THE MANAWATU RIVER WATER QUALITY IMPROVEMENT PROJECT: AN ECONOMIC POLICY STUDY

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ABSTRACT

Rivers are open access, environmental amenities from which the public derives a wide range of economic benefits. Because rivers are public amenity resources, with public good characteristics, they are often managed by governments. Policies that govern such public amenities should aim at allocating the resources to achieve their highest valued use. To achieve this aim resource managers need to consider the total costs and benefits that society might incur or gain as a result of implementing the policies. Some costs and benefits that society incur as a result of policies are not observed explicitly in the market place. These costs and benefits are often overlooked in policy formulation.

The management of the Manawatu River is a responsibility of the Manawatu-Wanganui Regional Council. It is hoped that if the public complies with council policies affecting the river, society's needs may be met. However, if these policies are implemented without considering society's preferences, implicit costs are likely to be imposed on society. Involvement of the public in the decision making process is one way of ensuring that society's preferences are considered, and upholds decision makers accountability and transparency in resource allocation.

This study aimed at measuring the nonmarket benefits in dollars that the public places on improved water quality in the Manawatu River using the contingent valuation method. A total of 1500 households in the Manawatu River catchment area were sent a mail questionnaire to elicit their willingness-to-pay for water improvement in the river. A return rate of 25% was obtained.

The results show that 69% of the households visit the river during the summer spending their time participating in non-rigorous activities. Lack of interest in river related activities may be one of the most important factors that hinders households' visitation to the river, rather than pollution. The lack of interest may be due to a poor general river environment. The majority of households are unlikely to alter their visitation habits to the river even if water quality was improved. Nevertheless they place a collective value ranging from $2,002,652 - $4,084,747 per year on improved water quality in the Lower Manawatu River.

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To my God and Lord I dedicate all that I have achieved in my studies.

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CHAPTER ONE

SURVEY BACKGROUND AND INCENTIVE

1.1 INTRODUCTION

Rivers fall into a group of public goods classified as common property resources. One distinctive characteristic of public goods is that they are non-rival in consumption. This means that individuals already using the good do not experience substantial loss of benefits as a result of the additional user. Public goods are also non-excludable. This means such goods are completely and freely accessible to anybody that would like to use them. The policy issue that arises from the nature of such goods is that they offer little incentive to private individuals to produce or preserve them, even when it would benefit everybody. The result is an inefficient utilization of the resource. As the demand for such goods or services increases, conflicts arise between interested parties, who usually compete to use as much of the resource as possible (Stokey and Zeckhauser, 1978). This is a situation of market failure and the Manawatu River being a common property resource exhibits such conflicts in its use as will be discussed below.

The Manawatu River is located in the lower central region of the North Island in New Zealand (See map in figure 1.1). The land alongside the river has always supported a dense population of people as compared to the surrounding areas, according to McLennan and O'Connor (1985), from the time it was first settled. This is largely due to the important role the river plays in the economy of the Manawatu region (McLennan and Reid, 1984). The Manawatu River and its tributaries fall within the jurisdiction of the Manawatu-Wanganui Regional Council (MWRC).

One of the earliest recorded conflicts of use of the Manawatu River goes back to the 1970s. The Motor Launch Regulation 1962, requires that boating speed in rivers be no greater than 8 km/hr. In 1970, an application by the New Zealand Jet Boat Association (NZJBA) to have the speed restriction uplifted was strongly opposed by the Manawatu Fresh Water Anglers Club. The NZJBA submission was based on the

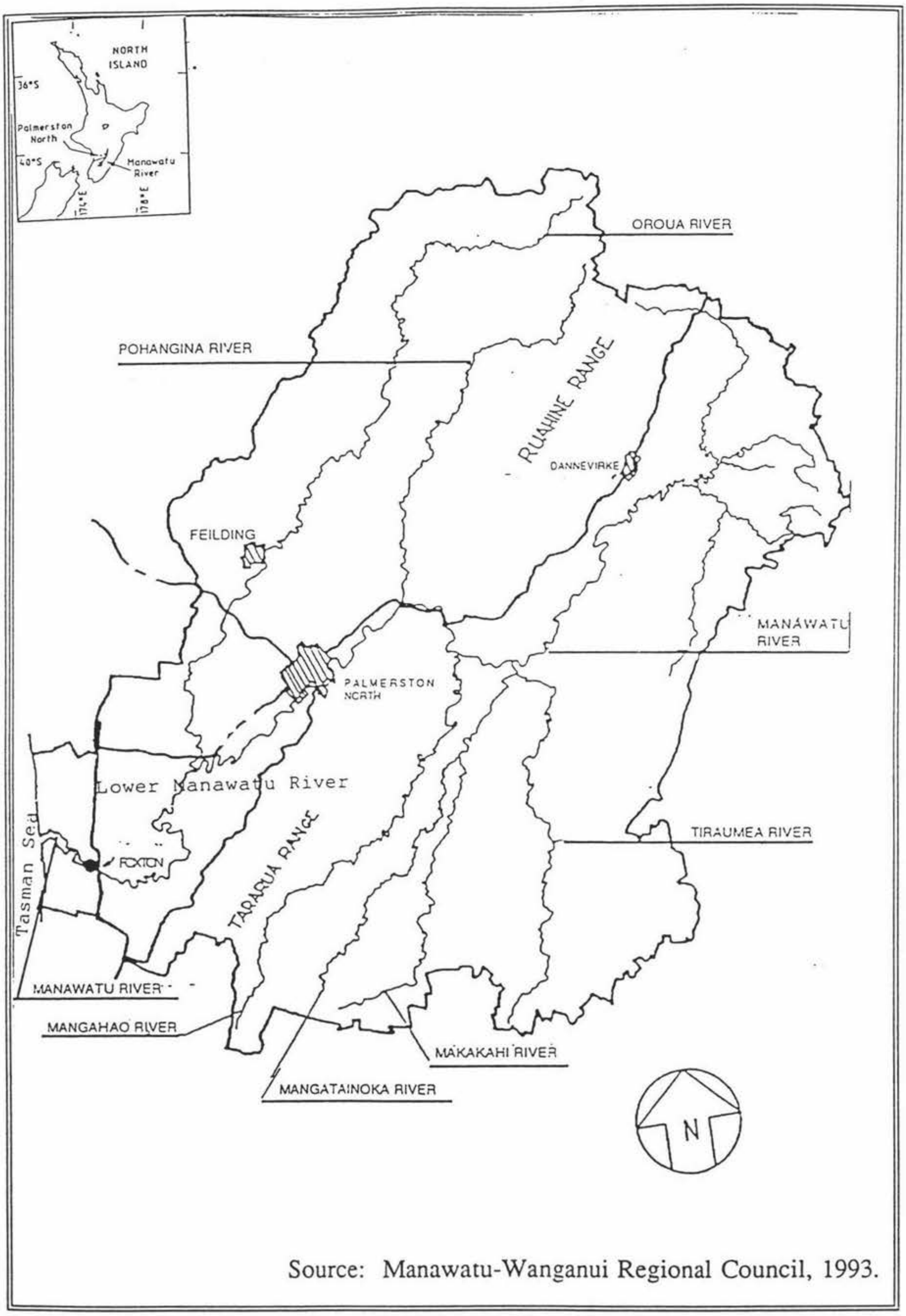

Figure 1.1 Location of the Manawatu River

assumption that the river is a public good and therefore the members of the NZJBA, had the right to the use of the river waters. On the other hand the Manawatu Fresh Water Anglers Club, represented users who felt that the uplifting of the speed restriction would interfere with their right to use the river (Charrott and Bennitt, 1976).

A second example involves bird-life as a resource that depends on the river for its existence. The Ornithological Society of New Zealand has consistently expressed its concern about bird-life utilizing the riverbanks of the Manawatu River. The contention is that the birds' lives are under threat from disturbances caused by human recreational and development activities (e.g. trail riding, dogs and gravel extractors), and weir and riverbank development (McLennan and O'Connor, 1985).

A final example involves waste discharges into the river. Within the Manawatu River catchment, there are numerous discharges onto the land and into the water, altering the natural characteristics of the water and making it unsuitable for use by others. There are recorded incidents showing how these discharges have, in the past, affected water quality in the Manawatu River. In 1978 there was a major fish kill in the river below Palmerston North due to waste discharges into the river (Quinn and Gilliland, 1989; Quinn and McFarlane, 1988 and 1989). The McLennan and Reid (1984) summer surveys of 1979/80 and 1983/84 revealed that recreation sites located downstream of certain wastewater discharge points in the vicinity of Palmerston North received less than 20% of visitor numbers than that recorded for upstream sites.

Economic theory postulates that in a perfectly competitive free market, in which property rights are completely defined, vigorously enforced, and in which exists a voluntary exchange of rights, resources will be allocated to their highest value in use. On the other hand, lack of completely defined property rights will result in market failure which will justify government intervention to manage the resource (Stokey and Zeckhauser, 1978).

In New Zealand this intervention in the market has occurred through an act of Parliament, the Resource Management Act 1991 (RMA). The RMA bestows upon regional councils the responsibility of managing natural and physical resources within their regional borders. Functions of the regional councils is discussed in detail in Chapter Three.

1.2 STATEMENT OF THE PROBLEM

In exercising its powers, the MWRC has developed a "Manawatu Catchment Water Quality Regional Plan" proposing that water quality in the river be improved. This is part of its policy in the Manawatu-Wanganui Regional Statement 1993. In part the proposed policy of the Manawatu Catchment Water Quality Regional Plan states:

> "Policy 1:
> To establish a water quality management regime for the Manawatu catchment that provides for the classification of:
> a. all rivers in the Manawatu catchment as class CR (contact recreation) ..." (Manawatu-Wanganui Regional Council, 1994).

The issue under investigation in this thesis is whether it is worthwhile to undertake improvement of water quality in the river plus its tributaries to achieve contact recreation standards. It is an issue worth investigating because there are numerous benefit and cost implications in adopting this water improvement policy. One thing that need be borne in mind constantly is that water quality improvement in a river is a costly undertaking. There is a need to justify the use of the funds to carry out such a project by showing how the public will benefit from it.

It is anticipated, for instance that the improvement of water quality in the river will result in better recreational opportunities to society. However, to achieve this level of water quality, many industrial, municipal and agricultural waste discharges into the waterways may need additional treatment before being discharged. Failing to meet this requirement, the only other option for the city and district councils is to adopt expensive landbased waste disposal systems. For example, if the Palmerston North City Council (PNCC), opts for a landbased project it is estimated to cost $116[1] million on a 25 year cycle (Anderson, 1993). In such a scenario we need to ask if the public is really prepared to meet the cost of river water improvement in return for improved water quality. It needs to be established whether the public is likely to increase their use of the river if the river water quality is improved, or whether their use will remain the same. Industrial and agricultural improvement costs that may be incurred will be met by the industry and the farmers but not the public.

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[1]This figure is not discounted.

This is an issue worth investigating because the RMA 1991 which empowers the MWRC to prepare a regional plans requires in section 32 (b) that, persons or institutions charged with the responsibility of caring for resources:

> "Carry out an evaluation, which that person is satisfied is appropriate to the circumstances of the likely benefits and costs of the principal alternative means including, in the case of any rule or other method, the extent to which it is likely to be effective in achieving the objective..."

The question, therefore, is whether the anticipated future benefits of undertaking water quality improvement in the Manawatu River catchment outweigh the costs to be incurred now. To answer these questions, some valuation is needed for the decision makers to determine whether it is worthwhile to carry out the project.

1.3 RATIONALE

Intervention by governments, when the market fails to allocate resources efficiently, in effect means that the agencies charged with the responsibility of allocating the resources have to use the planning process to achieve what the market failed to achieve. The government agent in this case is the MWRC and the resource is the Manawatu River and its tributaries. The MWRC must formulate policies that will govern the utilization of the river. Since these policies are public policies, inevitably they should reflect societal preferences toward river usage. People's preferences and objectives become very important in such a process of decision making (Stokey and Zeckhauser, 1978). For instance, the decision making body has to find out what amount and quality of water society wishes to allocate to each of the competing uses of the rivers.

There are numerous factors that go into the process of planning in resource allocation. Such factors include: politics, business interests, ancestral ownership claims, and environmental lobby groups. These factors combine to make the decision making process in resource allocation complex. Formulation of clear cut rules to follow is difficult because these resources carry different values to different interested parties. Therefore, it becomes crucial to determine the value of such resources to different users.

However, because these resources lack market values, a process has to be followed to establish their worth. To address such issues, economists have developed the concept of nonmarket valuation.

1.4 THE CONCEPTUAL FRAMEWORK

1.4.1 Nonmarket evaluation and the benefit-cost analysis

It is essential that policy makers predict consequences for all affected parties of every policy decision if they hope to make good decisions (Stokey and Zeckhauser, 1978). Benefit cost analysis (BCA) is an economic tool that is used to simplify the process of decision making by seeking to value costs and benefits involved in the project in question. There are three basic steps involved in carrying out a BCA.

(i) identification and quantification of costs of the water improvement project;

(ii) identification and quantification of the benefits, and

(ii) comparing both sides of the equation and making a decision whether to carry out the project or not. The decision rule is that the project is worth undertaking if the perceived benefits outweigh the costs (Hufschmidt *et al.*, 1983).

This research focuses on the identification and quantification of part of the benefits of water quality improvement in the Manawatu River. The concept of nonmarket valuation hinges upon the assumption that, since public funds are used to finance public projects and since these projects lack market values, their worth can be established by:

(i) using substitute prices or

(ii) consulting with the public as to whether they favour the project by asking them if they would be willing to pay to finance the project.

1.5 HYPOTHESIS AND HYPOTHESIS TESTING

The hypothesis is that people are willing to pay extra dollars through rates (or rent) to achieve improved water quality in the Manawatu River catchment. This can be tested by surveying households within the catchment regarding their willingness-to-pay (WTP) to achieve water quality improvement.

1.6 OBJECTIVES

(I) To select an appropriate method for evaluating benefits of the water quality improvement in the Lower Manawatu River.

(II) To gather people's opinions, perceptions and attitudes toward present and future water quality in the Manawatu River catchment. Some of the issues to be explored include finding:

- (a) the amount of time residents of the Manawatu River catchment spend visiting the river and its tributaries during summer;
- (b) the main activities in which people engage in different sections of the Manawatu River and its tributaries; and
- (c) the attitudes the residents have concerning current water quality in the river.

(III) To investigate attributes of water quality that are of importance to the residents as regards using rivers, and the effect improvement in water quality will have on the use of the river.

(IV) To identify factors that influence WTP for water quality improvement and to quantify the dollar value the residents place on water quality.

1.7 IMPORTANCE OF THE STUDY

This research will contribute to the decision making process of Manawatu River management and in the general field of resource evaluation research. It will serve as a reminder to public policy makers of the importance of considering alternative paths of action when formulating public policies.

1.8 OUTLINE OF THESIS

In Chapter Two, a discussion of nonmarket valuation methods is presented. The contingent valuation method is singled out and discussed in greater detail. Reasons why the contingent valuation method was selected as the appropriate method to carry out this study is explained.

The focus of Chapter Three is an outline of features of the Manawatu River catchment. This chapter explores the physical environment of the area, its people, and their cultural and economic life. The role of the Manawatu River and its tributaries is put into perspective.

Chapter Four is a discussion of the research method. The design of the survey questionnaire is explained, giving reasons why each question was asked.

The results of the survey are presented in Chapter Five. The method described in chapter four is applied to the data collected to derive the dollar value of water quality in the Lower Manawatu River.

In Chapter Six, the conclusion of the study is made with an explanation of how each of the objectives have been satisfied. Recommendations are made on areas that need further investigation.

CHAPTER TWO

NONMARKET VALUATION METHODS

2.1 INTRODUCTION

In this chapter a discussion of the role of the market in resource allocation is presented followed by a discussion of the concept of welfare economic theory as the basis of nonmarket valuation. Following this, nonmarket valuation techniques are discussed. The contingent valuation method (CVM) as one of the nonmarket valuation techniques, is selected and treated in depth giving reasons for its selection as the appropriate method for the current research.

2.2 MARKETS AND RESOURCE ALLOCATION

The utilization of the environment can only take place to a limited extent because the environment, as any other resource, is finite in the number of services it can provide. Yet people out of necessity, have to disrupt the natural environment to exist. How the scarce environmental resources are to be allocated to meet the needs of humanity depends on the goals society holds. Because of a limited understanding of the interrelationships between resources, interference with the environment by human activities has resulted in environmental problems such as water quality degradation. The presence of environmental degradation is an indication of resource misallocation (Meister, 1977).

One of the assumptions of a competitive free market is that, in the production and consumption of private goods, in a society with well defined property rights, producers and consumers each acting independently to maximize their production and consumer surplus make choices that are efficient in allocating resources in general. Private goods are goods that conform to well defined property rights characteristics of universality, exclusivity, transferability and enforceability.

Universality means that all entitlements of the good are completely specified. Exclusivity refers to the fact that all benefits and costs incurred as a result of owning and using the resource accrue to the owner. Transferability enables the owner to voluntarily exchange private property with others, while enforceability ensures that property is secure and safe from involuntary encroachment by others (Tietenberg, 1992). A combination of outputs or attributes is said to be efficiently allocated if it is impossible to increase one of the outputs without at least decreasing one other (Stokey and Zeckhauser, 1978).

In reality, the operation of the free market rarely functions as defined above. This leads to inefficient allocation of resources.

There are five factors that have been identified as being causes of resource misallocation: market failure, improperly defined property rights, imperfect market structures, disparity between the private and the social discount rates, and government failure. Market failure is evident in society whenever certain individuals in society bear the cost or benefit due to a third party effect. Common property goods have the characteristic whereby their use is unrestricted. In a river, there is a problem in that there is no restriction as to how much contaminants one can release into the waters. Thus, the resource gets overexploited, leading to inefficient allocation.

Public goods have a non-rival and non-exclusive element in their consumption making it difficult for private investors to provide them since they are unlikely to reap the entire bundle of benefits that will result from their investment. Water quality improvement in a river is a public good (read service). No private entrepreneur would be willing to invest in water quality improvement in the river because of the free-rider problem. The free-rider problem arises due to the non-rival and non-excludability of the good. If some individuals clean up the water, they will not benefit fully from their effort because others are able to enjoy their service without paying for it. Therefore, nobody has the incentive to offer such a service, and the service is undersupplied (Tietenberg, 1992).

When the market fails to supply the public good, many governments or the respective public decision maker, more often get obliged to provide the good in question. This necessitates the process of planning on the government side which in turn calls for criteria upon which the decision to supply, or not to supply, the good is to be based. Since governments manage the resources on behalf of the public, and use public funds to do so, it becomes imperative for resource managers to understand the values, aspirations and objectives of the public regarding these resources. Just as in the private sector, governments or public decision makers should allocate resources in such a manner that the last dollar spent is equally satisfying to society (Stokey and Zeckhauser, 1978). It is a difficult task to determine society's point of satisfaction, because these resources lack market prices upon which values can be established. As an alternative therefore, nonmarket valuation procedures are used to determine society valuation of these goods. To understand this process an investigation into the theory of welfare economics will be appropriate because it is the foundation upon which the nonmarket valuation process is built.

2.3 WELFARE ECONOMIC THEORY

A dictionary definition of welfare says that it is the "condition of having good health, comfortable living and working conditions,"... (Hornby, 1974). What one terms as being comfortable or good is very subjective and depends on value judgements. Welfare can therefore not be directly observed and measured in the same manner that a change in temperature is measured, for instance.

Policies are formulated and enforced with the aim of influencing society's welfare. First, the policy maker is interested in knowing the effects a policy will have on society. Second, the policy maker is interested in knowing the desirability of the policy to society. Positive economics is the branch of economics that tries to find answers to the former. It is involved in the analysis of the effects policy changes are likely to have in society. There is no objective method of measuring the desirability of a policy. Welfare economics deals with the evaluation of the consequences of policy effects. It aims at providing the policy maker with criteria for comparing and ranking various policy proposals. By and large, it depends on value judgements (Johansson, 1991).

2.3.1 Marshallian consumer surplus

In this section, measures that indirectly reflect changes in the welfare of society are explained on the basis of welfare economic theory. Take a situation in which there is a fall in price for a certain commodity. We need to know the amount by which social welfare has changed as a result of the fall in price; in other words, by how much the households have gained or lost. One way of doing this is through the collection of information on consumer behaviour in the market for the goods and services.

Following Johansson (1991), let us build a consumer society model in which the following assumptions are made:

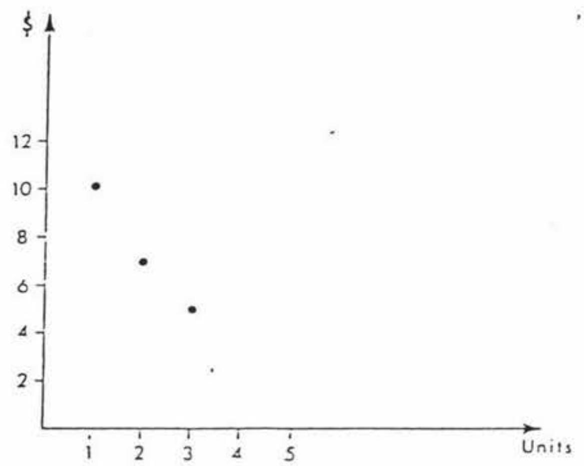
- that in this society there is only one consumer and buys bottles of juice in units (1, 2, etc), as one of the commodities he or she consumes;
- that the prices of other commodities remain constant, but the price of bottles of juice varies widely over time; and
- that the income of the consumer remains constant.

Table 2.1 depicts some points from the demand schedule of our consumer for juice consumed as a function of price. The consumer does not buy any juice at a price above $10. The consumer prefers to spend his or her money on other commodities instead because of limited income. The situation can be illustrated graphically as in figure 2.1.

Table 2.1 A demand schedule

Price ($)	Bottles of juice
10	1
7	2
5	3

Source: Johansson, 1991



Source: Johansson, 1991.

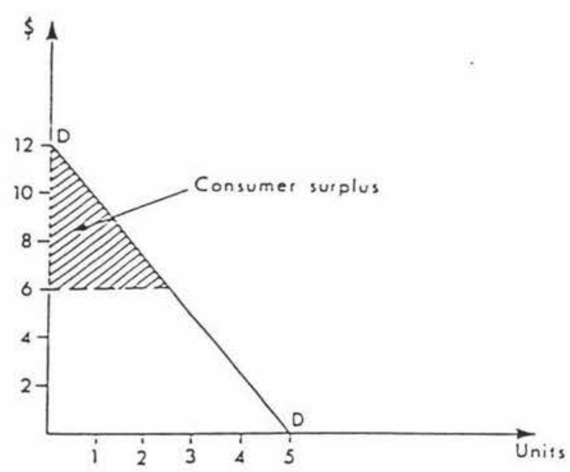
Figure 2.1 A consumer observed demand (units) as a function of price

If the price is reduced to $10, our consumer becomes indifferent between spending money in buying juice or to use it in the purchase of other commodities. The highest amount of money that the consumer is willing to pay for a bottle of juice is therefore $10. This is called the consumer's reservation price. Supposing the price is reduced further from $10 to $8. Purchases one bottle at this price results in a surplus over and above what he or she is willing to pay for it. The actual surplus i.e. $2 is equal to the difference between the reservation price and the actual buying price.

This difference between the maximum price one is willing to pay for a commodity and the actual price that one actually pays for it (or the market price), is called consumer surplus. Consumer surplus represents the gain the consumer receives in utility (or satisfaction). Thus an unobservable element can now be communicated in observable monetary units.

Let us see what happens if there is a third fall in price, this time to $6, and assume that the consumer's maximum willingness-to-pay for a second bottle of juice is $7. The consumer surplus for the second bottle becomes $1 (7-6). The consumer surplus for the first bottle now becomes $4 (10-6), and the total consumer surplus is now $5 (1+4) (Johansson, 1991). This is what constitutes Marshallian consumer surplus or ordinary consumer surplus.

The concept is also applicable to situations where the commodity in question is bought in continuous amounts rather than in units. Figure 2.2 gives a graphical representation of consumer surplus as the area between the price line and the demand line. The shaded area in figure 2.2 is the consumer surplus when the market price for the commodity is $6 per unit. Notice that the shaded area is a triangle, whose area can be calculated using the formula: area triangle = 0.5 x base x height. For figure 2.2, the base is 2.5 and the height is 6, therefore the area of the triangle is 0.5 x 2.5 x 6 = 7.5 square units.



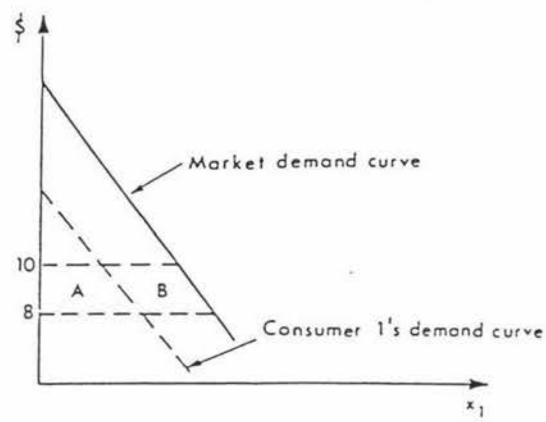
Source: Johansson, 1991

Figure 2.2 A consumer observed demand for a commodity bought in continuous amounts

2.3.2 Aggregation of consumer surplus

Let us move from our simple model of one consumer, and assume that there are now two consumers. Let us assume further that there is a single price change and see how the consumer surplus changes this time. Under such a situation we simply add the changes in consumer surplus to obtain the monetary value of the change in society's welfare.

