)**	-0.79
Regional Dummy	0.045	0.02	0.121	-0.043
(0-Border, Midlands and West, 1- East and South East)	(3.11)**	-1.11	(2.26)*	-0.91
Constant	1.249	1.258	0.876	0.725
	(40.55)**	(31.54)**	(7.53)**	(5.98)**
Observations	7980	5454	858	799
Number of PID	2507	1867	556	514
R-squared				

Absolute value of z statistics in parentheses
* significant at 5%; ** significant at 1%

Table 6.2. Alternative Hourly Earnings Regressions from European Community Household Panel (ECHP) Irish Dataset, Estimated for Employed Men and Women

	Fixed Effects Model		Pooled Cross-Sectional Model		First Differenced Model	
ln W	Men (Employed)	Women (Employed)	Men (Employed)	Women (Employed)	Men (Employed)	Women (Employed)
University level education achieved	-0.031	-0.121	0.402	0.418	0.054	-0.1
	-0.66	-1.95	(23.65)**	(20.89)**	-1.04	-1.38
Upper Secondary level education achieved	-0.028	-0.045	0.145	0.173	0.013	-0.043
	-1.22	-1.18	(12.76)**	(11.40)**	-0.5	-1.01
Experience	0.017	-0.003	0.049	0.031	0.025	0.002
(Age minus years of education minus 5)	(4.00)**	-0.5	(32.80)**	(16.79)**	(4.62)**	-0.28
Experience Squared	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001
	(10.32)**	(4.15)**	(22.77)**	(12.97)**	(5.45)**	(2.63)**
Working Part-time	0.482	0.359	0.419	0.21	0.006	0.084
(0 - part time worker, 1 - full time worker)	(10.17)**	(13.20)**	(8.55)**	(9.29)**	-0.19	(2.83)**
Public Sector Worker	0.038	0.085	0.226	0.231	0.577	0.433
(0- private sector, 1 - public sector)	-1.46	(3.25)**	(19.58)**	(17.11)**	(11.82)**	(15.68)**
Professionals	0.045	-0.012	0.087	0.163	0.021	0.011
	-1.48	-0.29	(3.99)**	(5.31)**	-0.65	-0.22
Technicians and associate professionals	0.053	0.041	-0.011	0.022	0.043	0.099
	(2.01)*	-1.07	-0.52	-0.69	-1.51	(2.27)*
Clerks	0.014	0.056	-0.154	-0.092	0.018	0.079
	-0.45	-1.52	(6.37)**	(3.13)**	-0.52	-1.85
Service workers and shop and market sales workers	0.015	-0.024	-0.193	-0.287	0.023	0.09
	-0.47	-0.61	(8.43)**	(9.62)**	-0.67	(2.07)*
Skilled agricultural and fishery workers	-0.027	-0.421	-0.384	-0.545	-0.007	-0.39
	-0.55	(2.14)*	(9.45)**	(3.77)**	-0.13	-1.85
Craft and related trade workers	0.02	0.05	-0.109	-0.101	-0.006	0.16
	-0.7	-0.74	(5.38)**	(1.96)*	-0.19	(2.13)*
Plant and machine operators and assemblers	-0.03	0.007	-0.158	-0.057	-0.027	0.021
	-1.03	-0.15	(7.56)**	-1.72	-0.86	-0.41
Elementary occupations	0.01	0.022	-0.37	-0.276	0.003	0.109
	-0.34	-0.48	(16.76)**	(7.96)**	-0.08	(2.09)*
Armed forces	-0.01	0.593	-0.165	-0.243	0.13	0.693
(0 is legislators, senior officers and senior managers)	-0.13	-1.5	(4.58)**	-0.85	-1.27	-1.92
1995	0.082	0.119	0.038	0.042		
	(6.95)**	(7.41)**	(2.58)**	(2.34)*		
1996	0.103	0.16	0.011	0.036	-0.059	-0.078
	(7.22)**	(8.33)**	-0.73	(1.99)*	(4.12)**	(3.93)**
1997	0.161	0.229	0.014	0.048	-0.082	-0.124
	(9.37)**	(9.98)**	-0.9	(2.59)**	(3.23)**	(3.55)**
1998	0.207	0.28	0.036	0.059	-0.112	-0.195
	(10.74)**	(10.95)**	(2.25)*	(3.17)**	(3.10)**	(3.90)**
1999	0.277	0.32	0.073	0.067	-0.121	-0.268
	(12.17)**	(10.72)**	(4.40)**	(3.50)**	(2.57)*	(4.14)**
Regional Dummy	0.017	-0.021	0.06	0.042	0.028	-0.042
(0-Border, Midlands and West, 1- East and South East)	-0.94	-0.86	(4.98)**	(2.94)**	-1.43	-1.53
Constant	2.045	1.962	1.356	1.345	0.07	0.116
	(25.06)**	(19.37)**	(50.57)**	(37.85)**	(6.03)**	(7.16)**
Observations	7980	5454	7980	5454	5309	3473
Number of PID	2507	1867				
R-squared	0.08	0.11	0.46	0.44	0.04	0.08

Absolute value of z statistics in parentheses

* significant at 5%; ** significant at 1%

Table 6.3. Alternative Hourly Earnings Regressions from European Community Household Panel (ECHP) Irish Dataset, Estimated for Male and Female Students

	Fixed Effects		Pooled Cross-Sectional		First Differenced	
ln W	Men (Students)	Women (Students)	Men (Students)	Women (Students)	Men (Students)	Women (Students)
University level education achieved	0.947	-0.483	0.616	0.776	0.82	-0.326
	(3.34)**	-1.3	(8.67)**	(10.79)**	(2.79)**	-0.87
Upper Secondary level education achieved	0.454	-0.261	0.327	0.466	0.304	-0.104
	(2.57)*	-0.97	(6.01)**	(7.44)**	-1.82	-0.4
Experience	0.092	-0.107	0.087	0.087	0.087	-0.104
(Age minus years of education minus 5)	(2.38)*	(2.46)*	(7.02)**	(8.03)**	-1.66	(2.05)*
Experience Squared	-0.002	0.005	-0.002	-0.003	-0.002	0.004
	-1.24	(2.62)**	(3.57)**	(4.34)**	-0.89	(2.13)*
Professionals	-0.042	0.114	0.073	0.21	-0.069	0.081
	-0.23	-0.78	-0.76	(2.46)*	-0.43	-0.58
Technicians and associate professionals	0.121	0.248	0.038	0.176	0.091	0.221
	-0.7	-1.6	-0.38	-1.93	-0.63	-1.57
Clerks	0.119	0.195	-0.114	0.035	-0.019	0.077
	-0.68	-1.29	-1.08	-0.41	-0.12	-0.56
Service workers and shop and market sales workers	0.231	0.393	-0.046	0.039	-0.086	0.328
	-1.24	(2.63)**	-0.47	-0.43	-0.52	(2.40)*
Skilled agricultural and fishery workers	0.223	0.547	-0.386	-1.149	-0.267	0.526
	-0.65	-0.95	(2.03)*	(2.47)*	-0.94	-1.06
Craft and related trade workers	0.155	-0.04	0.006	-0.083	-0.157	0.163
	-0.8	-0.12	-0.06	-0.41	-0.88	-0.6
Plant and machine operators and assemblers	0.079	0.085	-0.061	-0.017	-0.086	0.009
	-0.41	-0.44	-0.61	-0.16	-0.49	-0.05
Elementary occupations	0.17	0.197	-0.296	-0.086	-0.162	0.201
	-0.92	-0.74	(2.99)**	-0.73	-1.01	-1.03
Armed forces	-0.415	0.923	-0.066	0.262	0.051	0.809
(0 is legislators, senior officers and senior managers)	-1.17	-1.71	-0.39	-0.78	-0.09	-1.68
1995	0.106	0.256	0.057	0.009		
	-1.19	(3.21)**	-0.9	-0.16		
1996	0.073	0.377	0.015	0.061	-0.161	-0.103
	-0.74	(4.06)**	-0.24	-1.1	-1.66	-1.47
1997	0.295	0.441	0.165	0.032	-0.118	-0.227
	(2.68)**	(4.00)**	(2.56)*	-0.53	-0.7	-1.81
1998	0.249	0.637	0.109	0.022	-0.217	-0.308
	-1.91	(4.54)**	-1.75	-0.38	-0.89	-1.67
1999	0.458	0.722	0.226	0.037	-0.198	-0.424
	(2.99)**	(4.22)**	(3.59)**	-0.62	-0.62	-1.78
Regional Dummy	0.295	-0.152	0.1	-0.03	0.083	-0.198
(0-Border, Midlands and West, 1- East and South East)	(2.32)*	-1.38	(1.98)*	-0.72	-0.71	(2.08)*
Constant	0.445	1.801	0.928	0.754	0.137	0.254
	-1.66	(4.68)**	(7.93)**	(6.51)**	-1.8	(4.06)**
Year -Individual Observations	858	799	858	799	344	374
Number of Individuals	556	514	858	799		
R-squared	0.27	0.15	0.25	0.3	0.12	0.11

Absolute value of z statistics in parentheses

* significant at 5%; ** significant at 1%

The low R^2 values and insignificant variables in the first differenced model occur due to the fact that the time-invariant variables (such as education level and occupation) have been almost completely differenced out along with the fixed effects. These variables do not fall out of the equations completely due to a small amount of transitions between education levels, occupations, etc. over the lifespan of the ECHP panel. In any case a fixed effect modelling approach is not deemed suitable for the ECHP dataset. When data contains all existing cross-sectional units (for example a specific set of N firms or a set of N Irish counties), one finds that the fixed effect model works best. Where one has a limited sample of the existing cross-sectional units (as is the case with the ECHP dataset for Ireland, where there is data on the behaviour of a few thousand individuals over time – where these are only a few of the thousands of individuals in the Irish population), the random effects model typically works best.

The pooled cross-sectional model provides results that are broadly similar to the chosen Random Effects model and even provide a marginally higher R^2. Having said that, the OLS regression estimates, when they are applied to pooled data, are likely to be biased, inefficient and/or inconsistent[28]. Therefore, even though the Random Effects model estimated here fails the Hausman test, the bias involved is found to be small and it is still taken as the chosen model. The χ^2 test of significance for the dominant equation of males in employment yields a value of 2,445, which indicates that, taken jointly, the coefficients in the chosen model are significant. Almost all variables are significant at the 5% level for the male employed wage equation. Furthermore, the Breusch-Pagan Lagrange Multiplier Test indicates that all the Random effects models have significant unobserved effects. The χ^2 test of significance for the equation of males in employment

[28] A discussion of the complications that arise with the use of pooled cross-sectional models is beyond the scope of this thesis but the interested reader will find a full discussion of the problems involved in Hicks (1994).

for example, yields a value of 2,987, which indicates that the probability of the variance of v_{it} being equal to zero is virtually zero.

In regards to the male hourly earnings equation, the coefficients of what one would a priori expect to be the most relevant variables in explaining hourly wages (experience, education levels and experience squared) are significant at the 1% level and are of the expected sign. Indeed, these variables are significant at the 1% level for all four equations whether it be for men, women or students in part-time work. The dummy variables for occupation are of the correct sign in relation to the base category of "legislators, senior officers and managers" for the male employed wage equation. The dummy for armed forces however is found to be insignificant in all models. In terms of interpretation[29] it is estimated that having completed secondary level education has a rate of return of 15% while having completed third level education gives a rate of return of 44%. Total experience increases wages at a decreasing rate as expected. The increase in wages with experience turns around after 25.5 years. Working in agriculture/fishing or in some elementary occupation has the greatest negative impact on ones wages compared to the base occupational category at -19% and -16% respectively. Finally people in the East or South East of the country are estimated to have higher wages of 4.5%.

Because the explanatory variables in the Random Effects wage model are also variables collected in the kayaking questionnaire this earnings equation may be used to predict a potential hourly wage rate for each kayaker in the dataset[30]. On average, the proposed

[29] The interpretation is for the wage equation of male workers not in fulltime education as this is the dominant group in the ECHP dataset. Furthermore, this group caters for 68% of the individuals in the kayaking dataset.

[30] For current third level students in the kayaking dataset the potential hourly wage rate was not calculated with the full wage equations but instead with a part-time wage equation (columns 3 and 4 in Table 1 and again in Tables A and B in Appendix A), again estimated using data on full-time students with part-time employment in the ECHP dataset. This was done under the assumption that students could be working part-time rather than kayaking in the time they have available to them outside of their study commitments. It was further assumed that the opportunity cost of leisure time for unemployed persons in

wage model predicts potential wages that are 49% lower than the wage rate derived by dividing each respondent's gross earnings by 2,000 (€7.03 compared to €13.81).

Table 6.4 presents a comparison, by occupational category, of the potential wage as predicted by our preferred model to the wage rate derived by dividing each respondent's gross earnings by 2,000. On average, the proposed wage model predicts potential wages that are 49% lower than the wage rate derived by dividing each respondent's gross earnings by 2,000 (€7.03 compared to €13.81). This result is not unexpected. It needs to be kept in mind that the potential wage predicted by our preferred model is a net figure (only net hourly wage figures are given in the ECHP dataset) whereas the wage rate derived by dividing each respondent's gross earnings by 2000 is a gross. Therefore the fact that the proposed wage model predicts potential wages that are lower than the wage rate derived by dividing each respondent's gross earnings by 2,000 is what one would have expected. The fact that it is on average 49% lower is however a bigger difference than one would have expected.

Table 6.4. Comparison of Wage Estimates by Occupation

	Wage as calculated using ECHP		Wage as calculated by reported income/2000	
	Mean	Std. Dev	Mean	Std. Dev
Legislators, senior officers and managers	9.43	2.42	27.24	10.58
Professionals	9.51	1.92	20.59	8.18
Technicians and associate professionals	7.71	1.30	15.28	5.36
Clerks	8.37	1.86	17.50	5.12
Service workers and shop and market sales workers	5.69	3.11	9.64	5.14
Skilled agricultural and fishery workers	6.65	0.52	9.17	2.39
Craft and related trade workers	6.36	2.96	15.42	6.94
Plant and machine operators and assemblers	6.67	0.31	10.83	2.39
Elementary occupations	6.04	1.08	11.14	3.10

the dataset was zero. Therefore, even though their potential wage should be positive to reflect the fact that these individuals have attributes that should allow them to earn a certain wage in the labour market, it is set to zero as it is to be used as their opportunity cost of time figure in the calculation of their travel costs. It was assumed that with a situation of full (or near to full) employment in the Irish labour market disabilityfree unemployed persons choose to be in an unemployed state.

The dispersion of wages predicted for the respondents using the proposed wage equation is also 28% lower, as measured by the standard deviation statistic, than from the alternative method of dividing each respondent's gross earnings by 2000. Given these alternative measures of the opportunity cost of time, table 6.5 then presents summary statistics of three alternative travel cost specifications for the sample of 2,805 kayaker-whitewater site observations.

Table 6.5. Summary Statistics of Alternative Travel Cost Specifications

	Mean	Std. Deviation	Minimum	Maximum
Travel Cost including opportunity cost of leisuire as measured using ECHP data[1]	37.60	20.76	1.22	151.07
Travel Cost excluding opportunity cost of leisure time[2]	21.8	12.12	0.32	66.30
Travel Cost including opportunity cost of leisure as measured using derived hourly earnings from kayaker survey [3].	53.01	39.57	1.077	363.8

1. Travel Cost = ((2* (distance * €0.25))/2.3) + ((travel time/60) * Estimated Hourly Wage)
2. Travel Cost = ((2* (distance * €0.25))/2.3)
3. Travel Cost = ((2* (distance * €0.25))/2.3) + ((travel time/60) * ((Gross Earnings/2000)))

The dispersion of wages predicted for the respondents using the proposed wage equation is also 28% lower, as measured by the standard deviation statistic, than from the alternative method of dividing each respondent's gross earnings by 2000. Travel cost including opportunity cost of leisure time, as measured using the potential wage figure, has the average value of €37.60. This is 1.72 times greater than the travel cost specification that excludes the opportunity cost of time altogether and 30% lower than the travel cost specification that includes the opportunity cost of leisure time derived by dividing each respondent's gross earnings by 2000.

Table 6.6.The Z Values and Confidence Intervals of the Alternative Travel Cost Coefficients

Travel Cost Coefficient	Coef.	Std.Error	Z value	P> Z	P>z [95%	Conf. Interval]
TC echp	-0.07	0.00	-17.98	0.00	-0.08	-0.06
TC (no opportunity time included)	-0.12	0.01	-19.33	0.00	-0.13	-0.11
TC average wage from survey (TC + Income /2000)	-0.04	0.00	-15.42	0.00	-0.04	-0.03

As can be seen from Table 6.6 the alternative specifications of the travel cost (TC) coefficients are all statistically significant at the 95% level. There is however no overlap between the confidence intervals for the TC coefficients as calculated from the ECHP dataset and the alternative calculated by dividing the gross income figure by 2000 which implies that the estimates of the travel cost coefficients are completely statistically independent. Also, a Chi Squared test of the hypothesis that the TC coefficient as calculated from the ECHP dataset is equal to the alternative calculated by dividing the gross income figure by 2000 reveals a Chi Squared statistic of 62.16. The significance level of the test was found to be virtually zero so one must reject the hypothesis that the alternative travel cost coefficients are equal.

What this implies is our chosen methodology gives significantly different estimates for the TC coefficient than the usual TC calculation that includes an estimate for the opportunity cost of time by dividing the reported income levels by 2000 or some such figure. Again it needs to be kept in mind that that the TC coefficient predicted by our preferred model is a **net** figure (only net hourly wage figures are given in the ECHP dataset) whereas the alternative TC coefficient includes a wage rate derived by dividing each respondent's **gross** earnings by 2000 is a gross. The implication of the significant difference in the TC coefficient estimates is that welfare estimates from model CL3 will be significantly higher than the equivalent estimates from model CL2. Further research is necessary to see whether this significant difference in the alternative TC coefficients would hold over repeated sampling.

6.6.2. Random utility site choice model estimation and results

Having calculated the potential wage (or the opportunity cost of leisure time) and the travel cost for all individuals in the kayaking dataset the next goal was to estimate a random utility site choice model to examine the demand for whitewater kayaking in Ireland. Three RUSC or conditional logit (CL) models have been estimated in this chapter. In all models the choice probabilities of going to whitewater kayaking sites are regressed on travel cost and the six site attributes; parking, crowding, star rating, water quality, scenery and prior information on water levels. The other regressors are dummy variables for all the whitewater kayaking sites except the Liffey, which pick up all unobserved attributes that explain variations in site choice. The only way in which the three models differ is in the treatment of travel cost. The models were estimated in Stata using Maximum Likelihood estimation procedures. Alternatively one could also use a Random Parameters Logit model if the assumption of IIA was rejected. This method allows parameters on observed variables to vary across kayakers, rather than being fixed.

The first model (CL1) ignores the opportunity cost of leisure time completely, i.e. travel cost is simply travel distance times the average kilometre cost of travel divided by the average number of passengers in the vehicle travelling to the whitewater site. The second model (CL2) includes the opportunity cost of leisure time. The opportunity cost of leisure time is derived from a secondary data source and uses the potential hourly wage. As outlined in the previous 2 sections, an hourly earnings equation for the Irish labour force using the ECHP dataset is used in connection with the corresponding socio-economic information gathered in the kayaking survey to estimate a potential hourly wage figure for each respondent in the sample. It is this estimated potential hourly wage that is then used in CL2 to calculate the opportunity cost of time. For model CL3, the methodology most frequently followed in the literature when including some measure of the opportunity cost of time is incorporated into the travel cost variable. In this case, TC_{ij} = ((2* (distance * €0.25))/2.3) + ((travel time/60) * ((Gross Income)/2000)), i.e. each kayaker's gross income is divided by 2,000 labour hours to get an estimate for each respondents hourly wage.

Results from the three RUSC models, as estimated across all choice options using McFadden's (1974) Conditional Logit model, are presented in Table 6.7. The log likelihood value for Model CL3 is the lowest of the three models at -970.12. Under the IIA assumption it would be expected that there would be no systematic change in the coefficients of the CL models if one of the whitewater sites were to be excluded from the model. To test this hypothesis the parameters of model CL2 were re-estimated, excluding Clifden Play Hole as a whitewater site option, and performed a Hausman-McFadden[31] test against the complete model. On examination of the test results it was found that there was no evidence that the IIA assumption had been violated ($\chi^2(16)$ = 10.51, prob = .8389) and thus the null hypothesis that the differences in the coefficients between the complete and restricted model were not systematic was accepted. A similar result is obtained when alternative whitewater sites are excluded.

The estimated coefficients (other than the travel cost coefficient) vary slightly in magnitude in all three models. Travel cost, star rating, scenic quality and the whitewater site dummies are statistically significant at the 1-per cent level for all models, whereas crowding and parking are significant at the 5-per cent level for Models CL2 and CL3 but marginally insignificant for model CL1. The site dummies represent the somewhat unique physical characteristics of each kayaking site. The fact that they are all found to be highly significant could help explain the wide range of values associated with the loss in consumer surplus when the access to alternative sites is hypothetically denied (see section 6.7).

