STAKEHOLDER PREFERENCES

FOR WATER QUALITY ALTERNATIVES

IN THE RED RIVER BASIN

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Stakeholder Preferences For Water Quality Alternatives in the Red River Basin

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ABSTRACT

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The objective of this research is to estimate stakeholder preferences for management alternatives within the Red River of the North basin. Specifically, this thesis analyzes preferences related to water quality, water-based recreation, water supply, and institution. Results are estimated using choice experiments. Data show that residents are willing to pay approximately $84 per year for wetland restoration, $76 per year for additional bike trails, and $117 for enhanced fishery management. Taken to an aggregate level of all counties with land in the basin, willingness to pay is approximately $24 million for wetlands, $22 million for bike trails, and $34 million for enhanced fishery management. These values can assist institutions in making decisions related to the basin's water resources.

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CHAPTER 1. INTRODUCTION AND PROBLEM STATEMENT

I. Introduction

About 70% of the world's surface is covered with water. Roughly 2.5% of this is fresh water, which is water that contains low concentrations of salt. Fresh water is one of the world's most valuable natural resources for a number of reasons. It supports habitat for a number of different plant and animal species. It provides drinking water for people and wildlife. It nourishes land resources and helps plants to grow. Fresh water continues to be used for transportation and attractive recreation services (Postel and Carpenter, 1997).

Many regions experience drought-like conditions and a scarcity of fresh water resources while others retain abundant quantities. Other areas sometimes deal with the problem of too much water in the form of floods. Additionally, the quality and safety of water resources, such as clean drinking water and suitable habitats for fish and wildlife, are threatened when excessive pollutants enter the water.

Because of these concerns, fresh water management is vital (Postel and Carpenter, 1997). According to the Concise Oxford Dictionary (1999), a watershed, or basin, contains all the land that is drained by a river and its tributaries. Thus, water resources are not necessarily confined to political boundaries, but can pervade multiple states or countries such as the Great Lakes of North America. Proper comprehensive management often requires the collaboration of multiple governments, levels of government, and non-government organizations.

The Red River of the North basin is one such example of a watershed that has utilized the commitment of various levels of government and non-government players

to maintain its water resources. Containing land in three states in the United States and Canada, the basin contains approximately 45,000 square miles, of which about 39,200 square miles are in the United States (Krenz and Leitch, 1998). The Red River forms at the junction of the Otter Tail and Bois de Sioux rivers in Breckenridge, Minnesota and Wahpeton, North Dakota. The river flows in a northerly direction between North Dakota and Minnesota, meandering approximately 550 miles. In Canada it joins up with the Assiniboine River in Winnipeg, Manitoba, and then empties into Lake Winnipeg (Minnesota Department of Natural Resources, 2007).

Government intervention at the federal, state, and local level is organized to allocate duties to specific regulating and management agencies. At a federal level, the Soil Conservation Service, Fish and Wildlife Service, the U.S. Geological Survey, Army Corps of Engineers, Environmental Protection Agency, and National Park Service, among many others, are involved in natural resource management issues (Krenz and Leitch, 1998).

At a state level, Minnesota utilizes its Department of Natural Resources, the Minnesota Pollution Control Agency, and the Department of Health to deal with water and natural resource administration. In 1955 the Minnesota Watershed Act established watershed districts for local water management. Soil and water conservation districts in Minnesota are other local entities that aid in water management. These local special districts have the power to levy property taxes and to charge special assessments as a way to obtain funding for relevant projects (Kritzky, forthcoming).

In North Dakota, the State Water Commission, Department of Health, and the Game and Fish Department deal with water quality and supply issues as well as ecosystem and wildlife issues. Local water resource districts and soil conservation

districts have the power to levy the property tax for funds to complete projects (Kritzky, forthcoming).

In South Dakota, the Department of Environment and Natural Resources, the Department of Game, Fish, and Parks, and the Department of Health are state-level authorities over water resources. There are also local conservation districts and water project districts that help manage water-related issues. Conservation districts in general receive most of the funding, although occasionally a water project district will implement a project when deemed necessary. Both have the ability to levy property taxes in order to receive funding.

In addition to government institutions, there are non-government organizations that work and lobby as a voice of the people. These also provide management services and advice for basin water resources. They range from local grassroots involvement all the way to the international level.

These various institutions are involved in managing the Red River. The river is a valuable fresh water resource to the people that live within its watershed. The majority of people living in the United States' portion of the Red River valley use the river as their primary or sole source of water. Settlers were attracted to the area in part due to the available water and the fertile soil of the basin. Farmers often experience high yields from a variety of crops. In the past the river was used as a transportation hub, with steamboats traveling north and south. Trains continue to transport goods to and from communities along the river and within the basin. The river has also been used for recreation such as boating and swimming in the summer, and for snowmobiling in the winter. Recreational fishing services are attractive, as large catfish and other game fish are a part of the wildlife. The river supports habitat for wildlife,

plants, and animals. With these many benefits comes the responsibility of managing a natural resource both in terms of the quantity of water and the quality of water.

The Red River basin is susceptible to occasional droughts and floods. A drought in the 1930s reduced water supply to long lasting no-flow conditions, and less-severe droughts in the 1970s and 1980s also required conservation practices to be put into place for 3 and 2 years, respectively. A flood in 1950 devastated the city of Winnipeg, Manitoba. A historic flood of the Red River in 1997 caused about $5 billion dollars in damages in the United States and Canada, and required emergency intervention and aid from governments and volunteers (International Joint Commission, 2000). Two major floods since then, in 2003 and 2006, were better prepared for but still had negative impacts on communities in the basin.

Fish kills occurred in the Red River in 2003, 2006, and 2007 and occasionally occur in other basin lakes and streams (Dokken, 2007; Olson, 2006). These can occur as a result of weeks of dry weather that are followed by a rainstorm. This brings runoff swiftly into the water. The combined low-flow conditions and runoff such as sediment and sewage decrease the dissolved oxygen levels for fish. Fish kills can also occur when not enough oxygen gets into the water during long and cold winter months. This usually affects shallow lakes.

Major water quality impairments include excessive phosphorous and nitrogen (Paakh et al., 2006). These nutrients from city and farm runoff enter the Red River either directly or first into one of its tributaries. As these nutrients flow downstream, excess amounts have been linked to the buildup of algae strains in Lake Winnipeg. The buildup of blue-green algae on over 13,000 square kilometers of the surface area of the lake has impeded commercial fishing, caused lake water to be aesthetically undesirable,

and put five species on the endangered or threatened species list (Lake Winnipeg Implementation Committee, 2005).

The United States' Clean Water Act was originally enacted in 1972 as a result of growing public awareness about water pollution (U.S. EPA, 2007). Section 303.d requires each state to develop ambient pollution standards, ranking impairments in terms of priority and developing action plans for pollution mitigation. Each state must then develop a total maximum daily load (TMDL), which estimates the maximum amount of every identified pollutant that a water body can receive and still meet water quality standards. The Red River has two separate TMDL statements – one prepared by Minnesota and the other prepared by North Dakota (Hearne, 2007). Despite the link to algae growth, neither phosphorous nor nitrogen is listed in either state's TMDL.

II. Study Area

Wolf et al. (1999) list 261 international rivers that cross political boundaries. International waters require countries to communicate, manage, and share responsibility over their shared water resources. Waters that cross political boundaries sometimes create difficulty for those who manage them. The strain of upstream-downstream relations, ill-defined property rights, and institutional limitations contribute to management problems.

The Red River of the North is one such international water, and its basin contains territory in both the United States and Canada (Krenz and Leitch, 1998). For the purposes of this research, the study area is limited to all territory within the United States, which includes land in Minnesota, North Dakota, and South Dakota and contains roughly 39,200 square miles. Parts or all of 24 counties in North Dakota, parts of 2

counties in South Dakota, and parts or all of 21 counties in Minnesota lie in the basin. Drainage area in the Red River basin is the total amount of land that drains water into the Red River. About 11% of the Red River drainage area is in Canada. Approximately 41% of the drainage area lies in Minnesota, 47% in North Dakota, and the remaining 1% in South Dakota (Figure 1.1).

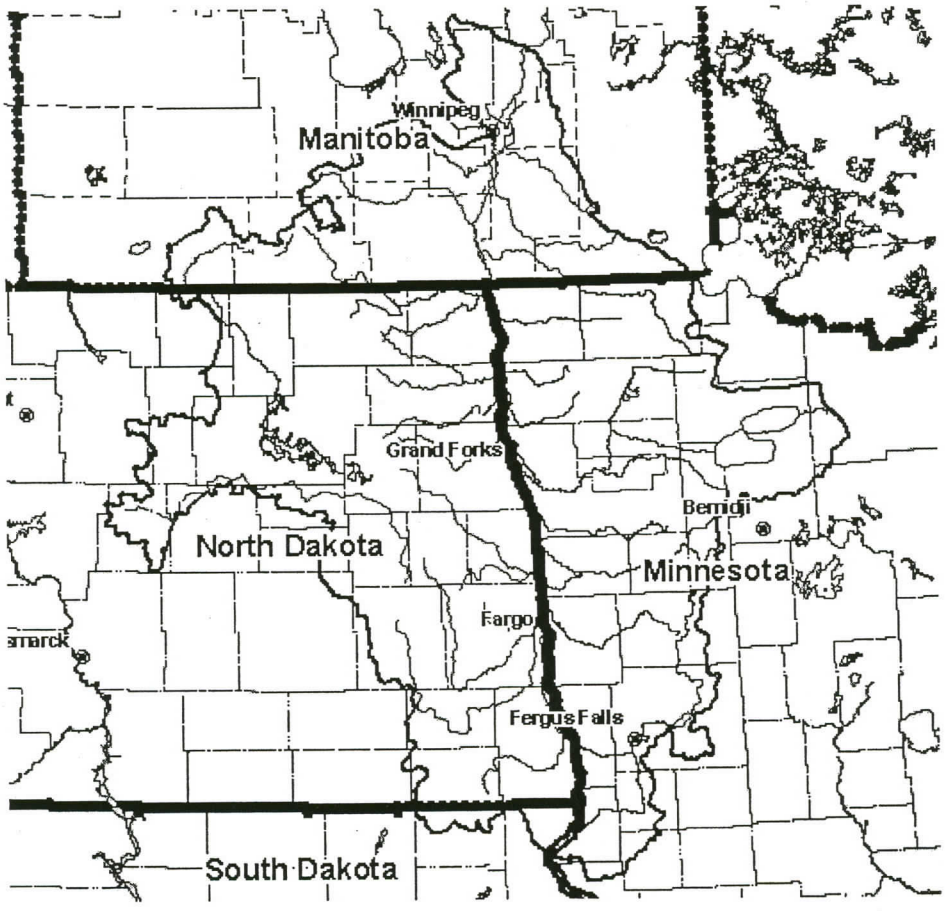

Figure 1.1. Red River basin map. Map from Red River Basin Decision Information Network (2007).

Historically, much of the basin was covered by ancient Lake Agassiz. The basin inherited its fertile soil and flat topographical features from this lake (Krenz and Leitch, 1998). The average slope of the Red River is one half foot per mile. The majority

(roughly 84%) of land in the basin is used for agriculture and livestock production. Major crops in the area include sugar beets, wheat, soybeans and corn (USDA ERS, 2007). Cattle are the major livestock produced. In North Dakota, the top five counties in the value of agricultural production all border the Red River. These are Cass County, Richland County, Walsh County, Grand Forks County, and Pembina County. Marshall County, which is one of two South Dakota counties that contain land in the basin, is one of the top five producing counties in South Dakota. None of the top five agricultural-producing counties in Minnesota have territory within the Red River Basin (USDA ERS, 2007).

