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Three essays on contingent valuation method

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by

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Abstract

The objective of this research was to examine some incentive and informational properties of contingent valuation surveys and provide some suggestions in survey design. The contingent valuation method uses survey questions to elicit individuals' preferences for nonmarket goods. The essential task of a contingent valuation exercise is to design a questionnaire which elicits respondents' preference for the good being valued.

This dissertation includes three essays that contribute to the contingent valuation literature. The contingent valuation method is widely used in estimating the economic value of nonmarket goods. The first essay offers an empirical test of a theoretical result in the contingent valuation literature, which argues that respondents will respond to survey questions truthfully, if they perceive the survey as being "consequential", regardless of the degree of consequentiality. The second essay tests the commitment cost theory suggested by Zhao and Kling (2001, 2004). They argue that a respondent's willingness to pay for a good at a particular point of time depends not only on the intrinsic value of the good, but also on the timing of the decision and the characteristics of the market environment. The third study examines whether three value elicitation formats—the dichotomous choice question, the multinomial choice question, and a modified multinomial choice question suggested by Carson and Groves (2007)—provide comparable welfare estimates.

Chapter 1. General Introduction

1. 1. Introduction

The contingent valuation method uses survey questions to elicit individuals' preferences for nonmarket goods. The essential task of a contingent valuation exercise is to design a questionnaire which elicits respondents' preference for the good being valued. The objective of this research was to examine some incentive and informational properties of contingent valuation surveys and provide some suggestions in survey design. This dissertation includes three essays. The first two essays of this study employ data from two years of the "Iowa Lakes Valuation Project." The Iowa Lakes Valuation Project is a four-year panel study aimed at understanding the recreational use and the economic value of improved water quality in the primary recreational lakes in the state of Iowa. In order to understand the physical processes that influence water quality, Iowa State University Limnology Laboratory designed a five-year project to gather physical water quality information for 132 of Iowa's principle recreation lakes. The Iowa Lakes Valuation Project was designed to complement the research done by the Iowa State University Limnology Laboratory by gathering respondents' recreational use patterns, objective measures of water quality, and the economic value of water quality improvement for the same set of recreational lakes in Iowa.

Respondents' willingness to pay is one way of representing the economic value of water quality improvement in Iowa lakes. Willingness to pay is the amount of income an individual is willing to give up for an improvement in circumstances. In the 2003 and 2005 versions of the Iowa Lakes Valuation Project questionnaires, respondents' willingness to pay for a water quality improvement scenario at one of eight focus lakes was collected via a contingent valuation referendum. These lakes were selected in consultation with the Iowa Department of Natural Resources. In addition to being geographically dispersed, these lakes are of policy interest and various restoration projects are being considered.

The first essay offers an empirical test of a theoretical result in the contingent valuation literature. In particular, it has been argued that respondents will respond to survey questions truthfully, if they perceive the survey as being "consequential", regardless of the degree of consequentiality. The argument further states that if respondents do not believe the survey to be consequential, economic theory can make no prediction about the responses. In this study, respondents' perceived consequentiality toward the survey was directly elicited using ordinal rankings ranging from "1" to "5." Given the potential endogeniety of individuals' "consequentiality" responses, in the 2005 version of survey, a subsample of the respondents was randomly assigned information suggesting their responses were important and would have direct impact on policy decisions. This exogenous treatment allows us to separate the impact of consequentiality on respondents' contingent valuation responses.

We employ a Bayesian treatment effect model to test whether respondents' perceptions of consequentiality has an impact on their willingness to pay for a hypothetical water quality improvement scenario. In particular, we test the theory by determining if the willingness to pay distributions are the same for each value of the ordinal responses.

The objective of the second essay is to test the commitment cost theory suggested by Zhao and Kling (2001, 2004). Typically, a respondent's willingness to pay is assumed to depend on some intrinsic value of the good that is invariant over time. However, they argue that a respondent's willingness to pay for a good at a particular point of time depends not only on the intrinsic value of the good, but also on the timing of the decision and the characteristics of the market environment. In particular, the commitment cost theory predicts that individuals would report a lower willingness to pay, if they expect (a) that delaying the transaction decision is possible, (b) that learning more information about the transaction in the future is possible, and (c) that reversing the transaction decision is difficult. If the intertemporal aspects of the contingent valuation referendum influence respondents' reported willingness to pay as the commitment cost theory predicts, the researchers should carefully convey not only the attributes of the project, but also the relevant intertemporal aspect of the project in their contingent valuation survey.

In this study, we randomize the survey instrument so that half of the 2003 sample receives a survey where they are told that they will have a second chance to revisit the contingent valuation referendum if the referendum is not passed. With this explicit statement of delay, we expect to separate out the impact of delay on respondents' willingness to pay. Next, we use respondents' perceptions of intertemporal aspects such as delay, learning, and reversal elicited in the 2003 version of survey to examine how these dynamic factors influence respondents' willingness to pay.

In the 2005 version of survey, we test the impact of delay with another approach. In particular, half of the 2005 sample is informed that there will be no opportunity to revisit the referendum in the future whereas the other half is told nothing about possible chances to revisit the question. We use this exogenous treatment to examine the impact of the immediacy on respondents' willingness to pay. Finally, besides respondents' perceived potential for delay, we use respondents' self-reported knowledge level and knowledge increment about the general water quality in Iowa lakes elicited in the 2005 version of survey to examine how respondents' knowledge perceptions influence their willingness to pay.

The third essay employs data from a web-based survey aimed at assessing farmers' perceptions, preferences, and reactions to alternative agricultural landscapes with increased perennial land cover in the state of Iowa. Perennial crops are of policy interest due to their environmental benefits, especially in water quality and wildlife habitat. In this contingent valuation survey, various value elicitation formats are employed to estimate respondents' willingness to accept for adopting perennial strips in landscape. These elicitation formats include the dichotomous choice question, the multinomial choice question, and a modified multinomial choice question suggested by Carson and Groves (2007). The purpose of this study is to examine whether these value elicitation formats provide comparable welfare estimates. Six landscape policy alternatives are considered. To estimate respondents' willingness to accept for these alternatives in a dichotomous choice question, fifteen combinations are used. We develop an estimation procedure to jointly estimate the responses from these questions. In addition, we extend Cameron's (1988) bid function model for the dichotomous choice question to individuals' responses to the multinomial choice question. Similar to the dichotomous choice question, we use the variance of the hypothetical bid values embedded in the multinomial choice question across the alternatives and the individuals to identify the regression coefficients and the variance-covariance matrix for the multinomial choice question.

1. 2. Dissertation Organization

Each essay in this dissertation is an individual chapter, with its own introduction, conclusion, references, and appendix. A general conclusion chapter summarizes the results from the three essays. Finally, the 2003 and the 2005 versions of Iowa Lakes Survey which are used in the first two essays and the Agricultural Landscape Survey which is used in the third essay are included as an appendix to the dissertation.

1. 3. References

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Chapter 2. What are the Consequences of Consequentiality?

2. 1. Introduction

The question as to the accuracy with which stated preference methods can be used to elicit an individual's values for environmental goods and services continues to be hotly debated in the literature. A wide variety of empirical tests have been conducted to date, including studies checking for convergent validity with other elicitation methods (e.g., revealed preference techniques such as recreation demand or hedonic pricing) or contrasting revealed and stated preference responses in an experimental setting. While such tests are quite informative, they are often context specific and reduced form in nature, not addressing the fundamental issues as to why and under what conditions stated preference methods will succeed or fail.

In contrast, Carson and Groves (2007), by detailing the incentive and informational properties of contingent valuation questions, provide the basis for discerning the key elements of a successful contingent valuation exercise. Specifically, Carson and Grove argue that a respondent can be predicted to answer a dichotomous choice referendum question in a manner that is consistent with expected utility maximization if he perceives the survey as being "consequential." That is, if a respondent believes the result of the survey might potentially have some influence on an outcome he cares about, he will answer a contingent valuation question truthfully since this is his dominant strategy to do so.

There have been several studies to date testing the "consequentiality" condition and its impact on a respondent's preference revelation by conducting experiments. These experimental studies largely take place outside of the context of an actual contingent valuation exercise and require the analyst to inform participants of the degree of consequentiality associated with the experiments. These experiments have the important advantage that the researcher can directly control the degree of consequentiality, but their disadvantage is that this direct control is not typical of contingent valuation surveys. Thus, findings from such experiments may be difficult to transfer to the survey arena.

In this paper, we take a different, but complementary approach, eliciting respondents' perceptions of consequentiality directly in a contingent valuation survey[1]. Specifically, we use respondents' perceptions of consequentiality elicited in two contingent valuation surveys (the 2003 and 2005 versions of the Iowa Lakes Surveys) to determine whether respondents have different perceptions concerning the degree of consequentiality of the valuation exercise and whether these perceptions affect their willingness to pay (WTP) in the pattern predicted by Carson and Groves (2007).

In both surveys, respondents were asked whether they would vote in favor of a referendum to improve the water quality at a lake where bid values were varied across the sample. Respondents were also asked, on a scale from 1 to 5, how likely it was that the survey results would influence decisions in the state concerning water quality programs. Thus, a measure of the degree to which respondents perceived the survey as consequential was directly elicited. Based on the Carson and Groves's arguments, respondents who do not believe that the survey is consequential should be omitted from the sample for estimation purposes, since they do not have an incentive to answer the referendum question truthfully. Additionally, the distribution of WTP from respondents with different views concerning the

1 Bulte et al. also study consequentiality within a contingent valuation context though they do not elicit perceptions of consequentiality from the respondent.

degree of consequentiality could be tested for consistency, thereby testing the fundamental Carson and Groves's argument.

Since respondents who indicate a high degree of consequentiality may do so because they place a high value in the proposed water quality improvement project, there is a potential endogeniety problem[2]. To address this concern, a split sample treatment was administered in the 2005 survey. Specifically, half of the sample was provided with a highlighted article from the *Iowa Conservationist*—the magazine of the Iowa Department of Natural Resources, the state agency with primary responsibility for water quality control—indicating that Iowa Department of Natural Resources was already using results from the survey in their policy decisions and planned to continue to do so (see appendix D of this paper). After reading this information, respondents were asked to provide their assessment of the degree of consequentiality of the survey. Thus, direct evidence of consequentiality was applied to the stratum. This exogenous treatment allows us to separate out the impact of consequentiality in the contingent valuation responses which we describe below.

The outline of this paper is as follows. Section 2.2 provides an overview of related studies in the literature. Section 2.3 describes the Iowa Lakes Project. The model and the simulator used to characterize the posterior distribution of the parameters of interests are described in section 2.4. Details of the posterior simulator are provided in the Appendix 2.A and Appendix 2.B of this paper. A summary in Section 2.5 concludes this paper.

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[2] We are particularly appreciative to comments from Camp Resource attendees who raised this concern and significantly sharpened our thinking concerning the problem.

2. 2. Literature Review and Theory

In exploring why, and under what conditions, a survey respondent is likely to reveal his preference, contingent valuation researchers have focused on the incentive and informational properties of contingent valuation questions. As Carson and Groves note, a consequential contingent valuation question requires that a respondent perceives his answer having some influence on the government's policy decision he cares about. Carson and Grove argue that a respondent can be predicted to answer a contingent valuation question in a manner consistent with expected utility maximization only if he believes that the result of the survey might potentially have some influence on an outcome he cares about. However, if a respondent views the survey as being inconsequential, truthful preference revelation is not his dominant strategy, since any response has the same influence on his utility. Thus, economic theory can say nothing about his preference. A "knife-edge" theoretical result is suggested: a respondent who perceives the survey as being somewhat consequential will respond to a contingent valuation referendum in the same way as he would to an actual referendum regardless of the degree of his perceived consequentiality.

Several studies have tested the impact of the "consequentiality" condition on respondents' preference revelation. Cummings *et al*. (1997) conducted an experiment involving real and hypothetical referenda to compare how respondents behave in these two settings. They find that respondents are more likely to vote "yes" in the hypothetical setting than in the real setting and they conclude that hypothetical referenda yield biased estimates of WTP. Cummings and Taylor (1998) explore this issue further by investigating how hypothetical bias of the dichotomous choice referendum varies with the degree of consequentiality. Specifically, their laboratory experiment employs a probabilistic treatment that varies the odds that the referendum will be binding. They find that participants in different treatments, including hypothetical, probabilistic, and real referendum, behave significantly different. Specifically, the probability of a respondent voting “yes” falls if the probability of the referendum being binding rises. They also find that respondents’ voting behavior is significantly different from an actual referendum unless there is a high probability that the referendum will be binding (e.g., greater than fifty percent).

Carson *et al*. (2004) conduct a similar study with a field experiment. In the experiment, participants were informed the probability of the dichotomous choice referendum being binding. In contrast to Cummings and Taylor (1998), they find the “knife-edge” theoretical results suggested in Carson and Grove (2007): as long as the probability of consequentiality exceeds zero even by a small amount, participants respond the same manner as in an actual referendum. They suggest that results from an inconsequential (hypothetical) referendum should not be used to make inference about how contingent valuation works in consequential referendum.

Bulte *et al*. (2005) employ exogenous treatments regarding the incentive and informational properties of the survey in split samples to explore the impact of consequentiality on respondents’ WTP in a survey setting. In particular, one subsample of respondents were informed that the results of the survey will be available to policy makers, one subsample of respondents were provided a cheap talk regarding the reasons for strategic biases of a hypothetical referendum, and the other respondents received a purely hypothetical referendum. Their WTP estimates obtained from the survey with “cheap talk” and the survey with a consequentiality device are significantly smaller than those obtained in a purely hypothetical survey. In addition, the WTP estimates obtained from the survey with cheap talk are not significantly different from the WTPs obtained from the survey with a consequential device.

2. 3. The Iowa Lakes Project

This study uses data from two years of the "Iowa Lakes Project," a four-year study and data collection effort aimed at understanding recreational use and the economic value of water quality improvement in the principle recreational lakes in the state of Iowa. The project began in 2002 with mail surveys sent out to a random sample of 8000 Iowa residents, obtaining detailed information regarding their visitation patterns to 132 lakes, as well as standard social demographic data such as age, income , gender, education. In subsequent years, surveys were sent to those individuals who completed a survey in the prior year.[3] Standard follow-up procedures, including a postcard reminder mailed two weeks after the initial mailing and a second copy of the survey mailed one month later, were employed. Individuals were provided a $10 incentive for completing the survey.

A referendum style contingent valuation question was included in the 2003 and the 2005 versions of the questionnaire. The contingent valuation question was posed to estimate WTP for a water quality improvement project at one of eight focus lakes targeted in the study. These lakes were selected in consultation with the Iowa Department of Natural Resources. In addition to being geographically dispersed, they are each of policy interest as various restoration projects are being considered at the lakes. Each respondent was asked a contingent valuation question for only one of the focus lakes. The survey described the current water quality information of the lake, including water clarity, watercolor, water odor,

[3] A second random sample was added into the panel in 2003 to fill in for the non-deliverable surveys in 2002 and returned the sample to a total of 8000 individuals. No additional individuals were added after 2003.

health concern from algae blooms and bacteria level, and variety and quantity of fish. A photograph, which demonstrates the water clarity and watercolor, was provided to help respondents picture the water quality of the focus lake vividly.

Prior to the main valuation question, respondents were reminded with a cheap talk essay about the incentive and information properties of the stated preference question in further attempt to elicit truthful responses to the contingent valuation question[4]. Specifically, respondents were told:

> *"When you think about your answer, it is important to keep in mind that people may indicate they would be willing to pay more money when payment is hypothetical than when they are immediately expected to pay. It may be easy for people to say that they support a project when they are not sure they will ever have to pay any money based on their response. However, if the proposed payments are real and immediate, people may be more inclined to think about other options and what they would have to give up to make the payment. So in answering the following questions, please keep in mind both the benefits of the water quality improvement and the impact that passage of such a referendum would have on your finances. In other words, please answer as if this were a real referendum."*

A water quality improvement project regarding the focus lake was then proposed that outlined the methods to achieve the water quality improvement at each lake, such as dredging and building protection strips around the perimeter. Respondents were then asked whether they would vote in favor of the referendum to improve the lake where bid values were varied across the sample of Iowan receiving the survey[5]. Finally, the perceived consequentiality of the survey was elicited from respondents by asking the following question:

> *"How likely do you think it is that the results of surveys such as the one will affect decisions about water quality in Iowa lakes?"*

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[4] See the NOAA Panel Guidelines and Cummings and Taylor (1998).
[5] See the contingent valuation question associated with one of the focus lakes in Appendix C.

Possible responses to this question ranged from 1 to 5 where a "1" denoted "no effect at all" (i.e., completely inconsequential) and "5" denoted "definite" effect.

Of the 7720 deliverable copies of 2003 Iowa Lakes Survey, there was a 68% response rate. 465 observations were eliminated for missing values in their votes on the hypothetical referendum or their perceptions of consequentiality. In total, 4784 observations were used in this study.

Table 2.1 lists a summary of the 2003 data across consequential groups. In our sample, the more consequential the respondents view the survey, the higher the observed "yes" rate to the proposed referendum. The "yes" rate rises from 13% for respondents who believe the survey is inconsequential to 38% for respondents who believe the survey is definitely consequential. Also of note, respondents who do not visit the lakes tend to view the survey inconsequential.

Figure 2.1 illustrates the voting patterns of respondents who report different levels of consequentiality across the bid values. Overall, the voting patterns of respondents who report any positive degree of consequentiality, i.e., anyone who reports a "2", "3", "4", or "5" to the consequentiality question, is consistent with economic theory: the "yes" rate falls as the bid value rises. In this sample, it is also the case that the "yes" rate of the inconsequential group is lower than that of consequential group at each bid value.

Recall that Carson and Grove's "knife-edge" result states that respondents' votes on the contingent valuation question will be the same as an actual referendum as long as the respondents perceive positive chance that the survey is consequential. This suggests that respondents who report any positive degree of perceived consequentiality should generate WTP values from the same distribution—their true preferences.

Table 2.1 Selected Data Summary by Consequentiality Level (2003 sample)

(Standard Errors in Parentheses)

	1	2	3	4	5
N	307	832	1995	1294	356
% YES	0.13	0.27	0.31	0.35	0.38
% Not Visited	0.48	0.32	0.29	0.24	0.22
% Male	0.70	0.65	0.68	0.69	0.65
% College	0.55	0.68	0.68	0.74	0.64
Age	58.31	53.42	53.22	51.29	55.51
	(16.41)	(15.85)	(15.61)	(15.27)	(16.73)
Income ($1,000)	54.1	58.8	55.9	58.2	49.4
	(40.7)	(37.8)	(34.7)	(38.1)	(37.3)

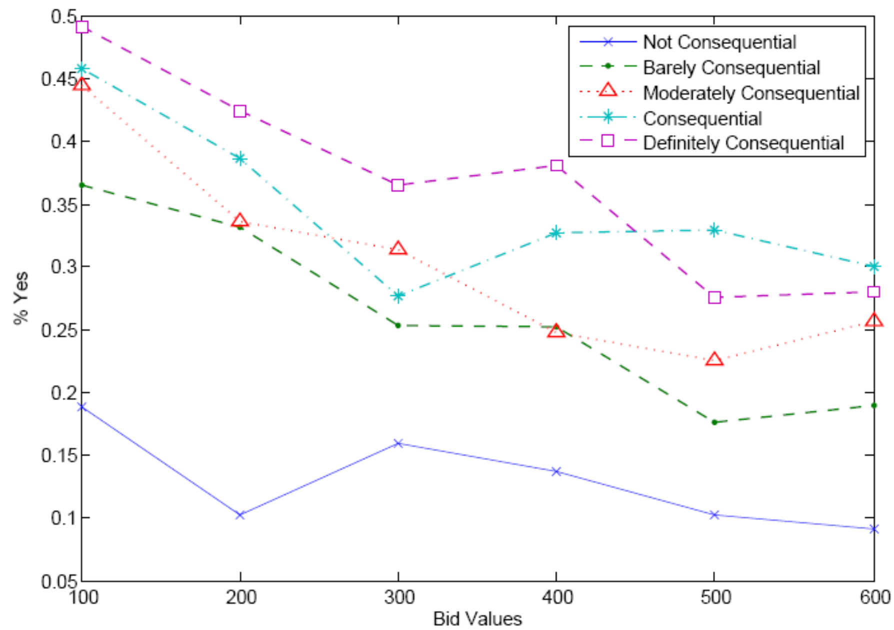

Figure 2.1 "Yes" Rate of Respondents with Different Beliefs of Consequentiality (2003 Survey)

To examine this conjecture, we could estimate a WTP function for each level of reported consequentiality and test whether the distributions are statistically different from one another. However, there is the potential endogeniety of respondents' responses to the consequentiality question[6]. In particular, respondents who have a high WTP may believe the survey is consequential due to the importance of the project. Likewise, respondents who indicated a low degree of consequentiality may do so because they place a low value in the proposed water quality improvement project.

To control for the potential endogeniety, a split sample treatment was randomly administered in the 2005 Iowa Lakes survey. We took advantage of a magazine article and a letter from the director of the Iowa Department of Natural Resources that had recently been published concerning how results from earlier years of the study were being used by the department to prioritize water quality improvement projects. Specifically, half of the sample was provided with a copy of the director's letter and an article from the *Iowa Conservationist* indicating that the Iowa Department of Natural Resources was already using results from the surveys in their policy decisions and planned to continue to do so. This information was also highlighted in the cover letter to the respondents[7]. Thus, direct evidence of consequentiality was applied to the stratum. The exogenous treatment to respondents' perception of consequentiality allows us to separate out the impact of consequentiality in the contingent valuation responses. Appendix D of this paper contains some of the relevant text and information respondents were sent.

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[6] Since the 2003 Iowa Lakes Survey resulted in an overall "yes" response rate that, we included additional lower bid values in the 2005 survey. Specifically, for half of the 2003 sample, the 2003 bid values were reduced by a factor of ten. The remainder of the sample received the same bids as they received in 2003.
[7] Permission from the DNR and Director's office was obtained prior to survey implementation.

The 2005 Iowa Lakes surveys were sent to a random sample of 2859 Iowa residents[8]. The same standard follow-up procedures, including a postcard reminder mailed two weeks after the initial mailing and a second copy of the survey mailed one month later, were followed. Of the 2611 deliverable surveys, there was an 85% response rate. 211 respondents were eliminated for missing values in their votes on the hypothetical referendum or their perception of consequentiality. In total, 1996 observations were used in this study.

Table 2.2 lists a summary of the 2005 data across consequential groups. Due to the additional lower bid values applied in 2005 survey, there is a significant increase in the overall "yes" rate. Further, similar to the voting pattern shown in Table 2.1, the more consequential the respondents view the survey, the higher the observed "yes" rate to the proposed referendum. The "yes" rate rises from 23% for respondents who believe the survey is inconsequential to 48% for respondents who believe the survey is definitely consequential.

Table 2.2 Selected Data Summary by Consequentiality Level (2005 sample)
(Standard Errors in Parentheses)

	1	2	3	4	5
N	83	266	782	689	176
% YES	0.23	0.42	0.47	0.53	0.48
% Not Visited	0.50	0.25	0.29	0.31	0.26
% Male	0.53	0.69	0.64	0.66	0.61
% College	0.33	0.42	0.41	0.49	0.37
Age	58.05	56.71	54.72	53.73	57.71
	(16.60)	(15.62)	(15.31)	(14.35)	(14.98)
Income ($1,000)	54.00	63.43	63.75	64.95	59.30
	(38.64)	(37.28)	(38.12)	(37.38)	(41.07)

[8] Observations from one of the eight focus were eliminated for there were an on going restoration project. In addition, observations from other three of the eight focus lakes were used as part of a different study. Thus, only respondents who responded four of the eight lakes were provided the exogenous treatment and were used in the 2005 study.

Table 2.3 reveals respondents' perception of consequentiality toward the 2005 survey. About 4% of respondents view the survey as inconsequential (response of a "1"), 87 % of respondents view the survey as probably consequential (response of a "2," "3," or "4"), and 9% of respondents view the survey as definitely consequential (response of a "5"). As also shown in the table, our treatment has a small, but positive influence on respondents' perceptions of consequentiality toward the survey. Respondents who receive the treatment are more likely to view the survey as consequential.

Table 2.3. Comparison of Respondents with and without Treatment (Number of Observations in Parentheses)

	1	2	3	4	5	N
Whole Sample	0.04	0.13	0.39	0.35	0.09	1996
	(83)	(266)	(782)	(689)	(176)	
With Treatment	0.04	0.13	0.38	0.36	0.10	1009
	(36)	(127)	(388)	(361)	(97)	
Without Treatment	0.05	0.14	0.40	0.33	0.08	987
	(47)	(139)	(394)	(328)	(79)	

Figure 2.2 illustrates the patterns of "yes" response rates in the 2005 survey which are similar to those observed in 2003 survey. Specifically, a clear trend of decreasing "yes" rates as the bid value rises is observed for the groups of respondents who indicated positive degree of consequentiality (responses of "2", "3", "4", or "5"). As observed in the 2003 survey, the "yes" rate amongst the inconsequential group is lower than that of consequential groups even in lower bid values.

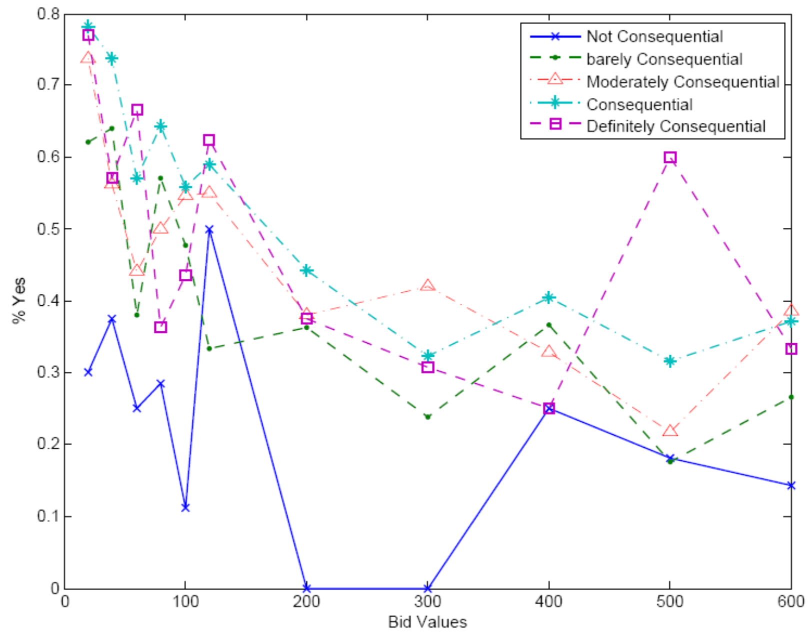

Figure 2.2. "Yes" Rate of Respondents with Different Beliefs of Consequentiality (2005 Survey)

2. 4. Model and Empirical Results

An exogenous treatment is employed to control for the potential endogeniety. We applied a Bayesian treatment effect model to jointly estimate respondents' WTP and perceptions of consequentiality. Details of the employed models and estimation results along with related discussion are provided in the following subsections

2. 4. 1. Three-group Estimation

To formally test the effects of consequentiality on WTP, we consider the following two equation triangular model:

$$c_i^* = \mathbf{x}_{ci}\boldsymbol{\beta}_c + \varepsilon_i \tag{2.1}$$

$$w_i^* = \mathbf{x}_{wi}\boldsymbol{\beta}_w + \bar{\mathbf{c}}_i\boldsymbol{\delta}_c + u_i \tag{2.2}$$

where

$$\begin{bmatrix} \varepsilon_i \\ u_i \end{bmatrix} | \mathbf{x}_{ci}, \mathbf{x}_{wi} \overset{iid}{\sim} \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \sigma_{cw} \\ \sigma_{cw} & \sigma_w^2 \end{pmatrix} \right]$$

Equation (1) corresponds to the "consequentiality" equation, while equation (2) corresponds to the "willingness to pay" equation. The latent variables, c_i^* and w_i^*, are not observed, but their values generate an observed consequentiality variable c_i and an observed binary willingness to pay indicator w_i. We thus relate the observables c_i and w_i to their latent variables as follows:

$$w_i = \begin{cases} 1 & \text{if } w_i^* \geq B_i \\ 0 & \text{if } w_i^* < B_i \end{cases} \qquad c_i = \begin{cases} 1 & \text{if } -\infty < c_i^* \leq 0 \\ 2 & \text{if } 0 < c_i^* \leq \alpha_3 \\ 3 & \text{if } \alpha_3 < c_i^* \leq \infty \end{cases}$$

where B_i is the bid value proposed to individual i and $\bar{\mathbf{c}}_i$ in (2) is a 1/3 vector with a "1" in the c_i^{th} column and zeroes elsewhere. We are primarily interested in the coefficients $\boldsymbol{\delta}_c$, which describe the "causal" impacts of various degrees of consequentiality on WTP. Of course, the instrument is included in $\mathbf{x}_{ci}$ without loss of generality.

The system of two equations contains an ordered probit model, described by equation (2.1), and a standard probit model, described by equation (2.2). At present, an ordered probit with only three possible values implying only one unknown cutpoint is considered. This limiting assumption is adopted for ease of initial estimation, and we will relax this restriction in next section.

In practice, it can be difficult to estimate the cutpoints in this system. It has been well-documented in the literature that the standard ordered probit Gibbs sampler (e.g., Albert and Chib, 1993) in these types of models can suffer from slow mixing, particular in large data sets, motivating the need to implement some type of reparameterization or blocking step. Here, we introduce a reparameterization, following the suggestion of Nandram and Chan (1996), which will avoid these problems. Specifically, let $\gamma = \alpha_3^{-1}$ and define the notation $\tilde{x} = \gamma x$. That is, the $\tilde{}$ notation simply denotes the operation of taking the original variable and multiplying it by γ. Multiplying (2.1) by γ and adjusting the rule mapping the latent c^* into the observed *c* produces the following observationally equivalent model:

$$\tilde{c}_i^* = \mathbf{x}_{ci}\tilde{\boldsymbol{\beta}}_c + \tilde{\varepsilon}_i \qquad (2.3)$$

$$w_i^* = \mathbf{x}_{wi}\boldsymbol{\beta}_w + \bar{\mathbf{c}}_i\boldsymbol{\delta}_c + u_i \qquad (2.4)$$

where

$$\begin{bmatrix} \tilde{\varepsilon}_i \\ u_i \end{bmatrix} | \mathbf{x}_{ci}, \mathbf{x}_{wi} \overset{iid}{\sim} N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \gamma^2 & \gamma\sigma_{cw} \\ \gamma\sigma_{cw} & \sigma_w^2 \end{pmatrix}\right]$$

$$w_i = \begin{cases} 1 & \text{if } w_i^* \geq B_i \\ 0 & \text{if } w_i^* < B_i \end{cases} \qquad c_i = \begin{cases} 1 & \text{if } -\infty < \tilde{c}_i^* \leq 0 \\ 2 & \text{if } 0 < \tilde{c}_i^* \leq \alpha_3 \\ 3 & \text{if } \alpha_3 < \tilde{c}_i^* \leq \infty \end{cases}$$

Let

$$\tilde{\Sigma} = \begin{pmatrix} \tilde{\sigma}_c^2 & \tilde{\sigma}_{cw} \\ \tilde{\sigma}_{cw} & \sigma_w^2 \end{pmatrix} = \begin{pmatrix} \gamma^2 & \gamma\sigma_{cw} \\ \gamma\sigma_{cw} & \sigma_w^2 \end{pmatrix}$$

We choose to work with the parameters:

$$\beta = \begin{bmatrix} \tilde{\beta}_c^{'} & \beta_w^{'} & \delta_c^{'} \end{bmatrix} \text{ and } \tilde{\Sigma},$$

rather than the original parameterization of the model. The primary reasons for doing this are: (1) the reparameterization helps to improve the mixing of the posterior simulation, (2) the reparameterization eliminates one component of the cutpoint, and finally, (3) the reparameterization eliminates the diagonal restriction on the 2x2 covariance matrix, which enables the application of a standard Wishart prior on $\tilde{\Sigma}^{-1}$. Since the structural parameters β_c, σ_{cw}, σ_w^2, and α_3 are ultimately of interest, we can recover these by using the appropriate inverse transformations:

$$\beta_c = \frac{\tilde{\beta}_c}{\gamma}, \ \sigma_{cw} = \frac{\tilde{\sigma}_{cw}}{\gamma}, \text{ and } \alpha_3 = \frac{\tilde{\alpha}_3}{\gamma}$$

Using the model described and the algorithm documented in the appendix, we run our posterior simulator for 55000 simulations, and discard the first 5000 iterations as burn-in. Generated experiments revealed that our algorithm mixed well and consistently recovered parameters of the data generating process in samples of a similar size and in a variety of experimental designs.

In our data, c_i takes on five different ordered values, ranging from regarding the survey as being completely irrelevant to the making of ($c_i = 1$) to regarding policy the survey as having a definite impact on government policy ($c_i = 5$). Table 2.4 reports results from an application of the model when the three order choices model in the consequentiality equation are {1, (2, 3) or (4, 5)}. That is, respondents who answered “2” and “3”, or “4” and “5” are

Table 2.4. Posterior Means, Standard Deviations and Probabilities of Being Positive (Three-Group Estimation)

Variable	$E(\cdot \mid y)$	$Std(\cdot \mid y)$	$\Pr(\cdot > 0 \mid y)$
Consequentiality, {1, (2, 3), (4, 5)}			
Iowa Conservationist Article	1.64	0.06	1.00
Treatment	0.10	0.05	0.98
Age	-0.03	0.03	0.10
Income	-0.01	0.03	0.36
Female	-0.05	0.05	0.18
College	0.15	0.06	1.00
Willingness to Pay, {1, (2, 3), (4, 5)}			
Intercept (N = 83)	2.80	0.53	1.00
Group 2 (N = 266)	1.39	0.44	1.00
Group 3 (N = 1647)	1.34	0.76	0.96
Age	0.11	0.10	0.87
Income	0.46	0.11	1.00
Female	0.41	0.20	0.98
College	0.78	0.21	1.00
Variance, Covariance, and Cutpoint			
σ_w^2	10.34	2.00	-
ρ_{cw}	0.11	0.10	0.87
α_3	1.91	0.05	-
Difference between Group 2 and Group 3			
$\delta_3 - \delta_2$	-0.05	0.50	0.46

treated as if they are in the same group. To study the sensitivity of our findings to this specific choice of aggregating the five responses into three, we also estimate the model with two other choice groupings: $\{1, (2, 3, 4), 5)\}$ and $\{1, 2, (3, 4, 5)\}$. The qualitative results are quite consistent across the specifications, so we report results for the first grouping only.