In figure 2.3, the consumer surplus gained by consumer 1 is A and that gained by consumer 2 is B, as a result of price falling from $10 to $8. The total change in consumer surplus is A + B (Johansson, 1991).



Source: Johansson, 1991.

Figure 2.3 An aggregate consumer demand curve.

2.3.3 Hicksian consumer surplus measures

Following the discussion in section 2.3.1 it can safely be concluded that in benefit analysis, preferences of consumers should be the benchmark upon which public decisions should be measured. Consumer's willingness-to-pay for a good or service has become an acceptable way of defining the consumer's values. An ordinary (i.e. Marshallian) demand curve, can be used to measure the benefits of price change by calculating the consumer's increment in consumer surplus. As it were, the Marshallian demand curve, though commonly used this way, is controversial.

The use of Marshallian demand curve is widespread because it is easy to evaluate and easy to estimate on the basis of observed household behaviour. However, it has its limitations. To be able to truly evaluate benefits derived by consumers as a result of price changes (or any other actions), it is mandatory to hold welfare constant along the demand curve. Unfortunately, the Marshallian demand curve holds income constant along the curve, making the derived measure inappropriate as a benefit measure (Smith, 1986).

Hicks (1943) identified four measures of consumer surplus for a price fall (in a similar manner a price increase can be illustrated) that try to make up for the limitations inherent in the Marshallian measure of benefits. The four measures can be defined as follows:

(I) Compensating variation (CV) is the amount of compensation that can be taken from the consumer while leaving him or her at the initial welfare level as before the price fall, if there is no constraint to price changes;

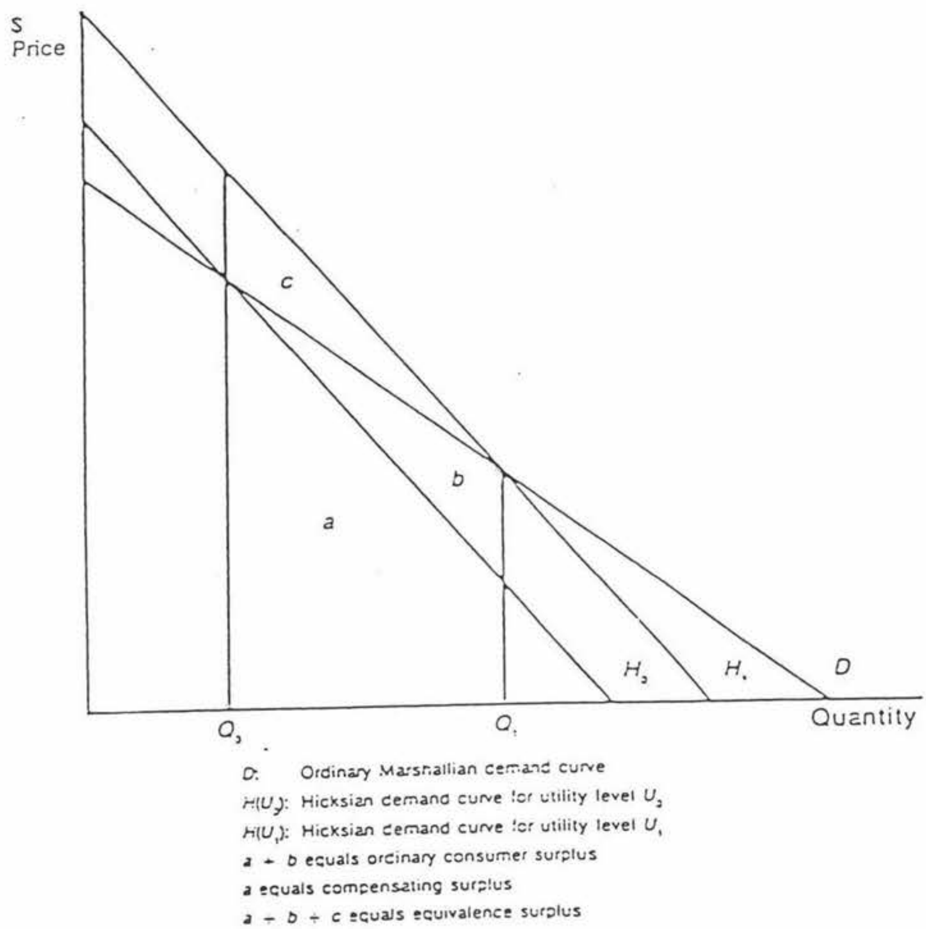
(II) Compensating surplus (CS) is the amount of compensation that can be taken from the consumer while leaving him or her at the initial welfare level in the absence of the change, if constrained to purchase at the new prices;

(III) Equivalent variation (EV) is the amount of compensation that has to be given to the consumer to bring him or her to the subsequent welfare level in the absence of the price fall, if not constrained to price changes; and

(IV) Equivalent surplus (ES) is the amount of compensation that has to be given to the consumer which would bring him or her to the subsequent welfare in the absence of the price fall, if constrained to purchase at old prices.

In figure 2.4 it can be seen that for a quantity increase from Q_0 to Q_1, Marshallian consumer surplus is the quantity equivalent to the area under the demand curve D (i.e. a + b). The Hicksian compensated demand curve H_0 (i.e. a) represents compensating surplus and the area under Hicksian compensated demand curve H_1 (i.e. a+b+c) represents equivalent surplus.

In most situations when dealing with policy cases, matters of greater concern are those addressing issues of potential benefits as measured from the initial utility level of the consumer. In this respect, Hicksian measure of consumer surplus become more relevant. If, for instance, the issue at hand concerns water quality improvement, the compensating surplus measure can be interpreted as the consumer's maximum willingness-to-pay (WTP) in order to gain the improvement and still retain the initial utility level. If on the other hand the case under question involved degradation of water quality, the compensating surplus would be viewed as the minimum compensation the consumer is willing-to-accept (WTA) in place of good quality water (Mitchell and Carson, 1989).



Source: Johansson, 1991.

Figure 2.4 Surplus measures for a change in quality

2.4 BENEFIT EVALUATION

The benefit evaluation process provides a check on the economic rationality of decisions to invest in public goods and services, like environmental improvement, by placing values on the goods and services. A policy will be worth undertaking if the gain from the policy exceeds the resource cost. To make this comparison, the benefits and the costs must be identified and expressed in comparable units. The benefit expenditure should continue until the extra benefits are approximately equal to the extra costs of environmental improvement. This ensures that the total net benefits to society are maximized. "What people want" is the basis of what is to be counted as a benefit or not. Individual preferences should be the basis of sorting benefits from costs. People's willingness-to-pay (WTP) for something or willingness-to-accept (WTA) compensation to forego what they are entitled to, should be taken as a positive indication of their preferences. The aggregate WTP for a certain commodity then becomes the socially desirable measure of determining what is socially beneficial (Pearce and Turner, 1990).

In a market situation, WTP, as measured by market prices, does not necessarily reveal the total benefits that society places on the good. There will always be individuals who will be willing to pay more than the market price. Thus, in an attempt to measure the total benefits of a resource to society, that is, one should seek to measure the total benefits of a resource to society, one should seek to measure the area under the demand curve. This area embodies the total economic value of a resource, including consumers' surplus (Pearce and Turner, 1990).

2.4.1 Total economic value (TEV)

In relation to environmental resources, the TEV can be looked at from two perspectives: user values and non-user values. User values are benefits derived from actual use of the environment. For example, fishers, hunters, and photographers all derive a user benefit from the environment. These use values can be subdivided into present use values and option values. Present use value is the actual benefit a consumer derives from a resource at the present time. While option value is the value of the resource as a potential benefit. Some authorities refer to this value as the preservation value (Walsh, Loomis, and Gillman, 1984). This value is revealed through the user's WTP for the resource to be preserved with the hope of using the resource at some future time. The option value has three components: value in use by the individual, bequest value, and vicarious value. Value in use by the individual refers to the value the individual holds with the hope of using the resource as an individual in the future. Bequest value is the value in use by future generations (descendants) of the individual while vicarious value is that pleasure one derives because others benefit from a resource. This is the equivalent of WTP for the benefit of others. Non-use value of a resource is also referred to as the intrinsic value of the resource. This is the value that is said to reside "in" something and is unrelated to human beings altogether, but is captured by people through their concern and sympathy of rights of non-human entities. A commonly used terminology for non-use value is existence value (Kneese, 1984), but Pearce and Turner, (1990) provisionally considered the two as being equivalent.

The importance of existence value was given recognition by Krutilla (1967), who pointed out that existence value had been overlooked in policy issues affecting natural resources. Recent literature uses the terminologies "passive-use value" and "nonuse value" which by definition are more inclusive terms for existence value. Current literature reveals that the place of passive value in determining the total economic value of natural resources has locked environmentalists, policy makers, lawyers, industrialists and other concerned groups in heated debates involving multimillion lawsuits seeking compensation as a result of industrial pollution. The question being asked is whether passive-use values are real and if they are, whether they can reliably be measured (Carson, Meade, and Smith, 1993).

In benefit identification, non-use values should be included to obtain this total economic value of a resource that encompasses actual use value and option value plus existence value (Pearce and Turner, 1990).

The contingent valuation method (CVM), has been the most frequently used method for valuing the passive-use. Before addressing the reliability of the CVM in measuring passive-use value, a brief discussion of other nonmarket valuation methods is explored.

2.4.2 Valuation methods

There are three main approaches that are commonly used to value nonmarket goods: the productivity approach, the surrogate market price approach and the survey approach. The productivity approach has not found much application in the valuation of environmental services and goods, and will not be explored here. The following focuses on surrogate market approach methods, followed by a detailed discussion of survey method techniques.

2.4.2.1 The surrogate market price approach

The surrogate methods commonly employed in environmental issues are the hedonic pricing techniques and the travel cost method (TCM). According to Rosen (1974), hedonic prices are implicit prices that reflect characteristics of a property (e.g., size, location, or quality of neighbourhood). By ranking the quality and quantity of these characteristics one is able to observe the variation in prices of the property at different levels of the characteristic. Take a house for instance, its price depends on, among other attributes, the number of rooms the house has. It is hypothesised by the proponents of hedonic prices that the environmental quality such as air quality of the locality in which the house is situated affects also the price of the house. With other factors held constant it is postulated that the price of the house will go up, the cleaner the ambient air becomes, until the marginal cost of providing clean air is equal to consumer's WTP for marginal improvement.

The travel cost method (TCM) is used mainly to value nonmarket recreational sites in which entrance costs are substantially undervalued. It is based on the premise that the cost an individual incurs to travel to a particular recreational site influences the frequency and length of that person's visit (Harris and Meister, 1981).

Though users of a site do not pay an admission fee to get access to the site (or, if a fee is charged it will be minimal), they, do incur a cost of travelling to and from the site. It is implicit that the further one lives from the site, the less one is expected to visit the site due to increased travel costs, while the nearer one is the greater the frequency of visitation expected. Through a survey, the TCM seeks to relate the variation in the number of visits with changes in travel costs. If other factors are held constant, and an admission fee is varied, it can enable the investigator to establish a demand schedule for the use of the site. The area below the demand curve is an estimate of the real consumer surplus obtained by the current users of the site (Hufschmidt *et al.*, 1983).

Sinden and Worrel (1979) outline some assumptions that are made when applying the TCM. First, it is assumed that users obtain the same total benefits from the use of a site and that this is equivalent to the travel cost of the furthest traveller visiting the site (or the marginal user). Second, it is assumed that the consumer surplus of the marginal user is zero. Third, it is taken that, at certain costs, all individuals consume equal quantities of activity.

The surrogate market price approach is not a suitable approach that can be used in the current research because of lack of surrogate markets for many of the services provided by the river. The TCM is particularly not suitable in this research because users of a river do not use a particular site of the river, and therefore do not incur measurable travel costs. The majority of users do not travel to use the river. The TCM also does not capture the total economic value of the resource of the commodity under valuation because it does include the passive-use value of those who do not visit the river.

2.4.2.2 Survey based techniques

Survey-based valuation techniques seek to directly elicit consumer WTP or WTA compensation for various changes of environmental goods and services. They are consumer oriented rather than market oriented. All survey techniques have a common theoretical basis from which consumer surplus is derived. They all attempt to formulate a consumer demand curve, either through direct bidding games or through inference, from choices consumers make from various bundles of goods. These techniques can be grouped into two broad categories on the basis of what is being questioned. In the first category techniques such as bidding games and trade-off games are included. The second group includes techniques such as the costless choice technique and the priority evaluation technique. The first group questions directly the consumer's WTP or WTA compensation. The second category consists of techniques that directly question the consumer about his or her choices of quantities or qualities. From the questions about consumer preferences of goods, inferences are deduced as to the WTP or WTA (Hufschmidt *et al.*, 1983).

To illustrate the tactics of the trade-off games, let us assume that the environmental good to be valued is water quality. In the trade-off game, the respondent is presented with a description of the good to be valued, in as much detail as possible, to enable him or her have a complete understanding of the situation. Visual aid, may be used if appropriate. For our model, a glass of water can do as outcome I--water which we shall assume to be water quality grade B. In outcome II, the respondent is presented with water of grade A, being water with an improved quality, at a cost of $10. The $10 payment is the annual cost to the respondent of the improved water quality of grade A. The dollar value is then varied systematically until a point of indifference is reached between the two outcomes. For instance the interviewer may increase the value to $11, then $12, $13 and so on. If the respondent indicates that $15 will be the highest he or she can offer for grade A water, then the conclusion to be drawn should be that the trade-off in money terms between the two outcomes is $15. The individual's WTP for the upgraded water quality is $15. If the population in the region being surveyed is 2000 then the aggregate WTP becomes $30,000 (Sinden and Worrel, 1979). The trade-off game is not suitable for this research because it is best administered through a personal interview and is, therefore cost prohibitive.

Using the water example above, we can illustrate the costless technique in the following manner. If we start with an arbitrary sample size of 50 respondents, the game starts by presenting the group with grade B water. The group is then divided into two. One group is presented with grade A water and $5 and given the option to choose either the $5 or the grade A water. The other group is presented with grade A water and $25, and given the same conditions of choice. If an individual chooses grade A and foregoes $5, the interpretation is that he or she has valued grade A water *at least* as much as the $5 foregone. On the other hand if an individual chooses to forego the grade A water and chooses to take the $25, the interpretation is that the *maximum* value he or she placed on the water is $25.

Three things are worthy of notice here:

- The willingness-to-pay for a good is inferred from the choices made by the respondent;

- the technique is called costless from the respondent's point of view in the sense that both choices offered are favourable to the respondent and are free; and
- the technique does not give an average value, but a minimum and maximum value of the good (Sinden and Worrell, 1979).

As with the costless choice technique, the priority evaluator technique questions respondents' preferences about goods, and WTP or WTA is inferred from the choices made. Through the use of interviews, the technique tries to simulate a perfectly competitive market. Unlike the costless choice technique, this technique assigns a set of goods starting point prices and subsequently adjusts the prices in a converging manner to a set of equilibrium prices.

Pendse and Wyckoff (1974), in their simulated market experiment, chose six variables to determine trade-off values for various combinations: natural surroundings, various types of noises, recreation, park facilities, vehicular traffic, travel time to work and parking convenience. The next step was to divide the various variables into levels and price each level to represent what it would cost an individual. As the environment is improved, the prices are increased. The respondents were allocated a limited budget of $18 and asked to purchase any one level of any of the six variables in such a manner as to exhaust the budget but remain indifferent of any trade-off. By selecting various combinations of variables to achieve maximum utility within the limited budget, the respondents reveal the relative value of the different variables. Priority evaluator technique has not found much application yet. It will require a considerable amount of time and research to develop a suitable methodology before it can be confidently used.

Essentially, delphi techniques are value judgement techniques that involve the questioning of "experts" to do the valuation. The first round of the exercise involves presenting and asking the experts to independently place a price on the good in question. Once the first set of prices is obtained, the researcher compiles them and presents the results to the experts in the form of graphs, charts or whatever suitable form that is available. The experts are asked to reevaluate the good having seen prices of others. The cycle is repeated over again with the aim of getting the price distribution to converge to a certain average price. If one of the valuators quotes an enormously variable price from what the rest of the valuators quote, the responsible expert is asked to explain that high value. Direct communication between the experts is avoided to reduce personality influences. Naturally the knowledge of the experts greatly influences the accuracy of the results (Dalkey and Helmer, 1963).

The delphi technique is more of a forecasting technique than an evaluation technique, and is, therefore, not suitable for the current research.

In the CVM, survey questions are used to discover preferences of people by asking them to state how much they are willing to pay for a specific action, such as water quality improvement, to take place. The respondents are presented with hypothetical scenario that resembles a real market situation and are given a chance to buy the nonmarket commodity (Mitchell and Carson, 1989).

If we compare the three evaluation approaches mentioned above--the productivity approach, the surrogate market approach and the survey approach--preference is given to the survey approach as the appropriate method for the current research. This approach involves the public in the decision making process and makes decisions involving public goods more transparent with subsequent implications for wider community participation and decision maker accountability (Meister 1994).

2.5 CONTINGENT VALUATION METHOD (CVM)

2.5.1 Historical perspective

The development of contingent valuation rose out of a need to evaluate benefits and costs associated with public goods. Ciriacy-Wantrup (1947), suggested that it was possible to use "direct interview method" to measure natural resource benefits. Though certain of the potential his idea had in using surveys to value goods, he did acknowledge the difficulties inherent in the method. It was not until the early 1960s that Davis (1963b) actually did conduct a natural resource valuation survey that employed a questionnaire. His first survey sought to value benefits of outdoor recreation. In an effort to determine the validity of the survey method, he conducted the same survey using the travel cost approach. On comparing the results he concluded that the CVM and TCM gave the same results.

Following Davis (1963b), others tried to use the method in their work. Ridker and Henning (1967) incorporated WTP in their air pollution surveys. Their methodology, though, was largely a property value approach. Hammack and Brown (1974) surveyed western waterfowl hunters seeking to find what they were willing to pay to forego their hunting rights. Cicchetti and Smith (1973) sought to value the benefits wilderness hikers derived from hiking by asking them their WTP or WTA compensation to reduce congestion in the area.

Randall, *et al.*, (1974) used the CVM to study benefits of air visibility. This study became pivotal to many later studies that designed WTP questions in hypothetical or contingent market frameworks. The study involved the valuation of economic benefits of visibility, a good that could not be valued by any other known method. It used photographs to reveal the visibility levels being valued. This study and many others laid a foundation for the use of the CVM as a viable resource valuation technique.

In studies of water quality, the CVM has been widely employed. Greenley *et al.*, (1981) investigated economic benefits associated with water quality improvement with particular interest in public perceptions of option and preservation value. Harris (1983) tested the suitability of the CVM in water pollution in New Zealand. Mitchell, and Carson, (1985) used the CVM to test for empirical evidence of the option value in water quality studies. Sheppard, *et al.*, (1993) used the CVM to study economic benefits of water quality improvement.

2.5.2 CVM designing techniques

CVM seeks to elicit the amount of compensation an individuals would pay or accept, so as to restore their original utility levels after experiencing an increase or decrease in quality or quantity of a public good in question (Randall, 1987). CVM presents to the respondents a hypothetical market scenario and offers them an opportunity to buy the unpriced good.

To obtain the true valuation of a public good the researcher has to design a plausible hypothetical market to sell the good. The first step towards this end requires that the researcher structures the rules of the market in which the good will be bought or sold. Second, the researcher should describe to the respondents the nature of the good being valued, and, finally, the researcher should elicit values of the good in the constructed market (Carson, 1991).

2.5.2.1 The hypothetical market scenario

In essence, a description of the market scenario takes both steps one and two mentioned above. The first step requires that the researcher establishes the baseline conditions with respect to physical availability of the good and the institutions that regulate public access to and use of it. Second, the researcher should define and give a detailed description of the good and the expected changes that would occur which necessitate the valuation. This may be accomplished through visual aids like charts, graphs, sketches and photographs. Taste and smell sensations have been used on some occasions too. All this is done to enable the respondent to accurately perceive the conditions under investigation (Randall, 1987; Carson, 1991).

2.5.2.2 The market mechanism

The description of the market conditions under which the good can be sold necessitates that a number of choices be made including: the choice to emulate the private market or political market (also referred to as the referendum or the public market); the choice of the elicitation method; and the choice of the amount and kind of information to pass on to the respondents.

The private market model predicts that, in a competitive market where goods and services are in rival supply, where property rights are well defined, and voluntary exchange is not hindered, a pareto-efficient equilibrium will be attained. The assumption here is that the consumer takes into consideration all possible alternative ways in which to spend their money.

As Bishop and Herberlein (1979) argue, the CVM study is far removed from a private goods market model. They point out that in a private market people spend considerable amount of time comparing alternatives of what to buy. More time may be spent consulting with professionals like lawyers and bankers. On top of that, the consumer draws on experience in the market to make current decisions. In contrast, in a CVM the survey, the respondents spend about one to two hours at most to value the amenity.

A second problem in basing CVM studies on a private market comes from what Buchanan (1954) refers to as people being more public-spirited when voting on public issues than when participating in private markets. In essence one's behaviour in a private market is self-centred. On the other hand, in a CVM study one is likely to be more public-spirited, as in an election.

The political market (referendum) is more suitable for CVM studies where the respondent is given a choice of saying yes or no to a predetermined situation. The referendum model assumes that choices are influenced by more than just having perfect information. There is a range of motives that come into play (Mitchell and Carson, 1989).

Ultimately a CVM study is about the provision of a public good, which once a decision has been made to supply the good, everybody in question must pay. This payment mode involves coercion. A referendum model is the ideal choice whenever public opinion is sought and, therefore, it is familiar to them when it is used in a CV study. For a CVM study to fit a referendum model, a number of criteria need be met.

The respondents should be supplied with enough information to enable them understand the amenity and how it will be provided and paid for. The respondents should be "encouraged " to participate rather than "required" because the process is voluntary. There is justification of eliminating extreme answers to the WTP question on grounds that a two-thirds majority rule is acceptable criteria for the provision of a public good (Mitchell and Carson, 1989).

In constructing the contingent valuation market, there are five criteria that the researcher should strive to fulfil. The researcher should ensure that the market scenario:

(i) is theoretically accurate;

(ii) is policy relevant;

(iii) is understandable to the respondents in the way the researcher intends;

(iv) is plausible and acceptable to the respondents; and

(v) is meaningful to the respondents.

If the scenario fails to meet the first three criteria, the following situations will arise: theoretical misconception; policy misconception; and conceptual misconception. All these misconceptions result in the respondents valuing the wrong thing and consequently the researcher will measure the wrong thing. If the scenario fails to meet conditions (iv) and (v), it will result in respondents failing to take it seriously leading to unreliable and potentially biased results (Carson, 1991).

The central issue in contingent valuation design is the determination of how the valuation response is to be elicited. The most straight forward elicitation approach is the direct questioning method in which the researcher simply asks the respondent, "What is your maximum willingness-to-pay for the good?" The main problem with this approach is that people find it difficult to answer such questions because normally in the market such goods are not bought or sold. Respondents under such conditions do not devote enough effort to quote a value that truly represents their valuation. They will quote a figure anyway. Such behaviour results in extreme responses of either zero or very large dollars values. Because of this problem better methods have been sought.

To overcome the difficulty involved with the direct questioning approach, the bidding game approach was developed by Davis (1963a) and perfected by Randall, Ives and Eastman (974). In this method the researcher starts with some value of willingness-to-pay and asks the respondents; "Are you willing to pay $X for the good?" If the respondent says "yes" the researcher progressively increases the bid and asks the question again. The game is repeated over and over again until a "no" response is obtained. Conversely, the bid is progressively decreased until a "yes" response is obtained. The main problem with this approach is that the starting point of the bidding is very likely to give rise to starting point bias, which is likely to influence the response. If the starting point is far from the true valuation of the respondent, the game can be long. As such, the respondent may choose to say "yes" prematurely to end the game and avoid boredom.

The payment card approach (Mitchell & Carson, 1989) was developed to try and overcome the problem of starting point bias. In this method, a card is used to present an array of dollar values starting from zero. The respondent is asked to select from the card one figure that represents his or her maximum willingness-to-pay for the good. One problem with the payment card is the uncertainty of knowing whether the responses actually represent people's maximum willingness-to-pay or whether they indicate the range within which his or her maximum willingness-to-pay falls.

The fourth method is referred to as the dichotomous choice approach in which the respondent is asked the question "Are you willing to pay $X for the good?" The respondent gives a discrete response of either a "yes" or "no" and that marks the end of the interactive bidding. The advantages of the dichotomous choice method include the fact that it makes it easy for the respondents to evaluate the good. These approach is also well suited for implementation in a mail survey (Carson 1991; Kerr, 1986; Mitchell and Carson, 1989).

Other aspects of CVM design involve inquiring about sociodemographic information of the respondent. The researcher asks for demographic information from the respondent such as sex, age, income, occupation and preferences that are relevant to the good being valued. These characteristics are used to discover their influence on the WTP of the respondent.

Statistical analysis of the responses involves the summarising of the results and estimating the aggregate WTP in the larger population at a local, regional or national level. Statistically the WTP figures are related to attributes of the respondents and finally the validity of the results is checked by comparing them with expected results from similar valuations.

A good estimate of the benefits can be achieved with a known error margin if the sample population is selected with precision in applying random sampling procedures, and if a high response rate is obtained and meaningful adjustments are made to cater for non-respondents and poorly completed responses. For accurate data to be collected, respondents' biases should be discouraged (Randall, 1987).

2.5.3 Limitations and shortcomings of CVM

The survey methods, and in particular the CVM, have limitations and weaknesses which must be understood to ensure minimal impact on the design and application of the survey.