While most of the land supports rural living, the population of the Red River basin is becoming more urbanized (USDA ERS, 2007). The river bordering cities of Fargo-Moorhead-West Fargo and Grand Forks-East Grand Forks comprise the majority of residents living in the U.S. portion of the basin. Winnipeg has the majority of residents in the Canadian portion. The majority of towns in the basin contains less than 5,000 people.

Trends over the last 40 years show an increase in those who complete all four years of high school. Trends also show an increase in residents who are receiving a 4-year college degree (USDA ERS, 2007). The 2004 median household income for all counties that contain land in the basin was $36,810. The counties with the highest median income were Sargent County in North Dakota ($45,253), Roseau County in Minnesota ($45,174), and Cass County in North Dakota ($44,531). The counties with the lowest median income were Benson County ($28,058), Rolette County ($28,085) and Sheridan County ($29,552), all three in the North Dakota portion of the basin.

III. Problem Statement

There are many water-related issues within the Red River basin that require proper management (Hearne, 2007). Society receives a number of benefits as a result of water resources in the Red River basin, but there are also inherent costs associated with living in its boundaries. It is important that institutions manage resources in a way that balances society's value system with the needs of habitat and wildlife. It is specifically important to bridge the information gap between the institution and the local stakeholder. It is needed to provide the institution with information about the preferences of basin stakeholders for water management issues.

IV. Objectives

As a valuable resource that involves many regulating and managing players, the Red River basin is an excellent case for studying stakeholder preferences and presenting them to involved institutions. The primary goal of this research is to analyze stakeholder preferences for hypothetical Red River basin fresh water management alternatives. The specific objectives are to

(1) Identify issues relevant to stakeholders within the basin of the Red River of the North;

(2) Estimate stakeholder willingness to pay for Red River basin water-related initiatives; and

(3) Compare preferences among different groups of stakeholders.

The first objective will be determined by administering personal interviews and meeting with focus groups following steps suggested by Morgan and Krueger (1998).

Data for the second objective will be received and analyzed using a survey instrument within a choice experiments framework. The choice experiments method is an economic tool utilized for valuing the environment. Objective three will be estimated using econometric methods and software.

V. Hypotheses

It is hypothesized that residents will be willing to pay for each water quality and recreation level identified in the survey. In terms of water supply, it is expected that regulations will be preferred to a diversion of water. It is also hypothesized that most residents will not care about what institutional type performs the program or policy, as long as the change is completed. However, informed stakeholders are expected to elicit stronger preferences towards institutional type. Finally, it is expected that informed stakeholders will, in general, have higher willingness to pay than random stakeholders for Red River basin initiatives.

CHAPTER 2. LITERATURE REVIEW

I. Introduction

The following literature reviews pertinent issues in the Red River basin. Environmental valuation methods have been utilized in estimating stakeholder preferences. The first section gives a background on issues in the Red River of the North's basin. Section two reviews economic approaches used in estimating stakeholder preferences. The next section discusses the method of choice experiments (CE). The fourth section includes case studies that were completed using CE to value the environment. Finally, a section on survey operations discusses focus groups, stakeholder selection, and survey development.

II. Red River Basin Management Issues

There are 261 major international river basins in the world, and managing water resources is likely to be the most pressing environmental concern of the 2000s (Wolf et al., 1999). The problem is compounded when water resources cross not only geographic but also political boundaries. While integrated management practices are key for maintaining water resources, achieving cooperation by various governments and levels of government can be a difficult task.

Krenz and Leitch (1998) discussed the management of the Red River of the North. The river's basin lies in two countries and three states. In addition to its territory in Manitoba, Canada, the basin includes 39,200 square miles of land in Western Minnesota, Eastern North Dakota, and North-Eastern South Dakota. While the

land on either side of the river tends to be fertile for crop growth, basin floods and droughts have historically impacted residents and communities in the basin. Probably the worst no-flow conditions the Red River experienced were from 1932 to 1941 where various parts of the river experienced zero or no flow conditions for extended periods of time. If serious drought conditions were to occur within the next few decades, potential impacts on urban areas within the basin would be devastating (Red River Valley Water Supply Project, 2007). A severe flood occurred in 1997 that caused an estimated $5 billion in damage to areas in the basin (International Joint Commission, 2000). Sometimes floods and droughts can occur soon after the other, such as the no-flow conditions of 1988 that were followed by a major flood in 1989, and zero-flow conditions for ten days in 1976 that came between major floods in 1975 and 1978.

Water supply issues, runoff storage, wetland restoration, drainage, and environmental protection are all significant issues when it comes to managing water resources (Krenz and Leitch, 1998). Structural and non-structural measures can be put in place to help mitigate the effects of these water quantity and quality issues, but leadership and cooperation among all groups of stakeholders is needed. The management system is complex due to the number and roles of involved institutions. For instance, there are separate TMDL standards for each state (Hearne, 2007). Also, the U.S. Army Corps of Engineers implements projects through two offices, the St. Paul office for the Minnesota side and the Denver office for the North Dakota side. Additionally, watershed districts in Minnesota receive more funding than their North Dakota water resource district counterparts (Kritzky, forthcoming). Soil and water conservation districts in Minnesota receive less funds than their North Dakota soil conservation district counterparts (Kritzky, forthcoming). A number of involved agencies at the local, state, federal, and international level have different focuses,

different goals, and sometimes conflicting tasks and information (Krenz and Leitch, 1998).

Hearne (2007) discusses institutional evolution and water management of the Red River basin. Institutions guide societal behavior via formal and informal rules and norms, and water management institutions are put in place to manage water resources. Since the social value of maintaining water quality has increased in recent years, new or evolved institutions need to adapt to changing social attitudes by establishing standards, mitigating point-source and non-point discharges, and supporting the improvement of water quality and ecology (Hearne, 2007).

Institutional organization of the Red River basin is a complex system partly because Minnesota, North Dakota, and South Dakota have different water laws (Hearne, 2007). Minnesota's water law is based upon riparian rights – landowners whose property borders a body of water have the right to use the water for reasonable purposes (Hearne, 2007). North Dakota's and South Dakota's water law is based primarily upon prior appropriation rights – the first person to use the water for a beneficial purpose is allowed to continue using the water for that purpose (Hearne, 2007). Other stakeholders may then use the water so long as they don't infringe on the person who was first there.

The Red River basin includes a long list of institutions that are involved in managing its water and natural resources (Hearne, 2007). This list includes the International Joint Commission, which was established in 1909 to help manage the Great Lakes that crossed the borders of Canada and the United States. It deals with issues of all international waters between the two countries. Additionally, the United States' Environmental Protection Agency (EPA) has a major role in environmental management within the United States.

At the state level, Minnesota's Department of Natural Resources (DNR) and the Pollution Control Agency (PCA) deal with water quality issues (Krenz and Leitch, 1998). In North Dakota, the State Water Commission and Department of Health are involved in managing the state's water resources (Krenz and Leitch, 1998). South Dakota's Water Management Board and Department of Environment and Natural Resources are the primary state institutions that handle water management issues (SD DENR, 2007).

Local efforts that have the ability to tax in Minnesota include soil and water conservation districts and watershed districts (Hearne, 2007). In North Dakota, the counterparts are soil conservation districts and water resource districts. In South Dakota, the counterparts are conservation districts and water project districts. There are also a number of non-government organizations that have responded to issues pertaining to the management of the Red River and its basin. Some of these institutions are local while others are national or international. Players at all levels must adapt to society's changing preferences and knowledge of natural resources in order to effectively manage basin resources (Hearne, 2007).

Anderson and Forthun (1971) prepared general water management guidelines and recommendations to be used in planning the Red River basin. In order for water resources plans to be implemented, there must exist an authority to plan, coordinate and enforce. The authors suggest that while different degrees of authority may apply to different areas of water plan implementation, the scope of a single basin authority would help to facilitate comprehensive water cooperation of the Red River. The authors argue that this basin-wide approach should be carried out with local involvement. This involvement would help ensure that benefits to society would outweigh the costs incurred (Anderson and Forthun, 1971).

Environmental quality, fish and wildlife, recreation, and aesthetics should be taken into account when implementing projects in the Red River basin (Anderson and Forthun, 1971). This includes water resources such as wetlands that are used as breeding areas for waterfowl. Regulating lakeshore development to preserve natural resources should also become a priority (Anderson and Forthun, 1971).

The Lake Winnipeg Implementation Committee (2005) researched pollution issues on Lake Winnipeg. An estimated 50% of the surface area of the lake was covered by thick mats of blue-green algae in August 2005. The Red River and its tributaries contributed to that eutrophication. While 8.2% of the water in Lake Winnipeg comes from the Red River, an estimated 57.7% of the phosphorous is transported to the lake via this route. The river receives phosphorous and nitrogen from point and non-point pollution sources in Canada and the United States. An example of point-source pollution is runoff from a building. The largest single transport of phosphorous and nitrogen occurred in 1997 due to the major flood (Lake Winnipeg Implementation Committee, 2005). Altogether, this pollution buildup impairs water quality, threatening water-based recreation, commercial fishing, and the survival of five species in Lake Winnipeg (Lake Winnipeg Implementation Committee, 2005).

Leitch and Hirsch (1998) demonstrated that wetland preservation has economic value for North Dakota residents. Attributes of wetlands that contributed to stakeholder preferences included flood control, water supply, habitat for fish and wildlife, recreation, and aesthetics. Roberts and Leitch (1997) showed that Minnesota and South Dakota residents placed similar economic value on preserving Mud Lake, a shallow wetland.

Leitch and Nelson (1976) identified a number of attributes related to the lower Sheyenne River basin, a sub-basin of the Red River basin, and estimated a positive economic value of wildlife. Anderson and Forthun (1971) published similar results at a

time when environmental concern was only beginning to gain momentum. For at least three and half decades, residents of the Red River basin have elicited preferences for maintaining environmental goods.

III. Stakeholder Preferences

Economic valuation of ecosystem resources is complicated due to changing social wants, changing natural resource environment, and changing available services (Holmes et al., 2004). Non-use value can only provide partial estimates of benefits because they are based on a finite list of potential services. It is important to research various attributes related to environmental goods.

A number of methods have been utilized for the purpose of measuring environmental costs and benefits (Garrod and Willis, 1999; Ward, 2006). Efforts have utilized both stated and revealed preference techniques for this valuation depending on what data are available, the issue being researched, and the preferences of researchers. Examples of revealed preference techniques include the travel-cost method and the hedonic pricing method. However, since environmental goods are not always traded in a market setting, alternative measures must sometimes be taken to estimate and understand stakeholder values of the goods. Widely used stated preference approaches include the contingent valuation method and choice experiments. A discussion and examples of revealed and stated preference methods used in environmental valuation follows.

a. Travel Cost Method

The travel-cost method is a method of environmental valuation that utilizes revealed preference data. Siderelis et al. (1995) used this method to estimate

willingness to pay for lake access per boating occasion to a number of lakes in North Carolina. They surveyed boat owners to determine how much each one paid in terms of time spent per trip, frequency of trips, lake facilities used, entrance fees paid, number of people accompanying them, and the distance they traveled to the lake. They then incorporated gas prices and fees in order to estimate the value of each trip. They analyzed their data to estimate how much value the broad population placed on their lake resources.

Mathews et al. (1999) used the travel cost method to complement a contingent valuation study to help estimate the willingness to pay of stakeholders for a 40% reduction of phosphorous in the Minnesota River. They surveyed visitors to the Minnesota Valley National Wildlife Refuge and analyzed the cost of the trip in terms of gas and services. Their study showed that the travel cost method revealed a higher willingness to pay than the stated contingent valuation.

b. Contingent Valuation Method

The contingent valuation method is one tool that has been utilized many times in the valuation of natural resources (Ward, 2006). A survey is sent to stakeholders within a proposed study area to elicit responses from individuals about their willingness to pay to maintain, restore, or implement new projects for environmental resources. Information is provided in the survey about the resource and proposed changes. At the end of the questionnaire the respondent is asked to state if he or she would be willing to pay $X amount for the changes. After answering yes or no, the respondent is asked to state his or her highest willingness to pay for that change, regardless of its relation to the original $X amount (Carson and Mitchell, 1989).