The consequentiality equation contains an intercept, a dummy variable indicating whether the respondent received the treatment (the copy of the *Iowa Conservationist* and the letter from the director), the standardized age of the respondent, standardized income level of the respondent, the gender of the respondent (female =1), and whether the respondent is a college graduate. The first column of the table reports the posterior mean, the second column reports the posterior standard deviation and the final column reports the probability that the parameter value is positive. Values in the final column near either 1 or 0 indicate a high likelihood of difference from zero, the former in the positive direction, and the latter in the negative.

The estimates from the consequentiality equation suggest that the treatment effect has its desired effect: all else equal, respondents who received the treatment report a higher level of consequentiality than those who do not with 98% likelihood that the value is positive. While encouraging, it is important to point out that the effect is quite small. Age and college education also appear to influence the likelihood that respondents view the survey as consequential.

Should the respondents' WTP be non-negative, we assume the relationship between their WTP and their characteristics is log-linear (meaning that we replace B_i with $\log(B_i)$ in the estimation process). The log WTP equation contains an intercept (a response of $c_i = 1$, the base category), two categorical dummies, and socioeconomic characteristics included in the consequentiality equation. We treat a response of $c_i = 1$ is viewed as the "base category", therefore, all the other elements of $\delta_c^{'}$ are interpreted relative to this base group.

The estimates from the willingness to pay equation suggest that the difference in the mean log WTP between the consequentiality group {2, 3} and consequentiality group 1 is 1.39 with 100% probability of that difference being positive. The difference in the mean log WTP between the consequentiality group {4, 5} and consequentiality group 1 is 1.34 with 96% probability of that difference being positive. In addition, female, older respondents, and those with college education and with higher income are more willing to pay for a given water quality improvement.

The primary interest of this paper is to test whether individuals respond in the same manner as long as the respondents perceive the survey as consequential. One of the advantages of Bayesian analysis via sampling methods is that it is often straightforward to examine the degree of correlation between model parameters. In our case, the posterior probability of difference in the mean log WTP between the consequentiality group {2, 3} and {4, 5} is -0.05 with a 46% probability of that difference being positive. As shown in Table 2. 5, the WTP distribution of consequentiality group {2, 3} is similar to that of consequentiality group {4, 5}.

Table 2.5. Posterior Predictive WTP Statistics across Consequentiality Groups

	$E\left(E\left(WTP\right)\right)$	$E\left(Std\left(WTP\right)\right)$	$E\left(Med\left(WTP\right)\right)$
WTP 2	105.11	2.00	91.75
WTP 3	103.92	2.04	93.80

Also of interest is to assess the correlation between the two equations error terms, ε and u, since suspected correlation between these two terms is what gives rise to the need to jointly estimate the model parameters. Our result suggests that there is a 0.11 correlation between respondents' perception of consequentiality and WTP with an 87% chance that the correlations are positive.

2. 4. 2. Five-Group Estimation

To fix the case considering five ordered values, the same model is used and the rule mapping the latent c* into the observed c is adjusted accordingly. Specifically, the model including reparameterization and a Metropolis-Hasting step, which is described in the appendix, is written as

$$\tilde{c}_i^* = \mathbf{x}_{ci}\tilde{\boldsymbol{\beta}}_c + \tilde{\varepsilon}_i \tag{2.5}$$

$$w_i^* = \mathbf{x}_{wi}\boldsymbol{\beta}_w + \bar{\mathbf{c}}_i\boldsymbol{\delta}_c + u_i \tag{2.6}$$

where

$$\begin{bmatrix} \tilde{\varepsilon}_i \\ u_i \end{bmatrix} \mid \mathbf{x}_{ci}, \mathbf{x}_{wi} \overset{iid}{\sim} N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \gamma^2 & \gamma\sigma_{cw} \\ \gamma\sigma_{cw} & \sigma_w^2 \end{pmatrix}\right]$$

$$w_i = \begin{cases} 1 & \text{if } w_i^* \geq B_i \\ 0 & \text{if } w_i^* < B_i \end{cases} \quad c_i = \begin{cases} 1 & \text{if } -\infty < \tilde{c}_i^* \leq 0 \\ 2 & \text{if } 0 < \tilde{c}_i^* \leq \alpha_3 \\ 3 & \text{if } \alpha_3 < \tilde{c}_i^* \leq \alpha_4 \\ 4 & \text{if } \alpha_4 < \tilde{c}_i^* \leq 1 \\ 5 & \text{if } 1 < \tilde{c}_i^* \leq \infty \end{cases}$$

We choose to work with the parameters:

$$\boldsymbol{\beta} = \begin{bmatrix} \tilde{\boldsymbol{\beta}}_c' & \boldsymbol{\beta}_w' & \boldsymbol{\delta}_c' \end{bmatrix}, \ \tilde{\Sigma}, \text{ and } \begin{bmatrix} \tilde{\alpha}3 & \tilde{\alpha}4 \end{bmatrix}$$

and we can recover these parameters of interests by using the appropriate inverse transformations:

$$\boldsymbol{\beta}_c = \frac{\tilde{\boldsymbol{\beta}}_c}{\gamma}, \ \sigma_{cw} = \frac{\tilde{\sigma}_{cw}}{\gamma}, \text{ and } \begin{bmatrix} \frac{\tilde{\alpha}3}{\gamma} & \frac{\tilde{\alpha}4}{\gamma} & \frac{1}{\gamma} \end{bmatrix}.$$

Using the model described, we run our posterior simulator for 3000 simulations, and discard the first 1000 as burn-in. Generated experiments revealed that our algorithm mixed well and consistently recovered parameters of the data generating process in samples of a similar size and in a variety of experimental designs. For our priors, we set $\boldsymbol{\mu}_\beta = \mathbf{0}$, $\underline{\boldsymbol{V}}_\beta = \left(100^2\right)\mathbf{I}_k$, $v = 5$ and $\boldsymbol{R} = \boldsymbol{I}_2$.

The estimates from the five-group model are similar to those from the three-group model. As shown in Table 2.6, the estimates from the consequentiality equation suggest that respondents who received the treatment report a higher level of consequentiality than those who did not We treat a response of $c_i = 5$ is viewed as the "base category", therefore, all the other elements of $\delta_c^{'}$ are interpreted relative to this base group. The estimates from the willingness to pay equation suggest that respondents who perceive the survey as consequential tend to have a higher WTP. Regarding to the respondents' social economic characteristics, female, older respondents, and those with college education and higher

Table 2.6. Posterior Means, Standard Deviations and Probabilities of Being Positive (Five-Group Estimation)

Consequentiality Equation			
Variables	$E(\cdot \mid y)$	$Std(\cdot \mid y)$	$\Pr(\cdot > 0 \mid y)$
Intercept	1.67	0.13	1.00
Iowa Conservationist Article	0.10	0.04	0.99
Age	-0.01	0.02	0.18
Income	-0.00	0.01	0.42
Female	0.00	0.05	0.51
College	0.07	0.05	0.89
Willingness to Pay Equation			
Intercept (N = 176)	2.96	0.80	1.00
Group 4 (N = 689)	0.33	0.51	0.74
Group 3 (N = 782)	-0.11	0.78	0.44
Group 2 (N = 266)	-0.51	1.07	0.33
Group 1 (N = 83)	-2.23	1.46	0.05
Age	0.09	0.07	0.90
Income	0.13	0.03	1.00
Female	0.39	0.21	0.98
College	0.74	0.21	1.00
Covariance Matrix Parameters and Cutpoints			
σ_w^2	10.89	2.29	-
ρ_{cw}	0.10	0.07	0.92
α_3	0.51	0.03	-
α_4	1.45	0.04	-
α_5	2.38	0.04	-

income are more willing to pay for a given water quality improvement. In addition, the correlation between the two equations error terms, ε and u, is 0.01 with only about an 92% chance that the correlations are positive with 99% likelihood that the value is positive. College education also appears to influence the likelihood that respondents view the survey as consequential.

Since the parameters capture the causal effect of consequentiality perceptions on WTP, other things equal, the posterior probability of difference in the mean WTP among the consequentiality groups may be viewed as a test of the theory. Specifically, we calculate the posterior probability of the form $\Pr\left(\delta_{cj} > \delta_{ck}\right)\ \forall j,k \in \{1,2,3,4,5\}$. It is obvious, from Table 2. 7, that the subgroup who perceives the survey as inconsequential has a lower WTP than those who view the survey as somewhat consequential and those who view the survey as definitely consequential. In addition, the consequentiality groups "2", "3", "4" and "5" have statistically indistinguishable distributions of WTP.

Table 2.7. Posterior Probabilities and Posterior Predictive WTP statistics

	Consequentiality Response				
	1	2	3	4	5
$\Pr\left(\delta_{c5} > \cdot \mid y\right)$	-	-	-	-	-
$\Pr\left(\delta_{c4} > \cdot \mid y\right)$	-	-	-	-	0.74
$\Pr\left(\delta_{c3} > \cdot \mid y\right)$	-	-	-	0.12	0.44
$\Pr\left(\delta_{c2} > \cdot \mid y\right)$	-	-	0.16	0.11	0.33
$\Pr\left(\delta_{c1} > \cdot \mid y\right)$	-	0.00	0.00	0.00	0.05
Median WTP	14.05	84.22	127.06	207.10	142.51
Mean WTP	19.88	93.91	130.58	220.47	184.47

2. 5. Final Remarks

Carson and Grove (2007) argue that respondents who view a contingent valuation survey as being consequential should truthfully reveal their preferences, implying that their responses to the contingent valuation question can be analyzed economically. If a contingent valuation survey is not viewed as being consequential, they argue that economic theory can say nothing about the interpretation of the responses. In this study, we employ data from the 2003 and 2005 versions of Iowa Lakes Survey to examine the effect of consequentiality on respondents' WTP. The respondents' degree of perceived consequentiality was directly elicited as part of the contingent valuation instrument.

To detect the potential endogeniety of consequentiality, we implemented a split sample treatment in one of the survey years. An article from the *Iowa Conservationist* was provided to half of the sample as an exogenous instrument, which indicates that the Iowa Department of Natural Resources was already using results from the surveys in their policy decisions, and planned to continue to do so. This exogenous instrument potentially allows us to separate out the impact of consequentiality in the contingent valuation responses.

While much additional work remains to be done using these data, several interesting findings have emerged. First, respondents report a wide range of perception concerning the degree to which the basic survey instrument is likely to influence actual decision making. However, most respondents view the survey as having at least some positive probability of influencing policy. Second, the degree to which respondents perceive the survey instrument as being consequential can be influenced by an exogenous treatment such as the one implemented here. However, the effect of that treatment, while statistically identifiable, was quite small. A third finding from the jointly estimated WTP/consequentiality model is that the mean WTP of the respondents who report a somewhat positive level of consequentiality is not significantly different from those who report a value of “5”.

Finally, these results and findings suggest that more work needs to be done to understand the way in which respondents determine whether a survey is consequential. The consequentiality equation estimated suggests that the instruments employed here provide little explanatory power. If the consequentialness of a survey instrument is destined to become an important criterion in evaluating the reliability of WTP estimates, a better understanding of its facets is needed.

2. 6. References

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Appendix 2.A Three-Group Bayesian Estimation

Priors and the Joint Posterior

The augmented posterior distribution involves adding the latent $\tilde{\mathbf{c}}^*$ and $\boldsymbol{w}^*$ to the joint posterior distribution. Under prior independence, the joint distribution can be represented as:

$$p\left(\tilde{\boldsymbol{c}}^*, \boldsymbol{w}^*, \tilde{\boldsymbol{\beta}}, \tilde{\Sigma} \mid \boldsymbol{c}, \boldsymbol{w}\right) \propto p\left(\boldsymbol{c}, \boldsymbol{w} \mid \tilde{\boldsymbol{c}}^*, \boldsymbol{w}^*, \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}\right) p\left(\tilde{\boldsymbol{c}}^*, \boldsymbol{w}^* \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}\right) p\left(\tilde{\boldsymbol{\beta}}\right) p\left(\tilde{\Sigma}\right)$$
$$= p\left(\tilde{\boldsymbol{\beta}}\right) p\left(\tilde{\Sigma}\right) \prod_{i=1}^{N} p\left(c_i, w_i \mid \tilde{c}_i^*, w_i^*, \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}\right) p\left(\tilde{c}_i^*, w_i^* \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}\right),$$

where the product term follows from the assumed conditional independence across observations. For the first term on the right-hand side of the product, note

$$p\left(c_i, w_i \mid \tilde{c}_i^*, w_i^*, \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}\right) = p\left(c_i \mid w_i, \tilde{c}_i^*, w_i^*, \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}\right) p\left(w_i \mid \tilde{c}_i^*, w_i^*, \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}\right)$$
$$= p\left(c_i \mid \tilde{c}_i^*\right) p\left(w_i \mid w_i^*\right)$$

where

$$p\left(c_i \mid \tilde{c}_i^*\right) = I\left(\tilde{\alpha}_{ci} < \tilde{c}_i^* \le \tilde{\alpha}_{ci+1}\right)$$

and

$$p\left(w_i \mid w_i^*\right) = I\left(w_i = 0\right) I\left(w_i^* < B_i\right) + I\left(w_i = 1\right) I\left(w_i^* \ge B_i\right)$$

Apart from the priors, the remaining pieces in our joint posterior follow immediately from our normality assumption:

$$\tilde{c}_i^*, w_i^* \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma} \overset{iid}{\sim} N\left(\begin{bmatrix} \mathbf{x}_{ci}\tilde{\boldsymbol{\beta}}_c \\ \mathbf{x}_{wi}\boldsymbol{\beta}_w + \overline{\mathbf{c}}_i\boldsymbol{\delta}_c \end{bmatrix}, \tilde{\Sigma}\right)$$

The model is completed by choosing priors of the forms:

$$\tilde{\boldsymbol{\beta}} \sim N\left(\boldsymbol{\mu}_{\beta}, \underline{\boldsymbol{V}}_{\beta}\right)$$

$$\tilde{\Sigma}^{-1} \sim W\left(\boldsymbol{R}, v\right)$$

where $\boldsymbol{\mu}_{\beta} = \mathbf{0}$, $\underline{\boldsymbol{V}}_{\beta} = \left(100^2\right)\mathbf{I}_k$, $v = 5$ and $\boldsymbol{R} = \boldsymbol{I}_2$.

The Gibbs Sampling Algorithm

As is well known in the literature, the standard Gibbs sampler in ordered outcome analysis can suffer form slow mixing. We use the reparameterization method in our posterior simulator to mitigate the slow mixing problem. The Gibbs sampler proceeds in four steps:

Step 1. Drawing from $p\left(\tilde{\boldsymbol{c}}^* \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}, \boldsymbol{w}^*, \boldsymbol{c}, \boldsymbol{w}\right)$. For $i = 1, 2, \ldots, n$,

$$\tilde{c}_i^* \mid w_i^*, \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}, \boldsymbol{w}^*, \boldsymbol{c}, \boldsymbol{w} \sim \boldsymbol{TN}_{\left(\tilde{\alpha}_{ci}, \tilde{\alpha}_{ci+1}\right]}\left(\mathbf{x}_{ci}\tilde{\boldsymbol{\beta}}_c + \frac{\sigma_{cw}}{\sigma_w^2}\left(w_i^* - \mathbf{x}_{wi}\boldsymbol{\beta}_w + \overline{\mathbf{c}}_i\boldsymbol{\delta}_c\right), \gamma^2\left(1 - \rho_{cw}^2\right)\right)$$

Step 2. Drawing from $p\left(\boldsymbol{w}^* \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}, \tilde{\boldsymbol{c}}^*, \boldsymbol{c}, \boldsymbol{w}\right)$. For $i = 1, 2, \ldots, n$,

$$w_i^* \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}, \tilde{\boldsymbol{c}}^*, \boldsymbol{c}, \boldsymbol{w} \sim \begin{cases} \boldsymbol{TN}_{(-\infty, \boldsymbol{B}_i]}\left(\mathbf{x}_{wi}\boldsymbol{\beta}_w + \overline{\mathbf{c}}_i\boldsymbol{\delta}_c + \frac{\sigma_{cw}}{\sigma_w^2}\left(\tilde{c}_i^* - \mathbf{x}_{ci}\tilde{\boldsymbol{\beta}}_c\right), \sigma_w^2\left(1 - \rho_{cw}^2\right)\right), & \text{if } w_i = 0 \\ \boldsymbol{TN}_{[\boldsymbol{B}_i, \infty)}\left(\mathbf{x}_{wi}\boldsymbol{\beta}_w + \overline{\mathbf{c}}_i\boldsymbol{\delta}_c + \frac{\sigma_{cw}}{\sigma_w^2}\left(\tilde{c}_i^* - \mathbf{x}_{ci}\tilde{\boldsymbol{\beta}}_c\right), \sigma_w^2\left(1 - \rho_{cw}^2\right)\right), & \text{if } w_i = 1 \end{cases}$$

Step 3. Drawing from $p\left(\tilde{\boldsymbol{\beta}} \mid \tilde{\Sigma}, \tilde{\boldsymbol{c}}^*, \boldsymbol{w}^*, \boldsymbol{c}, \boldsymbol{w}\right)$. First, define

$$\boldsymbol{X}_i = \begin{bmatrix} \mathbf{x}_{ci} & 0 & 0 \\ 0 & \mathbf{x}_{wi} & \overline{\mathbf{c}}_i \end{bmatrix}.$$

Similar to a SUR model, we obtain

$$\tilde{\boldsymbol{\beta}} \mid \tilde{\Sigma}, \tilde{\boldsymbol{c}}^*, \boldsymbol{w}^*, \boldsymbol{c}, \boldsymbol{w} \sim \boldsymbol{N}\left(\overline{\boldsymbol{\beta}}, \overline{V}_{\beta}\right)$$

where

$$\bar{\beta} = \bar{V}_\beta \left(\sum_i \boldsymbol{X}_i' \tilde{\Sigma}^{-1} \begin{bmatrix} \tilde{c}_i^* \\ w_i^* \end{bmatrix} + \underline{\boldsymbol{V}}_\beta^{-1} \underline{\beta} \right)$$

$$\bar{\boldsymbol{V}}_\beta = \left(\sum_i \boldsymbol{X}_i' \tilde{\Sigma}^{-1} \boldsymbol{X}_i + \underline{\boldsymbol{V}}_\beta^{-1} \right)^{-1}$$

Step 4. Drawing from $p\left(\tilde{\Sigma}^{-1} \mid \tilde{\beta}, \tilde{\boldsymbol{c}}^*, \boldsymbol{w}^*, \boldsymbol{c}, \boldsymbol{w} \right)$. Making use of techniques like those employed in the SUR model, we obtain

$$\tilde{\Sigma}^{-1} \mid \tilde{\beta}, \tilde{\boldsymbol{c}}^*, \boldsymbol{w}^*, \boldsymbol{c}, \boldsymbol{w} \sim \boldsymbol{W}\left(\left[\sum_i \begin{bmatrix} \varepsilon_i \\ u_i \end{bmatrix} \begin{bmatrix} \varepsilon_i & u_i \end{bmatrix} + \boldsymbol{R}^{-1} \right]^{-1}, n + v \right).$$

A Gibbs sampler proceeds by simulating (in order) from those posterior conditional distribution.

Appendix 2.B Five-Group Bayesian Estimation

Priors and the Joint Posterior

We fit the model using a Gibbs sampler with the Metropolis-Hasting algorithm suggested by Cowles (1996). The augmented posterior distribution involves adding the latent $\tilde{\mathbf{c}}^*$ and $\boldsymbol{w}^*$ to the joint posterior distribution. Under prior independence, the joint distribution can be represented as:

$$p\left(\tilde{\boldsymbol{c}}^*, \boldsymbol{w}^*, \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}, \tilde{\boldsymbol{\alpha}} \mid \boldsymbol{c}, \boldsymbol{w}\right) \propto p\left(\boldsymbol{c}, \boldsymbol{w} \mid \tilde{\boldsymbol{c}}^*, \boldsymbol{w}^*, \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}, \tilde{\boldsymbol{\alpha}}\right) p\left(\tilde{\boldsymbol{c}}^*, \boldsymbol{w}^* \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}, \tilde{\boldsymbol{\alpha}}\right) p\left(\tilde{\boldsymbol{\beta}}\right) p\left(\tilde{\Sigma}\right) p\left(\tilde{\boldsymbol{\alpha}}\right)$$
$$= p\left(\tilde{\boldsymbol{\beta}}\right) p\left(\tilde{\Sigma}\right) p\left(\tilde{\boldsymbol{\alpha}}\right) \prod_{i=1}^{N} p\left(c_i, w_i \mid \tilde{c}_i^*, w_i^*, \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}, \tilde{\boldsymbol{\alpha}}\right) p\left(\tilde{c}_i^*, w_i^* \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}, \tilde{\boldsymbol{\alpha}}\right),$$

where the product term follows from the assumed conditional independence across observations. For the first term on the right-hand side of the product, note

$$p\left(c_i, w_i \mid \tilde{c}_i^*, w_i^*, \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}, \tilde{\boldsymbol{\alpha}}\right) = p\left(c_i \mid w_i, \tilde{c}_i^*, w_i^*, \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}, \tilde{\boldsymbol{\alpha}}\right) p\left(w_i \mid \tilde{c}_i^*, w_i^*, \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}\right)$$
$$= p\left(c_i \mid \tilde{c}_i^*, \tilde{\boldsymbol{\alpha}}\right) p\left(w_i \mid w_i^*\right)$$

where

$$p\left(c_i \mid \tilde{c}_i^*, \tilde{\boldsymbol{\alpha}}\right) = I\left(\tilde{\alpha}_{ci} < \tilde{c}_i^* \leq \tilde{\alpha}_{ci+1}\right)$$

and

$$p\left(w_i \mid w_i^*\right) = I\left(w_i = 0\right) I\left(w_i^* < B_i\right) + I\left(w_i = 1\right) I\left(w_i^* \geq B_i\right)$$

Apart from the priors, the remaining pieces in our joint posterior follow immediately from our normality assumption:

$$\tilde{c}_i^*, w_i^* \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma} \overset{iid}{\sim} N\left(\begin{bmatrix} \mathbf{x}_{ci}\tilde{\boldsymbol{\beta}}_c \\ \mathbf{x}_{wi}\boldsymbol{\beta}_w + \bar{\mathbf{c}}_i\boldsymbol{\delta}_c \end{bmatrix}, \tilde{\Sigma}\right)$$

The model is completed by choosing priors of the forms:

$$\tilde{\boldsymbol{\beta}} \sim N\left(\boldsymbol{\mu}_\beta, \underline{\boldsymbol{V}}_\beta\right)$$

$$\tilde{\Sigma}^{-1} \sim W\left(\boldsymbol{R}, v\right)$$

$$p\left(\tilde{\boldsymbol{\alpha}}\right) = p\left(\tilde{\alpha}_3\right) p\left(\tilde{\alpha}_4 \mid \tilde{\alpha}_3\right) = I\left(0 < \tilde{\alpha}_3 < 1\right) \frac{1}{1-\tilde{\alpha}_3} I\left(\tilde{\alpha}_3 < \tilde{\alpha}_4 < 1\right)$$

where $\boldsymbol{\mu}_\beta = \mathbf{0}$, $\underline{\boldsymbol{V}}_\beta = \left(100^2\right)\mathbf{I}_k$, $v = 5$ and $\boldsymbol{R} = \boldsymbol{I}_2$. For the last of these priors, we impose the ordering restriction on the cutpoints. Unconditionally, we specify a prior for the smallest transformed cutpoint, $\tilde{\alpha}_3$ which is uniform over its support, while $\tilde{\alpha}_4$ is specified to be conditionally uniform over ($\tilde{\alpha}_3$, 1).

The Metropolis-Hasting Step

As is well known in the literature, the standard Gibbs sampler in ordered outcome analysis can suffer form slow mixing. We use the reparameterization method and a Metropolis-Hasting step in our posterior simulator to mitigate the slow mixing problem. First, note that

$$p\left(\tilde{\boldsymbol{\alpha}}, \tilde{\boldsymbol{c}}^*, \boldsymbol{w}^* \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}, \boldsymbol{c}, \boldsymbol{w}\right) \propto p\left(\tilde{\boldsymbol{\alpha}}\right) \prod_{i=1}^{N} p\left(\tilde{c}_i^*, w_i^* \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}\right) p\left(c_i \mid \tilde{c}_i^*, \tilde{\boldsymbol{\alpha}}\right) p\left(w_i \mid w_i^*\right)$$

Thus, we obtain

$$p\left(\tilde{\boldsymbol{\alpha}} \mid \tilde{\boldsymbol{\beta}}, \tilde{\boldsymbol{\alpha}}, \tilde{\Sigma}, \boldsymbol{c}, \boldsymbol{w}\right) \propto p\left(\tilde{\boldsymbol{\alpha}}\right) \prod_{i=1}^{N} \int_{\tilde{\alpha}_{ci}}^{\tilde{\alpha}_{ci+1}} \int_{\underline{w}_i}^{\overline{w}_i} p\left(\tilde{c}_i^*, w_i^* \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}\right) dw_i^* d\tilde{c}_i^*$$

In the above, we define

$$\underline{w}_i = \begin{cases} B_i & \text{if } w_i = 1 \\ -\infty & \text{if } w_i = 0 \end{cases} \quad \text{and} \quad \overline{w}_i = \begin{cases} \infty & \text{if } w_i = 1 \\ B_i & \text{if } w_i = 0 \end{cases}$$

Since the cutpoint $\tilde{\alpha}_3$ and $\tilde{\alpha}_4$ are only involved in the above expression for i such that $c_i \in \{2,3,4\}$, we can write

$$p\left(\tilde{\boldsymbol{\alpha}} \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}, \boldsymbol{c}, \boldsymbol{w}\right) \propto p\left(\tilde{\boldsymbol{\alpha}}\right) \prod_{i:c_i \in \{2,3,4\}} \Pr\left(\tilde{\alpha}_{ci} < \tilde{c}_i^* \leq \tilde{\alpha}_{ci+1}, \underline{w}_i < w_i^* \leq \overline{w}_i \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}\right)$$
$$= p\left(\tilde{\boldsymbol{\alpha}}\right) \prod_{i:c_i \in \{2,3,4\}} \Pr\left(\underline{A}_i < \frac{\tilde{c}_i^* - \mathbf{x}_{ci}\tilde{\boldsymbol{\beta}}_c}{\gamma} \leq \overline{A}_i, \underline{D}_i < \frac{w_i^* - \mathbf{x}_{wi}\boldsymbol{\beta}_w + \overline{\mathbf{c}}_i\boldsymbol{\delta}_c}{\sigma_w} \leq \overline{D}_i \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}\right),$$

where

$$\underline{A}_i = \frac{\tilde{\alpha}_{ci} - \mathbf{x}_{ci}\tilde{\boldsymbol{\beta}}_c}{\gamma},\ \overline{A}_i = \frac{\tilde{\alpha}_{ci+1} - \mathbf{x}_{ci}\tilde{\boldsymbol{\beta}}_c}{\gamma},\ \underline{D}_i = \frac{\underline{w}_i - \mathbf{x}_{wi}\boldsymbol{\beta}_w + \overline{\mathbf{c}}_i\boldsymbol{\delta}_c}{\sigma_w} \text{ and } \overline{D}_i = \frac{\overline{w}_i - \mathbf{x}_{wi}\boldsymbol{\beta}_w + \overline{\mathbf{c}}_i\boldsymbol{\delta}_c}{\sigma_w}.$$

Though routines for directly calculating joint probabilities like those above are often not available in standard software packages, files for calculating the bivariate normal cdf are often available. To make use of such routine to calculate the above, we first let $\rho_{cw} = \sigma_{cw}/\sigma_w$ and define the standard bivariate cdf notation:

$$\Phi(a,b;\rho) = \Pr(z_1 \leq a, z_2 \leq b; \rho)$$

where Z_1 and Z_2 are univariate normal variables with zero mean, unit variances, and correlation coefficient ρ. Since

$$\begin{aligned}\Pr(a_i < Z_1 \leq a_u, b_i < Z_2 \leq b_u; \rho) &= \Pr(Z_1 \leq a_u, Z_2 \leq b_u; \rho) - \Pr(Z_1 \leq a_l, Z_2 \leq b_u; \rho) \\ &\quad - \Pr(Z_1 \leq a_u, Z_2 \leq b_l; \rho) + pr(Z_1 \leq a_l, Z_2 \leq b_l; \rho) \\ &= \Phi(a_u, b_u; \rho) - \Phi(a_l, b_u; \rho) - \Phi(a_u, b_l; \rho) + \Phi(a_l, b_l; \rho)\end{aligned}$$

We can write

$$p\left(\tilde{\boldsymbol{\alpha}} \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}, \boldsymbol{c}, \boldsymbol{w}\right)$$
$$\propto p\left(\tilde{\boldsymbol{\alpha}}\right) \prod_{i:c_i \in \{2,3,4\}} \left[\Phi\left(\overline{A}_i, \overline{D}_i; \rho_{cw}\right) - \Phi\left(\overline{A}_i, \underline{D}_i; \rho_{cw}\right) - \Phi\left(\underline{A}_i, \overline{D}_i; \rho_{cw}\right) + \Phi\left(\underline{A}_i, \underline{D}_i; \rho_{cw}\right)\right]$$

The conditional posterior above is not a recognizable form, and thus we employ a Metropolis-Hasting (M-H) step for sampling from $p\left(\tilde{\boldsymbol{\alpha}} \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}, \boldsymbol{c}, \boldsymbol{w}\right)$. Specifically, building upon the idea of Cowles (1996), we make use of a random-walk type chain which incorporates the ordering and truncation restrictions on the elements of $\tilde{\boldsymbol{\alpha}}$.

To this end, we let $\tilde{\boldsymbol{\alpha}}^{(t-1)}$ denote the current value of the chain. Implementation of the M-H step requires the specification of a proposal density, which we denote as $q\left(\tilde{\boldsymbol{\alpha}} \mid \tilde{\boldsymbol{\alpha}}^{(t-1)}\right)$. This proposal density governs the likelihood of movement to $\tilde{\boldsymbol{\alpha}} = \tilde{\boldsymbol{\alpha}}^{(t)}$ given that the chain is currently at $\tilde{\boldsymbol{\alpha}}^{(t-1)}$. For this application, we choose

$$
\begin{aligned}
q\left(\tilde{\boldsymbol{\alpha}} \mid \tilde{\boldsymbol{\alpha}}^{(t-1)}\right) &= q\left(\tilde{\alpha}_3 \mid \tilde{\boldsymbol{\alpha}}^{(t-1)}\right) q\left(\tilde{\alpha}_4 \mid \tilde{\alpha}_3, \tilde{\boldsymbol{\alpha}}^{(t-1)}\right) \\
&= \left[\frac{\phi\left(\tilde{\alpha}_3; \tilde{\alpha}_3^{(t-1)}, d_1^2\right)}{\Phi\left(\dfrac{\tilde{\alpha}_4^{(t-1)} - \tilde{\alpha}_3^{(t-1)}}{d_1}\right) - \Phi\left(\dfrac{-\tilde{\alpha}_3^{(t-1)}}{d_1}\right)}\right] I\left(0 < \tilde{\alpha}_3 < \tilde{\alpha}_4^{(t-1)}\right) \\
&\times \left[\frac{\phi\left(\tilde{\alpha}_4; \tilde{\alpha}_4^{(t-1)}, d_2^2\right)}{\Phi\left(\dfrac{1 - \tilde{\alpha}_4^{(t-1)}}{d_2}\right) - \Phi\left(\dfrac{\tilde{\alpha}_3 - \tilde{\alpha}_4^{(t-1)}}{d_2}\right)}\right] I\left(\tilde{\alpha}_3 < \tilde{\alpha}_4 < 1\right)
\end{aligned}
$$

In other words, we decompose our transition kernel into a marginal for $\tilde{\alpha}_3$ and a conditional for $\tilde{\alpha}_4$ given $\tilde{\alpha}_3$ where both are conditional on the current value of the chain, $\tilde{\boldsymbol{\alpha}}^{(t-1)}$. With this choice of proposal density, we sample $\tilde{\boldsymbol{\alpha}}^{cand}$ from $q\left(\tilde{\boldsymbol{\alpha}} \mid \tilde{\boldsymbol{\alpha}}^{(t-1)}\right)$ and accept $\tilde{\boldsymbol{\alpha}}^{cand}$ as a draw from the conditional with probability:

$$\min\left\{\frac{p\left(\tilde{\boldsymbol{\alpha}}^{cand} \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}, \boldsymbol{c}, \boldsymbol{w}\right)}{p\left(\tilde{\boldsymbol{\alpha}}^{(t-1)} \mid \tilde{\boldsymbol{\beta}}, \tilde{\Sigma}, \boldsymbol{c}, \boldsymbol{w}\right)} \frac{q\left(\tilde{\boldsymbol{\alpha}}^{(t-1)} \mid \tilde{\boldsymbol{\alpha}}^{cand}\right)}{q\left(\tilde{\boldsymbol{\alpha}}^{cand} \mid \tilde{\boldsymbol{\alpha}}^{(t-1)}\right)}, 1\right\},$$

where the target and proposal density ordinates and the form of the transition kernel described above. If the candidate draw is not accepted, we set the current value of the chain equals to its previous value, i.e., $\tilde{\boldsymbol{\alpha}} = \tilde{\boldsymbol{\alpha}}^{(t-1)}$. In practice we set $d_1 = d_2 = 0.01$, which produced reasonable acceptance rates (near 40 percent) and also seemed to perform well in generated data experiments.

Appendix 2.C Contingent Valuation Section in Iowa Lakes Survey

In the following sections we will ask you some questions about potential changes to the water quality of Rathbun Lake located in Appanoose County. First, however, we will give you some information on the current condition of the lake. Please read this information carefully before answering the questions that follow.

Rathbun Lake's Current Condition

The quality of a lake can be described in many ways. One measure of water quality is the clarity of the lake water. Water clarity is usually described in terms of how far down into the water an object remains visible. The clarity of Rathbun Lake is currently between 2 to 4 feet. This means that objects are visible down to about 2 to 4 feet under the surface of the water.