The variables *water quality* and *prior information* are statistically insignificant in all 3 models. *Water quality* has the expected sign and its insignificance is not overly surprising. It may be explained by the fact that Irish kayakers will kayak at almost any whitewater site regardless of pollution levels so long as the quality of the kayaking feature or its "star rating" is high. Indeed in 2002, 8 kayakers contracted Weil's disease[32] through kayaking in "the sluice" on the river Liffey. Even though nothing has been done to improve the water quality at this whitewater site since this incident, it still remains one of the most frequented whitewater sites in the country due mainly to its proximity to the centre of Dublin city. This site was also the most visited site for the sample of kayakers. The Curragower wave on the Shannon is also a feature noted for its poor water quality but because it is one of the best standing wave features from a kayaking perspective in Europe, Irish kayakers still frequent it regularly.

[31] For an extensive discussion, see Hausman and McFadden (1984).

[32] Weil's disease is an infection carried in rats urine which contaminates water and banks of lakes, ponds and rivers. The disease, which is notifiable, is serious and requires hospital treatment. Symptoms start 3 to 19 days after exposure to contaminated water. Early symptoms are similar to 'Flu'.

Table 6.7.Random Utility Site Choice Models with Different Treatments of Travel Time.

Variable	Model CL1	Model CL2	Model CL3
Travel Cost	-0.121	-0.07	-0.039
	(19.33)**	(17.98)**	(15.42)**
Quality of Parking	-0.096	-0.145	-0.151
	-1.24	(2.04)*	(2.04)*
Crowding	0.101	0.153	0.158
	-1.45	(2.19)*	(2.31)*
Star Quality of the Whitewater Site	0.409	0.351	0.367
	(3.25)**	(2.82)**	(3.04)**
Water Quality	0.186	0.142	0.11
	-1.79	-1.39	-1.1
Scenic Quality	0.289	0.285	0.285
	(2.99)**	(2.99)**	(3.09)**
Availability of Information on water levels	-0.077	-0.08	-0.066
levels prior to visiting the site	-0.88	-0.92	-0.79
Clifden Play Hole	-1.38	-0.905	-1.085
	(3.78)**	(2.47)*	(3.03)**
Curragower Wave on the Shannon	-1.838	-1.413	-1.247
	(6.80)**	(5.34)**	(4.85)**
The Boyne	-2.003	-1.772	-1.562
	(6.51)**	(5.93)**	(5.42)**
The Roughty	-2.134	-1.641	-1.916
	(5.34)**	(4.10)**	(4.89)**
The Clare Glens	-4.016	-3.387	-3.185
	(10.11)**	(8.63)**	(8.29)**
The Annamoe	-2.597	-2.076	-1.829
	(7.55)**	(6.25)**	(5.70)**
The Barrow	-3.491	-2.914	-2.669
	(10.93)**	(9.27)**	(8.69)**
The Dargle	-5.787	-5.011	-4.502
	(13.80)**	(12.33)**	(11.52)**
The Inny	-2.35	-1.769	-1.478
	(7.86)**	(6.04)**	(5.19)**
The Boluisce (Spiddle)	-2.643	-2.344	-2.253
	(7.73)**	(6.96)**	(6.83)**

Absolute value of z statistics in parentheses; * significant at 5%; ** significant at 1%. Models CL1, CL2 and CL3 have log likelihood values of –865.11, –913.95 and –970.12 respectively.

All the statistically significant variables (in all models), except for *parking*, also have the expected signs. *Travel cost* is expected to have a negative impact on the choice probability that a site is visited, whereas *star quality*, *scenic quality* and how *uncrowded* a whitewater site is, are all expected to have positive impacts on the choice probability. The fact that *parking* has a negative sign would seem to indicate that the poorer the quality of parking is at a whitewater site, the higher is the probability of visiting that site. Even though at first this may seem counterintuitive, an explanation can be offered. Many respondents in the survey highlighted remoteness of the whitewater site as a characteristic that added significantly to their whitewater kayaking experience. Indeed, even though this characteristic was not raised by the focus groups, The Irish Whitewater Guidebook (MacGearailt, 1996) highlights solitude as one of the characteristics that allows kayakers to get "a great return for their effort" on Irish rivers. If this is indeed the case, then it is not an unreasonable assumption that the more secluded whitewater sites are, the poorer the associated parking facilities will be. This would suggest that the negative sign on the parking coefficient is correct and could be interpreted as showing that the remoter or more secluded the whitewater site is, the higher the probability the site will be visited.

The one major difference between CL1, CL2 and CL3 is the values attached to the coefficients of travel cost in the 3 models. As already stated, the opportunity cost of travel (or leisure) time is included in models CL2 and CL3 but excluded in CL1. This results in higher travel costs, and thus in lower coefficient values in CL2 and CL3. The travel cost coefficient for model CL2 is just over one half of the travel cost coefficient associated with model CL1 in absolute terms (-0.07 compared to –0.121). However, CL2's estimate of the travel cost coefficient may be a better indication of a kayakers true marginal cost of travel as it takes into account each individuals unique characteristics and what they could potentially earn in the labour market, through the use of the ECHP hourly earnings equation in calculating the opportunity cost of travel time. The travel cost coefficient for Model 3 is approximately one third of CL2's, in absolute terms, at –0.036. This lower absolute value should result in higher estimates of welfare changes when different whitewater site management options are considered. The estimated results for all three models will be used in the next section where the welfare impact of site changes is looked at.

6.7. Welfare Impacts of Site Changes

Most travel cost random utility models are estimated for the purpose of valuing site access or changes in site characteristics. With this in mind, a number of welfare scenarios for the three models were considered. These were closure of individual whitewater sites, a 50% reduction in star rating of the Roughty river due to the building of a hydro scheme, a 25% improvement in water quality at Curragower Wave on the Shannon, a 20% reduction in scenic value at the Annamoe whitewater site and a €3 parking fee at the Sluice site on the river Liffey.

Before going on to discuss the welfare estimates arising from out RUM model in relation to the above scenarios it is necessary to highlight fully the advantages and disadvantages of using perceived site quality estimates as opposed to objective measures. As discussed in chapter 5, I had to decide whether to use a subjective or an objective measure of each site characteristic. Objective measures value characteristics using external sources of data whereas subjective measures allow the respondent themselves to place a value on the attributes of each alternative site. Following the approach adopted by Hanley et al. (2001) we use the respondents perceived or subjective measure for all attributes other than travel cost.

We assume most kayakers have, through personal experience, a good knowledge of major whitewater kayaking sites and therefore allow them to use their own judgment to rank each alternative site in terms of the following attributes: average quality of parking at the site, average crowding at the paddling site, average quality of the kayaking site as measured by the star rating system used in The Irish Whitewater Guidebook, average quality of the water, scenic quality of the kayaking site, reliability of water information, travel distance to whitewater site and travel time.

There is a potential trade off here between possible bias (if using subjective measures leads to endogeneity) and a possible loss of efficiency (if the loss of information from moving from the individual to some sort of average or external measure is important). There is quite a wide scatter in the individual evaluations of whiterwater site characteristics, and it was felt important, therefore, to keep this subjective information in the model and not to use external data. In any case, endogeneity may not be an issue if the assumption that kayakers have the relevant experience to be able to make rational judgements on the ranking of the attributes holds true.

The other issue to be taken into account when using subjective measures to assess site characteristics is that any subsequent welfare estimates in relation to the changes in the quality of one or more of the site attributes should be discussed in terms of "perceived" quality changes as opposed to an objective change. For example, the value of a 25% improvement in water quality at Curragower Wave on the Shannon is the value associated with kayakers' perception of the water quality improvement taking place. It is not the value of an objectively measurable improvement in terms of reductions in the pollutants in the water. This is an important distinction and one that must be kept in mind in relation to the discussion of welfare estimates for water quality and scenic quality changes in the proceeding chapters of the thesis.

Having highlighted the potential pitfalls and advantages of using perceived site quality estimates as opposed to objective measures I will now review the welfare estimates in relation to the scenarios outlined on the previous page. The first scenario values site access while the remaining four values changes in a site characteristic. Table 6.8 displays a number of different policy scenarios, ranging from the loss of a site completely from the kayakers choice set to a change in the attribute of a particular site. All models suggest that the loss of any whitewater kayaking site will reduce consumer welfare, though the estimated compensating variations range from a low of €0.04 (estimated with 95% confidence to be between €0.036 and €0.044) for the Liffey in Model CL1 to a high of €3.35 (estimated with 95% confidence to be between €3.10 and €3.82) in the case of the Roughty in Model CL3. Obviously, the main explanation for the larger welfare estimates from model CL3 is that they contain an estimate of travel cost that is on average lower than the simpler models, CL1 and CL2 in absolute terms.

Table 6.8.Welfare Impact of Different Policy Scenarios

Scenario	Change in Consumer's Surplus per Visit for Model CL1 (€)	Change in Consumer's Surplus per Visit for Model CL2 (€)	Change in Consumer's Surplus per Visit for Model CL3 (€)
Closure of individual whitewater sites:			
The Liffey	0.035	0.406	0.159
Clifden Play Hole	0.890	1.65	2.781
Curragower Wave	0.868	1.428	2.562
The Boyne	0.721	1.166	2.049
The Roughty	1.089	1.976	3.355
The Clare Glens	0.861	1.433	2.564
The Annamoe	0.914	1.352	2.475
The Barrow	0.269	0.520	0.979
The Dargle	0.647	1.112	1.995
The Inny	1.171	1.959	3.322
The Boluisce	0.811	1.456	2.490
50% reduction in star rating of the Roughty river due to the building of a hydro scheme	0.039	0.062	0.131
25% improvement in water quality at Curragower Wave on the Shannon	0.005	0.008	0.009
20% reduction in the scenic quality at the Annamoe river	0.014	0.029	0.061
€3 parking fee at the "Sluice" on the river Liffey	0.144	0.309	0.333

Source: Calculated from models reported in Table 6.7.

Although the results based on all three models are shown in Table 6.8 in the following discussion the welfare estimates for the preferred model, CL2 are the focus of attention. It is possible to compute by how much consumer surplus per trip would fall on average if any of the whitewater kayaking sites were closed. All results are per kayaker per trip. The expected CV loss per trip per site is calculated using equation 3.11. The results reveal consumer surplus per trip varying between €0.406 for the Liffey and €1.98 for the Roughty (again, only based on results from the preferred model, CL2). These values are the loss in consumer surplus per trip (i.e. per choice occasion) if a kayaker is prevented from kayaking at his or her most preferred site only.

As discussed in chapter 2, at the same time as the sport of kayaking grows in popularity, Irish whitewater sites are coming under increasing threat from many different sources: water pollution, forestry, housing developments and hydro-electric schemes are but some examples. As can be seen from Table 6.8, a 50% reduction in the star rating of the Roughty river due to the building of a hydro scheme would result in a reduction in kayak surplus per visit of €0.06 (estimated with 95% confidence to be between €0.054 and €0.0678). Water pollution is another threat to whitewater recreation in Ireland. Curragower wave on the Shannon is one of the most polluted stretches of river that Irish kayakers frequent (Environment Protection Agency, 2000). The estimated perceived recreational benefit from a 25% improvement in water quality at the Curragower Wave on the Shannon would result in an increase in consumer's surplus per visit for each kayaker of €0.008 (estimated with 95% confidence to be between 0.0072 – 0.0090).

Forestry and housing developments represent other threats for Irish whitewater sites. A loss of compensating variation (CV) per trip of approximately €0.03 (estimated with 95% confidence to be between €0.027 and €0.039) would be the welfare implication for whitewater kayakers if there was a 20% reduction in the perceived scenic value at the Annamoe whitewater site due to, perhaps, the removal of 20% of the substantial deciduous woodlands along its northern bank and the development of a large housing estate at the put in to the river. The water quality improvement welfare benefit is very low and one would have thought that a water clean up program in Limerick city would have additional and perhaps greater benefits for whitewatre recreationalists. Indeed this result was found to be very surprising for a group of environmental economists from the Irish Economic and Social Research Institute who were presented with the welfare estimates at the Environmental, Energy and Natural Resource Economic Policy Symposium, in the National University of Ireland, Galway.

The final scenario analysed is what impact a €3 parking fee at the Sluice would have on kayakers' welfare. It would be interesting to know the drop in the number of trips due to this policy option but since participation is not modelled one cannot estimate the change in the number of trips taken. Nevertheless, it should be reasonable to assume that an entrance fee would reduce, to some degree, the number of trips taken by kayakers to the Sluice and thereby alleviate the overcrowding situation that occurs at this "park and play" feature. It was found that the €3 parking fee reduced consumer surplus per kayaker per visit to the Sluice by €0.31. This loss in per-trip consumer surplus is estimated with 95% confidence to be between €0.279 and €0.35. Of any of the policy options considered here this option has the greatest impact on the welfare of the kayaking population using a particular whitewater site, resulting in a decrease in total consumer surplus for the kayaking population per year of €10,358[33].

Not surprisingly, the three models analysed in table 6.8 yield a wide range of welfare estimates. In the case of the €3 parking fee at the Sluice on the river Liffey for example, Model CL2 yields an expected welfare loss that is 55% larger than the loss associated

[33] Calculated from mean number of trips to Liffey (16.5) x number of kayaking population likely to use the Liffey (2500) x percentage of the sample that had visited the Liffey in the last year (81%) x 0.31. It should be noted that this assumes that the number of trips to the Liffey does not change which is not likely to be the case after the imposition of the parking fee.

with model CL1 (where the opportunity cost of time is ignored in the travel cost specification completely). On the other hand, the same welfare estimate is approximately 6% larger for Model CL3. This is consistent with the parameter estimates for the travel cost variable provided in Table 6.7 and the fact that model CL3 contains an estimate of travel cost that is on average higher than the simpler models, CL1 and CL2.

A priori, it would not have been possible to predict whether the method of measuring travel cost using the secondary data source would lead to higher or lower average travel cost and thereby, ultimately, higher or lower welfare estimates when compared to the standard, somewhat ad hoc approach used in the literature of dividing annual reported earnings by 2,000 (or some such figure) and including this in the travel cost calculations. Given the inherent problems, outlined in section 6.2, with regard to survey responses on earnings, overall the methodology developed in this chapter leads to a more accurate method of calculating the opportunity cost of time and therefore, more accurate welfare estimates as well.

6.8. Summary and Conclusions

This chapter has shown how the potential wage rate can be used to calculate the opportunity cost of travel (leisure) time in order to calculate the travel costs associated with a recreational activity. These travel cost estimates are then used in a conditional logit random utility site choice model to analyse the demand for whitewater kayaking in Ireland. The whitewater site choice models are then used to estimate the welfare impacts of a number of different management scenarios. In order to use models of recreational behaviour to evaluate a policy measure, an attempt must be made to include not only the sites that are directly affected by the policy but also all sites that are likely to be close substitutes. The present study covers 11 Irish whitewater kayaking sites, and should thus meet this criterion. To my knowledge, this study is also the first RUM travel cost model applied to European whitewater kayaking data.

One weakness of the approach adopted in this chapter is that it does not take into account the effect of changes in whitewater site attributes on total kayaking trips taken. Three ways of solving this problem are discussed by Hanley et al. (2001). Firstly the site choice model could be combined with a count model, thus connecting decisions over trip frequency with decisions over trip duration (Parsons et al., 1998). Secondly, a repeated nested logit could be estimated that handles participation as well as site choice (Hanley et al. 2000). Finally, a system of count models could be estimated, although Hanley et al. (2001) point out that computational difficulties are often involved when trying to combine many Poisson equations. Also appealing, and worthy of additional research beyond this chapter, would be the use of a random parameter logit model as an analog to the conditional logit model presented above to allow for preference heterogeneity. It is this issue of heterogeneity in the kayaking population that will be investigated in subsequent chapters.

In much of the travel cost literature the average wage is taken as the upper bound estimate of the opportunity cost of time. In the modern era of incentive based pay structures such as overtime, piece-work and performance related pay regimes an individual's opportunity cost of time may actually be higher than his or her basic net hourly wage. Due to this fact, it was argued in this chapter that the full wage rate should in fact be taken as the lower bound estimate and that the use of the "fractional" wage may be grossly underestimating the true opportunity cost of leisure time.

The results presented in this chapter have potentially important implications for recreational demand policy and data collection. The preferred model gives higher welfare estimates of consumer surplus than the simpler model where the opportunity cost of time is excluded in the travel cost calculation. This means that this method may be underestimating the true welfare impacts arising out of different recreation management scenarios. However, whilst some reasons have been offered on why using a fraction of the (estimated) wage as the cost of time might be undesirable, knowing precisely what relationship the perceived cost of leisure time has with the implicit wage rate is something which could only be addressed with detailed micro-level questions as part of any recreation demand study. It is unlikely however that most recreation demand studies would be able to undertake this. Using some rule of thumb for what this fraction is, is thus likely to continue to be necessary. This chapter has argued however that the correct fraction to use might as likely be greater than one as less than one.

The approach adopted in this chapter will hopefully lead us some way towards meeting the criticism expressed by Randall (1994). He claimed that a fundamental problem with the travel cost method is that travel cost is unobservable. By using an individual's potential wage in calculating the opportunity cost of time, estimated from a secondary dataset on a sample of the labour market participants in the same population from which the kayaking survey was drawn (in the current case, the ECHP dataset), has helped us to come closer to a "truer" measure of travel cost.

Chapter 7. Exogenously determined preference heterogeneity in the kayaking population: accounting for participant skill levels in recreational demand modelling.

The assumption that preferences are homogenous has traditionally been a "given" in revealed preference analysis of non-market goods. However as Train (2003) points out, explicitly recognising the presence of heterogeneity in preferences is of importance in the estimation of random utility models, since otherwise biased attribute coefficient estimates can result. This can lead to misleading welfare measurements of changes in site attributes and hinder the proper aggregation of welfare measurements across individuals. This can adversely affect policy decisions by skewing the welfare distribution of decisions regarding natural resource management.

The object of the next 2 chapters is to analyse preference heterogeneity in discrete-choice recreational demand modelling, making use of the revealed preference data set of whitewater kayakers in Ireland. In both chapters, a number of alternative approaches will be developed to illustrate the alternative modeling strategies used to take into account the presence of individual heterogeneity in analyzing whitewater kayaking site choice decisions. This chapter develops an exogenous approach of incorporating preference heterogeneity using a "clustered" RUM model of whitewater kayaking site choice. Chapter 8 on the other hand uses an endogenous approach of incorporating preference heterogeneity, namely through the use of Random Parameter Logit and Latent Class models.

In the next section, the grading of whitewater sites and the type of kayaker likely to be found on the different grades is discussed. In section 7.2 the heterogeneous preferences of the kayaking population are outlined. Section 7.3 then summarises some sample characteristics, broken down by skill and experience. Model results are presented in section 7.4, while estimates of consumer surplus from whitewater recreation on Irish rivers, as predicted by the alternative skill based RUM models, are presented in section 7.5. Finally, section 7.6 summarises and concludes the chapter.

7.1. Whitewater River Grades

Rivers that may be kayaked in Ireland and Britain are classified by a five-grade system. This numerical grading system gives an idea of the technical difficulty of the rapids on the river or whitewater site. A grade of one indicates an easy run with occasional small rapids with regular and low waves, whereas grade five indicates extremely difficult rapids with chaotic water where the kayaker's reactive skills must be of the highest order.

Table 7.1.Whitewater Sites and Associated Whitewater Grade

Kayaking Site	*Grade*
The Liffey	2/3
Clifden Play Hole	2
Curragower Wave	3
The Boyne	2/3
The Roughty	4
The Clare Glens	4/5
The Annamoe	3
The Barrow	2
The Dargle	4/5
The Inny	2
The Boluisce	2/3

Grades from the Irish Whitewater Guide book (MacGearailt, 1996)

Table 7.1 outlines the associated grades of the whitewater sites in this analysis. In this chapter it is kayaking on moving water of grade two or above that is analysed. It would be expected that advanced proficiency level kayakers are more likely to kayak on rivers with a grade of 4 or higher, whereas basic and intermediate skilled kayakers are more likely to be found on moving water of grade 2 and 3. Of course it would not be unusual to find the odd intermediate pushing his or her limits on a technically more difficult river or an advanced proficiency level kayaker having a more relaxing run down a grade three whitewater river but in general it is assumed that the advanced proficiency – whitewater grade 4/5 and basic or intermediate proficiency – whitewater grade 2/3 divide holds. In our sample of kayakers for example, 36% of the advanced level kayakers had kayaked on the lowest grade river in the study (the Barrow) at least once in the previous year while 15% of the basic or intermediate kayakers in the sample had braved the grade 4/5 Dargle.

7.2. Heterogeneous preferences in the kayaking population

Heterogeneity in the preferences of individuals choosing from among several recreation sites is an issue that has been receiving considerable attention in the economics literature in recent times (Train, 1996; Chen and Cosslett, 1998 and Breffle and Morey, 2000)[34]. These studies reject homogeneity in preferences and indicate that allowing heterogeneity may have a substantial effect on estimates of trip welfare. The recognition of heterogeneity in preferences could lead to very different policy prescriptions than would be made otherwise. For example, a traditional conditional logit model with homogeneous preferences might indicate that the density of kayakers camping by and utilising a remote stretch of river has no effect on the decision to visit that particular whitewater site. Yet in truth this result may reflect the mixing of two contradictory sets of preferences: those of kayakers reassured by the presence of other kayakers at the whitewater site and who are looking for a sociable paddle down the river, and those of kayakers who prefer solitude and are looking for the "surviving in the wilderness"

[34] See also section 3.4 for an extended discussion on heterogeneity preferences in water based recreational studies.

experience. This suggests a strategy of locating campsites to satisfy two different types of kayaking groups at different points along the riverbank.