Holmes et al. (2004) identified fish habitat, wildlife habitat, water clarity, recreation, and ecosystem naturalness as important attributes of the Little Tennessee

River basin in North Carolina. A total of 96 people completed their survey. Results showed that stakeholders were willing to pay a premium price for a total restoration project versus a partial restoration project. Even if funds were currently not available for total restoration, it remained economically feasible to carry out partial restoration projects while waiting for revenue to come in.

Shrestha et al. (2002) used the contingent valuation method to analyze visitor preferences and willingness to pay for water-based recreation proposals in Florida's Ocala National Forest. In their survey they included improved facilities, various recreation opportunities, availability of food and supplies, rental craft, interpretive activities, and overnight accommodations as attributes. The authors discovered that stakeholders were willing to pay an increase in park fees for improved facilities. Visitors who stayed for more than one day at a time elicited a higher willingness to pay than those who only visited the national forest for a day at a time.

Due to a proposal to build a water treatment plant for the purpose of filtering Winnipeg water, McComb (2002) used the contingent valuation method to estimate stakeholder willingness to pay for improved tap water quality. Permission to send a survey was requested of stakeholders by first calling them on the telephone. The survey was sent in the mail only after permission was granted. Data were analyzed and multiplied by the number of households in Winnipeg, and showed that the benefits outweighed the costs of building the water treatment plant.

One problem associated with the contingent valuation method is the presence of protest zeros (Halstead et al., 1992). This occurs when respondents repeatedly vote for the proposed implementation but then state that they are not willing to pay anything for it. This elevates the value of a resource while maintaining a low stakeholder willingness to pay. Another problem is "yea-saying," which happens when the

valuation is exceedingly higher than expected (Blamey et al., 1999). Alpizar et al. (2001) suggest that a choice experiments design is preferred to the contingent valuation method because it offers alternative choice sets to choose from, forcing respondents to make tradeoffs. Analyzing these tradeoffs is helpful in understanding stakeholder preferences to a greater extent.

IV. Choice Experiments

The CE method is used to elicit stakeholder willingness to pay for proposed initiatives within an environmental framework. Models that result from using CE are qualitative response models, and may include both binomial and multinomial models (Greene, 2003). Binomial models occur when the dependent variable receives one of two possible values (typically 0 or 1). In cases where the dependent variable in a model is discrete with more than two possible values, the most oft-used model in environmental valuation has been the multinomial logit (MNL). Multinomial means the dependent variable can receive more than two values, and logit stands for logarithmic transformation (Louviere et al., 2000). One drawback of the MNL is the Independent of Irrelevant Alternatives (IIA) assumption. The IIA assumption means that choices are made only from the group of bundles shown, and that other mixes of the bundles that are not shown are not considered by any respondent. In other words, the probability of choosing one alternative over another only depends on the utility of the alternatives given in the choice set. While this assumption offers a convenient choice model, unobserved attributes of utility may not actually be independent of each other. The IIA property states that the probability of one option being selected from a choice set is not affected by adding or removing other options (McFadden, 1973; Hanley et al., 2006).

An alternative model to use in the case where the IIA assumption is violated is the nested logit (Hanley et al., 2002).

Estimating the value of non-market goods is different from estimating the value of goods and services traded in a market-like setting (Louviere et al., 2000). Revealed preference data are often not available for non-market goods, so stated preference techniques are generally utilized to estimate stakeholder willingness to pay for the good. When analyzing willingness to pay for non-market goods, stated preference techniques elicit responses from people based on what they say. Stated preference data can include hypothetical and existing alternatives (Louviere et al., 2000). Firms and researchers often use stated preference techniques to study the effect that new product attributes have on quantity demanded. Stated preference techniques have been used extensively in marketing, transportation and environment studies. Indeed, organizations have shown a revealed preference for stated preference data (Louviere et al., 2000).

Choice experiments (CE) is a relatively recent valuation method in environmental cost-benefit analysis. The CE method is well suited for environmental evaluation because it enables the researcher to estimate the value of projects that need not currently exist (Louviere et al., 2000). CE is a valid stated preference technique used to measure the value of goods not traded in a market-like setting. Since revealed preference data are not usually available for non-market and non-existing goods, stated preference responses must be obtained to form a data set. Since the mid to late 1990s, CE has been applied extensively in measuring values of the environment and natural resources (Hanley et al., 1998).

Among stated preference techniques for environmental valuation, the CE framework has gained momentum both in preferences of researchers and in application (Blamey et al., 2000). It helps reduce "yea-saying" that can occur in the commonly-

used contingent valuation method, and also takes away protest zeros, which are responses in which the respondent repeatedly votes for new proposals but then lists a willingness to pay of $0, which is in essence a hypothetical free-rider (Blamey et al., 1999). CE enables the researcher to include a number of attributes and levels, and provides data from which the researcher estimates willingness to pay for levels (Blamey et al., 2000).

CE has roots in random utility theory (Louviere et al., 2000). This theory states that in every decision a person faces, there is a measurable component and a random component. This does not imply that people make decisions randomly, but that there are important but unobserved influences on choice that are not included in the model.

Designing the choice experiment is important because it lays the groundwork for estimating feasible results (Alpizar et al., 2001). Researchers using CE present alternative bundles of attribute levels to individuals, asking them to choose from among options from each choice set. Respondents are asked to choose whichever choice profile they prefer the most, keeping in mind the tradeoffs that each set presents.

The survey development process takes a few steps. First, identify the problem at hand. Understand the issues and study area. Next, identify the key attributes and stakeholders relevant to the choices of interest. This step is accomplished through focus groups, personal interviews, and research of the study area (Krueger, 1988). Third, narrow the attributes and levels to be used in the actual experiment. After these steps are completed, data collection begins by sending out the finalized survey to identified stakeholders.

Unlike the contingent valuation method (CVM), which requires the respondent to rank or rate each attribute, CE estimates the value of attributes by offering choice bundles to respondents (Holmes and Adamowicz, 2003). Attributes and levels, one of

which is a price mechanism, are organized into choice bundles. The respondent chooses which bundle he or she prefers based on the attribute levels and price. By building a data set with responses to the choice bundles, willingness to pay for each attribute can be estimated. Further, tradeoff decisions can be understood and substitutes and complements can be identified (Holmes and Adamowicz, 2003).

CE incorporates the theory of value with random utility theory (Morrison et al., 2002). Proponents of the method list a number of advantages for CE versus other stated preference techniques (Hanley et al., 1998). It provides the opportunity to identify marginal values of attributes. It is better at avoiding the "yea-saying" problem of CVM since respondents are not faced with an all-or-nothing choice. Instead, levels of attributes are included rather than only a yes or no for the entire attribute. Tradeoffs among a broader set of attributes can be elicited (Adamowicz et al., 1998).

The survey is generally set up in three sections (Blamey et al., 2000). The first section assesses attitudes and biases of the respondent. The second section includes the choice bundles. The last section asks socio-demographic questions. Often included is an information packet to help respondents have better information when making their choices.

V. Choice Experiment Case Studies

Blamey et al. (2000) studied the valuation of remnant vegetation and species in the Desert Uplands of Central Queensland, Australia. Their model yielded marginal rates of substitution among attributes and levels, predicted market share for sets of alternatives, and provided the monetary equivalence of the utility difference among choice sets. They study the non-use value of vegetation that was being impaired by

grazing and tree clearing practices. The authors estimated a positive willingness to pay for protecting endangered species, preventing loss of regional income, and maintaining unique ecosystem attributes.

Carlsson et al. (2003) studied the value of wetlands in southern Sweden. In addition to being a cost-effective retention strategy, wetlands also promote biodiversity, recreation, and landscape diversity. Staffanstorp had experienced a 90% reduction of wetlands due to urban and rural expansion. This expansion increased overall nutrient runoff, which resulted in eutrophication of coastal waters and groundwater. Thus, constructing a wetland was proposed in order to mitigate the impairments. Due to the variety of uses of wetlands the authors sought to estimate marginal willingness to pay for various attributes of wetland restoration.

The authors surveyed a random group of residents in the Staffanstorp (Carlsson et al., 2003). Attributes included total cost, surrounding vegetation, biodiversity, fish, fenced waterline, crayfish, and walking facilities. Results showed that stocking crayfish and building fenced waterline were undesirable. Respondents were willing to pay for improved conditions for fish, biodiversity, walking facilities around the wetland, and the surrounding vegetation.

Collins et al. (2005) studied the economic value that residents place on restoration projects of Deckers Creek in West Virginia. Specifically the authors sought to estimate the value of mitigating the effects of acid mine drainage (AMD). Other water impairments to Deckers Creek included trash and sewage. The authors created a survey instrument to collect data for valuation within an AMD watershed, and used the data to estimate economic values for different levels of stream restoration. They compared the results across populations of users and non-users in the Deckers Creek watershed. Aggregate welfare of the watershed population was estimated to be $1.87

million per year for the complete restoration of aquatic life, swimming, and scenic quality.

Travisi and Nijkamp (2004) studied health problems in Italy that resulted from contamination to the environment. They used choice experiments and the contingent valuation methodology to do their study. They included food expense, human health, soil and groundwater contamination, and biodiversity as relevant attributes. Three levels of each attribute were included in addition to a status-quo condition. They reported that an advantage of the choice experiments method compared to the contingent valuation technique is that respondents were forced to make tradeoffs in CE, which lowered the estimated willingness to pay.

VI. Stakeholder Selection

One important step related to stated preference data is deciding who to elicit responses from. The process of selecting stakeholder groups is nontrivial. Leach (2002) detailed the selection of stakeholder groups when performing water resources research. It is important to select stakeholders that are informed and involved in the decision-making process. It is also best to obtain a representative sample of the basin. When choosing stakeholder groups, the researcher should maintain that representative sampling is a fundamental principal of good survey design. It is important not to 1) survey only watershed group coordinators; 2) survey only one stakeholder category; or 3) survey only participants in watershed partnerships (Leach, 2002).

Webler et al. (2003) stressed the need to get respondents who represent a full diversity of viewpoints. The best representation includes residents and local government officials. Leach et al. (2002) found that the most effective strategies for

resolving watershed issues include consensus-based process partnerships. They surveyed private interest groups, local public agency representatives, and state and federal officials. They surveyed these groups of people to compare preferences and better understand public and private opinions of watershed management. In order to understand each group and implement projects that have wide rather than limited support, it is important to elicit informed opinions as well as broad resident opinions (Leach et al., 2002).

Koontz and Hoag (2005) researched a management plan for elk and bison in Wyoming's National Elk Refuge and Grand Teton National Park. The study was motivated by polarized stakeholder preferences that caused food resources to be allocated inefficiently among the elk and bison. Some of the animals were not getting enough food while others received a great deal. This was causing health problems for a number of animals. The authors conducted interviews with representatives from 30 organizations including representatives from government entities, environmental interest groups, tribal groups and local interest groups. Surveying these stakeholders provided the authors with diverse and important perspectives of the management process.

Alberini et al. (2006) compared and contrasted the preferences of residents with the preferences of public officials for urban regeneration and transformation projects. The two stakeholder groups were selected to find out where infrastructure proposals were controversial. Results enabled the authors to identify the extent to which public officials agreed with their constituents and how communication could be improved.

VII. Survey Process

Conducting focus group meetings is important in the survey development process in order to identify proper and important questions to ask (Krueger, 1988). Morgan and Krueger (1998) give guidelines on choosing and utilizing focus groups to aid research projects. Facilitating focus groups and personal interviews enhance the research process and help form relevant questions for surveys. Personal interviews and focus groups should be utilized to enhance the questions proposed during the survey development stage. Ideally, each focus group should include people similar to selected stakeholder groups, in order to understand the stakeholders' knowledge. The authors emphasize the need for incentives to get people to attend the meeting. Focus groups and personal interviews can be used to identify stakeholder groups and important, relevant questions for the survey instrument.