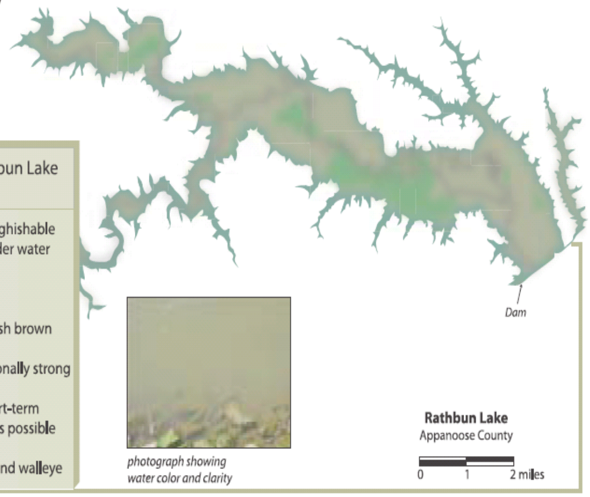


Figure 1. Current conditions of Rathbun Lake

Another measure of water quality is the amount of nutrients and other contaminants contained in the water. Water degradation can result from a number of sources, including urban runoff, fertilizers used in agriculture, motor vehicles, and others. Currently nutrients contribute to the occurrence of algae blooms in the lake, usually 1 to 3 times per year. Under some circumstances these blooms can be a health concern, causing skin rashes and allergic reactions. While Rathbun Lake is currently not regularly monitored, lakes with water quality measurements similar to those of Rathbun Lake had "Swimming is Not Recommended" signs posted by the Iowa Department of Natural Resources for anywhere from 6 to 8 weeks during a typical summer.

The overall quality of the water can affect other conditions of the lake. Poor water quality can result in an undesirable color and odor to the lake water. Currently, the color of Rathbun Lake varies between blue and greenish brown. The water usually has a mild to occasionally strong odor that many describe as "fishy."

Finally, the quality of the water affects the variety and quantity of fish in the lake. Rathbun Lake is a popular fishing lake for crappie and walleye. Catch rates for crappies are typically very good (about 120,000 annually) while walleye catches are more variable, but Rathbun Lake is the best walleye fishery in southern Iowa (about 2,000 annually). Large mouth bass and bluegill are not important sportfish species at Rathbun Lake.

4. During the course of the next year (2004), how many trips do you expect to take to Rathbun Lake?
   _____trips in 2004.

In the next question, we will be asking you how you would vote on a special ballot regarding the water quality of Rathbun Lake. While there is currently no such ballot initiative, we would like you to respond as if you were actually voting on the initiative and as if this were the only alternative available for improving water quality in the lake. (In particular, assume that no state action will be undertaken unless the referendum passes.)

Improved conditions of Rathbun Lake can be summarized as:	
Water Clarity:	objects distinguishable 6 to 8 feet under water
Algae blooms:	Rarely more than 1 per year
Water color:	green to blue
Water odor:	usually fresh
Bacteria:	rare swim advisories (most years none)
Fish:	strong walleye and high diversity

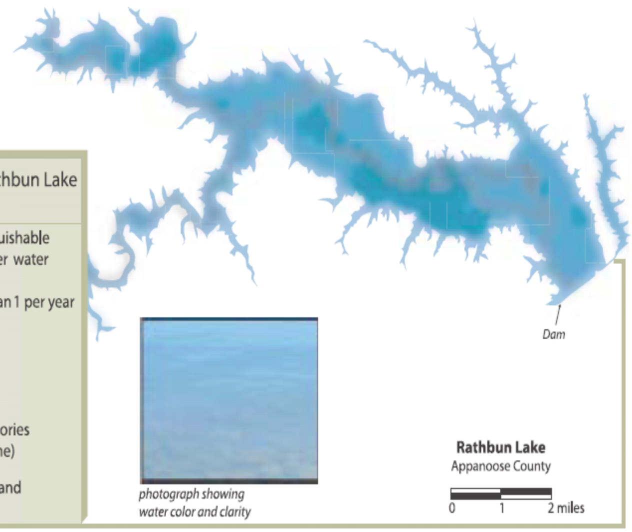


Figure 2. Conditions of Rathbun Lake following an improvement

When you think about your answer, it is important to keep in mind that people may indicate that they would be willing to pay more money when payment is hypothetical than when they are immediately expected to pay. It may be easy for people to say that they support a project when they are not sure they will ever have to pay any money based on their response. However, if the proposed payments are real and immediate, people may be more inclined to think about other options and what things they would have to give up to make this payment. So in answering the following questions, please keep in mind both the benefits of the water quality improvement and the impact that passage of such a referendum would have on your finances. In other words, please answer as if this were a real referendum.

Suppose that investments could be made to actually improve the quality of Rathbun Lake. These investments might include dredging, building protection strips along the edge of the lake to reduce runoff from the surrounding watershed or other structural changes to the lake and watershed. These changes would improve the lake over the next 5 years to the conditions described in Figure 2.

5. Would you vote "yes" on a referendum to improve the water quality in Rathbun Lake to the level described here? The proposed project would cost you $«CV BID» (payable in five $«Bid div 5» installments over a five year period.)

   ❑no ❑yes

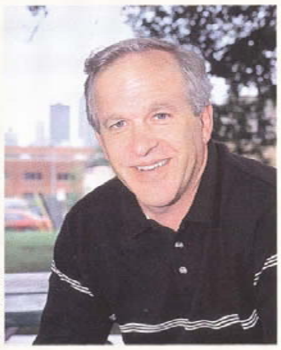
6. How sure are you of this answer?

   1 (not sure at all) 2 3 4 5 (certain)

Appendix 2.D Treatment in Iowa Lakes Survey 2005

Exerpt from the *Iowa Conservationist* January/February 2005

FROM THE DIRECTOR



Bob Casteline

A Road Map To Lake Improvement

Here's a fascinating passage in the *Iowa Conservation Plan* that I think is worth sharing:

"The natural lakes of Iowa constitute one of the state's most wonderful assets. They are of incomparable value for recreational purposes. They offer the finest fishing and the finest refuges for water birds. They serve as storage to equalize stream flow. They are enormously interesting from the biological standpoint and they comprise one of the loveliest features in the landscape."

The report continues:

"They (Iowa's lakes) have been greatly damaged. Uncontrolled erosion of banks and on drainage areas has deposited silt on the bottoms of most of the lakes and this has been aggravated by such heedless acts as taking natural rock protection barriers away from the shores. The silt deposits are in no small measure responsible for the unbalanced biologic condition and growth of algae. The intensive occupation of adjoining lands has cut the public off from access to these finest public playgrounds."

What's interesting about this assessment of Iowa's lakes is that it was done more than 70 years ago in the *Iowa Conservation Plan* of 1933. We still face many of the same challenges today in protecting and improving the water quality in our lakes.

This issue of the *Iowa Conservationist* examines two critical studies currently being done by Iowa State University. The first study is the completion of a five-year effort assessing the water quality in the lakes. The second study is a look at the economic value of our lakes.

Make no mistake, water quality and the economic value of our lakes are closely linked. The information from these two studies is going to be critical in prioritizing lake restoration projects not only from an environmental perspective, but from a return on investment standpoint.

While this additional research from Iowa State University will undoubtedly help us in our effort to improve the quality of water in our lakes, I believe the biggest challenge we face in improving water quality lies more on the social aspect. We need for our citizens to value water quality and recognize it as a fundamental requirement to the long-term future of our state. In many cases, we can identify sources of water quality problems and there may be financial programs available to provide assistance, but it still takes willing participants to make the changes necessary to improve water quality.

This issue of the *Iowa Conservationist* contains a number of success stories. The common thread linking these successes has been the interest and initiative local residents have taken to spearhead restoration efforts in their own communities.

One of the best examples we have to illustrate local leadership driving a successful lake restoration effort has been Storm Lake, which recently saw its hard work pay off in the form of an $8 million Vision Iowa grant.

The leaders in Storm Lake have recognized the importance that improving water quality means for the economic well being of their region.

For those not familiar with the efforts in Storm Lake, you are missing a truly remarkable story of a community that has the vision to recognize its strengths and improve on them. Not only are locally led efforts being made to improve the water quality in the lake, but also of developing the additional amenities such as parks and green spaces that will allow their community to flourish.

Iowans must come to accept that water quality is not just an

Director's Message

cont. on page 4

Director Vonk agrees that your input is important in prioritizing restoration projects!

Chapter 3. The Dynamic Formation of Willingness to Pay: the Impact of Delay, Learning, and Reversing in Contingent Valuation

3. 1. Introduction

The contingent valuation method (CVM) uses survey questions to elicit individuals' preferences for nonmarket goods. Respondents in a contingent valuation survey are given a scenario describing a proposed policy that would alter the quantity or quality of a public good and asked questions to elicit their maximum willingness to pay (WTP) to obtain the specified improvements. Typically, a respondent's WTP in a contingent valuation exercise is assumed to depend on some intrinsic value of the good that is invariant over time. Yet, as Zhao and Kling (2001, 2004) point out, that time (and the potential options it creates) does matter. Specifically, the individuals' WTP for a good at a particular point of time depends not only on the intrinsic value of the good, but also on the timing of the decision and the characteristics of the market environment.

Suppose, for example, that there is a lake restoration project under consideration and researchers wish to assess the welfare implication using a contingent valuation referendum in which respondents make decisions regarding their preference for the proposed project. In particular, a contingent valuation referendum may ask "would you vote 'yes' to the referendum to improve the water quality to the level as described here? The proposed project would cost you $X." Faced with this question, and any uncertainty they may have, the respondents may be influenced by the possibility of acquiring more information in the future that will help them make better decisions. If respondents believe that there is at least positive probability that the project will be proposed again in the future, so that their decision for the project can be delayed, their WTP to commit to decision today is likely to be reduced.

Furthermore, the decisions to whether the proposed changes are usually irreversible. Yet, if the government would be willing to cancel an ineffective project, respondents may perceive positive transaction costs incurred in terminating it. Again, respondents prefer to delay their decisions, allowing more information to be gathered regarding the efficiency of the proposed project, and report a lower WTP for the project today.

Zhao and Kling (2004) provide a dynamic model for understanding individuals' decisions to purchase or to sell a good under conditions of uncertainty, learning, and irreversibility. With limited information and limited ability of learning and reversal, individuals' implied welfare measure of the transaction decision contains (a) the expected intrinsic value of the good as typically conceived of in empirical welfare analysis and (b) the compensation associated with the timing of the transaction decision. Zhao and Kling refer to the latter as the commitment cost, which is related to but distinct from the quasi-option value demonstrated by Arrow and Fisher (1974), Henry (1974), Hanemann (1989), and Dixit and Pindyck (1994). The commitment cost theory predicts that individuals would prefer to delay their transaction decision and reveal a lower WTP, if they expect (a) that delaying the decision is possible, (b) that learning more information in the future is possible, and (c) that reversing the decision is difficult. In other words, when delaying the decision is possible, individuals' decisions may depend on the value of the information. If individuals are well informed of the project, or if individuals do not expect to obtain more information in the future, they may have less incentive to delay their decision and may ask lower compensation for committing the payment now. Furthermore, when delaying the decision is possible, if individuals perceive high transaction cost of reversing a bad decision, they may prefer to delay the decisions and may ask higher compensation for committing the payment now.

If the intertemporal aspects of the contingent valuation referendum influence respondents' decision and the reported WTP as the commitment cost theory predicts, the researchers should carefully convey not only the attributes of the project, but also the potential for delay, learning, and reversal in their stated preference surveys. For example, if uncertainty, learning, and irreversibility are inherent in the proposed project, then the commitment cost should be part of the WTP elicited from respondents in a stated preference survey. Without revealing the potential for delay, learning, and reversal in survey instruments, respondents may ignore the commitment cost and the researcher may overestimate respondents' WTP. On the other hand, if the researcher is interested in respondents' WTP for the proposed project with no opportunity to revisit the project or to reverse the decision at a later date, then the commitment cost is policy irrelevant. In this case, the immediacy of the decision should be communicated in the survey instrument; otherwise, respondents may perceive positive potential for delay, learning, and reversal. As a result, respondents may include the commitment cost in their valuation yielding a WTP that underestimates the value of the project given the current information.

The purpose of this paper is to explore the implications of delay, learning, and irreversibility on respondents' decisions and their implied welfare measure in a contingent valuation referendum. It is shown that the intertemporal aspects of the contingent valuation referendum do indeed influence the respondents' voting behavior and, hence, their implied WTP. Thus, researchers need to be careful in reflecting the information regarding the dynamic aspects of the proposed referendum in survey instruments.

In this paper, we use responses of contingent valuation referendums from the 2003 and 2005 versions of the Iowa Lakes Survey to examine the effects of the dynamic aspects on respondents' votes to the referendums. First, in the 2003 version of survey, we use a split sample treatment to test the effect of delay on respondents' WTP. Specifically, half of our 2003 sample was promised a definite opportunity to vote on the same referendum two years later in the 2005 version of the survey. With the explicit statement of delay, we expect to separate out the impact of delay on WTP.

Second, we use respondents' self-reported perceptions for delay, learning, and reversal elicited from the 2003 version of survey to examine the effects of these dynamic aspects on their WTP. In particular, we asked respondents who were not promised a second chance to vote on the referendum to indicate their perceptions regarding the potential for delay, learning, and reversal. We then investigate the linkage between these perceptions and the respondents' reported WTP.

Third, we examine the impact of delay with another perspective in the 2005 version of survey. In the 2005 version of survey, half of the sample was notified the immediacy of the lake restoration project. We use this split sample treatment to examine the impact of the immediacy on WTP.

Finally, Zhao and Kling argue that the commitment cost itself depends on the potential for additional learning foregone due to the commitment. If respondents were already well informed about the good or if they did not expect to learn more information, then they would have less incentive to delay their decision and would ask less compensation for forgoing their opportunity for delay (i.e., have a lower commitment cost). In the 2005 version of survey, we elicited from each survey respondent their knowledge about the general water quality in Iowa lakes and the perceptions regarding the potential for delay. These data are used to examine the impact of knowledge perception on individuals' WTP.

The paper is organized as follows. Section 3.2 provides a brief review of empirical studies related to the commitment cost theory. Section 3.3 describes the Iowa Lakes Project and the data used in this study. Our empirical results are provided in Section 3.4. Discussion and conclusions follow in section 3.5.

3. 2. Empirical Literature on Commitment Cost

There have been relatively few empirical investigations into the role of commitment costs in the estimation of WTP. Results from a field experiment in an actual sports card marketplace conducted by Kling, List, and Zhao (2003) conform to the predictions of the commitment cost theory. In particular, the WTP for sports cards increases when the buyers perceive increasing difficulty of delay and a decreasing difficulty of reversing the transaction. Conversely, WTA decreases when sellers perceive a decreasing difficulty of delay and an increasing difficulty of transaction reversal.

Both Lusk (2003) and Corrigan (2005) explore this issue in experimental auctions. Lusk (2003) explicitly controlled the experiment with different possibilities for delay, future learning, and reversal. Specifically, the values of coffee mugs and a lottery with various degrees of uncertainty were elicited via second price auctions in the experiment. The experiment consisted of one-period auction, two-period auction, and two-period auction with a return policy. The results from the coffee mug auctions provide a weak test of the commitment cost theory due to the inability to control the uncertainty about the value of the coffee mugs and the potential for resale (i.e., in the decision reversal portion of Lusk's study). On the other hand, the lottery provided a better test of the theory, with a convenient way to characterize uncertainty regarding the value of the lottery and with no market for the lottery outside the experiment. Lusk (2003) provided little support for the commitment cost theory. In particular, the theory's prediction that WTP decreases with the potential for future learning is supported in the lottery auction, but not in the coffee mug auction. However, neither auction supported the prediction that the individual's WTP increases when the decision can be reversed. Lastly, contrary to the theory, the experiment result did not support the theory's prediction that WTP increases when the respondent is more certain about the value of the good.

Instead of controlling the possibility of the dynamic aspects, Corrigan (2005) used similar goods in an experimental auction and elicited individuals' perceptions regarding the relative difficulty of reversal and delay outside the experimental market. Contrary to the results in Lusk (2003), he found that individuals' perceptions of the dynamic aspects influence their WTP in a manner consistent with the commitment cost theory.

Finally, Corrigan, Kling, and Zhao (2008) examine the dynamic nature of WTP in a contingent valuation study concerned with cleaning up a local lake. Specifically, two versions of survey instruments were used to test whether individuals who were promised a second chance to vote on the referendum one year later are less willing to vote "yes" to the referendum than individuals who were given no opportunity for delay. Their results indicate that when individuals are explicitly offered the opportunity to delay their decision, the resulting WTP is significantly less than when there is no opportunity for delay. In addition, the commitment cost, measured as the difference between a WTP with and without delay, can be substantial. While the results of Corrigan, Kling, and Zhao (2008) provide some empirical support to the commitment cost theory when the potential for delay is directly controlled, they do not investigate the role of either information or decision reversal on individuals' WTP.

3. 3. The Iowa Lakes Project

The data used in this study come from two years of the "Iowa Lakes Project," a four-year study aimed at understanding recreational use and the value of water quality in the principle recreational lakes in the state of Iowa. The project began in 2002 with mail surveys sent to a random sample of 8000 Iowa residents, obtaining detailed information regarding their visitation patterns to 132 Iowa lakes as well as standard demographic data such as age, income, gender, education. In subsequent years, surveys were sent to those individuals who completed a survey in the prior year.[1] Standard follow-up procedures were employed, including a postcard reminder mailed two weeks after the initial mailing and a second copy of the survey mailed one month later. Individuals were provided a $10 incentive for completing the survey.

The contingent valuation referendums analyzed in this study were included only in the 2003 and 2005 versions of the survey. The two-year gap between the surveys allowed us to vary across the sample both the promise and realization of a delay in voting on the referendum, as well to elicit from respondents their perceptions regarding delay, learning and the potential for project reversal. This provides the basis for testing the predictions of Zhao and Kling's commitment cost theory. Details of the survey designs for each survey are provided in the following subsections, along with summary statistics of the survey responses.

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[1] A second random sample was added into the panel in 2003 to fill in for the non-deliverable surveys and non-respondents in 2002. This returned the sample to a total of 8000 individuals. No additional individuals were added after 2003.

3. 3. 1. The Iowa Lakes Survey 2003

The 2003 Iowa Lakes Survey was second in the sequence of four mail surveys conducted during the Iowa Lakes Project. In January and February of 2003, the survey was mailed to 8,000 Iowa households, resulting in a response rate of 68% once non-deliverables were considered. Like the first year survey, respondents were asked to provide information regarding their visits to key lakes in the state over the past year, as well as to answer a sequence of socio-demographic questions.

The unique feature of the second survey was the addition of a dichotomous choice contingent valuation referendum in which respondents were asked to consider proposed water quality improvements at one of eight focus lakes. The focus lakes, chosen in consultation with the Iowa Department of Natural Resources (IDNR), allowed each respondent to be presented with a scenario concerning a lake in their region of the state and, hence, of local interest. Moreover, the focus lakes were geographically dispersed and each was of policy interest to IDNR as various restoration projects were considered at these lakes. Appendix 1 of the dissertation provides an example of the basic contingent valuation referendum, in this case targeting Big Creek Lake. The first page of the referendum provided a description of the focus lake's current condition characterized in terms of water clarity, water color, variety and quantity of fish, and health concerns from algae blooms and bacterial level. A photograph, which demonstrated the water clarity and water color, was provided to help respondents visualize the water quality of the focus lake vividly. Finally, a map of the lake was included using color to depict both lake depth and water quality.

The second page of the referendum then described a proposed water quality improvement scenario for the focus lake. The scenario outlined the improved water quality condition using the same components used to describe the lake's current conditions and described the methods to achieve the proposed changes, such as dredging and building protection strips around the perimeter. Individuals were then asked whether they would vote in favor of a referendum to fund the proposed improvements, with a specific cost ranging from $100 to $600 payable over a five-year period and randomly assigned to individuals in the sample.[2]

Of the 7720 deliverable surveys, there was a 68% response rate. There were 524 observations eliminated for missing values in their votes on the hypothetical referendum or their perceptions of the dynamic aspects such as delay, reversal, and future learning. In total, 4725 observations are used in this study.

The basic referendum components described above were common to all of the 2003 CV surveys. Two versions of the surveys, however, were created to investigate predictions of the commitment cost theory. To test the effect of potential delay option, a split sample treatment was randomly administered allowing us to separate the impact of potential delay in the CV responses. Specifically, in version 1 of the survey (denoted V1 hereafter), no mention was made of the possibility that the proposed referendum could be revisited in the future. In contrast, individuals who received version 2 of the survey (denote V2 hereafter) were told:

> *If the referendum fails, any plans to improve the water quality of the lake would be delayed for two years while further research takes place into the causes of lake pollution as well as alternative clean-up approaches. After this delay, any new information from studying the lake will be made available and you will then get a final chance to vote on the same referendum.*

---

[2] In attempt to elicit truthful responses to the CV referendum, a "cheap talk" section suggested by Cummings and Taylor (1999) was also contained in this section.

Table 3.1 summarizes the aggregate impact that the "delay" treatment in V2 of the survey had on individuals' responses to the CV referendum. If the treatment has an impact on WTP as predicted by the commitment cost theory, we would expect to have a significantly lower percentage of "yes" votes from V2. In our sample, however, both of the "yes" response rates from V1 and V2 are close to 31%.

Table 3.1 Effects of Stated Potential for Delay on CV Responses (Iowa Lakes Survey 2003)

	N	% N	% Yes
V1	2393	0.51	0.31
V2	2332	0.49	0.31
Whole Sample	4725	-	0.31

Figure 3.1 provides additional detail regarding the survey responses contrasting the voting patterns in versions V1 and V2 of the survey as they vary with the stated cost (or bid values). It is evident that the voting patterns under both versions of the survey were consistent with economic theory, i.e., the percentage of "yes" responses decreased as the bid value increased. However, the similarity in the "yes" response rates may suggest the

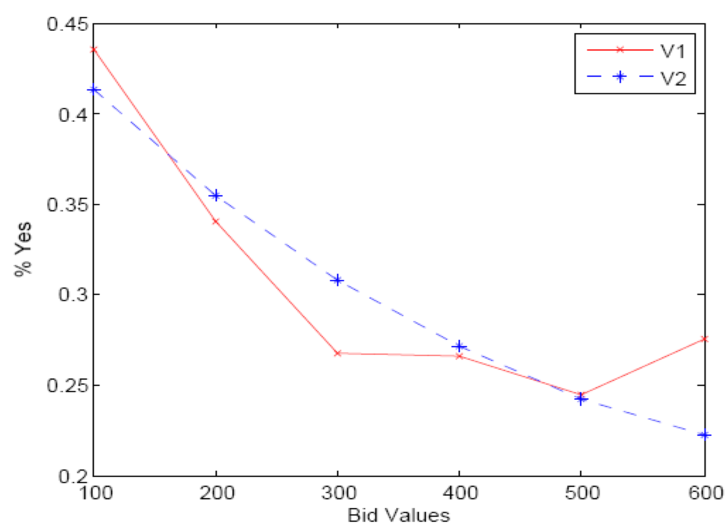

Figure 3.1 Effect of Stated Delay on Percentage of Yes Responses (Iowa Lakes Survey 2003)

ineffectiveness of the treatment. That is, based on the summary statistics provided on aggregate in Table 3.1 and by bid values in Figure 3.1, the stated potential for delay appears to have no impact on the survey response patterns and, hence, on WTP.

A final element in the 2003 Iowa Lakes Survey was embedded at the very end of the survey, following the standard socio-demographic questions. In this closing section, both versions of the survey asked respondents (on a scale from 1 to 5, where 1 denotes impossible and 5 denotes certainty) to rate the chances of future learning and project reversal. Specifically, the question regarding respondents' perceptions of future learning posed was:

> *What do you think is the likelihood that you will get additional information about the effectiveness of water quality improvement project in the next few years?*

Table 3.2 summarizes the respondents' perceptions of future learning and the effect of future learning on their responses to the contingent valuation referendum. In aggregate, 95% respondents perceived positive opportunity for learning about the effectiveness of the proposed project and 9% respondents perceived definite potential for future learning. Figure 3.2 illustrates the respondents' perceived potential for learning elicited from both versions of survey. It is evident that the respondents in the V2 sample were more likely to perceive a lower chance to learn the effectiveness of the proposed project. This may imply that the "delay" treatment had a negative impact on respondents' perceptions of future learning.

Table 3.2 Impact of Future Learning on Voting Behavior (Iowa Lakes Survey 2003)

	Whole Sample			V1			V2		
	N	% N	% Yes	N	% N	% Yes	N	% N	% Yes
1	227	0.05	0.18	58	0.02	0.12	169	0.07	0.20
2	1303	0.28	0.28	416	0.17	0.25	887	0.38	0.30
3	1657	0.35	0.30	912	0.38	0.28	745	0.32	0.32
4	1106	0.23	0.37	717	0.30	0.38	389	0.17	0.34
5	432	0.09	0.34	290	0.12	0.34	142	0.06	0.33
Total	4725	-	0.31	2393	-	0.31	2332	-	0.31

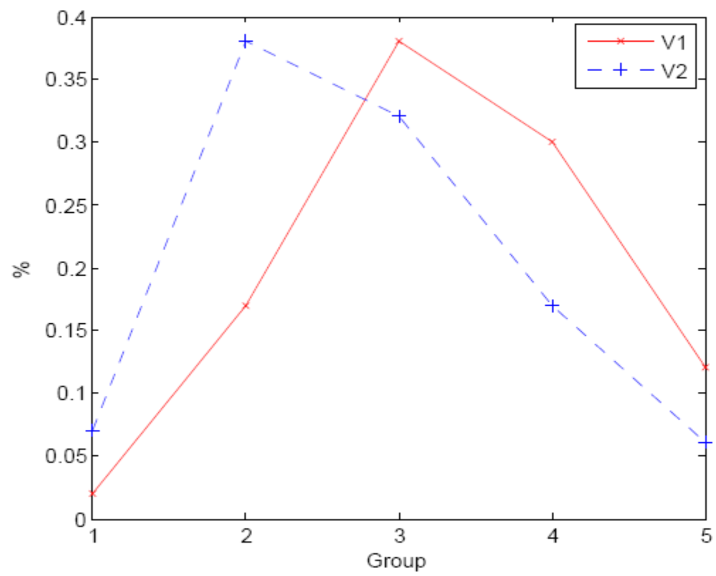

Figure 3.2 Distribution of "Learning" Perception (Iowa Lakes Survey 2003)

The theory argues that the respondents would have more incentive to delay their decision, i.e., less likely to vote "yes" to the referendum, if they perceived more learning potential. As shown in Table 3.2, the respondents' voting pattern did not conform to the theory's prediction. The respondents who perceived no chance to learn the effectiveness of the project had the lowest "yes" response rate. The respondents who perceived positive chance to learn the effectiveness of the project were more willing to vote "yes" for the project, and the "yes" response rate did not decrease with the respondents' perceived potential for learning.

Considering the potential for project reversal, individuals were asked:

> *If a water quality project such as this one described on page 9 were initiated but later information suggested that it would be ineffective, how likely is it that the project would be scrapped?*

The respondents' perceptions of reversal and the effect of reversal on their responses to the contingent valuation referendum are summarized in Table 3. 3. In this sample, 97% respondents perceived positive chance to cancel the project if it were not effective, and 23% respondents perceived definite chance to cancel the ineffective project. Figure 3 shows the respondents' perceived potential for canceling the proposed project if it were not effective elicited from both version. As shown in Figure 3.3, the similarity of the distributions of individuals' perceived potential for project reversal may imply that the "delay" treatment had no influence on respondents' perceptions of reversal.

Table 3.3 Impact of Reversal on Voting Behavior (Iowa Lakes Survey 2003)

	Whole Sample			V1			V2		
	N	% N	% Yes	N	% N	% Yes	N	% N	% Yes
1	120	0.03	0.11	60	0.03	0.12	60	0.03	0.10
2	721	0.15	0.27	340	0.14	0.28	381	0.16	0.26
3	1320	0.28	0.29	659	0.28	0.29	661	0.28	0.30
4	1472	0.31	0.35	771	0.32	0.34	701	0.30	0.35
5	1092	0.23	0.32	563	0.24	0.32	529	0.23	0.33
Total	4725	-	0.31	2393	-	0.31	2332	-	0.31

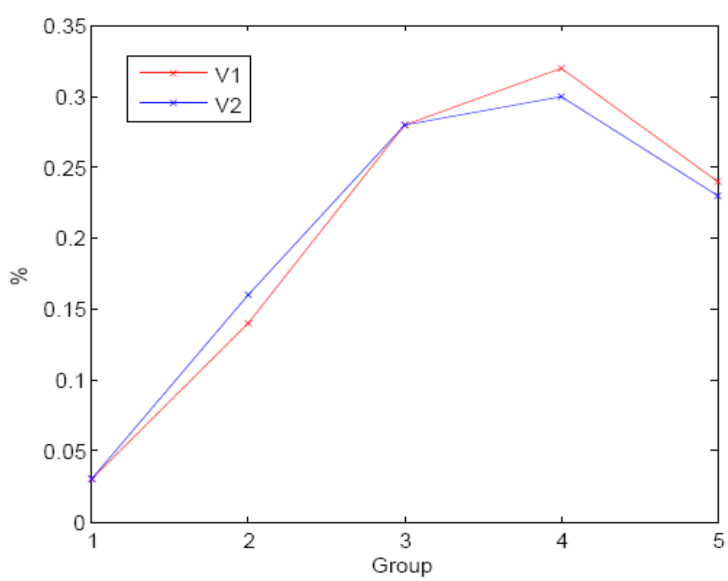

Figure 3.3 Distribution of "Reversal" Perception (Iowa Lakes Survey 2003)

The theory predicts that respondents would have less incentive to delay their decisions i.e., be more willing to vote "yes" to the referendum, if they perceived a higher likelihood to scrap an ineffective project. It is shown in Table 3.3 that, consistent with the theory, the respondents who perceived that the proposed project was irreversible had the lowest "yes" response rate. The respondents who perceived positive chance to cancel an ineffective project had higher "yes" response rates and the "yes" response rate increased with the respondents' perceived potential for reversal.

Finally, respondents to V1 of the survey were also asked to rate the possibility that the proposed referendum would be revisited at a later date, with the following wording:

> *If a project such as this one described on page 9 failed to pass in a referendum, what do you think is the likelihood that another, similar project would be considered within the next few years?*

Without mention of the possibility that the proposed referendum could be revisited in the future, Table 3.4 summarizes respondents' perceived potential for delay and the effect of delay on their responses to the contingent valuation referendum. In the V1 sample, 97% respondents perceived positive opportunity to vote on a similar referendum again, and 10% of the sample perceive definite chance to vote on a similar referendum in the future.

Table 3.4 Impact of Delay on Voting Behavior (Iowa Lakes Survey 2003)

	V1		
	N	% N	% Yes
1	82	0.03	0.17
2	583	0.24	0.31
3	851	0.36	0.30
4	627	0.26	0.34
5	250	0.10	0.30
Total	2393	-	0.31

The theory predicts that the respondents would be less willing to vote "yes" to the referendum if they perceived positive chance for delay. From Table 3.4, the respondents who perceived no chance to vote on a similar referendum in the future had the lowest "yes" response rate. Contrary to the theory's prediction, the respondents who perceived positive opportunity to vote on a similar project in the future had higher "yes" response rates, and the "yes" response rate did not decrease monotonically with their perceptions of delay.

3. 3. 2. The Iowa Lakes Survey 2005

The final survey of the Iowa Lakes Project in 2005 provided respondents an opportunity to revisit the CV referendum posed in 2003 and, in doing so, fulfilled our promise to those respondents receiving version V2 of the survey that they could indeed vote again on the proposed project. The survey also allowed us to ask individuals a series of new questions regarding how much they had learned over the years. At the same time, other factors reduced the proportion of the survey sample that could be allocated to the commitment cost issue. First, one of the focus lakes, Storm Lake, became the target of a major restoration effort, making our original proposed water quality scenario moot. Second, four of the focus lakes were set aside for our investigation into the impact of consequentiality, discussed in Chapter 2 of the dissertation. Thus, only three of the original eight focus lakes were used in 2005 to further study the commitment cost theory. For this subgroup, the relevant surveys were sent out to 1638 individuals who responded in the prior year. Of the 1361 deliverable surveys, there was a 96% response rate. There were 205 observations eliminated for missing values in their votes on the CV referendum or in the relevant following questions. In total, 1100 observations are used in this portion of our analysis.

There are basically two elements of the 2005 survey design related to our investigation into the commitment cost theory. The first element revisits the issue of potential impact of delay on WTP. As in 2003, a split sample treatment was employed.[3] For half of the sample (labeled NV1 hereafter), no mention was made regarding the possibility of revisiting the referendum at future date. For the other half of the sample (labeled NV2 hereafter), they were told:

> *When you answer this question, please remember that this is the last year of funding for this survey research. You may remember that two years ago we asked you a similar question; however, we will not be contacting you again to ask you this question. You will not have another such opportunity to express your views to us regarding such a referendum. Further, we know of no other plans to obtain your views regarding water quality improvements.*

Table 3.5 summarizes the aggregate impact of the “immediacy” treatment in NV2 of the survey had on respondents’ responses to the contingent valuation referendum. The theory predicts that the respondents who were told the immediacy of the project would be no less willing to vote “yes” than the respondents in sample NV1. Contrary to the theory, the percentage of “yes” response for NV2 was slightly lower than that from NV1. Figure 3.4 provides detail regarding the voting patterns of respondents in treatment groups NV1 and NV2 breaking down the responses by bid values.[4] As illustrated in Figure 3.4, the voting patterns of NV1 and NV2 are generally consistent with the economic theory. The percentage of “yes” responses typically decreases as the bid value increases, though the percentage of “yes” response from NV2 is slightly lower than that from NV1. Based on the summary

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[3] The split sample treatment was once again randomly assigned and, thus, orthogonal to the 2003 split sample treatment.

[4] In comparing Figure 1 and 4, it is apparent that some lower bid values were used in the 2005 survey compared to the 2003 survey. In fact, in order to better determine at what half of the population would say “yes” to the CV scenario, the 2005 survey bid values were set at one-tenth their 2003 levels for half of the survey.

Table 3.5 Effect of Stated Immediacy on CV Responses (Iowa Lakes Survey 2005)

	N	*% N*	**% Yes**
NV1	548	0.50	0.42
NV2	552	0.50	0.38
Whole Sample	1100	-	0.40

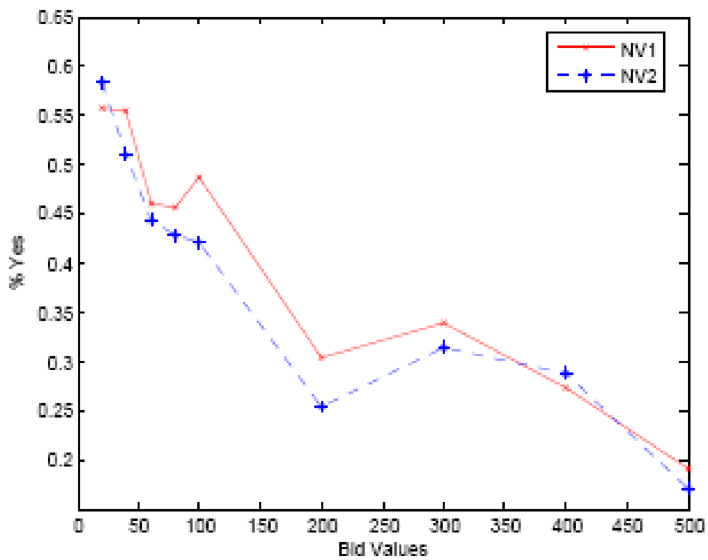

Figure 3.4 Effect of Stated Immediacy on Percentage of Yes Responses (Iowa Lakes Survey 2005)

statistics provided in Table 3.5 and Figure 3.4, the stated immediacy of the project seems to have had no impact on individuals' voting patterns.