When respondents are asked to value a public good in a survey, they get concerned as to how their valuation may affect decision makers and how this may eventually affect them in terms of actual payment to finance the provision of the good in question. If they foresee that in reality they may not actually pay, they may overstate their bids to ensure that the good is provided. On the other hand, if they sense that they may actually pay for the provision of the good, they may understate their valuation to lower what they may pay in the real situation. This predisposition to overstate or understate one's true valuation is referred to as strategic bias. In situations where the respondents are certain that they will not be prevented from using the resource, they may state a zero bid. Following measurements of strategic biases in some bidding games, it has been determined that strategic bias does not have significant effects on CVM results (Rowe *et al.*, 1980; Brookshire *et al.*, 1976).

The information with which respondents are provided about the good under valuation greatly influences their bids. Suppose the good under valuation is water quality, and the researcher describes it as being "dirty". This formulation of the information may result in what is called information bias, in which responses are biased, because different respondents have different concepts of what dirty water is. Information bias may be reduced by use of visual aids like photographs and charts as used by Sheppard *et al.* (1993).

In the bidding game, respondents are told the method they will use to make their payment, either through rates, taxes, or fees. The payment mechanism may not be acceptable to the respondents, and this will influence their valuation. Such a bias is called instrumental or payment bias. Thus the payment vehicle should be realistic and acceptable (Harris, 1983).

If the a survey is conducted in an interactive format, the initial bid the researcher indicates may influence the respondent, resulting in starting point bias. The respondents may misunderstand and take the starting point bid to represent the acceptable average bid. On the other hand if the interactive game is too long it may cause the respondents to state a value that is not their true value to shorten the game. Boyle *et al.*, (1985), found that starting point bias was a problem in two CVM applications they studied. They concluded that it is possible for the researcher's initial bid to influence the respondent's final bid.

Some respondents, if they realize that the conditions under which they are offering bids are hypothetical, may interpret the whole game as nonsense and provide bogus and unrealistic bids. Such a bias is referred to as hypothetical bias. According to Thayer (1981) however, correct design of the bidding game will reduce the problem.

2.5.4 Debates about the contingent valuation

2.5.4.1 Reliable valuation of passive-use values

In view of these biases, the CVM has been criticized, and its detractors cast doubt as to its reliability, in measuring nonmarket values such as passive values associated with environmental resources. Some of the arguments against CVM include: that respondents are inclined to give answers that are contrary to rational choice behaviour, that respondents pledge to contribute towards environmental programmes without budget limitations, and that when individual values are aggregated to obtain national figures, large totals amounting to billions of dollars are obtained. Such huge figures, detractors of the method argue, cast doubt on the reliability of the method.

Literature (Arrow *et al,* 1993) suggests that the observation of the "embedding" phenomenon would be the most important argument against the reliability of the CVM. The argument is that if different but similar samples of respondents are asked to state their willingness-to-pay to avert an environmental damage of two different scenarios that are identical but different in size it has been observed that the average willingness-to-pay for the two scenarios are not always substantially different enough to depict the differences in size.

This observation is interpreted to mean that responses in CVM do not measure equivalent dollar values of utility of the resource. If they did, the argument continues, average willingness-to-pay of large sized programmes would be substantially different from the small sized programmes. The CVM responses, they argue, are expressions of emotional rather than economic values. This is referred to as the "warm glow" effect.

The conclusion drawn from such arguments is that CVM is unsuitable for measuring passive values and should not be used in deciding policy issues nor in court of law rulings (Arrow *et al.*, 1993).

Responding in support of the CVM as a reliable technique for measuring passive use values, arguments for the approach claim that the "warm glow" effect can be avoided if questions are carefully presented, in context, to elicit answers that respond to the exact scene and avoid generalizations (Arrow *et al.*, 1993). Since the existence of passive-use values are firmly grounded on utility theory and the theory of efficient resource allocation, these values should not be excluded even though they are difficult to measure in practice (Randall, 1993).

2.5.4.2 Willingness-to-pay (WTP) and willingness-to-accept (WTA) concepts

In a contingent valuation survey, the elicitation question is phrased in terms of either a WTP or WTA format. Which of the two is selected depends largely on which of the four Hicksian consumer surplus measures the researcher is after. The question of property rights is crucial in deciding which to select. Issues involving public goods, like water quality in rivers, get complicated because property rights are vested in the hands of the community (Mitchell and Carson, 1989). The standard expected utility theory (Schoemaker, 1982) predicts that WTP should be equal to WTA values, but, as research has shown WTP values are less than, WTA values.

Hammack and Brown's (1974) contingent valuation study on waterfowl hunting indicated that disparities exist between WTP and WTA estimates. According to the study, WTA amounts were a little over four times as large as WTP amounts for the same amenity by the same respondents. Subsequent contingent valuation studies from then on have continued to show that the difference does exist as shown in table 2.2.

ɔle 2.2 Studies comparing WTP and WTA amounts

Study	WTP	WTA	WTA / WTP
mmack and Brown (1974)			
(Wildfowl and Wetlands)	247.00	1044.00	4.2
we, D'Arge and Brookshire			
(1979) (Visibility)	4.75	24.47	5.2
	6.54	71.44	10.9
	3.53	46.63	13.2
	6.85	113.68	16.6
shop and Heberlein (1979)			
(-)	21.00	101.00	4.8
ookshire, Randall and Stoll			
(1980) (Elk Hunting)	43.64	68.52	1.6
	54.07	142.60	2.6
	32.00	207.07	6.5
ıetsch and Sinden (1984)			
(-)	1.28	5.18	4.0

urce: Kirkland (1988)

The differences shown above have not caused researchers to abandon the use of ɜ contingent valuation (Gregory, 1986). There are a few hypotheses that have been rwarded to try to explain these disparities. The first hypothesis proposes that WTA lues are greater than WTP because the respondents reject the implied property rights the WTA questions. Evidence shows a large number of contingent valuation surveys at use WTA format receive a greater number of protest answers. The respondents ost likely regard the implied property rights as not being plausible (Bishop and ɜberlein, 1979).

A second hypothesis by Kahneman and Tversky (1979) will be explained by use an example. Take two situations, A and B, where A is a loss and B is a gain in ility to the consumer. From utility theory, the expectation is that the consumer will ılue both situations equally (Schoemaker, 1982). On the contrary, the prospect theory edicts that the consumer will value situation A more highly than B, because A is a ss of what is already owned while B is a gain of what does not belong to him or her. ı like manner, WTA questions imply that the consumer will forego what is already wned. To accept to forego what one already owns requires a higher compensation than hat one will pay to obtain that which one does not own.

On the other hand Hoehn and Randall (1987), attribute the differences to the fact that, in a contingent valuation survey, the respondents tend to be sensitive and therefore cautious of the uncertainty and lack of time to complete the questionnaire. They argue that given more time to familiarize themselves to the questions, the respondents will give WTA and WTP values that tend to converge.

The above debates represent the major group of potential sources of problems that may create doubt as to the validity of CVM results.

Despite the weaknesses of the CVM, it has its unique advantages compared to other nonmarket methods. First, evidence from studies that have employed CVM reveal that values obtained from such experiments give results comparable to those obtained from nonmarket methods such as hedonic studies of property values, travel cost, and other survey techniques. Second, CVM requires the least amount of data collection. Third, there are certain valuation situations that are suitable for evaluation by the CVM, but not by any of the other method. For instance, Schulze, *et al.* (1981), found the development of energy resources in formerly pristine environments could only be evaluated by the CVM. Thus, it is most practical to employ the CVM to elicit the total benefits users of Manawatu River derive from using its waters.

CHAPTER THREE

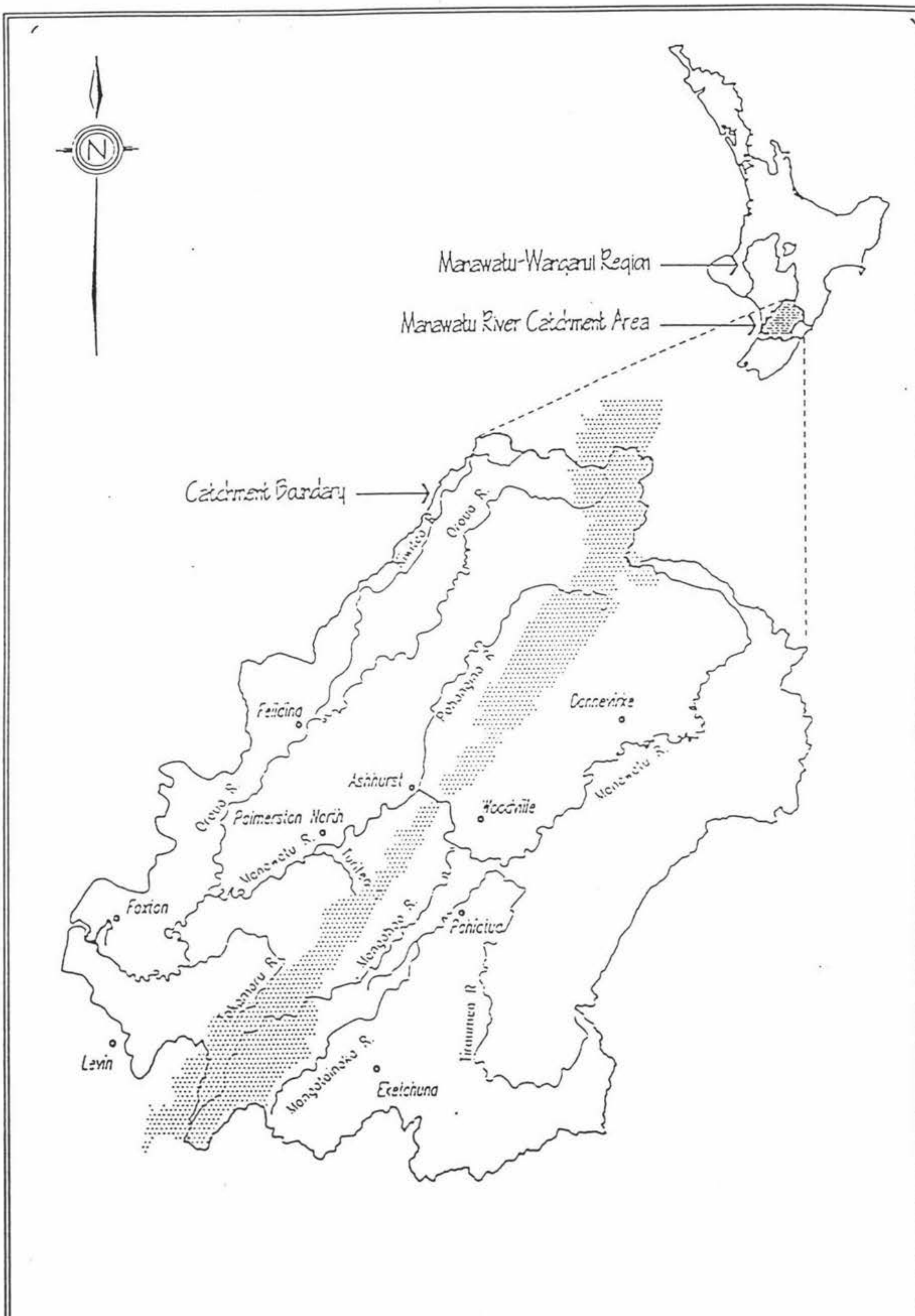
THE MANAWATU RIVER CATCHMENT

3.1 INTRODUCTION

The Manawatu River catchment covers an area of approximately 5992 km^2 (Poole, 1983). The map in figure 3.1 shows the Manawatu River catchment area. The Manawatu catchment is part of the Manawatu-Wanganui Region which is discussed below but it is worth mentioning here that some aspects of the catchment that will be discussed may be applicable to the larger Manawatu-Wanganui Region. The Manawatu catchment covers the district boundaries of Horowhenua, Manawatu and Tararua Districts and Palmerston North City (Manawatu-Wanganui Regional Council, 1993c). The map in figure 3.2 shows the Manawatu-Wanganui Region.

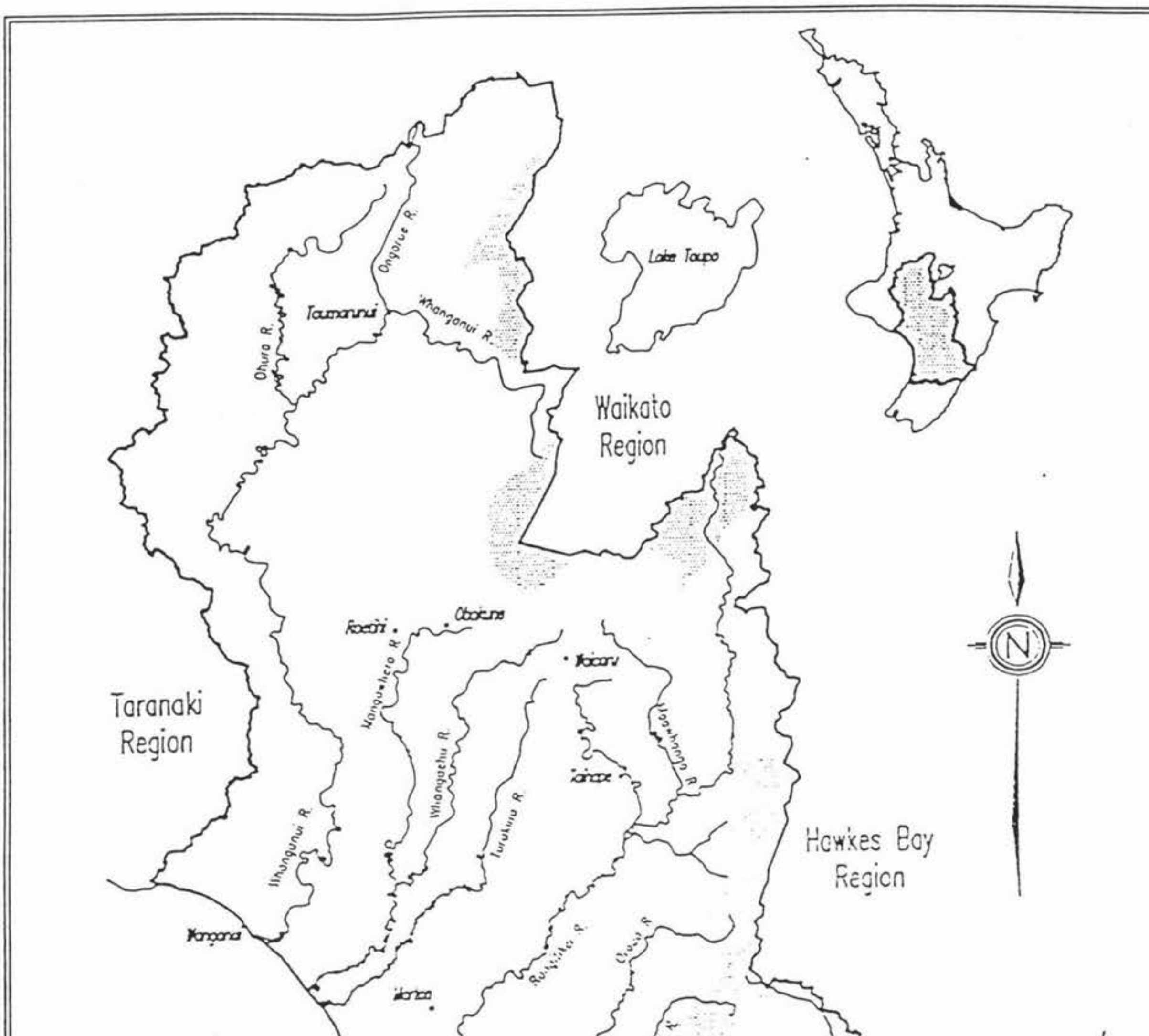
3.2 EARLY HISTORY AND SETTLEMENTS

Archaeological evidence suggests that Maori settlements existed within the catchment as early as 1400 to 1650 AD in what is now the Horowhenua District. These settlers are thought to have led a semi-nomadic hunting life. By the 1820s, tribal settlement patterns were more or less stable with the Rangitane tribe settling in what is now the Manawatu District and the Mua-Upoko on what is now the Horowhenua District. Permanent settlements are thought to have taken place later along the river course. Since the 1700s, the Manawatu River has supported relatively populous settlements within the catchment (Manawatu-Wanganui Regional Council, 1993c). According to Holland (1992), historians in 1874 approximated the Maori population to have been about 3,400 in 1855. In addition to being settlement sites, the rivers acted as the principal transport routes between the coast and the interior and provided for their livelihood. The early settlers obtained crayfish and shellfish from the rivers and cultivated the mudflats.



Source: Manawatu-Wanganui Regional Council

Figure 3.1 Manawatu River catchment area



Source: Manawatu-Wanganui Regional Council

Figure 3.2 Manawatu-Wanganui Region

The early 1800s saw the coming of European settlers, who first settled at Paikia, some 15 km upstream the Manawatu River mouth. Soon Foxton became the main European settlement along the coast. It prospered as an export outlet for flax, timber, and agricultural products that originated in the Manawatu and Wanganui regions. The history of Palmerston North dates back to 1859 when an open piece of land was purchased by the government from Rangitane. The land was surveyed in 1866, and the growth of the township slowly started taking place with pastoral farming and agricultural industries producing butter, cheese and meat for export, stimulating its growth. The Manawatu River continued to be the principal transport route well until 1870s when roads were constructed to connect the coast and the interior (Manawatu-Wanganui Regional Council, 1993c).

Other townships started developing in the late 1860s especially in the Tararua District. Eketahuna, Mangamutu, Dannevirke, and Pahiatua are some of the townships that developed around this time following the extension of roads and the railway. Timber milling became the main economic activity, which was followed later in the 1890s by farming. Dairy creameries and butter processing factories had developed by 1897. Other significant townships that have since developed within the catchment include Feilding, Woodville, Shannon, and Levin (Manawatu-Wanganui Regional Council, 1993c).

3.3 GEOGRAPHICAL FEATURES

3.3.1 Ranges and rivers

Apart from the Manawatu River which is the focal physical feature in this catchment, there are other physical features that are of significance in the catchment. Figure 3.2 shows the river network system of the entire Manawatu-Wanganui Region. The Ruahine Range extends in a line from Mangaweka peak, south-south-westwards to the Manawatu Gorge. The Tararua Ranges then extend south-westwards and together they form the main divide. They essentially divide the catchment into a western and eastern sections that are about equal in size. The Manawatu River head waters are in the Puketoi Ranges on the eastern side. Mangaweka is the highest peak (1733m) on the Ruahine Ranges. Other tributaries rise in both the Ruahine and Tararua Ranges, joining the main stem of the river and flowing from the east to the west through the ranges at the Manawatu Gorge, another significant feature of the river. Below the Manawatu Gorge the river flows across the lower Manawatu plain before entering the Tasman sea on the west coast (Burgess, 1988).

The main tributaries of the river on the eastern side are the Mangahao, Mangatainoka, Tiraumea, Makakahi, Makuri, and Upper Manawatu Rivers. In the western side the main tributaries are the Oroua, the Pohangina and the Tokomaru Rivers which flow into the main stem of the river referred to as the Lower Manawatu River. There are no major lakes in the catchment. Few wetlands are left in the catchment due to drainage that has taken place for purposes of timber production, and agricultural and horticultural development. Nevertheless, there are a few remnant wetlands along the coast (Manawatu-Wanganui Regional Council, 1993c).

3.3.2 Landforms and soils

Most of the central North Island is a volcanic plateau. The Manawatu River catchment is dominated by five principal land forms namely: mountainland, hillcountry, downland plains and terraces, and sand country. The predominant soils in the Tararua and Ruahine Ranges are of the greywacke type (Manawatu-Wanganui Regional Council, 1993c).

A large section of the catchment is an alluvial plane. A common feature underlying the alluvial plains is the presence of deep aquifers. These aquifers are well confined by impermeable layers. The aquifers are good sources of water supply especially in the Horowhenua. The impermeable layer protects the ground water from surface contamination making the water suitable for domestic use (Manawatu-Wanganui Regional Council, 1993c).

The Manawatu Plain lies between the Tararua Ranges in the east and the Tasman Sea in the west. It is largely an alluvial plain of sedimentary rock, and has fertile soils which have been developed for grazing, cropping and horticulture. Eighty percent of the land area in the catchment is under farming and the rest is native forest in the Tararua state forest park or commercial pine forests. Being low lying, the Manawatu plain is prone to flooding, and major flood protection schemes and drainage constructions have been developed over the years to protect residential settlements and farmland (Manawatu-Wanganui Regional Council, 1993c).

The west coast is mainly characterized by sand dunes and coastal wetlands. The wetlands are mainly near the mouth of the Manawatu River. East of the ranges the landscape is characterized mainly by highly rugged topography and inland depressions produced by tectonic activity. Puketoi Ranges form the eastern boundary of the catchment. Soil type between the Tararua-Ruahine Ranges and the Puketoi Ranges is predominantly silt-loam, 3-6 m deep, overlaying shallow ground water. Historically the area was mainly swamp, now drained for agriculture (Manawatu-Wanganui Regional Council, 1993c).

3.4 CLIMATE

The Manawatu River catchment, as with the rest of the Manawatu-Wanganui Region, is affected by the main weather systems that affect New Zealand, except where local topographical modification effects have influence. Palmerston North is noted for its windy climate, with prevailing west to north west winds. It is believed that this phenomenon ensures high air quality over the area (Meteorological Service, 1982; Manawatu-Wanganui Regional Council, 1993c). West of the ranges the prevailing winds are westerly. The south east winds are responsible for the shaping of sand dunes along the west coast (Burgess, 1988).

The close proximity of Palmerston North to the Tararua Ranges results in low sunshine of 1794 hours per year. The western coast experiences 2087 hours of sunshine annually. Elsewhere in the catchment annual sunshine hours vary from 1754 at Dannevirke to 1865 at Levin (Meteorological Service, 1982).

Palmerston North and the rest of the western section of the catchment receive reliable and evenly distributed rainfall throughout the year. Mean annual rainfall is about 995 mm in Palmerston North. In general the eastern part of the catchment receives low rainfall though Dannevirke receives 1093 mm per year. Winter is the wettest period while the driest period is during summer and autumn. On average, the catchment has 150 to 175 days of rainfall per year (Meteorological Service, 1980).

Manawatu and Horowhenua experience moderate temperatures with summer highs reaching 19°C to 23°C. Average low temperatures range between 9°C and 13°C. Sea breezes cause slightly lower summer temperatures along the coast than the interior (Meteorological Service, 1980).

There is a locally significant climatic effect created by the Ruahine, Tararua and Puketoi Ranges in the eastern section of the catchment. For instance, Mangamutu, which is near Pahitua, experiences 67.7 days of ground frost per year and the upper Mangatainoka catchment experiences snow fall in winter and spring. These cold features are not experienced in the western side of the catchment. These effects can be attributed to the shelter provided by the ranges against westerly winds (Manawatu-Wanganui Regional Council, 1993c).

3.5 VEGETATION AND WILDLIFE HABITATS

Native plants such as pingao and sand pimelea thrive within the Manawatu River catchment. In such vegetation, native animals like dabchick, fernbird, brown mudfish and golden stripped gecko make their habitat (Manawatu-Wanganui Regional Council, 1993c).

Vegetation in the Ruahine and Tararua Ranges undergoes transformation as one ascends the ranges from alpine grassland at the base, through scrubland and beech (kamah) to podocarp forest. The principal alpine grass at 1400 m is snow grass while such trees as kaikawaka, mountain beech and, pink pine (Hall's totara) dominate the high forest areas. Podocarp forest is dominated by the rimu, matai, kahikatea maire, and tawa. Under such vegetation, birds such as the bellbird, tui, New Zealand falcons and pigeons and the New Zealand robin make their homes (Manawatu-Wanganui Regional Council, 1993c).

The wetlands and the sand dunes along the western coastline, though stripped off much of their native vegetation, still retain localized areas of native habitat. Such habitats are suitable environments for flax, and reeds as typical vegetation. Plant life in coastal esturine and water include algae, and sea weed Animals that have made these wetlands their habitats include periwinkles, blackmussels, toheroa, tuatua, and the paddle crab. The Manawatu estuary is a bird habitat of regional and national significance (Manawatu-Wanganui Regional Council, 1993c).

3.6 DEMOGRAPHIC FEATURES

Table 3.1 The population of the districts of the Manawatu River catchment at the 1991 census

District	Population 1991	Percentage
Manawatu	27,182	18.56
Tararua	19,482	13.30
Horowhenua	29,476	20.13
Palmerston North	70,318	48.01
Total	146,458	100.00

Source: Department of Statistics

About 50% of this population lives in Palmerston North City, 20% in other urban areas of Feilding, Levin, Dannevirke, and the remainder in the rural countryside and small rural townships. The total population of the study area was 146,458. Given that the population of New Zealand is 3,434,950, the catchment population approximates to about 4.26% of the New Zealand population. (Department of Statistics, 1991a).

The districts of the catchment contain a multicultural population that includes people of European, Maori, Pacific Island, and Asian descent as the main representatives. The European population is the largest, making up about 81% followed by the Maori population of about 9%.

If an assumption is made that the population distribution by age exhibited in the entire Manawatu-Wanganui Region is echoed within the Manawatu River catchment districts, then one can infer that 16% of the population of the catchment is between 20-29 years old, making it the largest age group. The next largest age group is the over

60 years, which constitutes 15.7% while the under 5 years forms the smallest group of only 8.6%. However, there are slight localized deviations from one district to another (Department of Statistics, 1992).