Dillman (2007) describes the survey development process in great detail. It is important to use the tailored design method in order to reach desired groups of stakeholders and to improve the response rate. First, a pre-letter is mailed to inform the respondent of a survey that will come. Second, a survey is sent. Third, a postcard is sent to remind or thank the respondent. About a week after this, a reminder postcard is sent to those who have not yet completed the survey. Finally, a second copy of the survey is sent to all remaining non-respondents. In addition to multiple mailings, it has been shown that financial gifts enclosed in the survey, and return envelopes with stamps rather than business-reply, have improved response rates (Dillman, 2007).

CHAPTER 3. METHODOLOGY

I. Introduction

Estimating the value of non-market goods is different from estimating the value of goods and services traded in a market-like setting (Louviere et al., 2000). Revealed preference data are often not available for non-market goods, so stated preference techniques are generally utilized to estimate stakeholder willingness to pay for the good. When analyzing willingness to pay for non-market goods, stated preference techniques elicit responses from people based on answers to questionnaires. Stated preference data can include hypothetical and existing alternatives (Louviere et al., 2000). Firms and researchers often use stated preference techniques to study the effect that new product attributes have on quantity demanded. Stated preference techniques have been used extensively in marketing, transportation and environment studies. Indeed, organizations have shown a revealed preference for stated preference data (Louviere et al., 2000).

The valuation of non-market environmental goods has been applied in a number of research studies in various contexts (for some examples see Garrod and Willis, 1999; Ward, 2006). Since many people care about and use the natural environment for a variety of activities, it is important for decision-makers to adequately develop policies that reflect the preferences of society. Society's values are dynamic and one pillar of democratic public policy is to reflect these values as closely as possible. Measuring these values provides information for decision-making and project planning. While ideally public policy would quickly adapt to match society's preference changes, it is acknowledged that the policy-making process is often time consuming.

The research at hand estimates stakeholder willingness to pay for various hypothetical initiatives within the Red River of the North basin. Specifically, the research attempts to estimate stakeholder preferences for water quality improvement, water-based recreation activities, water supply initiatives, and institutional framework of the organization in charge of completing the changes. CE has been applied to many studies attempting to value environmental goods, and is used for the current case study.

II. The Model

The CE method is used to elicit stakeholder willingness to pay for proposed environmental initiatives within a random utility framework. Models that result from using CE are qualitative response models, and may include both binomial and multinomial models (Greene, 2003). Binomial models occur when the dependent variable receives one of two possible values (typically 0 or 1). In cases where the dependent variable in a model is discrete with more than 2 possible values, the most oft-used model in environmental valuation has been the multinomial logit (MNL). Multinomial means the dependent variable can receive more than two values, and logit stands for logarithmic transformation (Louviere et al., 2000).

Following Collins et al. (2005), utility derived from any given choice is assumed to be a function of the hypothetical basin attributes and levels of the water-related options in the choice set Z_{ih}, and socioeconomic characteristics of the respondent S_h. U_{ih} is assumed to have a systematic, measurable component V and a random component ϵ:

$$U_{ih} = V(Z_{ih}, S_h) + \epsilon_{ih} \qquad (3.1)$$

Each individual h is assumed to maximize his or her utility U by choosing the basin change option i such that the utility associated with i is greater than or equal to the level of utility achieved with any and every other j option offered in the choice set Z (Collins, et al., 2005). Then the probability of choosing the i^{th} option becomes:

$$\Pr(i|Z) = \Pr(U_{ih} \geq U_{jh}) \forall j \in Z, i \neq j. \tag{3.2}$$

Keeping in mind that utility is not directly observable, we can substitute (3.1) into (3.2) and get (3.3):

$$\Pr(i|Z) = \Pr[(V_{ih} + \varepsilon_{ih}) \geq (V_{jh} + \varepsilon_{jh})]. \tag{3.3}$$

In words, the probability of a respondent choosing option i is equal to the probability that the indirect utility from i plus some error is greater than or equal to the utility derived from j plus some error. The probability of choosing option i depends on the utility of that option relative to the utility of all other options. It can be estimated by a MNL, following Greene (2003):

$$\Pr(i) = \frac{e^{\lambda V_i}}{\sum_{j \in C} e^{\lambda V_j}}, \tag{3.4}$$

where $V_i = V(x_i, R)$, V_i is a utility function, x_j is a vector of market, R is a vector of environmental attributes, and λ is a scale parameter usually set equal to 1 so that the equation simplifies according to Greene (2003):

$$\Pr(i) = \frac{e^{V_i}}{\sum_{j \in C} e^{V_j}}. \qquad (3.5)$$

If the error components are assumed to be identically and independently distributed (IID) with the Gumbel distribution, then the probability of choosing option *i* can be estimated by a multinomial logit (Louviere et al., 2000). The IIA assumption means that choices are made only from the group of bundles shown and that other mixes of the bundles that are not shown are not considered by any respondent. In other words, the probability of choosing one alternative over another only depends on the utility of the alternatives given in the choice set. While this assumption offers a convenient choice model, unobserved attributes of utility may not actually be independent of each other. A Hausman specification test can be used to figure out if the assumption holds (Greene, 2003).

If the IIA test does not fail, then the multinomial logit is a useful model. If it fails, a nested logit is generally used. Researchers often choose the nested logit model as the appropriate alternative to the multinomial logit (Hausman and McFadden, 1984).

III. Designing the Choice Experiment

Designing the choice experiment is important because it lays the groundwork for ensuring that the results are feasible (Alpizar et al., 2001). Researchers using CE present alternative bundles of attribute levels to individuals, asking them to choose among options from each choice set. Respondents are asked to choose whichever choice profile they prefer the most, keeping in mind the tradeoffs that each set presents. Following Alpizar et al. (2001), there are four steps in designing a choice experiment:

1) defining the attributes and levels, 2) experimental design, 3) questionnaire development, and 4) sampling strategy.

a. Defining the Attributes and Levels

The first step in designing a choice experiment is to define the pertinent attributes and levels. This is done through a variety of mediums, including focus group meetings, expert group meetings, personal interviews, research of the topic of interest, and trial surveys. The selected attributes and levels are then arranged into choice sets within the experimental design.

In order to proceed with this research, approval was granted from the North Dakota State University Institutional Review Board (IRB). This required a few hours of coursework to complete the human research section of the collaborative institutional training initiative (CITI). After this, the project was submitted to the NDSU branch of IRB. Approval was obtained at two different times for the research study, first before meeting with focus groups and personal interviews, and again before administering the survey instrument.

Expert group and focus group meetings and personal interviews were conducted in order to identify relevant issues related to the Red River Basin. At first, discussions were broad. Questions were open-ended in order to avoid biasing group members towards any attribute or level. Meetings were scheduled with local business people, science teachers, county commissioners, and representatives from NGOs and state government agencies. Agencies that were represented included the Red River Basin Commission, River Keepers, the International Water Institute, Lake Agassiz Water Authority, the Buffalo-Red watershed district in Minnesota, the North Dakota Department of Health, and the Minnesota Pollution Control Agency. Conferences

organized by the Red River Basin Commission (Fall 2006) and the International Water Institute (March 2007) were also attended in order to get more information.

Expert meetings resulted in a greater understanding of the difficulty of managing basin water resources. The primary reason given for this difficulty was that there are so many involved institutions that are taking money from the same stakeholders and not communicating about or coordinating their projects. Some people stated that they desired improved communication among existing institutions. Some also wanted to limit the number of involved institutions in order to manage the basin water resources more efficiently. Expert groups also identified recreation, water quality, and water supply as key issues facing the Red River basin.

Discussions with science teachers and local business people tended towards water-based recreation issues. Ideas ranged from increased bike trails to enhancing fishing, skiing, boating, and swimming activities. Education activities and beautification were also identified as possible initiatives. An initial list of attributes and levels was developed after these discussions (Table 3.1).

Beginning in September 2007, the focus group meeting questions began to be more specific in order to narrow down the list of attributes and levels. This led to more specific discussions about the attributes and levels, populations of interest, and survey questions. Trial surveys were administered in small group and one-on-one situations in order to help improve the overall structure of the survey. The attributes and levels were redesigned and narrowed down (Table 3.2).

Table 3.1. Initial Set of Attributes and Levels

Attribute	***Level***	***Level***	***Level***	***Level***
Water Quality	Reduce Phosphorous and Nitrogen	Reduce Sediment	Reduce Fish Kills	
Recreation	Additional Access Points	Additional Bike Trails	Supervised Swimming Areas	
Education	Classroom Presentations	Red River Science Center		
Water Supply	Support Diversion from Missouri to Red River	Regulations During Dry Times		
Institution1	Responsibility and Resources go to Conservation Districts	Responsibility and Resources go to Water Districts	Responsibility and Resources go to NGOs	
Institution2	Projects Implemented by City	Projects Implemented by County	Projects Implemented by State	
Water Quality Monitoring	Expand School-based Water Quality Monitoring	Increase Frequency of Monitoring		
Payment Preference	Prefer User Fee	Prefer Mill Levy	Have No Preference	
Price	Increments up to $500 per year			
Habitat	Additional Buffer Strips	Increased Funding to Greenway on the Red	Wetland Restoration	Retention Ponds
Fish	Additional Fish Yearlings	Relaxed Limits for Red River Fishing	Reduce Invasive Species	
Tourism	Additional Boat Rides	Historic Signs Along Red River	Promote the Red River as a Tourist Destination	

Table 3.2. Trial Survey Set of Attributes and Levels

Attribute	***Level***	***Level***	***Level***	***Level***
Water Quality	Preserve Wetlands	Reduce Sediment	Reduce Fish Kills	Reduce Phosphorous and Nitrogen
Recreation	Additional Access Points	Additional Bike Trails	Supervised Swimming Areas	Additional Fish Stocking
Education	Classroom Presentations	Red River Science Center	Expand school-based water quality monitoring	
Water Supply	Support diversion from Missouri to Red River	Regulations during Dry Times		
Institution	Responsibility and Resources go to Conservation Districts	Responsibility and Resources go to Water Districts	Responsibility and Resources go to NGOs	Responsibility and Resources go to Basin-Wide Organization
Price	Increments of $25, from $0 to $250			

b. Experimental Design

The experimental design is the technique of listing all attributes for each choice set, and assigning particular levels to each attribute (Alpizar et al., 2001). The starting point of experimental design is the full factorial design, where every attribute level is combined with every other possible attribute level. Thus, for a survey that would include the attributes and levels from Table 3.2, the full factorial would be $4^3*2^1*3^1*10^1 = 3{,}840$ possible combinations. A fractional factorial is a subset of all possible combinations and is usually used for convenience. This design uses a computer program to systematically select subsets of combinations such that the effects of primary interest can be estimated under the assumption that interaction terms are insignificant. According to Alpizar et al. (2001), D-optimality occurs when D-error is minimized:

$$D-error = [|\Omega|^{1/K}]. \quad (3.7)$$

Zwerina et al. (1996) identify four principles to efficiently design a choice experiment: 1) orthogonality; 2) level balance; 3) minimal overlap; and 4) utility balance. Orthogonality is satisfied when the levels of each attribute vary independently of one another. Level balance is achieved when the levels of each attribute occur with equal frequency in the design. Minimal overlap occurs when an attribute level does not repeat itself in a choice set. Utility balance means that the utilities of the options within a choice set are equal. When these four principles are jointly satisfied, it indicates that the design has minimal D-error (Zwerina et al., 1996). Computer software is used to directly minimize D-error, and as a result all these principles are approximately satisfied in the design. D-optimality is the most common criterion for computer-generated optimal designs, and SAS has a general model statement that builds choice designs (Zwerina et al., 1996).