The second key element of the 2005 survey was a series of perception questions. In this section, both versions of the survey asked respondents (on a scale from 1 to 5) to rate their self-perceived knowledge level and knowledge increment about the general water quality in Iowa lakes and the chance of revisiting a similar referendum in the future. Individuals' knowledge level about the general water quality in Iowa lakes was elicited with the following question:

> *How well informed are you about the general state of water quality in Iowa's lakes?*

where a "1" denoted "not well informed at all" and a "5" denoted "very knowledgeable." The distribution of respondents' self-perceived knowledge level and the impact of the knowledge level on their vote to the referendum are summarized in Table 3.6. In this sample, 19% respondents perceived themselves knowing nothing about the water quality in Iowa lakes, 79% respondents had some knowledge, and 2% respondents were "very knowledgeable." Figure 3.5 provides a comparison of respondents' self-perceived knowledge

Table 3.6 Impact of "Knowledge" on Voting Behavior (Iowa Lakes Survey 2003)

	Whole Sample			NV1			NV2		
	N	% N	% Yes	N	% N	% Yes	N	% N	% Yes
1	205	0.19	0.27	101	0.18	0.28	104	0.19	0.27
2	321	0.29	0.37	162	0.30	0.41	159	0.29	0.33
3	384	0.35	0.44	194	0.35	0.46	190	0.34	0.42
4	163	0.15	0.48	78	0.14	0.51	85	0.15	0.45
5	27	0.02	0.48	13	0.02	0.31	14	0.03	0.64
Total	1100	-	0.40	548	-	0.42	552	-	0.38

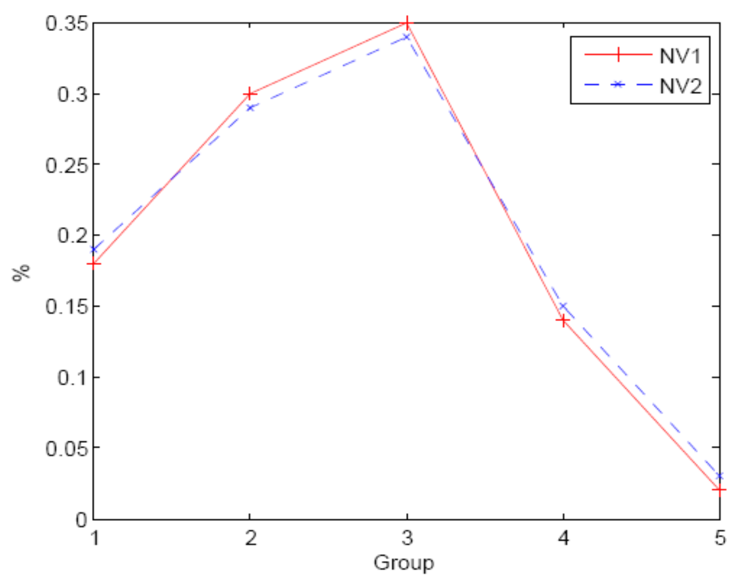

Figure 3.5 Distribution of "Knowledge Level" Perception (Iowa Lakes Survey 2005)

level in NV1 sample and NV2 sample. The similarity of perceived knowledge level distributions may suggest that the "immediacy" treatment had no effect on respondents' perceptions of knowledge level about general water quality in Iowa lakes. We would, of course, not expect an impact here, given the random nature of the treatment assignment.

The commitment cost theory predicts that respondents who were more knowledgeable about the good have less incentive to delay their decision, i.e., more willing to vote "yes" to the referendum.[5] We found a voting pattern consistent with the theory's prediction. Specifically, respondents who perceived that they knew nothing about the general water quality in Iowa lakes were less willing to vote "yes" to the referendum. The respondents who had some knowledge about the general water quality in Iowa lakes had higher "yes" response rates, and the "yes" response rate increased with their knowledge level.

To assess the respondents' knowledge increment about the general water quality in Iowa lakes after participating in the Iowa Lakes Project, respondents were asked to report their knowledge increment with the following wording:

> *How would you assess your knowledge of water quality in Iowa's lakes now, relative to three or four years ago?*

where a "1" denoted "I know much less," and a "3" denoted "I know about the same," and a "5" denoted "I know much more." Table 3.7 summarizes the distribution regarding the respondents' self-evaluated knowledge increment and the impact of knowledge increment on their decision. There were 10 % respondents perceived that they knew less, 58% perceived that they knew about the same, and 32% perceived that they knew more after participating

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[5] This result should be interpreted with some caution due to a potential endogeniety issue of the individuals' knowledge. In particular, individuals who hold a higher WTP may seek to be more knowledgeable about the proposal.

the Iowa Lakes Project. Figure 3. 6 compares the distributions of knowledge increment between NV1 and NV2. It is evident that the "immediacy" treatment did not have an impact

Table 3.7 Impact of "Knowledge Increment" on Voting Behavior (Iowa Lakes Survey 2003)

	Whole Sample			NV1			NV2		
	N	% N	% Yes	N	% N	% Yes	N	% N	% Yes
1	42	0.04	0.29	20	0.04	0.30	22	0.04	0.27
2	65	0.06	0.25	43	0.08	0.30	22	0.04	0.14
3	642	0.58	0.38	323	0.59	0.40	319	0.58	0.36
4	282	0.26	0.47	126	0.23	0.54	156	0.28	0.42
5	69	0.06	0.41	36	0.06	0.31	33	0.06	0.52
Total	1100	-	0.40	548	-	0.42	552	-	0.38

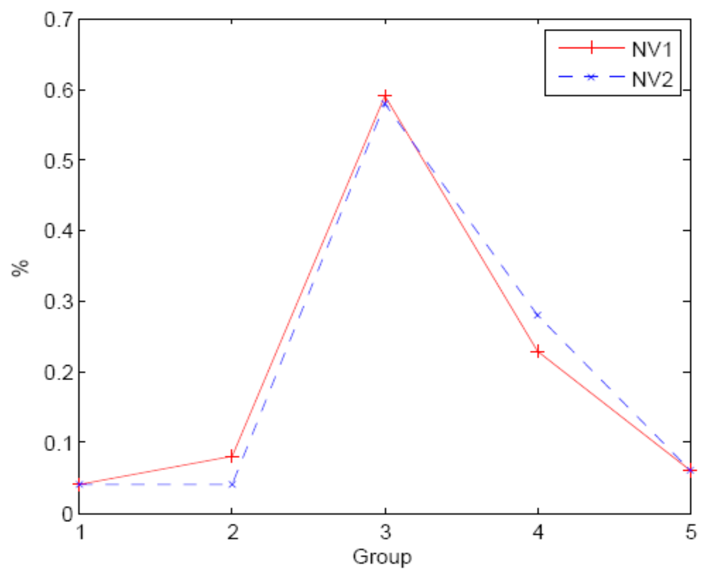

Figure 3.6 Distribution of "Knowledge Increment" Perception (Iowa Lakes Survey 2005)

on respondents' self-assessing knowledge increment since NV1 sample had a similar knowledge increment distribution to NV2 sample.

Regarding the impact of learning on respondents' voting behavior, the theory predicts that respondents who perceive that they will learn more information about the good would have more incentive to delay their decision, i.e., less willing to vote "yes" to the referendum. In aggregate, we found that respondents who perceived that they knew less after participating the Iowa Lakes Projects were less willing to vote "yes" to the referendum than the respondents who perceived that they knew about the same or more.

Finally, respondents' perceptions of further delay were elicited as follows:

> *In this survey, we have asked you about your usage of Iowa's lakes and your views about water quality improvements. Do you believe that you are likely to have other opportunities to express your views about water quality projects and programs?*

where a "1" denoted "not likely at all" and a "5" denoted "very likely." Table 3. 8 summarizes the respondents' perceptions of further delay and the impact of further delay on their votes to the referendum. In aggregate, 28% respondents perceived no further chance, and 5% respondents perceived definite chance to vote on a similar referendum in the future. Recall that we employed a split sample treatment regarding the "immediacy" of the proposed project in NV2 version of the survey. We expect that the respondents who responded to the NV2 version of survey perceived lower potential for delay. Figure 3.7 compares respondents' perceptions of delay with and without the "immediacy" treatment. The treatment did not have effect on respondents' perceptions of delay since the NV2 sample's perceptions of delay were not significant different from the NV1 sample's.

Table 3.8 Impact of "Further Delay" on Voting Behavior (Iowa Lakes Survey 2003)

	Whole Sample			NV1			NV2		
	N	% N	% Yes	N	% N	% Yes	N	% N	% Yes
1	308	0.28	0.30	156	0.28	0.33	152	0.28	0.26
2	258	0.23	0.43	119	0.22	0.45	139	0.25	0.40
3	310	0.28	0.44	161	0.29	0.47	149	0.27	0.40
4	168	0.15	0.39	82	0.15	0.34	86	0.16	0.44
5	56	0.05	0.57	30	0.05	0.63	26	0.05	0.50
Total	1100	-	0.40	548	-	0.42	552	-	0.38

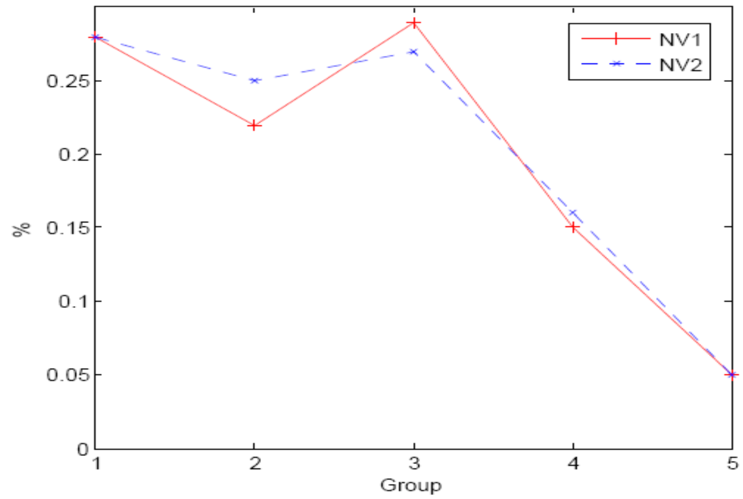

Figure 3.7 Distribution of "Further Delay" Perception (Iowa Lakes Survey 2005)

The theory predicts that respondents who perceived more likelihood to delay their decision would less likely to vote "yes" to the referendum. Similar to the result in the 2003 survey, we did not find a voting pattern consistent with the theory's prediction. In aggregate, the respondents who perceive no chance to vote on a similar referendum had the lowest "yes" response rate, while the respondents who perceived positive opportunity to revisit a similar referendum had higher "yes" response rates and the "yes" response rate did not decrease with the respondents' perceived potential for delay.

Also of note, individuals' perceptions for delay changed significantly between the 2003 and 2005 survey. As shown in Figure 3.8, only 3% respondents perceived no potential for delay in the 2003 sample, while 28% respondents perceived no chance for delay in the 2005 sample. Further, respondents held lower probability of delay in the 2005 survey in general. The change in individuals' perception of delay might be explained by the information provided in the 2003 and 2005 survey cover letter. In particular, the 2003 sample was informed that multiple years of data will be collected and their repeated responses are opportunity for delay. On the contrary, the finality information provided to the 2005 sample might convince individuals to perceive lower probability for delay.

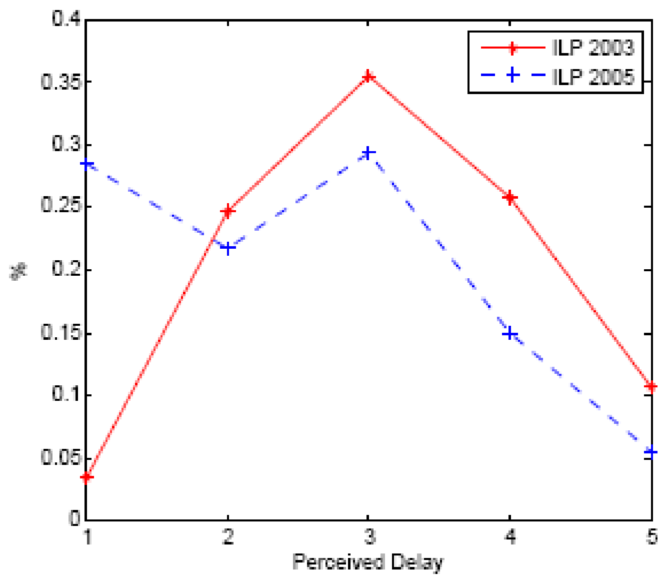

Figure 3.8 Distribution of Perceived Potential for Delay in 2003 and 2005 Surveys

3. 4. Empirical Results

To control for differences in survey designs, perceptions of dynamic aspects, and socio-demographic characteristics across respondents, we use a probit model to investigate the effects of the survey designs and perceptions of dynamic aspects on WTP. Details of the employed probit model and estimation results along with related discussion are provided in the following subsections.

3. 4. 1. Model

Following Cameron (1989), the dichotomous contingent valuation referendum responses in both of the 2003 and 2005 surveys can be interpreted indicating whether an individual's WTP exceeds the proposed bid value and can be modeled parametrically with a linear WTP function. Assume that the unobserved continuous variable, W_i^*, is the individual's latent log willingness to pay for the proposed water quality improvement, with

$$W_i^* = \mathbf{X}_i\boldsymbol{\beta} + \varepsilon_i \tag{3.1}$$

where $\mathbf{X}_i$ is a vector of explanatory variables and $\varepsilon_i \overset{iid}{\sim} N\left(0,\sigma^2\right)$. The latent variable, W_i^*, is not observed but its value generates an observed indicator variable, W_i, as follows:

$$W_i = \begin{cases} 0 & \text{if } W_i^* < \log\left(B_i\right) \\ 1 & \text{if } W_i^* > \log\left(B_i\right) \end{cases} \tag{3.2}$$

where B_i is the bid value ranging from \$100 to \$600 payable over a five-year period and randomly assigned to individual *i*.

We fitted the parameters of the model in equation (1) and (2) using Bayesian estimation with data augmentation, following the work of Albert and Chib (1993)[6]. We used several generating data experiments to test the performance of the algorithm. These experiments revealed that our algorithm mixed reasonably well, i.e., the lagged autocorrelations among our parameter simulations were not severe. Further, the algorithm recovered parameters of the pseudo-data. In each application of the model, we ran our posterior simulator for 6,000 simulations and discard the first 1,000 simulations as burn-in. We also used numerous chains with dispersed starting values to verify if the posterior distribution converged to the target distribution.

6 The prior and the posterior simulator are fully described in the appendix.

3. 4. 2. Findings from Iowa Lakes Survey 2003

The responses from the Iowa Lakes Survey 2003 are used to examine the commitment cost theory from two perspectives. First, we examine the impact of delay on individuals' WTP. In particular, as described in the previous section, the 2003 survey included a split sample treatment in which half of the sample was promised a second chance to vote on the contingent valuation referendum. In this case, we examine the theory by determining if respondents who were promised a second chance to vote on the referendum had a lower WTP.

Second, we use respondents' perceived potential for delay, reversal, and future learning elicited in the survey to examine the influence of the dynamic aspects on respondents' WTP in an ordinary CV referendum. In particular, we use the responses from the V1 sample regarding their perceptions for delay, reversal, and future learning, and their responses to the contingent valuation referendum to examine the influence of the dynamic aspects on their WTP.

To determine the impact of "delay" treatment on WTP, we assume

$$W_i^* = \beta_0 + \beta_1 Treatment_i + \beta_2 Age_i + \beta_3 Female_i + \beta_4 College_i + \beta_5 Income_i + \varepsilon_i$$

where $Treatment_i = 1$ if the individual received version V2 of the survey (promising a second chance to vote on the referendum), $= 0$ otherwise; $Female_i = 1$ if the respondent was female, $= 0$ otherwise; and $College_i = 1$ if the respondent completed college, $= 0$ otherwise. Age_i and $Income_i$ denote the age and household income of the survey respondent with both variables standardized to have a mean zero and unit variance, respectively.

The commitment cost theory suggests that respondents who were able to revisit their decision at some future date would take into account this opportunity, and report a lower WTP. Therefore, we expect β_1 to be negative. The signs of the remaining coefficients are indeterminate, though the literature typically finds β_3, β_4, β_5 to be positive.

Table 3.9 presents results of the probit model regarding the impact of the "delay" treatment on WTP. The first column of the table reports the posterior mean, the second column reports the posterior standard deviation, and the final column reports the probability that the parameter value is positive. Values in the final column near either 1 or 0 indicate a high probability of difference from zero, the former in the positive direction and the latter in the negative. The coefficients associated with the demographic variables in the WTP function are generally consistent with our expectation. Individuals who are younger, female, with college education, and higher income are more willing to pay for the water quality improvement project. However, we do not find very strong support for the commitment cost theory. Specifically, the posterior mean of the treatment is negative (-0.04) as expected, but the posterior distribution is almost evenly divided between positive and negative values, with $\Pr\left(\beta_1 > 0 \mid y\right) = 0.36$.

Table 3.9 Treatment Effect on Willingness to Pay (Iowa Lakes Survey 2003)

Willingness to Pay, N = 4223			
Variable	$E\left(\bullet \mid y\right)$	$Std\left(\bullet \mid y\right)$	$\Pr\left(\bullet > 0 \mid y\right)$
Intercept	3.71	0.15	1.00
Treatment	-0.04	0.11	0.36
Age	-0.19	0.06	0.00
Female	0.32	0.12	1.00
College	0.65	0.13	1.00
Income	0.26	0.06	1.00
Variance of WTP			
σ_w^2	6.55	0.68	-

The indifference of the WTP between the treated and the non-treated samples does not necessarily imply that delay does not have an impact on WTP. Instead, the indifference may be due to the ineffectiveness of the treatment. In particular, the treatment was used to reinforce the individuals' perceived potential for delay and in hope for separating out the impact of delay on WTP. Recall that 97% respondents who were not promised a second vote perceived positive opportunity to vote on the same referendum in the future and 10% respondents perceived definite opportunity to vote on the same referendum in the future. We suspect that the "delay" treatment did not significantly strengthen the treated respondents' perceived potential for delay as we expected so that the treated sample did not hold a lower WTP than the non-treated sample. However, this conjecture cannot be identified since the V2 sample's perceived potential for delay was not elicited.

We now turn to respondents' perceptions of delay, learning, and project reversal elicited in the survey to examine the relationship between the dynamic aspects and respondents' WTP. Incorporating individuals' perceived delay, reversal, and learning into the WTP function, we assume

$$W_i^* = \beta_0 + \beta_1(Delay_i \times Learn_i) + \beta_2 \mathrm{Re}verse_i + \beta_3 Age_i + \beta_4 Female_i + \beta_5 College_i + \beta_6 Income_i + \varepsilon_i$$

where $Delay_i$, $Learn_i$, and $\mathrm{Re}verse_i$ using index 1 to 5 to indicate respondent $i's$ perceptions of delay, learning, and reversal with 1 denotes impossible and 5 denotes definite possibility; $\left(Delay_i \times Learn_i\right)$ indicates the interaction of respondent $i's$ perceived delay and learning.

The commitment cost theory predicts that respondents who perceived having potential opportunities to revisit the referendum and getting more information about the proposal would report a lower WTP. In addition, if the respondents perceived higher likelihood to cancel an ineffective project, they would report a higher WTP. Therefore, we expect β_1 to be negative and β_2 to be positive.

Specification (1) of Table 3.10 presents the results of the probit model regarding the effects of respondents' perceived delay, learning, and reversal on their WTP. The cross effect of respondents' perceived delay and reversal does not influence their WTP as the theory predicts. In particular, the respondents who perceived more potential to revisit the referendum and expected to obtain more information about the project reported a higher WTP. In contrast, the respondents' perceived opportunity for reversal influence their WTP, as the theory would predict. In particular, the respondents who perceived a greater chance to cancel an ineffective project have a higher WTP.

Table 3.10 Effects of Perceived Dynamic Aspects on WTP (Iowa Lakes Survey 2003)

	Willingness to Pay, N = 2144					
Variable	Specification (1)			Specification (2)		
	$E(\bullet \mid y)$	$Std(\bullet \mid y)$	$\Pr(\bullet > 0 \mid y)$	$E(\bullet \mid y)$	$Std(\bullet \mid y)$	$\Pr(\bullet > 0 \mid y)$
Intercept	3.34	0.47	1.00	3.30	0.60	1.00
Delay*Learn	0.07	0.02	1.00	0.08	0.07	0.89
Reverse	0.15	0.07	0.99	0.13	0.07	0.97
Delay	-	-	-	-0.16	0.17	0.17
Learn	-	-	-	0.17	0.17	0.86
Age	-0.01	0.01	0.00	-0.01	0.01	0.00
Female	0.29	0.16	0.97	0.32	0.17	0.97
College	0.41	0.18	0.99	0.40	0.18	0.99
Income	0.01	0.00	1.00	0.01	0.00	1.00
	Variance of WTP					
σ_w^2	6.98	1.61	-	7.57	1.61	-

In the specification (2) of Table 3.10, we examine the direct effects of respondents' perceived potential for delay, learning, and reversal along with the cross effect of delay and learning on their WTP; i.e., let

$$W_i^* = \beta_0 + \beta_1(Delay_i \times Learn_i) + \beta_2 \mathrm{Re}verse_i + \beta_3 Delay_i + \beta_4 Learn_i + \beta_5 Age_i \\ + \beta_6 Female_i + \beta_7 College_i + \beta_8 Income_i + \beta_9 + \beta_{10} + \beta_{11} + \varepsilon_i$$

The estimated coefficients of the probit model suggest that the effects of respondents' perceived opportunity for delay and learning on WTP are mixed. The coefficient on delay is negative with somewhat weak support for its sign, with $\Pr(\beta_3 > 0 \mid y) = 0.17$. The direct learning coefficient (β_4) is positive with $\Pr(\beta_4 > 0 \mid y) = 0.86$. The interaction between delay and learning perceptions is positive, again contrary to the expectation from the theory, though $\Pr(\beta_2 > 0 \mid y) = 0.89$. Finally, the effect of reversal is positive, as the theory would predict.

Overall, in this sample, perceptions for reversal were positively correlated with the individual's revealed WTP. In other words, respondents who perceived positive opportunity to cancel an ineffective project had a higher WTP, as the theory would predict. However, contrary to the expectation of the theory, the interaction between respondents' delay and learning perception had a positive impact on WTP.

3. 4. 3. Findings from Iowa Lakes Survey 2005

In Iowa Lakes Survey 2003, we examine the impact of delay on WTP with a promised second chance to vote on the referendum. The impact of delay on WTP is examined with a reverse perspective in Iowa Lakes Survey 2005. Specifically, after a two-year lag with more information gathered, half of the 2005 sample was randomly informed that this is the last year of this study and there is no other water quality improvement plan so that they will not have another opportunity to vote on the referendum. We use the "immediacy" treatment to weaken the treated respondents' perceived potential for delay and in doing so, examine the impact of "immediacy" on WTP.

In addition, we examine the commitment cost theory regarding the impact of individuals' knowledge perceptions on WTP. In particular, the theory suggests that individuals who are well informed about the good or who do not expect to learn more information in the future would have less incentive to delay their purchase decision and, thus, have a higher WTP.

We first examine the impact of the "immediacy" treatment on WTP by assuming

$$W_i^* = \beta_0 + \beta_1 Treatment_i + \beta_2 Age_i + \beta_3 Female_i + \beta_3 College_i + \beta_4 Income_i + \varepsilon_i$$

where $Treatment_i = 1$ if the individual received version NV2 of the survey (indicating the last year of the study and no other opportunity to vote on the water quality improvement project), $= 0$ otherwise. If the "immediacy" treatment weakened respondents' perceived potential for delay and respondents responded in the manner predicted by the commitment cost theory, we expect β_1 to be positive.

The impact of the "immediacy" treatment on WTP is presented in Table 3.11. In this sample, respondents who were older, female, with college education, and higher income were more willing to pay for the proposed project. However, we do not find evidence supporting the commitment cost theory. Specifically, contrary to the theory's prediction, the posterior

Table 3.11 Treatment Effects on Willingness to Pay (Iowa Lakes Survey 2005)

Willingness to Pay, N = 1100			
Variable	$E(\bullet \mid y)$	$Std(\bullet \mid y)$	$\Pr(\bullet > 0 \mid y)$
Intercept	3.42	0.26	1.00
Treatment	-0.19	0.22	0.19
Age	0.26	0.16	0.99
Female	0.17	0.24	0.77

College	0.98	0.26	1.00
Income	0.27	0.12	0.99
Variance of WTP			
σ_w^2	7.43	1.61	-

mean of the treatment parameter on WTP is negative, (-0.19), though $\Pr(\beta_1 > 0 \mid y) = 0.19$. The weak impact of the treatment on WTP can be explained, in part, by the ineffectiveness of the treatment itself, since respondents who were informed the "immediacy" of the project did not have significant different perceptions of delay from the respondents who were not informed the immediacy of the project.

Next, examine the effects of respondents' knowledge perceptions on WTP. To test how respondents' knowledge perceptions influenced WTP, their WTP is estimated as

$$\begin{aligned} W_i^* = \beta_0 + \beta_1 Delay_i + \beta_2 KnowIncreased_i + \beta_3 Knowledge_i \\ + \beta_4 Age_i + \beta_5 Female_i + \beta_6 College_i + \beta_7 Income_i + \varepsilon_i \end{aligned}$$

where $Delay_i = 1,2,3,4,5$ with 1 indicates no chance to revisit the referendum and 5 indicates definite chance to revisit the referendum; $KnowIncreased_i = 1,2,3,4,5$ with 1 indicating know much less, 3 indicating know about the same, and 5 indicating know much more; and $Knowledge_i = 1,2,3,4,5$ with 1 indicating not informed at all, and 5 indicating well informed.

The commitment cost theory suggests that the value of the compensation respondents would ask for giving up her opportunity for delay depends on the value of the information. If respondents were well informed about the good or if respondents perceived less information about the good will be available, the value of delay would be lower. Thus, they would have less incentive to delay their decisions, i.e., higher WTP. Therefore, we would expect β_2 and β_3 to be positive, while β_1 would be negative.

Table 3. 12 presents the result of the probit model. The knowledge increment coefficient (β_2) is positive, but with week support for its sign, $\Pr(\beta_2 > 0 \mid y) = 0.66$. The

Table 3. 12 Effects of Perceived Dynamic Aspects on WTP (Iowa Lakes Survey 2005)

Willingness to Pay, N=548			
	$E(\bullet \mid y)$	$Std(\bullet \mid y)$	$\Pr(\bullet > 0 \mid y)$
Intercept	1.99	0.75	0.99
Delay	0.20	0.14	0.93
Knowledge Increment	0.08	0.20	0.66
Knowledge	0.28	0.17	0.95
Age	0.17	0.15	0.87
Female	0.76	0.33	0.99
College	0.69	0.34	0.98
Income	0.14	0.16	0.82
Variance			
σ_w^2	6.63	1.80	-

coefficient on respondents' knowledge level is positive, as the theory predicts. In particular, respondents' WTP did not increase with the information about the water quality in Iowa lakes they had learned. However, respondents who were more knowledgeable about the general water quality in Iowa lakes tend to have a higher WTP. Regarding respondents' perceptions for further delay, contrary to the theory's prediction, the coefficient on delay is positive; i.e., respondents who perceived higher potential for further delay tend to have a higher WTP.

3. 5. Discussion and Conclusions

The welfare measurement from a contingent valuation exercise is typically conceived as being static in nature. However, respondents' decisions are often dynamic. Incorporating the consequences of uncertainty, learning, and irreversibility, the commitment cost theory suggests that the formation of the welfare measurement is a dynamic process. Therefore, researchers need to reflect the potential for delay, learning, and reversal carefully in survey instruments.

In this paper, we examine the impacts of delay, learning, and irreversibility in two ways. First, we employed split sample treatments associated with the potential for delay to test the effect of delay on respondents' votes to the contingent valuation referendums. Specifically, half of our 2003 sample was promised a second chance to vote on the same referendum two years later. The 2005 version of survey provided respondents an opportunity to revisit the referendum posed in the 2003 version of survey. At the same time, half of the 2005 sample was randomly assigned a split sample treatment associated with the immediacy of the proposed project. Our findings showed that the exogenous treatments did not influence respondents' voting behavior and, hence, WTP. In other words, respondents who were promised a second chance to vote on the referendum did not have a lower WTP to the 2003 contingent valuation referendum. Furthermore, respondents who were told the immediacy of the project did not have a higher WTP to the 2005 contingent valuation referendum.

These results did not necessarily suggest that the potential for delay did not influence respondents' voting behavior. Instead, we would argue that the exogenous treatments employed in this study were not effective as expected. As a result, the failure of our treatment may stress the importance of a clear communication about the intertemporal aspects of the proposal in a contingent valuation referendum.

Next, we explored the linkage between the respondents' perceived dynamic aspects and their voting behavior. In particular, respondents' perceptions of delay, learning, and reversal were elicited in the 2003 version of survey. Incorporating respondents' self-reported potential for delay, learning, and reversal into consideration, we found that, as the theory's prediction, respondents who perceived a greater chance to cancel an ineffective project tend to have a higher WTP. However, the interaction between delay and learning did not influence respondents' voting behavior as the theory predicted. In particular, the theory expected that respondents who perceive more possibility to revisit the referendum and to obtain more information about the proposed project tend to have a lower WTP. Contrary to the theory's prediction, our result suggested that the interaction between delay and learning had a positive impact on WTP. Regarding the direct effects of delay and learning, our result weakly supported that respondents who expected less possibility to revisit the referendum and who expected more possibility to obtain more information about the proposed project tend to have a higher WTP.

In the 2005 version of survey, besides perceptions of delay, we asked respondents self-evaluated their knowledge and knowledge increment about the general water quality in Iowa lakes during the process of Iowa Lakes Project. The information was used to examine the relationship between knowledge, learning behavior, and their WTP. First, our results showed that respondents' knowledge increment about the proposed project did not influence their WTP. Second, respondents who were more knowledgeable about the general water quality in Iowa lakes tend to have a higher WTP. Finally, contrary to the empirical result in 2003 survey, respondents' perceived potential for delay had a positive impact on their WTP.

In general, our findings regarding the correlation between respondents' perceived dynamic aspects and WTP suggested that respondents would have a higher WTP if they perceived (a) that it was more likely to reverse their decisions, (b) that they were more knowledgeable about the proposed project. However, the correlation between the respondents' perceived delay and learning had a mixed effect on their WTP. In particular, the interaction between respondents' perceived delay and learning was positively correlated with their WTP. The respondents' perceived potential for acquiring more information about the proposed project was positively correlated with their WTP. The respondents' perceived potential for revisiting the referendum was negatively correlated with their WTP in the 2003 survey and was positively correlated with their WTP in the 2005 survey.

The mixed effect of respondents' perceived delay may suggest that there may be an endogeniety problem. One the one hand, respondents who perceived a higher potential to revisit the referendum may require a higher compensation to commit this decision, and hence, may hold a lower WTP. On the other hand, respondents who held a higher WTP may perceive a higher possibility to revisit the referendum. Normally, researchers would use an exogenous treatment to control for the endogeniety problem. Unfortunately, our exogenous treatments in 2003 survey and in 2005 survey did not successfully reinforce respondents' perceived potential for delay in the direction as we expected. Therefore, these treatments did not separate out the effect of respondents' perceived delay on their WTP. These results may suggest that a clear reflection of the dynamic aspects in a contingent valuation referendum is essential in obtaining a precise welfare measure. Our future works include (a) exploring effective treatments in communicating the dynamic aspects of the proposed project, (b) exploring the implications of various dynamic aspects surrounding individuals' behavior in dynamic environments, and (c) exploring the correlation between respondents' characteristics and their responses to the dynamic aspects.

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Appendix 3.A The Bayesian Estimation of Probit Model

Priors and the Joint Posterior

We fit the probit model using a Gibbs sampler with data augmentation suggested by Albert and Chib (1993).). The augmented posterior distribution involves adding the latent $\boldsymbol{W}_i^*$ to the joint posterior distribution. Under prior independence, the joint distribution can be represented as:

$$p\left(\boldsymbol{W}^*, \boldsymbol{\beta}, \sigma_{\mathrm{W}} \mid W\right) \propto p\left(\boldsymbol{W} \mid \boldsymbol{W}^*, \boldsymbol{\beta}, \sigma_{\mathrm{W}}\right) p\left(\boldsymbol{W}^* \mid \boldsymbol{\beta}, \sigma_{\mathrm{W}}\right) p(\boldsymbol{\beta})\, p\left(\sigma_{\mathrm{W}}\right)$$

$$= p(\boldsymbol{\beta})\, p\left(\sigma_{\mathrm{W}}\right) \prod_{i=1}^{N} p\left(\boldsymbol{W}_i \mid \boldsymbol{W}_i^*, \boldsymbol{\beta}, \sigma_{\mathrm{W}}\right) p\left(\boldsymbol{W}_i^* \mid \boldsymbol{\beta}, \sigma_{\mathrm{W}}\right),$$

where the product term follows from the assumed conditional independence across observations. For the first term on the right-hand side of the product, note

$$p\left(\boldsymbol{W}_i \mid \boldsymbol{W}_i^*, \boldsymbol{\beta}, \sigma_{\mathrm{W}}\right) = p\left(\boldsymbol{W}_i \mid \boldsymbol{W}_i^*\right)$$

where

$$p\left(\boldsymbol{W}_i \mid \boldsymbol{W}_i^*\right) = I\left(\boldsymbol{W}_i^* > \log(B_i)\right)$$

Apart from the priors, the remaining pieces in our joint posterior follow immediately from our normality assumption:

$$W_i^* \mid \boldsymbol{\beta}, \sigma_{\mathrm{W}} \overset{iid}{\sim} N\left(\mathbf{x}\boldsymbol{\beta}, \sigma_{\mathrm{W}}\right)$$

The model is completed by choosing priors of the forms:

$$\boldsymbol{\beta} \sim N\left(\boldsymbol{\mu}_{\beta}, \underline{\boldsymbol{V}}_{\beta}\right)$$

$$\sigma_W^{-1} \sim Gamma\left(\boldsymbol{R}, v\right)$$

For our priors, we use $\boldsymbol{\mu}_\beta = \mathbf{0}$, $\underline{V}_\beta = \left(100^2\right)\mathbf{I}_k$, $\boldsymbol{R} = 100$, and $v = 10$, which are reasonably non-informative choices, suggesting the information coming from the data will dominate information added through our prior.