3.7 ECONOMIC, RECREATION, AND SOCIOCULTURAL HERITAGE

Historically the mainstay of the Manawatu catchment economy has been forestry and farming. Over time, however, this trend has changed. The urban areas now accommodate a growing sector of manufacturing and service industries. The entire Manawatu-Wanganui Region experienced a 1.5% annual economic growth between 1987 and 1991. This is relatively good on the national scale. During the same period, employment in New Zealand decreased by 9.9% but the region only experienced a decrease of 6.1%. Wholesale and retail trade employs 33% of the Manawatu-Wanganui Region's population. The social and personal service industry engages 13%, business and financial services 11%, while the Manufacturing sector employs 10% (Department of Statistics, 1992b).

Palmerston North is a centre of education. Massey University and other educational, scientific, and research institutes are located in Palmerston North. Massey University, Palmerston North Campus, enrolled 8,855 internal students and 17,270 extramural students in 1994. The university employs 1724 equivalent full-time academic and general staff members. For the financial year ending December 1993 the University's income was $125 million (Massey University, 1994). Other institutes that contribute to the economy of the region include Manawatu Polytechnic, College of Education, International Pacific College, and research institutes like Dairy Research Institute. The presence of these institutes contribute significantly to the economy of the city.

3.7.1 Agriculture and horticulture

The rural areas still support agriculture, which differs from one district to another. The Manawatu and Tararua districts lean towards pastoral farming, while the Horowhenua does well in dairying and horticulture. The Manawatu River is a key resource for farming in the region. Farmers and horticulturalists depend on the watercourses for water supplies for stock, irrigation and farm effluent disposal. Water quality in the rivers becomes an important issue to the farmers if the water is to be suitable for animal consumption (Manawatu-Wanganui Regional Council, 1993c).

3.7.2 Recreation and tourism

A number of physical features exist within the catchment that offer tourism and recreational opportunities to residents and visitors alike. The Ruahine and Tararua Ranges offer opportunities for tramping, viewing the scenic beauty of the state forests, bird watching, photography and many other outdoor activities. Palmerston North is an important centre for conferences, sports, and the educational visitors industry. With an estimated 450,000 domestic and international visitors to the region annually, there are prospects of increased development of tourism spending and employment in the region (Manawatu-Wanganui Regional Council, 1993c).

The importance of the Manawatu River as a source of recreational opportunities is worth special mention with respect to water quality. The river provides recreational activities in which the participants come in direct contact with the water, such as fishing, canoeing, whitewater rafting, whitebaiting, and jetboating. The river is also important for recreationists who seek activities in which they do not come in contact with water, but in which the river forms part of the landscape. Such activities include sightseeing, picnicking, photography, and tramping. Different sections of the river afford better opportunities than others for various activities. For instance, most boating takes place downstream of the Manawatu Gorge, while water skiing is best between Shannon and Whirikino. Swimming is a favourable activity at Raumai, and Totara swimming holes in the Pohangina River; Albert St., Nelson St. and Horseshoe Bend in the Oroua River;

and Whirikino ramp and Ashhurt bridge. Similarly, fishers frequent the Manawatu estuary, also the Manawatu, the Mangatainoka etc. (McLennan, 1984).

A significant number of people engage in bird watching, while duck shooting has a special place in the calendar of many New Zealanders. Birds, therefore, provide another aspect of recreational opportunities provided by the Manawatu River particularly in connection with the river estuary at Foxton.

3.7.2.1 Manawatu River estuary

The Manawatu estuary is a significant bird habitat to the region and the nation. Bird counts at the estuary between 1958 and 1987 by the Ornithological Society of New Zealand (1985) revealed that there are about fifty eight species of birds associated with the habitat. About twenty four species of these are residents of the estuary and the rest are visitors at one time or the other. The wader family is predominant with about twenty five species present, including stilts, godwits, and oystercatchers. Another family of species is the heron family, including the of royal spoonbill, white-faced and white Heron, little and cattle Egret and Glossy and white Ibis (Ornithological Society of New Zealand, 1985).

From a regional point of view the estuary is an important habitat for wading birds on the west coast of the North Island, south of Kawhia harbour in Waikato. On a national scale the Manawatu estuary qualifies as a *wetland of national significance* on the basis of International Union of Conservation of Nature (IUCN). IUCN recommends that a habitat be accredited national status of significance if it supports at least 1% of the national population of any species. Records show that numbers of Royal Spoonbill, Least Golden Plover, and Far Eastern Curlew at the estuary exceed the 1% of the national population (Ornithological Society of New Zealand, 1985).

It has been mentioned above that much of the native wetland vegetation of the Manawatu catchment was cleared for agricultural and horticultural development. Human development has affected the Manawatu estuary in a rather different way than other wetlands within the region. The wetland has been altered due to the introduction of

Spartina Codgrass to the estuary. From the time it was introduced in the estuary in 1913, *Spartina* has spread to over 50% of the estuary mudflats.

Observations made from 1982 onwards indicate rapid spread of *Spartina* over the mudflats. In response, the Department of Conservation is currently involved in a spraying programme to control the weed. There are questions about the implications for water quality from the spraying programme.

3.7.2.2 Fishery Resources

The main sport fish species in the Manawatu River is trout. There are two species of the Manawatu fisheries, the brown and the rainbow trout. The brown trout is by far the most abundant. Other angling species include salmon, and perch. The trout is relatively abundant in the Manawatu compared to other fisheries in the nearby rivers. Special features of all fisheries of the Manawatu catchment include their large fishable areas, and their proximity to population centres. This enables more people to afford fishing without having to incur travel expenses. Most of the urban settlements in the Manawatu catchment, like Palmerston North, Feilding, Foxton , Dannevirke, and Pahiatua are built on the banks of the rivers. This close proximity is in itself an attribute of great value in resource utilization. The rivers are also abundant with indigenous fish like the flounder, eels, whitebait, bullies, smelt and others (Taylor, 1994).

According to a 1986 survey, the main stem of the Manawatu River receives about 980 anglers who made up to 8600 visits to the river during the 1985 - 1986 angling season. The river, according to survey results provides very good angling experience. It was recorded that anglers achieved a 10.47 mean seasonal catch. A comparison of the catch during the same season with other Wellington district rivers, indicated that the Manawatu scored highest. The Mangatainoka was reported as the most heavily fished river tributary of the Manawatu. The tributary received the highest number of visits per angler per season. One explanation for such a high visitation rate to a relatively short river is that the anglers receive a high average catch from the river. According to the report, the Mangatainoka offers beautiful scenic surroundings, good access and good catch characteristics. The river was rated highly by the anglers (Smith, 1986).

The Makuri river affords unique fishing opportunities in the sense that anglers value it highly due to its peaceful, scenic, challenging surroundings, and the cool spring fed water of the river. The river is also reported to have large sized fish. Other rivers like the Pohangina and the Oroua do offer such notable fishing opportunities but these opportunities are just average (Taylor, 1994).

Poor water quality was consistently identified by about 50% of the anglers surveyed in the Wellington district rivers survey, as a source of concern that threatens the catchment fishery resource. It is suspected for instance that pollution from Feilding is a probable cause of falling numbers of anglers using the lower reaches of Oroua River. A significant source of pollution in the rivers is sediment, which is of concern to the Wellington Fish and Game Council. Other threats to the fisheries include river stability, especially in the Mangatainoka, and nutrient enrichment from nonpoint source discharges (Taylor, 1994)

3.7.3 Maori cultural heritage

Water is perceived as a "taonga" (an invaluable treasure). To some tribes it is a gift from their ancestors that comes with a responsibility to care for it and pass it on to future generations. Not only is water in its various forms seen as a valuable physical resource that provided for their kai (e.g eel), but as having "mauri" (metaphysical life forces), and also "wairua" (spiritual dimension) (Otago Regional Council, 1993; Taranaki Regional Council, 1994).

The Maori people talk about the "Kerero" of the river (the story of the river). Part of that "kerero" explains the formation of the Manawatu Gorge. The story of the Manawatu is held by Rangitane, who live in both the eastern and western sides of the catchment. One such story is recorded by Buick (1975).

> Away upon the slopes of the Puketoi Ranges there grew in the days of old a giant totara tree, into which the spirit of a God called Okatia suddenly entered, and endowed it with the power of motion, whereupon it wormed its way over the land, gouging out a deep bed as it went, until

> it came to the mountain chain which separates the East from the West coast. Then it clove a course for itself through this huge barrier, which the mighty Okatia split asunder as easily as a child would break a twig, and on passed the inspired tree, ploughing its irresistible way with many serpentine wanderings towards the sea, leaving the turbulent waters and still reaches of the Manawatu River flowing in its wake.

The river is imbued with "mauri", which represents the interconnectedness of all things in the world. Inappropriate use of the river, for example, the discharge of sewage to the rivers and streams impacts directly on the mauri of those waterways and therefore all factors associated with them.

3.7.4 Waste water treatment and disposal

The use of the Manawatu River and some of its tributaries as a source of waste water treatment and disposal is of significant importance. According to Anderson (1993), this function of the river represents perhaps the single greatest existing use of the river. On average, the Palmerston North city sewage flow in dry weather is 22,400 m^3 per day. It is expected to increase to 30,000 m^3 per day by the year 2011 when the population of the city is projected to be 73,000. Twenty five percent of the sewage is trade waste and the rest is domestic waste. The main contributors of trade waste include the Fitzherbert Science Research Centre, and food and dairy factories.

The history of sewage disposal into the Manawatu River from Palmerston North dates back to 1890, when the river first received untreated effluent from an open septic tank system (Matteson, 1977). The growing population of the city made it necessary to replace the open septic tank disposal system by a primary treatment in 1968. In 1985, the secondary treatment facilities were commissioned which afforded biological treatment by two aerated lagoons.

Other urban areas within the catchment that use the rivers for waste water discharge include Feilding (8,640 m^3), Dannevirke (6,370 m^3), Foxton (2,880 m^3), and Woodville (1,296 m^3) per day (Manawatu-Wanganui Regional Council, 1992).

The use of the Manawatu River for waste disposal has significant implications for water quality. Water quality in the vicinity of Palmerston North has particularly attracted greater attention with a substantial number of water quality studies having been carried out. According to the Manawatu River Catchment Water Quality Regional Plan 1994, there are 24 discharges of treated sewage, 32 discharges of industrial waste, 378 discharges of dairy and piggery effluent system and an unknown number of urban and rural stormwater discharges that are classified as point source discharges into the Manawatu River. Non-point discharges include 427 dairy sheds and piggeries, 13 industries, and leachate leaking from rubbish tips and farm and forest runoff. Non-point runoff constitutes those discharges that are disposed of onto the land and, through runoff, get into the river.

Records reveal that prior to early 1970s water quality downstream of Longburn in Palmerston North was unacceptable. The river was characterized by prolific growths of sewage fungus (Anderson, 1993). A report by Hirsch (1958) indicates the presence of untreated wastes from Longburn industries in the river water.

3.7.5 Gravel extraction

There are numerous sites, both large and small, within the Manawatu River catchment from where gravel is extracted. There are 186 large sites from which more than 500 m^3 gravel is extracted annually. In total, about 309,500 m^3 of gravel is extracted per year for use in various construction and building works. Gravel extraction is therefore of enormous significance as an economic activity provided by the river systems within the catchment. The main rivers from which the extraction takes place are the lower Manawatu River, from which 132,000 m^3 of gravel are extracted per year from 20 sites; the Pohangina River, which yields 53,000 m^3 from 10 sites; the Oroua River yields 30,000 m^3 from 13 sites; the upper Manawatu River, main stem which provides 54,500 m^3 from 11 sites; and the Mangahao and Mangatainoka rivers. The highest yielding mine is located at Raukawa Road on the lower Manawatu River upstream of Palmerston North. A total of 30,000 m^3 of gravel is extracted from this mine (Manawatu-Wanganui Regional Council, 1992).

3.7.6 Hydropower generation: Mangahao Power Scheme

Electricity Corporation of New Zealand Limited (ECNZ), has dammed the waters of the Mangahao River on the eastern side of the Tararua Ranges for hydroelectric power generation since the 1920s. There are a total of three dams, two located on the Mangahao River and one on the Tokomaru River. The dams act as reservoirs to supply water to the power house located at Shannon, generating 20,000 KW of power. The waste water from the power house is discharged into the Mangaore stream, another tributary of the Manawatu River.

There are a number of environmental, recreational, and cultural issues that require attention in relation to the existence of this power generation scheme. Some of these issues include the effects of desilting the dams on the recreation use of the Mangahao River; the effects of discharging waste water from the power house into the Mangaore stream; flood control at the Mangahao River due to the dams; the flood risks at the Mangaore stream; Maori interests on the rivers and dam safety issues. The desilting process has raised concerns because it has damaging effects to macroinvertebrates of the rivers and causes disturbance of the fishery resources (Electricity Corporation of New Zealand, 1992).

3.8 WATER QUALITY MONITORING

The physical and chemical composition of water is the benchmark upon which the quality standards of water are based. The effect of the water on instream biota is also used to measure water quality, but this effect is still dependent on the chemical composition of the water. There are a wide range of indicators used to assess water quality, including the macroinvertebrate community index (MCI), suspended solids (SS), dissolved oxygen, biochemical oxygen demand (BOD), the nutrient content of the water, type of biological growth, water pH , conductivity, and bacteria content of the water.

MCI is a methodology that measures the presence of certain invertebrates in water. The main invertebrates used are larvae of insects, like stoneflies, mayflies, and caddisflies, that make their habitats under stones in river beds. Suspended solids are solid particles suspended in water, that affect the turbidity of the water which influences the colour and clarity of the water. This in turn affects the amount of light which can penetrate water. Water clarity is measured using the horizontal visibility of a 200 mm black disc. Dissolved oxygen is the concentration of oxygen in water measured in g/m^3, and BOD is a measure of the demand for the dissolved oxygen by organisms which break down organic matter in the water. Implicitly then, BOD can be used as a measure of organic matter concentration in water. The main inorganic nutrients measured as indicators of water quality are nitrates and phosphates. Phosphorus content is monitored by measuring the dissolved reactive phosphorus (DRP) in g/m^3. The nitrogen content in water is monitored by measuring dissolved inorganic nitrogen (DIN), nitrates, or ammonia in g/m^3 (Manawatu-Wanganui Regional Council, 1994).

Two categories of biological growths are used to indicate water quality in the rivers, namely sewage fungus (heterotrophic slime) and autotrophic organisms, which include benthic algae and aquatic plants. The sewage fungus is clumps of bacteria and fungi that is feathery or cotton-like in appearance. On the other hand the benthic algae are plant growths found growing on solid surfaces in the river bed (Manawatu-Wanganui Regional Council, 1994).

On a monthly basis the MWRC carries out specific impact monitoring of water quality at a number of sites throughout the catchment. On the basis of a 1988 MCI, it was concluded that the Manawatu and the Oroua rivers are grossly polluted downstream of Dannevirke and in the vicinity of Feilding, (Manawatu-Wanganui Regional Council, 1993).

On the basis of suspended solids (SS), it was concluded that water clarity in the entire catchment during low summer flows was good, with the suspended solids content being less than 2 g/m^3. However, during flooding, the suspended solids content increases rapidly to concentrations of up to 5,500 g/m^3 in places like Palmerston North. In general, the horizontal visibility is poor at places like Opiki, downstream of Palmerston North, and has never been recorded to be greater than 1.6 m (Manawatu-Wanganui Regional Council, 1994).

At 20°c saturated dissolved oxygen concentration in water is 9.1 g/m^3, which is the ideal for fauna and biota. On the basis of this criteria, rivers in the Manawatu catchment fare quite well with records showing 8 g/m^3 on a regular basis, with exception of the Lower Manawatu where concentrations below 5 g/m^3 have been recorded. This is a source of concern. The performance of the rivers in terms of BOD is generally good, except for a few occasions when excessive oxygen depletion has occurred during summer low flow periods (Manawatu-Wanganui Regional Council, 1993).

Two main factors influence the amount of nutrients in the watercourses of the catchment. One is the rate of discharge of waste water and runoff into the rivers. The other is the rate of removal of nutrients from the water. Removal of nutrients is mainly due to adsorption by instream sediment and uptake by biota. According to McBride and Quin (1993), the dissolved reactive phosphorus (DRP) concentration decreases as flow decreases, upstream of point discharges and the DRP is said to be less than 15 mg/m^3 at such sites. On the other hand, sections of the river downstream of point source discharges show that the DRP concentration increases as flow decreases due to less dilution. During periods of high flow, DRP concentrations increase in the river. This is expected to be caused by runoff from rural land. Point sources are generally diluted by higher flows and have relatively less effect at those times. During low flows, water quality is less affected by rural runoff and DRP concentrations are generally less than 15 mg/m^3. Point sources have a relatively high impact at this time.

Studies show that almost all tributaries of the Manawatu River contain a concentration of nitrates of over 1.0 g/m^3 as compared to 0.8 g/m^3 recorded in the main stem of the Manawatu River downstream of Palmerston North. This observation may be explained as a result of the absorption of the nitrates by undesirable biological growth in this section of the river (Ministry for the Environment, 1992).

The main effects of sewage fungus growth are that it degrades the aesthetic nature of the river, it makes it difficult for fish and other invertebrates to spawn, and can cause instream oxygen depletion. The growth of sewage fungus is influenced by physical factors such as temperatures and flooding. Lower temperatures and the scouring effect of floods during winter reduces sewage fungus growth drastically (Ministry for the Environment, 1992). On the other hand, high temperatures and low river flow promotes sewage fungus growth. According to Quinn and Gilliland (1989), at sites within a few kilometres of major discharges in Palmerston North, dissolved oxygen was below 5 g/m^3 between 1982 and 1984. These low levels of dissolved oxygen were caused by significant sewage fungus growth. These measurements were recorded during summers when the flow in the river was below 20 m^3 per second.

Under normal conditions, nutrient levels in the watercourses should support biological growth that is almost invisible on the stones and in the riverbed. But as the nutrient levels increase to pollution levels, growth intensifies resulting in a thick mat covering the bottom of the riverbed. Sites below Dannevirke have been visually judged to have excessive algal plant growth on the beds during low flow summer periods.

3.9 THE RESOURCE MANAGEMENT ACT 1991

The Resource Management Act became effective on 1 October, 1991. It is the overriding statute for the management of land, soil, water, the coast, air, and for the control of pollution. It defines the rights and duties of central and local government and creates institutional structure for resource management. The purpose of the act is to promote sustainable management of natural and physical resources (Section 5, Resource Management Act, 1991).

Sections of the Act that are of particular relevance to this study are, in part, produced below.

5. Purpose-

(1) The purpose of this Act is to promote the sustainable management of natural and physical resources.

(2) In this Act, "sustainable management" means managing the use, development, and protection of natural and physical resources in such a way, or at a rate, which enables people ... to provide for their health and safety while-

- (a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
- (b) Safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and
- (c) Avoiding remedying, or mitigating any adverse effects of activities on the environment.

6. Matters of national importance-

In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, ... of natural and physical resources, shall recognise and provide for the following matters of national importance:

(a) The preservation of the natural character of ... rivers and their margins, and protection of them from inappropriate ...use, ...:

(c) The protection of areas of significant indigenous vegetation and significant habitat of indigenous fauna:...

(e) The relationship of Maori and their culture and traditions with their ancestral lands, water, sites, ...

7. Other matters-

In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to use, ... shall have particular regard to-...

(c) The maintenance and enhancement of amenity values:

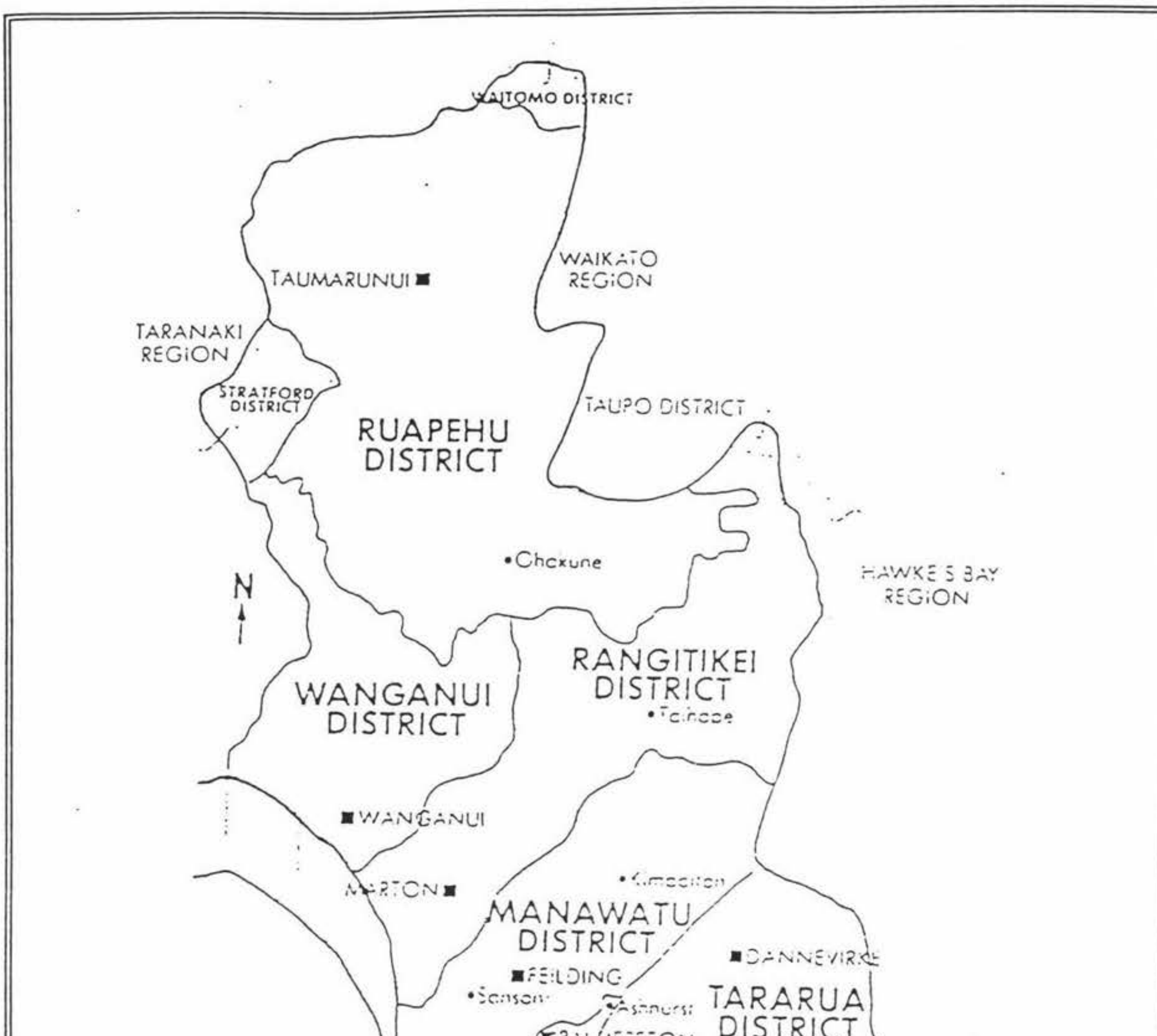
(e) Recognition and protection of the heritage values of sites

(h) The protection of the habitat of trout and salmon."

The functions of regional councils are defined in section 30 of the Act.

3.9.1 Manawatu-Wanganui Regional Council

This regional authority came into being on 1 November, 1979 through the amalgamation of 40 former local bodies within the region. These bodies were formerly catchment and Regional Water Boards, United Councils, Noxious Plants Authorities, Pest Destruction Boards, and Drainage Boards. As well as taking up all the duties of these dissolved authorities, the Manawatu-Wanganui Regional Council (MWRC) took over central government functions, such as of natural hazard mitigation (Manawatu-Wanganui Regional Council, 1993a). The map in figure 3.3 shows districts within the Manawatu-Wanganui Region. Other catchments within the region are the Rangitikei and the Wanganui River catchments. These fall within Rangitikei, Wanganui and Ruapehu Districts respectively. The powers, duties, and functions of the MWRC are defined by the RMA 1991 section 30 which in part states that "Every regional council shall have the following functions... the maintenance and enhancement of the quality of water in water bodies...".



Source: Manawatu-Wanganui Regional Council

Figure 3.3 Manawatu-Wanganui Region district boundaries

3.10 SUMMARY

The Manawatu River catchment, the area of interest for this study, is a natural resource managed by the Manawatu-Wanganui Region. The region is richly endowed with natural resources, and rivers occupy a significant place in the history, culture, economics and recreation of the region. The Manawatu river, having played a leading role in determining the early settlement patterns in the region, continues to play a significant role in the sociocultural and the economical aspects of the region. The river carries significant economic, aesthetic, and spiritual values to the people of the Manawatu. The farming community depends on its waters for irrigation; the urban areas depend on the river for industrial and domestic waste disposal; the building industry relies on its banks for gravel extraction; the recreation and tourism industry is centred around the river, and electricity is generated from its waters.

The regional council acts on behalf of the public to manage the resources within the region as governed by the RMA 1991. The council is therefore a decision making body that is accountable to the public. Since the council acts on behalf of the people, if its members understand the nature of the resources and the values people place on these resources, they are to manage the resources in accordance to the preferences of the people, within the statutory framework of the RMA. In respect to this perception, that the discussion in chapter four - a methodology to determined people's preferences and values for purposes of guiding policy formulation in natural resource management is represented.

CHAPTER FOUR

METHODOLOGY

4.1 INTRODUCTION

In this chapter, a survey methodology is developed to explore people's visitation habits to various sections of the Manawatu River, and to discover the activities they participate in while visiting the river. The survey will also be used to elicit people's opinions and attitudes towards water quality. The methodology is used to estimate the dollar value residents of the Manawatu River catchment would place on improved water quality in the Manawatu River. The section of the river of interest is between Palmerston North and the Tasman sea at Foxton. This area is referred to as the Lower Manawatu River.