The complete factorial design was reduced using SAS. This design consisted of 864 choice sets arranged into groups of 12. This provided each respondent with 4 choice sets of 4 possible options each per survey.

c. Survey Development

The survey was divided into four sections. First, the IRB approved cover letter mentioned the purpose and scope of the project, and pointed out that the survey was voluntary. Next, a likert-scale section was used to understand attitudes of the respondents. This followed Purdy and Decker (1989) and McGonagle and Swallow (2005), and presented a basin attitudes and values scale (BAVS) for agree-disagree responses. These questions elicited attitudes towards access to and conservation of

basin water resources, similar to the traditional-conservation attitudes, societal-benefits attitudes, and problem-acceptance attitudes of Purdy and Decker (1989). A copy of the survey instrument is attached in Appendix C. The third section contained the choice sets. This section explained each attribute and level and provided photographs as visual aids. Four choice questions were given in each survey. The final section of the survey asked socio-economic questions to check that a representative sample of the Red River basin was achieved.

d. Stakeholder Identification and Sampling Strategy

A number of potential survey respondents were identified in preliminary discussions with focus groups and interviews. Criteria developed by Leach (2002) were followed when choosing stakeholder groups. Responses should be received from watershed decision-makers, and should include at least three stakeholder groups (Leach, 2002). A number of potential stakeholder groups was identified (Table 3.3).

Table 3.3. Possible Stakeholder Groups to Survey

Potential Stakeholder Groups
Local Officeholders
Members of Recreation Groups
Water Board Members
Farmers
Water-Related Meeting Attendees
Science Teachers
County Extension Agents
Basin Residents

Responses were desired from decision makers, informed stakeholders, and a random list of stakeholders, and from each county that contained land in the Red River basin. Table 3.4 shows the names of counties in each state in the basin.

Table 3.4. Counties with Land in the Red River Basin

Minnesota: 21	***North Dakota: 24***	***South Dakota: 2***
Becker	Barnes	Marshall
Beltrami	Benson	Roberts
Big Stone	Cass	
Clay	Cavalier	
Clearwater	Dickey	
Grant	Eddy	
Itasca	Foster	
Kittson	Grand Forks	
Koochiching	Griggs	
Lake of the Woods	McHenry	
Mahnomen	Nelson	
Marshall	Pembina	
Norman	Pierce	
Otter Tail	Ramsey	
Pennington	Ransom	
Polk	Richland	
Red Lake	Rolette	
Roseau	Sargent	
Stevens	Sheridan	
Traverse	Steele	
Wilkin	Towner	
	Traill	
	Walsh	
	Wells	

Local officeholders, Red River meeting attendants, and a random stakeholder group of the sample population were identified as appropriate stakeholder groups to survey. The Red River meeting attendance list satisfied the informed stakeholder criteria. The combined population was limited to 1,062 and contained decision-makers (local officeholders – mayors and county commissioners), informed stakeholders (Red River Basin Commission meeting attendants), and a random list of stakeholders.

Officeholder names and addresses were found via city websites or by calling local government offices for contact information. At first, an entire list of mayors and county commissioners was drafted, and then it was decided to limit the mayor list to those who were mayors of towns with at least 500 population according to Census 2000 numbers. These were obtained for all counties that contained territory within the Red River basin. A list of water-related meeting attendees was obtained courtesy of the Red River Basin Commission. Finally, the random list of basin residents was obtained from InfoUSA, a private company that compiles lists of names and addresses for a small cost.

A number of ways to get a random stakeholder list were considered. After investigating alternatives, InfoUSA was selected as the data source. InfoUSA is a private company that sells addresses for survey research. They gather their data from sources such as phone books, utility bills, and cable bills. They then update their listings on a monthly basis with the United States Postal Service in order to maintain current records of people who move. This source eliminated the bias of not surveying people without phones or surveying a biased amount of people who recently moved. It was the most unbiased of the possibilities that we considered.

IV. Trial Surveys

The first pre-survey was administered mid-September in four ways. A sample of university professors and staff was given the survey via drop off format, and they were asked to return the survey via campus mail. A second method was a sit-down method in which the researcher sat down with people one-on-one in order to lead them through the survey and get immediate feedback on how well they understood the questions, what they thought of the levels and attributes, the layout of the survey, and

the ease of responding to questions. The third method was to give surveys to people in the area. This included people entering the West Acres mall and residents in the Fargo-Moorhead area. The final method was to give the survey to a graduate and undergraduate natural resource economics class at North Dakota State University.

These surveys were administered both by the researcher and by an assistant who was hired to help in the process. A total of 67 surveys were handed out for the trial survey. Of these, 46 surveys were used that had responded to at least one choice set in the survey.

Some respondents were unsure what the page of explanations was for, and were unsure how to answer the choice sets because there were so many tradeoffs involved. Feedback showed that the pictures in the explanation section did not help the responders understand the attributes any clearer than the word explanations. This section was condensed.

Some of the likert-scale attitudinal questions were misunderstood. Specifically, one was difficult to answer and another elicited the same responses from the entire trial survey sample. Following Purdy and Decker (1989), these questions were replaced.

Each choice set contained four options to choose from, and this proved to be a difficult task for many people. In order to make the tradeoff decision easier, one option was removed from each choice set. Further, the No Change option was moved to be with the other choices as a column instead of as a separate answer. In all, the survey was shortened from ten pages to seven.

A second trial survey was run with these changes, and results showed that the design was good but price was modified to include 12 increments of $20 rather 10 increments of $25. A sit-down method and drop-off/pickup method was utilized to

obtain responses from 13 individuals for the condensed survey. Results showed that the survey was much more understandable and manageable.

V. Final Survey Instrument

Following Dillman (2007), a pre-letter was sent October 15, 2007, to inform each identified stakeholder that they would soon be receiving the survey in the mail. The final survey instrument was mailed starting three days later, October 18, and ended on November 2. Included in the survey was the IRB approved cover letter, the survey in booklet format, a business-reply return envelope with the researcher's address printed on it, and a pen to help the respondent fill out the survey. The same day that the last surveys went out, a postcard was sent to remind people to mark their approximate location on the map included in the survey, in order to identify what state they lived in. This postcard also thanked those that had already responded, and reminded those who had not yet completed the survey to please do it soon. Based on the trial surveys, the attributes and levels were narrowed to those featured in Table 3.5.

Table 3.5. Finalized Survey Attributes and Levels

Attribute	***Level***	***Level***	***Level***	***Level***
Water Quality	Wetland restoration	Reduced fish kills	Reduced phosphorous and nitrogen	
Water Supply	Diversion	Regulations		
Recreation	Additional boat access points	Enhanced fishery management	Additional bike trails	Supervised swimming areas
Institution	Local water districts	Local conservation districts	Basin-wide organization	Non-governmental organizations
Price	12 increments of $20, $20-240			

The complete factorial for this design would be $3^1*2^1*4^2*12^1 = 1{,}152$ possible combinations. It would be unrealistic to expect respondents to answer this many combinations, so a fractional factorial design was applied to come up with 48 combinations of surveys, each with 4 choice sets of 3 options. Surveys were sent to officeholders, Red River Basin Commission meeting attendees, and a random list of residents that lived in counties that had at least some land in the Red River basin. In total, 1,062 survey instruments were sent (Table 3.6).

Table 3.6. To Whom the Surveys Were Sent

Stakeholder Group	***How Many Identified Respondents***
Officeholders	316
Red River Meeting Attendants	245
Random List of Residents	501

Of all the survey instruments sent, 30 were returned with insufficient address. Another nine were sent back with no responses, either because the respondent was deceased, or because the person refused to answer any of the choice questions. Four people received two surveys since the Red River Basin Commission meeting attendants list contained multiple signups. In all, 340 out of 1,019 surveys were returned that had at least one response to a choice set question, representing a 33.4% response rate. The cut-off date was November 30. Results of the final survey were analyzed using the econometric software Limdep NLOGIT 3.0. An alternative model to use in the case where the IIA assumption is violated is the nested logit (Hanley et al., 2002). Figure 3.1 shows the nested decision structure.

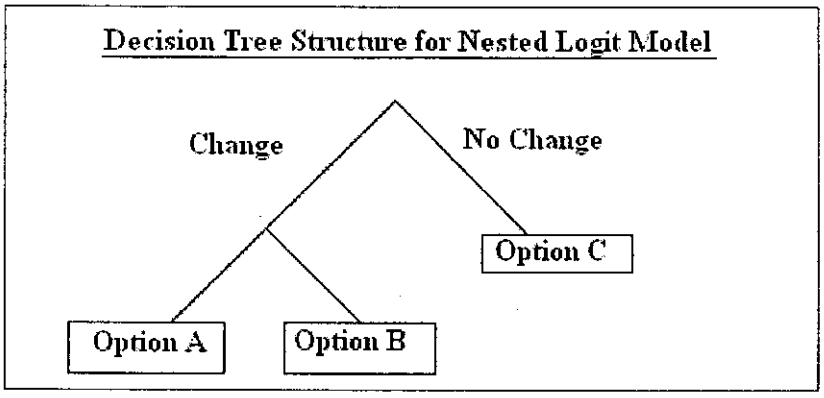

Figure 3.1. Nested decision structure.

For the nested decision, the respondent first chooses whether or not to vote for change or remain at status quo, as presented in the first branch. If the person chooses status quo, he or she would choose option C. If the person were to choose a change option, he or she would then choose between options A and B based on the levels of attributes and cost offered in each option.

CHAPTER 4. RESULTS

I. Introduction

Empirical results obtained from the logit models are discussed below. This section begins with describing statistics related to general socio-demographic results. After this the results will discuss tests of the model and finally models run as a result of the tests. A discussion follows describing implications of the results.

II. Descriptive Statistics

A total of 340 survey instruments were returned that had at least 1 response to a choice set question. Each group returned at least a 25% response rate (Table 4.1). Overall a 33.4% response rate was achieved.

Table 4.1. Stakeholder Response Rates

Stakeholder Group	***Number Sent***	***Number Received***	***Percentage***
Local Political Officeholders	305	106	35%
Informed Stakeholders	239	117	49%
Random	475	117	25%

Following studies by McGonagle and Swallow (2005) and Purdy and Decker (1989), Likert-scale questions were used to identify respondents who can be characterized as in favor of conservation and those in favor of access. These basin

attitude and value scale (BAVS) questions mimicked those in published research (Table 4.2).

Table 4.2. BAVS 5-Point, Likert-Scale Questions

	It is important to me personally that...
1†	...I fish in lakes and rivers for recreation.
2†	...I use lakes and rivers for non-fishing recreation.
3†	...I use floodplains and wetlands for hunting.
4‡	...lakes and river are managed to protect fish and wildlife habitats.
5†	...I observe or photograph wildlife along lakes and rivers.
6†	...river-shore and lakeshore land owners are able to develop their property.
7‡	...development of river-shore and lakeshore land is regulated to protect nature.
8†	...development of river-shore and lakeshore land is regulated so that everyone may use it.
9‡	...lakes and rivers maintain high water quality.
10†	...local economies benefit from the sale of equipment, supplies, or services related to water recreation.
11†	...public shoreline access is not blocked by wildlife or nature protection programs.
12‡	...rules and regulations are strictly enforced at river-shore and lakeshore access sites.
13‡	...I express my opinions about lake and river management to public officials or to officers of private conservation organizations.