The Posterior Simulator

Step 1. Drawing from $p\left(\boldsymbol{\beta} \mid \sigma_W, W^*\right)$, where.

$$\boldsymbol{\beta} \mid \sigma_W, W^* \sim N\left(\overline{\beta}, \overline{V}_\beta\right)$$

and

$$\overline{\beta} = \overline{V}_\beta \left(\sum_{i=1}^{N} \mathbf{X}_i' \Sigma^{-1} W_i^* + \underline{V}_\beta^{-1} \underline{\beta} \right), \quad \overline{V}_\beta = \left(\sum_{i=1}^{N} \mathbf{X}_i' \Sigma^{-1} \mathbf{X}_i + \underline{V}_\beta^{-1} \right).$$

Step 2. Drawing from $p\left(\sigma_W^{-1} \mid \boldsymbol{\beta}, W^*\right)$, where

$$\sigma_W^{-1} \mid \boldsymbol{\beta}, W^* \sim Gamma\left(\left[\rho R + \sum_{i=1}^{N} \varepsilon_i \varepsilon_i' \right]^{-1}, N + \rho \right)$$

Step 3. Drawing from $p\left(W_i^* \mid \boldsymbol{\beta}, \sigma_{\mathbf{W}}, \boldsymbol{W}\right)$. For $i = 1, 2, \ldots, n$

$$W_i^* \mid \boldsymbol{\beta}, \sigma_{\mathrm{W}}, \boldsymbol{W_i} \sim \begin{cases} \boldsymbol{TN}_{(-\infty, \log(B_i)]}\left(\mathbf{x}\boldsymbol{\beta}, \sigma_W^2\right) & \text{if } W_i = 0 \\ \boldsymbol{TN}_{[\log(B_i), \infty)}\left(\mathbf{x}\boldsymbol{\beta}, \sigma_W^2\right) & \text{if } W_i = 1 \end{cases}$$

A Gibbs sampler proceeds by simulating (in order) from the posterior conditional distribution.

Chapter 4. A Comparison of Value Elicitation Question Formats in Multiple Good Contingent Valuation

4. 1. Introduction

Economists use a variety of stated preference elicitation methods to estimate the economic value of non-market goods. Those various elicitation methods, particularly the form of the question used to infer value, have been the focus of a number of studies. The earliest elicitation question used is an “open-ended” question where respondents are asked directly to state their willingness to pay (WTP) or willingness to accept (WTA) for a given environmental change (Mitchell and Carson, 1986). While straightforward, respondents may find it difficult to answer an “open-ended” question for an environmental change they are not familiar with, and they may skip the valuation question or give unreliable answers. Therefore, the “open-ended” question often leads to a large number of non-responses and outliers (Desvousges, Smith, and McGivney, 1983).

An alternative elicitation format is the “payment card” approach where respondents are provided a list of monetary amounts and are asked to choose the level of payment that most closely approximates their WTP or WTA (Mitchell and Carson 1981, 1984). This method reduces the number of non-responses and outliers. However, the payment card question is sensitive to biases relating to the range of the numbers listed on the payment card (Mitchell and Carson, 1989).

In addition to the potential biases embedded in the “open-ended” and “payment card” formats, a fundamental issue about respondents’ strategic behavior exists in both elicitation formats. Mitchell and Carson (1989) provide a detailed review of respondent’s strategic behavior. Specifically, respondents would be expected to overbid if they believe that they will not have to pay their stated amounts even though the stated amounts would positively influence the provision of the good. On the other hand, respondents would be expected to underbid for the good if they believe they will have to pay their stated amount, and they perceive that other respondents will bid enough to provide the good. Mitchell and Carson present the evidence of strategic behavior in contingent valuation studies and suggest important factors in the preference revelation process which may mitigate the respondent's strategic behavior, such as information cost and social norms of altruism and truthfulness. Thus, they argue that respondents' strategic behavior can be prevented in preference revelation process, or at least be minimized.

The third question format is the "dichotomous choice" question in which respondents are provided two alternatives with one alternative typically being the status quo, and asked to choose one of them. The dichotomous choice question has several advantages and is now the most commonly used elicitation format since it was popularized by Bishop and Heberlein (1979). In particular, the "take-it-or-leave-it" question simplifies the respondents' task by asking respondents to decide whether to vote for or against the proposal at the fixed price provided. This is easier for the respondents than open-ended questions and result in higher response rates. More importantly, the dichotomous choice question circumvents the potential for strategic voting behavior and is incentive compatible. Indeed, one of the core theoretical results in mechanism design, derived independently by Gibbard (1973) and Satterthwaite (1975), is that no response method involving more than two choices can be incentive compatible without restrictions on the agents' preferences.

However, the dichotomous choice question can only measure the relative value between two alternatives. When more than two alternatives are under consideration, a researcher needs different constructs to elicit respondents' preferences. A number of stated choice methods commonly used in marketing and transportation literature have recently been applied in environmental valuation (Adamowicz, Louviere, and Williams, 1994; Garrod and Willis, 1996; Mackenzie, 1993; Roe, Boyle, and Teisl, 1996). These methods provide the respondents with a set of alternatives, each fully characterized by levels of attributes and costs. The respondents are then asked to rate the alternatives, to rank the alternatives, to choose the most preferred alternative, or to evaluate a series of pair-wise comparisons among the alternatives. With careful experimental design, these methods can be used to estimate economic value for the attributes of the environmental goods. The main difference between these stated choice approaches and contingent valuation is the focus of the former on obtaining marginal values for the attributes of the good.

Within the contingent valuation framework, the multinomial choice question is the most straightforward method when more than two alternatives are involved in the valuation process. Under a multinomial choice question, respondents are asked to choose the most preferred alternative out of a choice set. The respondents' answers to the multinomial choice question reveal the relative values between the chosen one and the other alternatives. However, the multinomial choice question may suffer from strategic voting behavior. Specifically, a respondent's choice among multiple policy alternatives may depend not only on his preferences among the alternatives, but also on his or her his belief about how the government will translate the survey results into action and his belief concerning other respondents' preference.

In order to mitigate respondents' strategic behavior, Carson and Groves (2007) suggest a modified multinomial choice question which changes one of the key elements in the multinomial choice question. They argue that if the respondents were convinced that the government would provide all but one of the policy alternatives, then the respondents would choose their most preferred alternative (i.e., the elicitation format would be incentive compatible). Their modified multinomial choice question is thus based on having the respondents choose which alternative they most want given that all but one of the remaining alternatives will be provided.

In this paper, we provide a convergent validity test of the dichotomous choice question, the multinomial choice question and the modified multinomial choice question by asking whether these elicitation question formats provide comparable welfare estimates. In particular, we accomplish the test with split samples where these value elicitation question formats are used to estimate the respondents' WTA for adopting perennial strips on farms in Iowa. The incentive and informational properties embedded in these elicitation question formats may provide respondents with different strategic incentives in revealing their true preferences and thus influence the location and the precision of the estimated distributions of the welfare measures. We use the estimated WTA distributions from the dichotomous choice referendum question as a baseline to examine the influence of the incentive and informational properties embedded in the multinomial choice question and in the modified multinomial choice question on respondents' WTA distribution in two aspects. First, since both the dichotomous choice question and the modified multinomial choice question are incentive compatible, we hypothesize that the modified multinomial choice question results in mean WTA's close to the mean WTA's derived from the dichotomous choice question. Second, the response from a multinomial choice question or a modified multinomial choice question contains more information than that from a dichotomous choice question, i.e., information on the relative value between the chosen alternative and all other alternatives in the choice set is provided, rather than just one. Therefore, we hypothesize that the multinomial choice question and the modified multinomial choice question will generate more precisely estimated WTA distributions than the dichotomous choice question.

Our result suggests that the multinomial choice question and the modified multinomial choice question produce similar WTA distributions. The mean WTA's elicited from the multinomial choice question and the modified multinomial choice question are greater than that elicited from the dichotomous choice question. In addition, the WTA distribution elicited from the multinomial choice question and modified multinomial choice question are more dispersed than that from the dichotomous choice question.

The paper is organized as follows. The next section describes the survey procedure and the value elicitation question formats employed in this study. The incentive and informational properties of these questions are discussed. The descriptive data summaries with respect to each valuation question are also provided. Section 3.3 describes the estimation procedures used in this study. The empirical results are provided in Section 3.4. Some final remarks follow in section 3.5.

4. 2. Survey Procedure and Stated Choice Methods

This study employs a web-based survey aimed at assessing farmers' perceptions, preferences, and reactions to alternative agricultural landscapes with increased perennial land cover both in flat land and in rolling land in the state of Iowa.[1] There is considerable interest in perennial crops due to their environmental benefits, particularly with respect to water

1 See Appendix 3 of the dissertation for a copy of the survey using the multinomial choice question format.

quality and wildlife habitat (Aase, Siddoway, and Black, 1985; Aase and Pikul, 1995). A link to the survey was put on the web page of the Center for Agricultural and Rural Development at Iowa State University from the November of 2006 through the August of 2007 (http://www.card.iastate.edu/). The survey was also placed on the website of the Agricultural Marketing Resource Center from mid-November to mid-December of 2006 (http://www.agmrc.org/agmrc/default.html). To provide an incentive for producers visiting the site to take the survey, the link contained information about a prize drawing. Two prizes of $250 each were given at the end of the survey period, randomly drawn from the survey respondents. To further increase the number of responses, we purchased from AgWeb.com a list of Iowa producers who had access to the internet and who had an e-mail address. This list contained 4,458 e-mail addresses, which were used to mail the survey message with the survey link and description of the incentive for a drawing.

The first section of the on-line survey collected information about the respondents' farming operation. The information included the respondents' occupation in 2005, whether the respondent was responsible for day-to-day farming decisions, the general location of the farm, ownership of the farm, total acres enrolled in conservation programs, and crop rotation and tillage system used in the farming operation.

Questions in the second section collected the respondents' perceptions regarding each of alternative landscape scenarios[2]:

∗ *Status quo*: No restrictions on tillage, crop rotation or any other management operation or practice, other than those currently required.

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[2] Copies of the pictures and accompanying text for each of the six scenarios are provided in Appendix C of this chapter.

∗ *Grazing*: Support partial conversion of cropland that is HEL or near streams, to pasture with rotational grazing.

∗ *59 ft. cropland, 19 ft. prairie strip*: Support converting HEL acres to rotating strips of corn and soybeans (59 ft. wide) that alternate with non-rotating perennial prairie mix strips (19 ft. wide)

∗ *120 ft. cropland, 15 ft. prairie strip*: Support for strips of annual crops strip (120 ft. wide) alternating with perennial plant strips (15 ft. wide).

120 ft. cropland, 30 ft. prairie strip: Support for strips of annual crops strip (120 ft. wide) alternating with perennial plant strips (30 ft. wide).

Native perennial cover: Support converting some or all cropland to native perennial cover, such as switch grass, that is harvested for biofuel.

Respondents were asked to rate each scenario in terms of to attractiveness, profitability, conservation, and ease of management based on the provided images. Possible responses to these perception questions ranged from 1 to 7 where a “1” denoted “the least favored” and “7” denoted “the most favored.” For a given image, if the respondent indicated a “1” in the conservation perception question, this meant that the respondent perceived that the proposed scenario was poor for conservation. On the other hand, if the respondent indicated a “7” in the conservation perception question, this meant that the respondent perceived that the proposed scenario was good in conservation.

The value elicitation questions in the third section assessed the respondents’ annual WTA to adopt the policy alternatives on their farms. The six policy alternatives were the same as the scenario respondents were asked to rate in the second section. Each policy alternative was presented with an image accompanied by a potential compensation payment and a summary of the land use/farming practices. Three value elicitation question formats were employed in split samples to estimate the WTA distributions of the alternatives. Each respondent was asked to choose one alternative in either a dichotomous choice question format, a multinomial choice question format, or a modified multinomial choice question format. These scenarios were presented to the respondents in two geographies: a relatively flat landscape or a hilling (or rolling) landscape. The final section collected the respondents' social demographic information, such as age, gender, education background, farming experience, and gross crop sales value in 2005.

In this study, 199 observations were assigned dichotomous choice questions, 170 observations were assigned modified multinomial choice questions, and 180 observations were assigned multinomial choice questions. In total, 549 observations were used. A brief discussion of the incentive and informational properties of the value elicitation question formats and the specific value elicitation questions used in this study is provided in the following subsections.

4. 2. 1. Dichotomous Choice Question

The dichotomous choice question has been the most widely used approach in the contingent valuation literature since the "take-it-or-leave-it" approach was developed by Bishop and Heberlein (1979). The referendum style survey, sometimes called the "close-ended" survey, first provides the respondent the attributes of the status quo and a proposed scenario with a hypothetical price. The respondent is then asked whether he would pay/accept the proposed scenario. This approach uses a number of hypothetical prices randomly assigned to the respondents to bracket their WTP/WTA. In a contingent valuation survey regarding a lake restoration project, for example, a respondent may be asked, "Would you vote 'yes' to the referendum to improve the water quality to the level as described here if the proposed project would cost you $x?"

This method has several advantages over its "open-ended" counterpart. First, it simplifies the respondents' cognitive task by asking them to make a judgment about a given value. It is similar to deciding whether to buy a market good at a given price. Second, this method is incentive compatible as it is in the respondents' interest to reveal their true preferences. However, each respondent's true valuation is an unobservable random variable since the respondent's yes/no response to the dichotomous choice question only reveals whether his WTP/WTA is above or below the proposed bid value. Thus, this method is less efficient and requires a large number of observations to obtain precise WTP/WTA estimates.

Six policy alternatives including the status quo were considered in this study. The six alternatives describe different agricultural land uses and compensation levels associated with their adoption. For each scenario, a picture of the cropping system was provided with information on the management practices that would accompany it. Each respondent who was assigned a dichotomous choice question was randomly assigned two of the six alternatives and was asked to choose his most preferred. Since a dichotomous choice question considers two alternatives at a time, in total, fifteen combinations of dichotomous choice questions were employed.

The respondent was provided a brief introduction before the information and the potential compensation payment associated with each alternative was proposed. The Script of the introduction and a sample of the dichotomous choice questions are provided in Figure 4.1 and Figure 4.2.

In the next section consider the alternative landscapes you have just seen. This time consider how much compensation you would need each year to be willing to implement these practices on all or part of ***your farm.***

On the following pages you will see two of the images you just rated. Each image is accompanied by a potential per-acre conservation payment and a summary of the farm program that would accompany it. Consider both alternatives and then select which **single** alternative you would most like to see offered in the next farm bill.

In considering these alternatives, assume that the current suite of farm programs would continue to be available unchanged **except that the new alternative would replace any existing programs that specifically apply to the identified practice.**

Figure 4.1 Introduction of the Dichotomous Choice Question

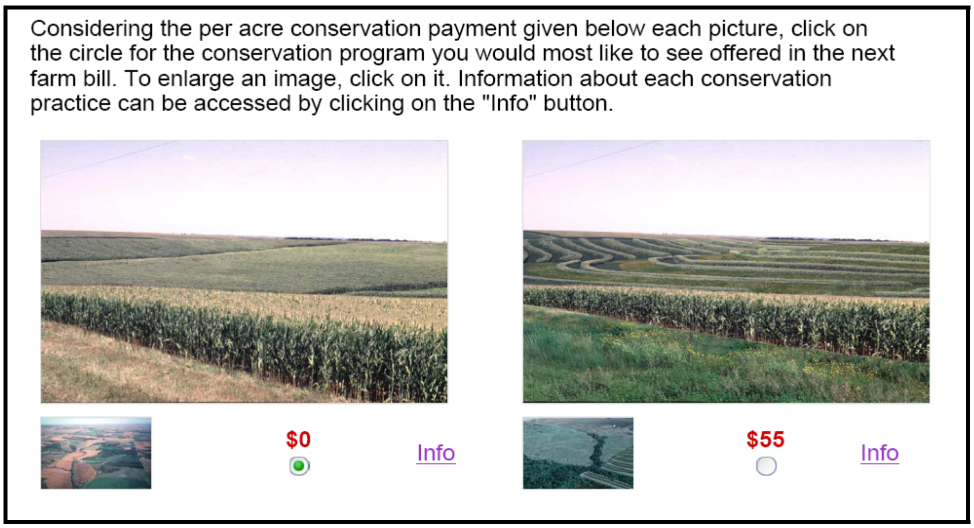

Figure 4.2 A Sample of the Dichotomous Choice Question

Table 4.1 and Table 4.2 report the descriptive data summaries categorized by the respondents' choice in the dichotomous choice question in the flat land scenario and in the rolling land scenario, respectively. On average, the respondents were about 53 years old with 28 years of farming experience and their mean gross value of sales in 2005 was $235,600. In this sample, 40% of the respondents were full-time farmers in 2005, 49% of the respondents were college graduates, and 85% of the respondents were responsible for making the day-to-day decisions for a farm. The variation of the total acre in the operation was large,

Table 4.1 Descriptive Data Summary (Flat Land, Dichotomous Choice Question)

(Standard Errors in Parentheses)

	Status Quo	Grazing	59 ft Crop, 19 ft Prairie	15 ft Crop, 120 ft Prairie	30 ft Crop, 120 ft Prairie	Native Perennial Cover	Dichotomous Choice Sample
Respondent's Characteristics							
Age	51.77 (10.71)	53.82 (13.01)	51.92 (13.43)	53.57 (11.40)	53.97 (9.25)	55.72 (10.13)	53.37 (11.43)
Farm Year	28.71 (10.84)	28.36 (14.44)	24.77 (15.05)	26.96 (12.25)	29.85 (12.24)	29.76 (14.21)	28.23 (13.35)
Gross Value of Sales in 2005 ($10,000)	25.65 (29.19)	22.75 (33.43)	15.05 (18.43)	25.49 (42.62)	26.33 (31.01)	25.05 (40.71)	23.56 (32.66)
Full-Time Farmer in 2005	0.48	0.38	0.19	0.26	0.58	0.44	0.40
College	0.43	0.48	0.77	0.57	0.36	0.44	0.49
Male	0.95	0.90	0.85	0.87	0.88	0.88	0.89
Decision Maker	0.90	0.88	0.88	0.96	0.70	0.80	0.85
Farm's Characteristics							
Acre Total	630.47 (619.41)	558.22 (599.86)	293.32 (304.97)	383.85 (460.69)	544.30 (520.37)	720.88 (1286.99)	536.83 (682.00)
Acre-Crop	0.71	0.55	0.67	0.77	0.45	0.65	0.62
Acre-CRP, WRP	0.07	0.26	0.26	0.09	0.12	0.16	0.16
Acre-HEL	0.55	0.38	0.27	0.25	0.29	0.31	0.36
No Tillage or Strip Tillage	0.33	0.48	0.50	0.35	0.36	0.32	0.40
Ridge Tillage	0.03	0.00	0.04	0.00	0.03	0.00	0.02
Mulch Tillage	0.31	0.18	0.27	0.30	0.15	0.20	0.23
Conventional Tillage	0.33	0.34	0.15	0.35	0.42	0.48	0.35
N	42	50	26	23	33	25	199

Table 4.2 Descriptive Data Summary (Rolling Land, Dichotomous Choice Question)

(Standard Errors in Parentheses)

	Status Quo	Grazing	59 ft Crop, 19 ft Prairie	15 ft Crop, 120 ft Prairie	30 ft Crop, 120 ft Prairie	Native Perennial Cover	Dichotomous Choice Sample
Respondent's Characteristics							
Age	49.24 (11.97)	53.06 (11.50)	55.50 (9.81)	52.45 (11.31)	53.83 (11.33)	56.34 (11.91)	53.37 (11.43)
Farm Year	27.60 (12.31)	30.45 (13.04)	31.86 (11.54)	25.03 (12.70)	28.28 (11.88)	25.28 (17.19)	28.23 (13.35)
Gross Value of Sales in 2005 ($10,000)	25.96 (31.70)	26.96 (33.46)	29.96 (39.65)	17.62 (18.24)	22.11 (32.81)	17.54 (36.61)	23.56 (32.66)
Full-Time Farmer	0.47	0.47	0.50	0.32	0.31	0.31	0.40

in 2005 (%)							
College (%)	0.37	0.51	0.50	0.58	0.52	0.47	0.49
Male (%)	0.93	0.88	0.93	0.84	0.93	0.88	0.89
Decision Maker (%)	0.57	0.90	1.00	0.90	0.86	0.88	0.85
Farm's Characteristics							
Acre Total	553.60 (667.93)	580.78 (820.19)	747.36 (931.94)	518.65 (485.67)	435.42 (421.71)	379.14 (536.17)	536.83 (682.00)
Acre-Crop (%)	0.77	0.48	0.65	0.70	0.68	0.55	0.62
Acre-CRP, WRP (%)	0.13	0.13	0.16	0.11	0.22	0.26	0.16
Acre-HEL (%)	0.63	0.29	0.37	0.25	0.31	0.37	0.36
No Tillage or Strip Tillage (%)	0.33	0.43	0.43	0.29	0.44	0.44	0.40
Ridge Tillage (%)	0.03	0.00	0.04	0.03	0.00	0.00	0.02
Mulch Tillage (%)	0.20	0.24	0.25	0.30	0.28	0.13	0.23
Conventional Tillage (%)	0.40	0.33	0.29	0.38	0.28	0.41	0.35
N	30	49	28	31	29	32	199

corresponding to the large variation of the gross sales value. Of the land in the respondents' operation, on average, 62% was cropland, 16% was enrolled in the Conservation Reserve Program (CRP) or Wetlands Reserve Program (WRP), and 36% was highly erodible land (HEL). Regarding the tillage system used on the majority of the respondents' cropland, on average, 40% used no tillage or strip tillage, 2% used ridge tillage, 23% used mulch tillage, and 35% used conventional tillage.

Turning to the respondents' vote in the dichotomous choice questions, the grazing scenario received the most votes both in the flat and rolling geographies. In addition, compared to the respondents who chose the other policy alternatives, the respondents who chose the status quo had a higher percentage of cropland in operation, a lower percentage of land enrolled in CRP or WRP, and a higher percentage of land in operation that was highly erodible.

Table 4.3 and Table 4.4 report the respondents' perceptions concerning the attractiveness, profitability, conservation, and ease of management of each landscape alternative in the flat and rolling land scenarios, respectively. In both scenarios, respondents perceived that the status quo was the easiest in farming operation and the most profitable among all alternatives. Compared to the other alternatives, the status quo was less favored in terms of conservation. The above findings may suggest that the respondents' current farming operation was cost minimizing and profit maximizing but less conservation oriented.

4. 2. 2. Multinomial Choice Method

In a multinomial choice question, respondents are provided a choice set containing more than two alternatives where each alternative is described and is associated with different prices. The respondents are asked to choose the most preferred alternative from the choice set. Similar to the dichotomous choice question, several bid prices are used for each alternative.

Each respondent's response to a multinomial choice question reveals more information than a dichotomous choice question. Specifically, the respondent's answer to a dichotomous choice question only reveals the relative value between the chosen alternative

Table 4.3 Respondents' Perceptions on Policy Alternatives (Flat Land, Dichotomous Choice Question)

	Status Quo	Grazing	59 ft Crop, 19 ft Prairie	15 ft Crop, 120 ft Prairie	30 ft Crop, 120 ft Prairie	Native Perennial Cover	Dichotomous Choice Sample
Attractiveness							
Status Quo	5.52	5.28	5.23	5.35	4.91	5.08	5.25
Grazing	5.24	5.34	5.19	4.78	4.91	5.68	5.21
59 ft Crop, 19 ft Prairie	4.64	4.94	5.04	4.61	4.64	5.72	4.90
15 ft Crop, 120 ft Prairie	5.05	5.34	5.62	5.48	5.00	5.56	5.30
30 ft Crop, 120 ft Prairie	4.90	5.36	5.65	5.39	4.97	5.88	5.31
Native Perennial Cover	5.07	5.32	5.04	5.04	4.91	5.56	5.16
Easy to Manage							
Status Quo	5.79	5.62	5.77	5.65	5.27	6.20	5.69
Grazing	4.10	4.12	4.69	4.26	3.85	4.64	4.23
59 ft Crop, 19 ft Prairie	3.45	3.84	4.27	3.35	3.27	4.32	3.72
15 ft Crop, 120 ft Prairie	3.86	4.30	4.77	4.48	3.88	5.00	4.31
30 ft Crop, 120 ft Prairie	4.02	4.34	4.58	4.43	4.12	5.08	4.37
Native Perennial Cover	4.98	5.40	5.31	5.13	4.82	5.92	5.24
Conservation							
Status Quo	4.85	4.46	4.62	4.30	3.94	4.16	4.42
Grazing	5.64	5.40	5.35	4.78	5.06	5.36	5.31
59 ft Crop, 19 ft Prairie	5.55	5.36	5.62	5.26	4.85	5.96	5.41
15 ft Crop, 120 ft Prairie	5.67	5.40	5.54	5.17	4.79	5.52	5.36
30 ft Crop, 120 ft Prairie	5.64	5.42	5.42	5.26	4.91	5.76	5.41
Native Perennial Cover	5.95	5.92	5.58	5.70	5.58	6.16	5.83
Profit							
Status Quo	5.76	5.60	6.19	5.65	5.30	5.92	5.71
Grazing	4.71	4.66	5.04	4.17	4.67	5.16	4.73
59 ft Crop, 19 ft Prairie	3.95	4.28	4.69	3.57	3.79	4.92	4.18
15 ft Crop, 120 ft Prairie	4.67	4.98	5.31	4.96	4.42	5.48	4.92
30 ft Crop, 120 ft Prairie	4.57	4.96	5.08	5.00	4.45	5.48	4.88
Native Perennial Cover	4.48	4.48	4.85	3.65	4.09	4.96	4.43

* Possible responses to these perception questions ranged from 1 to 7 where a "1" denoted "the least favored" and "7" denoted "the most favored."

and a second alternative. On the other hand, the respondent's response to a multinomial choice question provides the relative values between the chosen one and other alternatives.

and a second alternative. On the other hand, the respondent's response to a multinomial choice question provides the relative values between the chosen one and other alternatives.

However, this advantage comes with a price. The multinomial choice question provides respondents more choices, and thus more information, which requires more

Table 4.4 Respondents' Perceptions on Policy Alternatives (Rolling Land, Dichotomous Choice Question)

	Status Quo	Grazing	59 ft Crop, 19 ft Prairie	15 ft Crop, 120 ft Prairie	30 ft Crop, 120 ft Prairie	Native Perennial Cover	Dichotomous Choice Sample
Attractiveness							
Status Quo	4.97	4.88	4.32	5.42	5.45	4.53	4.92
Grazing	5.10	5.76	5.82	5.74	5.48	5.44	5.57
59 ft Crop, 19 ft Prairie	4.53	5.41	5.68	5.48	5.31	5.34	5.30
15 ft Crop, 120 ft Prairie	5.00	5.49	5.32	5.61	5.45	5.34	5.38
30 ft Crop, 120 ft Prairie	5.00	5.51	5.43	5.81	5.52	5.22	5.42
Native Perennial Cover	4.70	5.31	5.36	5.06	4.97	5.19	5.12
Easy to Manage							
Status Quo	5.20	5.31	5.32	5.16	5.38	4.78	5.20
Grazing	4.23	4.90	4.54	4.39	4.48	4.16	4.49
59 ft Crop, 19 ft Prairie	3.03	3.98	4.29	3.61	3.38	3.63	3.68
15 ft Crop, 120 ft Prairie	3.37	4.27	4.21	3.71	3.83	3.50	3.85
30 ft Crop, 120 ft Prairie	3.93	4.39	4.61	4.32	4.07	4.13	4.25
Native Perennial Cover	4.83	5.20	5.21	4.97	4.76	5.09	5.03
Conservation							
Status Quo	4.00	4.22	3.54	4.03	4.34	3.78	4.01
Grazing	5.53	5.78	5.86	6.10	5.58	5.38	5.71
59 ft Crop, 19 ft Prairie	5.30	5.90	5.79	5.90	5.48	5.47	5.66
15 ft Crop, 120 ft Prairie	5.53	5.80	5.50	5.77	5.38	5.34	5.58
30 ft Crop, 120 ft Prairie	5.40	5.84	5.64	5.90	5.55	5.38	5.64
Native Perennial Cover	5.37	5.88	6.00	5.94	5.72	5.63	5.76
Profit							
Status Quo	5.53	5.35	5.04	5.26	5.45	4.94	5.27
Grazing	4.07	4.84	4.89	4.19	4.31	4.28	4.46
59 ft Crop, 19 ft Prairie	3.67	4.67	4.64	4.32	4.21	4.53	4.37
15 ft Crop, 120 ft Prairie	4.47	5.10	5.18	4.71	4.76	4.84	4.86
30 ft Crop, 120 ft Prairie	4.47	5.04	5.04	4.94	4.79	4.66	4.84
Native Perennial Cover	3.93	4.47	4.64	4.13	3.79	4.13	4.21

∗ Possible responses to these perception questions ranged from 1 to 7 where a "1" denoted "the least favored" and "7" denoted "the most favored."

cognitive effort from respondents. More importantly, this method is not incentive compatible. In particular, the theoretical result from the voting literature regarding multinomial choice using plurality rule suggests that, from a respondent's point of view, a multinomial choice question can reduce to a dichotomous choice question between the two alternatives that the respondent believes will receive the most votes independent of his vote. Therefore, if a respondent believes that the government will provide the alternative which receives the most votes in the choice set, he will then strategically pick his optimal choice depending on his conjecture of the other respondents' choices. In this case, a respondent reveals his preferred choice, conditional on the other respondents' preference.

For example, as shown in Table 4.5, Thomas, Belinda, and Ruth are assigned to choose one of the three alternatives, A, B, and C. Suppose that the sequence of Thomas's preference order is A, B, then C; Belinda's preference order is B, C, then A; Ruth's preference order is C, A, then B. Suppose also that Thomas perceives that the government will provide the alternative which receives the most votes. If Thomas believes that Belinda would vote for B and Ruth would vote for C, then Thomas would vote for B. In this case, Thomas reveals his vote conditional on his belief about Belinda's and Ruth's preferences.

Table 4.5 An Example for Multinomial Choice Question

	Thomas	Belinda	Ruth
1	A	B	C
2	B	C	A
3	C	A	B

Before presenting the respondents the multinomial choice question regarding the attributes and bid value associated with each policy alternative, we provided respondents a brief introduction about the multinomial choice question. Specifically, each respondent was told to consider how much compensation he would need in implementing each practice on his farm each year and then select the one single alternative he would most like to see offered in the next farm bill. The script of the introduction and a sample of the multinomial choice question are provided in Figure 4.3 and Figure 4.4, respectively.

In the next section consider the alternative landscapes you have just seen. This time consider how much compensation you would need each year to be willing to implement these practices on all or part of ***your farm.***

On the following pages you will see smaller versions of the images you just rated. **Each image is accompanied by a potential per-acre conservation payment and a summary of the farm program that would accompany it. Consider all alternatives and then select the one single alternative you would most like to see offered in the next farm bill.**

Assume that current farm programs would continue to be available, except that the alternative you choose would replace existing programs that specifically apply to those land management choices.

Figure 4.3 Introduction of the Dichotomous Choice Question

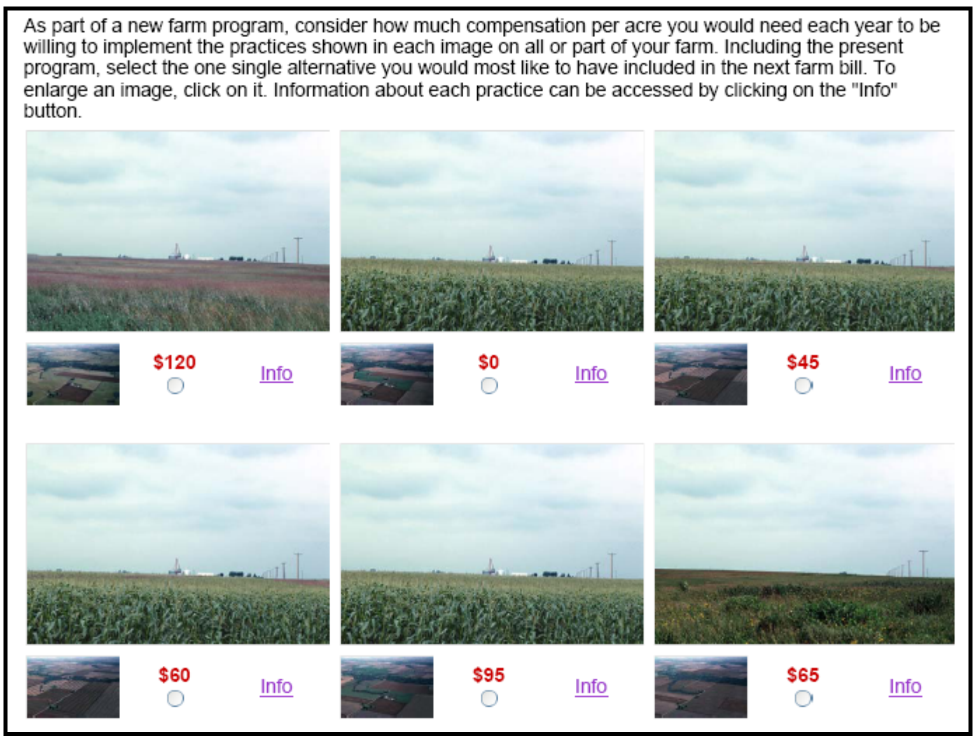

Figure 4.4 A Sample of the Multinomial Choice Question

The descriptive data summaries categorized by the respondents' choice to the multinomial choice question for flat rolling land scenarios are provided in Table 4.6 and Table 4.7. On average, the respondents were about 52 years old with 27 years of farming experience. Their mean gross value of sales in 2005 was $253,700. In this sample, 53% of

Table 4.6 Descriptive Data Summary (Flat Land, Multinomial Choice Question)

(Standard Errors in Parentheses)

	Status Quo	Grazing	59 ft Crop, 19 ft Prairie	15 ft Crop, 120 ft Prairie	30 ft Crop, 120 ft Prairie	Native Perennial Cover	Multinomial Choice Sample
Respondent's Characteristics							
Age	52.13	51.75	50.81	49.27	56.06	52.30	52.14
	(11.46)	(12.24)	(7.91)	(12.48)	(9.15)	(10.44)	(10.92)
Farm Year	31.00	28.52	20.25	23.45	27.75	24.65	26.82
	(12.59)	(13.73)	(12.90)	(14.00)	(16.27)	(11.74)	(13.33)
Gross Value of Sales in 2005 ($10,000)	42.22 (39.85)	25.06 (23.62)	15.86 (23.76)	18.18 (14.70)	15.94 (19.08)	20.12 (28.00)	25.37 (29.81)
Full-Time Farmer in 2005	0.68	0.59	0.25	0.45	0.31	0.43	0.53
College (%)	0.48	0.39	0.81	0.55	0.50	0.62	0.50
Male (%)	0.93	0.93	0.94	1.00	1.00	0.96	0.95
Decision Maker (%)	0.93	0.68	0.75	1.00	0.81	0.91	0.84
Farm's Characteristics							
Acre Total	824.13	763.07	306.56	401.18	463.25	445.02	593.64
	(767.13)	(996.27)	(352.47)	(348.63)	(425.67)	(656.51)	(748.92)
Acre-Crop (%)	0.86	0.72	0.63	0.80	0.73	0.61	0.71
Acre-CRP, WRP (%)	0.05	0.13	0.21	0.03	0.14	0.26	0.15
Acre-HEL (%)	0.36	0.29	0.38	0.25	0.26	0.51	0.37
No Tillage or Strip Tillage (%)	0.45	0.39	0.50	0.55	0.25	0.38	0.41
Ridge Tillage (%)	0.00	0.05	0.00	0.00	0.06	0.02	0.02
Mulch Tillage (%)	0.23	0.25	0.25	0.27	0.19	0.15	0.21
Conventional Tillage (%)	0.32	0.30	0.25	0.18	0.50	0.45	0.36
N	40	44	16	11	16	53	180

respondents were full-time farmers in 2005, 50% of the respondents were college graduates, and 84% of the respondents were responsible for making the day-to-day decisions for a farm. The size of the farms varied. In general, of the land in operation, 71% was cropland, 15% was enrolled in CRP or WRP, and 35% was highly erodible land. Regarding the tillage system employed on the respondents' cropland, on average, 41% used no tillage or strip tillage, 2% used ridge tillage, 21% used mulch tillage, and 36% used conventional tillage.