4.2 CHOICE OF TECHNIQUE

In Chapter two, extensive coverage of the various methods available to carry out nonmarket valuation analysis was given. The survey approach was selected as the appropriate one for this study. The survey approach can be implemented using a wide variety of techniques. The contingent valuation method (CVM) is favoured as it is the only method which can derive both user and non-user benefits in which option, existence and bequest values are included. In this section, a detailed discussion of implementing a CVM survey is presented.

The CVM is a survey method that can be conducted using three different approaches: personal interviews, telephone surveys, or mail questionnaires. Personal interviews are ideal for in-depth information gathering. However, they are expensive to administer, especially if the population to be surveyed is widely spread geographically. One should consider using personal interviews in situations where the target population is compact. On the other hand, if information required is less detailed, and if the interviewer does not have to explain details to the respondent, a telephone interview may be more appropriate. It provides quick answers and is useful for very small population samples. The current research requires a lot of information to be transferred from the researcher to the respondent to enable the respondent to understand the nature of the good being valued. This ruled out the use of telephone interview (Sheppard *et al.*, 1993).

A mail questionnaire is less costly than the personal interview and relatively rapid, yet detailed enough to transfer just enough information needed by the respondent to answer the questions. Thus the mail questionnaire has been used to gather data for this research.

4.3 BACKGROUND INFORMATION GATHERING

Apart from reviewing the literature on contingent valuation, there was need to have an understanding of local issues concerning the Manawatu River. One particular source of information was from submissions presented to the Manawatu-Wanganui Regional Council in response to the Manawatu River water quality Plan Discussion Document (Manawatu-Wanganui Regional Council, 1993b). Personal contacts with the submitters was useful in understanding the issues. Many other members of the public were contacted by the telephone or mail. Submitters varied from representatives of organizations such as acclimatization societies and town councils, to individuals. Field trips to meet the people at various river sites as far as Foxton were made. Anglers at Foxton estuary were interviewed personally.

Another area of important background work was listening to submitters at public hearings of submissions on the Regional Policy Statement conducted at the Manawatu-Wanganui Regional Council. An actual tour of the Palmerston North City Council sewage treatment plant was also made. The plant was a constant source of reference in submissions to the Regional Policy Statement on water quality.

4.4 SURVEY POPULATION

The questions asked about the use of the Manawatu River and its tributaries are best answered by an individual who is close to the waterways. This factor made it necessary to target respondents that live within the river catchment only. It is unlikely to find many people at the national level that have visited the river. Therefore, it was necessary to survey the Manawatu River catchment population.

There were three options from which one could choose to obtain a listing of the households from: the population census, the parliamentary electoral roll and the telephone directory. The population census was ruled out as it was thought to be costly. The parliamentary electoral roll was also not appropriate as there was not a one-to-one correspondence between roll entries and households. The telephone directory was chosen as it was thought to be up to date. The number of unlisted households was assumed to be small, it had a low number of duplicated households, and it was readily available.

4.5 SAMPLING PROCEDURE

Recent surveys that have employed the CVM have achieved a response rate of between 35 per cent and 50 per cent - Sheppard *et al.*, (1993) got 44.2 per cent; Rosawati, (1993) had 46.7 per cent and Greer and Sheppard, (1990) achieved a 47.1 per cent. For this survey the goal was to collect about 600 observations. This is a reasonably good figure in regard to finances available to carry out the research. Assuming a response rate of 40 per cent, it therefore required that a total of 600/0.40 = 1500 potential respondents be contacted.

The Manawatu 1994 telephone directory was used to provide a listing of households in the study area west of the Manawatu Gorge. Names from the Bulls calling area in the directory were not included because this area falls outside the Manawatu River catchment. Names from east of the Manawatu Gorge were selected from the Pahiatua calling area in the Wairarapa 1994 telephone directory. Thus the survey sample drew names from Palmerston North City, and the Manawatu, Horohwenua, and Tararua districts.

An effort was made not to select names of business firms, institutions, government departments and organizations, because they do not fit the definition of household as used in this study.

4.6 QUESTIONNAIRE DESIGN

See *appendix I and II* for the survey introductory letter and questionnaire.

Several specific attributes have been suggested in the design of questionnaires for CVM (Harris, 1983; Sheppard *et al.*, 1994; Edwards and Anderson, 1987; and Thayer, 1980). These authors suggest several characteristics of a good questionnaire.

- It should provide "user friendly " lead-in material and quality presentations to encourage participants to complete the questions and send the forms back.
- It should be realistic and credible to the interviewee, providing adequate information to enable comprehensive understanding of the commodity under valuation. The respondents should not be "over educated" through the questionnaires as this will not reflect the views held by the general population.
- It should suggest a realistic payment vehicle to enable the respondents to objectively assess their WTP, with the expectation that an actual payment of that amount may result from the research.
- It should provide a check for strategic bias, at the end of the survey so that extreme values can be eliminated.
- It should be designed to minimise starting point bias.
- It should use either equivalent or compensating surplus as the basis for the evaluation, or use both if it is not obvious which is to be the benchmark.
- It should address non-response bias by providing information to carry out a regression analysis with respect to demographic attributes of the respondents in relation to the WTP. According to findings by Willis and Garrod (1991), there should be evidence from the regression analysis to suggest a strong relation between the WTP and the demographic attributes. If this is not shown to be so

then there will be a reason to carry out further investigation into the data and alterations would become necessary.

Another step that can be pursued in dealing with non-responses is to carry out survey on the non-respondents. The aim here is to gather information on those variables found to be significantly related to WTP among the respondents.

The questionnaire was divided into three sections: Section I focused on finding the general visitation habits of households to the various sections of the Manawatu River and the various activities they participate in. Households were asked how much time they spent visiting the river during summer. A map was provided for the respondents to indicate the parts of the river they visited.

It is important to know how much time households spend visiting the Manawatu River because this is one way of measuring the importance of the river to the welfare of the people. Question 1, 2, and 3 sought to establish the amount of time households spent at the river. In question 4 households were asked to indicate what activities they participated in at each section of the river that they visited. If households indicated that they did not visit certain sections of the river they, they were asked to provide reasons why they did not visit that section of the river, or the entire river at all in question 5.

The aim of question 5 was to establish people's perception of water pollution in the Manawatu River. Question 6 asked the respondents to rate water quality in the whole catchment on a 0 to 4 scale where 0 represented a totally unacceptable condition and 4 represented a totally acceptable condition.

Section II focused on the Lower Manawatu River and sought to investigate the respondents' opinions, and valuation of water quality. Question 7 was divided into part (a) and (b) and a choice of indicators of water quality. The list of indicators provided was obtained from personal communications, telephone, and mail contacts with members of the public. In the communications, members of the public were asked to list factors that influence their decisions on the use of water based recreation. Part (a) asked the respondents to report how important each of the listed indicators were to them in making decisions about visiting a river. Having provided their preferences they were then questioned about their opinion on the state of the water in the Lower Manawatu River in respect to those indicators. Question 8 asked the respondents to indicate the effect improvement of water quality would have on their use of the river. It was expected that if poor water quality was a reason for failure to use the river, then those households affected would increase their usage of the river in the wake of quality improvement, or they would at least keep usage at the same level.

Responses to be obtained from these three questions would provide managers of water resources with information on relevant attributes of water quality which are of importance to the people. Resource managers would get a qualitative indication from question eight of how people's welfare can be affected if water quality was improved.

The public needs to understand that improvement of water quality in the river is achieved at a cost. A contingent market model is formulated to enable the public to place a dollar value on improved water quality. Many researchers use visual aids like photographs to depict the condition being evaluated. The researcher may choose to have two photographs A and B in which photograph A shows the poor water conditions and photograph B would show the improved water conditions hoped to be achieved. The researcher then asks the respondents to state how much they are willing-to-pay to achieve the improved water quality standard (Harris, 1983). In the survey, no photographs were used but a thorough description of the present water conditions was presented. This was contrasted with contact recreation water quality standards which were set to be achieved in the future. It was hoped that the descriptions of the two situations would help the respondents create mental pictures to enable them distinguish the two situations and evaluate them. The respondents were made aware also that there was a cost that comes along with the improvement of the water in the river.

Having created the contingent valuation scenario, the respondents were then asked in question 9 if they were willing to contribute in increased rates towards water improvement in the river. In question 10 those who indicate their willingness to contribute were presented with one of the several specific dollar bids: $1, $5, $10, $15, $20, $25, $30, $35, $40, $50, $60, $70, $90, $110, $150, and asked if they were willing to contribute that much towards water quality improvement. They were required to respond either "yes" or "no". Table 4.1 shows the number of households that were assigned the different bids. There was no particular formula used to determine the number to be assigned to each bid. It was reasoned that the probability of household willingness-to-pay would decrease as the bid increases. Therefore higher bids were assigned higher numbers of questionnaires to ensure some returns were obtained for each bid level. See table 4.1.

Those respondents who indicated in question 9 that they were not willing to contribute towards water quality improvement were asked in question 11 to give two reasons why they were not willing to contribute. A list of possible reasons was provided from which they were to tick any two reasons that applied in their case. Question 12 sought to establish how soon the respondents wished to see improved water quality attained in the Lower Manawatu River from the time the clean-up starts.

Table 4.1 Questionnaire distribution over the different bids

Bid ($\$X_i$)	Distribution of questionnaires
1	10
5	20
10	30
15	40
20	50
25	60
30	70
35	100
40	130
50	140
60	150
70	160
90	170
110	180
150	190

Section III focused on socioeconomic and demographic information of the households. Question 13 asked about the sex and age structure of the households. Questions 14, 15 and 16 asked about sex, age and occupation of the respondent. Questions 17, 18, 19, and 20 asked about household total annual income, household distance from the Lower Manawatu River, the length of time the respondent had lived in the Manawatu River catchment region, and the district they reside in respectively. In question 21 the involvement of the household in environmental groups was questioned. Finally question 22 gave the respondents a chance to air their views on any issue concerning water quality within the catchment in a free form question.

4.7 QUESTIONNAIRE TESTING

A pilot survey was run before the main survey to test the questionnaire. On the assumption that a 40% response rate would be obtained, and for at least 30 completed responses, a total of 75 potential respondents were sent questionnaires. The sampling procedure was exactly the same as described above. The last question in the pilot survey sought opinions on the structure and composition of the questionnaire. These questions acted as a feedback mechanism to pinpoint potential problem areas that could be modified in the main questionnaire before sending it out. The pilot survey was posted on 6 October, 1994 with a cover letter and a freepost return envelope. After two weeks 28 questionnaires had been returned, providing a good basis to make changes to the main questionnaire. The cut-off date for the pilot questionnaire was on the 25 October, 1994.

4.8 QUESTIONNAIRE IMPLEMENTATION

After an analysis of the responses and comments made by respondents in the pilot study, the questionnaire was adjusted and finalised before it was sent to the sample population. The main questionnaire was posted on the 3 November, 1994 with an introductory letter and a freepost return envelope. Envelopes and cover letters bore the official Massey University, School of Applied and International Economics logo, to create a professional image and so reinforce the importance of completing the questionnaire. To improve the appeal of the questionnaire it was printed on blue paper. The returns were analysed using the Statistical Package for Social Sciences (SPSS).

CHAPTER FIVE

RESPONSES AND DISCUSSION OF RESULTS

5.1 CHARACTERISTICS OF RESPONDENTS

Table 5.1 is a summary of responses that were obtained from the survey. Of the total questionnaires sent, 369 (24.6%) were counted as valid responses. The nonresponse rate was 1025 (68.3%) and 70 (4.7%) of the questionnaires failed to reach their destination due to wrong or change of address. Thirty one (2.1%) respondents returned their questionnaires, but refused to participate for reasons that will be discussed shortly, and 5 respondents (0.3%) returned their questionnaires late. If the 70 returned questionnaires that failed to reach their destination are disregarded, the response rate becomes 25.8%.

Table 5.1 Types of responses obtained

Type of response	Number of respondents	Proportion %
valid responses	369	24.6
invalid responses/late arrivals	5	0.3
refusal to participate due to:		
too old/ ill health	7	0.5
not concerned/no reasons	14	0.9
felt not part of the area	6	0.4
others	4	0.3
returns due to wrong address etc	70	4.7
nonresponses	1025	68.3
Total	1500	100.0

Research has shown that follow-up mailing increases the response rate (Heberlein and Baumgartner, 1978). A follow-up mailing was planned for this particular survey but this was not done because the survey was started too late and there was insufficient time left to do a follow-up. Besides, that response rate (25.8%) was thought to be adequate enough to draw conclusions from.

Factors that have been identified as possible contributors to low response rates include, saliency of the topic; the number of hypothetical questions asked; the month the survey was carried out (Brown *et al.* 1989); and the type of population surveyed (Heberlein and Baumgartner, 1978).

One can get some idea of how people responded to the survey by examining some comments they made in the questionnaires. For instance, some respondents wrote "I am more concerned about the murky water that I get in my tap..." This and other such comments gave a clear message that for the average citizen in the region, there are other more pressing issues that need to be addressed than river water quality, with the result that many did not bother to reply. Further, the questions asked in this survey were quite hypothetical and may not have been taken seriously.

This survey was carried out in the months of November and early December. This is the end-of-year festive season and many families tend to be away from home. As indicated by Baumgartmer (1978), the period of time when a survey is carried out does have an effect on the response rate. There is reason to believe that this factor contributed to the low response rate to this survey.

However, the 369 questionnaires obtained was a large enough sample to generate meaningful results that can be generalized over the entire population. The reasons given by those who returned incomplete questionnaires include lack of interest, too busy, sickness, just arrived in the area, or about to leave the area, while others did not wish to participate, gave no reasons, or considered themselves to be out of the survey area.

Table 5.2 is a summary of socioeconomic characteristics of the respondents that returned their questionnaires.

The table shows that about 61% of the respondents are male, and about 39% females. The majority of the heads of households are above 26 years of age. The distribution of heads of households within the age groups above 26 years is quite uniform. The distribution of households among income categories is also relatively uniform, with households earning $50,000 - $59,999 per annum forming the smallest group of about 7%, while the $10,000 - $19,999 group forms the largest with a representation of about 23%. In terms of occupation, 2% of heads of households

Table 5.2 Type of respondents contacted

Characteristics	Number of respondents	Proportion percent	Missing
Sex of respondents			
female	139	39.3	15
male	215	60.7	
Age groups			
below 18 years	2	0.6	7
18-25 years	11	3.0	
26-35 years	59	16.3	
36-45 years	89	24.6	
46-55 years	70	19.3	
56-65 years	51	14.1	
over 65 years	80	22.1	
Occupation			
home duties	24	6.9	19
retired	92	26.3	
unemployed	7	2.0	
farm owner	35	10.0	
technical	18	5.1	
student	10	2.9	
managerial	81	23.1	
services/nurses	21	6.0	
business owner	28	8.0	
clerical/salesperson	14	4.0	
semi-skilled	17	4.9	
others	3	0.9	
Average annual income			
less than $10,000	24	7.4	44
$10,000-$19,999	76	23.4	
$20,000-$29,999	53	16.3	
$30,000-$39,999	52	16.0	
$40,000-$49,999	37	11.4	
$50,000-$59,000	23	7.1	
$60,0200 and over	60	18.5	
District			
Palmerston North	154	42.3	5
Manawatu	90	24.7	
Horowhenua	93	25.7	
Tararua	27	7.4	

identified themselves as unemployed, 26% identified themselves as retired and the rest as employed in occupations identified in the questionnaire.

About 42% of the respondents were from Palmerston North, about 26% were from Horowhenua, 25% were from Manawatu, and about 7% were from Tararua.

5.2 HOUSEHOLD VISITATION OF MANAWATU RIVER

To establish visitation habits of households to the Manawatu River and its tributaries, respondents were asked whether they had visited the Manawatu River or its tributaries in the last three summers. The results are summarised in table 5.3 below.

Table 5.3 Proportion of households that have visited the Manawatu River or its tributaries in the last three summers

Visitation	Number of responses	Proportion %
yes	254	68.8
no	113	30.6
missing responses	2	0.6
Total	369	100.0

About 69% of the households indicated they had visited the Manawatu River or its tributaries in the last three summers. This was more than twice as many as the number of households that said they had not visited the river or its tributaries. The non-visiting group makes up about 30% of the respondents.

Those who had visited the river were asked to estimate the number of days per summer and hours per day they spent at the river on average. The results are summarised in table 5.4 below.

Table 5.4 Average number of days per summer households spent visiting the Manawatu River or its tributaries

Days spent	Number of households	Proportion %
Less than 5 days	86	23.3
5-9 days	45	12.2
10-14 days	47	12.7
15-19 days	7	1.9
20-24 days	14	3.8
25-30 days	20	5.4
over 30 days	28	7.6
missing values	122	33.1
Total	369	100.0

About 48% of the households, spent less than 15 days per summer visiting the river or its tributaries, and about 19% spent 15 days or more. On average, households spent about 16 days per summer visiting the Manawatu River or its tributaries.

Table 5.5 shows the amount of time households spent per day when visiting the Manawatu River or its tributaries. About 51% of the households spent 3 hours or less per day when visiting the Manawatu river or its tributaries. The average amount of time households spent visiting Manawatu River or its tributaries is about 2 hours 36 minutes per visit during summer.

Table 5.5 Average number of hours households spent visiting the river per day

Number of hours	Number of households	Proportion percent
1 hour & less	62	16.8
2	76	20.6
3	49	13.3
4	41	11.1
5	10	2.7
6	6	1.6
8	1	0.3
10	1	0.3
12	1	0.3
missing values	122	33.1
Total	254	100

5.3 PARTICIPATION IN RIVER RELATED ACTIVITIES

The visitation habits of households to the river was obtained by asking respondents to select activities that they engage in while visiting the various sections of the river. A summary of the results is given in table 5.6

The majority of the people interviewed tended to engage in non-rigorous activities such as walking, sightseeing, and picnicking. Other activities that were listed in the top three choices for some areas include swimming, fishing, and duck shooting.

At this stage, it is appropriate to investigate reasons why people do not visit certain sections of the river. It was of particular interest to find out the role that perceived pollution played in a decision not to visit. Table 5.7 depicts the nature of responses given. Only four sections have been analyzed and they do reflect the trend in the rest of the sections.

Table 5.6 Activities undertaken at various sections of the Manawatu River and its tributaries

Section of the River	Activities	Households	
		Number	Proportion
Foxton Beach-Opiki	walking	55	16.9
	sightseeing	49	15.0
	swimming	46	14.1
Opiki-Palmerston North	walking	47	37.9
	sightseeing	22	17.1
	picnicking	11	8.9
Upper Manawatu River	walking	73	33.5
	sightseeing	34	15.6
	picnicking	26	11.9
Oroua River	walking	30	27.1
	swimming	23	20.7
	picnicking	15	13.5
Pohangina River	picnicking	27	27.1
	walking	20	20.8
	sightseeing	18	18.4
Mangahao River	picnicking	15	19.2
	sightseeing	15	19.2
	swimming	13	16.7
Mangatainoka River	fishing	15	26.3
	walking	9	15.8
	swimming	9	15.8
Tiraumea River	duck shooting	4	22.2
	fishing	3	16.7
	picnicking	3	16.7

Table 5.7 Reasons people decline using certain sections of the Manawatu River and its tributaries

Section	Reasons	Households number	Households percent
Foxton Beach-Opiki			
	1. no interest	106	37
	2. far from home	55	19
	:		
	8. pollution	8	3
Opiki-Palmerston North			
	1. no interest	151	39
	2. go elsewhere	65	17
	:		
	8. pollution	9	2
Upper Manawatu River			
	1. no interest	111	35
	2. go elsewhere	61	19
	:		
	10.pollution	3	2
Oroua River			
	1. no interest	138	36
	2. far from home	68	17
	:		
	10.pollution	4	1

Households that did not visit any particular section of the river stated that lack of interest was the main reason for not visiting the river. The largest percentage to make this claim is about 39%, attributed to the Opiki-Palmerston North section of the river. For any section the percentage of households that cited pollution as a reason for failure to visit did not exceed 3%.

5.4 A GENERAL PERCEPTION OF WATER QUALITY

An assessment of the households' opinions was sought on their perception of water quality in all the sections of the Manawatu River. The assessment was done by asking households to indicate their perception of water quality in each section on a scale of 0 (totally unacceptable) to 4 (totally acceptable). The mean response for each section is tabulated in table 5.8 below.

Table 5.8 Household perception of water quality in various sections of the Manawatu River

Section	Household opinion	
	Mean value	Description
Mangatainoka River	3.12	acceptable
Mangahao River	3.09	acceptable
Pohangina River	3.03	acceptable
Tiraumea River	2.76	slightly acceptable
Upper Manawatu River	2.67	slightly acceptable
Oroua River	2.38	slightly acceptable
Foxton-Opiki	1.95	slightly unacceptable
Opiki-Palmerston North	1.86	slightly unacceptable

Generally speaking, the more remotely situated tributaries of the Manawatu River were quoted as having more acceptable water quality. These include the Mangatainoka, the Mangahao, and the Pohangina which scored 3.12, 3.09, 3.03, out of 4 respectively. The exception was the Tiraumea, which scored 2.76. The main river channel was quoted as being slightly unacceptable. The Foxton-Opiki run scored the lowest overall rating of 1.95.

Questions from section II dealt with the valuation of water quality in the Lower Manawatu River. The results presented from here onward deal with section II of the questionnaire.

A number of factors do influence household decisions to visit or not to visit recreational river sites. To find out which factors influence visitation to the Manawatu River, households were asked to rank water quality indicators on a scale of 0 (not important) to 4 (extremely important) scale. The mean value of their responses are presented in table 5.9 below.

Table 5.9 Importance of water quality indicators in decision making to visit rivers

Indicator	Importance	
	Mean value	Description
oil/grease on water	3.48	very important
scum or foam on water	3.25	very important
smell of water	3.17	very important
fishlife	2.97	quite important
presence of invertebrates in water	2.89	quite important
colour of water	2.87	quite important
fungus/algae growth in riverbed	2.86	quite important
soil/mud in water	2.53	quite important
branches of trees/ logs floating in water	2.13	quite important

Households consider presence of substances like oil, scum in water and the smell of water as the most important quality indicators when making the decision to visit the Manawatu River. These factors scored mean values of 3.48, 3.25 and 3.17 respectively. Scores are interpreted to mean that the indicators are very important to the residents when deciding to visit the river. The rest of the indicators are also regarded as being quite important in the decision making process of river visitation, because they attained a mean score above 2.13.

The importance of some of the factors that were highly ranked by the respondents in the survey, is reflected in the Resource Management Act (RMA), sections 70 and 107. Section 107 says in part:

> (2) a consent authority shall not grant a discharge permit allowing -
>
> (a) The discharge of a contaminant ... into water ... if, after reasonable mixing, the contaminant ...

gives rise to any of the following effects ...:

> (c) The production of any conspicuous oil or grease film, scums or floatable or suspended materials.

The RMA under the same section gives recognition of smell of water, and aquatic life as factors that should be safeguarded when issue discharge permits and all of them are were highly ranked by the respondents.

Having revealed the importance people attach to different water quality indicators, the respondents were asked to evaluate water quality in the Lower Manawatu River in respect to these qualities. The mean values of their valuations are presented in table 5.10 below.

Table 5.10 Respondents opinion of present water quality in the Lower Manawatu River

Indicator	Average Opinion	
	Mean response	Description
fishlife	2.63	slightly acceptable
branches of trees/ logs floating in water	2.23	slightly acceptable
presence of invertebrates in water	2.18	slightly acceptable
smell of water	2.14	slightly acceptable
colour of water	1.90	slightly unacceptable
soil/mud in water	1.86	slightly unacceptable
fungus/algae growth in riverbed	1.73	slightly unacceptable
oil/grease on water	1.68	slightly unacceptable
scum or foam on water	1.53	slightly unacceptable

From the mean values calculated in table 5.10 above, it is evident that no water quality indicator was ranked as being currently acceptable. The highest ranked quality, fishlife, only scored a 2.63 mean value, which is interpreted as being slightly acceptable. The presence of scum or foam on water was described as being the worst condition in the river, with a mean score of 1.53.

5.5 EFFECT OF CHANGE IN WATER QUALITY

Having considered households' participation in various activities and their valuation of water quality in the Lower Manawatu, the respondents were provided with a water quality chart. This indicated the present state of water quality in the Lower Manawatu River and the intended improved water quality status. All respondents were asked to indicate what effect this change in water quality would have on their participation. They were asked to indicate whether they would engage in "increased activity" or "no change" in participation. The results are given in table 5.11 below.

Table 5.11 Effects of water quality improvement in the Lower Manawatu River

Activity	Valid responses	Increased activity Number	Increased activity percent	No change Number	No change Percent
picnicking	310	168	54.2	142	45.8
sightseeing	299	147	49.2	152	50.9
swimming	306	143	46.7	163	53.3
fishing/angling	294	131	44.4	164	55.6
walking/dog walk	299	113	37.8	186	62.2
photography	280	79	28.2	201	71.8
nature study	279	74	26.5	205	73.5
whitebaiting	281	66	23.5	215	78.5
birdwatching	278	60	21.6	218	78.4
canoeing	282	47	16.7	235	83.3
waterboating	275	44	16.0	231	84.0
tramping/hiking	273	42	15.4	231	84.6
rafting	272	38	14.0	234	86.0
waterskiing	271	34	12.5	239	87.5
rowing	271	28	10.3	243	89.7
duck shooting	272	24	8.8	248	91.2
jetboating	270	22	8.1	248	89.7
sailing	269	21	7.8	248	92.2
Other	186	11	5.9	175	94.1

Between 20% and 55% households indicated that they would engage in increased participation in the following activities: picnicking, sightseeing, swimming, fishing, walking, photography, nature study, whitebaiting, and birdwatching, if water quality was improved. However, overall all recreation activities few respondents indicated they would make any change. For purposes of contact recreation, one may be inclined to conclude that the percentage of households that will increase their participation is significant, because of the 46.7 % increase in swimming reported.

