ATTACHING MONETARY VALUES TO ENVIRONMENTAL GOODS & SERVICES AN APPLICATION OF THE TRAVEL COST METHOD AT MIDMAR

BY

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ABSTRACT

Midmar is built on the Umgeni River, KwaZulu-Natal and is 1060m above sea level. The river starts as a small stream in Loteni and has a total catchment area of 906 square kilometres and an annual rainfall of 1016 mm. Midmar provides a multitude of benefits classified as either on-site use benefits or non-use benefits.

This dissertation focuses on environmental economics and is concerned with assigning a monetary value to a given environmental good, namely, recreation at Midmar. This entails estimation of the demand curve for recreation at Midmar, and using this curve, establishing the consumer surplus attached to Midmar.

The Individual Travel Cost method is used to investigate the nature of recreational demand at Midmar and essentially, measures the economic value of recreation use here. In addition, an examination as to whether consumers enjoy any consumer surplus associated with recreational demand is undertaken.

The survey undertaken concludes that recreational visitors to Midmar enjoy a consumer surplus of approximately R71 per visit. Total consumer surplus for Midmar during 1999 was estimated to be R4.9 million. This suggests that the actual price paid by visitors to Midmar understates the true value attached to such a visit and hence, park management needs to be aware of this.

Finally, this dissertation emphasizes the importance and potential use of research such as this which could assist and guide future planning and decision making in South Africa.

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PREFACE

This thesis was done through the School of Business, University of KwaZulu-Natal, Pietermaritzburg under the supervision of Mr George Oldham from the Department of Economics.

This study represents original work by the author and has not been submitted in any form to another University. Where appropriate the work of others has been duly acknowledged in the text.

Signed :

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Sunjay Lutchman

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I would like to thank my supervisor, Mr George Oldham for his guidance and suggestions in designing and implementing this study.

A special thank you to my parents, my family, and my wife Ameetha for her patience and help. This thesis would not have been possible without the unselfish assistance of many individuals who shared their knowledge and time with me.

I am indebted to KwaZulu Wildlife for their assistance and support. Working with such a dedicated group of conversationalists is indeed a pleasure.

Finally, I would like to thank God for affording me this opportunity.

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INTRODUCTION

The protection of the environment emerged as one of the principle concerns of the latter half of the 21th century. It is likely to increasingly dominate the political agenda of governments into the beginning of the third millennium. The continual growth of production forged out of a finite set of resources, the emergence of new technologies, the unveiling of new pollutants, and the increasing recognition of the trans-national nature of environmental resources are just some of the issues that have generated concern in society. Whereas in the past, many environmental issues were regarded as local and straightforward problems, they have now come to be recognised as having greater complexity than previously thought, with wider impacts than first-round or local impacts.

In South Africa, there is mounting pressure on conservation area managers and policy makers to make the protected areas more self sustainable. According to KwaZulu Natal Wildlife, whereas in the past the government heavily subsidised Provincial conservation bodies, this funding source has become increasingly threatened in recent times and alternative revenue sources are required. This also means that a better understanding of the economic worth of environment assets is needed, so that scarce funding may be better allocated.

The demand for recreation (or the positive use of the environment) has become more apparent in the last few decades as individuals move away from the hectic 'rat race' of purely hedonic existence to a more substantial, holistic approach in which the beauty and harmony of the environment and nature is the focal point. The demand for recreation is growing as a result of a number of factors, namely, an increasing population, increasing disposable incomes, easier access to recreational sites, and an overall change in consumer tastes and perceptions of how they view the environment.

Many of these recreational sites are available as open access, non-priced goods. This implies that no market mechanism exists for these recreational goods and as a result, there is a failure to charge a fee for the use of that recreational good. This failure of the market mechanism to charge for the use of the recreational good may occur as a result of a wide range of factors.

Often, the most common factors highlighted are:

- It is not feasible to charge a fee (the transaction costs are in excess of the income derived)
- Property rights cannot be exercised over the good (there is no legal enforceable right attached to the property custodian)
- The good may be provided as a public service
- The fact that the marginal cost of admitting an additional user (of the public good) is zero or below the economic value.

The failure of the market and the reluctance of governments to charge a fee due to moral grounds are just some of the problems that exist. These are further exacerbated by the problem of evaluating whether the benefits provided by the recreational good exceed its costs of its provision and maintenance. Given these pressures that society faces, it is therefore not surprising that the protection of the natural environment (and the use thereof) emerged as one of the principle concerns of the 20th century. The management and establishment of parks and protected areas are receiving greater recognition worldwide. This is largely due to the fact that people have realised that the assimilative capacity of the environment is limited and hence, the discharge of waste and pollution needs to be controlled.

South Africa as a nation needs to develop anticipatory policies for the administration and guidance of the environment. In the event of a sudden structural change in the natural environment, economic analysis regarding the monetary values of the environment (in terms of willingness to pay) will provide useful contribution. South Africa has been blessed with a plethora of biodiversity and hence, it becomes paramount that the protection of the environment, and indeed, the biodiversity, be one of the focal points of public debate.

Public debate concerning the use of the environment has, in recent years, focused on more than simply economic arguments. Some non-economic arguments such as intergenerational equity, the uncertainty of biodiversity loss to mankind, irreversibility loss of biodiversity, and cultural factors, have also gained momentum in the past decade. This serves to confirm that use of the environment is finally receiving the due recognition that it rightfully deserves.

Imputing monetary values to preservation and recreational sites in South Africa is important, and this is especially true when government funds become scarcer. These values will aid rational economic decisions regarding the future utilization of land and other natural resources. It appears that little effort has been devoted to quantitative economic analysis of protected areas in South Africa. Estimating the economic value of protected areas will mean enhancing conservation's ability to 'compete' with alternative land uses such as agriculture.

This dissertation will attempt to impute a monetary value to the recreational use of the environment. More specifically, a particular recreational site in KwaZulu-Natal that demands some sort of conservation has been chosen. It is assumed that through the use of this monetary value, governments and indeed the general public will view this resource as they would any other scarce resource in economics.

CHAPTER 1
ECONOMICS AND THE ENVIRONMENT

Economics is a science of choice and one of the fundamental objectives of economics is addressing the problems associated with scarcity. It therefore becomes imperative that some technique or method be used to evaluate non-traded goods and services. It is important that non-market benefits (and costs) be quantified in order to correctly price these benefits to society.

In 1962 Milton Friedman emphasized that national parks should be closed down if the commercial value of their natural resources exceeds the willingness of consumers to pay for recreation (Walsh et al 1984). In other words, Friedman suggested that when the marginal benefits which accrue to recreationists are lower than the marginal opportunity cost of the park, then the park should close down. This certainly sounds extreme and is likely to cause some sort of concern amongst conservationists. However, Walsh (1984:15) goes on to note that such comparisons between different land use values are somewhat dubious because recreationists will often understate its value to society because many persons expect that they may possibly visit the park and would be willing to pay for an option that guarantees their future access.

1.1 Problem Statement, Hypothesis And Objectives

This dissertation attempts to impute a monetary value for the *use* of an environmental good, namely, Midmar resort. It needs to be emphasized at the outset that this dissertation will only be concerned with the *use* value of Midmar, and will ignore the *non-use* values. Therefore, the true value or the total economic value (TEV) of Midmar will not be calculated (an explanation of TEV, use value, and non-use value is given on page 9 of this dissertation). The study will seek to impute an economic (use) value of Midmar through the use of consumer surplus. While consumer surplus is explained in detail later in the dissertation, a simple explanation is provided below.

Consumer surplus may be defined as 'the difference between what consumers pay and the value or utility that they receive' (Mohr et al 2000:259). In the case of Midmar, a visitor pays a certain fee to enter the resort, but this fee underestimates the utility that the visitor derives from the visit. It therefore leads to a situation where the fee being administered underestimates the true value of a visit to the resort, and in doing so, creates a consumer surplus. The *modus operandi* of the dissertation will be to firstly, estimate the demand for recreation at Midmar, and then secondly, using the derived demand curve, establish the consumer surplus attached to Midmar.

1.2 Organization Of The Study

This dissertation is divided into five chapters. In chapter 1, a few economic problems associated with environment are discussed. It needs to be highlighted that only the most pertinent problems (selected from a possibly infinite list) will be discussed. The chapter is also devoted to the discussion of the area under study and discusses some of the problems related to the area.

In chapter 2, the estimation technique used to impute a monetary value for recreation at Midmar is discussed. The estimation technique is discussed in detail and the chapter ends with the presentation of some of the theoretical issues regarding the estimation technique.

Chapter 3 deals with the emendation of some of the theoretical issues regarding the chosen estimation technique. In other words, this chapter deals with how some of the issues raised in the previous chapter are addressed during the survey.

Chapter 4 deals with the presentation of results and the discussion of these results. It is divided into a number of sections. The first section deals with the presentation of the different functional forms which explain the relationship between the number of visits to the site and the significant explanatory variables. The next section deals with the statistical analysis of the chosen model. The final section deals with the derivation of a demand for recreation curve and the estimation of the consumer surplus of Midmar.

Finally, chapter 5 serves as a conclusion. In this chapter, the findings of the research will be expanded and compared to results from similar research efforts elsewhere in the world.

1.3 Classification Of Goods (Private Vs Public Goods)

Most environmental goods and services are public goods (or quasi-public goods) in nature and have very different characteristics from their counterparts, namely private goods. Whereas private goods are rivaling in consumption and have excludability properties, public goods are non-rivaling in consumption and have non-excludability properties.

Van den Bergh clarifies that 'a public good may be contrasted with a private good. A private good is a good such that, if A buys it, B cannot buy the same unit of the good. A and B are said to be 'rivals' in the market place. One of the features of a public good, however, is that A's consumption of the good does not diminish B's consumption of the same good. It is said to be non-rival' (1999:491). An example of a perfectly public good is clean air. Another example of a public good (which may be more accurately defined as a 'quasi-public' good) would be a day spent as recreation in a game reserve, resort, or lake that is controlled by the central authorities and not by some private organisation. That is, one individual's consumption of the park or nature reserve does not diminish another individual's consumption of the same park or nature reserve.

Kopp et al (1985) identified three categories of goods which enter an individual's utility function: pure private goods, quasi-public goods, and pure public goods (Table 1.1). According to Holland (1993:28) pure private goods are those traded in a formal market place, with full property rights. A property right needs to have three characteristics: it needs to be specific, it needs to be enforceable, and it needs to be transferable.

Quasi-public goods are similar to private goods except that they are not freely traded in the formal market. An example would be the entrance fee charged at a specific nature reserve. The entrance fee (price) is not wholly determined through the forces of supply and demand, but through some provincial authority.

Pure public goods have no specific, enforceable, tradeable property rights attached to them and the principles of exclusion (any one individual consuming a good does not prevent or exclude another individual from consuming that same good) and rivalry (individuals do not compete with each other for the consumption of goods) do not apply.

Table 1.1: Classification of Goods

Class of Goods	Characteristics	Examples
Pure Private	Personal property rights	Agricultural product
	Ability to exclude recreationists	Private Game Reserve
	Traded freely in competitive markets	Financial Services
Quasi-public	Personal property rights	Public Libraries
	Ability to exclude potential recreationists	Recreation in parks
	Not traded freely in competitive markets	Television frequencies
Pure Public	Collective property rights	Tribal Land
	Cannot exclude potential recreationists	Environmental risks
	Not traded freely in any organized market	National Defence

Source: Adapted from Knop, 1985.

As can be seen from Table 1.1, recreational demand (the 'good' that is consumed at Midmar) can be considered to be quasi-public good. That is, recreational demand is freely traded in competitive markets and the 'market price' charged at Midmar is not wholly determined through the forces of supply and demand, but through some provincial custodian, namely, KwaZulu-Natal Wildlife. Midmar has some property rights being bestowed upon the custodian (although in the strict sense, the custodian does not own the property but merely administers the property).

This custodian may have the authority to exclude potential users, although in reality this may be difficult as environmental assets are normally open for use to all consumers. Enforceable property rights, the principles of exclusion, and rivalry are all important issues that need active discussion, if the custodian intends to properly administer and control of the environmental good. However, given the focus of this dissertation, the aforementioned issues will not be discussed in this dissertation.

1.4 The Concept Of Price / Value In Environmental Assets

The concept of 'economic' value has been an issue much debated among economists for many years. Many economists have criticised the concept of economic value as too narrowly defined (Arrow et al 1974, Krutilla 1967, Weisbrod 1964). Traditionally, the value of a good has been the amount of money received for that good once it has been transacted. This meant that a 'market' was created in which the buyer and seller of the good transacted and a suitable price (value) jointly negotiated.

The valuation of environmental assets is somewhat more problematic to determine. This is because environmental assets are likely to have both use and non-use benefits or values, which exacerbates the problem of assigning correct monetary values for the use of the environmental good or service. Direct use values are those that are derived directly and are often traded through the market mechanism. Bennett (1996:230) states that "use values of a national park are those derived directly". They include benefits enjoyed from visiting the area for recreational and educational purposes; undertaking scientific research; spillover effects such as water supply protection. These include ecotourism, recreation, hunting, and other similar activities.

Non-use values are more problematic and are benefits that individuals derive without actually visiting or using the site. Bennett (ibid) states that "the non-use benefits or preservation values can be enjoyed by people who visit a park as well as those who don't". These include the value people gain from knowing the area exists and that its flora and fauna remain in a protected state (i.e. the existence values and the option values that arise because of the uncertainty that surrounds future use of the area). Together, these use and non-use values make up the Total Economic Value. Table 1.2 below, which has been adapted from Wells (1997) and IUCN (1998) illustrates the concept of Total Economic Value.

Direct use values at Midmar occur when a person gets direct use out of the resort. This happens when he visits the resort for recreational purposes, or uses the resort to fish. Indirect use values occur when the resort provides protection from flood control, or aids in regulating the nutrient cycle in the area. Collectively, all the use values and the indirect use values of the resort will make up the Total Economic Value (TEV) of Midmar.

Table 1.2: Total economic value of a protected area

		Use Value		Non-use Value
Total Economic Value	=	1. ***Direct*** - associated with direct use of the area (market values). Examples are recreation, education research, and wildlife harvesting. 2. ***Indirect*** - associated with indirect uses of protected areas (non-market values). Examples are ecological functions of an area, watershed protection, wildlife habitat, climate influence, and carbon sequestration.	+	1. ***Option value*** - insurance to retain option of potential future site use. Protected areas act as a resource bank (non market values). 2. ***Existence value*** - Benefit of knowing a protected area exists. Often measured by willingness to donate money or time (non market values). 3. ***Bequest value*** - provides benefit of knowing that areas will be around for future generations. (non-market values)

Source: Adapted from Wells 1997, and IUCN 1998.

It needs to be stressed that this research is concerned with the *use* value of the resort and ignores the non-use value. Hence, this dissertation will underestimate the TEV of the resort. Also, there could be issues such as externalities, problems of free-riding, and property rights which may affect the monetary value of the resort, but which are ignored in this dissertation. Whilst the researcher tries to impute a monetary value for recreation at Midmar, he does not take into account these 'effects' that exist beyond the scope of the market, and which may question the monetary value provided in this dissertation. An example of such an effect is the benefit that the resort provides to local wildlife in terms of sustaining the ecosystem. It therefore suffices to state that while this dissertation seeks to estimate recreational demand at Midmar, the estimation *may* suffer from a problem of underestimating the TEV as non-use effects are ignored in the dissertation.