Table 4.7 Descriptive Data Summary (Rolling Land, Multinomial Choice Question)

(Standard Errors in Parentheses)

	Status Quo	Grazing	59 ft Crop, 19 ft Prairie	15 ft Crop, 120 ft Prairie	30 ft Crop, 120 ft Prairie	Native Perennial Cover	Multinomial Choice Sample
Respondent's Characteristics							
Age	49.36	53.71	47.89	55.00	53.10	52.43	52.14
	(10.01)	(11.54)	(9.35)	(14.74)	(11.91)	(9.92)	(10.92)
Farm Year	27.44	29.10	20.78	29.00	24.86	25.90	26.82
	(12.36)	(13.07)	(9.78)	(18.80)	(15.80)	(12.48)	(13.33)
Gross Value of Sales in 2005 ($10,000)	38.54 (37.44)	18.56 (19.75)	19.03 (25.32)	29.20 (26.82)	24.82 (34.46)	22.93 (28.88)	25.37 (29.81)
Full-Time Farmer in 2005 (%)	0.75	0.51	0.33	0.36	0.33	0.45	0.53
College (%)	0.44	0.58	0.56	0.55	0.57	0.53	0.50
Male (%)	0.92	0.93	1.00	0.91	1.00	0.97	0.95
Decision Maker (%)	1.00	0.93	1.00	0.82	0.24	0.86	0.84
Farm's Characteristics							
Acre Total	814.72	492.02	254.22	677.09	596.24	571.17	593.64
	(696.28)	(452.97)	(334.86)	(498.85)	(794.47)	(982.52)	(748.92)
Acre-Crop (%)	0.77	0.69	0.62	0.74	0.79	0.67	0.71
Acre-CRP, WRP (%)	0.08	0.11	0.23	0.18	0.14	0.22	0.15
Acre-HEL (%)	0.39	0.35	0.56	0.31	0.22	0.41	0.37
No Tillage or Strip Tillage (%)	0.44	0.51	0.44	0.55	0.29	0.31	0.41
Ridge Tillage (%)	0.00	0.04	0.00	0.00	0.05	0.02	0.02
Mulch Tillage (%)	0.19	0.20	0.22	0.18	0.29	0.21	0.21
Conventional Tillage (%)	0.27	0.24	0.33	0.27	0.33	0.47	0.36
N	36	45	9	11	21	58	180

Overall, the respondents' socioeconomic characteristics and farming operation characteristics are similar to those assigned in the dichotomous choice question sample.

In this sample, the "native perennial cover", the "grazing", and the "status quo" scenarios were chosen over 75% of the time in both scenarios. In particular, the "native perennial cover" received about 30% of the votes, the "grazing" received about 25% of the votes, and the "status quo" received about 20% of the votes. In addition, the respondents who chose the "status quo" had a higher percentage of cropland and a lower percentage of land enrolled in CRP or WRP in their operation. The respondents who chose the "native perennial cover" had a percentage of lower cropland and a higher percentage of land enrolled in CRP or WRP in their operation.

The respondents' perceptions regarding attractiveness, ease of management, conservation, and profitability of each alternative are reported in Table 4.8 and Table 4.9. In general, the respondents' perceptions with respect to these aspects in the multinomial choice question sample were similar to those assigned in the dichotomous choice question sample.

Table 4.8 Respondents' Perceptions on Policy Alternatives (Flat Land, Multinomial Choice Question)

	Status Quo	Grazing	59 ft Crop, 19 ft Prairie	15 ft Crop, 120 ft Prairie	30 ft Crop, 120 ft Prairie	Native Perennial Cover	Multinomial Choice Sample
Attractiveness							
Status Quo	5.98	5.39	4.19	4.82	5.63	5.38	5.39
Grazing	5.45	5.39	5.25	5.18	5.56	5.42	5.40
59 ft Crop, 19 ft Prairie	4.15	4.70	5.69	4.09	5.50	5.28	4.87
15 ft Crop, 120 ft Prairie	5.08	5.07	5.56	5.18	5.56	5.28	5.23
30 ft Crop, 120 ft Prairie	5.08	4.91	6.00	5.45	5.88	5.51	5.34
Native Perennial Cover	4.78	5.09	5.94	4.91	5.63	5.75	5.33
Easy to Manage							
Status Quo	6.03	5.77	5.88	5.91	6.06	5.75	5.87
Grazing	3.73	4.59	4.06	4.73	5.00	4.66	4.42
59 ft Crop, 19 ft Prairie	2.85	3.52	4.13	3.45	4.19	3.96	3.61
15 ft Crop, 120 ft Prairie	3.75	3.82	4.50	3.64	4.25	4.17	3.99
30 ft Crop, 120 ft Prairie	3.83	4.02	4.38	3.82	4.94	4.43	4.20
Native Perennial Cover	4.45	5.49	5.31	5.36	5.63	5.83	5.34
Conservation							
Status Quo	5.25	4.57	3.38	3.91	4.75	4.47	4.56
Grazing	4.85	5.64	4.88	5.00	5.13	5.66	5.32
59 ft Crop, 19 ft Prairie	4.73	5.64	5.75	5.64	6.13	5.92	5.57
15 ft Crop, 120 ft Prairie	5.05	5.45	5.25	5.36	5.38	5.53	5.36
30 ft Crop, 120 ft Prairie	5.18	5.39	5.31	5.00	5.81	5.64	5.42
Native Perennial Cover	5.60	5.95	5.88	6.09	6.38	6.40	6.04
Profit							
Status Quo	6.15	5.93	5.38	5.91	6.06	5.94	5.94
Grazing	4.40	4.84	5.00	4.64	4.94	4.74	4.72
59 ft Crop, 19 ft Prairie	3.23	3.77	5.06	3.82	4.50	4.23	3.97
15 ft Crop, 120 ft Prairie	4.53	4.75	5.44	4.82	5.31	5.08	4.91
30 ft Crop, 120 ft Prairie	4.48	4.75	5.25	4.82	5.50	4.81	4.82
Native Perennial Cover	4.10	4.45	5.13	4.09	4.75	4.98	4.59

∗ Possible responses to these perception questions ranged from 1 to 7 where a "1" denoted "the least favored" and "7" denoted "the most favored."

Table 4.9 Respondents' Perceptions on Policy Alternatives (Rolling Land, Multinomial Choice Question)

	Status Quo	Grazing	59 ft Crop, 19 ft Prairie	15 ft Crop, 120 ft Prairie	30 ft Crop, 120 ft Prairie	Native Perennial Cover	Multinomial Choice Sample
Attractiveness							
Status Quo	5.75	5.07	4.44	5.45	5.14	5.05	5.20
Grazing	5.36	6.04	6.00	5.55	4.57	5.91	5.66
59 ft Crop, 19 ft Prairie	4.31	5.22	5.78	4.91	4.19	5.66	5.07
15 ft Crop, 120 ft Prairie	5.20	5.42	6.00	6.27	4.76	5.72	5.48
30 ft Crop, 120 ft Prairie	5.22	5.58	5.78	6.18	4.57	5.72	5.48
Native Perennial Cover	4.33	5.18	5.89	5.27	4.95	5.67	5.18
Easy to Manage							
Status Quo	5.78	5.69	5.67	5.18	5.90	5.57	5.66
Grazing	3.95	5.33	5.11	4.73	3.62	4.71	4.61
59 ft Crop, 19 ft Prairie	2.33	3.84	4.11	3.00	2.19	3.95	3.34
15 ft Crop, 120 ft Prairie	2.78	4.13	4.89	4.27	2.95	4.09	3.76
30 ft Crop, 120 ft Prairie	3.31	4.49	4.44	4.64	3.48	4.33	4.09
Native Perennial Cover	4.22	5.09	5.78	5.73	5.43	5.72	5.23
Conservation							
Status Quo	4.95	4.07	3.56	4.45	4.24	4.03	4.25
Grazing	5.31	6.07	6.00	5.64	5.14	6.03	5.77
59 ft Crop, 19 ft Prairie	5.03	5.62	6.00	5.82	4.95	6.14	5.62
15 ft Crop, 120 ft Prairie	5.45	5.62	5.67	6.09	4.81	6.02	5.65
30 ft Crop, 120 ft Prairie	5.39	5.89	5.00	6.36	5.05	6.00	5.71
Native Perennial Cover	5.53	5.89	6.33	6.27	6.10	6.41	6.06
Profit							
Status Quo	5.89	5.49	5.00	5.55	5.57	5.66	5.61
Grazing	3.89	5.20	4.89	3.82	3.62	4.64	4.47
59 ft Crop, 19 ft Prairie	3.31	4.49	5.22	4.18	3.43	4.66	4.20
15 ft Crop, 120 ft Prairie	4.39	5.13	5.56	5.55	4.29	5.16	4.94
30 ft Crop, 120 ft Prairie	4.08	5.02	5.22	5.09	4.19	4.97	4.73
Native Perennial Cover	3.72	4.04	5.22	4.73	4.00	4.84	4.33

∗ Possible responses to these perception questions ranged from 1 to 7 where a "1" denoted "the least favored" and "7" denoted "the most favored."

Specifically, the respondents believed that the "status quo" was the easiest and the most profitable farming operation among all alternatives. The conservation ability of the "status quo" was the lowest among all alternatives.

4. 2. 3. CGM Multinomial Choice Method

Concerning the respondent's potential strategic voting behavior in answering a multinomial choice question, Carson and Groves (2007) argue that if a respondent only uses one of the alternatives and is convinced that the government will provide all but one of the alternatives, he should choose his favorite, i.e., reveal his true preference. That is, by convincing the respondent that all but one of the alternatives will be provided, the modified multinomial choice question reduces to a dichotomous choice question, i.e., the respondent votes for his most preferred alternative against the other alternatives competing for the alternative that will not be offered. The worst case for an individual is that his second best choice is provided but not the best. In order to increase the likelihood of his best choice being provided, his dominant strategy is to reveal his true preference.

Suppose that the water quality in six lakes is considered to be restored. If the respondent will use only one of the lakes and believes that the government will clean five out of the six lakes, his dominant strategy is to vote for his most preferred choice (reveal his true preference). In a contingent valuation survey, for example, a respondent may be asked, "Consider a water quality improvement project and the potential payment described. If the government would implement the lake restoration projects in only five of the six lakes, please select the one single lake you would like most to implement the water quality improvement project."

Similar to a multinomial choice question, a modified multinomial choice question collects more information about the respondents' relative value between the chosen alternative and the other alternatives than a dichotomous choice question. A modified multinomial choice question also shares the same disadvantage of a multinomial choice question, i.e., more cognitive effort is required in answering a modified multinomial choice question. However, the modified multinomial choice question has an advantage over the multinomial choice question; namely that the respondent's answer to the modified multinomial choice question should not depend on his conjecture about the other respondents' votes and the respondent's dominant strategy is to vote for his favorite.

As shown in Figure 4.5, each respondent a brief introduction before the alternatives were proposed. Each respondent was told that five of the six alternatives would be offered, and the respondent was then asked to select the alternative he would most like to have included in the five alternatives. A sample of the modified multinomial choice question is provided in Figure 4.6.

Table 4.10 and Table 4.11 report the descriptive data summaries categorized by the respondents' choice in the modified multinomial choice question for the flat land and rolling land scenarios, respectively. On average, the respondents were about 52 years old with over 30 years of farming experience and their mean gross value of sales in 2005 was $167,600. In this sample, 41% of the respondents were full-time farmers in 2005, 46% of the respondents were college graduates, and 90% of the respondents were responsible for making the day-to-day decisions for a farm. The variation of the total acre in operation was large which was corresponding to the large variation of the gross sales value. Of the land in the respondents'

In the next section consider the alternative landscapes you have just seen. This time consider how much compensation you would need each year to be willing to implement these practices on all or part of ***your farm.***

On the following pages you will see smaller versions of the images you just rated. **Each image is accompanied by a potential per-acre conservation payment and a summary of the farm program that would accompany it. Assume that only five of these programs would be offered in the next farm bill. Consider all alternatives and then select the one single alternative you would most like to have included in the five.**

Assume that current farm programs would continue to be available, except that the five alternatives available, including the one you choose, would replace existing programs that specifically apply to those land management choices.

Figure 4.5 Introduction of the Modified Multinomial Choice Question

Figure 4.6 A Sample of the Modified Multinomial Choice Question

operation, on average, 67% was cropland, 11% was enrolled in the Conservation Reserve Program (CRP) or Wetlands Reserve Program (WRP), and 27% was highly erodible land (HEL). Regarding the tillage system used on the majority of the respondents' cropland, on average, 42% used no tillage or strip tillage, 1% used ridge tillage, 20% used mulch tillage, and 36% used conventional tillage. Overall, the respondents' socioeconomic characteristics and farming operation characteristics are similar to those assigned in the dichotomous choice question sample and the multinomial choice question sample.

Turning to the respondents' vote in the modified multinomial choice questions, the "grazing" and the "native perennial cover" received the most votes in both scenarios. Specifically, the "native perennial cover" received about 35% of the votes in flat land and 33% in rolling land. The "grazing" received about 26% of the votes in flat land and 21% in

Table 4.10 Descriptive Data Summary (Flat Land, Modified Multinomial Choice Question)

(Standard Errors in Parentheses)

	Status Quo	Grazing	59 ft Crop, 19 ft Prairie	15 ft Crop, 120 ft Prairie	30 ft Crop, 120 ft Prairie	Native Perennial Cover	Modified Multinomial Choice Sample
Respondent's Characteristics							
Age	52.40	50.16	53.27	48.55	52.33	54.30	52.28
	(14.01)	(10.19)	(12.38)	(7.62)	(10.08)	(11.99)	(11.49)
Farm Year	31.16	26.76	20.27	21.27	26.44	37.60	30.42
	(14.82)	(12.43)	(12.99)	(10.22)	(12.10)	(69.36)	(42.63)
Gross Value of Sales in 2005 ($10,000)	26.95	19.14	8.07	12.50	17.01	13.04	16.76
	(33.36)	(17.57)	(6.53)	(17.72)	(21.74)	(14.52)	(20.21)
Full-Time Farmer in 2005	0.60	0.60	0.18	0.27	0.28	0.28	0.41
College (%)	0.36	0.51	0.64	0.64	0.50	0.38	0.46
Male (%)	0.96	0.93	0.82	1.00	0.89	0.85	0.90
Decision Maker (%)	0.84	1.00	0.82	0.91	0.89	0.87	0.90
Farm's Characteristics							
Acre Total	621.29	469.76	245.00	428.85	404.67	320.52	415.29
	(549.69)	(459.69)	(285.13)	(622.45)	(587.92)	(373.22)	(470.35)
Acre-Crop (%)	0.81	0.72	0.53	0.74	0.68	0.59	0.67
Acre-CRP, WRP (%)	0.05	0.11	0.02	0.09	0.06	0.16	0.11
Acre-HEL (%)	0.23	0.40	0.10	0.24	0.15	0.25	0.27
No Tillage or Strip Tillage (%)	0.40	0.38	0.55	0.36	0.50	0.43	0.42
Ridge Tillage (%)	0.00	0.00	0.00	0.00	0.06	0.02	0.01
Mulch Tillage (%)	0.16	0.24	0.18	0.27	0.11	0.20	0.20
Conventional Tillage (%)	0.44	0.38	0.27	0.36	0.33	0.35	0.36
N	25	45	11	11	18	60	170

rolling land. Compared to the respondents who chose the other policy alternatives, the respondents who chose the status quo had a higher percentage of cropland in operation and a lower percentage of land enrolled in CRP or WRP. These results are similar to those assigned in the dichotomous choice question sample and the multinomial choice question sample.

Table 4.11 Descriptive Data Summary (Rolling Land, Modified Multinomial Choice Question)

(Standard Errors in Parentheses)

	Status Quo	Grazing	59 ft Crop, 19 ft Prairie	15 ft Crop, 120 ft Prairie	30 ft Crop, 120 ft Prairie	Native Perennial Cover	Modified Multinomial Choice Sample
Respondent's Characteristics							
Age	50.45	53.33	54.91	47.77	50.32	53.96	52.28
	(13.11)	(13.71)	(11.25)	(10.55)	(8.99)	(10.84)	(11.49)
Farm Year	31.05	28.78	25.45	21.31	27.18	27.39	30.42
	(14.52)	(15.72)	(12.04)	(11.38)	(12.00)	(13.38)	(42.63)
Gross Value of Sales in 2005 ($10,000)	31.50 (35.88)	14.34 (15.75)	19.20 (22.12)	18.37 (20.30)	14.38 (16.22)	13.66 (14.77)	16.76 (20.21)
Full-Time Farmer in 2005 (%)	0.55	0.44	0.45	0.46	0.38	0.32	0.41
College (%)	0.40	0.44	0.45	0.46	0.47	0.48	0.46
Male (%)	1.00	0.92	1.00	0.92	0.88	0.84	0.90
Decision Maker (%)	0.90	0.92	1.00	0.85	0.91	0.88	0.90
Farm's Characteristics							
Acre Total	703.86	421.81	348.64	665.23	301.03	332.47	415.29
	(576.13)	(559.75)	(333.73)	(804.59)	(273.68)	(313.50)	(470.35)
Acre-Crop (%)	0.80	0.63	0.63	0.79	0.72	0.60	0.67
Acre-CRP, WRP (%)	0.06	0.13	0.14	0.01	0.09	0.14	0.11
Acre-HEL (%)	0.27	0.33	0.43	0.27	0.21	0.23	0.27
No Tillage or Strip Tillage (%)	0.45	0.44	0.64	0.38	0.35	0.41	0.42
Ridge Tillage (%)	0.00	0.03	0.09	0.00	0.00	0.00	0.01
Mulch Tillage (%)	0.15	0.19	0.18	0.23	0.29	0.16	0.20
Conventional Tillage (%)	0.40	0.33	0.09	0.38	0.35	0.43	0.36
N	20	36	11	13	34	56	170

Table 4.12 and Table 4.13 report the respondents' perceptions concerning attractiveness, profitability, conservation, and ease of management of each landscape alternative in flat land and in rolling land, respectively. In general, in either flat or rolling lands, the respondents perceived that the status quo was better in management and in profitability than other alternatives. Again, compared to the other alternatives, the status quo was rated as poor in terms of conservation.

Table 4.12 Respondents' Perceptions on Policy Alternatives

(Flat Land, Modified Multinomial Choice Question)

	Status Quo	Grazing	59 ft Crop, 19 ft Prairie	15 ft Crop, 120 ft Prairie	30 ft Crop, 120 ft Prairie	Native Perennial Cover	Modified Multinomial Choice Sample
Attractiveness							
Status Quo	5.84	5.44	4.82	5.18	5.28	5.50	5.45
Grazing	5.36	5.44	5.09	5.82	5.67	5.53	5.49
59 ft Crop, 19 ft Prairie	4.72	4.96	5.27	4.91	5.78	5.38	5.18
15 ft Crop, 120 ft Prairie	5.16	5.31	5.91	5.64	5.78	5.78	5.56
30 ft Crop, 120 ft Prairie	5.32	5.20	5.82	5.55	6.11	5.57	5.51
Native Perennial Cover	5.24	5.11	5.18	5.00	5.50	5.85	5.43
Easy to Manage							
Status Quo	5.80	5.69	5.64	5.82	5.56	5.52	5.64
Grazing	4.32	4.44	5.09	4.36	4.56	4.42	4.46
59 ft Crop, 19 ft Prairie	3.00	3.40	4.27	4.00	4.11	4.17	3.78
15 ft Crop, 120 ft Prairie	3.60	4.11	4.00	4.55	4.61	4.58	4.28
30 ft Crop, 120 ft Prairie	3.44	4.04	4.27	4.64	4.44	4.75	4.30
Native Perennial Cover	5.12	5.31	6.00	6.09	5.67	5.72	5.56
Conservation							
Status Quo	5.20	4.44	4.00	3.36	4.56	4.63	4.54
Grazing	5.28	5.47	5.27	6.09	5.06	5.45	5.42
59 ft Crop, 19 ft Prairie	5.68	5.44	6.00	5.55	5.89	5.78	5.69
15 ft Crop, 120 ft Prairie	5.40	5.58	6.09	5.91	5.61	5.73	5.66
30 ft Crop, 120 ft Prairie	5.56	5.40	6.36	5.91	6.00	5.60	5.65
Native Perennial Cover	4.32	4.91	5.45	5.27	5.06	5.08	4.96
Profit							
Status Quo	5.84	5.78	6.18	5.73	5.78	5.95	5.87
Grazing	4.64	4.84	5.00	5.18	5.06	5.05	4.94
59 ft Crop, 19 ft Prairie	3.72	4.24	5.09	4.36	4.39	4.55	4.35
15 ft Crop, 120 ft Prairie	4.48	4.96	5.27	5.45	5.00	5.17	5.02
30 ft Crop, 120 ft Prairie	5.80	5.67	6.27	6.09	5.94	6.30	6.01
Native Perennial Cover	4.32	4.47	5.45	4.91	4.61	4.90	4.71

∗ Possible responses to these perception questions ranged from 1 to 7 where a "1" denoted "the least favored" and "7" denoted "the most favored."

In sum, the respondents' social demographic characteristics and their farming characteristics were similar across the three samples answering the dichotomous choice question, the multinomial choice question, and the modified multinomial choice question. In addition, the respondents' perceptions regarding attractiveness, ease of management, conservation, and profitability with respect to each alternative were similar. In particular, the respondents perceived that the "status quo" was the easiest to manage and the most profitable

Table 4.13 Respondents' Perceptions on Policy Alternatives

(Rolling Land, Modified Multinomial Choice Question)

	Status Quo	Grazing	59 ft Crop, 19 ft Prairie	15 ft Crop, 120 ft Prairie	30 ft Crop, 120 ft Prairie	Native Perennial Cover	Modified Multinomial Choice Sample
Attractiveness							
Status Quo	5.85	5.08	4.64	5.85	4.56	5.12	5.11
Grazing	5.70	6.22	5.73	5.77	5.74	5.75	5.84
59 ft Crop, 19 ft Prairie	5.70	6.22	5.73	5.77	5.74	5.75	5.84
15 ft Crop, 120 ft Prairie	5.70	5.89	5.45	5.85	5.88	5.71	5.78
30 ft Crop, 120 ft Prairie	5.80	5.75	6.09	5.62	5.94	5.80	5.82
Native Perennial Cover	5.10	5.03	5.64	5.00	5.35	5.64	5.34
Easy to Manage							
Status Quo	5.60	5.42	5.45	5.23	5.56	5.36	5.44
Grazing	4.35	5.06	5.00	4.46	4.82	4.62	4.74
59 ft Crop, 19 ft Prairie	4.35	5.06	5.00	4.46	4.82	4.62	4.74
15 ft Crop, 120 ft Prairie	3.50	4.25	3.64	3.69	4.09	3.93	3.94
30 ft Crop, 120 ft Prairie	3.85	4.33	4.27	3.92	4.47	4.30	4.26
Native Perennial Cover	5.10	5.17	5.55	5.31	5.38	5.64	5.39
Conservation							
Status Quo	4.55	4.33	4.18	3.77	3.82	4.18	4.15
Grazing	5.65	6.31	6.18	5.85	5.88	5.73	5.91
59 ft Crop, 19 ft Prairie	5.65	6.31	6.18	5.85	5.88	5.73	5.91
15 ft Crop, 120 ft Prairie	5.95	6.06	6.00	6.08	6.12	5.91	6.01
30 ft Crop, 120 ft Prairie	5.80	5.97	6.45	5.92	5.94	5.88	5.94
Native Perennial Cover	6.00	5.72	6.27	6.08	6.03	6.14	6.02
Profit							
Status Quo	5.90	5.44	5.36	5.69	5.47	5.71	5.61
Grazing	3.90	5.33	5.36	4.54	4.68	4.55	4.72
59 ft Crop, 19 ft Prairie	3.90	5.33	5.36	4.54	4.68	4.55	4.72
15 ft Crop, 120 ft Prairie	4.45	5.33	5.36	4.69	5.18	4.93	5.02
30 ft Crop, 120 ft Prairie	4.50	5.17	5.64	4.77	5.35	5.12	5.11
Native Perennial Cover	3.75	4.94	4.91	4.00	4.18	4.50	4.43

∗ Possible responses to these perception questions ranged from 1 to 7 where a "1" denoted "the least favored" and "7" denoted "the most favored."

among the six alternatives. However, the "status quo" was rated to lowest in terms of conservation among the six alternatives.

4. 3. Estimation Approaches and Associated Posterior Simulators

In this study, we use three value elicitation question formats to elicit the respondents' WTA to the proposed five policy alternatives. In particular, for the dichotomous choice question, we use the traditional bid function model suggested by Cameron (1988) to estimate the value of the chosen alternative relative to the other alternative. We proposed an estimation procedure to estimate the responses jointly from the fifteen pairs of alternatives.

In a similar fashion, Cameron's argument can be extended to the multinomial choice context. Specifically, the bid values included in the valuation question can be used to bracket the respondents' WTA in multinomial choice question, we propose an estimation procedure that can separately identify every coefficient in this model.

4. 3. 1. A Joint Estimation Procedure for Multiple Dichotomous Choice Surveys: A Bayesian Approach

The most cited modeling strategy in a discrete choice model is the random utility maximization (RUM) model developed by McFadden (1974). Using the RUM model, Hanemann (1984) constructs the basic model rationalizing the response in a dichotomous choice question for welfare analysis. Cameron (1988) argues that the dichotomous choice referendum applied in contingent valuation is similar to the commuters' choices between bus and car mode of transportation, but contains more information. In a contingent valuation survey, an individual is provided two alternatives, usually one of them is the status quo, and is asked to choose the alternative which produces the highest utility. While the threshold values of the latent variables are not observable in a probit model, the threshold values of the latent variables in the dichotomous choice referendum data are observable. Taking advantage of the variance of the hypothetical bid values across the individuals, direct and separate point estimates of regression coefficients and standard deviation can be estimated.

In a WTA context, an individual's WTA can be written as:

$$w_i = \mathbf{x}_i \boldsymbol{\gamma} + \upsilon_i \qquad (4.1)$$

where $\mathbf{x}_i$ is a vector of his social-economic characteristics, γ is a vector of corresponding parameters, and υ_i is assumed independently and identically distributed with a normal distribution. The observed dichotomous choice survey response then indicates whether the individual's WTA is greater than or less than the offered bid value, b_i ; i.e.,

$$y_i = \begin{cases} 1, & \text{if } w_i < b_i \\ 0, & \text{otherwise} \end{cases} \tag{4.2}$$

Assuming that $\upsilon_i \overset{iid}{\sim} N\left(0,\sigma^2\right)$, the probability of yes for an individual can be written as:

$$\begin{aligned} \Pr\left(yes_i\right) &= \Pr\left(\mathbf{x}_i\gamma + \upsilon_i < b_i\right) \\ &= \Pr\left(\upsilon_i < -\mathbf{x}_i\gamma + b_i\right) \\ &= \Phi\left(\frac{\upsilon_i}{\sigma} < \frac{-\mathbf{x}_i\gamma + b_i}{\sigma}\right) \\ &= \Phi\left(\frac{-\mathbf{x}_i\gamma + b_i}{\sigma}\right) \end{aligned} \tag{4.3}$$

The coefficients of the model to be estimated are those associated with the variables $\mathbf{x}_i$ (i.e., γ) and the coefficient on the offered compensation b_i , which provides an estimate of $1/\sigma$.

There are six policy alternatives including the status quo considered in this study. Each individual who received a dichotomous choice question was randomly provided two of the six alternatives and asked to choose which of the two alternatives produced the highest utility. Therefore, fifteen versions of dichotomous choice questions were applied in split samples.

The responses from the fifteen samples were used to jointly estimate individuals' WTA's for the five proposed policy alternatives relative to the status quo. In particular, choosing alternative 0 as the status quo, an individual's WTA for each policy alternative relative to the status quo is defined as:

$$\begin{aligned} w_{i1} &= \mathbf{x}_i\boldsymbol{\beta}_1 + \varepsilon_{i1} \\ &\vdots \\ w_{ij} &= \mathbf{x}_i\boldsymbol{\beta}_j + \varepsilon_{ij} \\ &\vdots \\ w_{i5} &= \mathbf{x}_i\boldsymbol{\beta}_5 + \varepsilon_{i5} \end{aligned} \tag{4.4}$$

where $\mathbf{x}_i$ is a vector of explanatory variables and we assume that

$$\varepsilon_i = \begin{bmatrix} \varepsilon_{1i} \\ \vdots \\ \varepsilon_{5i} \end{bmatrix} \sim N(0, \Sigma) \tag{4.5}$$

where Σ is a 5×5 positive definite matrix with off-diagonal element denoted σ_{jk} and the j^{th} diagonal element denoted σ_j^2.

In the case of a single dichotomous choice question, an individual is provided two alternatives each with a threshold bid value. Although the respondent's true WTA is not observed, his WTA can be manifested through his discrete choice indicator, y_i. For example, if an individual is asked to choose between the status quo and policy alternative *j*, his vote reveals his WTA for option *j* relative to the status quo as follows

$$y_i = \begin{cases} j, & \text{if } w_{ij} < b_{ij} \\ 0, & \text{otherwise} \end{cases} \tag{4.6}$$

Similarly, if policy alternative *j* and *k* are offered for an individual to choose between, his vote to the dichotomous choice question reveals his WTA for option *j* and *k* relative to the status quo as

$$y_i = \begin{cases} j, & \text{if } b_{ij} - w_{ij} > b_{ik} - w_{ik} \\ k, & \text{otherwise} \end{cases} \tag{4.7}$$

The parameters of our model we estimated using a Bayesian approach with data augmentation and Gibbs sampling. In the current setting, the augmented variable is the individuals' unobserved WTA's for each alternative relative to the status quo. The posterior simulator for the dichotomous choice question is fully described in the appendix. In brief, under prior independence, the joint posterior distribution is represented as:

$$\begin{aligned} p(\mathbf{w}, \beta, \Sigma \mid y) &\propto p(y \mid \mathbf{w}, \beta, \Sigma)\, p(\mathbf{w} \mid \beta, \Sigma)\, p(\beta)\, p(\Sigma) \\ &= p(\beta)\, p(\Sigma) \prod_{i=1}^{N} p(y_i \mid \mathbf{w}_i, \beta, \Sigma)\, p(\mathbf{w}_i \mid \beta, \Sigma) \end{aligned} \tag{4.8}$$

where

$$\mathbf{w} = \begin{bmatrix} w_1 & \dots & w_5 \end{bmatrix} \text{ and } \beta = \begin{bmatrix} \beta_1 & \dots & \beta_5 \end{bmatrix} \tag{4.9}$$

The product term comes from the assumed (conditional) independence across observations. In particular, if, for example, the respondent is assigned to choose between alternative *j* and alternative *k*, the first term on the right-hand side of the product is

$$\begin{aligned} p(y_i \mid \mathbf{w}_i, \beta, \Sigma) = {} & I(y_i = j)\, I(b_{ij} - w_{ij} > B_{ik} - w_{ik}) \\ & + I(y_i = k)\, I(B_{ik} - w_{ik} > B_{ij} - w_{ij}) \end{aligned} \tag{4.10}$$

with $I(.)$ denoting the standard indicator function.