In almost all forms of outdoor recreation varying skill levels of participants partly determine both behaviour and preferences. This fact has not been adequately addressed in the travel cost literature to date. Skill level has been used as an independent variable in a number of recreational demand studies (Shaw and Jakus, 1996; Munley and Smith, 1976 and Ready and Kemlage, 1998) but I am unaware of any that exogenously take into account participant skill levels. Hanley et al. (2001) come the closest. They analysed rock climbing in Scotland by separating out their sample of rock climbers into those who were winter climbers and those who were summer climbers. A RUM model was developed for each group separately. They found significant differences for the two models.

Participation in the sport of whitewater kayaking at technically challenging sites is mainly attractive to individuals who have learned specific skills gained from prior whitewater experience. Without those skills the activity at these sites may be unfulfilling and possibly dangerous. For a given whitewater site with a particular skills portfolio, the population of potential kayakers likely to be observed by the researcher is self-selected. It is therefore important to take into account variations in skill levels when modeling the demand for recreation. This self-selection is applicable for many other outdoor activities where a proportion of sites are more suitable to participants of certain skill levels. Rock climbing, mountain biking, surfing and skiing are just a few examples. As far back as 1966, Davidson et al., highlighted the influence of skill and experience on the demand for outdoor recreation. Indeed they believed that "skill is often essential for the enjoyment of these (water based) activities". While Davidson et al.s' (1966) view is now widely accepted in the literature there is surprisingly little empirical evidence to show the magnitude of skill effects in a random utility model setting.

As already mentioned, heterogeneous preferences in the kayaking population may be due to differing skill levels. These differences are difficult to account for in behavioral choice models due to the structure of the conditional logit (CL) model, which forms the base of random utility models (RUM). Within a basic count data travel cost model the analyst can directly incorporate demographic or other individual characteristic data such as skill level directly into the individual's utility function to address preference heterogeneity. However, under the specification of the CL, individual characteristics drop out of the probability of an individual selecting a specific choice, unless interacted with site attributes or an alternative specific constant. To overcome this problem, the standard RUM model outlined in chapter 3, is adapted in this chapter to take account of the heterogeneity of kayaker preferences by using what will be referred to as a "clustered conditional logit framework". By separating out the sample into two exogenously identifiable groups (based on their skill level in a kayak) and running separate conditional logits for each group it is possible to take account of the fact that kayakers of different skill levels are looking for different characteristics from the whitewater site they choose to visit, and have different preferences for these characteristics.

Away from a RUM setting, but of relevance to this chapter, is a study by Munley and Smith (1976), who found that proxies for willingness to pay for white-water rafting (i.e. willingness to travel) were affected by past experience and skill. Munley and Smith distinguished between different types of crafts that are used to navigate a stretch of whitewater and made the assumption that those in closed decked canoes or kayaks had a higher skill level than those in open canoes. Both these groups have higher skills compared to those in rubber rafts. These groups were then included as dummy variables in a simple OLS model. They found that the higher skill classes had a higher willingness to pay (or higher willingness to take on additional travel cost) for whitewater recreation. In contrast to the Munley and Smith (1976) paper, this chapter looks at closed decked kayaks only and respondents categorise themselves as having basic, intermediate or advanced kayak handling skills.

7.2.1. Exogenously accounting for heterogeneity in the preferences of kayakers in a RUM setting.

The rich diversity among kayakers creates difficulties in terms of modeling whitewater site choice, and the economic value associated with a change in the whitewater resource characteristics. To address this type of heterogeneity in a RUM setting, the approach used in this chapter involves the *a priori* selection of skill variables. In what Hilger (2003) refers to as "cluster models", individuals are segmented into demographically homogenous/similar groups. The approach adopted in this chapter is also the first application of a "clustered" RUM model that implicitly takes into account the skill level of the participant when modeling the demand for an outdoor recreational pursuit. The model is then used to produce estimates of welfare change that are of potential relevance to policy-making that impacts on whitewater kayaking sites in Ireland. These estimates are shown to differ greatly when the skill of the kayaker associated with a particular grade of whitewater are taken into account.

For the sample of kayakers in this study it might be expected that an individual's decision to visit a particular whitewater site is based on his or her skill level in a kayak. To investigate this hypothesis the sample is separated into two groups (based on skill level[35]) and a separate conditional logit model is run for each group. A Chow type test is

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[35] The first group or cluster contains 143 individuals who have self-catergorised themselves as having basic or intermediate kayak handling skills. The second group contains 136 individuals who have self-categorised themselves as having advanced kayak handling skills.

then used to investigate whether the coefficients produced using this "cluster" approach are significantly different from the CL model estimated using the full (pooled) sample.

7.3. Sample Characteristics by Skill Level

Although the characteristics of the sample of kayakers used in this study has already been looked at in chapter 5, this section breaks down some of these characteristics by skill level. Table 7.2 presents some summary statistics of the respondents in the survey by skill level. Basic and intermediate kayakers in the sample are of a slightly younger age compared to the advanced proficiency kayakers, 25 compared to 29 respectively. Education levels, obligation free days per year and the rank of importance of kayaking amongst all outdoor pursuits are broadly similar across the 2 skill categories.

Table 7.2.Summary Statistics of Respondents in Kayaking Survey by Skill Level

	Mean	Std. Dev.	Min	Max
Skill Level 1 (143 obs.)**				
Age	25.34	6.91	16	52
Education	1.31	0.51	1	3
Income	22832.17	20011.25	5000	85000
Importance of Kayaking*	1.31	0.77	1	4
Travel Cost	34.93	18.41	1.220482	95.60081
Obligation Free Days	103.46	74.23	0	360
Skill Level 2 (136 obs.)**				
Age	28.87	6.97	18	51
Education	1.24	0.46	1	3
Income	32683.82	22433.10	5000	90000
Importance of Kayaking*	1.31	1.03	1	8
Travel Cost	40.41	22.64	1.573718	151.0717
Obligation Free Days	101.61	66.32	0	365

*1 indicates that kayaking is the respondents most important outdoor activity whereas 4 indicates that kayaking is but one of many outdoor pursuits participated in by the respondent.
** Skill Level 1 refers to kayakers who have basic and intermediate proficiency level kayak handling skills. Skill Level 2 refers to kayakers who have advanced proficiency level kayak handling skills.

It would appear that advanced proficiency kayakers earn substantially more than their basic/intermediate proficiency counterparts. Average annual income is approximately

€10,000 higher for advanced level kayakers. A simple explanation for this may be the fact that basic/intermediate proficiency kayakers are of a younger average age and therefore have not gained enough work experience to be on a par with the advanced level kayakers. Furthermore, a lot of people in Ireland start kayaking when they enter third level education by joining the university club. Therefore, many of the third level students in the sample would only be of a basic or intermediate proficiency level and (of course!) most students will be on a very low (if any) income.

Table 7.3.Mean Visits to Each Whitewater Site Last Year by Skill Level

	Skill Level 1		Skill Level 2	
Kayaking Site	*Mean Visits*	*Std. Dev*	*Mean Visits*	*Std. Dev*
The Liffey	8.80	20.30	24.78	55.67
Clifden Play Hole	2.43	6.33	2.85	4.53
Curragower Wave	2.76	5.51	3.96	7.25
The Boyne	4.63	7.29	6.72	19.64
The Roughty	0.30	0.69	1.36	2.66
The Clare Glens	0.37	1.08	1.66	2.70
The Annamoe	2.47	3.97	4.42	6.23
The Barrow	1.32	8.44	0.70	1.33
The Dargle	0.39	1.13	2.22	5.12
The Inny	0.87	1.23	1.28	2.26
The Boluisce	1.06	3.21	0.96	1.46
All Sites	2.31	7.99	4.63	19.37

Skill Level 1 refers to kayakers who have basic and intermediate proficiency level kayak handling skills.

Skill Level 2 refers to kayakers who have advanced proficiency level kayak handling skills.

In fact in the sample of kayakers, of the 68 studends, 53 classify themselves as basic or intermediate standard while the remaining 15 classify themselves as advanced proficiency kayakers. In relation to travel cost[36], on average, advanced proficiency kayakers are willing to pay 22.5% more than their basic or intermediate proficiency counterparts to get to their preferred whitewater site on any given choice occasion. A

[36] The travel cost variable has been calculated using the procedure developed in the previous chapter where the opportunity cost of time is calculated using a wage rate estimated for each person in the sample

priori, this is to be expected. Advanced proficiency level kayakers have spent a considerable amount of time and effort on their sport. This accumulated effort is an indication that they are probably more willing to spend additional money on travelling to whitewater sites than basic or intermediate proficiency level kayakers.

Table 7.3 gives a picture of kayaking activity during the 12 months prior to the completion of the survey by skill level. It is obvious from this table that kayakers who have better kayak handling skills are more likely to visit a whitewater site of a higher degree of difficulty[37]. Indeed, kayakers who had only basic or intermediate proficiency level kayak handling skills (skill level 1) made 78%, 77% and 82% less trips to the grade 3+ rivers of the Roughty, Clare Glens and Dargle respectively, compared to kayakers who had advanced proficiency level kayak handling skills (skill level 2). In fact, advanced proficiency level kayakers undertake more trips to 9 of the 11 whitewater sites in the sample than their basic and intermediate level counterparts.

In order to investigate the heterogeneity of preferences amongst the kayaking population the sample of kayakers could also have been exogenously split by years of experience. Table 7.4 gives a picture of kayaking activity during the 12 months prior to the completion of the survey by years of experience. It is obvious from this table that kayakers who have more years of experience are also, like the advanced proficiency group, more likely to visit a whitewater site of a higher grade of difficulty.[38] Since there is a relatively strong linear relationship between years of experience and the proficiency level of the kayakers in the sample (a correlation coefficient of 0.54) it was decided to only use the skill level variable when running the clustered RUM models.

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using a secondary data source, the European Community Household Panel and then related to respondents using questions regarding their socio-economic status (see section 6.4).

[37] Table 7.1 outlines the associated grades of the whitewater sites in this analysis.

[38] As mentioned in the first section of this paper, table 7.1 outlines the associated grades of the whitewater sites in this analysis.

Table 7.4. Mean Visits to Each Whitewater Site Last Year by Years of Experience

Kayaking Site	Less than 2 years of Kayaking Experience		2 to 5 years of Kayaking Experience	
	Mean Visits	*Std. Dev*	*Mean Visits*	*Std. Dev*
The Liffey	7.95	12.11	8.80	25.28
Clifden Play Hole	2.95	6.89	2.65	5.18
Curragower Wave	4.10	8.29	2.71	4.62
The Boyne	5.15	10.73	4.15	6.85
The Roughty	0.82	2.67	0.49	0.83
The Clare Glens	0.86	2.45	0.80	1.45
The Annamoe	2.46	5.10	2.85	4.04
The Barrow	1.38	9.85	0.86	1.89
The Dargle	0.92	5.05	1.08	2.00
The Inny	1.03	1.63	1.05	1.18
The Boluisce	1.15	3.41	1.31	2.44
All Sites	2.62	7.42	2.43	8.66
	5 to 10 years of Kayaking Experience		Greater than 10 years of Kayaking Experience	
	Mean Visits	*Std. Dev*	*Mean Visits*	*Std. Dev*
The Liffey	16.24	39.92	37.04	69.62
Clifden Play Hole	3.45	5.08	1.65	3.23
Curragower Wave	4.93	7.08	1.86	3.16
The Boyne	4.90	9.07	8.26	24.48
The Roughty	1.33	1.96	0.81	1.47
The Clare Glens	1.33	2.14	1.19	2.15
The Annamoe	4.86	5.71	4.52	5.92
The Barrow	0.55	0.96	0.90	1.68
The Dargle	1.40	2.78	1.94	3.22
The Inny	1.31	1.47	1.01	2.59
The Boluisce	0.95	1.46	0.57	1.01
All Sites	3.75	13.51	5.43	24.65

7.4. Results

Three conditional logit (CL) models have been estimated (one for the full sample and the other two based on the skill level of the kayaker). As in the previous chapter, in all models the choice probabilities of going to whitewater kayaking sites are regressed on travel cost, and the six quality attributes; parking, crowding, star rating, water quality, scenery and prior information on water levels. The other regressors are once again the site dummy variables for all sites except the Liffey. The models were estimated in Stata using Maximum Likelihood estimation procedures. Results are presented in Table 7.5.

The first column of table 7.5 presents the results of the model estimated using the full kayaker dataset (model CL1) ignoring the heterogeneity in preferences across respondents. The second column presents results for the sub-sample of the dataset that have basic and intermediate proficiency level kayak handling skills (model CL2). Finally, the third column presents the results for the remainder of the sample that have advanced proficiency level kayak handling skills (model CL3). The log likelihood values for Models CL1, CL2 and CL3 are -913.95, -358.22 and –447.78 respectively.

A likelihood-ratio test is first performed for the null-hypothesis that the parameter vector of the 2 clustered skill-based models may be nested in the parameter vector of the full sample model. The likelihood-ratio test statistic is distributed as χ^2 (with k degrees of freedom, 17 in this case; where k is the number of variables in the model to be estimated), with a calculated value of 142.33. One can thus reject the null hypothesis, at the 95% level of confidence, that the two subsets of the data (based on the skill level of the kayakers in the sample) can be described by the full model's (CL1) parameter vector. This is an important result as it indicates that the observations from the two different skill groups should not be pooled together but rather should be analysed using separate models.

Table 7.5.Random Utility Site Choice, All Trips, Models 1, 2 and 3

Variable	(CL1) All Kayakers	(CL2) Skill Level 1^	(CL3) Skill Level 2^
Travel Cost	-0.069	-0.099	-0.059
	(17.98)**	(14.15)**	(11.74)**
Quality of Parking	-0.145	-0.089	-0.22
	(2.04)*	-0.71	(2.16)*
Crowding	0.153	0.172	0.129
	(2.19)*	-1.51	-1.39
Star quality of the whitewater site	0.351	0.163	0.488
	(2.82)**	-0.82	(2.86)**
Water Quality	0.142	-0.241	0.397
	-1.39	-1.45	(2.87)**
Scenic quality	0.285	0.492	0.107
	(2.99)**	(3.22)**	-0.84
Availability of Information on water levels	-0.08	-0.311	0.178
	-0.92	(2.19)*	-1.52
Clifden Play Hole	-0.905	0.304	-1.643
	(2.47)*	-0.54	(3.18)**
Curragower Wave on the Shannon	-1.413	-1.141	-1.586
	(5.34)**	(2.89)**	(4.10)**
The Boyne	-1.772	-1.586	-1.864
	(5.93)**	(3.51)**	(4.41)**
The Roughty	-1.641	-1.707	-1.397
	(4.10)**	(2.67)**	(2.51)*
The Clare Glens	-3.387	-4.224	-2.734
	(8.63)**	(6.72)**	(4.99)**
The Annamoe	-2.076	-1.787	-2.105
	(6.25)**	(3.58)**	(4.47)**
The Barrow	-2.914	-2.408	-3.115
	(9.27)**	(5.18)**	(7.07)**
The Dargle	-5.011	-6.195	-4.303
	(12.33)**	(8.96)**	(7.87)**
The Inny	-1.769	-0.892	-2.393
	(6.04)**	(2.07)*	(5.70)**
The Boluisce (Spiddle)	-2.344	-1.437	-2.899
	(6.96)**	(2.81)**	(6.06)**

Absolute value of z statistics in parentheses; * significant at 5%; ** significant at 1%. Models CL1, CL2 and CL3 have log likelihood values of –913.95, -358.22 and –447.78 respectively.

^Skill Level 1 refers to kayakers who have basic and intermediate proficiency level kayak handling skills. Skill Level 2 refers to kayakers who have advanced proficiency level kayak handling skills.

The estimated coefficients for travel cost in both clustered models, CL2 and CL3, are of the expected sign and are statistically significant at the 1% level. Almost all the site dummies are statistically significant at the 1% level for both models. As outlined in the previous chapter these site dummies represent the somewhat unique physical characteristics of each kayaking site. Given the fact that they are nearly all found to be highly significant, one would expect a wide range of values associated with the loss in consumer surplus if access to alternative sites were to be denied. The variable indicating crowding was found not to be statistically significant in both models CL2 and CL3.

The results for water quality, star rating and scenic quality are very interesting for the two different skill groups. The water quality variable is not significant and of the intuitively-wrong sign for basic and intermediate proficiency level kayakers (CL2). It is however highly significant and of the expected sign for the advanced proficiency level kayakers (CL3). This result however can be explained from a taste heterogeneity perspective. Basic and intermediate proficiency level kayakers will tend to paddle on rivers of lower grade with gentle rapids where they are less likely to topple over. Since they spend more of their time "above water" they are likely to be less concerned with the water quality they paddle in. Advanced proficiency level kayakers on the other hand kayak on more technically difficult whitewater where they are likely to spend more time upside down, getting their torso and face hit by larger rapids and "rolling" their kayak. For this reason it would be expected that this group would be much more concerned with the quality of the water they are paddling in than their basic and intermediate skill counterparts[39].

[39] In the kayaking survey respondents were asked to indicate whether they had basic, intermediate or advanced kayak handling skills. This is the terminology used by the Irish Canoe Union in relation to proficiency in a kayak. In our dataset those who indicated they were of basic or intermediate standard were then coded 0 and those who were of advanced proficiency were coded 1.

Similarly, the fact that scenic quality of the white water site is of the correct sign and statistically significant at the 1% level for basic and intermediate skill kayakers but insignificant for advanced skill kayakers is not unexpected. Advanced level kayakers may not have the time to appreciate the beauty (or lack of) of the surrounds of a whitewater site as they have to concentrate on the job at hand, whereas the lower skill group who are likely to be on less challenging rivers do have the luxury of time to appreciate the scenery around them. The star quality variable is of the expected sign for both skill groups but is only significant for the advanced skilled kayakers. Indeed it is significant at the 1% level for this group. Again one might expect this, a priori. Advanced level kayakers are always in search of "the classic" whitewater experience. The star rating of a river is an indication of how classic a river is within its whitewater grade. Basic or intermediate level kayakers may not be as concerned with the star rating of a river as at this stage of their kayaking career they may be more interested in acquiring the skills to allow them to kayak on more challenging whitewater rather than getting the classic runs under their belt.

Results from the clustered CL models thus show considerable variation in preferences across skill levels of kayakers. This suggests that whitewater site managers and policy makers in charge of such sites should think carefully about the particular type of kayaker utilising the site and the attributes and facilities that such kayakers might want. For example, a water clean up program might be worth more on the Roughty river which is frequented by more advanced level kayakers than at a whitewater site such as the Boyne which is frequented more by basic and intermediate skill kayakers who are not as concerned by the quality of the water they paddle in. To quantify these differences in the value of site changes by skill group, the clustered CL models will be used in the next section to calculate compensating surplus measures, according to equation 3.11 above.

7.5. Welfare Impacts of Site Changes

In this section, a number of welfare scenarios for the alternative models are considered. These include:

- The Roughty river becoming unnavigable by kayak due to the building of a hydro scheme.
- The Boyne river becoming unnavigable by kayak due to the building of a hydro scheme.
- A 25% improvement in water quality at the Curragower wave on the Shannon.
- A €3 parking fee at the put-in to the Liffey river.

The first two scenarios value site access and investigate the very real development threat coming from investments in new hydroelectric plants in Ireland. As discussed in chapter 2, such investments are deemed necessary under Irish government targets for increasing the fraction of energy produced from renewable sources (Department of the Environment 1999) but hydro developments on some rivers may come at the expense of significant foregone non-market recreation benefits in terms of the use of "natural" rivers by whitewater kayakers. The last two scenarios then value changes in a site characteristic.

The results based on all models are shown in Table 7.6. It is possible to compute by how much compensating surplus would fall on average if any of the whitewater kayaking sites were closed. All results are, once again, per kayaker per trip. The first column of table 7.6 presents the results of using the parameter estimates from the full sample RUM model. The second column presents the results of using the parameter estimates from the "clustered" RUM where the grade of the whitewater site and the proficiency level of the kayaker likely to be found on the site are taken into account. In the second column, rows 1 and 4 use the results of model CL2 as the rivers in both these scenarios are of grade 3 or less whereas rows 2 and 3 use the results of model CL3 as the rivers in both these scenarios are of grade 4 or 5. All values relate to the loss in consumer surplus if a kayaker is prevented from kayaking at his or her most preferred site only.

Table 7.6.Welfare Impact of Different Policy Scenarios as measured by loss/gain in Consumer Surplus per kayaker per visit

Scenario	Base RUSC Model(€)	Skill RUSC Model (€)
Loss of the Boyne river due to the building of a hydro scheme	1.55	1.06*
Loss of the Roughty river due to the building of a hydro scheme	1.72	2.54**
25% improvement in water quality at Curragower wave	0.009	0.13**
€3 parking fee at the Liffey	0.30	0.19*

Source: Calculated from models reported in Tables 7.5.
* indicates estimated using the RUSC model for kayakers who have basic and intermediate proficiency level kayak handling skills.
** indicates estimated using the RUSC model for kayakers who have advanced proficiency level kayak handling skills.