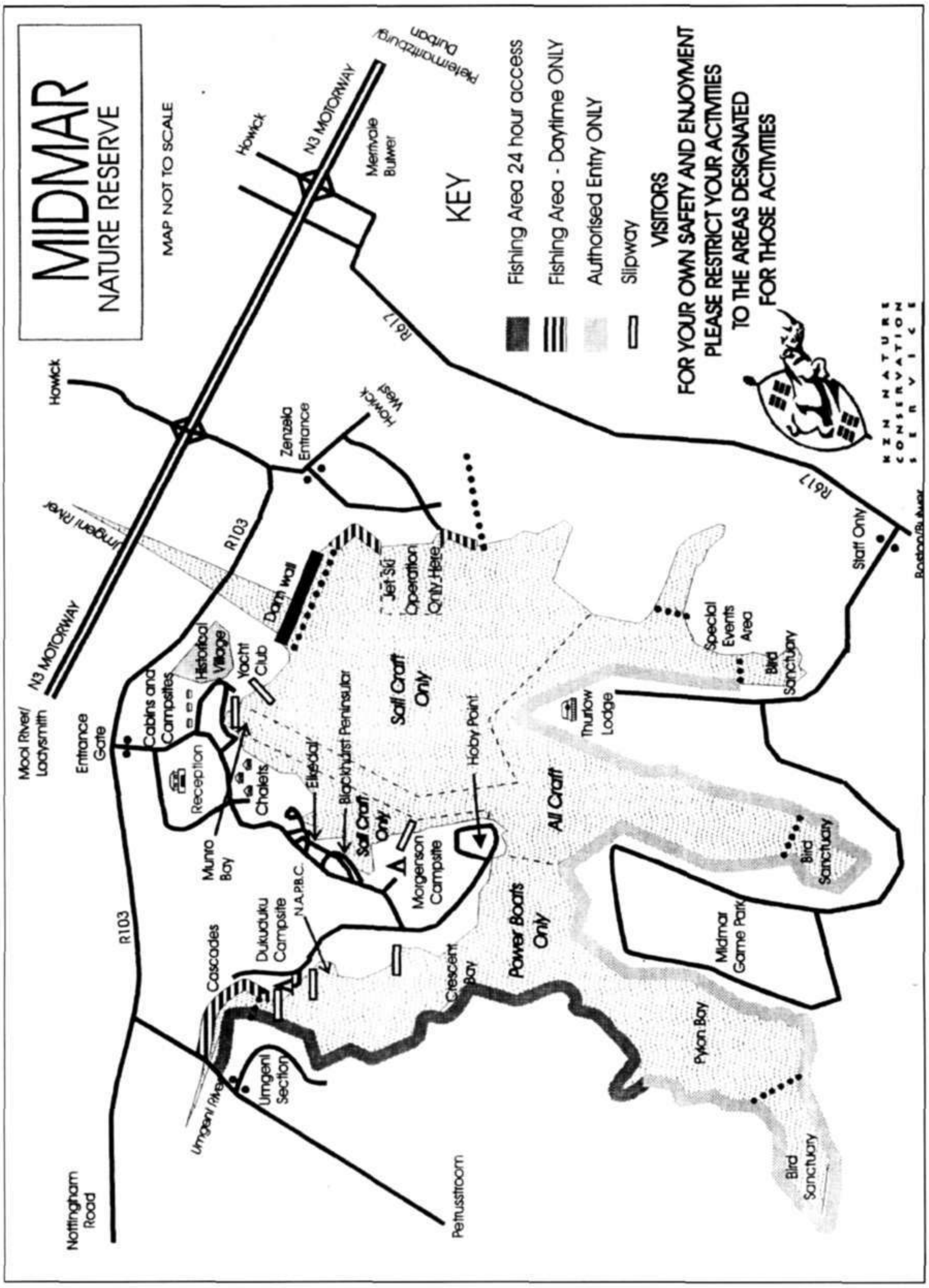
1.5 Study Area Under Review

Midmar is built on the Umgeni River, KwaZulu-Natal and is 1060m above sea level. The river starts as a small stream in Loteni and has a total catchment area of 906 square kilometres and an annual rainfall of 1016 mm.

Figure 1.1: Map of KwaZulu-Natal

Source: Adapted from Touring Atlas 2000.

Figure 1.2: Map of Midmar



Source: KwaZulu Natal Wildlife – Midmar Resort 1999.

Construction to build the dam started in July 1961 in order to accommodate the increase in the demand for water in Pietermaritzburg during the late 20th century as a result of the local population growing at an alarming rate. Midmar was officially opened on the 5th of October 1974, ten years after the completion of the dam. The dam is owned by the Department of Water Affairs & Forestry but water management is undertaken by Umgeni Water. It has a total surface area of 15.6 square kilometres (1560 ha) when full, and a shoreline of 56 kilometres. The average depth of the dam is 11.2 metres, with the deepest point being 22 metres. The Department of Water Affairs & Forestry realising that conservation needed to be controlled and managed, approached KwaZulu-Natal Wildlife (then called the Natal Parks Board) in 1968 to handle this matter. KwaZulu-Natal Wildlife accepted this offer and has thus far managed the conservation for the area.

The natural vegetation for the area is Grassland which needs to be protected. The most abundant grass species at the game park are common thatching grass (*Hyparrhenia hirta*), weeping love grass (*Eragrostis curvula*), dropseed (*Sporobolus spp*), wire grass (*Aristida junciformus*), and rooigras (*Themeda triandra*).

Typical fish species found in the dam are Largemouth Bass (*Micropterus salmoides*), Black Tilapia (*Orreochromis placidus placidus*), Common Carp (*Cyprinus carpio carpio*), Eel (*Pisodonophis boro*), Barbel (*Amphilius natalensis*) and Scaly (*Barbus natalensis*). All fish species are controlled by the KZN Wildlife.

Various animals have been introduced into the resort and a game park has been constructed near Thurlow Lodge However, some animals proved to be more resilient to the cold damp winters than others. The animal population in January 1997 was 243 Red Hartebeest (*Alcelaphus buselaphus*), 77 Black Wildebeest (*Connochaetes gnou*), 187 Blesbuck (*Damaliscus dorcas phillipsi*), 82 Zebra (*Equus burchelli*), 9 Oribi (*Ourebia ourebi*), and 12 Reedbuck (*Redunca arundinum*).

Apart from handling the conservation for the area, KwaZulu-Natal Wildlife also handles the demand for recreation in the area. A delicate balance between conservation and recreation has to be forged. Three camping and caravan complexes, Munro Bay, Morgenzon, and Duku Duku, have been built. A total of 16 cabins at Munro Bay to provide accommodation for visitors who want to stay at the dam have been built. A further 32 chalets and a lodge (Thurlow Lodge) have also been established. Recreational needs are also satisfied by KwaZulu-Natal Wildlife and 4 tennis courts, 2 squash courts, and a bowling green have been built.

Table 1.3: List of Amenities at Midmar

List of Amenities at Midmar
Launch Tours
Game Park and game viewing
Sporting Facilities:
Tennis courts
Swimming (pool)
Squash
Bowls
Bathing (dam)
Cycling
Wind-surfing
Canoeing
Yatching
Boating
Fishing

Source: KwaZulu Natal Wildlife - Midmar Resort, 1999.

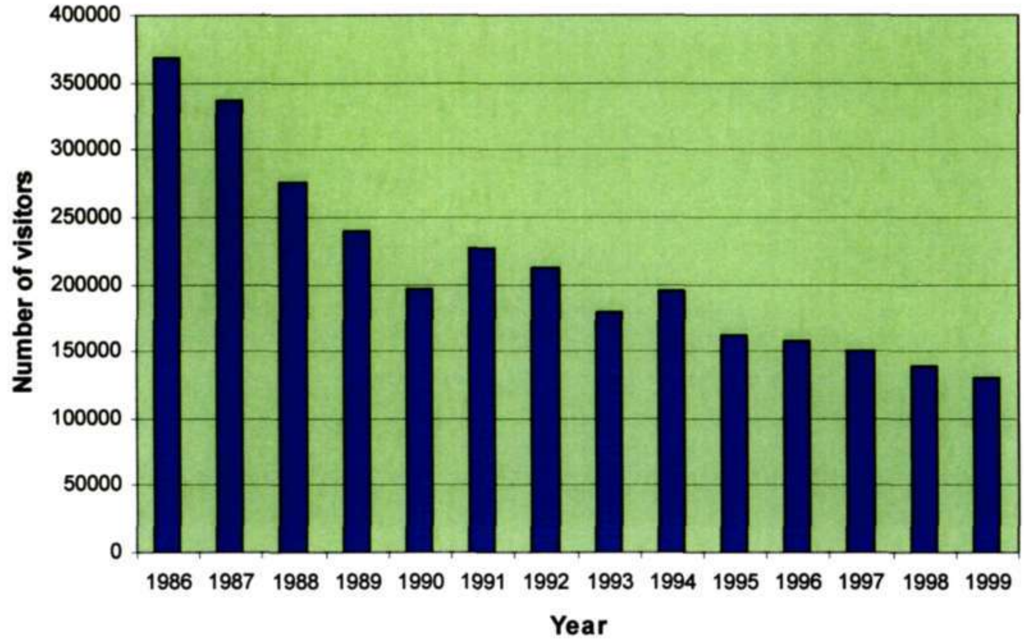
1.6 Problem Of Visitor Numbers At Midmar Resort

Midmar has enjoyed a considerable amount of success since its inception in 1974. This recreational site proved to be extremely successful during the 1970's and early 1980's. Apart from the number of amenities that could be enjoyed, many visitors just came to spend a day out in the open and enjoy the beauty and splendour of nature.

However, a serious problem of declining visitor numbers has plagued Midmar in recent times. Since 1986 up to 1999, the numbers of recreationists visiting the reserve has shown a steady decline. Table 1A, in the annexure of the dissertation illustrates the number of visitors who visit the site annually, on a *month to month* basis. Whereas Midmar enjoyed a total number of 367 670 recreational visitors in 1986, the number has displayed a dramatic decline to 129 908 in the year 1999. This represents a drop of 64.7 percent in visitor numbers over the years.

In order to identify the negative trend in visitor numbers, these visitor figures were plotted using a histogram (Figure 1.3) with the number of visitors on the vertical axis and the year on the horizontal axis. It is evident from the histogram that there is a downward trend in visitor numbers over the years concerned. This is especially true during 1986 to 1990 where the gradient is particularly steep. In 1991, visitor numbers increased, albeit marginally. Thereafter, each subsequent year, with the exception of 1994, has seen a decline in visitor numbers. The overall change in visitor numbers during 1986 to 1999 was 237 762 visitors, and as mentioned above, this represents a decline of 64.7 percent.

Figure 1.3: Annual Number of visitors to Midmar (1986 - 1999)



Source: KwaZulu Natal Wildlife - Midmar Resort, 1999.

The seasonal component in visitor numbers is not readily observable from Figure 1.3 due to annual figures being presented. An in-depth analysis of Table 1A (which illustrates the monthly visitor numbers) indicates that a seasonal component does in fact exist at Midmar. It appears that the number of visitors in the warmer months (Oct - Feb) is substantially higher than that during the colder months (Mar - Sept). Also, visitor numbers peak during December to February of each year when the weather is warmer and most schools are closed for Christmas. Visitor numbers also seem to be affected by 'extraordinary' events such as the Midmar Mile (which annually takes place during the 1st week of February) and the Energade Midmar Triathlon (which takes place annually during the 1st week of October. These events tend to create monthly spikes in the number of visitors.

Recreational visitors to Midmar Resort are charged an entrance fee upon entering the resort. The is undertaken on a *per person* basis and each individual entering the resort is charged a fee, irrespective of whether they are all present in one motor vehicle. It has been widely hypothesized that one of the reasons for the decline in visitor numbers at Midmar has been the increase in price (entrance fee) during the review period. In fact, the price increased by 500 percent during the period 1986 to 1999 and it seems plausible that this has had a dampening effect on visitor numbers. This hypothesis will be one of the issues that this dissertation tries to investigate and will test whether the price of entry is an important explanatory variable, and if it does significantly influence the number of visits to the resort annually.

CHAPTER 2

THE ESTIMATION OF RECREATION BENEFITS- ESTIMATION TECHNIQUES

The evaluation of recreation benefits has made significant headway in the past few years. The underlying reasons for this narrowing of focus can be classified as being largely pragmatic, ranging from often cited factors of increasing population, leisure, incomes, mobility, urbanisation, to calls for the continuing adjustments in resource allocations.

The benefits of recreation from the social or community viewpoint are alleged to be many and varied. However, those benefits which are derived from social investment are by nature more difficult to measure than the benefits of private investment, as often no well defined market exists. Arrow (1965:5) stresses that there is inevitably some failure in the extent for which the price system will be adequate. Arrow (ibid) goes on to say that never the less, the price system, even in its ordinary form does have an important role in the estimation of benefits and, in a more extended sense, there really is no benefit calculation possible that is not based on a set of at least hypothetical prices.

These benefits may accrue to the local community (inhabitants who live in close proximity to a particular environmental resource) which are often termed 'impact benefits' or they may accrue to the national or regional economy in which case they are termed 'primary benefits'. Brown et al (1984) analysed the expenditure of international visitors to Hwange and Mana Pools National Park in Zimbabwe and estimated that 61 percent of the Park's total use value leaves the country. In the case of Midmar, there are predominately likely to be impact benefits as most benefits (ranging from the selling of curios to formal employment) accrue to the local communities around the resort.

The evaluation of the benefits of recreation implies imputing monetary values to environmental goods and services. Amongst the more common approaches/techniques are the Travel Cost method, Hedonic Pricing method, Contingent Valuation method, Conjoint Analysis, and Mathematical models. These different evaluation techniques may be distinguished into two main groups: *demand* curve approaches and *non–demand* curve approaches. Some approaches such as the Contingent Valuation method do not capture the use but non-use values and hence individuals in the surrounding areas are questioned. Other approaches like the Travel Cost method captures use values and hence visitors to a particular site are questioned. Each approach has merits and limitations and the choice of method will depends on the type of research needed, availability of data sources, time constraints, and costs.

This dissertation attempts to impute a recreational *use* value to Midmar, and hence methods capturing non-use values, have been disregarded. Considerations pertaining to the suitability and popularity of approach were carefully assessed and it was finally decided that the Travel Cost method would be the intended approach in this dissertation.

2.1 The Travel Cost Method

The Travel Cost method (TCM) has been specifically designed to measure the economic value or consumers' surplus that is associated with the recreational use of an area. It was originally developed by Harold Hotelling in 1949 and has thus far been used extensively in the area of measuring economic value of non-marketed goods and services (Prewitt 1949; Clawson et al 1966; Sinden et al 1979; Bennett et al 1995).

The TCM makes use of surrogate markets which estimate an implicit value for the environmental good or service by means of the price paid for another good which is marketed. It looks at the pattern of recreational use of a park and uses this information to derive a demand curve. This demand curve is then used to estimate the total amount of consumers' surplus. The approach assumes that individuals react to increases in travel costs as they would to increases in the admission fees to the park. In essence, increasing travel costs are used as a surrogate for increasing admission fees to determine the consumers' surplus. It is assumed by Hanley (1989:362) that the "minimum willingness to pay to consume the services provided by the country park can be measured by estimating their travelling costs, plus any other costs they occur in consuming these services".

Pearce et al (1990) describe the approach as being "based on an extension of the theory of consumer demand in which special attention is paid to the value of time". Smith et al (1983) assert that the method "assumes that various factors influencing visitors' travel costs, including both direct costs and the opportunity costs of visitors' time, influence the length and frequency of visitation to a given destination".

The TCM is generally thought to comprise two steps. The first step examines the relationship between the rate of visitation to a recreational park and the costs of travelling to and from the park. This step leads to what is referred to as the 'whole experience' demand curve (Sinden et al 1979; Hufschmidt et al 1983). This information can then be said to represent a single point on the true demand curve. The travel cost visitation rate relationship, once identified, can then be used to estimate other points on the true demand curve. This comprises the second step and allows the researcher to derive the normal or Marshallian demand curve.

The basic concept of the TCM depends on the inverse relationship that exists between the rate of visitation to a site, and the costs associated with visiting that site. It is a method that accepts the costs of travelling to and from a site as a proxy for the price paid to visit that site. When the price associated with visiting a site (the travel costs) increases, the quantity demand (number of visitations) decreases. This relationship in its simplest form can be shown as follows:-

$$Visits = f(Travel\,costs)$$

Garrod et al (1999:7) state that the Travel Cost method is primarily employed to estimate the demand or marginal valuation curve for recreation sites. Many recreational sites do not charge an entry fee, but individuals need to purchase a private good to get to and from the recreational site. The private good in question is transport. The demand for the recreational good is then estimated by observing how the degree of the visitation to the recreational site varies according to the price of the private good (transport). This would imply that since greater distances from a particular recreational site should incur higher transport costs, the number of visits to the recreational site would be lower. The converse would also hold true, that is, shorter distances should incur lower transport costs and therefore increase the number of visits to the particular recreational site.