The posterior simulator involves drawing sequentially from the conditional posterior distributions for $\mathbf{w}_i$, β, and Σ. Apart from the prior distributions, the remaining piece in our joint posterior distribution follows immediately from our normality assumption

$$\mathbf{w}_i \mid \beta, \Sigma \overset{iid}{\sim} N(\mathbf{x}_i \beta, \Sigma) \tag{4.11}$$

This model is completed by choosing prior distributions of the forms:

$$\beta \sim N\left(\underline{\beta}, \underline{V}_{\beta}\right) \text{ and } \Sigma^{-1} \sim W\left(\left(\rho R\right)^{-1}, \rho\right) \tag{4.12}$$

4. 3. 2. Estimation Procedure for the Multinomial Choice Question and the Modified Multinomial Choice Question: A Bayesian Approach

Extending the willingness to pay model for the dichotomous choice question suggested by Cameron (1988), we propose an estimation method using the variance of the hypothetical bid values embedded in the multinomial choice question across the individuals to identify the regression coefficients and standard deviation for the multinomial choice question and the modified multinomial choice question. Specifically, each individual who received a multinomial choice question or a modified multinomial choice question was asked to choose one of the six alternatives that produced the highest utility. again, letting alternative 0 denote the status quo, an individual's WTA for each policy alternative relative to the status quo can be defined as:

$$\begin{aligned} w_{i1} &= \mathbf{x}_i \boldsymbol{\beta}_1 + \varepsilon_{i1} \\ &\vdots \\ w_{ij} &= \mathbf{x}_i \boldsymbol{\beta}_j + \varepsilon_{ij} \\ &\vdots \\ w_{i5} &= \mathbf{x}_i \boldsymbol{\beta}_5 + \varepsilon_{i5} \end{aligned} \tag{4.13}$$

where $\mathbf{x}_i$ is a vector of explanatory variables and we assume that

$$\varepsilon_i = \begin{bmatrix} \varepsilon_{1i} \\ \vdots \\ \varepsilon_{5i} \end{bmatrix} \overset{iid}{\sim} N\left(0, \Sigma\right) \tag{4.14}$$

where Σ is a 5×5 positive definite matrix with off-diagonal element denoted σ_{jk} and the j^{th} diagonal element denoted σ_j^2. Through an individual's discrete choice indicator, y_i, his true WTA is revealed as

$$y_i = \begin{cases} 0, & \text{if } b_{ji} - w_{ji} < 0, \ \forall j = 1,\ldots,5 \\ k, & \text{if } \max\limits_{j=1,\ldots,5} \left\{ b_{ji} - w_{ji} \right\} = b_{ki} - w_{ki} > 0 \end{cases} \tag{4.15}$$

The probability for an individual choosing alternative j is:

$$\begin{aligned}
\Pr\left(y_i = j\right) = {} & \Pr\left(b_{ij} - \mathbf{x}_i \boldsymbol{\beta}_j + \varepsilon_{ij} > 0\right) \\
& \times \Pr\left(b_{ij} - \mathbf{x}_i \boldsymbol{\beta}_j + \varepsilon_{ij} > b_{i1} - \mathbf{x}_i \boldsymbol{\beta}_1 + \varepsilon_{i1}\right) \\
& \vdots \\
& \times \Pr\left(b_{ij} - \mathbf{x}_i \boldsymbol{\beta}_j + \varepsilon_{ij} > b_{ik} - \mathbf{x}_i \boldsymbol{\beta}_k + \varepsilon_{ik}\right) \\
& \vdots \\
& \times \Pr\left(b_{ij} - \mathbf{x}_i \boldsymbol{\beta}_j + \varepsilon_{ij} > b_{i5} - \mathbf{x}_i \boldsymbol{\beta}_5 + \varepsilon_{i5}\right) \\
& = \Pr\left(\frac{\varepsilon_{ij}}{\sigma_j} > \frac{\mathbf{x}_i \boldsymbol{\beta}_j - b_{ij}}{\sigma_j}\right) \\
& \times \Pr\left(\frac{\varepsilon_{ij} - \varepsilon_{i1}}{\sqrt{\sigma_j^2 + \sigma_1^2 - \sigma_{j1}}} > \frac{\left(\mathbf{x}_i \boldsymbol{\beta}_j - b_{ij}\right) - \left(\mathbf{x}_i \boldsymbol{\beta}_1 - b_{i1}\right)}{\sqrt{\sigma_j^2 + \sigma_1^2 - \sigma_{j1}}}\right) \\
& \vdots \\
& \times \Pr\left(\frac{\varepsilon_{ij} - \varepsilon_{i5}}{\sqrt{\sigma_j^2 + \sigma_5^2 - \sigma_{j5}}} > \frac{\left(\mathbf{x}_i \boldsymbol{\beta}_j - b_{ij}\right) - \left(\mathbf{x}_i \boldsymbol{\beta}_5 - b_{i5}\right)}{\sqrt{\sigma_j^2 + \sigma_5^2 - \sigma_{j5}}}\right), \qquad \text{for } j = 1,\ldots,5 \text{ and } \forall j \neq k
\end{aligned}$$

As long as each of the alternatives is chosen by at least one individual, all of the coefficient of the variance-covariance matrix, Σ, and the coefficients of the explanatory variables, $\boldsymbol{\beta}$, can be separately identified.

As was the case with our analysis of the dichotomous choice referendum, a Gibbs sampler with data augmentation is used to characterize the posterior distribution of the parameters of interest. The posterior simulator is fully described in the appendix. The posterior distribution of the bid function model involves adding the latent WTA variables to the joint posterior distribution. Under prior independence, the joint posterior distribution is represented as:

$$
\begin{aligned}
p(\mathbf{w},\beta,\Sigma \mid y) &\propto p(y \mid \mathbf{w},\beta,\Sigma)\, p(\mathbf{w} \mid \beta,\Sigma)\, p(\beta)\, p(\Sigma) \\
&= p(\beta)\, p(\Sigma) \prod_{i=1}^{N} p(y_i \mid \mathbf{w}_i,\beta,\Sigma)\, p(\mathbf{w}_i \mid \beta,\Sigma)
\end{aligned}
\tag{4.16}
$$

where the product term comes from the assumed (conditional) independence across observations. The first term on the right-hand side of the product is

$$
\begin{aligned}
& p(y_i \mid \mathbf{w}_i,\beta,\Sigma) \\
&= I(y_i = 0)\, I(b_{i1} - w_{i1} < 0) \cdots I(b_{i5} - w_{i5} < 0) \\
&+ \sum_{j=1}^{j=5} I(y_i = j)\, I(b_{ij} - w_{ij} > 0)\, I(b_{ij} - w_{ij} > b_{i1} - w_{i1}) \cdots I(b_{ij} - w_{ij} > b_{i5} - w_{i5})
\end{aligned}
\tag{4.17}
$$

with $I(.)$ denoting the standard indicator function. Apart from the prior distributions, the remaining piece in our joint posterior distribution follows immediately from our normality assumption

$$
\mathbf{w}_i \mid \beta,\Sigma \overset{iid}{\sim} N(\mathbf{x}_i\beta,\Sigma) \tag{4.18}
$$

This model is completed by choosing prior distributions of the forms:

$$
\beta \sim N(\underline{\beta},\underline{V}_{\beta}), \text{ and } \Sigma^{-1} \sim W\left((\rho R)^{-1},\rho\right) \tag{4.19}
$$

4. 4. Empirical Results

In this paper, we examine whether the dichotomous choice question, the multinomial choice question, and the modified multinomial choice question elicit similar WTA distributions. We use the derived WTA distributions from the dichotomous choice question as the base line to examine how the incentive and informational properties of the multinomial choice formats (both basic and modified) influence the location and the precision of the derived WTA distributions. In particular, since the dichotomous choice question and the modified multinomial choice question are incentive compatible, we expect that the mean WTAs derived from the modified multinomial choice question would close to the mean WTAs derived from the dichotomous choice question. Second, the response from a multinomial choice question or a modified multinomial choice question contains more information than the response from a dichotomous choice question. In particular, the response from a multinomial choice question or a modified multinomial choice question provides the relative values between the chosen alternative and all the other alternatives in the choice set. However, the response from a dichotomous choice question only provides the relative value between two alternatives proposed in the dichotomous choice question. Therefore, we hypothesize that the WTA distributions derived from the multinomial choice question or the modified multinomial choice question would be more precise than the WTA distributions derived from the dichotomous choice question.

Applying the estimation procedures described in the previous section and the algorithm fully documented in the appendix, we estimate the respondents' WTA. Specifically, choosing alternative 0 as the status quo, an individual's WTA for each policy alternative relative to the status quo can be defined as

$$w_{i1} = \beta_1 + \varepsilon_{i1}$$
$$\vdots$$
$$w_{ij} = \beta_j + \varepsilon_{ij}$$
$$\vdots$$
$$w_{i5} = \beta_5 + \varepsilon_{i5}$$

Instead of using a non-informative prior, we use some prior information in our posterior simulation since the sample size with respect to each question format is small. In particular, six sets of bid values to each alternative are used in this survey. These bid values are designed using soil rental rates and current conservation payments in federal programs such as CRP. These sets of bid values are presented in Table 14. We use the values close to the mean of the bid values used in the survey as the prior mean of the $\beta's$, {115, 45, 35, 30, 135}. In addition, the prior variance-covariance of the $\beta's$ are set as $400 I_5$. The prior information is employed in the estimation across the three samples. Since our interest is to compare the WTA distributions derived from these elicitation question formats, by using the same prior information, the difference in estimation results should comes from the data, not the prior. We run our posterior simulators for 110,000 simulations and discard the first 10,000 simulations as the burn-in.

Table 4.14 Bid Values

	1	2	3	4	5	6
Grazing	105	125	145	90	115	95
19 ft crop, 59 ft prairie	30	40	50	40	55	65
120 ft crop, 15 ft prairie	15	25	35	25	30	45
120 ft crop, 30 ft prairie	20	30	40	30	40	60
Native Perennial Cover	115	135	155	110	130	120

Table 4.15 and Table 4.16 present the posterior means (β) and dispersions (σ^2) associated with the WTAs for the landscape alternatives in flat land scenario derived from each format, respectively. The dispersions reported here are the diagonal elements in the variance-covariance matrix corresponding to each alternative. Our result suggests, first, that, the mean WTAs derived from the multinomial choice question and the modified multinomial choice question are generally greater than the mean WTAs derived from the dichotomous choice question. The mean WTAs derived from the modified multinomial choice question are closer to that derived from the dichotomous choice question.

Table 4.15 Estimated Mean WTA (Flat Land)
(Standard Errors in Parentheses)

	Grazing	19 ft crop, 59 ft prairie	120 ft crop, 15 ft prairie	120 ft crop, 30 ft prairie	Native Perennial Cover
Dichotomous choice sample	93.22	64.42	31.72	23.66	96.23
	(10.05)	(9.24)	(10.80)	(10.51)	(12.56)
Multinomial choice sample	114.17	58.75	48.71	49.52	120.71
	(15.47)	(14.11)	(14.79)	(14.72)	(15.09)
Modified multinomial choice sample	106.05	57.60	42.58	43.47	118.09
	(17.81)	(15.79)	(15.72)	(16.66)	(17.42)

Table 4.16 Estimated Variance of WTA (Flat Land)
(Standard Errors in Parentheses)

	Grazing	19 ft crop, 59 ft prairie	120 ft crop, 15 ft prairie	120 ft crop, 30 ft prairie	Native Perennial Cover
Dichotomous choice sample	4.94	3.78	2.44	2.85	5.93
	(3.32)	(2.96)	(1.98)	(2.70)	(4.14)
Multinomial choice sample	17.50	3.14	2.40	3.82	18.18
	(14.67)	(3.23)	(2.41)	(4.14)	(14.80)
Modified multinomial choice sample	9.06	6.78	4.99	6.73	27.40
	(7.76)	(8.25)	(6.20)	(11.04)	(28.75)

Second, as shown in Figure 4. 7, the WTA distributions derived from the modified multinomial choice question and the multinomial choice question are more dispersed than the WTA distributions derived from the dichotomous choice question. A possible explanation may be that both the multinomial choice and the modified multinomial choice questions provide the respondents more policy alternatives, and thus more information, than a dichotomous choice question. Therefore, respondents are required to put more cognitive effort in answering the multinomial choice question and the modified multinomial choice question. With more alternatives under consideration, respondents may be more likely to make mistakes or not patient to give a precise answer, leading to WTA distributions derived from the multinomial choice questions that are more dispersed than the WTA distributions derived from the dichotomous choice question. In other words, the cognitive effort burden embedded in the multinomial choice question and the modified multinomial choice question dominates the informational advantage of these methods. Third, the WTA distributions derived from the modified multinomial choice question are more dispersed than the WTA distributions derived from the multinomial choice question. This may be explained by that respondents were less familiar to the modified multinomial choice question and were more likely to make mistakes to the valuation question.

Table 4.17 and Table 4.18 present the posterior means and variances associated with the WTA distributions derived from the three elicitation methods for the landscape alternatives in rolling land scenario, respectively. First, similar to the results in the flat land scenario, the mean WTAs derived from the multinomial choice question and the modified multinomial choice question are greater than the mean WTAs derived from the dichotomous

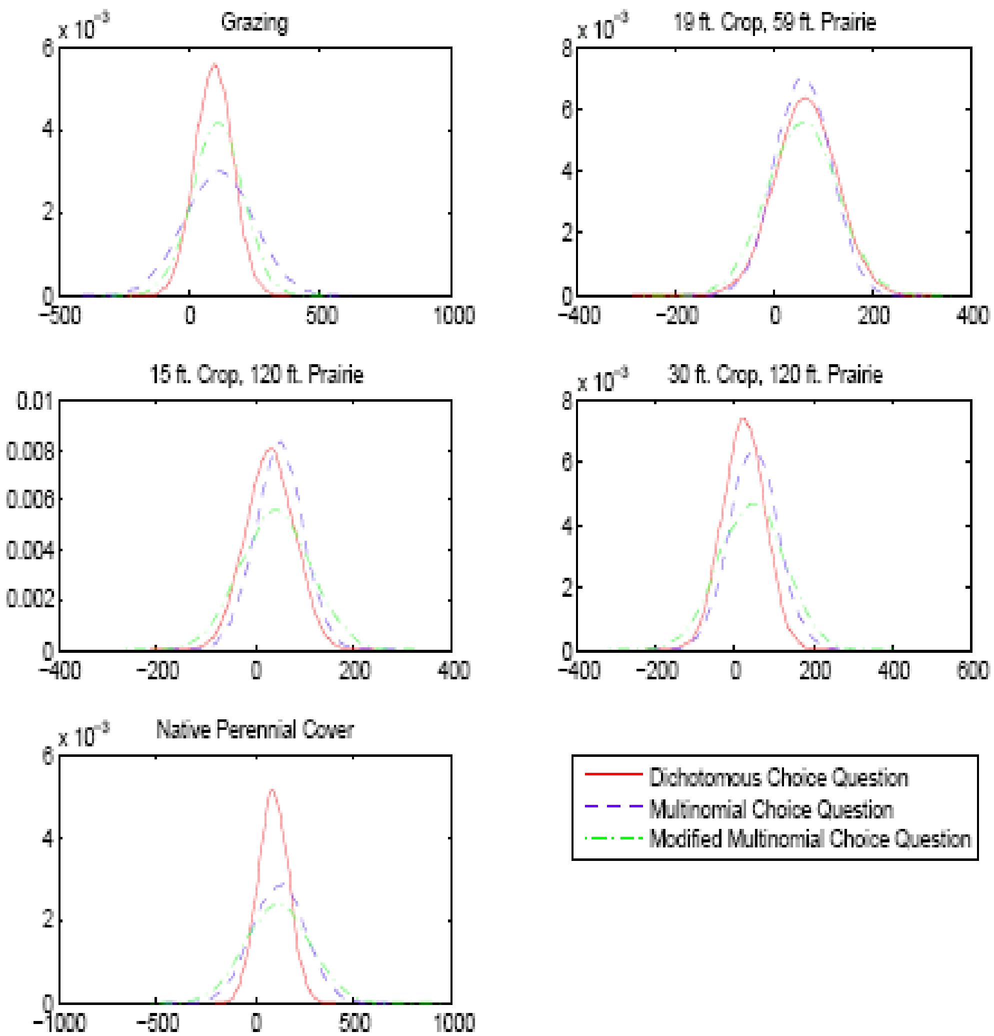

Figure 4.7 Predicted Distribution of WTA (Flat Land)

Table 4.17 Estimated Mean WTA (Rolling Land)

(Standard Errors in Parentheses)

	Grazing	19 ft crop, 59 ft prairie	120 ft crop, 15 ft prairie	120 ft crop, 30 ft prairie	Native Perennial Cover
Dichotomous choice sample	94.97	54.17	20.64	19.37	91.38
	(10.97)	(11.73)	(12.02)	(13.17)	(12.66)
Multinomial choice sample	115.46	68.19	49.88	41.93	113.93
	(15.68)	(14.52)	(15.21)	(14.04)	(14.95)
Modified multinomial choice sample	117.21	69.93	45.80	37.47	111.53
	(21.90)	(21.88)	(21.04)	(21.50)	(19.36)

Table 4.18 Estimated Variance of WTA (Rolling Land)

(Standard Errors in Parentheses)

	Grazing	19 ft crop, 59 ft prairie	120 ft crop, 15 ft prairie	120 ft crop, 30 ft prairie	Native Perennial Cover
Dichotomous choice sample	6.80	5.42	4.86	5.68	2.30
	(10.30)	(6.22)	(5.51)	(7.98)	(2.63)
Multinomial choice sample	15.89	2.81	2.39	3.70	14.12
	(11.83)	(2.82)	(2.32)	(3.56)	(11.82)
Modified multinomial choice sample	12.80	4.74	4.85	5.31	14.14
	(10.88)	(4.40)	(5.10)	(5.02)	(14.26)

method. The mean WTAs derived from the modified multinomial choice question are closer to those derived from the dichotomous choice question.

Second, as shown in Figure 4.8, the WTA distributions derived from the modified multinomial choice question and the multinomial choice question are more dispersed than the WTA distributions derived from the dichotomous choice question. Third, the WTA distributions derived from the modified multinomial choice question are more dispersed than the WTA distributions derived from the multinomial choice question.

4. 5. Final Remarks

Stated preference methods are useful to estimate the economic value of non-market goods. In this study, we use the dichotomous choice question, the multinomial choice question, and the modified multinomial choice question to estimate farmers' WTAs to adopt perennial strips in landscape in the state of Iowa. In particular, fifteen versions of the survey using the dichotomous choice method, one version of survey using the multinomial choice method, and one version of survey using the modified multinomial choice method are employed in split samples. We develop an estimation procedure jointly estimate the fifteen versions of survey using the dichotomous choice method. In addition, we proposed an

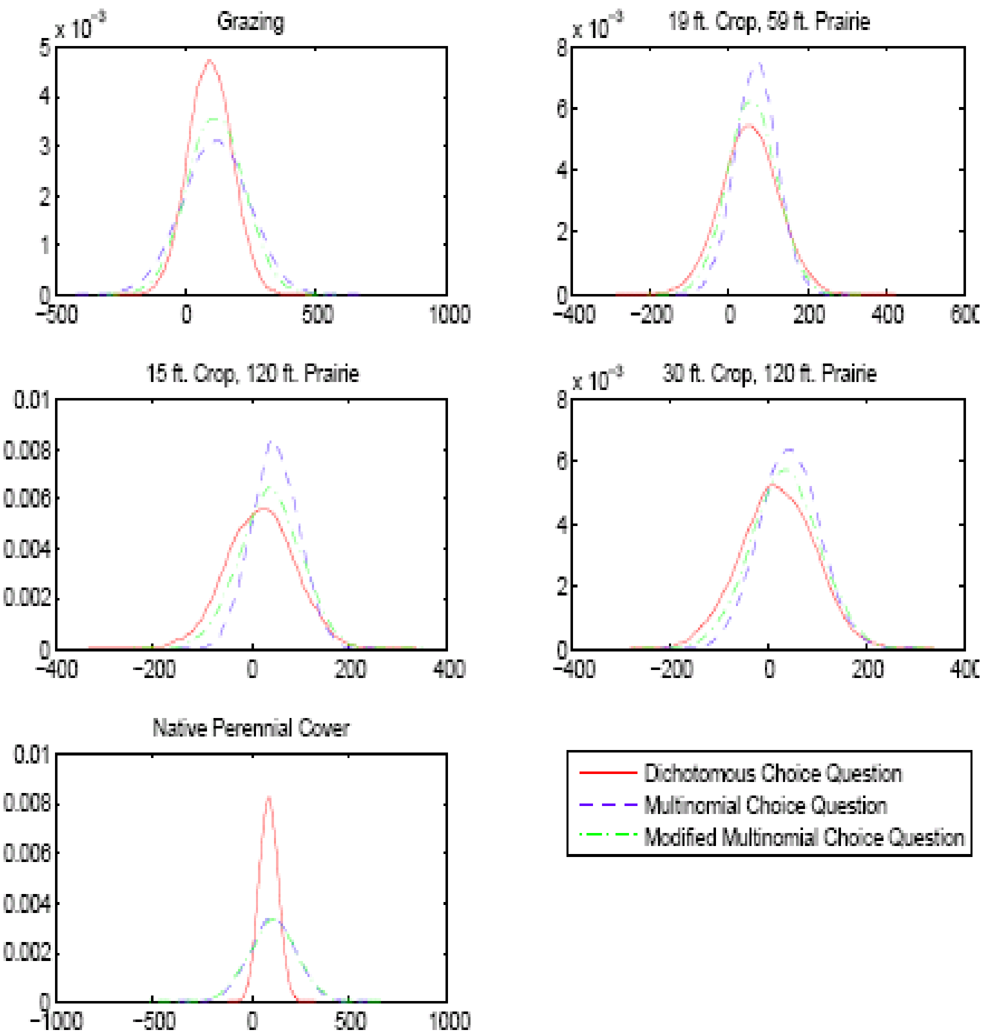

Figure 4.8 Predicted Distribution of WTA (Rolling Land)

estimation procedure by extend the bid function model suggested by Cameron (1988) to estimate individuals' WTA distributions using the multinomial choice question and the modified multinomial choice question.

Our result suggests, first, the mean WTAs derived from the multinomial choice method and the modified multinomial choice method are greater than the mean WTAs derived from the dichotomous choice method. Consistent with our expectation, the mean WTAs derived from the modified multinomial choice question are closer to the mean WTAs derived from the dichotomous choice question. Second, the WTA distributions derived from the modified multinomial choice question and the multinomial choice question are more dispersed than that derived from the dichotomous choice question implying that the cognitive effort burden embedded in the multinomial choice method and the modified multinomial choice method dominates the informational advantage of these methods. Third, since respondents were less familiar to the modified multinomial choice method, the WTA distributions derived from this method are the most dispersed.

There are three value elicitation formats and six alternatives included in this study. The respondents' true valuation is not directly observable since their responses to the value elicitation questions only reveal whether their WTAs are greater or smaller than the proposed bid values. Thus, these methods require a large number of responses to obtain precise WTA estimates. However, the sample size of each question format we used in this study is small. Applying the prior information in hand across the question formats allowed us to discern the properties of these value elicitation formats. Our future work may include (a) applying these question formats in surveys with more observations to further examine their properties, and (b) involve different number of alternatives in surveys to explore what is the reasonable number.

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Appendix 4.A The Gibbs Sampling Algorithm for Dichotomous Choice Question

Drawing from $p\left(\beta \mid \Sigma^{-1}, \mathbf{w}, y\right)$. First, define

$$\mathbf{X}_i = \begin{bmatrix} X_{1i} & 0 & \cdots & 0 \\ 0 & X_{2i} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & X_{Ji} \end{bmatrix}$$

Similar to a SUR model, we obtain

$$\beta \mid \Sigma^{-1}, \mathbf{w}, y \sim N\left(\overline{\beta}, \overline{V}_{\beta}\right)$$

where

$$\overline{\beta} = \overline{V}_{\beta}\left(\sum_{i=1}^{N} \mathbf{X}_i' \Sigma^{-1} \mathbf{w}_i + \underline{V}_{\beta}^{-1} \underline{\beta}\right), \quad \overline{V}_{\beta} = \left(\sum_{i=1}^{N} \mathbf{X}_i' \Sigma^{-1} \mathbf{X}_i + \underline{V}_{\beta}^{-1}\right).$$

Step 4. Drawing from $p\left(\Sigma^{-1} \mid \beta, \mathbf{w}, y\right)$. Making use of techniques like those employed in the SUR model, we obtain

$$\Sigma^{-1} \mid \beta, \mathbf{w}, y \sim W\left(\left[\rho R + \sum_{i=1}^{N} \varepsilon_i \varepsilon_i'\right]^{-1}, N + \rho\right)$$

Step 5. Drawing from $p\left(\mathbf{w} \mid \beta, \Sigma^{-1}, y\right)$. Denote w_{ji}^{*} as a new draw for respondent $i's$ WTA for alternative j from $p\left(\mathbf{w} \mid \beta, \Sigma^{-1}, y\right)$. For i=1,…,N,

$$\mathbf{w}_i \sim N\left(\mathbf{X}_i \boldsymbol{\beta}, \Sigma\right).$$

The respondent is randomly assigned to choose the preferred alternative between two alternatives, say *j* and *k*. for the respondent chooses alternative *j*, if

$$B_{ji} - w^*_{ji} > B_{ki} - w^*_{ki}, \quad \forall j, k = 1, \ldots, J, \text{ and } j \neq k,$$

set

$$w_i = w^*_i \;,$$

otherwise, start over.

A Gibbs sampler proceeds by simulating (in order) from the above posterior conditional distributions. For our prior, we set $\underline{\beta} = \{115;\ 45;\ 30;\ 35;\ 130\}$, $\underline{V_\beta} = 400 I_k$, $\rho = 10$, and $R = 10^{-4} I_k$.

Appendix 4.B The Gibbs Sampling Algorithm for Multinomial Choice Question and Modified Multinomial Choice Question

Step 1. Drawing from $p\left(\beta \mid \Sigma^{-1}, \mathbf{w}, y\right)$. First, define

$$\mathbf{X}_i = \begin{bmatrix} X_{1i} & 0 & \cdots & 0 \\ 0 & X_{2i} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & X_{Ji} \end{bmatrix}$$

Similar to a SUR model, we obtain

$$\beta \mid \Sigma^{-1}, \mathbf{w}, y \sim N\left(\overline{\beta}, \overline{V}_\beta\right)$$

where

$$\overline{\beta} = \overline{V}_\beta\left(\sum_{i=1}^{N} \mathbf{X}_i' \Sigma^{-1} \mathbf{w}_i + \underline{V}_\beta^{-1} \underline{\beta}\right), \quad \overline{V}_\beta = \left(\sum_{i=1}^{N} \mathbf{X}_i' \Sigma^{-1} \mathbf{X}_i + \underline{V}_\beta^{-1}\right).$$

Step 2. Drawing from $p\left(\Sigma^{-1} \mid \beta, \mathbf{w}, y\right)$. Making use of techniques like those employed in the SUR model, we obtain

$$\Sigma^{-1} \mid \beta, \mathbf{w}, y \sim W\left(\left[\rho R + \sum_{i=1}^{N} \varepsilon_i \varepsilon_i'\right]^{-1}, N + \rho\right)$$

Step 3. Drawing from $p\left(\mathbf{w} \mid \beta, \Sigma^{-1}, y\right)$. Denote w_{ji}^* as a new draw for respondent $i's$ WTA for alternative j from $p\left(\mathbf{w} \mid \beta, \Sigma^{-1}, y\right)$. For i=1,…,N,

$$\mathbf{w}_i \sim N\left(\mathbf{X}_i \boldsymbol{\beta}, \Sigma\right).$$

For $y_i = 0$, if

$$B_{ji} - w^*_{ji} < 0, \quad \forall j = 1, \ldots, J,$$

set

$$w_i = w^*_i \;,$$

otherwise, start over. For $y_i = j,\; j = 1,...,J$, if

$$B_{ji} - w^*_{ji} > 0 \text{ and } B_{ji} - w^*_{ji} > B_{ki} - w^*_{ki}, \quad \forall k = 1,...,J, \text{ and } j \neq k,$$

set

$$w_i = w^*_i \;,$$

otherwise, start over.

A Gibbs sampler proceeds by simulating (in order) from the above posterior conditional distributions. For our prior, we set $\underline{\beta} = \{115;\, 45;\, 30;\, 35;\, 130\}$, $\underline{V_\beta} = 400 I_k$, $\rho = 10$, and $R = 10^{-4} I_k$.

Appendix 4.C Images and descriptions of associated landscape alternatives

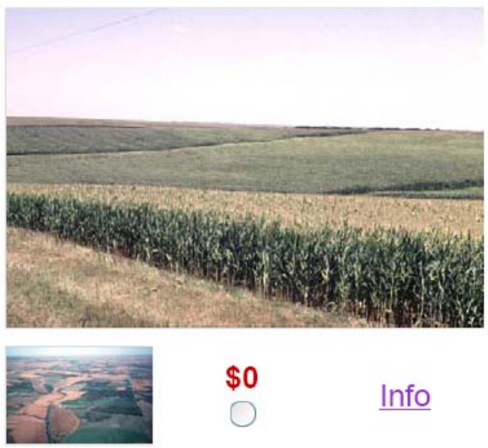
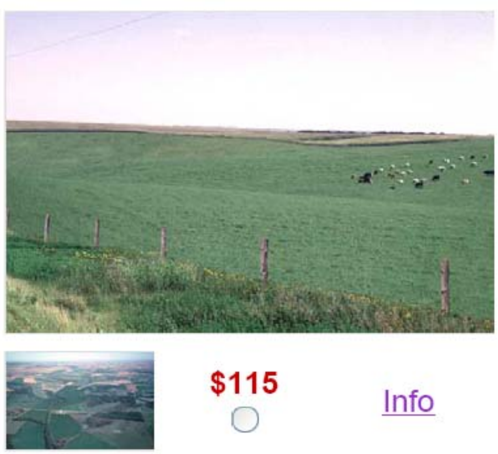
Image	Description
Status Quo 	No restrictions on tillage, crop rotation or any other management operation or practice, other than those currently required (such as conservation compliance requirements, manure management plans, etc.). No restrictions on pesticide or fertilizer.
Grazing 	This farm program supports partial conversion of cropland, that is HEL or near streams, to pasture with rotational grazing. If there are waterways within the fields, the waterways must be protected from cattle. Herd size and type can be chosen by the farmer. No restrictions on pesticide and fertilizer.
59 ft. Crop, 19 ft. Prairie 	This farm program purchases HEL or wetlands for biodiversity reserves of about 640 acres in every township. Reserves enhance habitat and water quality. The program also supports converting HEL acres to rotating strips of corn and soybeans (59 ft. wide) that alternate with non-rotating perennial prairie mix strips (19 ft. wide). Prairie seed from the strips could be marketed. No tillage restrictions for non-HEL acres. Reduced tillage requirements continue for HEL acres. No restrictions on pesticide and fertilizer.

Image	Description
15 ft. Crop, 120 ft. Prairie   $30 Info	This farm program provides support for strips of annual crops alternating with perennial plant strips. Perennial strips = 15 ft wide, crop strips = 120 ft. wide. No restrictions on choice of crop rotations in the annual strips. No tillage restrictions for non-HEL acres. Tillage restrictions and BMP's remain on HEL acres. No restrictions on pesticide or fertilizer.
30 ft. Crop, 120 ft. Prairie   $40 Info	This farm program provides support for strips of annual crops alternating with perennial plant strips. Perennial strips = 30 ft wide. Crop strips =120 ft. wide. No restrictions on the choice of crop rotation in the annual strips. No tillage restrictions for non-HEL acres. Tillage restrictions and BMP's remain on HEL acres. No restrictions on pesticide and fertilizer.
Native Perennial Cover   $130 Info	This farm program provides support for converting some or all cropland to native perennial cover, such as switch grass, that is harvested for biofuel. No restrictions on pesticide and fertilizer.

Chapter 5. General Conclusions

5. 1. General Discussion

The three essays in this dissertation contribute to the contingent valuation literature. The contingent valuation method is widely used in estimating the economic value of nonmarket goods. Thus, it is important to understand the incentive and informational properties embedded in the contingent valuation method to improve the economic value estimates derived from this method. The first essay examines the impact of a consequential survey on respondents' willingness to pay, the second essay examines the influence of intertemporal aspects of the contingent valuation survey on respondents' willingness to pay, and the third essay provides a comparison regarding respondents' willingness to accept derived from various value elicitation question formats.

In the first essay, we examine how a consequential survey may influence respondents' willingness to pay. It has been argued that respondents will respond to survey questions truthfully, if they believe the result of the survey might potentially have some influence on an outcome they care about, the property is known as consequentiality. In the 2003 and 2005 versions of Iowa Lakes Survey, we directly elicited respondents' perceived consequentiality toward this survey in ordinal responses ranging from "1" to "5." To address the potential endogeniety of individuals' "consequentiality" responses, in the 2005 version of survey, we randomly provided a subsample of the respondents an article from the *Iowa Conservationist* suggesting their responses were important and would have impact on policy decisions. This exogenous treatment allows us to separate out the impact of consequentiality on respondents' contingent valuation responses.

We employed a Bayesian treatment effect model to test the impact of respondents' perceived consequentiality on their willingness to pay for a hypothetical water quality improvement scenario. The results of the jointly estimated willingness to pay/consequentiality models suggested, first, that the exogenous treatment positively influenced respondents' perceptions of consequentiality toward the survey, though the magnitude of this effect is small. Second, the mean willingness to pay derived from respondents who perceived this survey as being policy irrelevant was smaller than those who perceived the survey as being positively consequential. Finally and most importantly, consistent with the "knife-edge" result suggested by Carson and Groves (2007), the mean willingness to pay derived from respondents who perceived the survey as being somewhat positive consequential was statistically indifferent from the mean willingness to pay derived from respondents who perceived the survey as being definitely consequential.

The second essay provides an empirical test of the commitment cost theory suggested by Zhao and Kling (2001, 2004). It is typically conceived that respondents' willingness to pay in a contingent valuation exercise depends on some intrinsic value of the good that is invariant over time. However, the commitment cost theory suggests that respondents' willingness to pay for a good at a particular point of time depends not only on the intrinsic value of the good, but also on the timing of the decision and the characteristics of the market environment. In particular, respondents would report a lower willingness to pay if they believed that their transaction decision could be delayed and more information about the transaction would be available, or if they believed that it is more difficult to reverse the transaction decision.

In this study, we employed respondents' perceived intertemporal aspects elicited in the 2003 and 2005 versions of Iowa Lakes Survey to explore the theoretical results. First, half of the 2003 sample was randomly promised a second chance to revisit the contingent valuation referendum if the referendum was not passed. With this explicit statement of delay, we expected the treated respondents to report a lower willingness to pay. Our result suggested that the exogenous treatment did not influence respondents' willingness to pay.

Second, in the 2003 version of survey, we tested the influence of individuals' responses regarding their perceived potential for revisiting the contingent valuation referendum, obtaining more information about the proposed water quality improvement scenario, and canceling an ineffective water quality improvement project, i.e., delay, learning, and reversing, on their willingness to pay. Our results suggested, consistent with the theory, that respondents report a greater willingness to pay if they perceived a greater chance that the government would cancel an ineffective project. However, contrary to the theory prediction, the interaction between respondents' perceived potential for delay and learning had a positive impact on their willingness to pay.

Third, we tested the impact of delay in another perspective. In particular, half of the 2005 sample was informed that they would have no opportunity to revisit the referendum in the future. With this explicit statement of no delay, we expected the treated respondents to report a higher willingness to pay. Our result suggested that this exogenous treatment did not influence the treated respondents' willingness to pay.