As can be seen from column 2, it is important for resource managers and policy makers to take into account the type of recreationalist that is likely to be found at a particular site. The Boyne and the Liffey are grade 2/3 rivers. The Roughty is a grade 4 and the Curragower wave on the Shannon is a grade 3/4 river feature. It would be expected that there would be mainly basic and intermediate proficiency kayakers on the first 2 of these whitewater sites and advanced level kayakers on the Roughty and Curragower wave due to the technical difficulty of the whitewater involved. Using the skill based estimated RUM models yields welfare estimates that are statistically significantly different compared to the overall RUM model (the confidence intervals are presented in the text below). The expected CV loss per kayaker from the loss of the Roughty river is calculated at €2.54 when the type of kayaker that would be using this river is taken into account. This is done by using the results of the advanced skill RUM model (column 3, table 7.5). This estimate of the loss in per-trip consumer surplus is estimated with 95% confidence to be between €2.19 and €3.06. The corresponding estimate when the results of the overall RUM model are used is 32% less than this lower bound at €1.72.

The opposite result is found when the basic/intermediate skill RUM model (column 2, table 7.5) is used to calculate the welfare losses (or gains) associated with a loss of (or change in) an attribute of a lower grade river. The expected CV loss per kayaker from the loss of the Boyne river is calculated at €1.06 when taking into account the type of kayaker that would be using this river. This loss in per-trip consumer surplus is estimated with 95% confidence to be between €0.93 and €1.24. The corresponding estimate when using the results of the overall RUM model is 46% higher at €1.55. Similarly, the loss in kayaker welfare per trip when a €3 parking fee is imposed at the Sluice on the river Liffey is 50% less if one uses the basic/intermediate skill RUM model instead of the overall RUM, to take into account the fact that basic and intermediate kayakers are more likely to be on this river that advanced level kayakers (€0.19 compared to €0.29). The estimate in the loss in per-trip consumer surplus due to the parking fee (using the clustered model) is estimated with 95% confidence to be between €0.17 and €0.22.

Water pollution is another threat to whitewater recreation in Ireland. The result is virtually zero (€0.009) when the welfare gain to kayakers of a perceived 25% water quality improvement at the Curragower wave on the river Shannon using the full RUM model is estimated. However, the estimated perceived recreational benefit from a 25% improvement in water quality results in an increase in consumer's surplus of €0.13 per kayaker per trip when taking into account that it is mainly kayakers with advanced handling skills that will be utilising this whitewater site. This gain in per-trip consumer surplus is estimated with 95% confidence to be between €0.11 and €0.16.

Finally, skill differences are one aspect of heterogeneity in preferences. There are of course many alternative approaches to incorporating heterogeneity within RUM models of recreation, such as the latent class (LC) and random parameter logit (RPL) approaches. One interesting comparison is then between the clustered RUM approach used here to account for heterogeneity, and these alternatives. In the next chapter these alternative endogenously determined modelling approaches will be investigated.

7.6. Summary

Participation rates in outdoor activities like whitewater kayaking and mountaineering that require specialized skills and experience are increasing. Policy decisions impacting on access to and quality of these recreational service flows can be improved with valid estimates of consumer surplus values accruing to the recreationalists. To accurately estimate those values it is necessary to account for the necessary skill levels that are required to participate at recreational sites of differing grades. This chapter accomplishes that goal by using an approach that implicitly takes account of the proficiency level of the kayaker in a "clustered" RUM model. This "clustered" whitewater site choice model was then used to estimate the welfare impacts of a number of different management scenarios.

By not taking into account the differences in the skill of the kayakers or the different type of recreationalist that frequent different recreational sites in general, recreation demand modellers may be underestimating (overestimating) the welfare losses (gains) associated with changes in site attributes. For the particular recreational activity analysed in this thesis, not taking into account the differences in the skill of the kayakers and the grade of the river will result in overestimating the welfare estimates associated with lower grade whitewater sites (which are frequented by basic/intermediated proficiency level kayakers) and underestimating welfare estimates associated with changes in the attributes of higher grade whitewater sites (which are frequented by advanced proficiency level kayakers).

In this chapter economic welfare values associated with access to whitewater kayaking sites and changes in the quality of the kayaking experience at these sites in Ireland were also estimated. The results have potentially important implications for recreational demand policy and data collection. The "clustered" RUM model gives higher welfare estimates of consumer surplus than the simpler model when the skill level of the kayaker is more advanced and the grade of the whitewater is higher. These findings are consistent with those of Munley and Smith (1976), which to the best of my knowledge is the only other study that has looked at the importance of skill and experience in whitewater recreation.

Chapter 8. Endogenously determined preference heterogeneity in the kayaking population: An application of Random Parameter Logit and Latent Class Modelling Techniques

In this chapter two empirical models are used to endogenously take account of individual heterogeneity in analyzing whitewater kayaking site choice decisions. The two models are the random parameter logit (RPL) model and the latent class model (LCM). The RPL model and LCM are chosen as they are regarded by many researchers as the most promising discrete choice analytical models available to meet this requirement. They represent fundamentally different approaches to modelling heterogeneity than that employed in more traditional fixed parameter logit models (Greene and Hensher, 2002), such as the exogenously-imposed divisions of the kayaking sample demonstrated in the previous chapter.

As discussed in previous chapters, kayakers' appreciation of a kayaking site is determined by a possibly large number of site and route features, such as its grade or star rating, the scenic quality of the whitewater site, and the degree of crowding on the water. One would expect to find that preferences for different types of whitewater site attributes are affected by the kayaking skill level and the years of experience that the kayaker possesses. This was indeed the case in the previous chapter and the results of the two models that incorporate kayaker heterogeneity into the whitewater site choice analysis in this chapter also indicate that kayaker preferences for recreational demand sites are likely to be characterized by systematic heterogeneity. Which approach is taken to model this heterogeneity turns out to have a big impact on welfare estimates of site quality or access changes.

In the next section the two logit based modeling approaches are reviewed. These models may be used to analyse multi-attribute products such as whitewater kayaking site choice demand, while at the same time taking into account kayaker heterogeneity. The rational for endogenously modelling preference heterogeneity within the sport of whitewater kayaking is discussed in section 8.2. Model results are presented in section 8.3 while estimates of consumer surplus from whitewater recreation on Irish rivers, as predicted by the alternative models, are presented in section 8.4. Finally, section 8.5 concludes with some recommendations for further research.

This chapter adds to the literature (i) by being the first study to utilise the RPL model and the LCM to analyse any outdoor recreation pursuit in Ireland and (ii) by also being the first application of these particular models to the sport of whitewater kayaking. In addition the models are used to produce estimates of welfare change that are of potential relevance to any policy-making that has an impact on whitewater kayaking sites in Ireland. In the next section the two random utility based modeling approaches that are used to analyse the heterogeneity of preferences within the Irish kayaking population for whitewater kayaking sites will be set out.

8.1. Methodology

The random utility model (RUM) of McFadden (1974) is the standard statistical economic model used to estimate recreation choice. The two models reviewed in this section are also one level, logit choice models but they are of a much more general form in terms of the model specifications that these 2 models can accommodate, and in terms of the range of behaviour that can be modeled (Greene, 2004).

8.1.1. The Random Parameter Logit Model

The Random Parameter logit model generalizes the Random Utility Model (RUM) by allowing the coefficients of observed variables to vary randomly over people rather than being fixed. It has been argued that some undesirable properties and assumptions are embodied in conditional logit models (Train 1998, Layton 2000). First, they are known to overestimate the joint probability of choosing close substitutes. This was discussed in chapter 3 and is known as the Independence of Irrelevant Alternatives (IIA) property (McFadden 1974). Second, they are based on the assumption that the random terms ε_{ij} are independently and identically distributed. It may alternatively be the case that the individual specific factors influence evaluation of all the available alternatives and make random terms correlated instead of independent. Third, as discussed in this and the previous chapter, assuming homogeneous preferences alone is restrictive. Any substantial variation in individual tastes conflicts with this assumption, possibly resulting in violations in many applications. Partitioning the stochastic component ε_{ij} of equation 3.4 into two additive (i.e. uncorrelated) parts allows for the possibility that the information relevant to making a choice that is unobserved may indeed be sufficiently rich in reality to induce correlation across the alternatives in each whitewater choice situation. One part is correlated over alternatives and heteroskedastic, and another part is independently, identically distributed over alternatives and individuals as shown in equation (8.1)

$$U_{ij} = bX_{ij} + \eta_i X_{ij} + \varepsilon_{ij} \tag{8.1}$$

where b is a vector of coefficients that is unobserved for each kayaker and varies randomly over kayakers representing each individuals tastes. ε_{ij} is once again the unobserved random term that is independent of the other terms in the equation and is identically and independently distributed. This specification is the same as for the RUM, except that now the coefficients of V_{ij} in equation 3.4 vary in the population rather than being fixed. The variance in V_{ij} induces correlation in utility over sites and trips. In particular, the coefficient vector for each kayaker can be expressed as the sum of the population mean, b, and individual deviation, η_i, which represents the kayakers tastes relative to the average tastes in the population of all kayakers. As Train (1997) points out, the researcher estimates b but does not observe η_i for each kayaker. The unobserved portion of utility is therefore $\eta_i X_{ij} + \varepsilon_{ij}$. This term is correlated over sites due to the common influence of η_i, i.e. the kayaker evaluates each site using the same tastes. Because the unobserved portion of utility is correlated over sites, RPL does not exhibit the independence from irrelevant alternatives property of a standard RUM. The utility equation (8.1) can also be expressed in form $X_{ij}(b+\eta_i)+\varepsilon_{ij}$, which is easily comparable to fixed parameter conditional logit models. The only difference is that previously fixed β now varies across people as $\beta_i = b + \eta_i$.

Although RPL models account for heterogeneous preferences via the parameter η_i, individual tastes deviations η are neither observed nor estimated. RPL models aim at finding the different moments, for instance the mean and the deviation, of the distribution of β, from which each β_i is drawn. Parameters β vary in population with density $f(\beta|\Omega)$, with Ω denoting the parameters of density. Since actual tastes are not observed, the probability of observing a certain choice is determined as an integral of the appropriate probability formula over all the possible values of β weighted by its density. The probability of choosing alternative j out of J alternatives can now be written as

$$P_{ij} = \int \left[\frac{\exp(\mu\beta_i X_{ij})}{\sum_{j=1}^{J} \exp(\mu\beta_i X_{ij})} \right] f(\beta \mid \Omega) d\beta \qquad (8.2)$$

Equation (8.2) is a random parameter extension of conditional logit model (3.7). Integral (8.2) cannot be analytically calculated and must be simulated for estimation purposes. Exact maximum likelihood estimation is not available and simulated maximum likelihood is used instead. Train has developed a method that is suitable for simulating (8.2). His simulator is smooth, strictly positive and unbiased (Brownstone and Train 1999), and can be easily modified to allow for non-negative/positive random parameters. Simulating (2.16) is carried out simply by drawing a β_i, calculating the bracketed part of the equation and repeating the procedure over and over again. Although Train's simulator is unbiased for just one draw of β_i, its accuracy is increased with the number of draws. Using R draws of β_i from $f(\beta| \Omega)$, the simulated probability of (8.2) is:

$$SP_{ij} = \frac{1}{R} \sum_{r=1}^{R} \frac{\exp(\mu\beta_i X_{ij})}{\sum_{j=1}^{J} \exp(\mu\beta_i X_{ij})} \qquad (8.3)$$

In order to estimate this model it is necessary to make an assumption over how the coefficients b are distributed over the population of kayakers. Train (1997) assumes them to be distributed either normally or log-normally. Green (2003) proposes estimating the parameters of the above model by maximizing with respect to β the simulated log likelihood,

$$\log L_s = \sum_{i=1}^{N} \log \frac{1}{R} \sum_{r=1}^{R} \frac{\exp(\mu\beta_i X_{ij})}{\sum_{j=1}^{J} \exp(\mu\beta_i X_{ij})} \tag{8.4}$$

where R is the number of replications (i.e. draws of b). Green (2003) claims that estimation of the model by the alternative method of direct integration to compute the probabilities would be infeasible because the mixture distribution composed of the original ε_{ij} and the random part of the coefficient is unknown.

8.1.2. The Latent Class Model

Heterogeneity can also be statistically accounted for by utilizing the LC logit approach or finite mixture model (suggested in a RUM setting by McFadden (1986), and later developed by Swait (1994) and Boxall and Adamowicz (2002)). This is achieved by simultaneously assigning individuals into behavioural groups or latent segments, and estimating the choice model (Hyde, 2004). LC analysis was actually first introduced in 1950 by Lazarsfeld (1950), who used the technique as a tool for building typologies (or clustering) based on dichotomous observed variables. It is only in the last decade that one can find applications of the model in the non-market valuation setting. Examples include Boxall and Adamowicz (2002), Provencher et al. (2002) and Provencher and Bishop (2004)[40].

[40] See section 3.4 for a more in-depth look at the latent class modelling literature.

Within each latent class preferences are assumed to be homogeneous; however preferences, and hence utility functions, can vary between segments. A primary benefit of this approach is being able to explain the preference variation across individuals conditional on the probability of membership to a latent segment. The basic idea underlying latent class (LC) analysis is a very simple one; some of the parameters of a postulated statistical model differ across unobserved subgroups. These subgroups form the categories of a categorical latent variable (Vermunt and Magidson, 2003). The application of the latent class model in this chapter follows this approach and identifies and characterizes a number of discrete, latent preference classes of kayakers that differ in their attitudes towards recreational kayaking characteristics of whitewater recreation sites in Ireland.

Since in our sample of kayakers the membership probabilities are informed by attitudinal self-reported responses and are specified to be conditional on the skill and years of experience of the kayaker the formulae for class (c) membership probability can be written as:

$$\Pr(i \in c) = \begin{cases} K_c = \dfrac{\exp((\alpha 1 * skill) + (\alpha 2 * \exp er))_c)}{\sum_{c=2}^{C} \exp((\alpha 1 * skill) + (\alpha 2 * \exp er))_c)}, \forall c \neq 1 \\ \hline K_1 = \dfrac{\exp((\alpha 1 * skill) + (\alpha 2 * \exp er))_c)}{\sum_{c=2}^{C} \exp((\alpha 1 * skill) + (\alpha 2 * \exp er))_c)}, c = 1 \end{cases}$$

where $(\alpha 1 * skill) + (\alpha 2 * \exp er))_c$ is a class-specific constant conditional on the skill and years of experience of the kayaker for classes 2, 3, …,C. For ease of interpretation we only report the values of K_c, rather than the individual class-specific constants.

Within the latent class structure the probability of whitewater site j being chosen by kayaker i within the class c is exactly the same as equation (3.6) except that it is conditional on the class c.

$$P_{icj} = \frac{\exp(V_{ij})}{\sum_{j=1}^{J}\exp(V_{ij})}. \tag{8.5}$$

where $V_{ij} = b_c{}'X_{icj}$. The expected probability of whitewater choice j being chosen for kayaker i is the expected value (over classes) of the class specific probabilities, that is:

$$P_{ic} = \sum_{c=1}^{C} \Pr ob(class = c)\left[\frac{\exp(V_{ij})}{\sum_{j=1}^{J}\exp(V_{ij})}\right] \tag{8.6}$$

Given membership to class c, the choice probability equation above explains the mechanics of probabilistic choice across alternatives in each choice occasion and is based on a conventional random utility framework. Once the parameters of the model are estimated, both Roeder et al. (1999) and Greene (2003) demonstrate how the individual specific posterior class probabilities can be computed using Bayes theorem. They show that the individual specific posterior parameter estimates can be computed as the weighted average of the parameters over classes, $\hat{B}_i = \sum_{c=1}^{C} \hat{P}_{ic}\hat{B}_c$.

In this chapter these two separate (but related) choice models shall be compared in terms of the Hicksian welfare measures that they imply. The Hicksian welfare measure (as measured by compensatiing variation (CV)) for a change in a choice attribute (in this case, improved quality of a characteristic at a whitewater kayaking site) based on a standard RUM model is the log-sum formula (Hanemann, 1984):

$$CV_i = -1/\beta_m \left[\ln\left[\sum \exp(V_i^1(b_i^1))\right] - \ln\left[\sum \exp(V_i^0(b_i^0))\right]\right] \quad (8.7)$$

Even though the expression in (8.7) is shown and expanded upon previously in chapter 3, it is represented again in this chapter, as it is also the key to computing the welfare measures in the RPL and LCM models. In the random parameter logit model, some of the $\beta's$ are random. By integrating the formula in (8.5) with respect to these random $\beta's$, the expected welfare gain (or loss) associated with a change in a whitewater site attribute can be derived ($\int CV(\beta)d\beta$). A simulation approach of random draws from the estimated distribution of βs is employed to compute the multiple integrals (Train, 1998). In the case of the latent class model the $\beta's$ will differ across classes. The expected welfare gain (or loss) associated with a change in a whitewater site attribute, based on the latent class model, can be estimated by calculating the weighted sum of welfare measure in all classes, weighted by the posterior individual specific class probabilities (Boxall and Adamowicz, 2002):

$$CV_i = \sum_{c=1}^{C} P_{ic}[-1/\beta_{im} \left[\ln\left[\sum \exp(V_i^1(b_i^1))\right] - \ln\left[\sum \exp(V_i^0(b_i^0))\right]\right]] \quad (8.8)$$

In regards to the latent class model, if resource managers are interested in aggregate welfare measures over the sample, these can be calculated by (8.8). Hilger (2003) notes that this welfare measurement is an improvement over the traditional welfare calculation using coefficient estimates from the standard RUM model due to the proper weighting of each class's compensating variation. Welfare measurements for an arbitrary change in one or more of the attributes can also be calculated for each latent segment separately by simply using formula (8.7) for each segment.

8.2. Rationale for Endogenously Modelling Preference Heterogeneity

Within the sport of whitewater kayaking there are a number of different specialisations, which can help in developing the rational for the expected differences in preferences amongst kayakers of different skill and experience levels. *River running* involves the use of a paddle to negotiate one's kayak successfully through a stretch of rapids on a river. Kayakers of different proficiency levels will run rivers according to the grade of the whitewater that suits their skill level (table 7.1 presented the grade of each of the whitewater sites in the survey). *Freestyle kayaking* is when kayakers "park and play". They stay at the one river feature and use that feature to surf their kayaks. This area of the sport has had the most growth in the last decade (www.irishcanoeunion.com/core/rodeo.html). It is very skill-intensive but would be considered safer than river running.

Whitewater kayakers could also be categorised by the competitive aspect of the sport he or she is (or has been) involved in. *Long distance "k-boat" kayakers* or *kayak polo enthusiasts* will enjoy rivers of lower grade. *Slalom kayakers* and *wild water racers* will favour whitewater of grade 3 or 4 and will tend to have better kayak handling skills while *Rodeo kayakers* will probably have the highest skills and will be probably favour park and play kayaking rather than river running. While these are all distinct disciplines there may be considerable overlap. It would not be uncommon for instance to find a top rodeo kayaker participating in river running or a polo player kayaking at his favourite local playspot. Nevertheless, within the whitewater kayaking community a kayaker would usually be categorised by his or her peers as being either a river runner or a freestyle playboater.

8.2.1. Expectations on the different preferences one would expect for the whitewater site attributes for kayakers from different backgrounds and with different skill and experience levels

This section attempts to outline the expectations on the different preferences that would be expected for the whitewater site attributes for kayakers from different backgrounds and with different skill and experience levels. Generally speaking, most kayakers should favour better parking facilities at whitewater sites. Having said that, as I have argued in chapter 6, for some kayakers the quality of parking could be taken as a proxy for remoteness which may be valued by some kayakers. If this is the case, one might expect some river runners and kayakers with more years of experience to favour more wilderness kayaking excursions that might be associated with poorer parking facilities.

The star rating of the whitewater site indicates whether, within its grade, the site is a particularly good example. For example, the Roughty river in Co. Kerry receives three stars in the Irish Whitewater Guidebook (MacGearailt, 1996) as it is "one of the classic grade 4 whitewater runs in the country". Basic and intermediate skill kayakers may not be concerned with star rating but may be more interested in a "nice day out" as one of the respondents put it or "good company and good craic[41]" as another put it when asked in the questionnaire "In your opinion, what other factors are important in choosing a site to kayak at?". Similarly, freestyle kayakers will probably not be overly concerned with the star rating of a feature. In comparison, advanced level kayakers are more interested in the physical features of the whitewater: the gradient;

[41] In an Irish context "having the craic" refers to having a good time and enjoying one's self.

the technical difficulty of the rapids; the presence of standing waves; waterfalls, etc. Taking this into account it would be expected that advanced skill kayakers and river runners may be more concerned with the star rating of the run than their basic or playboater counterparts.

For the water quality attribute one might expect that all types of kayaker would prefer better quality water to kayak in. Higher skilled paddlers or freestyle kayaker who might spend more time under water and rolling their kayak should be particularly in favour of cleaner water. One would expect that all kayakers would favour quality scenery at the whitewater sites. However, one might expect river runners and advanced skill level kayakers to be more concerned with the quality of the whitewater and to be concentrating on getting through the technically challenging whitewater than on the quality of the scenery around them. On the other hand, long distance or polo kayakers may visit a whitewater site just for the beauty of the area surrounding the whitewater site.