Garrod et al (ibid) assert that invariably, there is an inverse relationship between the cost of visiting the recreation site and the number visits observed. Since people living a greater distance from the site would incur greater transport and time costs, they would make fewer visits per year than those living nearer to the site. This relationship, if represented by a curve will amount to a downward sloping demand curve.

The TCM is thus an ideal approach that can be implemented to estimate the demand for recreation at Midmar. Apart from the times when large events such as the Midmar Mile are being held, and in which instances, visitors come from all over South Africa, most frequently visitors come from the towns or cities surrounding the resort. Therefore, it can be readily assumed that the visitors who frequent Midmar are those individuals who live in close proximity to the resort. This is due to the fact that visitors from further areas incur a greater travel cost when visiting Midmar. By assessing the relationship between the cost of travelling (explanatory variable) to Midmar and the number of visits per annum (dependant variable), the travel cost visitation rate function can be identified. This function can then be used to derive the demand for recreation at Midmar which in turn can be used to estimate the monetary value of Midmar by using the concept of consumer surplus.

The Travel Cost method can be largely divided into 2 sub categories, namely, the Zonal Travel Cost method and the Individual Travel Cost method. Each of the methods is discussed below in order to determine which method will be most applicable to Midmar.

2.2 The Zonal Travel Cost Method

The Zonal Travel Cost method has been applied to estimate demand and consumer surplus for wildlife and nature conservation at specific sites since the 1960's (Clawson and Knetsch 1966). More recent cases where the method has been implemented are Farber (1988); Willis (1990); and Hanley (1989). The Zonal Travel Cost method is based on data relating to zones of origin for each visitor and according to Markandya et al (2002:365), the Zonal Travel Cost model defines the trip generating function as:

$$\frac{V_j}{P_i} = f(C_{ij}, X_i)$$

Where V_j = the total number of trips by individuals from zone j to the recreational site per unit of time; P_i is the population of zone j ; C_j is the travel cost from zone j to the recreational site; and X_j represents the socioeconomic characteristics of zone j. Socio economic characteristics will include things such as income levels, expenditure incurred in consuming other goods, substitute sites, and educational levels. The visitor rate $\frac{V_j}{P_i}$ is generally calculated as visits per unit of the population, and is usually assumed to be 1000 persons in a zone. The trip generating function is essentially a demand curve for it expresses the number of visits that individual visitors will make to a particular site at any given level of travel cost. This trip generating function is then used to derive the per person consumer surplus estimates for recreation at site.

Assuming the above relationship is a linear one, in each zone the average consumer surplus (ACS) per person for all visits to the site for a given time period, is calculated by integrating the equation to the type:

$$\frac{V}{P} = \alpha + \beta TC$$

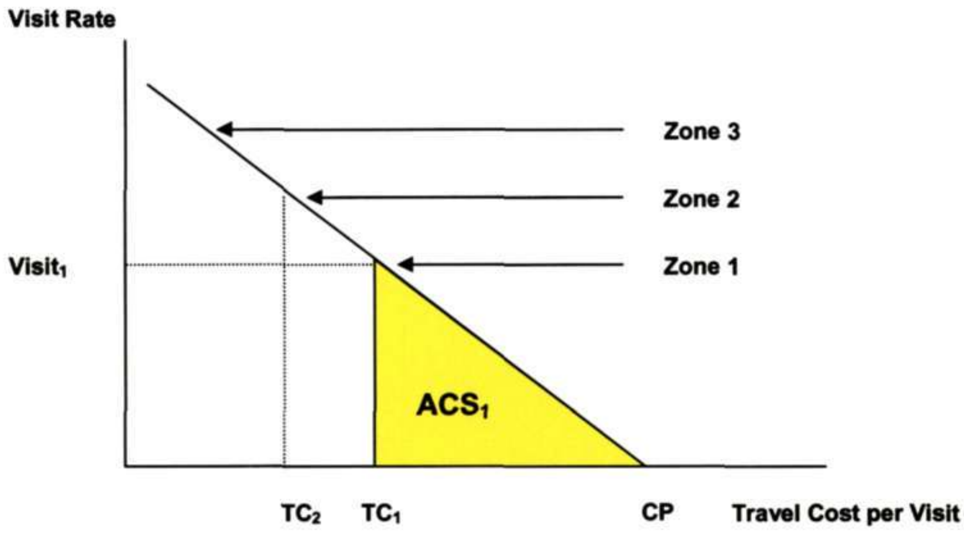
between the cost (price) of the visits actually made from each zone, and the price at which the number of visits will fall to 0. This is sometimes referred to as the 'choke price' (CP) and will represent the intercept of the demand curve on the TC axis.

If for example, 3 zones are defined in the survey, then the ACS_1 for zone 1 can be calculated as:

$$ACS_1 = \int_{TC_1}^{CP} (\alpha + \beta TC) dTC$$

In Figure 2.1, the ACS for a visitor from zone 1 will equal the shaded area which is bounded between the average travel cost (TC_1) incurred by visitors from zone 1 when visiting the site, and the choke price (CP). This means that the curve is integrated between these two points and the area enclosed by these critical points will equal the average consumer surplus for visitors from zone 1. Similarly, the ACS for zone 2 will be the area bounded between the average travel cost (TC_2) for zone 2, and the choke price (CP).

Figure 2.1: Consumer Surplus of Visitors



Source: Adapted from Markandya, 2002.

When implementing the Zonal Travel Cost method, data are collected on site recording the point of origin of the respondent and the number of visits made to the site in a given time period. The area surrounding the site is then divided into different zones of origin, each of which has an associated average travel cost to the site. The simplest form of the Zonal Travel Cost method is based on straight line distances from the recreational site. Each zone is then defined by a series of concentric circles/rings radiating away from the recreational site. Zones can be defined based on road distances of travel times, areas of population, or any other geographic unit.

Once the zones have been identified, the individual number of visits from any of the zones to the recreational site can be calculated. This means that any one individual can make one or more visits per time period (year). Through the use of sampling, the data collected by surveys can be used to estimate the zonal visits per capita to the site. The zonal visits per capita are calculated by dividing the number of individual visits originating in a particular zone by the number of individuals in that zone. The trip generating function is then estimated explaining per capita zonal visits by average travel cost. The Zonal Travel Cost method therefore assumes that all households in a particular zone have similar preferences for recreation in a particular recreational site, and that they would react similarly to changes in the cost of access. Furthermore, the Zonal Travel Cost method assumes that all individual households (in a particular zone) incur the *same* marginal costs when travelling to a particular site. This seems unlikely in reality and is therefore subject to serious criticism.

The total annual consumer surplus for each zone can be calculated by multiplying the annual ACS for that zone by the number of population units (individuals) in that zone. Finally, aggregate consumer surplus for the recreational experience provided by visits to site (by all households across all zones) is then calculated by summing up the total annual consumer surplus estimates across all zones. Some authors (Sinden et al 1979; Hufschmidt et al 1983) have assumed that the consumer surplus from the most distant zones of origin is zero.

The Zonal Travel Cost method is normally used at recreational sites where there is no restriction of entry (ie: there are no entrance fees). However, when an entrance fee is charged, the same methodology may be used except that the entrance fee is added to the average cost of each zone. In doing so, calculations for consumer surplus will be accordingly adjusted.

The Zonal Travel Cost method is ideally suited to estimate consumer surplus for recreation at sites where visitor origins are relatively evenly distributed. If visitor origins are distributed asymmetrically or where there are just a few 'important' visitor origins, problems may arise. The Zonal Travel Cost method is also unsuitable for recreational sites which are linear rather than circular in topology.

The implementation of the Zonal Travel Cost method for estimating the demand for recreation at Midmar could theoretically be used quite successfully. Visitors to Midmar would have to be asked where they reside and be fitted into clearly defined zones. The average travel costs from different zones could then be calculated and regressed against the number of visits undertaken from individuals from that zone. However, from a practical perspective, the implementation of the Zonal Travel Cost method at Midmar could be problematic. The reason for this is that visitor origins are not relatively evenly distributed and the bulk of the visitors to Midmar come from a few 'important' visitor origins. This means that samples will be biased and will create problems when calculating estimates for consumer surplus.

2.3 The Individual Travel Cost Method

When using the Individual Travel Cost method, the trip generating function may be defined as

$$V_i = f(TC_i, X_i)$$

where V_i is the number of visits made in a particular time period by individual *i* to the site, TC_i is the costs incurred by individual *i* in visiting the site, and X_i is all other factors that influence the number of visits made by individual *i* to the site. These include things such as income, education, substitute sites, and preferences.

The procedure when implementing the Individual Travel Cost method shares a number of similarities with the Zonal Travel Cost method. The researcher undertakes an onsite survey in order to estimate household or individual visitation rates over a given time period. The questionnaire is designed in order to elicit other information (cost of travel to the recreational site, socio - economic characteristics, recreational preferences, use of substitute sites, etc) from the respondent. These data are then utilized to derive the demand curve (as in the case of the Zonal Travel Cost method) from which consumer surplus may be derived.

In the case of the Individual Travel Cost method, integrating the demand curve between the actual travel cost (TC_i) and the choke price (CP) gives an estimate of the individual annual consumer surplus (ICS) for individual *i*:

$$ICS_i = \int_{TC_i}^{CP} f(TC, X) dTC$$

Balkan et al (1988:69) state that average individual consumer surplus may be estimated by integrating under the demand curve between zero visits and the average number of visits made by the individuals in the sample over a specific time period. The approach in calculating the individual consumer surplus (ICS) is identical to that of the average consumer surplus (ACS) in the Zonal model. Therefore, in Figure 2.1, the individual consumer surplus will again be represented by the area bound within the *actual* travel cost (TC_i) and the choke price (CP). The only noticeably difference is that in the Individual Travel Cost method, *actual* travel cost (of an individual visitor) is used whereas in the Zonal Travel Cost method, *average* travel cost (for all individuals from a particular zone) is used.

The total annual consumer surplus for the site is obtained by multiplying the individual consumer surplus (ICS) by the number of individuals visiting the site annually. That is, once individual consumer surplus has been estimated, total annual consumer surplus for the site can be derived by either aggregating across all individuals visiting the site, or alternating, by multiplying the ICS by the number of individuals visiting the site.

It is important to note that any random sample of visitors to a recreational site is selective and therefore excludes those people who choose not to visit the site. This gives rise to the problem of truncation and Garrod et al (1999:60) state that when using the Individual Travel Cost method, it may be sometimes necessary to adjust the estimation procedure since the behaviour of non-visitors is not included in the model, which will bias the model and over-estimate the consumer surplus. Interviewing non-visitors to a particular site could therefore adjust the model by trying to determine why they choose not to visit the site.

2.4 Truncation

When conducting an 'on-site' sample, the observed visit rate to a particular recreational site (for any given time period) immediately starts with a value of 1 visit per year. This means that the dependant variable will not take on values less than 1, or excludes any values less than one. The dependant variable (the number of visits per given time to a particular recreational site) cannot be negative in reality, but could equal zero (if non visitors were included in the sample). However, due to the 'on-site' survey being conducted, the sample is truncated in that only those respondents who make one or more visits will be observed. This produces a dependant variable which is truncated to below one visit.

It may appear as though such a modification cannot seriously affect the survey, but when implementing the ordinary-least-squares (OLS) regression model to assess the data, the problem sometimes becomes evident. This is due to the fact that OLS regression models specifies a normal distributed error term, which implies that the number of trips should range from negative infinity to positive infinity. Thus, the OLS estimation may not always be appropriate for the estimation of Individual Travel Cost method and its use may sometimes bias the consumer surplus estimation. This suggests that if the Individual Travel Cost method is to be implemented, the OLS assumptions (hetroscedasticity, serial correlation and mulitcollinearity) need to be thoroughly investigated, and any breaches in the assumptions identified, so as to ensure that the model is free of any bias.

Some authors (e.g. Maddala 1983) indicate that the problem of truncation can be dealt with by using the maximum-likelihood (ML) estimation approach which corrects the bias that could arise from the OLS estimation. It is important to note that the recognition of truncation and the use of ML estimation (instead of OLS estimation) alters the consumer surplus estimates substantially. Studies carried out by Smith et al (1985;1986), Willis et al (1991a;1991b) and Balkan et al (1988) have found significant differences in consumer surplus estimates when comparing ML estimators with OLS estimators for the same data. Several authors including Kling (1987; 1988) and Smith (1988) question the efficacy of using the ML techniques to combat the truncation effects and suggest rather that the OLS be adjusted to account for the truncation effects which will in essence produce far superior and more accurate estimates of consumer surplus.

Although the survey at Midmar could 'suffer' the problem of truncation, the OLS estimation approach has been adopted during the 'analysis of data' stage of the survey. Accepting that the OLS estimation may bias the consumer surplus, a thorough investigation of the OLS assumptions and their significance is discussed in chapter 4. Further, the statistical analysis which was undertaken is also discussed in this chapter and the reasons as to why the model was accepted are given. However, even before discussing the results of the survey, the decision as to which method should be implemented at Midmar still needs to be described. This is done in the following chapter and a brief explanation as to why the particular method was chosen is given.

CHAPTER 3
IMPLEMENTATION OF THE TRAVEL COST METHOD AT MIDMAR

When comparing both the Travel Cost methods, the most apparent advantage of the Individual Travel Cost approach over the Zonal Travel Cost approach is that it takes account of variations in data (individual demographics are used) rather than relying on zonal aggregate data. Accordingly, estimation of consumer surplus based on individual data as opposed to zonal data should be statistically more efficient. This is because "the Zonal Travel Cost method assumes that the estimated demand is generated by a 'representative consumer' whose behaviour reflects the average behaviour in the population" (Garrod et al 1999:63).

Apart from the question of truncation which both methods suffer from, the Individual Travel Cost method has similar benefits and limitations as the Zonal Travel Cost method. A major advantage of the Individual Travel Cost method is that it captures the vast differences that visitors may display which the Zonal Travel Cost method ignores. The Individual Travel Cost approach also enjoys a more practical advantage in that the trip generating function can be estimated using a smaller number of observations. The downside of the Individual Travel Cost approach is that it requires more information of the individual characteristics of the respondents, and is therefore reliant on more expensive questionnaire surveys being undertaken in order to elicit visitor characteristics, preferences, and behaviour.

Another reason why the Individual travel cost was considered more appropriate was because the travel costs reported by individual visitors displayed variability. By assigning the same average travel costs (as in the case of the Zonal model) to such a small sample, the variability factor of the model may be removed, resulting in the model becoming distorted. In the survey, the travel costs variable (T) accounted for the vehicle operating costs borne during the travel to the site. Other vehicle operating costs (e.g. toll fees) were added to the running costs to give one the total travel costs.

Also the Individual model provides a more comprehensive model for the assessment of net economic value of recreation, as it allows for the inclusion of other behavioural variables (income; age; sex; etc) into the analysis. However, when implementing the Individual model, it is necessary that some variability in the visitation rates of individuals exists. Fortunately, the sample displayed a reasonable amount of variability and hence warranted the use of the Individual Travel Cost method. Finally, the Individual Travel Cost approach is generally more flexible and is applicable to a wider range of sites in comparison to the *Zonal travel cost approach. It was for these reasons that the* Individual Travel Cost method was selected and used in this study.

It was hypothesized that the demand for recreation at Midmar was dependent on a number of explanatory variables. According to Garrod et al (1999:55), Travel Cost method studies have consistently shown that as the price of access (cost of travel) increases, the visit rate to the site falls. The Travel Cost method usually estimates a trip generating function where the number of visits (the dependent variable) is a function of one or more factors (the independent/explanatory variables). The various travel cost studies that are found in the literature are based on the above relationship with variations arising from the manner by which the variables are defined and measured, or from the estimation procedure employed.

The *equation listed below indicates the explanatory factors considered during the* survey. Recreational visitors at Midmar were asked to complete a questionnaire, explaining which explanatory factor(s) were considered important by them in choosing to visit Midmar. As far as possible, open ended questions were excluded from the questionnaire, forcing the respondent to choose between predetermined alternatives. This was done to limit the possible number of answers provided by the visitor, so that a meaningful relationship between the number of trips (per annum) undertaken by the visitor and the explanatory variable(s) could be achieved.

$$N = f(T, P, Y, F, W, Q, A, K)$$

Where :

N = Number of visits per annum

T = Average cost of travel

P = Price of entry

Y = Income of the visitor

F = Fishing

W = Water-sports

Q = Quality and attractiveness of site

A = Demographics

K = Weather

It is expected that whilst some explanatory factors may have a major influence on the number of visits undertaken per annum, others may not have a large influence on the number of visits. The average cost of travel (T) to Midmar is expected to have an inverse influence on the number of visits per annum. As the costs of travel increase, it is expected that the number of visits (per annum) undertaken by visitors decreases. If individuals find it more expensive to travel to Midmar, then it is quite likely that those individuals would decrease the number of times that they visit Midmar.