†Pro-Access Questions; Max = 40, Min = 8

‡Pro-Conservation Questions; Max = 25, Min = 5

Pro-Access Response Mean: 28.4	Pro-Access Standard Deviation: 5.6
Pro-Conservation Response Mean: 19.1	Pro-Conservation Standard Deviation: 4.3

Pro-access and pro-conservation attitudes were determined by taking the average of the related Likert-scale questions and then adding one standard deviation from the mean. The Likert-scale questions ranged from 1 to 5, with 1 being "strongly disagree," 3 "neutral," and 5 "strongly agree." If the sum related to pro-access questions was greater than the average plus one standard deviation, then the person was

identified as pro-access. If the sum related to pro-conservation questions was greater than the average plus one standard deviation, then the person was identified as pro-conservation.

Results showed that 17% preferred actions that would allow for greater access to basin water resources, while 13% preferred actions that would allow for greater preservation of basin water resources (Table 4.3). These were not completely mutually exclusive, as a few respondents favored both actions that allowed for greater access and for greater preservation.

Table 4.3. Participants' Attitudes Toward Basin Water Resources

Pro Access	***Pro Conservation***
17 %	13 %

The third and last section of the survey instrument identified socio-economic characteristics of the respondents. Of the respondents, 83% lived within the Red River basin. This was expected since a number of survey respondents lived within counties of the Red River basin, but not in the basin itself. Thus for someone who lives in Bemidji, Minnesota, he or she would be in Beltrami county, which has territory in the basin, but would not be in the basin itself. Approximately 32% of responders lived in cities larger than 5,000 population. This was less than expected, since Fargo-Moorhead and Grand Forks-East Grand Forks lie in the basin. However, this can be explained since the politicians and meeting attendees' populations are skewed toward rural areas (approximately 16% and 24%, respectively). Roughly 53% of the random stakeholders lived in cities larger than 5,000 (Table 4.4).

Table 4.4. Breakdown of Percent Living in Population Greater Than 5,000

Stakeholder Group	***Percent in Population > 5,000***
Local Officeholders	16 %
Meeting Attendees	24%
Random	53%

While 94% of respondents owned the property where they lived, only 6% rented (Table 4.5). About 22% of responders earned the majority of their income from commercial farming. Approximately 78% were male. One reason for this is that mainly males were in political office and mainly males attended the Red River Basin Commission meetings. Of officeholders, only 10% were female while 20% of meeting attendees were female. Finally, 32% of the random stakeholders were female.

Table 4.5. Stakeholder Demographics

	Demographic	***Percentage***
All Stakeholders	Live Within the Red River Basin	83%
	Own Their Property	94%
	Male	78%
	Majority of Income from Commercial Farming	22%

An ambitious, and perhaps cognitively difficult, solicitation was used to identify the location of the respondent. This question asked the responder to place an 'X' on a map of the basin to mark where he or she lived. Approximately 31% of people did not answer the question. The rest were determined from people that did mark their location on the map combined with the return envelopes that were stamped with the location

from which it was sent. These results show that 21% of responders were from Minnesota, 41% from North Dakota, and 7% from South Dakota, which implies that response rate from North Dakotans was higher than for Minnesotans (Figure 4.1).

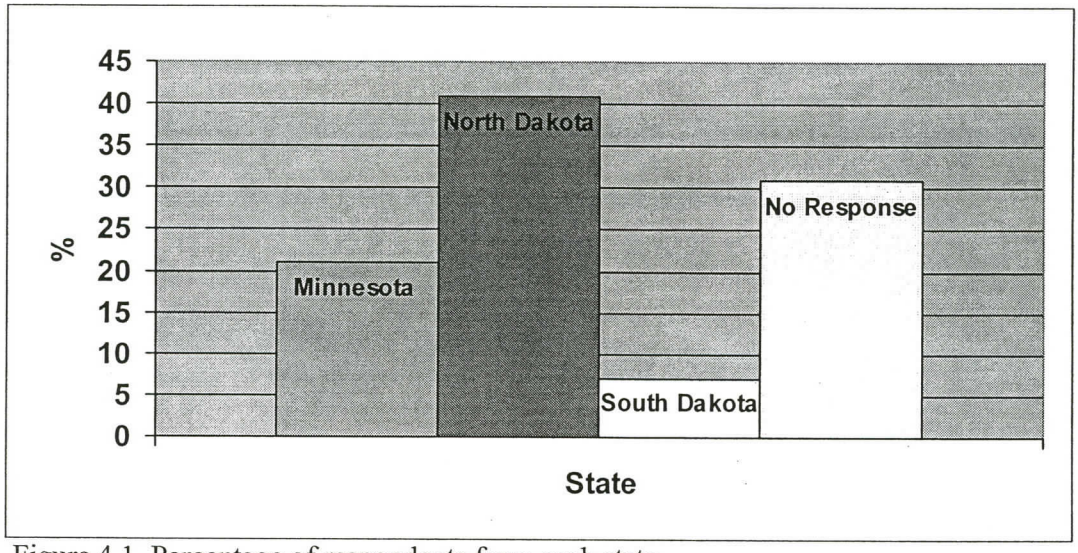

Figure 4.1. Percentage of respondents from each state.

In order to know if results were biased towards change, the frequency of change choice A or B was compared to the frequency of choosing a status quo option, choice C. Results show that responses were almost equally distributed among the three possibilities (Table 4.6).

Table 4.6. Frequency of Respondent Choosing Change

Choice	***Percentage***
Option A (Change Bundle)	34.0%
Option B (Change Bundle)	34.8%
Option C (No Change)	31.2%

III. Model Tests

a. Likelihood-Ratio Tests

Likelihood ratio tests were run to examine each sub-population against the rest of the population (Louviere et al., 2000; Hearne and Salinas, 2002). Each sub-population was expected to elicit different preferences. However, results showed that the equality of coefficients from each group were not rejected (Table 4.7).

Table 4.7. Likelihood-Ratio Tests

$-2[\text{LogL (pooled)} - \text{LogL (Pol)} - \text{LogL (Non-Pol)} = 5.2474 \sim X^2_{11}$	(4.1)
$-2[\text{LogL (pooled)} - \text{LogL (Informed)} - \text{LogL (Non-Informed)} = 9.4943 \sim X^2_{11}$	(4.2)
$-2[\text{LogL (pooled)} - \text{LogL (Random)} - \text{LogL (Non-Random)} = 7.1373 \sim X^2_{11}$	(4.3)

Given that the critical value with the Chi-squared distribution with 11 degrees of freedom at the 90% confidence level is 17.28, we do not reject the equality of the combined coefficients and scale parameters among the three populations. This means that local political officeholders, informed stakeholders, and random list do not elicit completely different preference orderings and may be combined into one population.

b. Hausman Test

The IIA property states that the probability of one option being selected from a choice set is not affected by adding or removing other options (McFadden, 1973; Hanley et al., 2006). In order to test the validity of this assumption, a Hausman test was run (Blamey et al., 2000). Specifically, 'Option A' was left out to complete the test.

With 1,322 observations in the first model, minus 450 in the second model, the Chi-squared value of the Hausman test was 20.09. This is greater than the critical value of 18.31 at a 95% confidence level, and indicates that the IIA assumption is rejected at a 95% significance level. An alternative model to use in the case where the IIA assumption is violated is the nested logit (Hanley et al., 2002).

IV. Nested Logit Models

Due to the results of the Hausman test, a nested logit model was run. The pooled population results are shown in Table 4.8.

Table 4.8. Pooled Data (N = 1,322)

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]
Attributes in the Utility Functions				
Option A	-0.0459	0.0721	-0.64	0.5241
Phos & Nit	0.2694	0.1189	2.27	0.0235**
Wetlands	0.1435	0.1240	1.16	0.2474
Bike Trails	0.1310	0.1302	1.01	0.3145
Access Points	0.0752	0.1335	0.56	0.5732
Fishery Mgmt	0.4164	0.1366	3.05	0.0023***
Regulations	-0.0315	0.0904	-0.35	0.7276
Basin Org	-0.2342	0.1359	-1.72	0.0849*
Cons Dist	0.1083	0.1309	0.83	0.4082
Water Dist	-0.0100	0.1323	0.08	0.9396
Bid Price	-0.1104	0.0144	-7.66	0.0000***
Attributes of Branch Choice Equations				
Income	-0.1112	0.0802	-1.39	0.1655
Size > 5000	0.1308	0.1510	0.87	0.3863
Female	-0.3829	0.1564	-2.45	0.0144**
Age	-0.2058	0.0621	-3.32	0.0009***
Education	0.0864	0.6762	1.28	0.2013
No Farm	0.8337	0.1573	5.30	0.0000***
Pro Pres	0.4701	0.2108	2.23	0.0258**
IV Parameters				
No Change	1.0000	(Fixed Parameter)		
Change	0.4052	0.2677	1.51	0.1302

Results show that there is not a significant desire for change versus status quo. For the model with choices among alternatives, option A was not significantly preferred to option B, which implies that there was not random answering to the choice sets. Results from the pooled data show that voting for change was not statistically different from choosing not to vote for change. Further, option A was not statistically preferred to option B. This implies that respondents were not specifically biased towards the titles of each choice.

Neither income, education, nor living in a city with population greater than 5,000 had significant impact on choosing option A or B. However, females elicited less willingness to choose a change option. As age increases, so does the likelihood to stick with the status quo. Non-farmers and pro-conservationists preferred options A and B to option C.

Preferences for reduced phosphorous and nitrogen and enhanced fishery management were positive and statistically significant. This implies that an option was selected at a higher percentage rate if these attributes were included in the option. A basin-wide organization was significantly not preferred to alternative basin organizations. Finally, bid price was negative and significant. This implies that as the bid price negatively affects choice, which was expected.

Results for officeholders are shown in Table 4.9. Results from local officeholders showed that options A and B were significantly preferred to the status quo option C (Table 4.9). Farmers and females were less likely to choose change options than non-farmers and males. Also, income and education had no impact on option choice. For this group, pro-conservationists did not impact the decision to change or remain at status quo.

Table 4.9. Political Officeholders (N = 410)

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]
Attributes in the Utility Functions				
Option A	-0.1298	0.1262	-1.03	0.3037
Phos & Nit	0.3015	0.1813	1.66	0.0964*
Wetlands	-0.0438	0.1780	-0.25	0.8057
Bike Trails	0.0935	0.1898	0.49	0.6222
Access Points	-0.1699	0.1937	-0.88	0.3805
Fishery Mgmt	-0.0163	0.1969	-0.08	0.9341
Regulations	-0.0118	0.1397	-0.08	0.9328
Basin Org	-0.1483	0.1988	-0.75	0.4558
Cons Dist	-0.0331	0.1907	-0.17	0.8623
Water Dist	-0.0588	0.1979	-0.30	0.7663
Bid Price	-0.1093	0.0224	-4.88	0.0000***
Attributes of Branch Choice Equations				
Income	0.1613	0.1725	0.94	0.3499
Female	0.7989	0.4083	1.96	0.0504*
Age	-0.0908	0.1406	-0.65	0.5183
Education	0.0923	0.1214	0.76	0.4471
No Farm	0.8398	0.2888	2.91	0.0036***
Pro Pres	0.0410	0.3675	0.11	0.9111
IV Parameters				
No Change	1.0000	(Fixed Parameter)		
Change	1.3942	0.6181	2.26	0.0241**

Officeholders elicited a preference for reduced phosphorous and nitrogen (Table 4.9). Statistics were not significant for the institution variable. This result was unexpected as political officeholders were expected to have strong opinions about the institutional organization of Red River water management. Bid price was negative and significant.