Knowing the water levels at a whitewater site prior to visiting them is an important issue for kayakers and it would be expected that all kayakers would favour better prior information. Water levels in Irish rivers are directly determined by rainfall. For this reason, winter tends to be the best time of year for whitewater kayaking. Rainfall, though, can be very localised. So even though it may be very wet in a kayaker's home area, the river 20 miles north may still be not running as there has not been any rain in its catchment area in the previous 24 hours. This situation makes prior information on water levels in different locations an important consideration when undertaking a kayaking trip. As well as this, freestyle kayakers may need even more information on water conditions at their favourite playspots as these locations may be affected by the height of the tides. For example, Curragower wave on the Shannon River is situated near the estuary of the river and only works on the 2 hours either side of low tide. Also, kayakers with more years of experience may be better judges of likely water conditions on rivers and therefore may not need the same levels of prior information compared to kayakers with little experience.

8.3. Results

In this section the results of the Random Parameter Logit (RPL) model and the latent class (LC) model are presented. In both models, as in previous chapters, the dependent variable is the number of trips taken to the river in the previous year. The choice probabilities of going to whitewater kayaking sites are regressed on travel cost, and the six site attributes; parking, crowding, star rating, water quality, scenery and prior information on water levels. The other regressors are site-specific constants for all whitewater kayaking sites, except the Liffey. The models were estimated in Limdep using Maximum Likelihood estimation procedures.

8.3.1. Results from the Random Parameter Logit model

The results for this model are presented in table 8.1. For the RPL model it was assumed that each whitewater site attribute acts independently on the kayaker's utility (i.e. no cross effects are present). The estimated coefficients for the travel cost variable and the whitewater site choice dummies are specified as fixed to aid estimation. Running the RPL model requires an assumption to be made about the distribution of preferences for each attribute. The main candidate distributions are normal and log normal. The former allows preferences to range between positive and negative for a given attribute while the latter restricts the range to being of one sign only. I experimented with allowing some of the coefficients to follow a log-normal distribution. One would suspect that kayakers would appreciate better quality scenery compared to worse quality scenery, or cleaner water to kayak in rather than displaying a preference for more polluted water. In these cases a log-normal distribution should be more appropriate. However, when specifying these variables to be log-normally distributed the model failed to converge. Brownstone & Train (2003) experienced the same problem. Following the example of Brownstone & Train (2003) and Hensher & Greene (2003) I also explored using the lognormal distribution on transformed variables (i.e. negative of travel cost) to circumvent this problem. The model still failed to converge however and the model therefore treats all coefficients as random and normally distributed.

Mean effects for the quality of parking, star quality, water quality, prior information and scenic quality are all of the expected sign and significant at the 5% level. Unexpectedly the crowding coefficient has a negative sign and is significant at the 5% level, indicating that the more crowded a whitewater site is, the more kayakers favour it. This may be true over a certain range, as kayakers prefer company on the whitewater runs, but one would expect that when crowding reaches a certain threshold it would have a negative impact on the kayaker's utility function. Perhaps it is the case that this threshold level is not reached or has not been experienced by the kayakers in the sample, at the eleven whitewater sites. Indeed, in general, overcrowding is not a major problem at the majority of Irish whitewater sites.

Table 8.1.Random Parameters Logit Model, all trips

Variable		*Coefficient*	*St. Error*
Random Parameters in Utility Functions			
Quality of Parking	Mean of coefficient	0.220	0.022*
	Stnd. Dev. of coefficient	0.382	0.058*
Crowding	Mean of coefficient	-0.215	0.022*
	Stnd. Dev. of coefficient	0.782	0.043*
Star quality of the whitewater site	Mean of coefficient	0.546	0.033*
	Stnd. Dev. of coefficient	1.000	0.056*
Water Quality	Mean of coefficient	0.260	0.025*
	Stnd. Dev. of coefficient	0.230	0.070*
Scenic quality	Mean of coefficient	0.275	0.024*
	Stnd. Dev. of coefficient	0.590	0.042*
Availability of Information on water levels prior to visiting the site	Mean of coefficient	0.278	0.025*
	Stnd. Dev. of coefficient	0.700	0.048*
Nonrandom Parameters in Utility Functions			
Travel Cost		-0.063	0.001*
Clifden Play Hole		-1.999	0.102*
Curragower Wave on the Shannon		-1.738	0.067*
The Boyne		-1.601	0.054*
The Roughty		-2.560	0.117*
The Clare Glens		-4.130	0.115*
The Annamoe		-2.598	0.069*
The Barrow		-3.186	0.095*
The Dargle		-4.577	0.105*
The Inny		-2.829	0.086*
The Boluisce (Spiddle)		-2.899	0.101*

* indicates significant at 5%, RPL Model has log likelihood value of –15,912.37.

The significance of the parameters on the standard deviations of the site choice coefficients shows whether taste differences vary significantly across the kayaking population. Since the estimated standard deviations of the coefficients for the site choice attributes are all significant at the 5% level, this would seem to indicate that these parameters do indeed vary considerably in the population. Part of this variation in preferences could perhaps be captured by characteristics of the kayakers, which are not included in the model. However, in a RPL model of appliance choice, Revelt and Train (1998) found considerable variation still remained even after including demographic variables. This would suggest that preferences vary considerably more than can be explained by observed characteristics of people. The whitewater site dummies are significant and, as with the RUM model presented in the previous 2 chapters, all sites display a negative sign. Although use has been made in the literature of socio-economic characteristics interacted with site attributes to pick up on heterogeneity in the sample (Adamowicz et al., 1997 and Pollack and Wales, 1992), this approach has not been followed in this thesis. As Boxall and Adamowicz (2002) point out, this method is limited in practice because it requires prior knowledge regarding which individual and choice variables to interact in order to distinguish groups with similar preferences.

The results of the RPL are quite similar in sign and magnitude to the standard conditional logit (CL) model of chapter 6 where preferences are assumed to be homogenous. The travel cost coefficient for the standard CL is -0.069 whereas it is –0.063 for the RPL. The CL model also contains all negative and significant site choice dummies with similar magnitudes to the RPL results. The major difference between the two models is with regard to the parking, water quality and crowding coefficients. The CL model, unlike the RPL model, displays the expected sign for the crowding variable but a negative sign for the parking variable. Finally, the water quality variable, even though it is of the expected sign, is found not to be significant in the CL model whereas it is highly significant in the RPL model.

8.3.2. Results from the Logit Latent Class Model

Model estimation using the Logit Latent Class Model (LCM) once more allows the researcher to focus on the heterogeneous nature of the kayaking population's preferences. The results of the LC models are presented in tables 8.3 to 8.6. The basic specification of the LCM is the same as that of the CL model and the RPL model. In this chapter a LCM with two classes is presented in table 8.3, with three classes in table 8.5 and with 4 in table 8.6. A specification of the LCM was also estimated imposing 5 latent class segments. The results of this specification yielded classes with many large and statistically insignificant coefficients. Therefore, only the results of the LCM with 2, 3 and 4 classes are presented in this chapter.

The conventional specification tests used for maximum likelihood estimates (likelihood ratio, Lagrange multipliers and Wald tests) are not valid in the context of latent class models as they do not satisfy the regularity conditions for a limiting chi-square distribution under the null. Therefore, in order to decide the number of classes with different preferences, an information criteria statistic is used that was developed by Hurvich and Tsai (1989) and used in the application of a recreational latent class model by Scarpa and Thiene (2005). The information criteria statistic (C) is specified as $-2lnL + J\delta$ where lnL is the log-likelihood of the model at convergence, J is the number of estimated parameters in the model and δ is a penalty constant.

There are a number of different types of information criteria statistics that can be employed. Each one depends on the value taken by the penalty constant δ. For $\delta = 2$ one obtains the Akaike Information Criteria (AIC); for $\delta = \ln(N+1)$ one obtains the consistent AIC (cnAIC); for $\delta = \ln(N)$ one obtains the Bayesian Information Criteria (BIC), which by construction is very similar to the cnAIC (N is the number of observations in the sample). Finally, for δ = 2+2(J+1)(J+2)/(N-J-2) one has the corrected AIC (crAIC), which increases the penalty for the number of extra parameters estimated. Even though these criteria statistics are very useful in deciding on what the optimum number of classes are, they can fail some of the regularity conditions for a valid test under the null (Leroux, 1992). As such, Scarpa and Thiene (2005) point out that "the chosen number of classes must also account for significance of parameter estimates and be tempered by the analyst's own judgment on the meaningfulness of the parameter signs".

Table 8.2.Criteria for Number of Classes

		N=279			
Number of Classes	lnL	Parameters	AIC	BIC	crAIC
2	-2481.54	34	5031.08	5154.54	5315.95
3	-2266.19	51	4634.38	4819.57	5776.69
4	-2184.03	68	4504.06	4750.98	7511.68
5	-2218.67	85	4607.34	4915.99	11062.91

The values for selected information criteria of different preference-groups are reported in Table 8.2 and are consistent with the hypothesis that there are at least 4 classes with satisfactory parameter estimates, in both statistical and theoretical terms. As can be seen from the table, the AIC and the BIC criteria statistics decreases in absolute value up until the 4 class model and then starts to increase once more. Although the crAIC statistic would appear to indicate that the model with 5 classes is statistically preferred, the estimates it produces are difficult to interpret and in any case have a high number of statistically insignificant estimates.

In all of the following LC models the latent classes are specified as a function of kayaking experience (number of years kayaking) as well as the kayak handling skill of the kayaker[42]. A correlation coefficient of 0.54 indicates that there is a strong positive linear relationship between the experience and skill variable in the data set. When estimating the "clustered" RUM model in the previous chapter the kayaking sample was separated by skill level. If the LC models were specified as a function of the kayaker skill variable alone one would be estimating for two identifiable rather than latent classes. Therefore, in this thesis, the latent classes are instead specified as a function of kayaking experience (number of years kayaking) as well as the kayak handling skill of the kayaker. In this case the latent classes are instead specified as a function of a continuous variable (the experience variable) and a variable with 2 classes (the skill level variable) rather than the discrete, skill level variable on its own. Kayakers can therefore be grouped together from a large number of possible categories, ranging from basic or intermediate skilled kayakers with only 1 year of kayaking experience to those with advanced skills and more than 15 years of kayaking experience.

In addition to a complete set of whitewater site attribute coefficients being estimated for each latent class, a set of probabilities for each class was estimated assigning class membership as a function of the kayaker's experience and his or her level of kayak handling experience. For these characteristics the number of coefficients estimated has to be equal to the number of latent classes minus one in order to account for the indeterminacy in the model which is caused by the lack of normalization (Hilger, 2002).

The 2 class LCM

[42] The skill variable is 0 if the kayaker has basic or intermediate kayak handling skills and 1 if he or she has advanced kayak-handling skills.

As can be seen from table 8.3, the latent class model with 2 classes (A and B) produces coefficients that vary considerably in both classes. The travel cost, crowding, quality of scenery and star quality variables are all of the expected signs. The signs on three of the attribute variables are however not as expected.

Table 8.3.Latent Class Model (2L), Latent Classes A and B

	Latent Class A		**Latent Class B**	
Variable	*Coefficient*	*St. Error*	*Coefficient*	*St. Error*
Travel Cost	-0.049	0.002*	-0.526	0.035*
Quality of Parking	-0.425	0.04*	0.009	0.120
Crowding	0.114	0.035*	0.014	0.117*
Star quality of the whitewater site	0.469	0.072*	0.812	0.198*
Water Quality	0.037	0.067	-0.949	0.123*
Scenic quality	0.039	0.046	1.120	0.127
Availability of Information on water levels	0.689	0.055*	-0.201	0.144
Clifden Play Hole	-3.613	0.199*	-3.613	0.199*
Curragower Wave on the Shannon	-5.686	0.162*	-5.686	0.162*
The Boyne	-9.824	0.397*	-9.824	0.397*
The Roughty	-25.791	2871.440	-25.791	2871.440
The Clare Glens	-15.404	5.601*	-15.404	5.601*
The Annamoe	-11.384	0.690*	-11.384	0.690*
The Barrow	-14.692	0.814*	-14.692	0.814*
The Dargle	-14.970	0.937*	-14.970	0.937*
The Inny	-7.114	0.328*	-7.114	0.328*
The Boluisce (Spiddle)	-16.723	0.851*	-16.723	0.851*
Class Probability				
Experience	0.135	0.033*		
Kayak Handling Skill	0.684	0.185*		

* significant at 5%, LC Model (2L) has log likelihood value of –2,481.54

Although some case may be made for a negative sign on the quality of parking variable (kayakers preferring remoter sites that have worse parking), it is very difficult to make a case for a group of kayakers preferring poorer water quality at whitewater sites (class B displays a negative sign on the statistically significant water quality coefficient). Having said that kayakers do not in general take much notice of the quality of the water they paddle in unless the pollution levels are extreme. Indeed, the most frequented white water site in the sample was the "Sluice" whitewater site on the river liffey. This would also be the most polluted of the whitewater sites looked at in this analysis. Similarly, it is hard to justify one group of kayakers preferring less prior information on water levels and yet this is suggested in the results above.

The estimated coefficients on the whitewater site choice dummy variables are negative and highly significant in the basic CL model (see table 6.5). They are also all significant in the RPL model (except for the Curragower wave dummy). In the 2 class LC model, 9 out of the 10 site specific constants are significant. However, estimation of the model yields surprising results if one does not restrict the coefficients for the whitewater site choice dummies to be constant across latent segments (see Table 8.4 below). In this case the magnitude of the coefficients and the size of the standard errors are very large in comparison to the preferred latent class model structure where the whitewater site choice dummies are assumed constant across latent segments.

One explanation for this phenomenon is that the true coefficients for the whitewater site choice dummies are constant across latent segments; that is to say that preferences for the unobserved whitewater site–specific characteristics are homogenous among the sample population. A similar result was found when the RPL model was run, allowing the estimated coefficients of the whitewater site dummies to randomly vary across kayakers. In that case it was found that many of the standard deviations of the coefficients were insignificant implying little variation in tastes with respect to these unobserved whitewater site–specific characteristics. Restricting the coefficients on the whitewater site choice dummies to be equal across classes, as is done in Table 8.3, yields whitewater site dummy coefficients that are statistically significant (except for the Roughty) and of the expected sign.

Table 8.4.Unrestricted Latent Class Model (2L), where Site Choice Coefficients are Free to Vary Across Classes.

	Latent Class A		Latent Class B	
Variable	*Coefficient*	*St. Error*	*Coefficient*	*St. Error*
Travel Cost	-0.8267	0.0266*	-0.0021	0.0005*
Quality of Parking	8.6568	0.3137*	-0.1491	0.01690*
Crowding	-5.786	0.2257*	-0.2868	0.0172*
Star quality of the whitewater site	-4.4098	0.1959*	-0.4918	0.0213*
Water Quality	-3.8804	0.1545*	0.0259	0.0203
Scenic quality	7.9132	0.2763*	-0.0347	0.0186
Availability of Information on water levels	-1.9213	0.1167*	0.3254	0.0197*
Clifden Play Hole	-13.1131	0.5419*	-1.1538	0.0280*
Curragower Wave on the Shannon	4.9923	0.2449*	-2.7033	0.0497*
The Boyne	6.2507	0.3281*	-3.5924	0.0764*
The Roughty	-63.5108	38.3093	-3.087	0.0555*
The Clare Glens	-56.8732	12.4842*	-5.6871	0.1907*
The Annamoe	-20.0809	0.6566*	-68.5422	126000
The Barrow	-33.2016	1.1773*	-37.0107	1659516
The Dargle	-140.3663	147766	-6.9883	0.3249*
The Inny	-38.5922	2.313*	-25.4044	408.101
The Boluisce (Spiddle)	-31.6939	0.8889*	-116.0856	2577777
Class Probability				
Experience	0.4237	0.0223*		
Kayak Handling Skill	-0.8869	0.0717*		

* significant at 5%, LC Model (2L) has log likelihood value of –2,481.54

For the restricted model of Table 8.3, it could be speculated that class B is representative of the *river running* kayaker. They appear to prefer good parking facilities and to avoid crowded whitewater sites. They seem to have little use for prior information on water levels and are unconcerned about scenery or better quality water. This would be in keeping with the image of this type of kayaker. They also, as expected, prefer the more classic whitewater runs as indicated by the positive sign on the star rating coefficient for this group of kayakers. Class A kayakers could be thought of as the *freestyle or playboating* kayakers with more advanced kayak handling skills. From the estimated coefficients it can be seen that this group prefer uncrowded whitewater sites and are positively concerned about water quality (since they are likely to be in (and under) more turbulent whitewater, polluted water could have much more serious health consequences). The star rating of the site also appears to be important (significant) to this group. Finally, reliable prior information on water levels is important to this type of kayaker. This is perhaps the most important defining variable in this class. Park and play spots such as the Curragower wave on the Shannon and Clifden play hole are effected by the height of the tide. These park and play features only work on low tides so prior information on water levels is very important for this group of kayakers before a trip is undertaken. All this is very much in keeping with the image of the *freestyle* kayaker.

The 3 class LCM

The results of the latent class model with 3 class segments (Model 3L) are presented in table 8.5. This model provides coefficients that are significant for all the whitewater site attribute variables in class C but very few significant attributes in the other two classes. 6 out of 10 of the coefficients on the whitewater site dummies, which are once more held constant across classes, are found to be significant at the 5% level. The signs and magnitudes of coefficients vary greatly across the three classes. The 2-class model displays a marginally lower value for the maximum log-likelihood than for the 3-class model (–2,482 as apposed to -2,266).

It is important to keep in mind that one of the key contributions of the latent class model is the ability to distinguish between coefficients estimated from samples with heterogeneous preferences. Within the 3L latent class model, only one of the coefficients estimated, the crowding coefficient, retained the same sign across all segments. This result may be explainable in the cases of parking, crowding and star rating but is harder to explain in the case of water quality, scenic quality and availability of prior information on water levels. Once again a positive coefficient would have been expected for water quality where the representative kayaker in the sample prefers rivers with cleaner water. Although Class C displays a negative sign on the parking variable, indicating that these classes of kayakers prefer worse parking facilities, this may not be unexpected (see discussion in previous section).

Table 8.5.Latent Class Model (3L), Latent Classes A, B and C

	Latent Class A		Latent Class B		Latent Class C	
Variable	*Coefficient*	*St. Error*	*Coefficient*	*St. Error*	*Coefficient*	*St. Error*
Travel Cost	-0.059	5.929	-0.044	0.010*	-0.317	0.031*
Quality of Parking	10.978	261.723	0.235	0.141	-1.724	0.212*
Crowding	18.984	421.925	0.005	0.178	2.062	0.293*
Star quality of the whitewater site	50.033	1062.945	0.149	0.273	-1.117	0.359*
Water Quality	-26.110	597.227	0.396	0.282	-0.965	0.243*
Scenic quality	29.490	646.867	-1.100	0.162*	2.548	0.273*
Availability of Information on water levels	27.690	736.529	0.024	0.019*	3.329	0.489*
Clifden Play Hole	-3.884	0.718*	-3.884	0.718*	-3.884	0.718*
Curragower Wave on the Shannon	-5.665	0.455*	-5.665	0.455*	-5.665	0.455*
The Boyne	-20.425	1.375*	-20.425	1.375*	-20.425	1.375*
The Roughty	-36.688	27345	-36.688	27345	-36.688	27344
The Clare Glens	-54.852	57135	-54.852	57135	-54.852	57135
The Annamoe	-20.362	81.758	-20.362	81.758	-20.362	81.758
The Barrow	-28.163	83017	-28.163	83017	-28.163	83017
The Dargle	-24.908	1.676*	-24.908	1.676*	-24.908	1.676*
The Inny	-12.465	0.604*	-12.465	0.604*	-12.465	0.604*
The Boluisce (Spiddle)	-19.516	1.478*	-19.516	1.478*	-19.516	1.478*
Class Probability						
Experience	-0.329	0.086*	0.148	0.022*		
Kayak Handling Skill	-15.698	12049	-0.564	0.158*		

* significant at 5%, LC Model (3L) has log likelihood value of –2,481.54

The interpretation of the type of kayaker in each of the classes in model 3L is somewhat different than that for the 2-class model. It could be speculated that class C is representative of the less experienced basic or intermediate skilled *river running* kayaker. These kayakers appreciate the wilderness experience (negative sign on parking coefficient), like uncrowded sites and enjoy the scenery along the whitewater runs. The quality of the whitewater is also important for this group. Being of a lower skill level they are looking for lower quality, less technically challenging runs. The negative sign on the statistically significant star quality variable confirms this. Class A might describe the "*competitive*" kayakers. From the estimated coefficients it can be seen that this minority group would appear to be unconcerned about the attributes of the river. They simply require a venue to train and race on. They are so focused in their training they are even unconcerned with the cost of getting to and from training and race sites.

Class segment B collects together what might once more be called "*the playboaters*". These individuals will gather at single features on a river to "park and play" for the duration of the kayaking excursion. They enjoy kayaking at less crowded features and appear to be the only group positively concerned with the quality of water at the whitewater site, as they tend to spend a lot of time under water and rolling in/on the feature, be it surfing a river wave or cartwheeling in a whitewater hole. Prior information on water levels is once again important for this group as some of the features may even be affected by the tides.

The 4 class LCM

The results of the latent class model with 4 class segments (Model 4L) are presented in table 8.6. Restricting the coefficients on the whitewater site choice dummies to be equal across classes yields 7 (out of 10) whitewater site dummy coefficients that are statistically significant and of the expected sign. In relation to class C, this model also provides coefficients that are significant for all the whitewater site attribute variables except water quality. Class B's attributes are significant except for the parking quality, crowding and star rating coefficients. The quality of water and quality of scenery are the only significant attributes in class D and class A (as was the case with the 3 class model) has no significant site attributes at all. Even the travel cost variable is of the unexpected sign in class A. Also, there is a wide variation in the signs of the coefficients across classes indicating very different preference patterns among the kayaking population.