The price of entry (P) is also expected to have a negative influence on the number of visits undertaken annually. This follows from the law of demand which states that "as the price of a product increases *ceteris paribus*, the quantity demanded would decrease" (Mohr 2000: 78). It is often hypothesized that one of the reasons why visitor numbers at Midmar have fallen over the last decade is largely due to price increase. The price of entry of entry at Midmar has increased by 500 percent over the 13 years under review.

The income (Y) of the visitor is also expected to influence the number of times a person chooses to visit Midmar. If Midmar is considered to be a 'normal' good, then an increase in the income of the visitor would result in a positive influence on the number of visits. That is, the increase in the visitor's income would lead to an increase in the number of visits to Midmar.

The taste and preferences held by visitors could also influence the number of visits undertaken to Midmar per annum. If the individual has some affinity towards nature or nature-based activities, then it is quite likely that he would increase the number of visits to Midmar. If, on the other hand, the individual is more comfortable in urban surroundings, then it is quite likely that Midmar would not appeal to him and therefore the number of visits to Midmar undertaken by him would be fewer.

Two dummy variables, one capturing the influence of fishing (F) at Midmar, and the other capturing the influence of watersports (W) at Midmar, were introduced to capture the tastes and preferences of visitors. Visitors were asked questions determining whether they engaged in either fishing or watersport (or both activities) at Midmar. If they did engage in either of these activities, then a score of 1 was assigned to that visitor. If it was identified that the visitor is indifferent to fishing or watersport, then a score of 0 was assigned to the visitor.

The quality or attractiveness (Q) of Midmar was also considered to influence the number of visits individuals make every year. Attractiveness of surroundings and the cleanliness of amenities are attributes that help to promote the dam. If Midmar was perceived by the general public as being of a high quality (or attractive in terms of the environment), then more individuals would be willing to visit the dam. The same holds for the converse. The more unattractive the environment around Midmar is, the fewer individuals would be willing to visit the dam. A dummy variable was also implemented for quality or attractiveness where a score of 1 meant that the site was considered attractive by the visitor, and a score of 0 implied that the site is considered unattractive by the visitor.

The demographics (A) of visitors were also expected to influence the number of visits undertaken per annum. The age of the visitor, his gender, and education levels, were all expected to influence the number of visits made per annum. The actual influence however, whether positive or negative, is unknown.

Finally, it was assumed that Midmar was more popular during certain times of the year, when the weather (K) was conducive to recreational activities. That is, the weather was expected to play an important role in determining whether a person chooses to visit Midmar or not. It was assumed that when there are favourable weather conditions, more individuals choose to visit the dam. In poor weather conditions, fewer individuals choose to visit the dam. This is echoed in the seasonal trend of visitor numbers at Midmar (Annexure 1A) where it can be seen that in summer, the number of visits increases, whilst in winter the number of visits plummets. Weather was also captured as a dummy variable.

The TCM has been extensively implemented throughout the world in various fields of study. It has proven to be extremely potent in the field of resource economics where often there are only a few other methods available to calculate the economic benefits of non-market goods and services. However, "while studies using TC have provided useful insights into the value of ecotourism in protected areas in developing countries, they have typically focussed more on estimating consumer surplus than on evaluating user fees as a guide toward designing improved park pricing strategies" (Chase et al 1998). This would suggest that the custodian of Midmar should use this research more as a basis for the economic valuation of Midmar, rather than use it as a basis for establishing entrance fees. However, this dissertation could assist in determining the price elasticity of demand for recreation at Midmar. Despite its popularity, the TCM has certain theoretical issues (which are discussed below) that need to be emended before applying the technique. A failure to adequately address these theoretical issues would impinge on the accuracy of the survey results.

3.1 Multiple Purpose Trips

The standard TCM model assumes that the sole purpose of any particular trip was the visit to the site in question. In reality, this is not always the case as many visitors choose to visit a site as a result of that site being in close proximity to another site that the visitors planned to visit, or the site being one of the many sites (as part of an itinerary) that the visitors plans to visit. Indeed, it is quite likely that visitors will enjoy "economies in combining visits to a number of recreational activities on the one trip" (Ulph et al 1981:203). Also the further the zone is from the site being evaluated, the greater the chance for visitors engaging in multiple purpose trips (Sinden et al 1979).

In either case, the TCM will overstate the net benefit to the consumer derived from visiting the site. That is, consumer surplus will vary according to whether the respondents are day visitors or holiday makers. The inclusion of total travel costs of multiple destination visitors in the use value of the park would bias the results since a proportion of the costs have be used in visiting the other sites. By dividing joint costs between multiple destinations, lower costs are assigned to the furthest site than would otherwise be the case in the single destination trip.

The question that then arises is how should one apportion travel costs among the different sites visited? There have been a number of approaches used and there seems to be no universally accepted method. It seems that the best possible approach needs to be assessed on a *case-by-case* basis. Ulph et al (ibid) reported that in some studies, only the marginal distance travelled to the site is used to determine the benefits of the site. This can be severely criticised as it depends on the distance of the previous site visited, because if two sites are relatively close to each other, then the marginal distance travelled is short and this will bias the estimation of benefits of that site.

Ulph and Reynolds (1981) also identified two other approaches used in other studies that were based on the ratios of time. In a study conducted by Trice et al (1958), the time spent in a particular site was apportioned in relation to the total trip time. That is, the time spent on the *nth* site was divided by the total trip time. Once this ratio was calculated, the total travel costs were multiplied by this ratio to give one the value of costs that could be apportioned to the *nth* site. The second approach is to omit travelling time totally. That is, the travel time was omitted from the total trip time. The rationale for such an approach was that "it can be assumed that visitors allocate both their expenditure and time in proportion to the benefits received from the several sites visited" (Ulph et al 1981:203).

An alternative approach is to rely on the perceptions of the visitors and ask users "to rank, on a percentage basis, the importance or level of benefits gained at various stops made or contemplated on the trip" (Ulph et al 1981:204). Bennett (1995) used a slightly different approach and asked users to subjectively identify the importance of the site to the overall trip.

During the survey for this research, the questionnaire solicited the visitor to establish whether the trip to Midmar was the sole purpose of the trip or not. Where it was established that the trip to Midmar was not the sole purpose of the trip (but rather one of the sites visited in a multi purpose trip), the questionnaire was ignored. It was felt that to apportion the travel costs among the different sites or to calculate the time spent at Midmar in relation to the total trip time (and then multiply this ratio by the total travel costs to get the travel cost incurred when visiting Midmar) would complicate the model, especially since the expected sample size was only 100 respondents. Instead, where respondents indicated that Midmar was not the sole reason for the visit, their completed questionnaires were later completely rejected. This meant that 2 questionnaires (of the total 100 questionnaires) were rejected as they indicated that Midmar was not the sole reason for their visit. A further 5 questionnaires were rejected on the basis that the data provided were inherently inconsistent.

Therefore, although the expected sample size was initially 100 visitors, a total of 93 questionnaires was accepted and analysed. All 93 visitors listed that Midmar was the sole reason for their visit and that they did not visit any other sites along the way. This may be interpreted as introducing some bias into the model as the sample may not be representative of the universal. However, of the total number of visitors interviewed at Midmar, only 2 visitors of the actual 100 interviewed indicated that Midmar was one of many sites along the way that they visited. Therefore, the influence of rejecting their questionnaires can be construed as being negligible.

3.2 The Opportunity Of Time

Visitors to a site are faced with the dual constraint of time and direct money costs. If the money constraint was removed, it could be argued that respondents living in more distant zones will visit the site less frequently than respondents living closer to the site. Therefore, according to some writers (Hufschmidt et al 1983), it is important to incorporate the cost of time into the TCM. If one ignores the cost of time in the derivation of the demand curve, then the demand curve will underestimate the consumer surplus of the site.

Studies carried out in 1973 by Knetsch et al recognised that the TCM should include both the direct monetary costs as well as the cost of time. Failure to recognise both these costs will imply that the consumer surplus estimation will be distorted. Creating an independent variable to represent the cost of time, however, uncovers another problem. That is, the inclusion of an independent variable representing the cost of time results in multicollinearity (see page 45) between direct monetary costs (travel costs) and time cost. That is, as travel costs increases, time costs also increases. Much discussion (Smith et al 1983; Mc Connell et al 1981; Lockwood et al 1995; Wilman 1980) has revolved around this issue and to date no definite direction has been provided. Some authors have recommended individual trip observations rather than zonal averages. Other authors (Bockstael et al 1987) have asserted that in practice, time cost and travel cost can be combined into one cost variable to eliminate multicollinearity.

In trying to estimate the demand curve for recreation at Midmar using the TCM, the opportunity cost of time was ignored. This was done for two reasons, namely, it is often difficult to accurately calculate the cost of time spent travelling to and from a site, and secondly, travel time would not always have an opportunity cost. That is, individuals who are on vacation may have travel time cost equal to or close to zero. Most visitors who were questioned were either on vacation or had nothing else to do for the day and therefore it is quite likely that the opportunity costs of travel time are close to zero.

3.3 Homogeneity Of Marginal Costs

The TCM can be examined on either an individual visitor basis (individual model) or across a number of defined zones (Zonal model). While the Zonal Travel Cost method assumes that individuals from the same zone have the same travel costs and identical preferences, the Individual Travel Cost method indicates that there are differences between individuals. During the study at Midmar, the Individual Travel Cost method was implemented. This means that the problem of homogeneity of marginal costs and preferences of visitors from each region was circumvented. The travel costs of individual respondents were elicited via the questionnaire.

3.4 Apportioning The Travelling Costs

The question of how to apportion the travelling costs of a party across individual members of that party also needs qualifying. Again, there is no specific theoretical guidance available and the most appropriate method seems to be to apportion the travelling costs equally amongst the different adult members of the party. Such an assumption could again distort the estimation of the consumer surplus of the site as sometimes, individuals may be 'free-riders' within the party. Free riding occurs when individuals enjoy the utility from consuming a good or service, without having to pay for that good or service. In the case of Midmar, any individual travelling to the resort for free, but yet deriving some satisfaction from the visit, can be considered a 'free-rider'.

One approach is to rely on the perceptions of the visitors and ask visitors to estimate the percentage of the travel costs covered by them. This was the approach favoured for the survey at Midmar. If the visitor paid for the entire trip, then the cost per person for every member of his immediate family was calculated. This was done so that some cost per person was determined, although in reality the parents would have paid for the children. When families are treated as individuals and the costs apportioned, individual costs within the sample are significantly reduced, and the question as to whether children should be included as individual consumers also becomes important. However, due to this study being based on individual visits to Midmar, costs were apportioned between all family members in order to get the cost per individual visitor.

Finally, where the total cost was split between parties (for example, between two families), the costs were divided between the parties and then the cost per person was calculated using the same method explained above.

3.5 Quantity Variable

Travel cost studies have used different types of variables to measure the quantity of use of any recreational site. For example, Darvall (1990) states that some studies used number of hours, whilst others have used number of days or number of visits. McConnell (1992) argued that the most appropriate measure of quantity use was the number of trips or visits as, once the respondent reached his destination, the length of stay at the recreational site was of no significance.

Given this argument, the quantity variable used for Midmar was the number of trips (N) per annum made by the visitor to Midmar. The sample that was selected comprised solely of recreational visitors (and not those individuals seeking accommodation). This meant that the duration of the visit was a single day or part of one day. Hence, this made it possible to define the dependent variable for the purpose of this study as 'total annual trips per person' or 'total annual visitor days per person'.

3.6 Congestion

According to Bennett (1995) in the presence of congestion at a recreational site, the consumer surplus estimates derived through the use of TCM could be unreliable. However, as explained above, the TCM will be used to estimate the demand curve for a particular recreational site. Based on the interaction of this demand curve and the entrance fee charged (the supply curve), the net consumer surplus will be calculated. However, in the presence of congestion, the interaction of the demand and supply curve does not truly reflect the consumer surplus of the site. This is because congestion results in a marginal social cost which will affect consumer demand and therefore visitation rates. These effects are represented by a shifting of the supply curve, and since the TCM only estimates demand and does not consider the supply side, the estimates of the consumer surplus will be unreliable.

However, it was assumed that Midmar is free from congestion. Therefore, the demand for the site is not affected by the level of congestion. This is not unlikely as the number of daily visitors at Midmar is relatively small in comparison to the available space allocated by park management for recreation. This is also especially true for weekdays when the number of visitors falls substantially.

Having emended all the above issues, the Individual Travel Cost method was finally implemented at Midmar. However, before implementing the TCM at Midmar, certain assumptions still needed to be highlighted. These assumptions, which were identified by Sinden and Worrell (1979:365); Bennett (1995); and Gillespie (1997) are as follows and also apply to the study at Midmar:

- All users obtain the some marginal benefit, and this is equal to the travel cost of the marginal user
- Travel cost is a reliable proxy for entrance fees, which implies that people visiting a site would react to an increase in entrance fees into the site in the same way as they would to an increase in the travelling costs associated with visiting the site.
- The consumer surplus of the marginal user is zero

CHAPTER 4
SURVEY RESULTS AND DISCUSSIONS

This chapter discusses the findings of the TCM survey implemented at Midmar during 1999. The sample size consisted of 93 visitors and each visitor was questioned about his reason(s) for visiting Midmar, and the amount of money he spent in travelling to Midmar. The data were then captured into a spreadsheet and a multi-variable regression analysis was done using a computer software programme (Microsoft Excel).

In order to facilitate the discussion, this chapter has been broken into sub sections. Initially, the testing of different functional forms considered is highlighted, and the selection of the most appropriate functional form is discussed. Thereafter, the development of the travel cost visitation relationship and the prediction of the visitation rate is discussed. Finally, the derivation of the demand curve for recreation at Midmar and the estimation of consumer surplus for Midmar is calculated.

4.1 Testing Of The Different Functional Forms

Economic theory does not prescribe any particular functional form for travel cost studies. In reality, the most appropriate practice is to statistically test various functional forms. From past travel cost studies, it would appear that the linear, log-linear, negative exponential, double-log, and the hyperbolic are the most common types used. The choice of the functional form is often based on the magnitude of the R^2 statistic. However, Garrod et al (1999:64) think that it is generally inappropriate to use the R^2 statistic exclusively, and that the choice of functional form should be based on a *number* of statistically criteria, such as R^2, predicted number of total visitors as compared to actual number, and the correlation between the distribution of predicted and actual visit rates across zones.

According to Darvall (1990), the selection of an appropriate functional form for the travel cost visitation rate is an important point because the variance of the economic welfare measured by the travel cost demand curve is affected by the choice of functional form. Selection of an inappropriate functional form may increase hetroscedasticity (discussed on page 48) which is most apparent in zonal models, and inappropriate functional forms could lead to distorted estimates of consumer surplus. Darvall (ibid) recommends that the selection of the most appropriate functional form should be based on the statistical significance of the different functional forms.

Ziemer et al (1980) have proved that the linear model is most inappropriate to estimate recreational demand because it provides for a poor fit of data. Bennett (1995) claim that the linear and double-log offered potential, and that the semi-log and exponential can also be used in certain cases. There is no specific theoretical guidance on the selection of the functional form and many writers suggest that a useful starting point is to look at the scatter plot of the data.

Garrod et al (1999:65) assert that "conventional statistical and economic protocols can be used to judge the fundamental suitability of any particular functional specification for a given model". Issues of heteroscedasticity and multicollinearity (discussed on pages 48 and 50 respectively) may also need to be addressed and econometric tools such as the Brausch-Pagan test, and the more popular t-statistic, could be implemented. It is also important to identify that consumer surplus estimates can vary considerably depending on the functional form chosen. Ultimately, some degree of subjective judgement would be needed when employing travel cost studies. A combination of statistical reliability as well as subjective intuition would be needed in order to create travel cost studies that are both reliable and robust.