The results for informed stakeholders are shown in Table 4.10. For the group of informed stakeholders, choosing change versus status quo was not statistically significant (Table 4.10). This may imply no strong preference between staying at status quo and a change option. Pro-conservationists and non-farmers elicited a higher likelihood of choosing a change option. Income was negative and significant, which was opposite of what was expected. One possible reason for this is that farmers in this

Table 4.10. Red River Basin Commission Meeting Attendees (N = 447)

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]
Attributes in the Utility Functions				
Option A	0.0935	0.1259	0.74	0.4576
Phos & Nit	0.3355	0.2177	1.54	0.1233
Wetlands	0.2276	0.2103	1.08	0.2792
Bike Trails	-0.0305	0.2276	-0.13	0.8934
Access Points	0.3022	0.2331	1.30	0.1948
Fishery Mgmt	0.5942	0.2490	2.39	0.0170**
Regulations	0.0954	0.1559	0.61	0.5404
Basin Org	-0.2175	0.2484	-0.88	0.3811
Cons Dist	0.2390	0.2433	0.98	0.3260
Water Dist	0.1372	0.2379	0.58	0.5642
Bid Price	-0.1079	0.0268	-4.02	0.0001***
Attributes of Branch Choice Equations				
Income	-0.4461	0.1441	-3.10	0.0020***
Size > 5000	-0.3707	0.3014	-1.23	0.2188
Age	-0.1368	0.1145	-1.19	0.2325
Education	0.0422	0.1400	0.30	0.7633
No Farm	0.8722	0.2710	3.22	0.0013***
Pro Pres	0.5851	0.3512	1.67	0.0958*
IV Parameters				
No Change	1.0000 (Fixed Parameter)			
Change	0.1901	0.4070	0.47	0.6404

sample had higher incomes than non-farmers, and farmers were less likely to choose a change option. If they lived in cities with more than 5,000 people or if they were more educated or older, it had no significant impact on choosing A or B versus C. Results showed that informed stakeholders had no strong preferences of one institution type over another.

The results for the random stakeholders are shown in Table 4.11. Random stakeholders were not biased towards a change option versus the status quo (Table 4.11). This may imply that they do not have strong preferences for a change option. They were also not biased towards option A versus option B. People who lived within the basin elicited preference for a change option. This was expected since they live closer to basin water resources than those outside the basin.

Table 4.11. Random Stakeholders (N = 465)

Variable	*Coefficient*	*Standard Error*	*b/St.Er.*	*P[|Z|>z]*
		Attributes in the Utility Functions		
Option A	-0.0666	0.1267	-0.53	0.5993
Phos & Nit	0.2437	0.1904	1.28	0.2005
Wetlands	0.6400	0.1767	3.62	0.0003***
Bike Trails	0.3639	0.2053	1.77	0.0764*
Access Points	0.1463	0.2137	0.69	0.4934
Fishery Mgmt	0.4554	0.2248	2.03	0.0428**
Regulations	-0.2961	0.1494	-1.98	0.0475**
Basin Org	-0.2395	0.2932	-0.82	0.4141
Cons Dist	-0.1019	0.2183	-0.47	0.6406
Water Dist	-0.0606	0.2550	-0.24	0.8122
Bid Price	-0.6617	0.0443	-1.49	0.1352
		Attributes of Branch Choice Equations		
Income	-0.0126	0.1417	-0.09	0.9293
Size > 5000	0.4255	0.2330	1.83	0.0678*
Basin	0.8528	0.3290	2.59	0.0095***
Rent	0.6767	0.4293	1.58	0.1149
Age	-0.4020	0.1068	-3.76	0.0002***
Education	0.0588	0.1139	0.52	0.6057
No Farm	1.3868	0.3639	3.81	0.0001***
Pro Pres	0.7837	0.4035	1.94	0.0521*
		IV Parameters		
No Change	1.0000	(Fixed Parameter)		
Change	-1.0564	0.9487	-1.11	0.2655

Those in larger cities were more likely to vote for change (Table 4.11). This may be because most large cities in the basin are along the Red River, such as Wahpeton, Fargo, Moorhead, Grand Forks, and East Grand Forks. Pro-conservationists were more likely to vote for change, while farmers and older people were less likely. Renters were expected to vote for change since they, in general, do not explicitly pay property taxes, but the result was statistically insignificant, which means that it did not matter to them. Once again, education and income were statistically insignificant. As education and income increase, the odds of choosing a change versus the status quo do not increase or decrease.

Wetlands were significantly preferred to other water quality options at a 99% confidence level (Table 4.11). Enhanced fishery management was the most preferred recreation option, followed by additional bike trails. Bike trails were statistically significant and positive, implying a desire for additional trails. This may be because 53% of the random stakeholder list was from cities with greater than 5,000 residents. Also shown is that the diversion project is preferred to regulations. Finally, the bid price variable was not statistically significant. This implies that the respondents chose their preferences not as much based on the cost as on their preferred water management alternatives.

V. Willingness To Pay

One important capability of CE is measuring willingness to pay. Marginal willingness to pay (WTP) was estimated from the random stakeholder results for the significant variables. This group was used because it represents the basin-wide population in general. The values are in number of tax dollars per year, per household. This is multiplied by the aggregate number of households in counties in the basin to estimate aggregate WTP (Table 4.12).

Table 4.12. Marginal and Aggregate Willingness to Pay

Variable	*M-WTP*	*St. Er*	*b/St. Er.*	*P[|Z|>z]*	*A-WTP*
Wetlands	$84.33	48.05	1.755	0.0792*	$24.3 Million
Bike Trails	$76.11	42.14	1.806	0.0709*	$21.9 Million
Fishery Management	$117.26	42.79	2.740	0.0061***	$33.7 Million

The number of households in counties in the Red River basin is 287,789 (Census 2000). The results show that people are willing to spend money to increase wetlands, add additional bike trails, and enhance fishery management practices such as additional fish stocking. At the marginal rate, estimates show WTP for increased wetlands is approximately $84 per year, WTP for additional bike trails is approximately $76 per year, and is roughly $117 per year for enhanced fishery management practices. At the aggregate, the estimates are about $24 million for increased wetlands, $22 million for additional bike trails, and $34 million for enhanced fishery management.

CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS

I. Introduction

This research sought to estimate stakeholder preferences for Red River basin management alternatives. Specifically, it identified issues that basin residents and experts considered relevant and estimated their willingness to pay for implementing the changes. The choice experiments method was used for estimations, and a nested model was applied to elicit the probability of a respondent choosing change or no change based on his or her socio-demographics, then choosing which change option based on attributes of the each change option.

II. Results

Some socioeconomic characteristics of the individual respondent impacted the choice of change versus no change. Specifically, someone who was pro-conservation was more likely to vote for a change option. Farmers were significantly likely to stick with the status quo. An interesting result was that neither income nor education significantly impacted the change decision. Income did not significantly increase the responder's willingness to pay. Renters were not more likely to vote for change, which was unexpected since they do not explicitly pay property taxes, implying that they would get the benefits without paying the costs. As age went up, the respondent was generally less likely to choose a change option. Also, females were less likely to vote for change options.

One result related to water supply is that regulations were not significantly preferred to a diversion. This may be because stakeholders do not want a diversion but are also not willing to pay for regulations, since regulations tend towards conservation rather than use of resources. Finally, no institution was significantly preferred to another. This may be a result that many stakeholders feel that each level of institution is desirable for managing basin water resources. While many institutions are involved, it is important that they communicate amongst each other in order to more efficiently manage basin resources.

Results showed that in general, pooled basin stakeholders preferred reducing phosphorous and nitrogen over other forms of improving water quality. However, the random stakeholders preferred restoring wetlands over other water options. For water-based recreation issues, enhanced fishery management was preferred to bike trails, supervised swimming areas and additional public access points in the pooled data set. For the random list of stakeholders, a positive marginal willingness to pay was placed on wetlands, bike trails, and enhanced fishery management. This was then multiplied by the number of households in counties with land in the basin in order to estimate aggregate willingness to pay.

III. Recommendations

Results for local officeholders revealed little understanding about their preferences for institution. However, this may be since a number of them during interviews or through comments on their surveys, suggested a greater need for collaboration, that the institutions are not being effective as they could. Another reason

may be that the choice experiments method uses a bid price to estimate preferences. Perhaps if a financial tool were not used, officeholders would be able to better elicit their preferences. A method such as the analytical hierarchy process may be used to do this. It is recommended to look more into how to analyze preferences for institutional management.

Another recommendation would be to improve the state identifier. This question was answered less than 50% of the time and should be straight forward for future projects. It may also improve the results to see how long the respondent had lived within the basin. Perhaps more than income, the person's length of living in the basin, or expected future time in the basin, may affect their preferences for basin water resources. A related question could be asked.

Another recommendation would be to do a similar project for Canada to see what its stakeholders desire. International institutions would then be able to compare and contrast preferences from both sides of the border and understand what issues to deal with. If Canadian residents prefer reduced phosphorous and nitrogen then it may be beneficial to Canadians to enact legislation upstream in order to help those downstream.

Finally, a comprehensive update of all basin water-related organizations is suggested. A study examining each level of government and non-government organizations would help inform stakeholders of all the involved institutions and their focuses within the Red River basin.

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APPENDIX A

RESEARCH APPROVAL LETTER FROM THE NDSU IRB

NDSU NORTH DAKOTA STATE UNIVERSITY

Institutional Review Board
Office of the Vice President for Research, Creative Activities and Technology Transfer
1735 NDSU Research Park Drive
P.O. Box 5756
Fargo, ND 58105-5756

701.231.8908
Fax 701.231.8098

Federalwide Assurance #FWA00002439
Expires April 22, 2008

September 25, 2007

Dr. Robert Hearne
Dept. of Agribusiness & Applied Economics
205B Morrill Hall

Re: IRB Certification of: **"Evaluating Stakeholder Preferences for Red River Basin Initiatives"**
Protocol #: **AG08054**

Co-investigator(s) and research team: **David Torpen**

Study site(s): **NDSU** Funding: USGS

The IRB has determined that this project qualifies for exempt status (category # 2b, 3a) in accordance with federal regulations governing human subjects research (Code of Federal Regulations, Title 45, Part 46, *Protection of Human Subjects*).

Please also note the following:

- This determination of exemption expires 3 years from this date. If you wish to continue the research after 9/24/2010, submit a new protocol several weeks prior to this date.
- The project must be conducted as described in the approved protocol. If you wish to make changes, pre-approval is to be obtained from the IRB, unless the changes are necessary to eliminate an apparent immediate hazard to subjects. A *Protocol Amendment Request Form* is available on the IRB website.
- Prompt, written notification must be made to the IRB of any adverse events, complaints, or unanticipated problems involving risks to subjects or others related to this project.
- Any significant new findings that may affect the risks and benefits to participation will be reported in writing to the participants and the IRB.
- Research records may be subject to a random or directed audit at any time to verify compliance with IRB policies.

Thank you for complying with NDSU IRB procedures; best wishes for success with your project.

Sincerely,

Teryl Grosz, MS, CIP
IRB Director

APPENDIX B

CONSENT LETTERS

Dear Red River Basin Resident:

My name is David Torpen and I am a graduate student in the department of Agribusiness and Applied Economics at North Dakota State University. I am conducting a research project to help water institutions understand resident preferences for issues related to the Red River.

You are invited to complete this survey to help the research study. Your participation is entirely voluntary, and you may withdraw from participation at any time. However, your assistance is greatly appreciated in making this a meaningful study. If you decide to complete this survey, you may tear off this sheet and keep it for your information.

It should take about 15 minutes to complete and enclose the attached questionnaire in the envelope to send back to me.

Your identity will not be revealed in the experiment results, and your responses will remain confidential. Only group comparisons will be made and reported in summary form.

If you have any questions about this project, please call me at 701-373-5992, or call my advisor Dr. Robert Hearne at 701-231-6494. You can also email either of us at Robert.Hearne@ndsu.edu, or David.Torpen@ndsu.edu. If you have questions about the rights of human participants in research, or to report a problem, contact the NDSU IRB Office, (701) 231-8908, or ndsu.irb@ndsu.edu.

Thank you for your participation in this study. If you wish to receive a copy of the research results, please email either one of us.

Dear Red River Basin Resident:

My name is David Torpen and I am a graduate student in the department of Agribusiness and Applied Economics at North Dakota State University. I am conducting a research project to help water institutions understand resident preferences for issues related to the Red River.