5.6 DICHOTOMOUS CHOICE MODEL OF WILLINGNESS-TO-PAY

The respondents were asked, "Would your household be willing to contribute an additional $\$X_i$ in rates (rent) per year towards water quality improvement...." The $\$X_i$ value is varied from \$1, \$5, \$10, \$15, \$20, \$25, \$30, \$35, \$40, \$50, \$60, \$70, \$90, \$110, and \$150.

To infer the maximum willingness-to-pay (WTP) for water quality improvement, one needs to estimate a function, $Y = f(x)$ that translates the responses, represented as ones and zeros, into a set of probabilities that vary as the dollar amounts vary.

Since we are dealing with a qualitative variable, the mathematical expectation is that the equation is a nonlinear function of its independent variables (Aldrich and Forrest, 1984). Therefore one cannot apply ordinary least squares (OLS) regression to the data to fit the equation, because OLS is applicable to linear models. To overcome the incompatibility of the data with OLS, non-linear probability models that are consistent with consumer utility maximization theory should be employed. Such models include the logit and probit models (Hanemann, 1984).

5.6.1 The logit model

The Logit model is used in economics when dealing with discrete choice variables (Cramer, 1990). The consistency of the logistic model and the utility maximization theory can be explained by relating the probability that a household will say "yes", that is, that they are willing to pay $\$X_i$ to have improved water quality, to the probability that the utility gained from the improved water quality exceeds utility from the lost $\$X_i$. It is presumed that the respondent compares the current situation (having $\$X_i$ and unimproved water quality) and the new situation (having no $\$X_i$ but having improved water quality). If the difference in utility between the new situation and the current situation is positive, the answer is expected to be "yes" (Loomis, 1988).

According to Hanemann (1984), the two sets of probabilities can be related by formulating a utility difference model. In most cases the probability distribution of the error term in the utility difference model follows a logistic distribution; as such a logistic model is estimated, (Aldrich and Forrest, 1984).

Following Gujarati (1988), the logistic model can be represented in the following manner. Consider the probability (P_i) of a household to answer "yes", to the willingness-to-pay question.

$$P_i = E(Y = \frac{1}{X_i}) = \frac{1}{1+e^{-(\beta_1+\beta_2 X_i)}} \tag{1}$$

Where

- $E(Y = 1/X_i)$ is the conditional expectation of Y given X_i,
- X_i is some independent variable such as household income,
- Y = 1 if the household responds with a yes to the willingness-to-pay question, and Y = 0 if the household says no to the willingness-to-pay question.
- e is the base of the natural logarithm, and
- β_1 and β_2 are parameters that represent the intercept and the slope coefficient respectively.

The expression can be simplified to:

$$P_i = \frac{1}{1+e^{-z_i}} \tag{2}$$

where

$$Z_i = \beta_i + \beta_2 X_i. \tag{3}$$

Equation 2 above is called the cumulative logistic distribution function. From the equation it can be observed that as Z_i ranges from $-\infty$ to $+\infty$, P_i ranges between 0 and 1, and that P_i is nonlinearly related to Z_i (i.e. X_i). Given these two characteristics, it may appear that ordinary least-squares (OLS) procedure may not be used to estimate the parameters because P_i is both nonlinearly related to X and to the β's. In reality, however, equation 4 is intrinsically linear.

Since the P_i is the probability of saying "yes" to the willingness-to-pay question, then the probability of saying "no", is ($1-P_i$). Therefore, ^OThe ratio of the probability of a "yes" to the probability of a "no" becomes:

$$1-P_i=\frac{1}{1+e^{z_i}} \tag{4}$$

$$\frac{P_i}{1-P_i}=\frac{1+e^{z_i}}{1+e^{-z_i}}=e^{z_i} \tag{5}$$

The ratio of P_i to $(1 - P_i)$ is the odds ratio in favour of saying "yes". In other words the expression gives the probability that the household will say "yes" to the probability that it will say "no". For instance if $P_i = 0.6$, $1 - P_i = 0.4$, that is to say odds are 3 to 2 in favour of the household saying "yes". Taking the natural log of both sides yields:

$$\ln(\frac{P_i}{1-P_i})=z_i. \tag{6}$$

Substituting $Z_i = \beta_1 + \beta_2 X_i$ back into equation 3, results in

$$L_i=\ln(\frac{P_i}{(1-P_i)})=Z_i=\beta_i+\beta_2 X_i \tag{7}$$

Where L_i is the logit, the log of the odds ratio. A logistic model graph shown in figure 5.1 demonstrates the following characteristics of the logit.

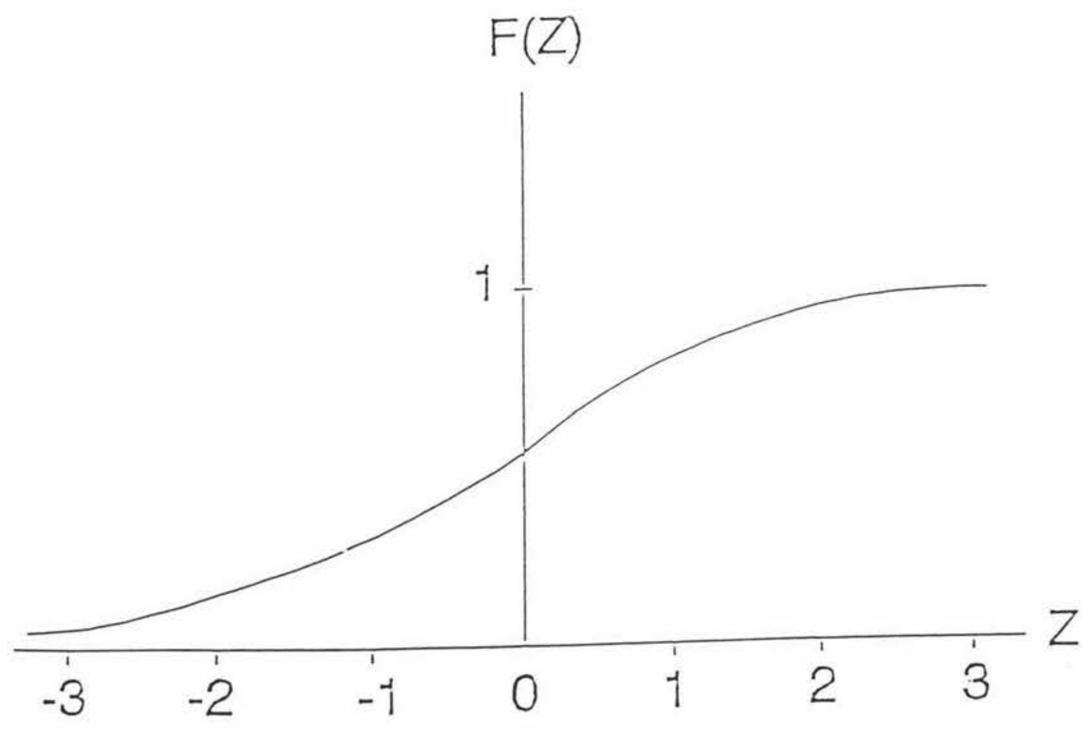
- The probabilities (P) lie between 0 and 1 while the logit (L) is boundless. From the equation it can be seen that as P values range from 0 to 1 (and therefore as Z varies from $-\infty$ to $+\infty$), L varies from $-\infty$ to $+\infty$.
- Although L is linear in X, the probabilities themselves are not.
- Beta 1 (β_1) is the intercept which represents the value of the log-odds in favour of saying "yes" if the suggested value is zero. Beta 2 (β_2), on the other hand is the slope of the graph, which is a measure of the change in L for a unit change in X. It can be interpreted as revealing how the log-odds in favour of saying "yes" change as X changes by unit amounts.

Given the logit above, we can attempt to estimate values of P given certain values of the X variables, if values of β_s are known. The next discussion addresses the question of how the values of β_1, and β_2 are obtained through estimation of the model.

Since the logit is not a deterministic equation, we shall add the error term (u) to the logistic equation for estimation purposes, obtaining the equation:

$$L_i = \ln\left(\frac{P_i}{(1-P_i)}\right) = \beta_i + \beta_2 X_i + u_i \qquad (8)$$

Estimation of the model involves obtaining values of X_i and those of the logit L_i.



Source: Rosawati 1993

Figure 5.1 A logistic model curve

At this point it is appropriate to briefly consider two commonly used procedures of estimating regression models. Assume a Y has a probability distribution, f(Y), characterized by coefficients β_1 and β_2 and that we observe a sample Y_1, Y_2 ... Y_n, to estimate the values of the coefficients from the sample data by means of ordinary least square or maximum likelihood regression.

In the ordinary least square (OLS) procedure, one selects regression coefficients that result in the smallest sum of the squared error terms (e). In the maximum likelihood (ML) procedure, one selects regression coefficient estimators that would produce the observed sample data most often. In other words the ML estimators of β_1 and β_2 are those values that make the sample (observed) results "most likely".

In equation (8), let us suppose that data is obtained from individual households concerning their responses to the willingness-to-pay question. If we use the OLS procedure to estimate the model we will need to substitute $P_i = 1$ for a "yes" response and $P_i = 0$ for a "no" response. The following expressions will be obtained:
$L_i = \text{In}\ (1/0)$ if the response is "yes", and $L_i = \text{In}\ (0/1)$ if the response is "no".

Clearly, both expressions are meaningless, so for data obtained at the household level, the use of OLS procedure cannot be used to the estimate equation. Under such circumstances, the ML procedure is used.

5.6.2 Logit model estimation

In the dichotomous choice response question every individual was offered only one bid. Each respondent was required to respond either "yes" or "no", to indicate his or her willingness-to-pay that amount in extra rates (rent), toward water quality improvement in the lower Manawatu River. The responses to each bid are summarised in table 5.12 below. See *Appendix III*, table A1 for the detailed analysed data.

Table 5.12 Grouped observations of data on WTP (X_i)

Bids ($)		Questionnaires		Responses	
$X_I	Sent	Returned	Proportion	Yes	No
1	10	3	0.30	2	1
5	20	2	0.10	0	2
10	30	3	0.10	2	1
15	40	11	0.30	5	6
20	50	17	0.34	7	10
25	60	15	0.25	7	8
30	70	15	0.21	9	6
35	100	28	0.28	11	17
40	130	27	0.21	4	23
50	140	36	0.26	8	28
60	150	32	0.22	7	25
70	160	46	0.29	10	36
90	170	37	0.22	9	28
110	180	42	0.23	7	35
150	190	50	0.26	7	43
invalid		5			
Total	1500	364		95	269

Details of the logistic regression in the calculations that follow were derived from Norusis, (1992), which outlines procedures of logistic regression as applicable to the SPSS statistical package.

5.6.3 Univariate logistic regression analysis

Appendix III shows the SPSS result print out of how β_1 and β_2 were calculated. A logistic regression procedure is applied to the data above, in which the dependant variable AGREE, is binary, taking a value of 1 if the response was "yes" and a value of 0, if the response was "no". The independent variable is BID. The values of β_1 and β_2 were found to be β_1 = -0.22648 and β_2 = -0.0124.

Substituting these values into equation (7) above yields:

$$L_i=\ln\left(\frac{P_i}{1-P_i}\right)=-0.22648-0.0124X_i \qquad (9)$$

5.6.4 Extension to multivariate logit

Appendix IV shows the SPSS result print out of how the multivariate model is built. It is expected that bid is not the only variable that may influence one's willingness--to-pay. It is natural then to investigate other factors that are likely to influence the willingness-to-pay. The set of independent variables from which the selection was made were: BID, US1, DS2, HR3, SEX14, AGE15, INC17, DT18, LIV19, ENV21, LOC20.

The independent variables are:

BID	= Bid offered.
US1	= Households that have visited the river (yes = 1, no = 2).
DS2	= Number of days households spent visiting the river (continuous variable).
HR3	= Average number of hours spent per day (continuous variable).
SEX14	= Sex of head of household (female = 1, male = 2).
AGE15	= Age of the head of household (continuous variable).
INC17	= Average annual household income (continuous variable).
DT18	= Distance the household lives from the lower Manawatu River (continuous variable).
LIV19	= Length of time household has lived in the Manawatu River catchment region (continuous variable).
ENV21	= Household membership in environmental groups (yes = 1, no = 0).
LOC20	= Household home district location (a categorical variable).

The selection of variables to be included in building the model in logistic regression can be accomplished by wilfully entering variables one thinks are good predictors. However, there are automated methods like forward stepwise selection or backward elimination that build the model by selecting and eliminating variables one at a time based on tests of statistical significance. Here the forward stepwise method is described below. The backward elimination method gave the same final model.

5.6.4.1 Forward stepwise selection

Modelling using the forward stepwise selection in logistic regression starts with an initial model containing only the constant. In the next step, the variable with the smallest significant level for the score statistic is entered, on condition that it is below the default 0.05 (the cut off value). This is followed by a reexamination of previously entered variables to check whether they meet removal criteria. The variable with the largest significance level for the Wald statistic, is removed if it is above the default cut off value of 0.1. In the absence of a variable that meets the removal criteria the next variable is entered.

The procedure is repeated until all variables eligible for entry or removal have been examined. If no more entries or removal can be accomplished, the model is estimated. Below is the procedure that was followed in developing the model.

Table 5.13 Model one

(a) Variable(s) in the Equation

Variable(s)	B	S.E.	Wald	df	Sig
Constant	-0.7698	0.1456	27.9499	1	0.0000

Residual Chi Square 31.866 with 13 df Sig = 0.0025

(b) Variable(s) not in the Equation

Variable(s)	Score	df	Sig	R
BID	8.2705	1	0.0040	0.1518
US1	0.6404	1	0.4236	0.0000
DS2	0.0005	1	0.9820	0.0000
HR3	0.4558	1	0.4996	0.0000
SEX14	2.0282	1	0.1544	0.0102
AGE15	0.4267	1	0.5136	0.0000
INC17	7.1008	1	0.0077	0.1369
DT18	0.6785	1	0.4101	0.0000
LIV19	0.6220	1	0.4303	0.0000
ENV21	10.3385	1	0.0013	0.1750
LOC20	7.8846	3	0.0485	0.0832
LOC20(1)	3.6029	1	0.0577	0.0767
LOC20(2)	2.7947	1	0.0946	0.0540
LOC20(3)	2.4242	1	0.1195	0.0395

(c) Goodness-of-fit statistics for model one

Test statistic	Chi-Square	df	Significance
-2 Log Likelihood	272.157	217	0.0065
Goodness of Fit	218.000	217	0.4681

The output of the first step in the forward selection shows a summary of statistics for the model when it contains the constant only. The column headed *B* represents the estimated coefficients; the *SE* column stands for standard error; the column labelled *Wald* represents the Wald statistic ($\{B/SE\}^2$) and the significance of the Wald statistic is shown by the *sig* column, where the cutoff point is 0.05. *The Wald statistic* is used to test the hypothesis that the coefficient is 0.

The column labelled *R* represents the R statistic which shows the partial correlation between the dependent variable and each of the independent variables. If the value of *R* is positive the indication is that as the variable increases so does the likelihood of the event occurring. On the other hand a negative *R* value indicates the opposite relationship. A small value of R means that the variable has a small partial contribution to the model.

The residual chi-square is used to test the null hypothesis that the coefficients for the rest of variables in the model are 0. It is upon this basis that a decision to continue building the model is made. If the significance level of the *residual chi-square* is small then there is reason to continue building the model by selecting more variables.

From model one above, the *residual chi-square* is small, (there is a reason to reject the hypothesis that all of the coefficients are 0) therefore variable selection can proceed. It is evident that *ENV21* has the smallest observed significance level for the score statistic of 0.0013 (which is below the default value for entry 0.05), so it is entered into the model as shown in model two. In model three the variable *BID* with a significance level of 0.0056 is entered (Refer to Appendix IV model three). Finally in model 4 the variable *INC17* with significance level 0.0077 is entered (Refer to Appendix IV model three).

Notice that tables 5.14 (b) for model two and table 5.15 (b) for model three, have been omitted deliberately because they look basically as table 5.13 (b) except for the variables that have been removed to be included in the models. However details can be found in Appendix IV.

Table 5.14 Model two

(a) Variable(s) in the equation

Variable(s)	B	S.E.	Wald	df	Sig	R
ENV21	-1.1535	0.3699	9.7258	1	0.0018	-0.1685
Const	1.3160	0.6806	3.7384	1	0.0532	

Variable entered on step number 1: ENV21
Residual Chi Square 22.738 with 12 df Sig = 0.0738

(c) Goodness-of-fit statistics for model two

Test statistic	Chi-Square	df	Significance
-2 Log Likelihood	262.447	216	0.0169
Model Chi-Square	9.710	1	0.0018
Improvement	9.710	1	0.0018
Goodness of Fit	218.000	216	0.4491

Table 5.15 Model three

(a) Variable(s) in the equation

Variable(s)	B	S.E.	Wald	df	Sig	R
BID	-0.0106	0.0039	7.3824	1	0.0066	-0.1406
ENV21	-1.1343	0.3768	9.0617	1	0.0026	-0.1611
Constant	1.9933	0.7427	7.2024	1	0.0073	

Variable entered on step number 2: BID
Residual Chi Square 15.352 with 11 df Sig = 0.1670

(c) Goodness-of-fit statistics for model three

Test Statistic	Chi-Square	df	Significance
-2 Log Likelihood	254.379	215	0.0339
Model Chi-Square	17.778	2	0.0001
Improvement	8.068	1	0.0045
Goodness of Fit	221.960	215	0.3579

Table 5.16 Model four

(a) Variable(s) in the equation

Variable(s)	B	S.E.	Wald	df	Sig	R
BID	-.0111	0.0039	7.9001	1	0.0049	-0.1472
INC17	0.2052	0.0794	6.6793	1	0.0098	0.1311
ENV21	-1.0952	0.3828	8.1866	1	0.0042	-0.1508
Constant	1.0642	0.8230	1.6720	1	0.1960	

Variable entered on step number 3: INC17
Residual Chi Square 8.728 with 10 df Sig = 0.5581

(b) Variable(s) not in the equation

Variables	Score	df	Sig	R
US1	0.0005	1	0.9813	0.0000
DS2	0.0859	1	0.7695	0.0000
HR3	0.0206	1	0.8859	0.0000
SEX14	0.9340	1	0.3338	0.0000
AGE15	2.1067	1	0.1467	0.0198
DT18	0.4006	1	0.5268	0.0000
LIV19	1.1140	1	0.2912	0.0000
LOC20	5.6755	3	0.1285	0.0000
LOC20(1)	2.8151	1	0.0934	0.0547
LOC20(2)	3.0073	1	0.0829	0.0608
LOC20(3)	0.3762	1	0.5397	0.0000

(c) Goodness-of-fit statistics for model four

Variable(s)	Chi-Square	df	Significance
-2 Log Likelihood	247.500	214	0.0578
Model Chi-Square	24.657	3	0.0000
Improvement	6.879	1	0.0087
Goodness of Fit	216.668	214	0.4362

(d) Classification table for AGREED

	Predicted		
Observed	0	1	Percent Correct
0	137	12	91.95%
1	53	16	23.19%
	Overall		70.18%

Since the observed significance levels of the coefficients for *BID, INC17,* and *ENV21*, in the model are less than 0.1, the default criterion for removal, none of the variables is removed from the model. The observed significance levels of all the variables not in model 4 are greater than 0.05, so none will be added into the model and at this stage the process of model building is terminated.

5.6.4.2 Assessment of model performance

The performance of the final model is assessed using the following statistical tests: percentage correct prediction, -2 log likelihood and the goodness of fit score.

Percentage correct prediction is a statistic that assesses how well the model classifies the observed data by comparing observed outcomes to predicted outcomes. Comparisons are expressed in a table form to reveal how well the model classified the observed data. (Norusis, 1992).

Table 5.16(d) shows that 137 households that said "no" to the willingness-to-pay were correctly predicted by the model as not to being willing to pay for improved water quality. This accounts for 91.95% of those who said no being correctly predicted. A total of 16 households that said "yes" to the willingness-to-pay question were correctly predicted to be willing to pay for improved water quality. Thus those who said "yes" and were correctly classified make up 23.19%. The off-diagonal entries of the table tell of the number of respondents incorrectly classified. A total of 65 were incorrectly classified. Sixteen of the households that said "no" to the willingness-to-pay were incorrectly predicted as being willing to pay. Fifty-three of the households that said "yes" to the willingness-to-pay question were incorrectly classified as saying "no". Overall, 70.18% of the 218 households were correctly classified.

Log likelihood is used to assess the goodness of fit of the model by determining how "likely" the sample results actually are given the parameter estimates. The probability of the results, given the parameter estimates, is what is referred to as the likelihood. However, for practical reasons, the -2 log likelihood (-2LL) is used instead to make it possible to overcome technical calculation problems that may arise due to the fact that the likelihood is too small a number. The higher the likelihood of the observed results, (which converts to a small -2LL value), the better the model. A perfectly fitting model has a likelihood of 1 and a -2LL of 0.

The change in the overall -2LL caused by entering a variable into the model is called 'improvement'; it tests the hypothesis that the coefficient of that variable is 0. This is comparable with the F-test in ordinary multiple regression.

The model chi-square in table 5.16(b), is the difference between -2LL for the model with only a constant and the present model. The model chi-square tests the null hypothesis that the coefficients for all of the terms in the current model, except the constant, are 0. This value is comparable to the overall F test for regression. The improvement value, table 5.16(b) is the difference between the -2LL of the previous model (table 5.15(b) model three) and the current model. On the basis of the chi-square of model four, a small significance level for the model is observed, which indicates that the null hypothesis, that the coefficients of BID, INC17, and ENV21 are zero, should be rejected. The small observed significance level of the improvement chi-square, indicates that the coefficient INC17 is not zero (Norusis, 1992).

The Goodness of Fit Statistic is defined as:

$$Z^2=\sum \frac{Residual_i^2}{P_i(1-P_i)} \qquad (10)$$

Where the residual is the difference between the observed value, Y_i and the predicted value P_i. The Goodness of Fit statistic compares the observed probabilities to those predicted by the model. The lower the Goodness of Fit statistic, the better the fit (Norusis, 1992). Table 5.17 is a summary of the test statistics all the models, to help show how the final model fits the data.

Table 5.17 Summary of test statistics

Model	-2LL	Improvement	Goodness of fit	Percent correct
1 (constant)	272.157	-	218.000	68.35
2 (ENV21)	262.447	9.710	218.000	69.72
3 (BID)	254.379	8.068	221.960	71.10
4 (INC17)	247.500	6.879	216.668	70.18

As ENV21 and BID were entered into the model, the percentage of correct predictions increased, the -2LL decreased, and the Goodness of Fit got marginally better. When INC17 was entered into the model, the percentage of correct predictions and the Goodness of Fit both got marginally worse; however, there was a significant improvement in the -2LL.

Given these coefficients, the logistic equation for the probability of the WTP can be written as:

$$prob(WTP) = \frac{1}{1+e^{-z}} \qquad (11)$$

where: Z = 1.0642 - 0.0111 (BID) + 0.2052 (INC17) - 1.0952 (ENV21)

Applying this to an individual whose income is 10,000 (coded as 1) and is a member of an environmental lobby group (coded as 1), and is asked his/her willingness to pay $50 to achieve improved water quality, we find:

Z = 1.0642 - 0.0111 (50) + 0.2052 (1) - 1.0952 (1) = -0.3808

The probability of WTP is then estimated to be:

$$prob(WTP) = \frac{1}{1+e^{-(-0.3808)}} = \frac{1}{1+1.4634549} = 0.4059339 \qquad (12)$$

If the estimate is less than 0.5, we predict that the individual will be unlikely to agree to pay the suggested bid. On the basis of this criteria, we would predict that the individual is unlikely to agree to pay $50 towards water quality improvement.

5.7 AGGREGATION OF WILLINGNESS-TO-PAY

Appendix III, table A1 shows the calculations the probabilities of willingness-to-pay that are produced in table above it is possible to predict the willingness-to-pay a given amount of dollars towards improved water quality for any household with certain characteristics (Kerr,1986). For example, the probability of any household being willing to pay $10 can be calculated by substituting X_i = $10 in equation (9) to obtain:

$$\log(\frac{P_i}{1-P_i})=-0.22648-0.0124\times10=-0.35048 \quad (13)$$

Taking the antilog on both sides of the equation:

$$\frac{P_i}{1-P_i}=e^{-0.35048}=0.7043499 \quad (14)$$

$$P_i=\frac{0.7043499}{1.7043499}=0.413266 \quad (15)$$

The results for the rest of the bids are produced in the table 5.18 below.

Table 5.18 The probability of willingness-to-pay the bid offered.

Bid ($)	Probability (Pi)
1	0.441
5	0.428
10	0.413
15	0.398
20	0.384
25	0.369
30	0.355
35	0.341
40	0.327
50	0.300
60	0.275
70	0.251
90	0.207
110	0.169
150	0.111

Figure 5.2, is a graph of the predicted probability P_i, derived from the logistic regression in equation (9) vis X_i. The area under the curve is equal to the expected mean of maximum willingness-to-pay for households in the sample (Loomis, 1988; Kerr, 1986). The result of integrating the probability curve ,which is a function of the mean expected willingness-to-pay, it was found to be $50.70. At a 95 confidence level the amount will be expected to range from $39.83 to $81.24.