In order to identify the 'best' possible travel cost visitation relationship for Midmar, four functional forms (linear, log-lin, lin-log, double-log) were tested. A synthesis of each functional form commonly considered is provided below.

4.1.1 Linear Models

In linear models, there is a linear function (relationship) between the explanatory variables. That is, the explanatory variables are raised to the first power only.

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_n X_n$$

4.1.2 Semi-Log Models (Log-Lin And Lin-Log)

In semi-log models, only one variable appears in the logarithm form. For descriptive purposes, the conventions adopted in Gujarati (1995:169) will be adhered to in this dissertation. A model in which the regressand is logarithmic will be called a log-lin model, while a model in which the regressand is linear but the regressor(s) are logarithmic is called a lin-log model.

Log-lin: $LnY = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_n X_n$

Lin-log: $Y = \alpha + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_n LnX_n$

In the log-lin model, the slope coefficient measures the constant proportional or relative change in *Y* for a given absolute change in the value of the regressor. That is, these models estimate the percent growth in *Y* for an absolute change in *X*. In lin-log models, the model estimates the absolute change in *Y* for a percent change in *X*.

A point of caution when implementing the semi-log models is that such models may only be appropriate if the time series of data are stationary. A time series is said to be stationary if 'its mean value and its variance do not vary systematically over time' (Gujarati 1995:23).

4.1.3 Double-Log Models

In double-log models, both the regressand and the regressor(s) are transformed using natural logarithms.

Partial transformation: $LnY = \alpha + \beta_1 LnX_1 + \beta_2 X_2 + \beta_n X_n$

Full transformation: $LnY = \alpha + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_n LnX_n$

Full transformation models - this model is linear in its parameters (α and β_n) as well as in its variables (X_1 and Y). An attractive feature of the double-log model is that the slope coefficient (β_n) measures the elasticity of *Y* with respect to *X*. That is, it measures the percentage change in *Y* for a given percentage change in *X*. In double-log full transformation models, the elasticity coefficient remains constant through-out the series and hence double-log models are also termed 'constant elasticity models'.

Partial transformation models - Double-log models are sometimes partially amended by transforming the regressand, and only *some* of the regressor(s). In these models, not all the regressors are transformed and some are left as natural numbers. In such a case (where explanatory variables are left as natural numbers), the slope coefficient (β_n) will not measure the elasticity of *Y* with respect to *X*, but rather measure the constant proportional or relative change in *Y* for a given absolute change in the value of the regressor.

4.2 Regression Estimates For Midmar

Most studies (Christiansen 1997, Gillespie 1997) have tested the above four functions, and then selected the most appropriate functional form. Therefore, a similar approach has been adopted in this dissertation and a description of each functional form according to the strength of the linear associations between variables and the joint tests of significance of explanatory variables is given in Table 4.1.

As can be seen from Table 4.1 below, parameters vary considerably according to how the models are specified. Also, although many explanatory variables were initially hypothesized to significantly influence the number of visits to Midmar, through a series of stepwise regression, the less significant explanatory variables (price of entry, personal income, quality of site, demographics, and weather) were dropped. The omission of these explanatory variables did not significantly alter the predictability of the models (measured in terms of the R^2 statistic or the *F* statistic).

Three explanatory variables, namely, travel cost (T), water-sport (W), and fishing (F) were found to be significant, at the 5 percent level of significance, in the log-lin and double-log functional models, while just two explanatory variables, namely, travel cost (T) and fishing (F) were significant in the linear and lin-log models. The double-log model considered was only *partially* a double-log model. That is, while travel cost (T) was transformed using its natural logarithm, the other two explanatory variables, namely watersport (W) and fishing (F) were left untransformed. When all three explanatory variables were transformed, the results obtained from the model were not as significant as the partially transformed double-log model. Note, watersport (W) and fishing (F) was treated as dummy variables and an index was used to capture their importance as a reason for visiting Midmar.

Table 4.1: Regression of Visitation Rate and Travel Cost[1]

Functional Form	Constant	Travel Cost	Watersport	Fishing	F	R^2
Linear	**3.19037** 1.61545 1.975	**-0.27223** 0.06343 -4.292	**0.71705** 0.48019 1.493	**1.28239** 0.35243 3.639	**11.98229**	**0.28770**
Lin-log[2]	**8.85138** 1.86180 4.754	**-4.07979** 0.64337 -6.341	**0.80531** 0.43733 1.841	**1.07310** 0.32465 3.305	**20.43136**	**0.40783**
Log-lin	**0.86361** 0.26230 3.292	**-0.05464** 0.01030 -5.305	**0.15611** 0.07797 2.002	**0.18855** 0.05722 3.295	**14.85028**	**0.33359**
Double-log[3]	**1.23138** 0.29301 4.203	**-0.53309** 0.09859 -5.407	**0.24926** 0.04612 5.405	**0.17483** 0.04829 3.620	**33.82360**	**0.53274**

Linear model - The linear model was the weakest in terms of estimating the number of visits to Midmar. The linear model explained just under 29 percent of the variation in the number of visits. The explanatory variables travel cost (T) and fishing (F) were significant at the 95 percent confidence level. Water-sport (W) was not significant in the linear model. Collectively, the explanatory variables had an *F* statistic of 11.98 which can be construed as being relatively significant.

Lin-log model - The lin-log model also identified travel cost (T) and fishing (F) as being significant at the 95 percent confidence level, whilst watersport (W) was insignificant. By amending the linear model using the natural logarithms of the *all* explanatory variables, the model was considerably improved. The lin-log model explained 41 percent of the variation in the number of visits. Collectively, the explanatory variables were also considered significant and had an *F* statistic of 20.43.

Log-lin model - The amendment in the case of the log-lin model was less satisfactory. The log-lin model explained 33 percent of the variation in the number of visits to Midmar.

[1] Information presented in the following order – coefficient, standard error, and *t* statistic.
[2] All explanatory variables were transformed using natural logarithms in the lin-log model.
[3] The double-log model was partially transformed with only travel costs being transformed using natural logarithms.

However, in this model as opposed to the lin-log model, all three explanatory variables, namely, travel cost (T), watersport (W) and fishing (F) were significant at the 95 percent confidence level. Jointly, these explanatory variables were also considered significant and had an *F* statistic of 14.85.

Double-log model - A comparison of the four models considered showed that the the double-log model was the best according to statistical criteria. The double-log model was statistically more robust than the other models in terms of the *F* statistic, the *t* statistics, and in the 'goodness of fit'. It was for these reasons that the double-log model was selected. The double-log model showed that the three explanatory variables were collectively significant (the *F* statistic was equal to 33.82) in predicting the number of visits an individual will undertake. The model explained 53 percent of the variation in the number of visits to Midmar. That is, 53 percent of the number of visits to Midmar undertaken by an individual could be explained by the three explanatory variables considered in the double-log model. The double-log model also identified that individually, each explanatory variable, namely travel cost (T), water-sport (W), and fishing (F), was significant at the 95 percent confidence level.

The *t* statistic (5.40) for travel costs shows that the explanatory variable is highly significant at the 95 percent confidence level. This is an important finding because it implies that Midmar, as a destination for recreational activities, becomes less desirable as the costs of travelling to and from the site increase. This could possibly be one of the main factors why Midmar has faced a decline in visitor numbers over the last decade. The fact that the price of petrol has escalated drastically over the last decade could connote that visitors find it more expensive to visit Midmar, and therefore have curtailed the number of visits. However, it has to be noted that most visitors come from the surrounding areas and thus, this influence should strictly influence the visitation rate in theory, although in practice it can be considered negligible.

Water-sport (W) was also statistically significant ($t = 3.62$). This suggests that one of the main determinants of an individual choosing to visit Midmar was the fact that he can enjoy water-sport activities at the site. Individuals were asked whether they engaged in any water-sport activities at Midmar. As explained in the previous chapter, a dummy variable was used to capture the effects of water-sport activities. A value of 1 signified that the respondent did engage in water-sport activities at Midmar, whilst a value of 0 implied that he did not engage in any water-sport activities at Midmar. Further, a value of 1 assigned to a visitor implied that he views the site as being suitable for water-sport activities and therefore will be willing to visit Midmar more often. The non logarithm coefficient for water-sport in the double-log regression model suggests that, on average, the number of visits per individual per annum will increase by 25 percent if the visitor engages in water-sport activities.

Respondents were also asked whether they engaged in fishing at Midmar. A dummy variable was again used so that the effects of fishing could be captured by the model. A value of 1 assigned to a visitor implied that Midmar was sought after by that visitor as a destination for fishing. Fishing proved to be statistically significant at the 95 percent confidence level (t-stat = 5.40). The double-log model predicted that individual visits per annum would be higher by 17 percent if the respondent participated in fishing activities.

4.3 Estimation Of The Predicted Number Of Visits

The double-log function described in Table 4.1 was used to estimate the number of visits (per annum) per visitor at Midmar. The double-log function was chosen on the grounds that it was statistically the most significant with regards to the *F* and *t* statistics, and also because the model did not violate any of the OLS assumptions. Please note that an investigation of the statistical significance of the model is undertaken in sections 4.4, 4.5 and 4.6 of the dissertation.

Before the visitation rate could be predicted, a slight modification was made to the double-log function. In order to derive the demand curve in terms of entrance fee and the number of visits per person per annum, all other explanatory variables except travel costs, were set to equal their average value. That is, the other two significant explanatory variables, namely watersport (W) and fishing (F), were held constant at their mean values. By holding these two explanatory variables constant at their average value, the visitation rate travel cost relationship transformed into a more simple function given below:-

$$LnN = 2.17 - 0.53LnT$$

The above function was used to predict the number of visits (per annum) that a visitor would make to Midmar. Bearing in mind that the key assumption for the Travel Cost method is that travel costs to and from the recreational site acts as a proxy for entrance fee, a hypothetical entrance fee was imputed into the above function. The range of 'entrance fees' considered was 50, starting from a minimum of R1 entrance fee to a maximum entrance fee of R51. The range was based on the data gathered from the questionnaires. Each entrance fee was then incremented upwards by R1. This was done in order to simulate increments in the entrance fee. The procedure was repeated for each simulated entrance fee increase of R1 up to a maximum of R51. This data can be found in Annexure 4A of the dissertation. It should be noted that the maximum 'entrance fee' was derived as a result of the primary data collection where it was established that the maximum price (travel cost per person) any individual visitor would be willing to pay was approximately R50 (which is made up of R40 for travel costs and R8 for the gate fee).

A relationship between the predicted number of visits per individual per annum and the 'entrance fee' was established and this is show graphically in Figure 4.1 below.

Figure 4.1: Predicted number of visits (p.a) per visitor

It is evident that a negative relationship exists between the 'entrance fee' and the number of visits. This is in keeping with the Law of Demand in Economics which states that as the entrance fee increases, *ceteris paribus*, the number of visits demanded will decrease. According to the demand curve, the number of visits made per visitor per annum will approach 1 as the entrance fee approaches R50. Similarly, at an entrance fee of R1, the number of trips per annum will be approximately 8.75 visits. During the year in which the survey was conducted, the applicable entrance fee at Midmar was R17.81 per person. This entrance fee was calculated by adding the actual gate fee of R8 with the average travel cost per person of R9.81. This meant that an individual would make 1.90 visits per annum. Figure 4.2 also indicates that at an 'entrance fee' of R9.81 (made up of the R0 gate fee and the R9.81 average travel cost), the number of visits (per annum) undertaken by a visitor will equal just over 2 visits.

4.4 The Elasticity Of Demand At Midmar, 1999

The sensitivity of quantity demanded to changes in the price of the commodity is commonly referred to as the Price Elasticity of Demand (Ped) in Economics. The price elasticity of demand is the percentage change in the quantity demanded if the price of the product changes by one percent, *ceteris paribus* (Mohr et al 2000:218). Given that the price elasticity of demand measures percentage change in quantity demanded as a result of a percentage change in the price of the product, it may be calculated as:

$$Ped = \frac{\frac{\partial Q}{Q} \times 100}{\frac{\partial P}{P} \times 100}$$

$$= \frac{\partial Q}{Q} \times \frac{\partial P}{P}$$

$$= \frac{\partial Q}{\partial P} \times \frac{P}{Q}$$

The above formulae indicates that the price elasticity of demand is calculated by the slope $\left[\frac{\partial Q}{\partial P}\right]$ of the demand curve being multiplied by the coordinates $\left[\frac{P}{Q}\right]$ at a specific point.

Linear demand curves

Mathematically, the slope of a linear demand curve, which is measured by the first derivative, $\left[\frac{\partial Q}{\partial P}\right]$ is constant throughout the curve. However, this does not mean that the elasticity of demand will be constant as the point co-ordinates $\left[\frac{P}{Q}\right]$ will vary from point to point. This implies that at various points on a linear demand curve, the price elasticity of demand will vary.

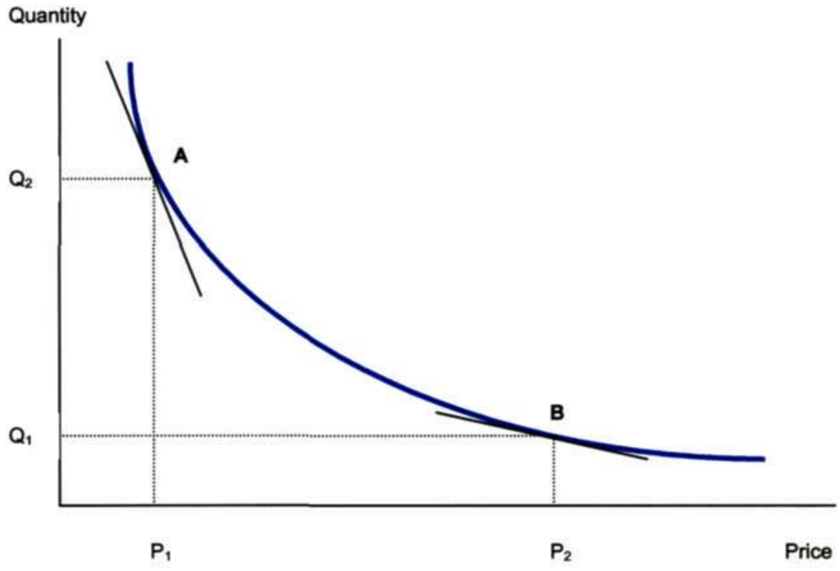
When comparing two linear demand curves at a specific point, the steeper the slope of the demand curve, the less sensitive or *inelastic*, would be the demand. The flatter the demand curve, the more sensitive or *elastic* would be the demand. An inelastic demand curve will lead to a situation where the price change leads to a proportionally smaller change in quantity demanded, while an elastic demand curve will lead to a situation where a price change leads to a proportionally greater change in quantity demanded.

Double-log demand curves

The price elasticity of demand in double-log functions are relatively easy to calculate. In this case, the price elasticity of demand remains constant throughout the curve and does not matter at which point a reading is taken. This is due to the change in the slope of the curve being fully or perfectly 'compensated' by the change in the co-ordinates. This means that, although the slope at point A on Figure 4.2 is different from that taken at point B, the accompanied change in the ratio of the coordinates exactly or perfectly compensates for this.

In other words, the decrease in the slope $\left[\frac{\partial Q}{\partial P}\right]$ of the curve as one moves from point A to B, is compensated by the accompanied increase in the ratio $\left[\frac{P}{Q}\right]$ of the coordinates. Therefore, in the case of a double-log function, the coefficient of the price variable indicates the price elasticity of demand.