The negative sign for the star quality variable in class C may seem surprising, indicating that kayakers prefer lower star quality whitewater sites. However, one may expect some kayakers to prefer lower star quality whitewater sites, as these whitewater sites are less technically difficult and may result in a more pleasant paddle for kayakers with less experience. Also, it should be kept in mind that "playboaters" are not concerned in general with the star rating of a whitewater site as they are only concerned with one "park and play" feature at the site.

Although some case may be made for a negative sign on the crowding variable (kayakers preferring crowds on the river as they are social creatures!), it is very difficult to make a case for a group of kayakers preferring poorer water quality at whitewater sites (classes C and D display a negative sign on the water quality coefficient). Once again, it is hard to justify a group of kayakers preferring worse scenery but yet this is the case for class A and B in the results. The fact that parking has a negative sign for classes C and D could be interpreted as showing that the remoter or more secluded the whitewater site is, the higher the probability the site will be visited by these classes.

Table 8.6. **Latent Class Model (4L), Latent Classes A, B, C and D**

	Latent Class A		Latent Class B		Latent Class C		Latent Class D	
Variable	*Coefficient*	*St. Error*	*Coefficient*	*St. Error*	*Coefficient*	*St. Error*	*Coefficient*	*St. Error*
Travel Cost	0.765	2738729	-0.037	0.010*	-0.264	0.036*	-0.676	0.172*
Quality of Parking	22.789	9780169	0.005	0.140	-0.970	0.304*	-1.649	1.958
Crowding	5.814	5940854	0.033	0.171	2.211	0.353*	1.443	1.452
Star quality of the whitewater site	11.234	6517027	0.464	0.298	-2.000	0.564*	2.080	0.866
Water Quality	19.822	6209869	0.318	0.138*	-0.718	0.468	-3.467	1.379*
Scenic quality	-3.482	7284839	-0.914	0.172*	2.243	0.587*	3.305	1.002*
Availability of Information on water levels	-45.381	8083810	0.373	0.115*	3.329	0.584*	0.971	2.178
Clifden Play Hole	-4.185	0.646*	-4.185	0.646*	-4.185	0.646*	-4.185	0.646*
Curragower Wave on the Shannon	-6.250	0.570*	-6.250	0.570*	-6.250	0.570*	-6.250	0.570*
The Boyne	-18.997	1.717*	-18.997	1.717*	-18.997	1.717*	-18.997	1.717*
The Roughty	-28.728	682.950	-28.728	682.950	-28.728	682.950	-28.728	682.950
The Clare Glens	-27.234	267.168	-27.234	267.168	-27.234	267.168	-27.234	267.168
The Annamoe	-16.810	6.393*	-16.810	6.393*	-16.810	6.393*	-16.810	6.393*
The Barrow	-17.463	4.574*	-17.463	4.574*	-17.463	4.574*	-17.463	4.574*
The Dargle	-22.930	15.602	-22.930	15.602	-22.930	15.602	-22.930	15.602
The Inny	-10.197	0.578*	-10.197	0.578*	-10.197	0.578*	-10.197	0.578*
The Boluisce (Spiddle)	-22.741	2.308*	-22.741	2.308*	-22.741	2.308*	-22.741	2.308*
<u>*Class Probability*</u>								
Experience	-3.079	52.366	0.137	0.065	-0.048	0.069		
Kayak Handling Skill	-1.723	7930.570	3.902	8.756	5.650	8.786		

* significant at 5%, LC Model (4L) has log likelihood value of –2,184.0

For the restricted model of Table 8.6, it could be speculated that class C is representative of the less experienced, basic or intermediate skilled *river running* kayaker, favouring remote runs, lower star quality runs, good scenery and good prior information on water levels. This would be in keeping with the image of this type of kayaker, where he is interested in a lazy stroll down the relatively slow moving, uncrowded river. Class D kayakers could be thought of as the more experienced, *river running* kayakers. From the estimated coefficients it can be seen this group prefer more remote (negative parking coefficient), higher star quality runs. They also prefer more scenic whitewater sites and seem to be unconcerned about prior information on water levels before they make a trip. These individuals have more experience and a better understanding of where good water levels may be found and so prior information on water levels is not as important for this group as it is for the less experienced river runner described by group C.

Class A kayakers could be thought of as the "*competitive, long distance*" kayakers. From the estimated coefficients it can be seen this minority group would appear to be unconcerned about the attributes of the river. They simply require a venue to train and race on. Also, judging from the unusually positive sign on the travel cost variable, they appear to prefer travelling large distances to get to the racing sites. The probability of any kayaker in the sample being described by this class is extremely low at only 0.003. Finally, I would speculate that class B represents the *freestyle playboaters*. As can be seen from the coefficients these kayakers prefer (as one would expect) better parking facilities, proper prior information on water levels and uncrowded playspots. Given the amount of time this group spends under water and rolling their kayaks, one finds as expected that this group of kayakers is positively concerned with water quality.

The individual specific posterior class probabilities were calculated as outlined in section 8.2. The average individual specific posterior class probabilities for class segments A, B, C and D were found to be 0.003, 0.53, 0.31 and 0.16 respectfully. This indicates that within the sample kayakers have a 50% chance of having the preferences described by the latent class B parameters. The individual specific posterior class probabilities will be utilised in the next section, where the estimated results from the RPL model and the latent class model will be used to look at the welfare impact of a number of whitewater site changes.

8.4. Welfare Impacts of Site Changes

In this section a number of welfare scenarios for the alternative models are considered. These include: (a) The Roughty river becoming unnavigable by kayak due to the building of a hydro scheme; (b) The Boyne river becoming unnavigable by kayak due to the building of a hydro scheme; (c) A 25% improvement in water quality at the Curragower wave on the Shannon; and (d) A €3 parking fee at the put-in to the Boluisce river. The results based on both models are shown in tables 8.7. All results are per kayaker per trip. The 2 columns of table 8.7 present the welfare estimates for the RPL model and the LC model containing 4 classes. The LC model containing 4 classes was chosen to calculate the welfare estimates based on the results of the information criteria statistics and my own interpretation of which model might best describe the different groups to be found in the kayaking population.

Table 8.7. Welfare Impact of Different Policy Scenarios as Measured by Loss/Gain in Consumer Surplus per Kayaker per Visit

Scenario	RPL Model (€)	4L LC Model (€)
Loss of the Boyne river due to the building of a hydro scheme	26.22	55.01
Loss of the Roughty river due to the building of a hydro scheme	2.78	36.72
25% improvement in water quality at Curragower wave	0.56	14.50
€3 parking fee at the Liffey	3.70	5.49

Source: Calculated from models reported in Tables 4 and 6.

The expected CV loss per kayaker from the loss of the Roughty river is calculated at €2.78 when using the results of the RPL model. The corresponding estimate when using the results of the LC model is much higher than this at €36.72. A less extreme difference is found when one calculates the welfare loss associated with the closer of the Boyne river to whitewater kayaking. The expected CV loss per kayaker from the loss of the Boyne river is calculated at €26.22 when using the results of the RPL model. The corresponding estimate when using the results of the LC model is almost double the RPL welfare estimate at €55.01. These results may be accounted for by the fact that the Boyne river is a lower grade river more likely to be frequented by less experienced and less skilful kayakers (those in class C) whereas the Roughty is a grade 4 run that would be frequented by kayakers of higher skill and more whitewater experience (class D). The average probability of a kayaker being in class C or class D is relatively high at 0.47 (0.31 and 0.16 respectively). A relatively high weight is therefore attached to these classes in the calculation of the welfare estimate. Also, the travel cost coefficient values associated with these two classes are much lower than the travel cost coefficient for the RPL, -0.264 and -0.676 compared to –0.063. This leads to the welfare estimate for the loss of the whitewater sites from the choice being much larger when estimated by the LC model compared to when they are estimated from the RPL model.

In relation to changes in the attributes of particular sites, the LC model once more gives higher estimates of the welfare impacts on whitewater kayakers. For instance, the estimate of the welfare gain to kayakers of a 25% water quality improvement at the Curragower wave on the river Shannon using the LC model is €14.50. However, the estimated recreational benefit is only €0.55 per kayaker per trip when using the RPL results. The local county council may be more willing to undertake a water clean-up program in Limerick city if presented with the first estimates whereas they may be unlikely to if presented with the second calculation. Similarly, the loss in kayaker welfare per trip when a €3 parking fee is imposed at the put-in to the Sluice on the river Liffey is 43% less if one uses the RPL model instead of the LC model results, €3.70 compared to €5.49.

There are of course many alternative approaches to incorporating heterogeneity within RUM models of recreation. One interesting comparison is then between the clustered RUM approach used in the previous chapter to account for heterogeneity, and the alternative models utilised in this chapter. In table 8.8 a comparison of the welfare estimates of site quality/access changes is made between the random parameters model, the LC model and the clustered RUM results. As may be seen, the expected CV loss per kayaker from the loss of the Roughty river is calculated at €2.78 when the results of the RPL model are used, a result that is very similar to the clustered RUM estimate. A much more extreme difference is found when the welfare loss associated with the closure of the Boyne river to whitewater kayaking is calculated. The expected CV loss per kayaker in this case is calculated at €26.22 when the results of the RPL model are used. This is 24 times greater than the result from the clustered RUM model. As can be seen from table 8.8, the LC model gives the highest values associated with the loss in any of the river systems from the point of view of whitewater recreation. In the case of the Roughty, the expected CV loss per kayaker from the building of a hydro-scheme is 14.5 times greater when measured using the LC model compared to the Clustered RUM.

Table 8.8. Welfare Impact of Different Policy Scenarios as Measured by Loss/Gain in Consumer Surplus per Kayaker per Visit

Scenario	Skill RUSC Model (€)	RPL Model (€)	4L LC Model (€)
Loss of the Boyne river due to the building of a hydro scheme	1.06*	26.22	55.01
Loss of the Roughty river due to the building of a hydro scheme	2.54**	2.78	36.72
25% improvement in water quality at Curragower wave	0.13**	0.56	14.50
€3 parking fee at the Liffey	0.19*	3.70	5.49

Source: Calculated from models reported in Tables 7.5, 8.1 and 8.6.
* indicates estimated using the RUSC model for kayakers who have basic and intermediate proficiency level kayak handling skills.
** indicates estimated using the RUSC model for kayakers who have advanced proficiency level kayak handling skills.

In relation to changes in the attributes of particular sites, the RPL model once more gives estimates of the welfare impacts on whitewater kayakers that are slightly higher than the clustered RUM results. The LC model gives higher estimates again than either the RPL or the Clustered RUM. For instance, the estimate of the welfare gain to kayakers of a perceived 25% water quality improvement at the Curragower wave on the river Shannon is once again very low at only €0.56 per kayaker per trip when using the RPL results, compared to €0.13 for the clustered RUM result or a high of €14.50 for the LC model welfare estimate. The differences in the results may be explained by the fact that the RPL and LC models allow explicitly for a range of attitudes towards attributes within the kayaking population whereas the clustered RUM model only allows for differences in attitudes and tastes based on differing skill levels. This distinction will of course yield welfare estimates that vary in their magnitude.

It is very difficult to decide which values one might use from table 8.8 to put forward to policy makers. It is obvious from table 8.8 that some of the differences in welfare estimates between the models are very large. Given the fact that the RPL and LC model allows explicitly for a range of attitudes towards attributes within the kayaking population this author would tend to use these results over the CL and "clustered RUM" models. Although the latent class approach generates additional information which is potentially very useful to recreational site managers and policy managers, the kayaking dataset here may not be large enough to support the welfare estimates derived from the 4 class model. The LC model also depends on what one assumes is the correct number of classes. If our kayaking data set was larger I would favour the use of the latent class model, but in relation to the current kayaking dataset the welfare estimates derived from the RPL model would be the ones I would personally present to policy makers. It should also be noted that the estimates from the RPL model may depend on what one assumes about the distribution of preferences. Perhaps a more simplistic reason for this choice is that the welfare estimates from the RPL model lie between those of the clustered RUM and the latent class model.

8.5. Summary

This chapter examined alternative ways of modelling heterogeneity of tastes for attributes of an outdoor recreational good via a travel cost survey. Two advanced modelling techniques were compared, namely the random parameter logit model and the latent class model. These models were then used to explain whitewater site choice in Ireland. The results of the RPL model gives considerably lower welfare estimates of consumer surplus than the LC model when analysing changes in the attributes of particular sites. This chapter, like the previous highlights the fact that by not taking into account different preferences of different types of kayakers or the different type of recreationalist that frequent different recreational sites in general, recreation demand modellers may be underestimating (overestimating) the welfare losses (gains) associated with changes in site attributes.

The random parameter logit approach has some intuitive attraction in so far as it allows explicitly for a range of attitudes towards attributes within the population, identifies which attributes have significant levels of heterogeneity in preferences, and quantifies the degree of the spread of values around the mean. This is important in circumstances such as the one presented here where one is interested in the demand for recreation service flows by a certain set of individuals whose attitudes and tastes in relation to their recreational activity vary considerably. However, the analyst must impose a distributional form on preferences. A simple normal distribution for preference parameters allows both positive and negative attitudes towards an attribute. However, in some cases such as for water quality one may suspect that they should be uniformly negative or positive, in which instance one requires some restriction on the distribution. The model, however, failed to converge when these restrictions were attempted.

The latent class model provides further insight into the data by endogenously identifying groups of kayakers who have similar preferences for particular whitewater site attributes, but where preferences vary considerably between groups. The latent class analysis presented statistical evidence in favour of the existence of four distinct preference groups. An immediate interpretation of the differences between groups is possible based on knowledge of the different types of kayakers in the Irish whitewater community. While most preference structures in the classes are consistent with theoretical expectations in terms of signs, groups representing small fractions of the sample tend to show much lower significance of parameter estimates (see for example class segment A in model 4L). The latent class approach generates additional information, which is potentially very useful to recreational site managers for a wide range of purposes. For example, knowing that *freestyle playboaters* are likely to be the only group of kayakers found at a site such as Clifden play hole allows us to concentrate on the parameter estimates of class B in the LC model 4L when budgeting maintenance or improvement plans for this whitewater destination.

As Scarpa and Thiene (2005) point out there is no unambiguous test of the superiority of one approach (RPL or LCM) over the other. However, it is the belief of this author that the LCM approach may offer a much more in-depth understanding of the heterogeneity of recreationalist preferences that are not readily identifiable through the random parameter logit model. The latent class model, put simply, provides a greater range of potentially-useful information. Randall (1997) foresaw the changes in non-market valuation research methodologies when he said "the future belongs to a broad-based research program of learning about preferences from what people tell us, whatever it takes." This chapter has presented two possible methodologies that attempt to implement Randall's aspirations. It also provides evidence that the latent class method may in general have a slight advantage over the RPL in its powerful combination of being able to specify a model that simultaneously estimates the marginal benefits associated with different attributes for different groups and assigning group membership. This trait of the LC model is the main reason that it is likely to become an important tool for resource managers in the future.

Chapter 9. Conclusions and Recommendations

This chapter summarises and highlights the most important findings of the thesis. Limitations of the study and potential future avenues of research in relation to modeling the demand for whitewater recreation are discussed. Finally I draw conclusions and make recommendations based on the research results.

9.1. Important findings of the thesis

There are a number of important findings arising from the research in this thesis. Firstly, in chapter 3, which reviewed the single site study on the river Roughty, the conflict between commercial interests and recreational pursuits on Irish rivers was highlighted. This chapter has contributed to the understanding of outdoor recreational pursuits in Ireland by estimating the first whitewater kayaking demand function for an Irish river. The other major contribution of this chapter was the finding that the data collected over the internet could be pooled with data from an onsite survey. If this finding could be generalised to other contexts, then it would have important implications for the cost and time spent in carrying out field surveys and could also offer a solution to the problem of endogenous stratification which results when recreational demand surveys are carried out only on-site.

Chapter 6 presented the results of the first application of the Random Utility Model to any outdoor recreation pursuit in Ireland. The major contribution of this chapter is that it develops a new approach to measuring the opportunity cost of travel time in travel cost models using information from a secondary micro level data set, the European Community Household Panel (ECHP). It was also argued in chapter 6 that the full wage rate should in fact be taken as the lower bound estimate of an individuals opportunity cost of time and that the use of the "fractional" wage may be underestimating the true opportunity cost of leisure time. Also, since large micro-datasets of labour markets are now becoming more and more available, they could be utilised, as was done in chapter 6, to get a better estimate of the wage rate of recreationalists, especially when the sample size collected in the recreation demand study is limited, as was the case here. In this regard the methodology for calculating the opportunity cost of time adopted here and used throughout the thesis is not just a once-off method due to some uniquely available dataset, rather, it is a process that could be implemented in the field with relative ease when carrying out travel cost studies due to the current widespread availability of labour market datasets in most developed countries. The use of a secondary data source model as a way to estimate the opportunity cost of time, as was done in this thesis, is potentially a very useful approach to take, especially in cases where the secondary data is available and the item non-response of labour market questions is high.

Chapters 7 and 8 highlighted the importance and influence of observed and unobserved heterogeneity in contemporary recreation demand models. This is consistent with other areas of applied economics, where accounting for unobserved heterogeneity in applications has taken on greater importance as computer power and micro data sets have become increasingly available. Chapter 7 highlighted the fact that not taking into account the differences in the skill of the kayakers and the grade of the whitewater river could result in overestimating the welfare estimates associated with lower grade whitewater sites (which are frequented by basic/intermediated proficiency level kayakers) and underestimating welfare estimates associated with changes in the attributes of higher grade whitewater sites (which are frequented by advanced proficiency level kayakers). The main contribution of this chapter is that it demonstrates that, by not taking into account the type of individuals that frequent different sites, policy makers and resource managers could potentially make incorrect resource allocation decisions that are based upon unreliable consumer surplus estimates and the misguided assumption of homogenous preferences amongst recreationalists.

Chapter 8 continues along the same vein as chapter 7, once again highlighting the fact that kayaker preferences for recreational demand sites are likely to be characterized by systematic heterogeneity. In this chapter, the random parameter logit (RPL) model and the latent class model (LCM) are used to endogenously take account of individual heterogeneity in analyzing whitewater kayaking site choice decisions. This chapter makes a number of contributions to the travel cost valuation literature. Firstly, it is the first piece of research to utilise the RPL and the LC Model to analyse any outdoor recreation pursuit in Ireland. Secondly, it is the first application of these particular models to the sport of whitewater kayaking.

The welfare estimates presented in this thesis also highlight a number of important findings. The welfare estimates were discussed in detail in each of the relevant chapters but I will briefly review the most important findings from those results here. Firstly, the single site study found that the mean consumer surplus of the average kayaker using the Roughty river in Co. Kerry was €83.30 per day trip. This figure indicated that there are significant opportunity costs to altering the flow of river systems in Ireland through the (government backed) building of hydro-schemes and that is before one even considers the opportunity cost of such development in terms of other recreational activities on and around whitewater rivers such as fishing.

It is interesting to note that the consumer surplus figure presented above is a lot smaller in magnitude to that of the other major whitewater recreationalist in Ireland, the fisherman. This is according to the results of a study by Curtis (2002). He found that the average consumer surplus of salmon anglers in Co. Donegal was €176 per day trip, approximately double the figure of the average kayaker. Considering each 600 kWh of electricity generated with a small scale hydro plant is equivalent to 1 barrel of oil (assuming an efficiency of 38 % for the conversion of oil into electricity (www.microhydropower.net)), it is obvious that the value of whitewater resources, from a hydro power viewpoint, is going to increase further in the future as oil reserves become even scarcer. Nevertheless the consumer surplus figures for kayakers and fishermen quoted above clearly indicate that the value of whitewater resources from a recreational viewpoint is also important and is something that needs to be carefully considered when planning for any development of Irish whitewater rivers.

The welfare estimates presented in this thesis highlight another interesting fact. That is, even though water pollution is a major problem on many whitewater rivers in Ireland, most kayakers in Ireland would not appear to be overly concerned with the quality of the water they kayak in. In fact, bar the latent class model, all other models' welfare estimates indicate that the perceived recreational benefit from a 25% improvement in water quality at the Curragower wave on the Shannon would result in an increase in consumer's surplus of less than €1 per kayaker per trip. Considering the high concentration of pollutants in the water at this particular site (EPA (b), 2004) this may seem surprising but, as discussed in chapter 6, Irish kayakers will kayak at almost any whitewater site regardless of pollution levels so long as the quality of the kayaking feature or its "star rating" is high.

Finally, this thesis highlighted the fact that how one specifies the recreational demand model has important repercussions for the magnitude of the welfare estimates. The "clustered" RUM model of chapter 7, that exogenously takes account of heterogeneity in the kayaker sample, gives higher welfare estimates of consumer surplus than the simpler RUM model in the case when the skill level of the kayaker is more advanced and the grade of the whitewater is higher and lower welfare estimates of consumer surplus than the simpler RUM model in the case when the skill level of the kayaker is less advanced and the grade of the whitewater is low. The results of models in chapter 8, which endogenously takes account of heterogeneity in the kayaker sample, give higher welfare estimates of consumer surplus than both the simple and "clustered" RUM models when analysing changes in the attributes of particular sites. In fact, the latent class model gives considerably higher welfare estimates of consumer surplus when analysing changes in the attributes of particular sites than any of the other models in the study. The range of welfare estimates that result from the different models indicate that recreation demand modellers need to be aware that the choice of which type of model to fit to ones data will have a significant impact on the magnitude of the resulting welfare estimates.