You are invited to complete this survey to help the research study. We are sending this to science teachers, local office holders, and people who attended Red River Basin Commission meetings, because we consider you informed about many of these issues. Your participation is entirely voluntary, and you may withdraw from participation at any time. However, your assistance is greatly appreciated in making this a meaningful study. If you decide to complete this survey, you may tear off this sheet and keep it for your information.

It should take about 15 minutes to complete and enclose the attached questionnaire in the envelope to send back to me.

Your identity will not be revealed in the experiment results, and your responses will remain confidential. Only group comparisons will be made and reported in summary form.

If you have any questions about this project, please call me at 701-373-5992, or call my advisor Dr. Robert Hearne at 701-231-6494. You can also email either of us at Robert.Hearne@ndsu.edu, or David.Torpen@ndsu.edu. If you have questions about the rights of human participants in research, or to report a problem, contact the NDSU IRB Office, (701) 231-8908, or ndsu.irb@ndsu.edu.

Thank you for your participation in this study. If you wish to receive a copy of the research results, please email either one of us.

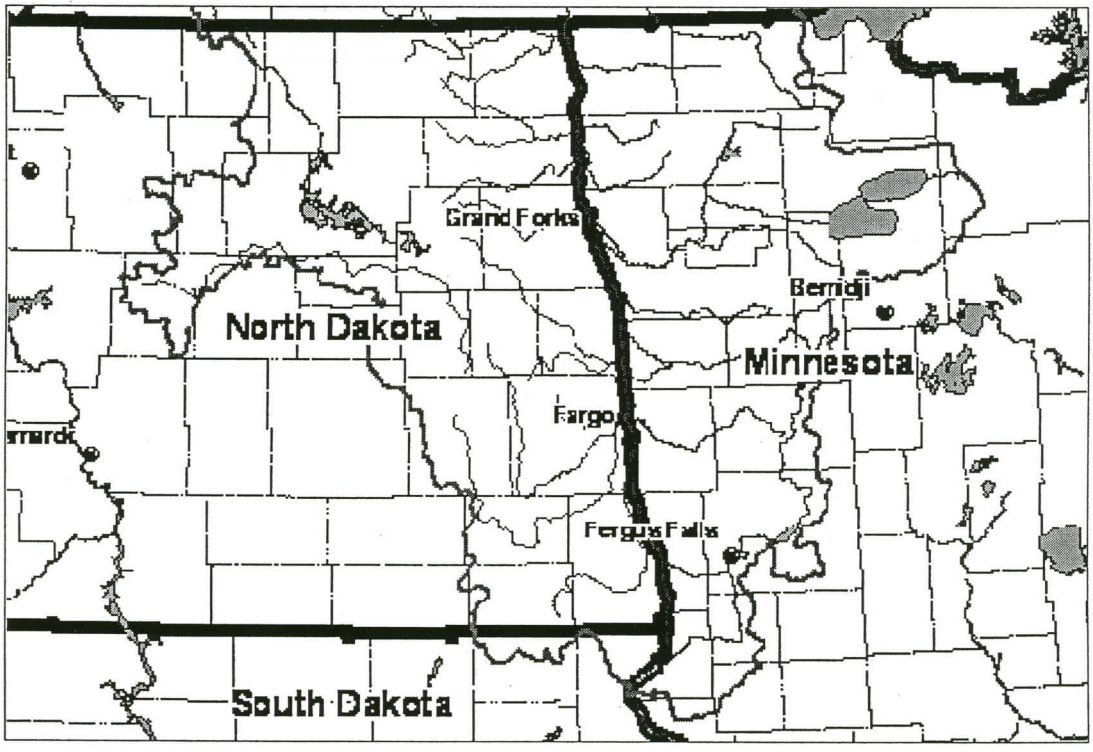
APPENDIX C

EXAMPLE OF SURVEY

NDSU

DEPARTMENT OF AGRIBUSINESS AND APPLIED ECONOMICS

The United States' Portion of the Red River of the North Basin:



Map shows the Red River basin outlined in red.
The basin contains about 39,200 square miles of land
in North Dakota, Minnesota, and South Dakota.
Roughly 350,000 people live in the basin.

Section 1.

We would like to find out your attitude about Red River watershed usage. Please circle the degree of importance that you consider the following statements according to the following scale.

1 – Strongly Disagree
2 – Somewhat Disagree
3 – Neither Disagree nor Agree
4 – Somewhat Agree
5 – Strongly Agree

← Disagree ... Neutral ... Agree →

It is important to me personally that...

...I fish in lakes and rivers for recreation.
1 2 3 4 5

...I use lakes and rivers for non-fishing recreation.
1 2 3 4 5

...I use floodplains and wetlands for hunting.
1 2 3 4 5

...lakes and river are managed to protect fish and wildlife habitats.
1 2 3 4 5

...I observe or photograph wildlife along lakes and rivers.
1 2 3 4 5

...river-shore and lakeshore land owners are able to develop their property.
1 2 3 4 5

...development of river-shore and lakeshore land is regulated to protect nature.
1 2 3 4 5

...development of river-shore and lakeshore land is regulated so that everyone may use it.
1 2 3 4 5

...lakes and rivers maintain high water quality.
1 2 3 4 5

...local economies benefit from the sale of equipment, supplies, or services related to water recreation.
1 2 3 4 5
...public shoreline access is not blocked by wildlife or nature protection programs.
1 2 3 4 5

...rules and regulations are strictly enforced at river-shore and lakeshore access sites.
1 2 3 4 5

...I express my opinions about lake and river management to public officials or to officers of private conservation organizations.
1 2 3 4 5

Section 2.

The following information about water-related issues is provided to help you answer the four choice question sets. Potential initiatives within the basin are discussed below in four broad categories: water quality, recreation, water supply, and governing institution.

1. Water quality:
    a. *Wetland Restoration:* Wetlands provide habitat and breeding grounds for waterfowl and other wildlife. They also filter and absorb polluted water before it enters lakes and rivers. Legislation in the early years of statehood led to many wetlands being drained in Minnesota, North Dakota and South Dakota. It is possible to restore some of these to their proper and natural use.

    b. *Reduced fish kills:* Fish kills occur in some lakes and rivers each year. Often these are caused by low oxygen levels for fish. Installing aerators and managing urban storm water runoff can help reduce fish kills.

    c. *Reduced phosphorous and nitrogen:* These nutrients in excess may cause algae growth, which can harm fish habitat, water-based recreation, and diminish aesthetic values. Reducing the nutrient levels in surface water would improve habitat, water quality and decrease algae growth. This would be achieved through best management practices by farmers and cities, and by constructing natural buffer zones along river banks and lakeshores.

2. Water Supply:
    a. *Diversion:* This buried pipeline would provide communities that use the Red River as their main source of water with a backup source of water from the Missouri River in case of a severe drought.

    b. *Regulations:* Regulations would be set in place during low-flow conditions. Potential regulations include limiting water for lawns, car washes, cooking and cleaning, and regulating water storage to prepare for future droughts.

3. Recreation:
    a. *Additional boat access points:* These would provide more public access points for boats into lakes and rivers within the Red River basin.

    b. *Enhanced fishery management:* This would include activities such as additional fish stocking, trapping undesirable species, and relaxed limits when fish kills are expected.

    c. *Additional bike trails:* These would allow for walking, running and biking.

    d. *Supervised swimming areas:* These would provide sandy beach areas and lifeguards for some lakes and rivers.

4. Governing Institution:
    a. *Local water districts:* Local water districts would receive the responsibility and additional resources to coordinate the proposed changes within the Red River basin. These districts currently implement water conservation practices for flood control and lake management. They also operate water infrastructure.

    b. *Local conservation districts:* Local conservation districts would receive the responsibility and additional resources to coordinate the proposed changes within the Red River basin. Conservation districts currently are responsible for developing local water management plans. They plan water activities and support best management practices for agriculture and other land uses, drainage, and solid waste disposal.

    c. *Basin-wide organization:* A single basin-wide organization would receive the responsibility and additional resources to coordinate the proposed changes within the Red River basin. This may make it easier to coordinate and implement projects, and improve allocation of resources.

    d. *Non-governmental organizations:* Non-government organizations would receive the responsibility and additional resources to coordinate the proposed changes within the Red River basin.

5. Price per Year:

    This represents an additional property tax that would be assessed yearly. In the Minnesota portion of the Red River Basin households currently pay, on average, about $65 per year to Watershed Districts, through organization taxes and special assessments. Minnesota households also pay, on average, about $7 per year to Soil and Water Conservation Districts through county taxes. In North Dakota, Red River Basin residents currently pay, on average, about $28 per year to Water Resource Districts and about $25 per year to Soil Conservation Districts, both of which are primarily funded through county taxes.

Please choose among the following sets of possible changes. Your responses to these questions will help water management organizations understand and prioritize the changes that residents want the most within the Red River basin. Answer as best you can, referring to the explanation section on the previous two pages as necessary.

Choice #1. Please consider the different options and place a checkmark in the box of the choice you most prefer.

	Option A	Option B	Option C
Water Quality	Reduce Nitrogen and Phosphorous	Reduce Nitrogen and Phosphorous	No Change
Recreation	Additional Bike Trails	Additional Bike Trails	
Water Supply	Diversion	Diversion	
Institution	Non-Government Organizations	Local Conservation Districts	
Price per Year	$100	$160	$0

My Choice: ☐ A ☐ B ☐ C

Choice #2. Please consider the different options and place a checkmark in the box of the choice you most prefer.

	Option A	Option B	Option C
Water Quality	Reduce Fish Kills	Wetland Restoration	No Change
Recreation	Supervised Swimming Areas	Additional Boat Access Points	
Water Supply	Diversion	Regulations	
Institution	Basin-Wide Organization	Local Water Districts	
Price per Year	$240	$80	$0

My Choice: ☐ A ☐ B ☐ C

Choice #3. Please consider the different options and place a checkmark in the box of the choice you most prefer.

	Option A	Option B	Option C
Water Quality	Wetland Restoration	Reduce Fish Kills	No Change
Recreation	Additional Boat Access Points	Enhanced Fishery Management	
Water Supply	Regulations	Regulations	
Institution	Local Water Districts	Local Conservation Districts	
Price per Year	$20	$140	$0

My Choice: ☐ A ☐ B ☐ C

Choice #4. Please consider the different options and place a checkmark in the box of the choice you most prefer.

	Option A	Option B	Option C
Water Quality	Reduce Fish Kills	Wetland Restoration	No Change
Recreation	Supervised Swimming Areas	Enhanced Fishery Management	
Water Supply	Diversion	Regulations	
Institution	Non-Government Organizations	Basin-Wide Organization	
Price per Year	$120	$60	$0

My Choice: ☐ A ☐ B ☐ C

Section 3.

In order to help us represent the population, we would like to know some general information about you.

1. Are you male or female?
   ___Male
   ___Female

2. What is your age?
   ___18-29
   ___30-39
   ___40-49
   ___50-59
   ___over 60

3. What is your highest education degree completed?
   ___Less than High School
   ___High School
   ___Some College
   ___College Degree
   ___Graduate or Professional Degree

4. Some people who received this questionnaire do not live in the Red River basin. Please mark your approximate location on the front page map with an 'X' and determine if you live within the basin.
   ___Yes, I live in the basin.
   ___No, I do not live in the basin

5. Do you live in a city that has 5,000 or more people?
   ___Yes
   ___No

6. Do you own or rent the property where you live?
   ___Own/Pay mortgage
   ___Rent

7. What was your before-tax household income last year?
   ___less than $39,999
   ___$40,000 to $79,999
   ___$80,000 to $150,000
   ___More than $150,000

8. Last year did the majority of your household income come from commercial agriculture?
   ___Yes ___No