Figure 4.2: Elasticity of Demand in Double-log Demand Curves



The price elasticity of demand in the case of Midmar measures the proportional change in the number of visits made per annum as a result of a proportional change in the entrance fee. In terms of a mathematical function, the price elasticity of demand may be calculated as:

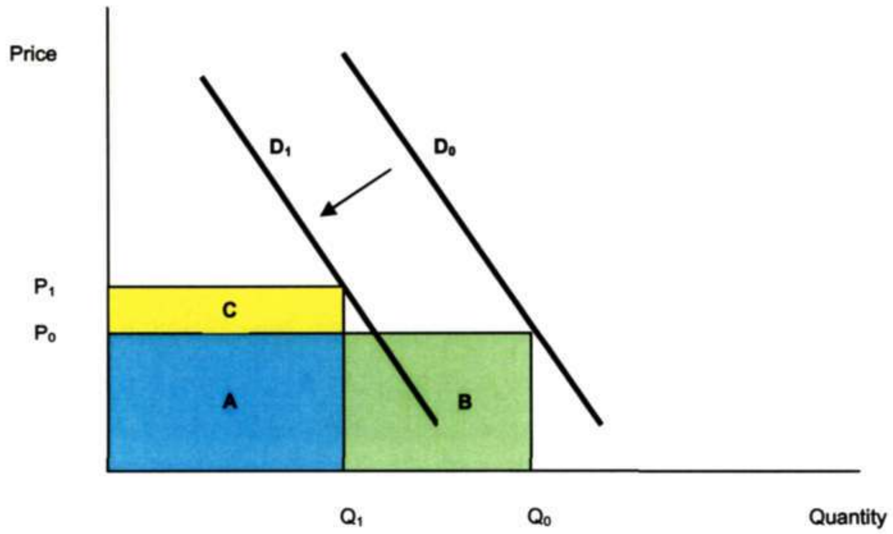
$$Ped = -\frac{\partial N}{\partial T} \cdot \frac{T}{N}$$

Given that the chosen model is a double-log function where the coefficient of the price variable equals 0.53, this means that a 10 percent increase in travel costs causes a 5.3 percent decrease in the number of visits to the site. This implies that the "price elasticity" of demand for recreation at Midmar is inelastic. That is, a proportional change in the travel cost would lead to a less than proportionate change in the number of visits per annum.

The above explanation of the elasticity of demand suggests that total revenue or entrance fee revenue which is calculated by multiplying the entrance fee by the number of visits $[TR = T \times N]$ will increase, given that demand is inelastic. This seems contrary to reality as total revenue has declined during the period 1986 to 1999 and hence deserves further elaboration.

Total revenue will only increase when price increases, *under specific conditions*, namely, when the estimated demand curve is considered stable. A demand curve is considered stable when it does not shift (either inward or outward) over time. If a demand curve shifts, then it is not considered stable and an increase in price need not necessarily lead to total revenue increasing. This is graphically illustrated in Figure 4.3. The shaded areas represent total revenue at different price levels. Prior to the price increase and the demand curve shifting, total revenue is given by adding areas A and B. Assuming that the price increases from P_0 to P_1 and the demand curve simultaneously shifting inwards from D_0 to D_1, then total revenue is now given by adding areas A and C. It can be clearly seen that the loss in total revenue (area B) from the simultaneous effects of the price increasing and the demand curve shifting inwards *is greater than* the gain in revenue (area C). This means that overall, total revenue will not increase, but rather decrease.

Figure 4.3: Influence of a Shift in the Demand Curve on Total Revenue



In the case of Midmar, the demand curve is certainly not stable. A review of the monthly visitor numbers at the resort over the period 1986 to 1999 (Table 1A in the annexure) clearly indicates that visitor numbers has fallen drastically. This is predominately due to visitor preferences and taste patterns changing over time. More specifically, whereas Midmar was a sought after venue for windsurfing (and other watersport) during the latter half of the 80's, this consumption pattern waned during the 90's. This resulted in fewer people visited Midmar, and consequently shifted the demand curve for recreation at Midmar inwards. Therefore in the case of Midmar, because the demand curve is not stable, total revenue will not increase when there is an accompanying price increase, even though the demand curve is inelastic.

The double-log model performed reasonably well in explaining the number of visits to Midmar, as well as in explaining the price elasticity of demand at Midmar. It can also be argued that, in terms of the standard statistical t and F tests, the double-log model was relatively significant. However, before accepting the double-log model as being unanimously statistical sound, certain additional statistical tests were required to ensure that the OLS assumptions were not violated. Hence, an investigation of heteroscedasticity, multicollinearity, and serial correlation of the model was undertaken, and this is recorded in the following sections.

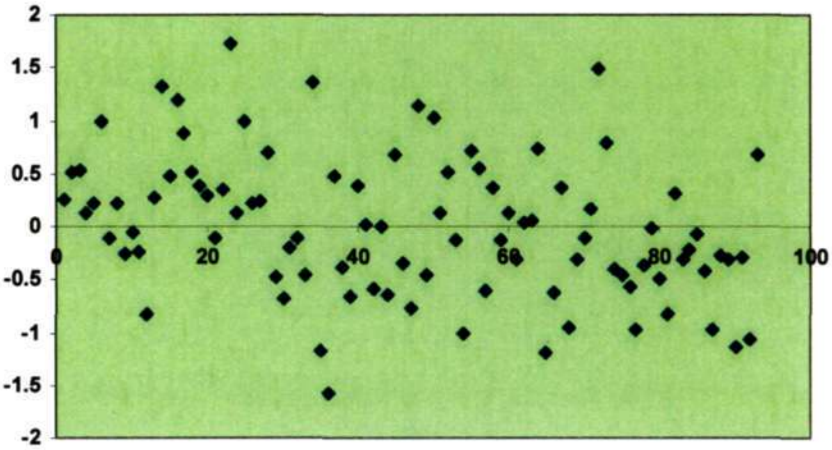
4.5 Heteroscedasticity

One of the assumptions made about OLS regressions is that there is homoscedasticity or equal variance of the residuals (u_i). Homoscedasticity can be defined as the case when "the probability distribution for any random variable u remains the same over all observations of X, and in particular that the variance of each u_i is the same for all values of explanatory variable (Koutsoyiannis 1977:181). Gujarati (1978:193) explains the assumption of homoscedasticity as when the variance of each disturbance term u_i has equal (homo) spread (scedasticity), that is, equal variance.

Strong (1983) suggests that two types of model specification, namely the quadratic and the semi-log (Lin-log) often display symptoms of heteroscedastic disturbances, and as a result, they become unsuitable postulants of ordinary least squares. Since neither of these functional forms was chosen, it can be assumed that the limitations cited by Strong need not apply.

The case of heteroscedasticity is shown by the increasing or decreasing dispersion of the observations from the regression line. Informal tests normally include a visual inspection of the residuals to detect any significant increasing or decreasing trends. The consequence of heteroscedasticity implies that the OLS estimators are no longer BLUE (best linear unbiased estimator) - that is, it can be shown that the OLS estimators are still unbiased and consistent, but they are no longer efficient. This does not mean that the model need necessarily be discarded, as the OLS estimators are still unbiased and consistent, albeit not efficient. It could also mean that 'in cases where the test statistic is significant, hetroscedasticity may not necessarily be the cause, but specification errors' (Gujarait 1995:380). Specification errors normally occur when there is an omission of a relevant variable, or when there is an inclusion of an unnecessary or irrelevant variable.

Figure 4.4: Plot of Residuals for Double-log Model



In the above plot, the residuals indicate a random distribution and therefore the regression analysis can be informally assumed to be homoscedastic and free of problems associated with heteroscedasticity. However, a more formal test was needed in order to detect the presence of hetroscedasticity. While there are many tests (Park test; Glejser test; Spearman's rank correlation test; Goldfeld-Quandt test) that can be applied, the White's hetroscedasticity test was selected for this study.

This test involved a regression of the square of the residuals u_i^2 (from the original regression) with the original explanatory variables, the square of the original explanatory variables, and the cross products of the regressors in an auxiliary regression, and deriving an auxiliary R^2. This auxiliary R^2 was then multiplied by the sample size and the calculated value was then compared to the critical value using the Chi-square distribution. The full calculations for the White's test for hetroscedasticity can be found in Annexure 2A.

In comparing the calculated value (13.8012) with the critical value (16.9190), the null hypothesis that there is no hetroscedasticity was not violated, and hence the model can be considered to be homoscedastic. It suggests that the OLS estimators within the double-log model are efficient, unbiased and consistent.

4.6 Multicollinearity

Multicollinearity is used to denote the presence of linear relationships (or near linear relationships) among explanatory variables. If the explanatory variables are perfectly linearly correlated, that is, if the correlation coefficient for these variables is equal to unity, the parameters become indeterminate: it is impossible to obtain numerical values for each parameter separately and the method of least squares breaks down (Koutsoyiannis 1977:233). The term muticollinearity is due to Ragnar Frisch and means the existence of a "perfect" or exact, linear relationship among some or all explanatory variables of a regression model (Gujarati 1978:171). Even if multicollinearity is very high, the OLS estimators still retain the property of BLUE. However, with multicollinearity in a function, there is the danger of mis-specification, because a variable whose standard errors appear high may be rejected, although this variable is an important determinant of the dependent variable (Koutsoyiannis 1977:237).

While there is no formal test for multicollinearity, a study of the matrix of partial correlation coefficients between all pairs of the independent variables is normally used to determine whether the model has any effects of multicollinearity. However, Gujarati (1978:182) points out that, although a study of partial correlations may be useful, there is no guarantee that they will provide an unfailing guide for multicollinearity. In Table 4.2, the partial correlation coefficients for the double-log model are provided. It appears from the table that the double-log regression model is free of multicollinearity since most research conducted suggests that a correlation coefficient (between variables) of greater than 0.5 implies some degree of multicollinearity.

Gujarati (1978) suggests that, if the model has traces of multicollinearity, then by either performing a ridge regression, transforming the variables, or combining the variables, the problem of multicollinearity may be alleviated. Fortunately, the double-log model considered in this dissertation is free from the problems of multicollinearity and hence, no transformation was required.

Table 4.2: Partial correlation coefficients [4]

Partial Correlations				
Variable	**Travel cost**	**Fishing**	**Watersport**	**Number of visits**
Travel Cost	1.00	-0.16	-0.27	-0.56
Fishing	-0.16	1.00	0.01	0.33
Watersport	-0.27	0.01	1.00	0.52
Number of visits	-0.56	0.33	0.52	1.00

4.7 Serial Correlation

Serial correlation occurs when there exists some relationship between the successive residuals. Formally, serial correlation in the residuals implies that the successive values of the random variable *u* are temporally independent, that is, the value which *u* assumes in any one period is independent from the value it assumed in any previous period (Koutsoyiannis 1977:200). Gujarati (1978:219) defines correlation as a relationship between members of series of observations ordered in time (as in time series data) or space (as in cross sectional data).

While it is common practice to treat the terms 'autocorrelation' and 'serial correlation' synonymously, some authors such as Tintner (1965:187) prefer to distinguish the two terms. Tintner defines autocorrelation as 'lag correlation of a given series with itself, lagged by a number of time units' whereas he defines serial correlation as 'lag correlation between two different series'. For the purposes of this dissertation, the two terms will be taken as being synonymous.

[4] The variables Travel cost and Number of visits were transformed using their natural logarithms.

When the disturbance term exhibits serial correlation, the values as well as the standard errors of the parameters are affected. Therefore, the residual variance σ^2 is likely to underestimate the true σ^2. The result of this would be that although the OLS estimators will remain unbiased as well as consistent, they are no longer efficient. As a result, the usual *t* and *F* stats cannot be legitimately applied.

Various tests for serial correlation (Durbin Watson, von Neumann, etc) have been suggested by different authors with varying degrees of success. Perhaps the most successful of all tests is the Durbin Watson *d* test and hence, this test was used. Although most statistical packages automatically calculate the Durbin Watson *d* statistic, this statistic was manually calculated, and then compared to the one generated by the statistical package. The Durbin Watson *d* statistic was calculated using the following formula which was suggested by Gujarati (1995:421).

$$d = \frac{\sum_{t=2}^{t=n} (\hat{u}_t - \hat{u}_{t-1})^2}{\sum_{t=2}^{t=n} \hat{u}_t^2}$$

The calculation of the Durbin Watson *d* statistic can be found in Annexure 3A of the dissertation. It should be noted that the calculated *d* was identical to the computer generated statistic. The calculated *d* (1.764) and the critical *d* values obtained from the Durbin Watson tables (for 93 observations and 3 explanatory variables) were compared. The lower limit (d_L) was 1.602 while the upper limit (d_U) was 1.732. In order to make a decision regarding serial correlation, the following decision table (Table 4.3) taken from Gujarati (1995:423) was also used.

Table 4.3: Durban-Watson *d* test: Decision rules

Null Hypothesis	Decision	If
No positive autocorrelation	Reject	0 < d < dL
No positive autocorrelation	No decision	dL ≤ d ≤ dU
No negative autocorrelation	Reject	4 - dL < d < 4
No negative autocorrelation	No decision	4 - dU ≤ d ≤ 4 - dL
No autocorrelation, positive or negative	Do not reject	dU < d < 4 - dU

Source: Gujarati 1995.

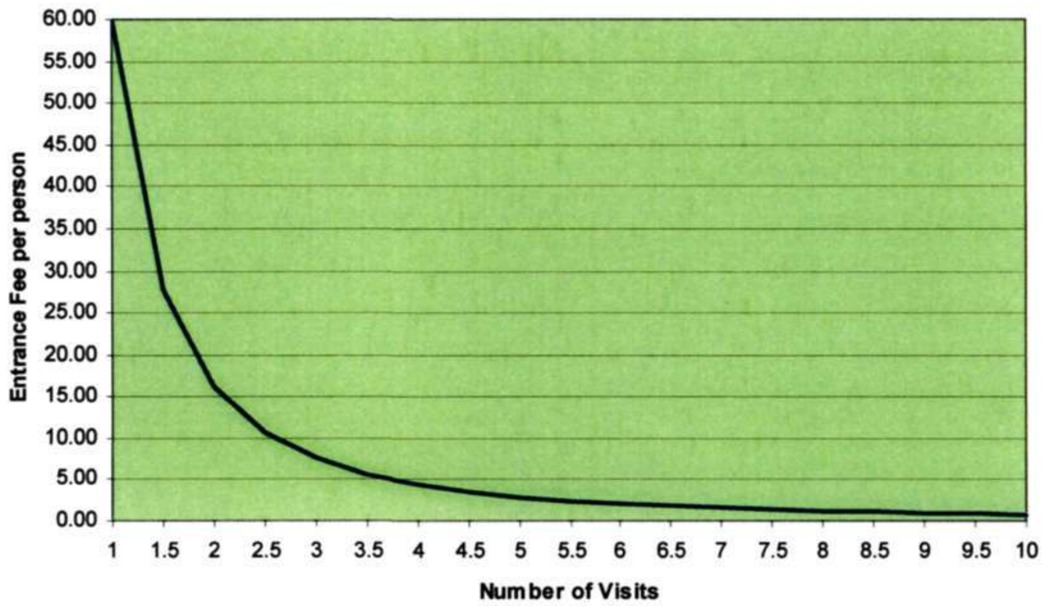
Using the decision table, it is evident that the calculated *d* is greater than the upper limit d_U, but less than 4 - d_U . This means that the null hypothesis of no autocorrelation, positive or negative cannot be rejected, and consequently, the double-log model can be considered to be free from autocorrelation. This is considered important as now the model can be considered to be not only unbiased and consistent, but efficient as well and that the normal *t* and *F* tests may be legitimately applied in the results.

4.8 Estimation Of The Demand Function

The visitation rate equation is useful for estimating the elasticity of demand, but for the purpose of determining consumer surplus, the equation is transformed into the more familiar relationship with price as the dependent variable, and number of visits as the explanatory variable. This is easily achieved by inverting the visitation rate equation to read as follows:

$$LnT = 4.094 - 1.887\,LnN$$

Figure 4.5 Demand Curve for recreation at Midmar 1999



This also means that the horizontal and vertical axes of the visitation rate function depicted in Figure 4.1 will be inverted, and this transformed relationship is now captured graphically in Figure 4.5.

Figure 4.5 depicts the relationship with the entrance fee on the vertical axis and the number of visits on the horizontal axis. This does not change the relationship between the two variables but merely illustrates it in more conventional terms. As previously explained, as the entrance fee approaches R50, visits per person per annum approaches 1 visit while as the entrance fee approaches R1, the number of visits per person per annum approaches 8.75 visits. The model also predicts that the visitor will undertake exactly 1 visit when the entrance fee equals R59.98 (see annexure 4A). In between this interval, the function is non-linear.