9.2. Limitations of the Results

This study is limited in the sense that the sample size is quite small. Given the relatively small sample size (.05 of the estimated kayaking population in Ireland) it would be wise to take a cautious view as to how representative the study sample is of the population of Irish kayakers. Also, limited information exists on actual numbers of kayakers who visit the study areas to engage in whitewater kayaking (participation or visitation rates). This information is needed in order to calculate aggregate value estimates. The Irish Canoe Union (ICU) could only supply information on the estimated current number of registered members and the percentage change in kayaker ICU course participation over the previous 5 years[43]. The ICU figures would be an underestimate of the total number of whitewater kayakers in the country, as many kayakers never become members of the ICU. It is recommended that the Irish Canoe Union work to generate such information to facilitate future benefit estimation efforts.

The questionnaire was designed to obtain insight into recreationists' past experiences with kayaking in the 11 chosen river sites in Ireland. Overall, conducting the survey seems to have been successful, as response rates were high and a considerable number of respondents provided additional positive comments on the questionnaire. However, there also appeared to be some important drawbacks, which should be taken into consideration in future applications. Firstly, the most prominent issue that has been raised at presentations of this research work relate to the thorny issue of on-site time. I failed to include a question asking respondents about the length of time spend on the river. This meant that the opportunity cost of on-site time could not be taken account of in calculating monetary values. Of course one could argue that the whole reason for taking a kayaking trip is to spend the time on the river and this time is actually part of the benefit one receives from the recreational activity. If this is the case, on-site time should not be considered an opportunity cost at all. Also, it needs to be stated that the average whitewater run in Ireland is very short compared to whitewater runs in the U.S., continental Europe or Canada. In this context, the opportunity cost of on-site time for our sample of kayakers may be low and constant across the kayaking sample so as not to have a significant impact on the results. Nevertheless, future research should aim to carefully design one, or a set of questions, to reveal the value of kayaker's on-site time.

[43] Although I contacted the ICU on a number of occasions, they were unable or not inclined to release actual figures on participation numbers in their kayaking courses. Instead they furnished me with their own estimate of the rate of change in kayak course participation rates.

Secondly, when the survey was collected a number of people highlighted the fact that the length of the whitewater run was an attribute they felt should have been included in the attribute set. This was something that did not come to light at the focus group stage but it may have been a more appropriate attribute to use than "the number of other sites within 10 mile proximity of this site", an attribute that I did not use in the analysis in the end. Thirdly, overseas visitors have not been incorporated in the analysis. While an Irish Canoe Union contact indicated that the total number of individuals visiting Ireland with the specific intention of whitewater kayaking is probably quite low there would still be a number of kayakers from abroad who would visit Ireland annually for big kayaking events such as the Liffey Decent in September of each year, or the Freestyle "Big Boat Bonanza" held in November each year. These international kayakers would kayak on many of the whitewater rivers in this study while in Ireland for the competitions. Thus, the welfare values estimated for the whitewater sites do not take account of the additional travel expenses incurred by these individuals and are therefore likely to understate the consumer's surplus associated with positive changes in site attributes.

Finally, in relation to the input of the main dataset (into spreadsheets) from the collected surveys, I failed to note which surveys were from the on-site survey and which were collected via email. All surveys were printed off and my brother and myself then went through the pain staking process of entering the data into excel. At this stage all I was concerned with was getting the data set up in a usable format and I neglected to take into account whether the observation was coming from the on-site or internet survey. By the time I realized this error it was to late to do anything about it. This meant that I could not run a Wald test similar to the one I ran for the single site study (discussed in chapter 4) to see if both datasets could be pooled. I was forced to make the assumption that following the results of the Wald test from the single site study it was acceptable to pool both my on-site and internet based samples in my main survey.

The estimates of recreationalist's welfare losses from development on whitewater rivers presented in this thesis also suffer from many of the generic drawbacks of the travel cost model methodology. For instance, they do not include lost non-use values from the deterioration in the wilderness quality of rivers and the welfare values depend on assumptions made about the value of leisure time and what should constitute the marginal cost of visiting. As discussed in chapter 2 omission of lost non-use values due to hydro developments and loss of water flow may be particularly important in rivers with unique scenic or flora/fauna qualities and characteristics or rivers of high cultural significance and will certainly bias any cost-benefit analysis if based solely on lost recreation use values.

9.3. Future Research

There are a number of areas where I would be interested in doing further research on whitewater recreation. Firstly, it may be a worthwhile exercise to compare the coefficient results of the models presented in this thesis, which are based on respondents perceived or subjective measure for the whitewater site attributes, to the coefficients from models where the attribute measures are sourced externally from the respondents. Field trips, the opinion of experts, whitewater kayaking guidebooks and river catchment data from the Irish Environmental Protection Agency could be used to externally rate each whitewater site in the study. It would then be interesting to see by how much the corresponding coefficients for each of the site attributes deviate from each other based on whether they are endogenously determined by the respondents or exogenously specified by the researcher.

Secondly, models that incorporate the demand for all recreational pursuits on whitewater sites would be another interesting area for future research. Past specifications of recreation models have tended to focus on continuous effects of quality or to consider only recreation sites that serve a dominant activity. Whitewater sites can support multiple activities such as kayaking, canoeing, rafting, canyoning, fishing, hiking and in some cases even swimming. It would be interesting to model the demand for all recreational pursuits on and around whitewater sites and to specify exogenous restrictions that imply quality has an exclusive role in some recreation activities at different quality levels. For example, the grade of the whitewater will influence the level of activity of the different recreational pursuits on whitewater rivers. Kayakers and rafters will require a higher grade river than canoeists and fishermen may prefer very slow moving, low grade rivers for their recreational activity. The goal of these models is to consistently integrate choice at the extensive margin among many sites with conditional usage decisions. Phaneuf and Smith (2004) refer to these types of models as Corner Solution models and they contend that these models are at the frontier of recreation demand modeling. Corner solution models for whitewater rivers, generalized to describe how river characteristics such as water quality and the whitewater grade of the river influences specific activities in discontinuous ways would offer policy makers and river catchment management a methodology that allows all users of a whitewater facility to be taken into account when planning for developments or changes to a particular site.

Finally the data from this thesis could be used to develop a benefit transfer function for whitewater kayaking recreation. In particular it would be interesting to investigate the use of spatial microsimulation techniques to develop a benefit transfer system for the demand for whitewater recreation on alternative whitewater sites outside the case study sites. Benefit transfer is the ability to take the results from one "study site" and apply them to other "policy sites", that is, being able to construct estimates of recreational demand based on set of parameters that are applicable to a wide range of sites (Hanley et al, 2002). In terms of whitewater kayaking demand, it means being able to take the estimates of recreational demand obtained from the case study rivers and apply them to all other whitewater rivers in the country. At present I have access to a spatial microsimulation model designed to analyse the relationships among regions and localities and to project the spatial implications of economic development and policy change in rural areas. The Spatial Microsimulation model for the Irish Local Economy (SMILE) is a spatial dynamic microsimulation model that takes a spatially representative population and projects the population between census periods and into the medium term (O'Donoghue, 2000). The model is therefore a spatially dynamic microsimulation model. By linking physical, geo-referenced information on the spatial distribution of whitewater water bodies and there associated attributes to the SMILE model it may be possible to estimate the value of whitewater kayaking on any river in the country using our kayaking demand model results. Spatial information is available in Ireland on water quality and the whitewater grade of Irish rivers. The density of the population and the infrastructural development in the river catchment areas could be used as a proxy for remoteness and quality of parking and the opinion of relevant experts could be used to rank the rivers in terms of the other attributes. By matching in this river information to the SMILE model one could predict, using the model coefficients developed in this thesis, the value associated with changes to any whitewater river in Ireland.

Benefit transfer systems have always been a contentious issue in the environmental valuation literature (Bateman et al., 2002). Building a benefit transfer system using a spatial microsimulation framework would not only be a interesting new avenue for future research in the area of whitewater kayaking recreational demand but could also offer a viable alternative to the often referenced ad-hoc benefit transfer methodologies to be found in the literature (Loomis et al. 1995, Barton, 2002 and Rozan, 2004). It would be a platform with a sufficiently detailed structure to permit recreational development issues to be addressed by using geo-referenced data collection efforts that could be linked to the base recreational demand model and data. The SMILE model was set up to consider rural development issues. Identifying rural areas where the demand for whitewater kayaking or other types of outdoor recreational activities could potentially be high, based on the characteristics of the rivers and other landscape features, would be a valuable policy tool for the provision of suitable amenities and the development of rural enterprises to exploit rural areas often underutilized outdoor assets.

9.4. Final Comments and Recommendations

At the outset of this thesis the main objective was to study the demand for an outdoor recreational pursuit in Ireland. This thesis addressed a comprehensive range of questions. It used and extended the different travel cost methods of valuation for whitewater kayaking recreation in Ireland. A new method for dealing with the contentious issue of measuring the opportunity cost of time in recreational demand modeling was developed and a number of approaches were adopted to investigate the heterogeneity of tastes and preferences in the Irish kayaking community.

The results presented in this thesis have potentially important implications for recreational demand policy and data collection. Our models in chapters 6, 7 and 8 use a wage rate in the travel cost calculation derived from a secondary data source that gives higher estimates of changes in consumer surplus than the simpler model where the opportunity cost of time is excluded in the travel cost calculation but lower estimates than when the opportunity cost of time is calculated using the standard reported annual earnings approach. This need not necessarily always be the case empirically but whether the travel cost estimate is higher or lower I would contend that the approach adopted in this thesis for measuring the opportunity cost of time is an appropriate method to use in cases where (a) the secondary data is available, (b) the item non-response of labour market questions is high or (c) for whatever reason, accurate labour market information is not gathered in the recreation survey. Since similar large panel data sets with excellent labour market information have become much more available in recent times, this is an important result form this thesis as our approach can be replicated in recreation travel cost studies for almost any site in almost any country.

The other major contribution of this thesis from a research point of view is the fact that I have shown that an "on-line web based survey of recreationalists can provide additional data to supplement an on-site survey and give 'hard to reach' individuals an opportunity to respond thus providing a richer dataset on the recreational group. The full dataset in chapter 4 for the Roughty single site study includes respondents from an on-line survey, thus containing information on individuals other than those present on the survey weekend and the likelihood of being sampled does not depend on the frequency with which an individual visits the river. Thus, even though part of the sample used in chapter 4 involved an on-site survey, endogenous stratification was not found to be a problem in this case. This important result clearly illustrated that Internet data collection can produce results that are very similar to those from more conventional on-site travel cost surveys. Also by utilising data collected via the internet with data collected on-site, researchers can avoid some of the pitfalls associated with on-site surveys alone, save time and resources on data collection and perhaps most importantly widen the sample in terms of representativeness.

This results of this thesis are also important as they will provide direction for planners and managers involved with river conservation and management. The latent class and random parameter approaches approach developed in chapter 8 generates additional information which is potentially very useful to recreational site managers for a wide range of purposes. For example, knowing that *freestyle playboaters* are likely to be the only group of kayakers found at a site such as Clifden play hole allows one to concentrate on the parameter estimates of class B in the LC model when appraising maintenance or improvement plans for this whitewater destination. I believe that the LCM and RPL approaches may offer a much more in-depth understanding of the heterogeneity of recreational preferences than the standard conditional logit model. This thesis has shown that the latent class model and RPL model provides a greater range of potentially-useful information for planners and managers involved with river conservation and management.

For kayaking governing bodied in Ireland and the kayaking community in general, this thesis provides, for the first time, estimates of the value of the sport on individual rivers and the economic impacts of site changes on kayaking activity. The estimated welfare values presented in this thesis will help organizations such as the Irish Canoe Union and the Canoe Association of Northern Ireland to promote the protection of the many Irish whitewater rivers that are currently under threat from developments of many types. The results should be used in particular to aid fair decision-making within the hydro-power policy arena. To date, in the hydro-power debate the loss to whitewater kayakers of whitewater recreation when a river is altered by a dam or run of the river scheme is something that has not been considered at the planning and evaluation stage of the hydro development. It is hoped that the results of this thesis will add to the debate on whether rivers should be altered for hydro schemes and the results used in future cost benefit analyses of such schemes on popular kayaking rivers such as the Roughty.

The estimates generated in this study validate the notion that the recreational services provided by the whitewater sites in Ireland are significant and that deterioration in water flow due to hydro developments or any negative impacts on the attributes of whitewater rivers could result in significant losses in economic value to the kayaking community. This thesis has demonstrated that water levels, the quality of surrounding natural resources (scenery) and high water quality (in the case of advanced level kayakers) are all important to the experiences and behavior of whitewater kayakers. These issues should remain high priorities for river management. Judging by the concerns of many kayakers in Ireland at present in relation to the threat of hydro-power developments on Irish waterways, this issue in particular needs to be diligently monitored and addressed as effectively as possible.

The fact that the recreation demand model results presented in this thesis reveal that kayakers are very sensitive to hypothetical changes in water flow and to greater restrictions in river access via parking fees is important and should be noted. Changes of this nature could have important adverse impacts on a significant portion of whitewater kayakers and should be considered only if there are compelling reasons to do so and only in close collaboration with kayakers and other affected users wherever possible. The finding that there is a core of frequent visitors who have been kayaking for many years and that most of these users are highly satisfied with their river experiences, should be an indication for river managers and advocates that the level of attributes associated with the free flowing case study whitewater sites is something that should be maintained. The results also indicate that the impact of not taking into account the different type of recreationalists that frequent different recreational sites, may be underestimating (overestimating) the welfare losses (gains) associated with changes in site attributes.

As the Irish Whitewater guidebook states (MacGearailt, 1996), "we in Ireland are very lucky with the whitewater available to use" and Irish whitewater rivers have some "outstanding" resource values. The nature of these "outstanding features" may vary widely from river to river, but based on the results of this thesis, those features generate high levels of benefits to the kayaking community. Whether the river is popular for fishing, kayaking, hiking, or some mix of these or other recreation activities, users will come because they value protected free-flowing rivers and their surroundings. Something else that should be noted is the level of local expenditure by kayakers (highlighted in table 5.7) which is a strong indication that the recreation use of whitewater rivers does not only benefit the users but also the local communities.

The common element in the popularity of the whitewater sites studied in this thesis is the availability of the high quality natural resources themselves. The protection and conservation of these natural resources should remain one of the main focal points of programs such as the European Water Framework Directive (Directive 2000/60/EC). Protecting free-flowing Irish whitewater rivers, that have different "outstanding" resource values is consistent with a basic principle of outdoor recreation resource planning and management that indicates that providing a diversity of opportunities will help to maximize resource benefits in general and user satisfaction in particular. Given the wide variety of tastes and preferences in a group such as whitewater kayakers that was highlighted in chapters 7 and 8, the conservation of a diverse system of free flowing whitewater rivers gives potential users the ability to consider a variety of settings and choose the ones that provide the sort of activities and experience opportunities they are seeking.

In summary, this thesis has assessed kayakers' demands and preferences for whitewater recreation and calculated the economic value associated with the recreational use of a number of alternative whitewater sites in Ireland and the loss or gain in consumer surplus resulting from changes in site attributes. The survey responses enabled us to compare kayakers' past experiences with respect to specific features within the whitewater sites, features initially identified by the kayaking focus groups. The generated welfare estimates provide evidence that the introduction of entrance or parking fees will result in a significant loss in consumer surplus per kayaker per trip. Also the welfare estimates support the argument for sustaining the whitewater sites in their current free flowing states, as it has been demonstrated that the benefits derived are large (see table 6.6 in particular).

Lastly, the methods applied in this thesis to (a) measure the opportunity cost of leisure time, (b) resolve the issue of endogenous stratification in on-site surveys and (c) take account of the heterogeneity within a group of recreationalists, has proved to be workable and appears to be relatively easy to implement. Thus, despite the fact the travel cost method is still subject to a substantial number of problems and criticisms, this thesis, it is hoped, has resolved some of the uncertainty surrounding its results and has made a positive contribution to the travel cost valuation literature.

Unspoilt whitewater rivers in Ireland, that can be used for whitewater recreation, are indeed becoming more and more of a rarity. The River Sheen in Kenmare, Co. Kerry has recently had a hydroelectric plant build on it. It has also had its rapids altered and new weirs built to facilitate fisheries. These features, as well as being unsightly, make the river more dangerous and less suitable for kayaking. Many other Irish rivers have suffered a similar fate, the Liffey, the Erne, the Lee, the Dodder and the Boluisce to name but a few. Although the value of whitewater rivers as a renewable energy source is recognized by many, efficient policy decisions impacting access to and the quality of Irish whitewater rivers require reliable estimates of consumer surplus values accruing to recreationists under a "conservation scenario". Planning authorities thus need to consider Irish rivers not just for their economic potential from a hydroelectric viewpoint but also for their whitewater recreational value, and as environmental amenities valued by other outdoors enthusiasts such as fishermen, canoeists, hillwalkers and canyoneers.

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Appendix A

Description of Valuation Techniques used in the Economic Appraisal of Environmental Resources.

Valuation technique	**Advantages**	**Disadvantages**
ARKET PRICES METHODS *se prevailing prices for goods and rvices traded in domestic or ternational markets.*	*Market prices reflect the private willingness to pay for kayaking costs and benefits that are traded (e.g., equipment, lessons). They may be used to construct financial accounts to compare alternative kayaking uses from the perspective of the individual or company concerned with private profit and losses. Price data are relatively easy to obtain.*	*Market imperfections and/or policy failures may distort market prices which will therefore fail to reflect the economic value of goods or services to society as a whole. Seasonal variations and other effects on prices need to be considered when market prices are used in economic analysis.*
fficiency (shadow) prices method. se of market prices but adjusted for ansfer payments, market nperfections and policy distortions. lay also incorporate distribution eights, where equality concerns are ade explicit. Shadow prices may also calculated for non-marketed goods.	Efficiency prices reflect the true economic value or opportunity cost, to society as a whole, of goods and services that are traded in domestic or international markets (e.g., kayak equipment, price of water releases).	Derivation of efficiency prices is complex and may require substantial data. Apparently 'artificial' prices may not be accepted by decision-makers (Barbier et al., 1997).
edonic pricing method. The value of environmental amenity (such as a ew) is obtained from property or bour markets. The basic assumption that the observed property value (or age) reflects a stream of benefits (or orking conditions) and that it is ssible to isolate the value of the levant environmental amenity or tribute.	Hedonic pricing has potential for valuing certain whitewater functions (e.g., asthetic function, water quality) in terms of their impact on land values, assuming that the whitewater functions are fully reflected in land prices.	Application of hedonic pricing to the recreational functions of whitewater requires that these values are reflected in surrogate markets. The approach may be limited where markets are distorted, choices are constrained by income, information about environmental conditions is not widespread and data are scarce.
ravel cost approach. The travel cost proach derives willingness to pay for vironmental benefits at a specific cation by using information on the nount of money and time that people end to visit the location.	Widely used to estimate the value of recreational sites including public parks and wildlife reserves in developed countries. It could relatively easily be used to estimate willingness to pay for kayaking recreation on whitewater rivers.	Data intensive; restrictive assumptions about consumer behaviour (e.g., multifunctional trips); results highly sensitive to statistical methods used to specify the demand relationship.

roduction function approach. stimates the value of a non-marketed source or ecological function in terms f changes in economic activity by odelling the physical contribution of e resource or function to economic utput.	Could be used to estimate the impact of hydro schemes and water pollution, etc., on productive activities such as fishing on whitewater rivers.	Requires explicit modelling of the 'dose-response' relationship between the resource or function being valued and some economic output. Application of the approach is most straightforward in the case of single use systems but becomes more complicated with multiple use systems. Problems may arise from multi-specification of the ecological-economic relationship or double counting. Not suitable for whitewater recreation.
elated good method. Uses formation about the relationship etween a non-marketed good or rvice and a marketed product to infer alue. The *barter exchange approach* lies on actual exchange of non-arketed goods. The *direct substitute proach* simply assumes that a arketed good can be substituted for a on-marketed good. The *indirect bstitute approach* also relies on a bstitute good, but if the latter is not changed in the market its value is ferred in terms of a change in onomic output (i.e. the direct bstitute approach combined with the oduction function approach).	These approaches may provide a rough indicator of economic value, subject to data constraints and the degree of similarity or substitutability between related goods.	The barter exchange approach requires information on the rate of exchange between two goods. The direct substitute approach requires information on the degree of substitution between two goods. The indirect substitute approach requires information on the degree of substitution and on the contribution of the substitute good to economic output.
ONSTRUCTED MARKET ECHNIQUES *easure of willingness to pay by rectly eliciting consumer preferences.*	*Directly estimates Hicksian welfare measure - provides best theoretical measure of willingness to pay.*	*Practical limitations of constructed market techniques may detract from theoretical advantages, leading to poor estimates of true willingness to pay.*
imulated market (SM) constructs an perimental market in which money tually changes hands.	SM: controlled experimental setting permits close study of factors determining preferences.	SM: sophisticated design and implementation may limit suitable applications.
ontingent valuation method (CVM) nstructs a hypothetical market to icit respondents' willingness to pay.	CVM: only method that can measure option and existence values and provide a true measure of total economic value.	CVM: results sensitive to numerous sources of bias in survey design and implementation.
ontingent ranking (CR) and Choice odelling (CM) ranks and scores lative preferences for amenities in alitative rather than monetary terms.	CR: generates value estimate for a range of products and services without having to elicit willingness to pay for each.	CR: does not elicit willingness to pay directly, hence lacks theoretical advantages of other approaches.