See *Appendix V*, table A3, table A4, and table A5 for a detailed description of how to obtain the mean WTP, lower and higher bound mean willingness-to-pay values.

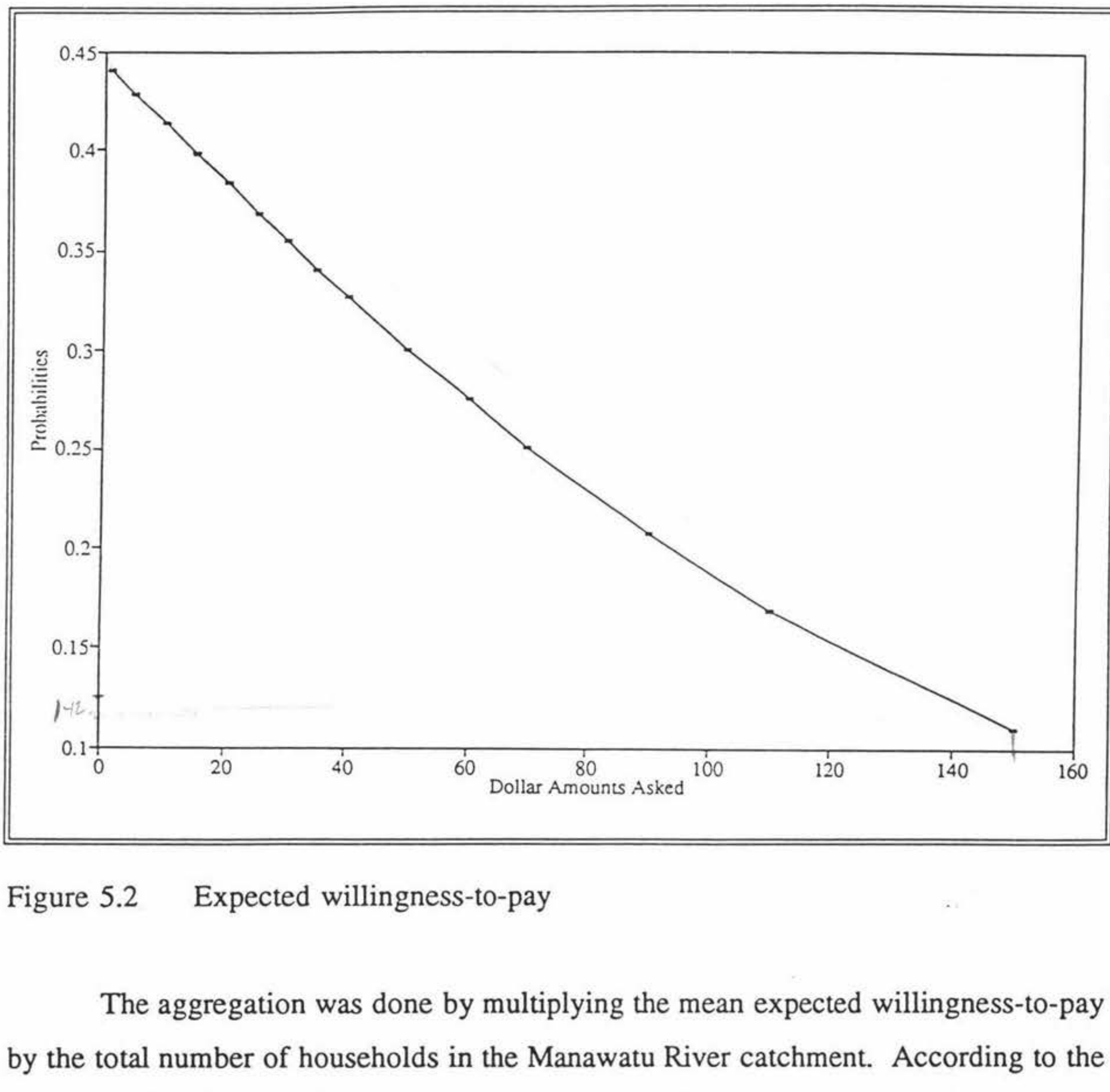


Figure 5.2 Expected willingness-to-pay

The aggregation was done by multiplying the mean expected willingness-to-pay by the total number of households in the Manawatu River catchment. According to the Census of Population, 1991 statistics, household numbers in the districts that make up the Manawatu River catchment were, Palmerston North City Council, 23,808; Horowhenua District Council, 10,608; Tararua District Council, 6,717, and Manawatu District Council, 9,147. This gives a total of 50,280 households. The result of the calculation yields a total willingness-to-pay for improved water quality in the Manawatu River catchment of $2,549,196. This will range from $2,002,652 to $4,084,747 at the 95% confidence level.

This amount of money is certainly an over estimate since the entire populations of the four districts were considered in aggregating the WTP. In reality however not all populations in the four districts fall within the Manawatu River catchment borders. For instance the Otaki River runs through a good portion of the Horowhenua District. This river is not part of the Manawatu River catchment, yet in the aggregation households from this catchment have been included because of the difficulty of separating households outside the catchment.

Having elicited respondents willingness-to-pay, the next question investigated why people were unwilling to pay for water quality improvement. The responses are summarised in table 5.19 below.

Table 5.19 Reasons for not being willing to pay for improved water quality

Reasons	Number of households	Proportion percent
polluters to pay	77	36.7
pay enough rates	47	22.0
don't use river	30	14.0
can't afford	28	13.1
fund misallocation	17	7.9
use other places	6	2.8
other reasons	9	4.2
Total	214	100.0

The table shows that about 50% of the respondents to this question indicated that polluters should pay for water quality improvement in the Lower Manawatu River, 22% of the households indicated that they were unwilling to pay in extra rates because they already pay enough rates. It was interesting to note that some people from the upper reaches of the river felt that it was not their responsibility to subsidize the people in the lower reaches in paying for water quality improvement. On the other hand, certain people in the lower reaches of the river felt that the poor quality of the water was largely due to farming activities in the upper reaches of the river. Consequently, their opinion was to have people from the upper reaches pay for water quality improvement in the lower Manawatu River.

To investigate the people's opinion on how long they felt it should take for water quality to be improved, table 5.20 shows that over 83% of the respondents indicated that the improvement programme should achieve its objectives in less than 10 years.

Table 5.20 Length of time the water quality improvement programme should take

Years	Number of households	Proportion percent
1-2	109	29.4
3-4	129	35.0
5-9	70	19.0
10-14	7	1.9
15 +	5	1.4
invalid	49	13.3
Total	369	100.0

Finally the respondents were asked to make any comments they regarded as relevant to the issue of water quality improvement. There were four main issues that received frequent mention: the need to provide accessability to the natural waterways, the need to provide facilities to enable people to use the water for recreation, the issue of polluters to pay for the cleanup exercise, and the redistribution of income from rates to meet needs of all services.

Comments made by the respondents gave the impression that the Manawatu River and its tributaries are not accessible. It was suggested that there are few places that are safe for swimming or to engage in other recreational activities. In addition to the lack of accessability there was lack of facilities to encourage people to utilize the waterways. The respondents exclaimed "What a waste of a resource!" Older people that have lived in Palmerston North for over 30 years claimed that some years back there existed swimming holes along the Awapuni area in Palmerston North. These facilities broke down and were neglected. Suggestions for the following facilities were given: the construction of a weir to allow the use of the water, construction of walkways and paths along the waterways, provision of boat hire services, and establishment of gardens close to the waterways to encourage family oriented activities.

From such comments one may conclude that people with such opinions would rather have accessibility to the river before being worried about its water quality.

Other opinions did reveal that there is a need for keeping water quality standards high but felt that the burden of the cleanup should be met by the factories that discharge waste to the water. Such comments were often accompanied by the suggestion that income from rates should be redistributed to meet the needs of all services to the community.

Other comments that are of interest to note included comments like "I will never eat fish caught in the Manawatu River downstream of Richmond Factory in Shannon, however clean the water may be!" Such comments invoke interesting implications. One can conclude that people are prejudiced against the presence of factories discharging waste to the waterways, such that, however much the waste being discharged to the water may be improved, they will not feel free to use the water downstream.

CHAPTER SIX

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

6.1 MEETING GOALS AND OBJECTIVES OF THE STUDY

6.1.1 Selection of appropriate methodology

The first objective set for this research was to select an appropriate methodology for evaluating the benefits of water quality improvement in the Lower Manawatu River. This process of selection consisted of four basic steps.

The first step involved the selection of an appropriate approach from among three choices. The valuation exercise could have been based on either:

(i) market values, (the market value approach) or

(ii) surrogate values, (surrogate value approach) or

(iii) values determined by means of surveys (willingness-to-pay approach).

The market and surrogate value approaches were regarded as inappropriate because many of the benefits associated with water quality improvement cannot be traded in the market place, nor do they possess substitute goods or services. The survey approach was preferred because it allows for the involvement of the public in the decision making process. Since improvement of water quality in the river is a public service, it is important to assess the preferences of the public on the issue. This approach ensures transparency and accountability on the side of decision makers, who in essence make decisions on behalf of the public.

The second step in the methodology selection process involved making a choice between the use of bidding games or the use of direct questioning to elicit households' willingness-to-pay for water quality improvement. The use of bidding games was regarded as inappropriate for eliciting households' willingness-to-pay due to inherent biases such as starting bid bias. The bidding game of necessity also requires that a personal survey be conducted, leaving little room for other implementation options for the survey. The direct questioning method was therefore preferred, because it allows for more options of implementing the survey. Furthermore it has no inherent starting point bias.

The third step involved making a decision on the format of the willingness-to-pay question. Either an open-ended question format or a closed-ended (dichotomous choice) format could be followed. The open-ended format was deemed inappropriate because of the difficulty individuals would face in picking a monetary value for a good or service that is not normally bought or sold in the market place. The dichotomous choice format was selected because it simplifies the valuation process for the respondents. The respondents say either "yes" or "no" to the question which asks their willingness-to-pay $X towards water quality improvement.

The final decision in the methodology development involved deciding on the survey implementation procedure. The survey could be implemented in person, by telephone, or by mail. A personal survey is financially expensive and time consuming. The financial resources for such an approach were not available. The nature of the current research involved long questions that could not appropriately be administered by phone. The mail survey was selected because it is relatively cheaper and consumes less time in comparison to a personal survey. Furthermore, through a mail survey, relatively more information can be passed on to the respondent than would otherwise be possible in a telephone survey.

6.1.2 To discern people's opinions and perceptions towards present water quality in the Manawatu River

The objective of discovering people's opinions and perceptions, was fulfilled by conducting a survey which questioned households in the region about the amount of time they committed to visiting the river. Table 5.3 shows that 254 households, about 69% of the households surveyed, had visited the Manawatu River or its tributaries during the last three summers. About 31% of the respondents had not visited the river or its tributaries in the last three summers. It was found that on average those who had visited the river spent about 16 days per summer participating in different activities at the river or its tributaries. These households spent about two and half hours participating in various activities on any one visit to the river.

The objective was pursued further by inquiring from the respondents about the activities they participate in at different sites of the river. In general households engaged in non-vigorous activities. Walking, sightseeing, picnicking, swimming, fishing, and duck shooting appeared as the leading activities at any particular site.

Finally in pursuit of this objective, households were asked to reveal their general perception of water quality in the various sections of the river they had visited. Table 5.8 shows that the Mangahao, the Mangatainoka, and the Pohangina, rated 3.12, 3.09, and 3.03, respectively on a 0 - 4 scale were perceived as having high water quality. The main river section was perceived as possessing water quality that is slightly unacceptable. The Foxton-Opiki section achieved the lowest overall score of 1.95, which is interpreted as being slightly unacceptable.

6.1.3 The effects of improving water quality in the river will have on the use of the river

In the survey, households were asked what attributes of the river were important to them when deciding to visit the river or not. Table 5.9 shows that the presence of oil or grease, foam or scum, and smell of water were the major attributes of river water quality that households considered when deciding to visit the river. These attributes scored mean values of 3.48, 3.25 and 3.17 on a 0 - 4 opinion scale respectively, all interpreted to mean "very important".

The investigation was narrowed down to focus on the Lower Manawatu River. Households' opinions on water quality showed that the top three ranked qualities of this section of the river were fish life, presence of logs or branches, and presence of invertebrates. As table 5.10 shows, on a 0 - 4 opinion scale, these attributes achieved 2.63, 2.23, and 2.18 mean score respectively, tallying in the slightly acceptable category. The worst three attributes of water quality in the river were reported to be the presence of scum in water, the presence of scum or foam, oil or grease in water, and fungus or algae growth in the riverbed. These attributes attained mean scores of 1.53, 1.68, and 1.73 respectively, which were described as slightly unacceptable.

An investigation into the effects of water quality improvement on use of the Lower Manawatu River gave the following results (table 5.11). In general, households indicated that they would not change their participation in activities at the river even if water quality was improved. Picnicking was the only activity in which more than 50% of the household indicated a possibility of increased participation if water quality was improved.

6.1.4 Factors influencing people's willingness-to-pay for improved water quality and quantify the value of improved water in dollars

An investigation was carried out of the socioeconomic characteristics of the households that participated in the survey. A logistic regression analysis was carried out. The results show that factors such as bid offered, household income, and household involvement in environmental groups appeared to significantly influence the probability of saying "yes" to the bid offered as an indication of their willingness-to-pay for water quality improvement.

The mean expected willingness-to-pay, was found to be $50.70 per year per household. At a 95 percent level of confidence the amount will be expected to range from $39.83 to $81.24. The aggregate WTP was calculated to be $2,549,196. This will range from $2,002,652 to $4,084,747.

6.2 DISCUSSION AND CRITIQUE OF THE METHODOLOGY

There are indications of increasing reliance on the contingent valuation method as an appropriate methodology to investigate nonmarket issues involving environmental amenities, such as the benefits of water quality improvement in the Manawatu River catchment. To obtain results that are of value for policy formulation, there is a need to follow prudent survey procedures. These procedures include correct specification of the population to be surveyed, proper sample size selection, skilled questionnaire design and implementation.

Edwards and Anderson (1987), showed that research in social psychology and marketing reveals that nonrespondents differ from respondents in terms of age, level of education, socioeconomic status and interest in the survey topic and participation in the survey. A high rate of non-participation is likely to introduce nonresponse bias. As Becker *et al.* (1987) showed that the nonresponse rate is likely to be high if the population being surveyed is not homogenous. One criteria pointed out as being appropriate in defining a homogenous population is if the population engages in a specific recreation activity at a specific site. This not being the case with the current survey, there is therefore reason to believe that some nonresponse bias exists in the results obtained from the survey.

Dilliman (1978) suggests a number of techniques that can be used to minimize the nonresponse bias. These include conducting a number of follow-ups. However this was not done in the current research due to time constraints and financial limitations.

The contingent valuation method has its limitations. If results from such studies are to be used in policy formulation, there is a need to have an understanding and an agreement among affected parties of these limitations before the survey is conducted. For the current research, it is important to point out that if the results are going to be used in decision making, note should be taken of, to say the least, the low return rate of the questionnaire and other weaknesses in the technique. Willingness-to-pay results can at best be taken only as an indication of the magnitude of the preferences of the public for the good or service under question.

6.3 CONCLUSIONS AND RECOMMENDATIONS

This research, tested the Proposed Manawatu Catchment Water Quality Regional Plan (1994). The research tried to verify the proposed policies against public opinion. Such a task can prove difficult because of the likelihood of the two sides having different perceptions as to what constitutes improved water quality. For instance, the water quality in the policy document is described using chemical standards. Such characteristics as biochemical oxygen demand (BOD), and water pH are the descriptive terminologies used. On the other hand the public uses different expressions to describe water quality. Thus it turns out to be a difficult task trying to get the public to value the policy if their expressions differ from those of the policy makers. This could have contributed to a high nonresponse rate.

However despite all the shortcomings, it can still concluded that:

- A good proportion (69%) of the households in the Manawatu River catchment visit the river during the summer. The majority of households spend their time participating in non-rigorous activities when visiting the river.
- Lack of interest in river related activities may be one of the most important factors that inhibits households' visitation to the river. Pollution did not appear to be a major hinderance.
- In general water quality in remotely situated tributaries of the Manawatu River is rated highly compared to that in the main stream river. The water quality in the main stream was described as unacceptable.
- The majority of households would not alter their visitation habits to the river even if water quality was improved.
- Though the study indicates that the value of water quality improvement in the Manawatu River is worthwhile to the residents, the research also reveals that a greater proportion of the residents are unwilling to contribute to the programme.

In light of these findings it may cautiously be concluded that it may not be in the interest of the public to implement the section of the Manawatu River catchment Water Quality Plan, that addresses the improvement in water quality to a standard suitable for contact recreation immediately. This is only fair because this research did not test all sections of the plan. There is need to carry out more investigations on other issues that are relevant to water quality management in the river. From comments made by respondents one gets the impression that what the public actually needs is easy access to the river in the form of footpaths, swimming holes and facilities that will enable households to utilize the river resource.

It would be recommended that the following areas be investigated:

- The suitability of the river environment to visitation by the public in terms of availability of facilities, road system, toilets, picnic tables etc.

- Commercial benefits associated with water quality improvement in the Manawatu River. This will provide a full comprehension of the benefits associated with water quality improvement in the river.
- Assess costs associated with the water quality improvement in the Manawatu River catchment. With both cost and benefit estimates, a more justified case of improving the water quality in the Manawatu River catchment can then be made.

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APPENDICES
Appendix I
Covering letter

SCHOOL OF
APPLIED AND
INTERNATIONAL
ECONOMICS

MASSEY
UNIVERSITY

1 November, 1994.

Dear Head of the Household,

MANAWATU RIVER WATER QUALITY STUDY

I am a postgraduate student in the Dept. of Agricultural Economics and Business, Massey University. I am carrying out research as part of my thesis for a masters of science in agricultural economics. The research is an economic study of water quality of the Lower Manawatu River. I am collecting information from a number of households within the Manawatu catchment area and your name was randomly selected from the telephone directory to participate in the survey.

Your participation in this survey is anonymous and voluntary. Most questions have to do with your attitude and opinions and there are no wrong answers. Your response is valuable to ensure that accurate information on benefits of quality water to the residents is obtained. Please complete the form even if you do not visit the river. This is essential to my research.

The information you provide will be considered strictly confidential. The number on the questionnaire is there for the purpose of identifying and reminding those who have not returned their forms. All ties between your identity and the number will be destroyed once the study is completed.

Thank you for your willingness to participate. Please complete and return the questionnaire by 14th. November, 1994. Use the **freepost envelope** provided. **You do not need a stamp.** For further information or inquiries contact me or any of my supervisors at the provided address of the Department of Agricultural Economics and Business.

Yours sincerely,

Marucha Omwenga
Student Researcher

Prof. Anton D. Meister,
Professor of Natural Resource &
Environmental Economics

Dr Robert R. Alexander,
Lecturer Natural Resource &
Environmental Economics

**Department of Agricultural
Economics and Business
Massey University
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Palmerston North
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**Telephone 0-6-356 9099
Facsimile 0-6-350 5642**

Appendix II
Questionnaire

HHCN

INTRODUCTION

Through this research an understanding is sought of perceptions, uses and values that the general population of the Manawatu River catchment attaches to water quality in the Manawatu River and its tributaries.

All the questions are straight forward involving ticking the choices provided or filling short blank spaces. Some words that may have different meanings to various readers have been clarified in the footnotes. Please do refer to them to ensure uniformity of usage of the words. Use the map provided to refer to sections of the river.

We estimate that it will take about **fifteen minutes to complete the questionnaire.**

SECTION 1: MANAWATU RIVER CATCHMENT

Section I focuses on use of the Manawatu River and its tributaries during the summer. The term "**household**" here refers to one or more than one person living in your house. The term "**use of a river**" refers to either involvement in such active activities as swimming, or in passive activities, such as sightseeing, by the river.

Q1. Please tell us whether a member(s) of your **household has visited the Manawatu River** or its tributaries in the **last three summers** (November to May inclusive)?

YES [__]

NO [__]

If NO please go to question 5.

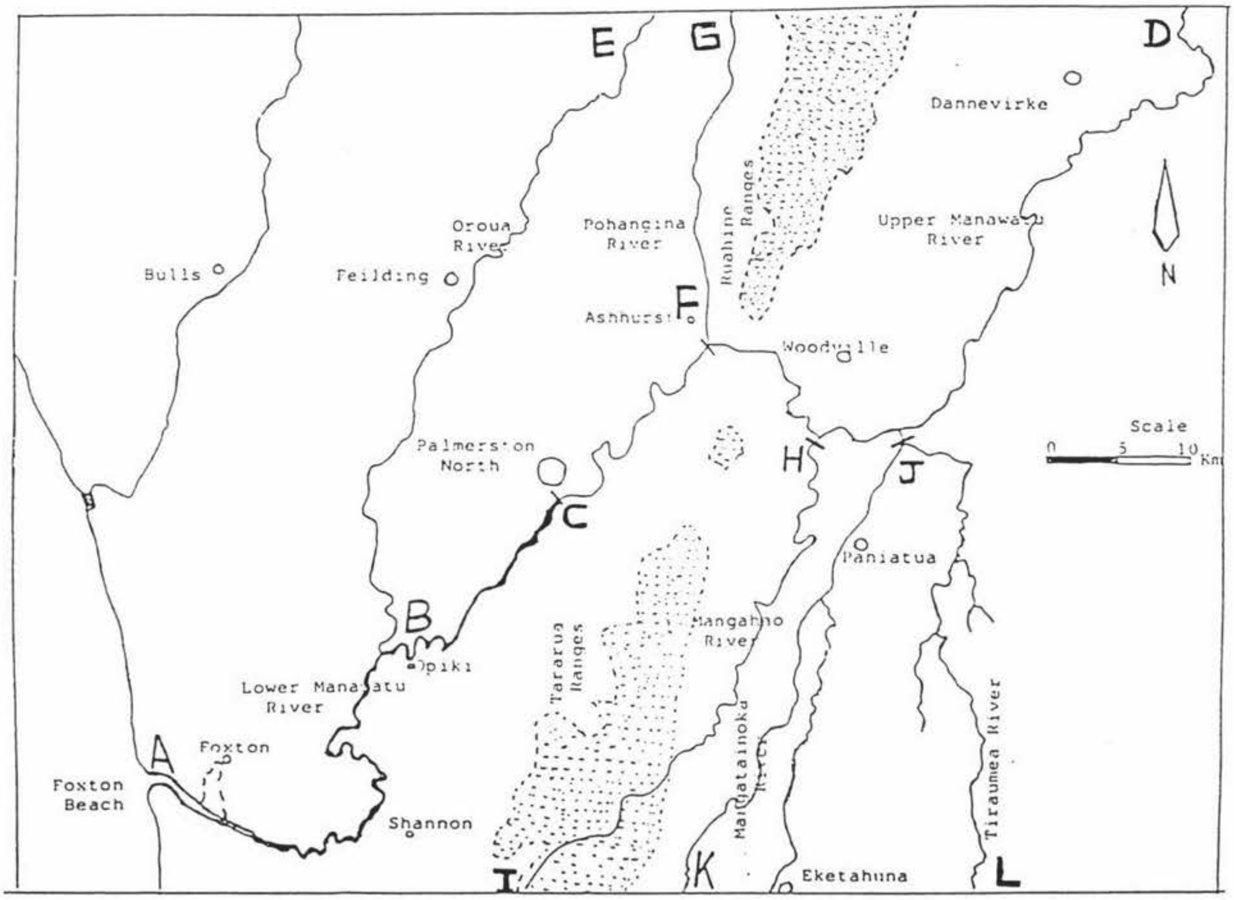
Q2. During the **last three summers**, what is the average number of days per summer did the member(s) of your household spend visiting the Manawatu River? Please write your answer in the space below.

_________ days per summer.

Q3. Please estimate the **average number of hours** that member(s) spent per day and **write your estimate in the space provided.**

_________ hours per visit.

THE MANAWATU RIVER



Q4. Please refer to the **Manawatu River Catchment map (figure 1)** and the list of activities provided below. List up to **three main activities** your household member(s) undertook in **each section of the river catchment during the last three summers? Write the number of the activities** as given in the list to match the section, of the river. If your household did not visit a certain section please indicate by ticking the no visit column.

	Section of the river		**Activities**	**No Visit**
1.	A-B	(Foxton Beach-Opiki)	__, __, __.	[ ]
2.	B-C	(Opiki-Palmerston Nrth)	__, __, __.	[ ]
3.	C-D	(Upper Manawatu River[1])	__, __, __.	[ ]
4.	B-E	(Oroua River)	__, __, __.	[ ]
5.	F-G	(Pohangina River)	__, __, __.	[ ]
6.	H-I	(Mangahao River)	__, __, __.	[ ]
7.	J-K	(Mangatainoka River)	__, __, __.	[ ]
8.	J-L	(Tiraumea River)	__, __, __.	[ ]

List of Activities

1.	swimming	11.	nature study
2.	canoeing	12.	duck shooting
3.	sailing	13.	whitebaiting
4.	waterskiing	14.	rowing
5.	powerboating	15.	jetboating
6.	sight seeing	16.	rafting
7.	photography	17.	fishing/angling
8.	walking/dog walk	18.	run/jog
9.	picnicking	19.	other
10.	birdwatching		Please specify________

Upper Manawatu River refers to the stretch of the river between the source and erston North, Fitzherbert Bridge.

Q5. For those sections of the river which you ticked "no visit" in question 4, or for all sections, if you skipped question 4, please indicate at most **two important reasons why your household didn't use those sections of the river. Indicate the number that matches your appropriate reason** from the list of reasons given below.