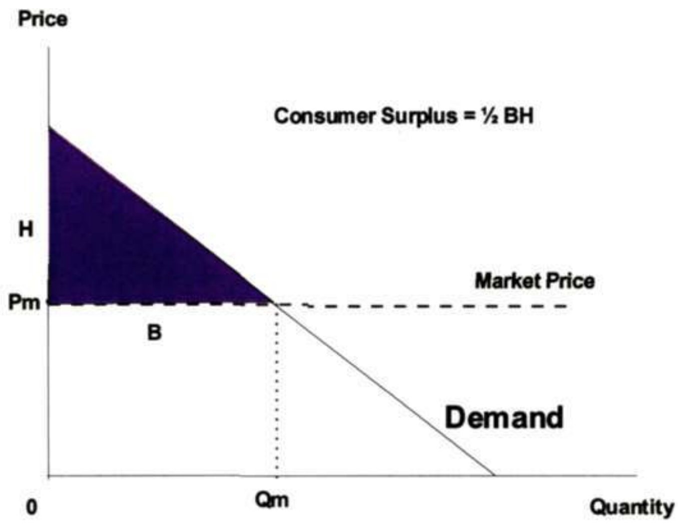
4.9 Consumer Surplus

According to Johannson (1999:747) the concept of consumer surplus was firstly introduced by Dupuit ([1844] 1933) in his paper *De l'utilite et de la mesure*, who was concerned with the costs and benefits of constructing a bridge. Marshall (1920:124) then introduced the concept to the English-speaking world when he defined consumer surplus as 'the excess of the price which he would be willing to pay rather than go without the thing, over that which he actually does pay is the economic measure of this surplus of satisfaction'.

Consumer surplus can be defined as the difference between what consumers pay and the value or utility they receive (Mohr et al 2000:259). In Figure 4.6, this is represented by the shaded region or area. That is, although the market price is P_m, some consumers are willing to pay more than P_m. When no entry fee is levied, the consumer surplus (economic benefit) is measured by the area under the demand curve. When an entry fee is levied, then the consumer surplus becomes the net area which falls under the demand curve, but above the price line (P_m in Figure 4.6).

When one derives the demand curve through the use of the Travel Cost method, it is important to realise that the economic benefit to consumers is represented by the area under the demand curve and above the *actual* price level (where the actual price is often an *underestimation* of the true value as it does not reflect the true costs associated with producing the product), and not the area under the demand curve and above the *optimal* or true price level.

Figure 4.6: Consumer Surplus



Consumer surplus represents a benefit to society, given that some consumers of the product (a recreational visit to Midmar) would be willing to pay a higher price for the use or consumption of that product, but would only pay the 'market' price. For example, some consumers indicated that they would be willing to pay an entrance fee (accepting that the travel cost to the recreational site can be taken to be a proxy for the entrance fee to the recreational site) of R20 in order to gain entry to the recreational site, but actually only pay the 'market' price of R8. This implies that the consumer values the product in excess of what he actually pays for the product, and therefore enjoys a net benefit of R12. This net benefit that the consumer enjoys represents the consumer surplus of the product. Therefore, given a market demand curve for any product and given the actual price paid for the use or consumption of that product, the total consumer surplus of that product will be given by the area above the price but below the demand curve (Figure 4.6). Consumer surplus is seen as a measure of welfare enjoyed by society.

Johannson (1999:747) highlight that, measuring the consumer surplus as an area to the left of an ordinary or Marshallian demand curve, yields what is known as the ordinary, or uncompensated, or Marshallian consumer surplus. Hicks (1940) and Henderson (1940) demonstrate that consumer surplus could be interpreted in terms of the amounts of money that must be given/taken from an individual.

The Hicksian or income-compensated consumer surplus is measured as an area to the left of a compensated or Hicksian demand curve of the individual. The Hicksian demand curves explain consumer surplus through the use of *compensating variation* and *equivalent variation*. Compensating variation is the amount of income that would compensate a person for a price change to keep the initial utility level constant. Conversely, equivalent variation is the amount of income a person would be willing to pay to avoid a price change, so that he would have the same utility level afterwards.

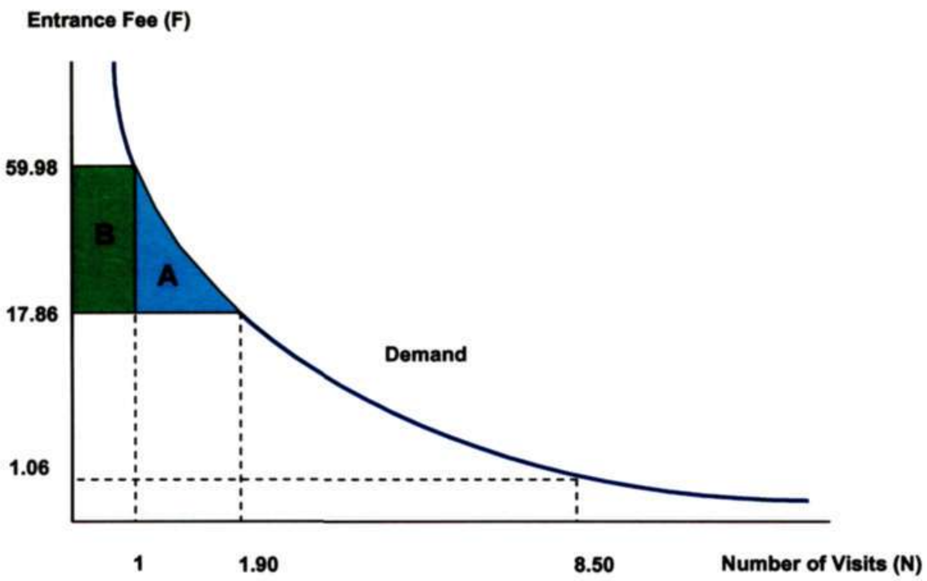
If any Marshallian demand curve is modified by holding the utility constant at its initial level, it becomes a Hicksian demand curve which excludes the income effect of a price change. Braden et al (1991) criticise the Marshallian demand curve as being a poor measure of economic welfare, because of the inclusion of the income factor in the measurement of consumer surplus.

The demand curve estimated during the survey is a Marshallian demand curve as it does not hold the utility of the visitor constant. In fact, it is expected that as the entrance fee increases, the utility derived from a visit to the resort changes. This change in utility is not compensated for within the model. Further, personal income is not included in the model when measuring consumer surplus, and hence the demand curve can be considered to be a Marshallian demand curve.

The calculation of the consumer surplus is relatively straightforward for a linear demand model, while it is more complicated for non-linear functions. In Annexure 5A, a detailed description of the procedures and calculations for estimating the consumer surplus is provided. While linear demand models require a simple mathematical procedure of finding the area of the triangle above the price level, non-linear functions require the mathematical procedure of integration.

As mentioned previously, during 1999, the entrance fee at Midmar was R17.81 per person (made up of the summation of the R8 gate fee and the average travel cost of R9.81), which corresponded with 1.90 number of visits per annum on the predicted demand curve (Figure 4.5). Also, the demand curve illustrates that a visitor will undertake exactly 1 visit to Midmar at an entrance fee of R59.98. In other words, a visitor would be willing to pay up to a maximum of R59.98 to visit Midmar. Hence, the consumer surplus can be calculated as being the sum of areas A and B in Figure 4.7. That is, the total area between price levels R17.81 and R59.98 is the consumer surplus for Midmar.

Figure 4.7: Calculation of Consumer Surplus at Midmar, 1999.



Consequently, the resultant consumer surplus per individual visitor to Midmar during 1999 can thus be calculated to equal R71.47 or R71 per person (when rounded off to the nearest rand). The total number of visits to Midmar in 1999 was 129 908 visitors. This means that there was a total of 68 372 visitors who visited Midmar during 1999. This was calculated by dividing the total number of visits in 1999 by 1.90 visits, given that each visitor will undertake 1.90 visits per annum at an entrance fee of R17.86.

$$ConsumerSurplus = \frac{129908}{1.90}$$
$$= 68372 \times R71$$
$$= R4854412$$

If the consumer surplus attached to each visitor is accepted as R71, then the total consumer surplus for all visitors to Midmar for the year 1999 is approximately R4.9 million.

CHAPTER 5
CONCLUSION

This research has tried to convey the nature of research within Resource Economics by highlighting some of the empirical and conceptual issues associated with it. Society does not directly impute monetary values to environmental resources and, through this research, it is hoped that some interest have been generated, opening the doors for further research in South Africa.

Public sector decisions regarding the environment need to be guided by efficient and concise information and it is envisaged that this dissertation will act as a tool for investigating and analysing public sector investment by providing some meaningful information regarding the environment. The acquisition of reliable data is a fundamental necessity in any management planning process, and it is intended that this dissertation serves that purpose. This research seeks to increase managers' understanding of the economic value of biodivesity, thereby enabling them to make more efficient allocation decisions regarding the environment.

The Individual Travel Cost method (TCM) was used to investigate the nature of recreational demand at Midmar and essentially, measures of the economic value of recreation use here. In addition, an examination as to whether consumers enjoyed any consumer surplus associated with recreational demand was undertaken. The first step of the project was to determine the travel cost visitation relationship. Using this relationship, a demand curve for recreation at Midmar was then generated. Finally, the demand curve was used to determine the consumer surplus for recreational demand at Midmar.

The results of this research show that the Travel Cost method offers great potential for determining the value of biodiversity in South Africa. The dissertation has proved that recreational visitors to Midmar do enjoy a consumer surplus when they visit. It was calculated that visitors to Midmar enjoy a consumer surplus of approximately R71 per visit. Given that a total of 68 372 individuals visited Midmar during 1999, the resultant total consumer surplus therefore amounted to R4.9 million.

Although the TCM has been widely accepted, estimates from particular studies can easily understate or overstate the consumer surplus attached to a particular recreation site. In order to detect whether the estimates provided in this dissertation are in keeping with research carried out elsewhere, the estimates have been compared to estimates from other TCM studies. It is quite clear that estimates vary considerably.

Table 5.1: Travel Cost Estimates[5] from other studies

Researcher	Study Area	Travel Cost Estimate
Ulph et al, 1981	Warrumbungles, NSW	A$ 312.50
Amirfathi et al, 1987	Northern Utah, USA	A$ 245.41
Hanley, 1989	Queen Elizabeth Forest, Scotland	A$ 1.06
Bell et al, 1990	Florida, USA	A$ 70.83
Maille et al, 1993	Beza Mahafaly Reserve, Madagascar	A$ 457.07
James et al, 1993	Gerringong-Gerroa, NSW	A$ 123.36
Bennet, 1995	Dorringo National Park, Aus	A$ 35.79
Bennet, 1995	Gibraltar National Park, Aus	A$19.00
Gillespie, 1997	Minnamurra Rainforest, Aus	A$ 29.47

A consumer surplus of R71 equals A$14.48[6] Australian dollars, and it is clear that the consumer surplus derived for Midmar resort is in keeping with other studies undertaken elsewhere, as the estimate lies within the range derived in other studies.

It is important to realise that all research suffers some limitations. In this case, the absence of substitute effects in the model might have overestimated the consumer surplus. For example, if individuals have a choice between two similar sites, they may not be as willing to incur higher travel costs in visiting the further site and may substitute one for the other. Hence, the demand for the further site will decline as individuals choose the closer, substitute site. This would likely influence the consumer surplus of the further site as individuals might be reluctant to spend larger amounts of money to travel.

Also, the results of this dissertation represent only a partial estimate of the total economic value (TEV) of Midmar. This is because only *use* values of Midmar were captured in the model. As indicated earlier, the total economic value of any environmental good or service is made up of *use* and *non-use* values. Therefore, although the consumer surplus estimate of R71 per person may be construed as being

[5] All travel cost estimates are quoted in 1999 Australian Dollar prices.
[6] Converted to 1999 Australian Dollar price.

high, this figure ignores *non-use* value which could have increased the economic value of Midmar even further.

Further, the travel costs that were used in the model were those reported by visitors, and many visitors could easily have overstated (or understated) their true costs. That is, visitors may likely overstate their true costs in an attempt to 'impress' the researcher. In doing so, the reported 'willingness to pay' could be higher than what it really is. In such a case, there would be an over-exaggerated demand curve and an over-estimation of consumer surplus.

Another point of concern is the question of truncation. Given that an on-site survey was carried out at Midmar, the number of visits possible was truncated to a minimum of 1 visit. That is, an instance of 0 visits per annum was not considered by the model although this may quite likely occur in reality, as some individuals may chose not to visit Midmar entirely. If these non-visitors are included in the sample, the consumer surplus estimates could decrease substantially.

However, having flagged some of the concerns, it is acceptable that the consumer surplus estimate derived by the model is still realistic. Visitors enjoy a consumer surplus when they visit Midmar and it follows that the actual price paid by visitors underestimates the true value attached in visiting Midmar. Park management needs to be aware of this and adjust the entrance fees accordingly. This divergence between the actual fee paid by a visitor and the fee that visitors are willing to pay illustrates a possible failure of the market mechanism. That is, the market mechanism breaks down and does not provide a true valuation of the goods being consumed. As mentioned in chapter 1, recreational use of parks is considered to be quasi-public goods and therefore exhibits some of the problems of public goods. The divergence between the price that consumers are willing to pay and the actual price is a common problem associated with public or quasi-public goods.

Throughout this study, it can be seen that the entrance fee currently being charged at Midmar is lower than the amount that visitors are willing to pay. However, given the pressures of falling visitor numbers, park management may see fit to charge lower prices in order to attract more visitors. It is evident from the survey that only a small segment of the market visits the resort regularly. These are normally the people living close to the resort, or avid recreationists. The majority of visitors visit the resort infrequently, perhaps once a year.

The entrance fee that park management wishes to charge will depend heavily on what focus they wish to pursue. If they choose to maximise economic gain and sacrifice biodiversity conservation, then they may lower prices or leave prices the same. If, on the other hand, they wish to maximise biodiversity conservation, and sacrifice economic gain, then an increase in the entrance fee is recommended. This will have the effect of decreasing visitor numbers and applying less pressure on the environment.

This dissertation has also determined the price elasticity of demand at Midmar. It has confirmed that an increase in entrance fees would result in a decrease in the number of visits made to Midmar by recreationists. In addition, it has concluded that the price elasticity of demand of 0.53 exists at Midmar, which suggests that the demand for recreation at Midmar is inelastic. That is, demand is not price sensitive and a 10 percent change in the entrance fee would lead to a 5.3 percent decrease in the number of visits per annum. Therefore, it can be concluded that an increase in the entrance fee would exacerbate the problem of declining visitor numbers at the resort.

Finally, the indigenous Cree people of the United States of America have a beautiful proverb that succinctly encapsulates the argument for the better management of the environment. It states that "*only when the last tree has died, and the last river been poisoned, and the last fish been caught, will we realise that we cannot eat money*". Let us be wary of this before it is too late.