:OST-BASED VALUATION	*It is easier to measure the costs of producing benefits than the benefits themselves, when goods, services and benefits are non-marketed. Approaches are less data- and resource-intensive.*	*These second-best approaches assume that expenditure provides positive benefits and net benefits generated by expenditure match the original level of benefits. Even when these conditions are met, costs are usually not an accurate measure of benefits.*
ıdirect opportunity cost (IOC) ıethod uses wages foregone by labour ı production of non-marketed goods.	IOC: useful in evaluating subsistence benefits where harvesting and collecting time is a major input.	IOC: may underestimate benefits significantly if there is substantial producer or consumer surplus.
lestoration cost (RSC) method uses osts of restoring ecosystem goods or ervices.	RSC: potentially useful in valuing particular environmental functions. Useful if one wanted to assess the value to kayakers of removing a dam from a river.	RSC: diminishing returns and difficulty of restoring previous ecosystem conditions make application of RSC questionable.
leplacement cost (RPC) method uses ost of artificial substitutes for ıvironmental goods or services.	RPC: useful in estimating indirect use benefits when ecological data are not available for estimating damage functions with first-best methods.	RPC: difficult to ensure that net benefits of the replacement do not exceed those of the original function. May overstate willingness to pay if only physical indicators of benefits are available.
ıverting Behaviour (AB) approach ıfers a monetary value for an ıvironmental externality by observing ıe expenditures individuals are repared to make in order to avoid any ınoyance	AB: modest data requirements and uses real market data	AB: mismatching the benefits of investment in avoidance to the original level of benefits may lead to spurious estimates of willingness to pay. Cannot predict the changes in use values due to environmental changes without precedence
lamage costs avoided (DC) approach :lies on the assumption that damage stimates are a measure of value. It is ot a cost-based approach as it relies on ıe use of valuation methods described bove.	DC: first-best methods to estimate damage costs are useful for comparison with cost-based approaches, which implicitly assume damage is worth avoiding.	DC: data or resource limitations may rule out first-best valuation methods.

Sources: Barbier et al., 1997, Ward and Beal, 2000 and Phaneuf and Smith, 2004.

Appendix B.

Roughty River Kayaking Survey

Q1. Compared to your other outdoor recreational activities (such as hill-walking, mountain biking, surfing etc.) how would you comparatively rate kayaking?

1. Your most important outdoor activity
2. Your second most important outdoor activity
3. Your third most important outdoor activity
4. Only one of many outdoor activities

Q2. Would you describe your proficiency level in a kayak as:

1. Basic 2. Intermediate 3. Advanced

Q3. How many years have you been kayaking for?

____________ YEARS

Q4. In the past 12 months, including today, how many trips away from home to the Roughty river did you make for the specific purpose of Kayaking?

____________ TRIPS

Q5. How many miles (one-way) did you travel from your home to the Roughty river to go kayaking?

____________ MILES

Q6. About how long did it take you to get from your home to this river?

____________ HOURS ____________ MINUTES

Q7. Approximately, how many days per year are you free from other obligations so that you may undertake whitewater recreation?

____________ DAYS

Q8. Did you come to this area:

1. With the specific purpose of kayaking
2. On other business and kayaked because the opportunity arose

Q9. What is your age?

____________ YEARS

Q10. Are you:

1. Male   2. Female

Q11. What is your approximate total income before taxes? (Circle one)

1.	Less than €10,000	4.	€30,000 - €49,999
2.	€10,000 - €19,999	5.	€50,000 - €74,999
3.	€20,000 - €29,999	6.	Over €75,000

Q12. Are you currently employed?

1. YES   2. NO

Q13. Are you:

1.	A Student	5.	Employed by a private firm
2.	A civil servant	6.	Self-employed
3.	Professional	7.	Housewife
4.	Other (Please state)		

Appendix C

The Economic Value of Whitewater Kayaking in Ireland: Questionnaire

Introduction and Aims of the Study

The Department of Economics at the National University of Ireland in association with the Department of Economics at the University of Glasgow is currently carrying out a study on the economic value of whitewater kayaking in Ireland. The study which is being led by Mr. Stephen Hynes focuses on a number of specific rivers within the country, which have been identified, through our discussions with kayakers to date, as being of key importance.

Three key aims of the current study are:

⇒ to gain an insight over what factors/site characteristics influence kayakers in their actual choice of paddling destination, and

⇒ to provide a profile of those who are actively participating in the sport today.

⇒ To assess how much money kayakers contribute to local economies

The following questionnaire has been designed in an attempt to satisfy these aims. Your cooperation in answering the questions below would be greatly appreciated. All responses will be treated in confidence.

Definition of Whitewater Kayaking

In this questionnaire we are concerned with kayaking on moving water of grade two or above. Whitewater kayaking may defined in terms of the equipment used; whitewater kayaking, in nearly all cases requires the use of a decked kayak, a paddle, a buoyancy aid, a helmet and some form of waterproof clothing. Whitewater kayaking may involve negotiating ones way through whitewater rapids on a section of river. It could alternatively involve what is referred to as "park and play"; paddling at one particular site such as a play hole (e.g. Cliften) or a standing river wave (e.g. Curragower wave on the Shannon).

Part 1: Kayaking Activity and Choice of Kayaking Sites over the last 12 Months

1.1. Which of the following kayaking sites in Ireland have you visited in the last 12 months?

- Please indicate by stating in the appropriate box, how many days you have paddled at each location.

Kayaking Site	No. of Days
1. The Liffey (including the "Sluice")	
2. Clifden Play Hole	
3. Curragower Wave on the Shannon	
4. The Boyne	
5. The Roughty	
6. The Clare Glens	
7. The Annamoe	
8. The Barrow	
9. The Dargle	
10. The Inny	
11. The Boluisce (Spiddle)	
12. Other rivers in Ireland Please specify...	

1.2 **How accurate would you say the information you have provided above is? (please highlight one only):**

1. Very accurate...I remember exactly/keep records

2. Pretty accurate...I remember pretty well where I went and how often

3. Not very accurate at all ..., a bit of a guess really

Part 2: Evaluation of Kayaking Sites in Ireland

2.1. Assuming that the sites you have been kayaking at in the past have been within your technical ability/grade, how would you describe each of the areas below under the following factors?

- You may evaluate the kayaking sites you have visited throughout your kayaking experience but please do not comment on sites you have never visited.

- Please highlight the appropriate answer unless otherwise instructed.

Site 1: The Liffey (including the "Sluice")

Factor	Score/Level of Factor				
Average quality and safety of parking at the site (Score from 1 = poor to 5 = excellent).	1	2	3	4	5
Average crowding at the paddling site (How many other kayakers are on the water you are paddling - Score from 1 = very crowded to 5 = uncrowded)	1	2	3	4	5
Average quality of the kayaking site (i.e. No. of stars).	0 star	1 stars	2 stars	3 stars	
Average quality of the water (Score from 1 = extremely polluted to 5 = unpolluted).	1	2	3	4	5
Scenic quality of the kayaking site (Score from 1 = not at all scenic to 5 = very scenic).	1	2	3	4	5
Reliability of Water (score from 1 = before visiting the site, completely unsure of water level at the site to 5 = positive about water level at the site)	1	2	3	4	5
Number of other kayaking sites within 10 miles proximity of this site (Score 1 = none to 5 = many).	1	2	3	4	5
Travel Distance (one way journey from home to site). Please give distance in miles.					
Travel Time (one way journey from home to site). Please give time in mins/hours					

Site 2: Clifden Play Hole

Factor	Score/Level of Factor				
Average quality and safety of parking at the site (Score from 1 = poor to 5 = excellent).	1	2	3	4	5
Average crowding at the paddling site (How many other kayakers are on the water you are paddling - Score from 1 = very crowded to 5 = uncrowded)	1	2	3	4	5
Average quality of the kayaking site (i.e. No. of stars).	0 star	1 stars	2 stars	3 stars	
Average quality of the water (Score from 1 = extremely polluted to 5 = unpolluted).	1	2	3	4	5
Scenic quality of the kayaking site (Score from 1 = not at all scenic to 5 = very scenic).	1	2	3	4	5
Reliability of Water (score from 1 = before visiting the site, completely unsure of water level at the site to 5 = positive about water level at the site)	1	2	3	4	5
Number of other kayaking sites within 10 miles proximity of this site (Score 1 = none to 5 = many).	1	2	3	4	5
Travel Distance (one way journey from home to site). Please give distance in miles.					
Travel Time (one way journey from home to site). Please give time in mins/hours					

Site 3: Curragower Wave on the Shannon

Factor	Score/Level of Factor				
Average quality and safety of parking at the site (Score from 1 = poor to 5 = excellent).	1	2	3	4	5
Average crowding at the paddling site (How many other kayakers are on the water you are paddling - Score from 1 = very crowded to 5 = uncrowded)	1	2	3	4	5
Average quality of the kayaking site (i.e. No. of stars).	0 star	1 stars	2 stars	3 stars	
Average quality of the water (Score from 1 = extremely polluted to 5 = unpolluted).	1	2	3	4	5
Scenic quality of the kayaking site (Score from 1 = not at all scenic to 5 = very scenic).	1	2	3	4	5
Reliability of Water (score from 1 = before visiting the site, completely unsure of water level at the site to 5 = positive about water level at the site)	1	2	3	4	5
Number of other kayaking sites within 10 miles proximity of this site (Score 1 = none to 5 = many).	1	2	3	4	5
Travel Distance (one way journey from home to site). Please give distance in miles.					
Travel Time (one way journey from home to site). Please give time in mins/hours					

Site 4: The Boyne

Factor	Score/Level of Factor				
Average quality and safety of parking at the site (Score from 1 = poor to 5 = excellent).	1	2	3	4	5
Average crowding at the paddling site (How many other kayakers are on the water you are paddling - Score from 1 = very crowded to 5 = uncrowded)	1	2	3	4	5
Average quality of the kayaking site (i.e. No. of stars).	0 star	1 stars	2 stars	3 stars	
Average quality of the water (Score from 1 = extremely polluted to 5 = unpolluted).	1	2	3	4	5
Scenic quality of the kayaking site (Score from 1 = not at all scenic to 5 = very scenic).	1	2	3	4	5
Reliability of Water (score from 1 = before visiting the site, completely unsure of water level at the site to 5 = positive about water level at the site)	1	2	3	4	5
Number of other kayaking sites within 10 miles proximity of this site (Score 1 = none to 5 = many).	1	2	3	4	5
Travel Distance (one way journey from home to site). Please give distance in miles.					
Travel Time (one way journey from home to site). Please give time in mins/hours					

Site 5: The Roughty

Factor	Score/Level of Factor				
Average quality and safety of parking at the site (Score from 1 = poor to 5 = excellent).	1	2	3	4	5
Average crowding at the paddling site (How many other kayakers are on the water you are paddling - Score from 1 = very crowded to 5 = uncrowded)	1	2	3	4	5
Average quality of the kayaking site (i.e. No. of stars).	0 star	1 stars	2 stars	3 stars	
Average quality of the water (Score from 1 = extremely polluted to 5 = unpolluted).	1	2	3	4	5
Scenic quality of the kayaking site (Score from 1 = not at all scenic to 5 = very scenic).	1	2	3	4	5
Reliability of Water (score from 1 = before visiting the site, completely unsure of water level at the site to 5 = positive about water level at the site)	1	2	3	4	5
Number of other kayaking sites within 10 miles proximity of this site (Score 1 = none to 5 = many).	1	2	3	4	5
Travel Distance (one way journey from home to site). Please give distance in miles.					
Travel Time (one way journey from home to site). Please give time in mins/hours					

Site 6: The Clare Glens

Factor	Score/Level of Factor				
Average quality and safety of parking at the site (Score from 1 = poor to 5 = excellent).	1	2	3	4	5
Average crowding at the paddling site (How many other kayakers are on the water you are paddling - Score from 1 = very crowded to 5 = uncrowded)	1	2	3	4	5
Average quality of the kayaking site (i.e. No. of stars).	0 star	1 stars	2 stars	3 stars	
Average quality of the water (Score from 1 = extremely polluted to 5 = unpolluted).	1	2	3	4	5
Scenic quality of the kayaking site (Score from 1 = not at all scenic to 5 = very scenic).	1	2	3	4	5
Reliability of Water (score from 1 = before visiting the site, completely unsure of water level at the site to 5 = positive about water level at the site)	1	2	3	4	5
Number of other kayaking sites within 10 miles proximity of this site (Score 1 = none to 5 = many).	1	2	3	4	5
Travel Distance (one way journey from home to site). Please give distance in miles.					
Travel Time (one way journey from home to site). Please give time in mins/hours					

Site 7: The Annamoe

Factor	Score/Level of Factor				
Average quality and safety of parking at the site (Score from 1 = poor to 5 = excellent).	1	2	3	4	5
Average crowding at the paddling site (How many other kayakers are on the water you are paddling - Score from 1 = very crowded to 5 = uncrowded)	1	2	3	4	5
Average quality of the kayaking site (i.e. No. of stars).	0 star	1 stars	2 stars	3 stars	
Average quality of the water (Score from 1 = extremely polluted to 5 = unpolluted).	1	2	3	4	5
Scenic quality of the kayaking site (Score from 1 = not at all scenic to 5 = very scenic).	1	2	3	4	5
Reliability of Water (score from 1 = before visiting the site, completely unsure of water level at the site to 5 = positive about water level at the site)	1	2	3	4	5
Number of other kayaking sites within 10 miles proximity of this site (Score 1 = none to 5 = many).	1	2	3	4	5
Travel Distance (one way journey from home to site). Please give distance in miles.					
Travel Time (one way journey from home to site). Please give time in mins/hours					

Site 8: The Barrow

Factor	Score/Level of Factor				
Average quality and safety of parking at the site (Score from 1 = poor to 5 = excellent).	1	2	3	4	5
Average crowding at the paddling site (How many other kayakers are on the water you are paddling - Score from 1 = very crowded to 5 = uncrowded)	1	2	3	4	5
Average quality of the kayaking site (i.e. No. of stars).	0 star	1 stars	2 stars	3 stars	
Average quality of the water (Score from 1 = extremely polluted to 5 = unpolluted).	1	2	3	4	5
Scenic quality of the kayaking site (Score from 1 = not at all scenic to 5 = very scenic).	1	2	3	4	5
Reliability of Water (score from 1 = before visiting the site, completely unsure of water level at the site to 5 = positive about water level at the site)	1	2	3	4	5
Number of other kayaking sites within 10 miles proximity of this site (Score 1 = none to 5 = many).	1	2	3	4	5
Travel Distance (one way journey from home to site). Please give distance in miles.					
Travel Time (one way journey from home to site). Please give time in mins/hours					

Site 9: The Dargle

Factor	Score/Level of Factor				
Average quality and safety of parking at the site (Score from 1 = poor to 5 = excellent).	1	2	3	4	5
Average crowding at the paddling site (How many other kayakers are on the water you are paddling - Score from 1 = very crowded to 5 = uncrowded)	1	2	3	4	5
Average quality of the kayaking site (i.e. No. of stars).	0 star	1 stars	2 stars	3 stars	
Average quality of the water (Score from 1 = extremely polluted to 5 = unpolluted).	1	2	3	4	5
Scenic quality of the kayaking site (Score from 1 = not at all scenic to 5 = very scenic).	1	2	3	4	5
Reliability of Water (score from 1 = before visiting the site, completely unsure of water level at the site to 5 = positive about water level at the site)	1	2	3	4	5
Number of other kayaking sites within 10 miles proximity of this site (Score 1 = none to 5 = many).	1	2	3	4	5
Travel Distance (one way journey from home to site). Please give distance in miles.					
Travel Time (one way journey from home to site). Please give time in mins/hours					

Site 10: The Inny

Factor	Score/Level of Factor				
Average quality and safety of parking at the site (Score from 1 = poor to 5 = excellent).	1	2	3	4	5
Average crowding at the paddling site (How many other kayakers are on the water you are paddling - Score from 1 = very crowded to 5 = uncrowded)	1	2	3	4	5
Average quality of the kayaking site (i.e. No. of stars).	0 star	1 stars	2 stars	3 stars	
Average quality of the water (Score from 1 = extremely polluted to 5 = unpolluted).	1	2	3	4	5
Scenic quality of the kayaking site (Score from 1 = not at all scenic to 5 = very scenic).	1	2	3	4	5
Reliability of Water (score from 1 = before visiting the site, completely unsure of water level at the site to 5 = positive about water level at the site)	1	2	3	4	5
Number of other kayaking sites within 10 miles proximity of this site (Score 1 = none to 5 = many).	1	2	3	4	5
Travel Distance (one way journey from home to site). Please give distance in miles.					
Travel Time (one way journey from home to site). Please give time in mins/hours					

Site 11: The Boluisce (Spiddle)

Factor	Score/Level of Factor				
Average quality and safety of parking at the site (Score from 1 = poor to 5 = excellent).	1	2	3	4	5
Average crowding at the paddling site (How many other kayakers are on the water you are paddling - Score from 1 = very crowded to 5 = uncrowded)	1	2	3	4	5
Average quality of the kayaking site (i.e. No. of stars).	0 star	1 stars	2 stars	3 stars	
Average quality of the water (Score from 1 = extremely polluted to 5 = unpolluted).	1	2	3	4	5
Scenic quality of the kayaking site (Score from 1 = not at all scenic to 5 = very scenic).	1	2	3	4	5
Reliability of Water (score from 1 = before visiting the site, completely unsure of water level at the site to 5 = positive about water level at the site)	1	2	3	4	5
Number of other kayaking sites within 10 miles proximity of this site (Score 1 = none to 5 = many).	1	2	3	4	5
Travel Distance (one way journey from home to site). Please give distance in miles.					
Travel Time (one way journey from home to site). Please give time in mins/hours					

Part 3: Relative Influence of Factors

3.1. Please rank the following factors from 1 to 8, according to their importance in your decision to choose a kayaking site to paddle at. E.g. 1 = most important among the set of factors listed when choosing a paddling destination / 8 = least important among the set of factors listed when choosing a kayaking site to paddle at.

- No two factors should be given the same ranking

Please complete this table:

Factor	Ranking 1-8
Average quality and safety of parking at the site	
Average crowding at the paddling site	
Average quality of the kayaking site (i.e. No. of stars).	
Average quality of the water	
Scenic quality of the kayaking site	
Reliability of Water	
Number of other kayaking sites in close proximity	
Travel Time	

3.2. In your opinion, what other factors are important in choosing a site to kayak at?

____

____

Part 4:Personel Expenditure on Kayaking

4.1. What has been your approximate spend on kayaking in Ireland over the last 12 months, under the following categories? Please outline your responses in the table below:

Category of Spend	€ Spend over the last 12 months	% of each category spend which was spent locally, in the kayaking areas.
Travel to Sites (i.e. petrol)		
Food		
Magazines/ Guides/ books/ maps etc.		
Kayaking Equipment		
Kayaking Courses and Tuition		
Socialising		
Accommodation		
Other, please specify…		
Total		

Part 5: Kayaking Experience

5.1. Compared to your other outdoor recreational activities (such as hill-walking, mountain biking, surfing etc.) how would you comparatively rate kayaking?

5. Your most important outdoor activity
6. Your second most important outdoor activity
7. Your third most important outdoor activity
8. Only one of many outdoor activities

5.2. Would you describe your proficiency level in a kayak as:

1. Basic 2. Intermediate 3. Advanced

5.3. How many years have you been paddling for?

____________ YEARS

5.4. Approximately, how many days per year are you free from other obligations so that you may undertake whitewater recreation?

____________ DAYS

5.5. Approximately, how many days of work do you miss per year because of your whitewater recreational pursuits?

____________ DAYS

5.6 In the last 12 months have you kayaked solely within Ireland or have you also paddled abroad?

Paddled in Ireland only ____________

Paddled in Ireland and Abroad ____________

If you have paddled abroad in the last 12 months, what countries have you paddled in?

	Country	No. of Visits
1.		
2.		
3.		
4.		

Part 6: Classification Questions

6.1. What is the nearest major town to where you live? ______________

6.2. What is your age?

____________ YEARS

6.3. Are you:

2. Male 2. Female

6.4 Marital Status

Single ____ Married ____
Single with children ____ Married with children ____
Partnership ____

6.5. Level of Education (Please tick the highest level you have achieved):

1. Recognised third level education: degree/certificate/diploma
2. Leaving certificate or equivalent
3. Junior or inter certificate or lower

6.6 Are you currently employed?

2. YES 2. NO

6.6 Are you employed

1. Full-time 2. Part-time

6.7 What is your current occupation:

____

6.8 Do you work in the:

1. Private Sector (including non-profit private organisations)
2. Public Sector

6.9. What is your approximate total income before taxes? (highlight one)

5. Less than €10,000
6. €10,000 - €19,999
7. €20,000 - €29,999
8. €30,000 - €39,999
9. €40,000 - €49,999
6. €50,000 - €59,999
7. €60,000 - €69,999
8. €70,000 - €79,999
9. €80,000 plus

Thank you for the time and care you took in completing this questionnaire