	Section of the river		**Reasons**
1.	A-B	(Foxton Beach-Opiki)	___, ___.
2.	B-C	(Opiki-Palmerston Nrth)	___, ___.
3.	C-D	(Upper Manawatu River)	___, ___.
4.	B-E	(Oroua River)	___, ___.
5.	F-G	(Pohangina River)	___, ___.
6.	H-I	(Mangahao River)	___, ___.
7.	J-K	(Mangatainoka River)	___, ___.
8.	J-L	(Tiraumea River)	___, ___.

Reasons for not visiting

1. No need/No interest using that section of river
2. Too far from my home
3. Prefer to go to other places
4. Section of the river is polluted
5. Ill health/Old age
6. Had not thought of it
7. No means of transport
8. No time to visit
9. Recently arrived in the Manawatu
10. Don't like the river environment
11. No facilities (eg toilets, picnic table)

12. Other (please specify)____________________

Q6. How does your household perceive water quality of the various sections of Manawatu River? Please indicate your household's **opinion**[2] of water quality of the sections by rating each section on a **0-4 scale. Please tick one box for each section below.** If you have **no opinion** indicate so by **ticking the don't know column** at the far right.

0	Totally unacceptable	1	Slightly unacceptable		
2	Slightly acceptable	3	Acceptable	4	Totally acceptable

Section			**0**	**1**	**2**	**3**	**4**	**n/o**
1.	A-B	(Foxton Beach-Opiki)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
2.	B-C	(Opiki-Palmerston Nrth)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
3.	C-D	(Upper Manawatu River)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
4.	B-E	(Oroua River)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
5.	F-G	(Pohangina River)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
6.	H-I	(Mangahao River)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
7.	J-K	(Mangatainoka River)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
8.	J-L	(Tiraumea River)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Your household opinion of water quality may be from actual visit of the section of the or from hearsay.

SECTION II: LOWER MANAWATU RIVER

Section II looks at perceptions, and valuation of water quality in the **lower Manawatu River.**

Q7. In the table below are some river water quality indicators.

(a) If your household was to make a decision to visit any river, how important would the indicators in the table below be to your household? Please **rate their importance on a 0-4 scale on the left hand side, one box for each indicator.**

0	Not important	1	Slightly important	2	Quite important
3	Very important	4	Extremely important		

(b) On the **right hand side** indicate your opinion of present water quality in the lower Manawatu as per the indicators by **ticking one box. If you have no opinion tick the n/o** column.

0	Totally unacceptable	1	Slightly unacceptable
2	Slightly acceptable	3	Acceptable
4	Totally acceptable	5	n/o No opinion

(a)Importance **0 1 2 3 4**	**Water Quality Indicators**	**(b)Opinion** **0 1 2 3 4**	**n/o** **5**
[ ] [ ] [ ] [ ] [ ]	1.smell of water	[ ] [ ] [ ] [ ] [ ]	[ ]
[ ] [ ] [ ] [ ] [ ]	2.branches of trees/ logs floating in water	[ ] [ ] [ ] [ ] [ ]	[ ]
[ ] [ ] [ ] [ ] [ ]	3.colour of water	[ ] [ ] [ ] [ ] [ ]	[ ]
[ ] [ ] [ ] [ ] [ ]	4.soil/mud in water	[ ] [ ] [ ] [ ] [ ]	[ ]
[ ] [ ] [ ] [ ] [ ]	5.fungus/algae growth in riverbed	[ ] [ ] [ ] [ ] [ ]	[ ]
[ ] [ ] [ ] [ ] [ ]	6.oil/grease on water	[ ] [ ] [ ] [ ] [ ]	[ ]
[ ] [ ] [ ] [ ] [ ]	7.scum or foam on water	[ ] [ ] [ ] [ ] [ ]	[ ]
[ ] [ ] [ ] [ ] [ ]	8.Invertebrates presence in water	[ ] [ ] [ ] [ ] [ ]	[ ]
[ ] [ ] [ ] [ ] [ ]	9.fishlife	[ ] [ ] [ ] [ ] [ ]	[ ]

Some of the characteristics of **present water quality in the lower Manawatu River**, are shown in column 1 below. There are plans to ensure water in the river is upgraded to achieve "**contact recreation**" standards. Some of the characteristics of "contact recreation" standards are shown in column 2.

PRESENT WATER QUALITY STANDARDS	anticipated CONTACT RECREATION STANDARDS
1.Horizontal visibility[3] is less than 1m in most places.	1.Horizontal visibility in most places should be 1.6m or more.
2.Visible bacterial &/fungal growth as mat at many sites of the riverbed.	2.Should have no visible bacterial &/fungal growth.
3.Not suitable for bathing at all sites of the river.	3.Should be suitable to bathe at all sites of the river.
4.At some sections dissolved oxygen concentration is below $5g/m^3$ at certain times of the day.	4.Dissolved oxygen concentration to be always above $8g/m^3$ at all times at all sites.
5.Enterococci bacteria concentration at certain sites exceeds 33 per 100ml.	5.Enterococci bacteria concentration not to exceed 33 per 100ml at any site.

[3]Water clarity is measured by the horizontal visibility of a 200 mm black disc.

Q8. What **effect would improvement** in water quality (in the lower Manawatu River) from the current quality standard to "**contact recreation**" standards have on **your use** of the section the river? **Please tick one box for each activity.**

Activities		**Increased activity**	**No change**
1.	Swimming	[ ]	[ ]
2.	Canoeing	[ ]	[ ]
3.	Sailing	[ ]	[ ]
4.	Waterskiing	[ ]	[ ]
5.	Waterboating	[ ]	[ ]
6.	Sightseeing	[ ]	[ ]
7.	Photography	[ ]	[ ]
8.	Walking/dog walk	[ ]	[ ]
9.	Picnicking	[ ]	[ ]
10.	Birdwatching	[ ]	[ ]
11.	Nature study	[ ]	[ ]
12.	Duck shooting	[ ]	[ ]
13.	Whitebaiting	[ ]	[ ]
14.	Rowing	[ ]	[ ]
15.	Jetboating	[ ]	[ ]
16.	Rafting	[ ]	[ ]
17.	Fishing/angling	[ ]	[ ]
18.	Run/jogging	[ ]	[ ]
19.	Other	[ ]	[ ]

(please specify)____________

Water quality in the lower Manawatu is influenced by many activities that take place within its catchment. Among the factors that reduce water quality in the river are sewage discharges from Palmerston North, Feilding, Foxton, Dannevirke and other urban centres; industrial waste discharges; agricultural waste discharges and rural runoff; and water removal for irrigation and other purposes.

However, water quality can be improved through increased treatment of discharges from all sources. One option the city and district councils have is to spend income from rates to install and run advanced sewage treatment facilities. The other option is to stop discharging sewage into water and opt for a landbased disposal. In either option there is a financial cost to be met. If we assume the only way to finance the advanced sewage facilities or landbased disposal is to increase rates, then improved water quality would result in increased rates for home owners in the Manawatu region.

Q9. Would your household be **willing to contribute extra rates (or rent[4]) each year** to improve water quality in the **lower Manawatu River**?

YES [ ]

NO [ ]

If NO go to Q11.

Q10. Let us assume that a decision has to be made about upgrading water quality in the lower Manawatu River. Would your household be willing to contribute an **additional $1 in rates (rent) per year** towards Water quality improvement from **present standards to "contact recreation"** standards.

YES [ ]

NO [ ]

Go to Q12

---

[4]Increase in rates would be passed on to people in rental accommodation through rent.

Q11. **Tick one reason** your household considers **most important** that best explains why you are not willing to contribute in extra rates to improve water quality in the lower Manawatu River.

1.	I don't use that section of the river	[ ]
2.	I already pay enough rates	[ ]
3.	I cannot afford to pay	[ ]
4.	Polluters should pay	[ ]
5.	I will use other places	[ ]
6.	I am convinced the money will not be used for upgrading water as intended	[ ]
7.	Other (please specify)______________	[ ]

Q12. If water quality is to be improved, what **length of time** should be allowed to upgrade water in the Manawatu River to **"contact recreation"** standards? **Tick one correct box.**

(1)	1-2	years	[ ]
(2)	3-4	years	[ ]
(3)	5-9	years	[ ]
(4)	10-14	years	[ ]
(5)	15	years and over	[ ]

PART III: SOCIOECONOMIC DATA

Please tell us about your household to enable us analyze the data you have provided.

Q13. Please **write the number of members of your household** that are:

Below 18 years ____(male)_______(female)

More than 18 years ____(male) ____(female).

Q14. Are you female [ ] or male [ ]?

Q15. Please **tick the correct box** to indicate your age group.

1. Below 18 years [ ]
2. 18-25 years [ ]
3. 26-35 years [ ]
4. 36-45 years [ ]
5. 46-55 years [ ]
6. 56-65 years [ ]
7. Over 65 years [ ]

Q16. Please **tick one box** below to indicate **your occupation**.

1.	Home duties [ ]		7.	Managerial/professional	[ ]
2.	Retired	[ ]	8.	Services/Nurses etc	[ ]
3.	Unemployed [ ]		9.	Business	[ ]
4.	Farm owner [ ]		10.	Clerical/Salesperson	[ ]
5.	Technical	[ ]	11.	Semi-skilled/Labourer	[ ]
6.	Student	[ ]	12.	Others (specify)___________	

Q17. Please indicate your **household's average annual income** before tax for this year.

1. Less than $10,000 [ ]
2. $10,000-$19,999 [ ]
3. $20,000-$29,999 [ ]
4. $30,000-$39,999 [ ]
5. $40,000-$49,999 [ ]
6. $50,000-$59,000 [ ]
7. $60,000 and over [ ]

Q18. Approximately **how far do you live from Lower Manawatu river**? (Feilding is about 18Km on a straight line from the nearest point at lower Manawatu River).

1. less than 1 Km [ ]
2. 1-10 Km [ ]
3. 11-20 Km [ ]
4. 21-30 Km [ ]
5. 31-40 Km [ ]
6. 41-50 Km [ ]
7. over 50 Km [ ]

Q19. Please indicate the **length of time** your household has **lived this region**?

1.	Less than 1	year	[ ]
2.	1-10	years	[ ]
3.	11-20	years	[ ]
4.	21-30	years	[ ]
5.	31-40	years	[ ]
6.	41-50	years	[ ]
7.	over 50	years	[ ]

Q20. **Please tick one box** below to indicate the **district** your home is located?

1.	Palmerston North	[ ]
2.	Manawatu	[ ]
3.	Horowhenua	[ ]
4.	Tararua	[ ]

Q21. Is there any **member of your household** belonging to an **environmental group**?

Yes	[ ]
NO	[ ]

Q22. Please **Comment** about the management or use of the Manawatu River here below.

THANK YOU FOR YOUR TIME
PLEASE RETURN YOUR QUESTIONNAIRE IN THE FREEPOST ENVELOPE
(NO STAMP IS NEEDED)

Appendix III
Univariate logistic regression

SPSS/PC+ The Statistical Package for IBM PC

Appendix III(a) Commands which generated the output

```
compute asked=1.
compute bid = wtpx10.1.
compute agreed=wtpx10.2.
if (wtp9=2) agreed = 2.
recode agreed(1=1)(2=0).
aggregate outfile = * /break =bid/ n=n(agreed) /r=sum(agreed).
probit r of n with bid /MODEL LOGIT
/PRINT all/LOG NONE.
```

---

15 unweighted cases accepted. 1 cases rejected because of missing data.
MODEL Information: ONLY Logistic Model is requested.
ML converged at iteration 4. The converge criterion = 0.00023 Parameter Estimates (LOGIT model:

(LOG(p/(1-p))/2 + 5) = Intercept + BX): Note 5 added to intercept and logit divided by 2.

	Regression Coeff.	Standard Error	Coeff./S.E.
BID	**-0.00620**	0.00164	-3.77869

Intercept	Standard Error	Intercept/S.E.
4.88676	0.11665	41.89415

Pearson Goodness-of-Fit Chi Square = 14.493 DF = 13 P = 0.340
Since Goodness-of-Fit Chi square is NOT significant, no heterogeneity factor is used in the calculation of confidence limits.

Calculating the value of β_1 and β_2 from the output above.

Given that (LOG(p/(1-p))/2 + 5) = Intercept + BX):
Substituting for intercept = 4.88676 and B = -0.00620

$$\frac{\log\left(\frac{P}{(1-p)}\right)}{2}+5=intercept+BX=4.88676-0.00620X$$

$$\frac{\log\frac{P}{(1-p)}}{2}=-0.11324-0.00620X$$

$$\log\frac{p}{(1-P)}=-0.22648-0.0124X$$

Thus the values of β_1 and β_2 are -0.22648 and -0.0124 respectively.

Table A1 Observed and expected frequencies

BID	Number of subjects	Observed responses	Expected responses	Residual	Prob
1.00	3.0	2.0	1.322	0.678	0.44057
5.00	2.0	0.0	0.857	-0.857	0.42839
10.00	3.0	2.0	1.240	0.760	0.41329
15.00	11.0	5.0	4.382	0.618	0.39835
20.00	17.0	7.0	6.521	0.479	0.38359
25.00	15.0	7.0	5.536	1.464	0.36905
30.00	15.0	9.0	5.321	3.679	0.35475
35.00	28.0	11.0	9.539	1.461	0.34069
40.00	27.0	4.0	8.827	-4.827	0.32692
50.00	36.0	8.0	10.809	-2.809	0.30025
60.00	32.0	7.0	8.796	-1.796	0.27488
70.00	46.0	10.0	11.540	-1.540	0.25088
90.00	37.0	9.0	7.667	1.333	0.20722
110.00	42.0	7.0	7.116	-0.116	0.16944
150.00	50.0	7.0	5.527	1.473	0.11053

Table A2 Confidence Limits for Effective BID. 95% Confidence Limits

Prob	BID	Lower	Upper
0.01	352.52812	668.31371	251.61364
0.02	295.77536	550.69178	213.95111
0.03	262.22870	481.24168	191.61230
0.04	238.17797	431.50744	175.53997
0.05	219.32642	392.57323	162.89338
0.06	203.76006	360.46883	152.40577
0.07	190.45781	333.07743	143.40014
0.08	178.81011	309.13647	135.47116
0.09	168.42368	287.83263	128.35611
0.10	159.02995	268.61180	121.87421
0.15	121.69854	193.01528	95.32615
0.20	93.59193	138.20547	73.23186
0.25	70.37742	97.54956	50.36925
0.30	50.09760	69.98129	22.44875
0.35	31.67827	51.53403	-9.50218
0.40	14.44391	37.23390	-42.35797
0.45	-2.08198	24.73122	-75.07270
0.50	-18.27510	13.05162	-107.70003
0.55	-34.46822	1.68664	-140.64197
0.60	-50.99411	-9.71575	-174.45700
0.65	-68.22847	-21.47181	-209.85686
0.70	-86.64781	-33.93468	-247.79217
0.75	-106.92763	-47.57387	-289.64175
0.80	-130.14213	-63.11393	-337.62021
0.85	-158.24874	-81.85794	-395.78030
0.90	-195.58015	-106.67455	-473.10827
0.91	-204.97389	-112.90887	-492.57668
0.92	-215.36031	-119.79818	-514.10626
0.93	-227.00801	-127.51981	-538.25457
0.94	-240.31026	-136.33340	-565.83801
0.95	-255.87662	-146.64132	-598.12209
0.96	-274.72818	-159.11751	-637.22671
0.97	-298.77891	-175.02500	-687.12579
0.98	-332.32556	-197.19879	-756.74092
0.99	-389.07833	-234.68277	-874.54139

Appendix IV
Multivariate logit model development

SPSS/PC+ The Statistical Package for IBM PC

LOGISTIC REGRESSION /VARIABLES AGREED WITH BID us1 ds2 hr3 sex14 age15 inc17 dt18 liv19 env21/method fstep /CATEGORICAL loc20.

Total number of cases:	369 (Unweighted)
Number of selected cases:	369
Number of unselected cases:	0
Number of selected cases:	369
Number rejected because of missing data:	151
Number of cases included in the analysis:	218

Dependent Variable Encoding:

Original Value	Internal Value
.00	0
1.00	1

	Value	Freq	Parameter Coding (1)	(2)	(3)
LOC20					
	1	102	1.000	0.000	0.000
	2	61	0.000	1.000	0.000
	3	42	0.000	0.000	1.000
	4	13	-1.000	-1.000	-1.000

Note: This coding results in deviation coefficients.

Dependent Variable.. AGREED
Beginning Block Number 0. Initial Log Likelihood Function
-2 Log Likelihood 272.15715
* Constant is included in the model.
Beginning Block Number 1. Method: Forward Stepwise (WALD)

* If redundancies exist among the variables specified on the varlist, the residual chi-square may not be correct.

Model 1

Estimation terminated at iteration number 3 because parameter estimates changed by less than .001

	Chi-Square	df	Significance
-2 Log Likelihood	272.157	217	0.0065
Goodness of Fit	218.000	217	0.4681

Classification Table for AGREED

	Predicted		
Observed	0.00	1.00	Percent Correct
0.00	149	0	100.00%
1.00	69	0	0.00%
	Overall		68.35%

--------------------- Variables in the Equation ----------------------

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
Constant	-0.7698	0.1456	27.9499	1	0.0000		

-------------- Variables not in the Equation ----------------

Residual Chi Square 31.866 with 13 df Sig = 0.0025

Variable	Score	df	Sig	R
BID	8.2705	1	0.0040	0.1518
US1	0.6404	1	0.4236	0.0000
DS2	0.0005	1	0.9820	0.0000
HR3	0.4558	1	0.4996	0.0000
SEX14	2.0282	1	0.1544	0.0102
AGE15	0.4267	1	0.5136	0.0000
INC17	7.1008	1	0.0077	0.1369
DT18	0.6785	1	0.4101	0.0000
LIV19	0.6220	1	0.4303	0.0000
ENV21	10.3385	1	0.0013	0.1750
LOC20	7.8846	3	0.0485	0.0832
LOC20(1)	3.6029	1	0.0577	0.0767
LOC20(2)	2.7947	1	0.0946	0.0540
LOC20(3)	2.4242	1	0.1195	0.0395

MODEL 2

Variable(s) Entered on Step Number 1.. ENV21

Estimation terminated at iteration number 3 because Log Likelihood decreased by less than .01 percent.

	Chi-Square	df	Significance
-2 Log Likelihood	262.447	216	0.0169
Model Chi-Square	9.710	1	0.0018
Improvement	9.710	1	0.0018
Goodness of Fit	218.000	216	0.4491

Classification Table for AGREED

	Predicted		
Observed	0.00	1.00	Percent Correct
0.00	132	17	88.59%
1.00	49	20	28.99%
	Overall		69.72%

---------------------- Variables in the Equation ----------------------

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
ENV21	-1.1535	0.3699	9.7258	1	0.0018	-0.1685	0.3155
Constant	1.3160	0.6806	3.7384	1	0.0532		

--------------- Variables not in the Equation ----------------

Residual Chi Square 22.738 with 12 df Sig = .0300

Variable	Score	df	Sig	R
BID	7.6765	1	0.0056	0.1444
US1	0.3403	1	0.5596	0.0000
DS2	0.0181	1	0.8929	0.0000
HR3	0.3141	1	0.5752	0.0000
SEX14	1.4272	1	0.2322	0.0000
AGE15	0.7434	1	0.3886	0.0000
INC17	6.2701	1	0.0123	0.1253
DT18	0.4575	1	0.4988	0.0000
LIV19	1.1469	1	0.2842	0.0000
LOC20	7.1639	3	0.0669	0.0654
LOC20(1)	3.0766	1	0.0794	0.0629
LOC20(2)	2.9020	1	0.0885	0.0576
LOC20(3)	2.0848	1	0.1488	0.0177

No variables can be removed.

MODEL 3

Variable(s) Entered on Step Number 2.. BID
Estimation terminated at iteration number 3 because Log Likelihood decreased by less than .01 percent.

	Chi-Square	df	Significance
-2 Log Likelihood	254.379	215	0.0339
Model Chi-Square	17.778	2	0.0001
Improvement	8.068	1	0.0045
Goodness of Fit	221.960	215	0.3579

Classification Table for AGREED

	Predicted		
Observed	0.00	1.00	Percent Correct
0.00	138	11	92.62%
1.00	52	17	24.64%
	Overall		71.10%

---------------------- Variables in the Equation ----------------------

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
BID	-0.0106	0.0039	7.3824	1	0.0066	-0.1406	0.9895
ENV21	-1.1343	0.3768	9.0617	1	0.0026	-0.1611	0.3217
Constant	1.9933	0.7427	7.2024	1	0.0073		

--------------- Variables not in the Equation ----------------
Residual Chi Square 15.352 with 11 df Sig = 0.1670

Variable	Score	df	Sig	R
US1	0.0925	1	0.7610	0.0000
DS2	0.0503	1	0.8225	0.0000
HR3	0.2184	1	0.6403	0.0000
SEX14	1.6223	1	0.2028	0.0000
AGE15	0.5622	1	0.4534	0.0000
INC17	6.8424	1	0.0089	0.1334
DT18	0.7082	1	0.4000	0.0000
LIV19	0.7806	1	0.3770	0.0000
LOC20	7.5472	3	0.0564	0.0754
LOC20(1)	3.5079	1	0.0611	0.0744
LOC20(2)	3.3094	1	0.0689	0.0694
LOC20(3)	1.6627	1	0.1972	0.0000

No variables can be removed.

MODEL 4

Variable(s) Entered on Step Number 3.. INC17
Estimation terminated at iteration number 3 because Log Likelihood decreased by less than .01 percent.

	Chi-Square	df	Significance
-2 Log Likelihood	247.500	214	0.0578
Model Chi-Square	24.657	3	0.0000
Improvement	6.879	1	0.0087
Goodness of Fit	216.668	214	0.4362

Classification Table for AGREED

	Predicted		
Observed	0.00	1.00	Percent Correct
0.00	137	12	91.95%
1.00	53	16	23.19%
	Overall		70.18%

--------------------- Variables in the Equation ----------------------

Variable	B	S.E.	Wald	df	Sig	R	Exp(B)
BID	-0.0111	0.0039	7.9001	1	0.0049	-0.1472	0.9890
INC17	0.2052	0.0794	6.6793	1	0.0098	0.1311	1.2278
ENV21	-1.0952	0.3828	8.1866	1	0.0042	-0.1508	0.3345
Constant	1.0642	0.8230	1.6720	1	0.1960		

-------------- Variables not in the Equation ----------------
Residual Chi Square 8.728 with 10 df Sig = .5581

Variable	Score	df	Sig	R
US1	0.0005	1	0.9813	0.0000
DS2	0.0859	1	0.7695	0.0000
HR3	0.0206	1	0.8859	0.0000
SEX14	0.9340	1	0.3338	0.0000
AGE15	2.1067	1	0.1467	0.0198
DT18	0.4006	1	0.5268	0.0000
LIV19	1.1140	1	0.2912	0.0000
LOC20	5.6755	3	0.1285	0.0000
LOC20(1)	2.8151	1	0.0934	0.0547
LOC20(2)	3.0073	1	0.0829	0.0608
LOC20(3)	0.3762	1	0.5397	0.0000

No variables can be removed. No variables can be added.

APPENDIX V
Mean willingness-to-pay procedure

Procedure to obtain mean WTP from the survey data, following Loomis (1988).

(1) The data were recorded, aggregated, and supplied to the SPSS PROBIT procedure (refer to *Appendix III*, table A1 for details).

(2) The values for BID and predicted probability were extracted from the SPSS output (*Appendix III*, table A2).

(3) The entries which had negative values for BID were deleted and replaced by one entry: a probability of 1 for a BID of $0.

(4) The table of BID versus probability was sorted in ascending order of BID.

(5) The area under the curve of BID (x-axis) versus probability (y-axis) was estimated by trapezoidal approximation to give the mean WTP (see table A3 below).

In similar manner lower and higher bound willingnes to pay at 95 % confindence were estimated as shown in tables A4 and A5 below.

Table A3 Trapezoidal approximation mean willingness-to-pay

BID	Probability	Mean WTP
14.444	0.400	10.111
31.678	0.350	16.574
50.098	0.300	22.560
70.377	0.250	28.137
93.592	0.200	33.360
121.699	0.150	38.279
159.030	0.100	42.945
168.424	0.090	43.838
178.810	0.080	44.720
190.458	0.070	45.594
203.760	0.060	46.459
219.326	0.050	47.315
238.178	0.040	48.163
262.229	0.030	49.005
295.775	0.020	49.844
352.528	0.010	**50.695**

Table A4 Approximation of lower bound mean willingness-to-pay

BID	Probability	Lower bound WTP
22.449	0.300	14.592
50.369	0.250	22.270
73.232	0.200	27.414
95.326	0.150	31.280
121.874	0.100	34.599
128.356	0.090	35.215
135.471	0.080	35.819
143.400	0.070	36.414
152.406	0.060	37.000
162.893	0.050	37.576
175.540	0.040	38.145
191.612	0.030	38.708
213.951	0.020	39.266
251.614	0.010	**39.831**

Table A5 Approximation of upper bound mean willingness-to-pay

BID	Probability	Lower WTP
1.687	0.550	1.307
13.052	0.500	7.274
24.731	0.450	12.822
37.234	0.400	18.135
51.534	0.350	23.498
69.981	0.300	29.493
97.550	0.250	37.074
138.205	0.200	46.222
193.015	0.150	55.814
268.612	0.100	65.263
287.833	0.090	67.089
309.136	0.080	68.900
333.077	0.070	70.696
360.469	0.060	72.476
392.573	0.050	74.242
431.507	0.040	75.994
481.242	0.030	77.735
550.692	0.020	79.471
668.314	0.010	**81.235**