ANNEXURES

Table 1A: Monthly Visitor Numbers at Midmar (1986 – 1999)

Year	1986	1987	1988	1989	1990	1991	1992
Month							
Jan	43942	44338	38820	32946	22877	24764	24422
Feb	38710	44284	31771	29054	29988	29870	28797
March	49543	39013	18643	36779	15956	22858	17978
April	21550	39861	27895	18395	23406	22725	25788
May	20864	34427	15899	12402	12585	13836	13834
June	12479	11039	9785	5364	7992	7291	7884
July	14212	10675	10662	11888	8382	10046	10439
Aug	20399	13070	14287	11444	8160	11962	13264
Sept	25504	12975	16581	15273	11804	13653	6831
Oct	30611	21094	28107	16531	14568	15839	19861
Nov	24320	21376	21615	13198	16062	15923	15888
Dec	65536	43845	41511	36184	25278	38629	27428
Total	367670	335997	275576	239458	197058	227396	212414

Year	1993	1994	1995	1996	1997	1998	1999
Month							
Jan	26186	24493	21118	19759	17088	16031	13928
Feb	28388	26954	30192	27568	30169	32149	31066
March	14059	17848	13983	12595	14829	12251	11660
April	18712	19545	17684	19408	10003	16116	14264
May	11621	8785	7388	7811	5633	5940	4665
June	4886	5748	4537	4650	3663	3174	3794
July	7762	6323	6542	3424	4969	4256	4556
Aug	7617	9305	14408	5744	6350	5991	6135
Sept	12056	20840	11915	8980	8999	8714	10200
Oct	10733	16696	8841	6673	8995	8306	6817
Nov	12833	13634	6734	9341	14529	8801	8560
Dec	23894	24822	17812	31439	25086	16633	14263
Total	178747	194993	161154	157392	150313	138362	129908

ANNEXURES

Table 2A: White's Test for Hetroscedasticity

Regression Statistics	
Multiple R	0.2317
R Square	0.1484
Adjusted R Square	0.1187
Standard Error	0.5374
Observations	93

Analysis of Variance

	df	*Sum of Squares*	*Mean Square*	*F*	*Significance F*
Regression	7	7.4012	1.0573	3.6612	0.0017
Residual	85	24.5473	0.2888		
Total	92	31.9485			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95.00*	*Upper 95.00*
Intercept	1.6836	0.4846	3.4741	0.0008	0.7200	2.6471
Travel Cost	-0.1506	0.3618	-0.4162	0.6782	-0.8700	0.5688
Fishing	-0.6228	0.2296	-2.7127	0.0080	-1.0794	-0.1663
Watersport	-0.2590	0.2202	-1.1759	0.2427	-0.6969	0.1789
Travel Cost (Squared)	0.0067	0.0827	0.0815	0.9352	-0.1576	0.1711
Fishing (Squared)	0.1016	0.0394	2.5817	0.0114	0.0234	0.1799
Watersport (Squared)	0.0270	0.0371	0.7292	0.4677	-0.0467	0.1008
Cross Product	0.0000	0.0000	4.2918	0.0000	0.0000	0.0000

Calculation:

Whites test for hetroscedasticity = 0.1484 x 93

= **13.801**

ANNEXURES

Table 3A: Calculation of the Durbin Watson *d* Statistic

Residuals	Difference	Difference Squared	Residuals Squared
0.264881117	-0.242903345	0.059002035	0.070162006
0.507784462	-0.030199915	0.000912035	0.25784506
0.537984377	0.413732664	0.171174717	0.28942719
0.124251713	-0.101551711	0.01031275	0.015438488
0.225803424	-0.769745332	0.592507876	0.050987186
0.995548755	1.108667539	1.229143713	0.991117325
-0.113118784	-0.336660271	0.113340138	0.012795859
0.223541487	0.472884845	0.223620076	0.049970797
-0.249343357	-0.198520529	0.0394104	0.06217211
-0.050822829	0.19260049	0.037094949	0.00258296
-0.243423319	0.587192178	0.344794654	0.059254912
-0.830615497	-1.110918046	1.234138906	0.689922104
0.280302549	-1.047505647	1.097268079	0.078569519
1.327808196	0.856916723	0.73430627	1.763074605
0.470891473	-0.730296469	0.533332932	0.221738779
1.201187942	0.322042907	0.103711634	1.442852471
0.879145035	0.358263696	0.128352876	0.772895992
0.520881339	0.135610156	0.018390114	0.271317369
0.385271183	0.08846338	0.00782577	0.148433884
0.296807803	0.409878935	0.168000742	0.088094872
-0.113071133	-0.456285242	0.208196222	0.012785081
0.343214109	-1.390059195	1.932264566	0.117795925
1.733273304	1.596194633	2.547837306	3.004236346
0.137078671	-0.851217158	0.724570651	0.018790562
0.988295829	0.762821242	0.581896247	0.976728647
0.225474587	-0.011432308	0.000130698	0.05083879
0.236906895	-0.469004884	0.219965581	0.056124877
0.705911779	1.190073706	1.416275425	0.49831144
-0.484161926	0.193093389	0.037285057	0.234412771
-0.677255315	-0.470274963	0.221158541	0.458674762
-0.206980352	-0.10378692	0.010771725	0.042840866
-0.103193433	0.358358095	0.128420524	0.010648885
-0.461551528	-1.814076529	3.290873653	0.213029813
1.352525002	2.518244933	6.34155754	1.82932388
-1.165719931	0.414308721	0.171651717	1.358902957
-1.580028652	-2.055092009	4.223403166	2.496490542
0.475063357	0.85230229	0.726419194	0.225685193
-0.377238934	0.277174013	0.076825434	0.142309213
-0.654412947	-1.047970265	1.098241676	0.428256305
0.393557318	0.377665453	0.142631194	0.154887363
0.015891865	0.597247429	0.356704491	0.000252551
-0.581355564	-0.578570701	0.334744056	0.337974292
-0.002784863	0.636082911	0.404601469	7.75546E-06
-0.638867773	-1.30948468	1.714750126	0.408152032
0.670616906	1.024234258	1.049055816	0.449727035
-0.353617352	0.414794867	0.172054781	0.125045232
-0.768412219	-1.897793669	3.60162081	0.590457338
1.12938145	1.583407373	2.507178907	1.27550246

-0.454025922	-1.475113755	2.175960591	0.206139538
1.021087833	0.901046433	0.811884675	1.042620363
0.1200414	-0.397215325	0.157780014	0.014409938
0.517256725	0.654725041	0.42866488	0.267554519
-0.137468316	0.869614788	0.75622988	0.018897538
-1.007083105	-1.730870449	2.995912512	1.01421638
0.723787344	0.16810848	0.028260461	0.52386812
0.555678864	1.160075223	1.345774522	0.308779
-0.604396358	-0.967546483	0.936146198	0.365294958
0.363150125	0.500618441	0.250618824	0.131878013
-0.137468316	-0.273657117	0.074888218	0.018897538
0.1361888	0.44773433	0.20046603	0.018547389
-0.31154553	-0.339771704	0.115444811	0.097060617
0.028226174	-0.028980475	0.000839868	0.000796717
0.057206649	-0.684409938	0.468416963	0.003272601
0.741616587	1.940447415	3.765336172	0.549995162
-1.198830828	-0.56770864	0.3222931	1.437195355
-0.631122188	-0.993467624	0.98697792	0.398315217
0.362345436	1.309807459	1.715595579	0.131294215
-0.947462023	-0.638422039	0.4075827	0.897684285
-0.309039984	-0.204682565	0.041894952	0.095505712
-0.104357419	-0.26202029	0.068654632	0.010890471
0.157662871	-1.333409823	1.777981757	0.024857581
1.491072694	0.696522223	0.485143207	2.223297779
0.794550471	1.199383599	1.438521019	0.631310451
-0.404833128	0.047946559	0.002298873	0.163889862
-0.452779688	0.117520056	0.013810964	0.205009445
-0.570299744	0.405680624	0.164576769	0.325241798
-0.975980368	-0.603733939	0.364494669	0.952537678
-0.372246429	-0.355075048	0.126078289	0.138567404
-0.017171381	0.474078097	0.224750042	0.000294856
-0.491249478	0.339366019	0.115169295	0.24132605
-0.830615497	-1.144028944	1.308802224	0.689922104
0.313413447	0.622453431	0.387448274	0.098227989
-0.309039984	-0.097193637	0.009446603	0.095505712
-0.211846347	-0.141546955	0.020035541	0.044878875
-0.070299391	0.357695991	0.127946422	0.004942004
-0.427995382	0.549092182	0.301502225	0.183180047
-0.977087565	-0.697895894	0.487058679	0.954700109
-0.279191671	0.029848313	0.000890922	0.077947989
-0.309039984	0.835771812	0.698514521	0.095505712
-1.144811796	-0.855277184	0.731499061	1.310594048
-0.289534612	0.780851502	0.609729069	0.083830292
-1.070386114	-1.741003021	3.031091518	1.145726434
0.670616906			0.449727035
Sum		**71.57014068**	**40.5509813**

$$d = \frac{\sum_{t=2}^{t=n} (\hat{u}_t - \hat{u}_{t-1})^2}{\sum_{t=2}^{t=n} \hat{u}_t^2} = \frac{71.57014}{40.55098} = 1.764942$$

ANNEXURES

Table 4A: Prediction of the number of visits

Ln N = 2.17 - 0.53 Ln T

No of Visits	Ln No of Visits	Constant		Coefficient	Ln of Travel Cost	Travel Cost
8.75	2.17	2.17	0	-0.53	0	1
6.07	1.80	2.17	-0.37	-0.53	0.69	2
4.89	1.59	2.17	-0.58	-0.53	1.10	3
4.20	1.44	2.17	-0.73	-0.53	1.39	4
3.73	1.32	2.17	-0.85	-0.53	1.61	5
3.39	1.22	2.17	-0.95	-0.53	1.79	6
3.12	1.14	2.17	-1.03	-0.53	1.95	7
2.91	1.07	2.17	-1.10	-0.53	2.08	8
2.73	1.01	2.17	-1.16	-0.53	2.20	9
2.58	0.95	2.17	-1.22	-0.53	2.30	10
2.46	0.90	2.17	-1.27	-0.53	2.40	11
2.35	0.85	2.17	-1.32	-0.53	2.48	12
2.25	0.81	2.17	-1.36	-0.53	2.56	13
2.16	0.77	2.17	-1.40	-0.53	2.64	14
2.08	0.73	2.17	-1.44	-0.53	2.71	15
2.01	0.70	2.17	-1.47	-0.53	2.77	16
1.95	0.67	2.17	-1.50	-0.53	2.83	17
1.89	0.64	2.17	-1.53	-0.53	2.89	18
1.84	0.61	2.17	-1.56	-0.53	2.94	19
1.79	0.58	2.17	-1.59	-0.53	3.00	20
1.74	0.56	2.17	-1.61	-0.53	3.04	21
1.70	0.53	2.17	-1.64	-0.53	3.09	22
1.66	0.51	2.17	-1.66	-0.53	3.14	23
1.63	0.49	2.17	-1.68	-0.53	3.18	24
1.59	0.46	2.17	-1.71	-0.53	3.22	25
1.56	0.44	2.17	-1.73	-0.53	3.26	26
1.53	0.42	2.17	-1.75	-0.53	3.30	27
1.50	0.40	2.17	-1.77	-0.53	3.33	28
1.47	0.39	2.17	-1.78	-0.53	3.37	29
1.44	0.37	2.17	-1.80	-0.53	3.40	30
1.42	0.35	2.17	-1.82	-0.53	3.43	31
1.40	0.33	2.17	-1.84	-0.53	3.47	32
1.37	0.32	2.17	-1.85	-0.53	3.50	33
1.35	0.30	2.17	-1.87	-0.53	3.53	34
1.33	0.29	2.17	-1.88	-0.53	3.56	35
1.31	0.27	2.17	-1.90	-0.53	3.58	36
1.29	0.26	2.17	-1.91	-0.53	3.61	37
1.27	0.24	2.17	-1.93	-0.53	3.64	38
1.26	0.23	2.17	-1.94	-0.53	3.66	39
1.24	0.21	2.17	-1.96	-0.53	3.69	40
1.22	0.20	2.17	-1.97	-0.53	3.71	41
1.21	0.19	2.17	-1.98	-0.53	3.74	42
1.19	0.18	2.17	-1.99	-0.53	3.76	43
1.18	0.16	2.17	-2.01	-0.53	3.78	44
1.16	0.15	2.17	-2.02	-0.53	3.81	45
1.15	0.14	2.17	-2.03	-0.53	3.83	46

1.14	0.13	2.17	-2.04	-0.53	3.85	47
1.13	0.12	2.17	-2.05	-0.53	3.87	48
1.11	0.11	2.17	-2.06	-0.53	3.89	49
1.10	0.10	2.17	-2.07	-0.53	3.91	50
1.09	0.09	2.17	-2.08	-0.53	3.93	51

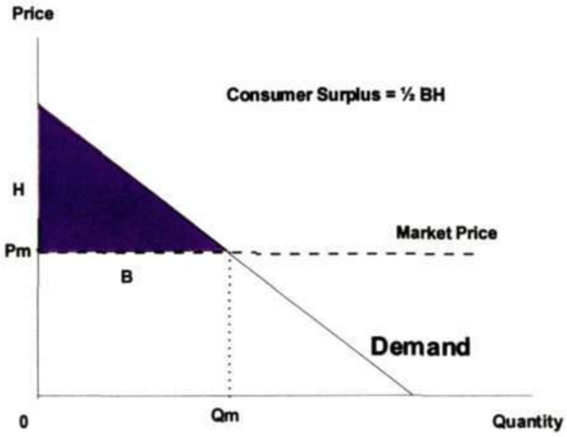
Ln T = 4.094 - 1.887 Ln N

Travel Cost	Ln of Travel Cost	Constant		Coefficient	Ln No of Visits	No of Visits
59.98	4.09	4.094	0.00	-1.887	0.00	1
27.91	3.33	4.094	-0.77	-1.887	0.41	1.5
16.22	2.79	4.094	-1.31	-1.887	0.69	2
10.64	2.36	4.094	-1.73	-1.887	0.92	2.5
7.55	2.02	4.094	-2.07	-1.887	1.10	3
5.64	1.73	4.094	-2.36	-1.887	1.25	3.5
4.38	1.48	4.094	-2.62	-1.887	1.39	4
3.51	1.26	4.094	-2.84	-1.887	1.50	4.5
2.88	1.06	4.094	-3.04	-1.887	1.61	5
2.40	0.88	4.094	-3.22	-1.887	1.70	5.5
2.04	0.71	4.094	-3.38	-1.887	1.79	6
1.75	0.56	4.094	-3.53	-1.887	1.87	6.5
1.53	0.42	4.094	-3.67	-1.887	1.95	7
1.34	0.29	4.094	-3.80	-1.887	2.01	7.5
1.19	0.17	4.094	-3.92	-1.887	2.08	8
1.06	0.06	4.094	-4.04	-1.887	2.14	8.5
0.95	-0.05	4.094	-4.15	-1.887	2.20	9
0.86	-0.15	4.094	-4.25	-1.887	2.25	9.5
0.78	-0.25	4.094	-4.34	-1.887	2.30	10

ANNEXURES

Table 5A: Calculation of Consumer Surplus

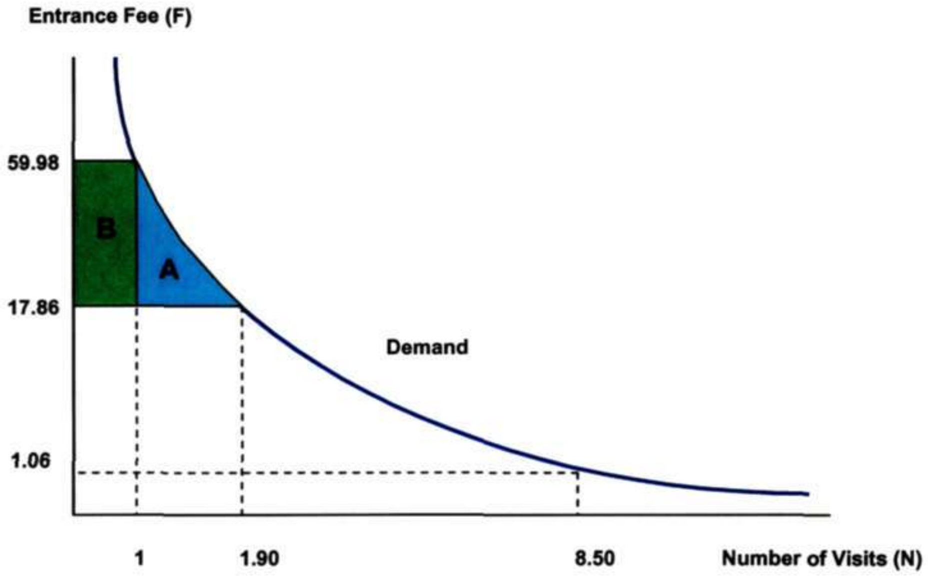
Linear Models:



$$ConsumerSurplus = \frac{1}{2}base \times height$$

$$= \frac{1}{2}BH$$

Non Linear Models:



The following mathematical procedure is used to calculate area A in the above diagram:

$$LnF = a + bLnN$$
$$F = e^{(a+bLnN)}$$
$$F = e^{a}e^{bLnN}$$
$$F = e^{a}e^{LnN^{b}}$$
$$F = e^{a}N^{b}$$

Hence:

$$\int FdN = e^{a}N^{b}$$
$$e^{a}\int FdN = N^{b}$$
$$e^{a}.\frac{N^{b+1}}{b+1}$$

Therefore, given $LnF = 4.094 - 1.887LnN$,

Area A:

$$A = e^{4.094}.\frac{N^{-0.887}}{-0.887}\Big[_{1.00}^{1.90}$$
$$A = e^{4.094}\left(\frac{1.90^{-0.887} - 1.00^{-0.887}}{-0.887}\right)$$
$$A = R29.35$$

Area B:

$$B = lenght \times breath$$
$$B = R42.12 \times 1.00$$
$$B = R42.12$$

Total Area (A + B): R29.35 + R 42.12 = **R71.47**

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