Finally, we tested the influence of respondents' knowledge on their willingness to pay. The theory suggested that respondents would hold a higher willingness to pay if they were more knowledgeable about the transaction or if they believed that less information would be provided in the future. In the 2005 version of survey, respondents' perceived potential for delay, their self-reported knowledge level and knowledge increment about the general water quality in Iowa lakes were elicited. Our results suggested that, consistent with the theory, the more knowledgeable the respondents were, the higher willingness to pay the respondents had. However, respondents' knowledge increment did not influence their willingness to pay in either direction. Lastly, respondents' perceived potential for delay had a positive impact on their willingness to pay, which was contrary to the theory would predict.

It could be argued that the potential endogeniety may exist in individuals' "delay" responses. Normally, an exogenous treatment regarding respondents' perceived delay could be used to control for the endogeniety issue. However, the exogenous treatments we employed in the 2003 and 2005 survey did not successfully influence the treated respondents' perceived delay. Therefore, this conjecture could not be tested. In the future, an effective treatment would be needed to control for the endogeniety of delay perception.

The third essay examines whether the dichotomous choice question, the multinomial choice question, and the modified multinomial choice question elicit comparable willingness to accept distributions. These value elicitation formats are different in their incentive and informational properties which may influence the location and the precision of their derived willingness to accept distributions. Our results suggested that the modified multinomial choice question and the multinomial choice question produced similar willingness to accept distributions. In particular, the means of willingness to accept distributions derived from these questions were greater than those derived from the dichotomous choice question. The willingness to accept distributions derived from these questions were more dispersed than those derived from the dichotomous choice question. Finally, compared to the willingness to accept distributions derived from the multinomial choice question, the willingness to accept distributions derived from the modified multinomial choice question were more dispersed, and the means of the willingness to accept distributions derived from the modified multinomial choice question were closer to those derived from the dichotomous choice question.

5. 2. References

Carson, R. T., and T. Groves. 2007. "Incentive and Informational Properties of Preference Questions." *Environmental and Resource Economics* **37**:181-210.

Zhao, J., and C. L. Kling. 2001. "A New Explanation for the WTP/WTA Disparity." *Economic letters* **73**: 293-300.

Zhao, J., and C. L. Kling. 2004. "Willingness to Pay, Compensation Valuation, and Cost of Commitment." *Economic inquiry* **42**: 503-17.

Appendix 1. Iowa Lakes Survey 2003

In order to make sound decisions concerning the future of Iowa lakes, it is important to understand how the lakes are used, as well as what factors influence your selection of lakes to visit. The answers you give to the questions in this survey are very important. Even if you have not visited any lakes in Iowa, please complete and return the questionnaire. It is critical to understand the characteristics and views of both those who use and those who do not use the lakes.

In this first section, we would like to find out which of the lakes on the enclosed map you visited and what you did there.

1. Please indicate how often you or other members of your household visited each of the following lakes in the current year. If you have not visited any lakes in Iowa this year please check this box.

   ☐ I have not visited any lakes in Iowa this year.

   In addition to recording the number of visits you took to each lake, if any, please indicate which of the lakes you *considered* visiting this year by marking the box in the second column.

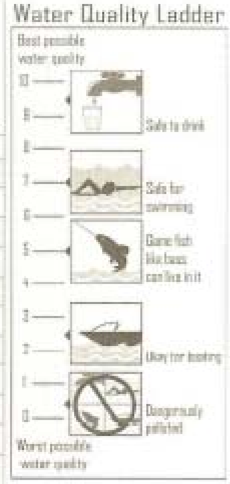
   We are very interested in your view of the water quality of Iowa's lakes. One way of thinking about water quality is to use a ladder like the one shown to the right of the list of lakes. The top of the water quality ladder stands for the best possible quality of water, while the bottom of the ladder stands for the worst. On the ladder you can see the different levels of water quality.

   For example: the lowest level is so polluted that it has oil, raw sewage, and/or other things in it like trash; it has almost no plant or animal life, smells bad, and contact with it is dangerous to human health. Water quality that is "boatable" would not harm you if you happened to fall into it for a short time while boating or sailing. Water quality that is "fishable" is a higher level of quality than "boatable." Although some kinds of fish can live in boatable water, it is only when water is "fishable" that game fish like bass can live in it. Finally, "swimmable" water is of a high enough quality that it is safe to swim in and ingest in small amounts.

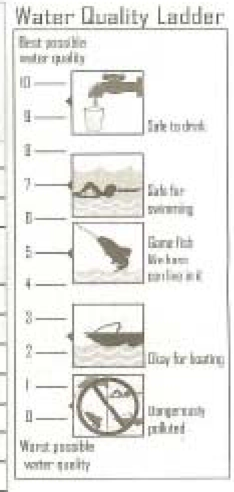
   For any lake with which you are familiar, please indicate your assessment of the level of water quality associated with that lake by assigning a number between 0 and 10 that is based on the water quality ladder pictured. Familiar lakes include both those that you have visited this year as well as those you have visited in the recent past.

Name of Lake (County)	Check if you have ever considered visiting this lake	Number of visits (January-December) in 2003		Water Quality Assessment
		Single-day	Over-night	
Arbor Lake (Poweshiek)		#___ (trips)	#___ (trips)	#___
Arrowhead Lake (Pottawattamie)		#___ (trips)	#___ (trips)	#___
Arrowhead Pond (Sac)		#___ (trips)	#___ (trips)	#___
Avenue of the Saints Lake (Bremer)		#___ (trips)	#___ (trips)	#___
Badger Creek Lake (Madison)		#___ (trips)	#___ (trips)	#___
Badger Lake (Webster)		#___ (trips)	#___ (trips)	#___
Beaver Lake (Dallas)		#___ (trips)	#___ (trips)	#___
Beeds Lake (Franklin)		#___ (trips)	#___ (trips)	#___
Big Creek Lake (Polk)		#___ (trips)	#___ (trips)	#___
Big Spirit Lake (Dickinson)		#___ (trips)	#___ (trips)	#___
Black Hawk Lake (Sac)		#___ (trips)	#___ (trips)	#___
Blue Lake (Monona)		#___ (trips)	#___ (trips)	#___
Bob White Lake (Wayne)		#___ (trips)	#___ (trips)	#___
Briggs Woods Lake (Hamilton)		#___ (trips)	#___ (trips)	#___

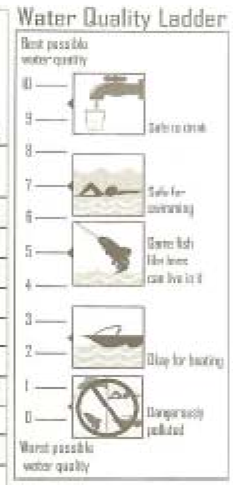
Water Quality Ladder



Name of Lake (County)	Check if you have ever considered visiting this lake	Number of visits (January-December) in 2003		Water Quality Assessment
		Single-day	Over-night	
Browns Lake (Woodbury)		#___ (trips)	#___ (trips)	#___
Brushy Creek Lake (Webster)		#___ (trips)	#___ (trips)	#___
Carter Lake (Pottawattamie)		#___ (trips)	#___ (trips)	#___
Casey Lake (aka Hickory Hills) (Tama)		#___ (trips)	#___ (trips)	#___
Center Lake (Dickinson)		#___ (trips)	#___ (trips)	#___
Central Park Lake (Jones)		#___ (trips)	#___ (trips)	#___
Clear Lake (Cerro Gordo)		#___ (trips)	#___ (trips)	#___
Cold Springs Lake (Cass)		#___ (trips)	#___ (trips)	#___
Coralville Lake (Johnson)		#___ (trips)	#___ (trips)	#___
Crawford Creek Impoundment (Ida)		#___ (trips)	#___ (trips)	#___
Crystal Lake (Hancock)		#___ (trips)	#___ (trips)	#___
Dale Maffitt Lake (Madison)		#___ (trips)	#___ (trips)	#___
DeSoto Bend Lake (Harrison)		#___ (trips)	#___ (trips)	#___
Diamond Lake (Poweshiek)		#___ (trips)	#___ (trips)	#___
Dog Creek (Lake) (O'Brien)		#___ (trips)	#___ (trips)	#___
Don Williams Lake (Boone)		#___ (trips)	#___ (trips)	#___
East Lake (Osceola) (Clarke)		#___ (trips)	#___ (trips)	#___
East Okoboji Lake (Dickinson)		#___ (trips)	#___ (trips)	#___
Easter Lake (Polk)		#___ (trips)	#___ (trips)	#___
Eldred Sherwood Lake (Hancock)		#___ (trips)	#___ (trips)	#___
Five Island Lake (Palo Alto)		#___ (trips)	#___ (trips)	#___
Fogle Lake (Ringgold)		#___ (trips)	#___ (trips)	#___
George Wyth Lake (Black Hawk)		#___ (trips)	#___ (trips)	#___
Green Belt Lake (Black Hawk)		#___ (trips)	#___ (trips)	#___
Green Castle Lake (Marshall)		#___ (trips)	#___ (trips)	#___
Green Valley Lake (Union)		#___ (trips)	#___ (trips)	#___
Greenfield Lake (Adair)		#___ (trips)	#___ (trips)	#___
Hannen Lake (Benton)		#___ (trips)	#___ (trips)	#___
Hawthorn Lake (aka Barnes City) (Mahaska)		#___ (trips)	#___ (trips)	#___
Hickory Grove Lake (Story)		#___ (trips)	#___ (trips)	#___
Hooper Area Pond (Warren)		#___ (trips)	#___ (trips)	#___
Indian Lake (Van Buren)		#___ (trips)	#___ (trips)	#___
Ingham Lake (Emmet)		#___ (trips)	#___ (trips)	#___
Kent Park Lake (Johnson)		#___ (trips)	#___ (trips)	#___

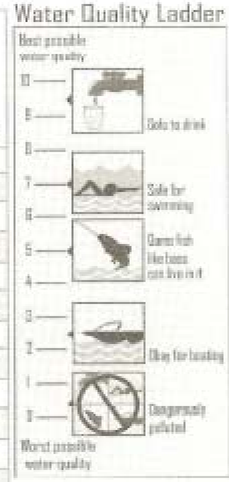


Name of Lake (County)	Check if you have ever considered visiting this lake	Number of visits (January-December) in 2003		Water Quality Assessment
		Single-day	Over-night	
Lacey-Keosauqua Park Lake (VanBuren)		# ___ (trips)	# ___ (trips)	# ___
Lake Ahquabi (Warren)		# ___ (trips)	# ___ (trips)	# ___
Lake Anita (Cass)		# ___ (trips)	# ___ (trips)	# ___
Lake Cornelia (Wright)		# ___ (trips)	# ___ (trips)	# ___
Lake Darling (Washington)		# ___ (trips)	# ___ (trips)	# ___
Lake Geode (Henry)		# ___ (trips)	# ___ (trips)	# ___
Lake Hendricks (Howard)		# ___ (trips)	# ___ (trips)	# ___
Lake Icaria (Adams)		# ___ (trips)	# ___ (trips)	# ___
Lake of the Hills (Scott)		# ___ (trips)	# ___ (trips)	# ___
Lake Iowa (Iowa)		# ___ (trips)	# ___ (trips)	# ___
Lake Keomah (Mahaska)		# ___ (trips)	# ___ (trips)	# ___
Lake Manawa (Pottawattamie)		# ___ (trips)	# ___ (trips)	# ___
Lake McBride (Johnson)		# ___ (trips)	# ___ (trips)	# ___
Lake Meyer (Winneshiek)		# ___ (trips)	# ___ (trips)	# ___
Lake Miami (Monroe)		# ___ (trips)	# ___ (trips)	# ___
Lake Minnewashta (Dickinson)		# ___ (trips)	# ___ (trips)	# ___
Lake Orient (Adair)		# ___ (trips)	# ___ (trips)	# ___
Lake Pahoja (Lyon)		# ___ (trips)	# ___ (trips)	# ___
Lake Smith (Kossuth)		# ___ (trips)	# ___ (trips)	# ___
Lake Sugema (Van Buren)		# ___ (trips)	# ___ (trips)	# ___
Lake of Three Fires (Taylor)		# ___ (trips)	# ___ (trips)	# ___
Lake Wapello (Davis)		# ___ (trips)	# ___ (trips)	# ___
Little River (Decatur)		# ___ (trips)	# ___ (trips)	# ___
Little Sioux Park Lake (Woodbury)		# ___ (trips)	# ___ (trips)	# ___
Little Spirit Lake (Dickinson)		# ___ (trips)	# ___ (trips)	# ___
Little Wall Lake (Hamilton)		# ___ (trips)	# ___ (trips)	# ___
Littlefield Lake (Audubon)		# ___ (trips)	# ___ (trips)	# ___
Lost Island Lake (Palo Alto)		# ___ (trips)	# ___ (trips)	# ___
Lower Gar Lake (Dickinson)		# ___ (trips)	# ___ (trips)	# ___
Lower Pine Lake (Hardin)		# ___ (trips)	# ___ (trips)	# ___
Manteno Lake (Shelby)		# ___ (trips)	# ___ (trips)	# ___
Mariposa Lake (Jasper)		# ___ (trips)	# ___ (trips)	# ___
Meadow Lake (Adair)		# ___ (trips)	# ___ (trips)	# ___



Name of Lake (County)	Check if you have ever considered visiting this lake	Number of visits (January-December) in 2003		Water Quality Assessment
		Single-day	Over-night	
Meyers Lake (Black Hawk)		#___ (trips)	#___ (trips)	#___
Mill Creek (Lake) (O'Brien)		#___ (trips)	#___ (trips)	#___
Mitchell Lake (Black Hawk)		#___ (trips)	#___ (trips)	#___
Moorhead Lake (Ida)		#___ (trips)	#___ (trips)	#___
Mormon Trail Lake (Adair)		#___ (trips)	#___ (trips)	#___
Nelson Park Lake (Crawford)		#___ (trips)	#___ (trips)	#___
Nine Eagles Lake (Decatur)		#___ (trips)	#___ (trips)	#___
North Twin Lake (Calhoun)		#___ (trips)	#___ (trips)	#___
Oldham Lake (Monona)		#___ (trips)	#___ (trips)	#___
Otter Creek Lake (Tama)		#___ (trips)	#___ (trips)	#___
Ottumwa Lagoon (Wapello)		#___ (trips)	#___ (trips)	#___
Pierce Creek Lake (Page)		#___ (trips)	#___ (trips)	#___
Pleasant Creek Lake (Linn		#___ (trips)	#___ (trips)	#___
Pollmiller Park Lake (Lee)		#___ (trips)	#___ (trips)	#___
Prairie Rose Lake (Shelby)		#___ (trips)	#___ (trips)	#___
Rathbun Lake (Appanoose)		#___ (trips)	#___ (trips)	#___
Red Haw Lake (Lucas)		#___ (trips)	#___ (trips)	#___
Red Rock Lake (Marion)		#___ (trips)	#___ (trips)	#___
Roberts Creek Lake (Marion)		#___ (trips)	#___ (trips)	#___
Rock Creek Lake (Jasper)		#___ (trips)	#___ (trips)	#___
Rodgers Park Lake (Benton)		#___ (trips)	#___ (trips)	#___
Saylorville Lake (Polk)		#___ (trips)	#___ (trips)	#___
Silver Lake (Delaware)		#___ (trips)	#___ (trips)	#___
Silver Lake (Dickinson)		#___ (trips)	#___ (trips)	#___
Silver Lake (Palo Alto)		#___ (trips)	#___ (trips)	#___
Silver Lake (Worth)		#___ (trips)	#___ (trips)	#___
Slip Bluff Lake (Decatur)		#___ (trips)	#___ (trips)	#___
South Prairie Lake (Black Hawk)		#___ (trips)	#___ (trips)	#___
Spring Lake (Greene)		#___ (trips)	#___ (trips)	#___
Springbrook Lake (Guthrie)		#___ (trips)	#___ (trips)	#___
Storm Lake including Little Storm Lake (Buena Vista)		#___ (trips)	#___ (trips)	#___
Swan Lake (Carroll)		#___ (trips)	#___ (trips)	#___
Thayer Lake (Union)		#___ (trips)	#___ (trips)	#___
Three Mile Lake (Union)		#___ (trips)	#___ (trips)	#___

Water Quality Ladder



Name of Lake (County)	Check if you have ever considered visiting this lake	Number of visits (January-December) in 2003		Water Quality Assessment
		Single-day	Over-night	
Trumbull Lake (Clay)		#___(trips)	#___(trips)	#___
Tuttle Lake (Emmet)		#___(trips)	#___(trips)	#___
Twelve Mile Creek Lake (Union)		#___(trips)	#___(trips)	#___
Union Grove Lake (Tama)		#___(trips)	#___(trips)	#___
Upper Gar Lake (Dickinson)		#___(trips)	#___(trips)	#___
Upper Pine Lake (Hardin)		#___(trips)	#___(trips)	#___
Viking Lake (Montgomery)		#___(trips)	#___(trips)	#___
Volga Lake (Fayette)		#___(trips)	#___(trips)	#___
West Okoboji Lake (Dickinson)		#___(trips)	#___(trips)	#___
West Osceola (Clarke)		#___(trips)	#___(trips)	#___
White Oak Lake (Mahaska)		#___(trips)	#___(trips)	#___
Williamson Pond (Lucas)		#___(trips)	#___(trips)	#___
Willow Lake (Harrison)		#___(trips)	#___(trips)	#___
Wilson Park Lake (Taylor)		#___(trips)	#___(trips)	#___
Windmill Lake (Taylor)		#___(trips)	#___(trips)	#___
Yellow Smoke Park Lake (Crawford)		#___(trips)	#___(trips)	#___
Other Lakes in Iowa		#___(trips)	#___(trips)	#___

2. Please indicate how often you or other members of your household visited lakes or rivers in each of the following locations this year.

	Single-day	Over-night
Lakes in Illinois		
Lakes in Minnesota		
Lakes in Missouri		
Lakes in Nebraska		
Lakes in South Dakota		

	Single-day	Over-night
Lakes in Wisconsin		
The Missouri River		
The Mississippi River		
Other Lakes and Rivers		

3. What activities do you or members of your household typically participate in during your lake visits? Check all that apply.

❑Boating ❑Jet skiing ❑Nature Appreciation/wildlife viewing
❑Camping ❑Sailing ❑Snowmobiling and other winter recreation
❑Fishing ❑Canoeing ❑Swimming and beach use
❑Hunting ❑Picnicking ❑ Other______________________________

In the following sections we will ask you some questions about potential changes to the water quality of Silver Lake located in Delaware County. First, however, we will give you some information on the current condition of the lake. Please read this information carefully before answering the questions that follow.

Silver Lake's Current Condition

The quality of a lake can be described in many ways. One measure of water quality is the clarity of the lake water. Water clarity is usually described in terms of how far down into the water an object remains visible. The clarity of Silver Lake is currently between 8 inches and 1 foot. This means that objects are visible down to about 8 inches to 1 foot under the surface of the water.

Another measure of water quality is the amount of nutrients and other contaminants contained in the water. Water degradation can result from a number of sources, including urban runoff, fertilizers used in agriculture, motor vehicles, and others. Currently nutrients contribute to the occurrence of algae blooms in the lake at an almost constant rate. Under some circumstances these blooms can be a health concern, causing skin rashes and allergic reactions.

Current conditions of Silver Lake can be summarized as:

Water Clarity:	objects distinguishable 8 inches to 1 foot under water
Algae blooms:	constant
Water color:	flourescent blue green
Water odor:	always strong odor
Fish:	no significant fish population

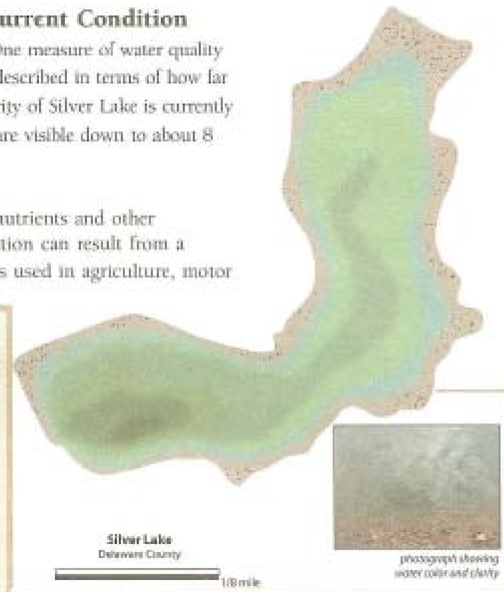


Figure 1. Current conditions of Silver Lake

The overall quality of the water can affect other conditions of the lake. Poor water quality can result in an undesirable color and odor to the lake water. Currently, the color of Silver Lake varies between green and brown. The water has a mild odor that many describe as "fishy" with periods of less mild odor.

Silver Lake is severely impaired. Forty years ago the lake supported viable fish populations and significant angling recreation. However, today water quality problems prevent the development of fish populations. Extremely high levels of phosphorus and nitrogen in the lake have resulted in low levels of dissolved oxygen during both summer and winter periods. Recreational use on Silver Lake is virtually nil.

1. During the course of the next year (2004), how many trips do you expect to take to Silver Lake?
   ______trips in 2004.

In the next question, we will be asking you how you would vote on a special ballot regarding the water quality of Silver Lake. While there is currently no such ballot initiative, we would like you to respond as if you were actually voting on the initiative and as if this were the only alternative available for improving water quality in the lake. (In particular, assume that no state action will be undertaken unless the referendum passes.)

When you think about your answer, it is important to keep in mind that people may indicate that they would be willing to pay more money when payment is hypothetical than when they are immediately expected to pay. It may be easy for people to say that they support a project when they are not sure they will ever have to pay any money based on their response. However, if the proposed payments are real and immediate, people may be more inclined to think about other options and what things they would have to give up to make this payment. So in answering the following questions, please keep in mind both the benefits of the water quality improvement and the impact that passage of such a referendum would have on your finances. In other words, **please answer as if this were a real referendum.**

Suppose that investments could be made to actually improve the quality of Silver Lake. These investments might include dredging, building protection strips along the edge of the lake to reduce runoff from the surrounding watershed or other structural changes to the lake and watershed. These changes would improve the lake over the next 5 years to the conditions described in Figure 2.

Improved conditions of Silver Lake can be summarized as:

Water Clarity:	objects distinguishable 6 to 8 feet under water
Algae blooms:	Rarely more than 1 per year
Water color:	green to blue
Water odor:	usually fresh
Fish:	high diversity

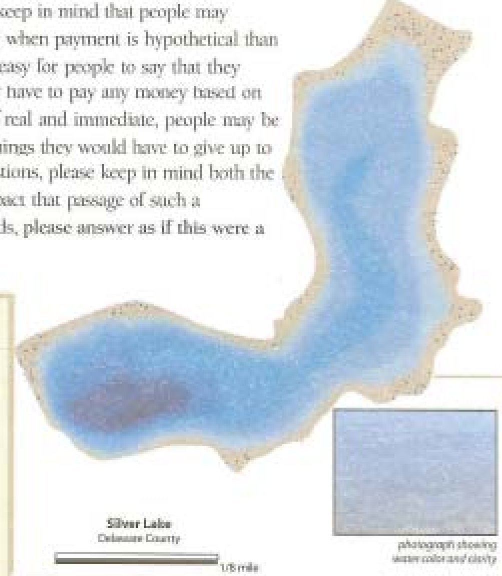


Figure 2. Conditions of Silver Lake following an improvement

Further, suppose that if the referendum passes, the improvements would proceed immediately. However, if the referendum fails, any plans to improve the water quality of the lake would be delayed for *two years* while further research takes place into the causes of lake pollution as well as alternative clean-up approaches. After this delay, any new information from studying the lake will be made available and you will then get a final chance to vote on the same referendum.

5. Would you vote "yes" on a referendum to improve the water quality in Silver Lake to the level described here? The proposed project would cost you $500 (payable in five $100 installments over a five year period.)

   ❑no ❑yes

6. How sure are you of this answer?

   1 (not sure at all) 2 3 4 5 (certain)

7. To help us better understand your answer, please indicate the **single** most important reason for your response to the preceding question:

❑In general, the project is not a good use of my money

❑In general, the project is a good use of my money

❑The project is not realistic or unclear

❑The costs of the project should be paid for by those damaging the lake, not by me

❑I already contribute to environmental causes as much as I can afford

❑No one should have the right to damage the lake in the first place

❑ Other____

8. How many trips to Storm Lake would you make next year (2004) if the water quality at Storm Lake was improved by the amount described in Figure 2?
__________trips in 2004.

Information on you and other members of your household will help us better understand how household characteristics affect an individual's use of Iowa lakes and attitudes towards changes in them. It will also help us to determine how representative our sample is of the state of Iowa. All of your answers are strictly confidential. The information will only be used to report comparisons among groups of people. We will never identify individuals or households with their responses. Please be as complete in your answers as possible. Thank you.

9. What is your age?

❑Under 18 ❑26 – 34 ❑50 - 59 ❑76 +
❑18 – 25 ❑35 – 49 ❑60 - 75

10. Are you

❑male ❑female

11 What is the highest level of schooling that you have completed? (Please check only one)

❑Some high school or less ❑Some college or trade/vocational school ❑Advanced degree
❑High school graduate ❑College graduate

12. How many adults (including yourself) live in your household? ______

13. How many children live in your household (18 or under)?______

14. What is your current employment status?

❑full time ❑part time ❑student ❑unemployed ❑retired

15. If you are currently employed, how many hours a week do you typically work? ______

16. If you are currently employed, do you have the option of working additional hours to increase your total income?
   ❑no ❑yes—if so, what would your hourly wage be? $______per hour

17. If you answered "no" to question 16, and you could have the option of working more or less hours, which would you prefer?

   ❑Work more hours ❑Work the same number of hours ❑Work fewer hours

18. What is your total household income (before taxes) for 2003?

❑Under $10,000	❑$25,000-$29,999	❑$50,000-$59,999	❑$125,000-$149,999
❑$10,000-$14,999	❑$30,000-$34,999	❑$60,000-$74,999	❑Over $150,000
❑$15,000-$19,999	❑$35,000-$39,999	❑$75,000-$99,999	
❑$20,000-$24,999	❑$40,000-$49,999	❑$100,000-$124,999	

19. Do you own a boat? ❑yes ❑no

Finally, we would appreciate a little more information on your reaction to this survey.

20. How likely do you think it is that the results of surveys such as this one will affect decisions about water quality in Iowa lakes?

   1 (no effect at all) 2 3 4 5 (definite effects)

21. If a water quality project such as the one described on page 9 were initiated but later information suggested that it would be ineffective, how likely is it that the project would be scrapped?

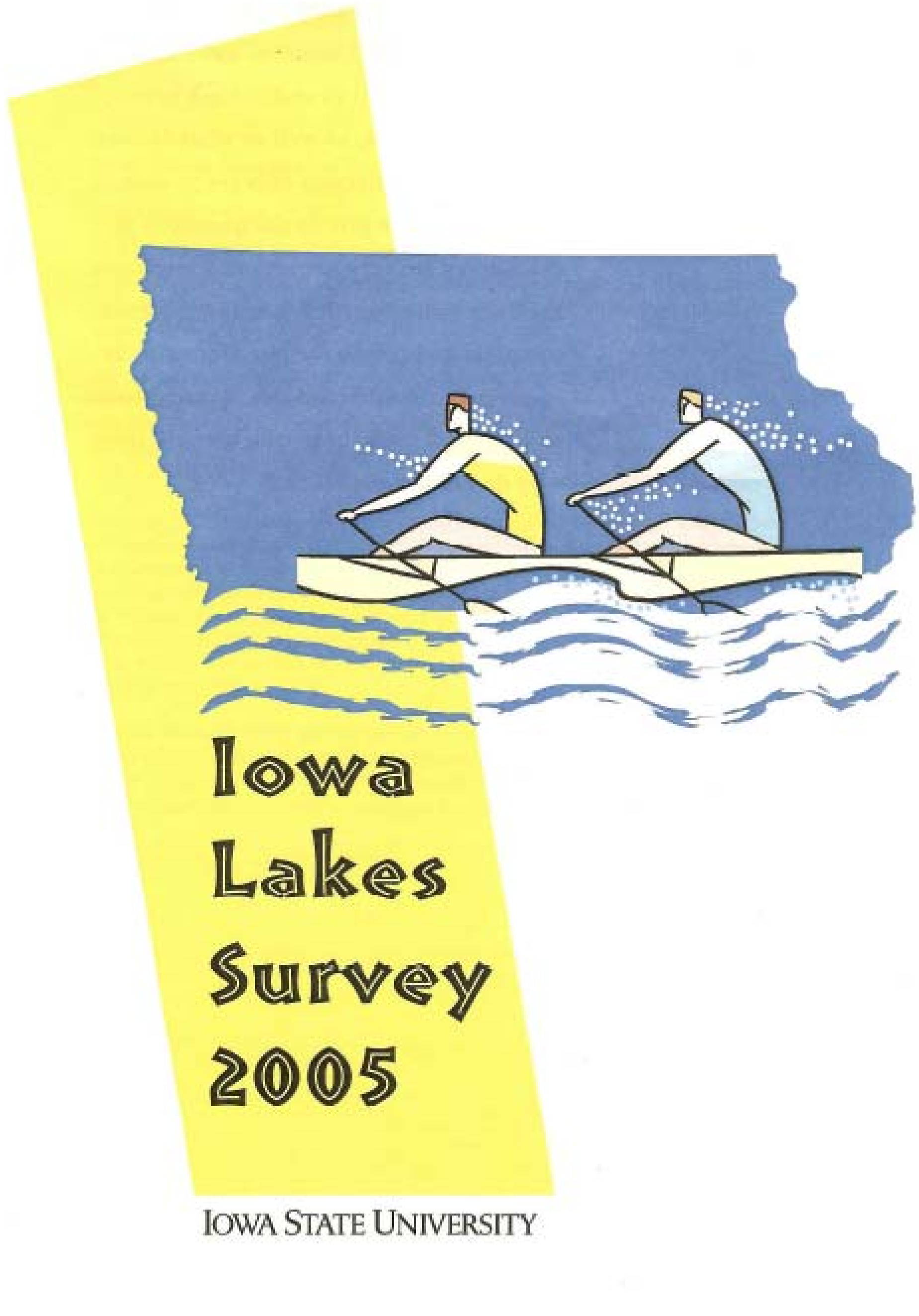
   1 (impossible) 2 3 4 5 (certainly)

22. Other than the information you will be receiving from us, what do you think is the likelihood that you will get additional information about the effectiveness of water quality improvement projects in the next few years?

   1 (impossible) 2 3 4 5 (certainly)

Thank you for your participation in this survey. After completion, surveys should be returned to:
Catherine Kling
568 Heady Hall, Mailstop M9391
Iowa State University
Ames, IA 50011-1070

Appendix 2. Iowa Lakes Survey 2005



In order to make sound decisions concerning the future of Iowa lakes, it is important to understand how the lakes are used, as well as what factors influence your selection of lakes to visit. The answers you give to the questions in this survey are very important. Even if you have not visited any lakes in Iowa, please complete and return the questionnaire. It is critical to understand the characteristics and views of both those who use and those who do not use the lakes.

In this first section, we would like to find out which of the lakes on the enclosed map you visited and what you did there.

1. Please indicate how often you or other members of your household visited each of the following lakes in the current year. If you have not visited any lakes in Iowa this year please check this box.

   ❑ I have not visited any lakes in Iowa this year.

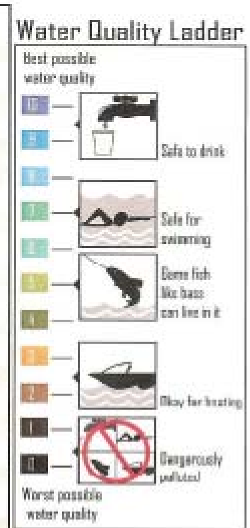
   In addition to recording the number of visits you took to each lake, if any, please indicate which of the lakes you *considered* visiting this year by marking the box in the second column.

   We are very interested in your view of the water quality of Iowa's lakes. One way of thinking about water quality is to use a ladder like the one shown to the right of the list of lakes. The top of the water quality ladder stands for the best possible quality of water, while the bottom of the ladder stands for the worst. On the ladder you can see the different levels of water quality.

   For example: the lowest level is so polluted that it has oil, raw sewage, and/or other things in it like trash; it has almost no plant or animal life, smells bad, and contact with it is dangerous to human health. Water quality that is "boatable" would not harm you if you happened to fall into it for a short time while boating or sailing. Water quality that is "fishable" is a higher level of quality than "boatable." Although some kinds of fish can live in boatable water, it is only when water is "fishable" that game fish like bass can live in it. Finally, "swimmable" water is of a high enough quality that it is safe to swim in and ingest in small amounts.

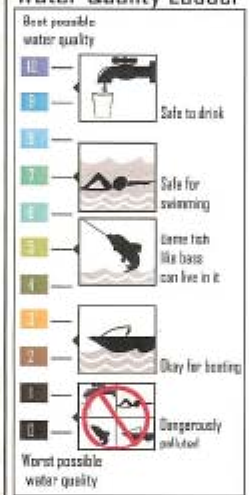
   For any lake with which you are familiar, please indicate your assessment of the level of water quality associated with that lake by assigning a number between 0 and 10 that is based on the water quality ladder pictured. Familiar lakes include both those that you have visited this year as well as those you have visited in the recent past.

Name of lake (County)	Check if you have ever considered visiting this lake	Number of visits (January-December in 2005)		Water Quality Assessment
		Single day	Overnight	
Lake Ahquabi (Warren)		#___ (trips)	#___ (trips)	#_____
Lake Anita (Cass)		#___ (trips)	#___ (trips)	#_____
Arbor Lake (Poweshiek)		#___ (trips)	#___ (trips)	#_____
Arrowhead Lake (Pottawattamie)		#___ (trips)	#___ (trips)	#_____
Arrowhead Pond (Sac)		#___ (trips)	#___ (trips)	#_____
Avenue of the Saints Lake (Bremer)		#___ (trips)	#___ (trips)	#_____
Badger Creek Lake (Madison)		#___ (trips)	#___ (trips)	#_____
Badger Lake (Webster)		#___ (trips)	#___ (trips)	#_____
Beaver Lake (Dallas)		#___ (trips)	#___ (trips)	#_____
Beed's Lake (Franklin)		#___ (trips)	#___ (trips)	#_____
Big Creek Lake (Polk)		#___ (trips)	#___ (trips)	#_____
Big Spirit Lake (Dickinson)		#___ (trips)	#___ (trips)	#_____
Black Hawk Lake (Sac)		#___ (trips)	#___ (trips)	#_____
Blue Lake (Monona)		#___ (trips)	#___ (trips)	#_____
Bob White Lake (Wayne)		#___ (trips)	#___ (trips)	#_____
Briggs Woods Lake (Hamilton)		#___ (trips)	#___ (trips)	#_____
Brown's Lake (Woodbury)		#___ (trips)	#___ (trips)	#_____
Brushy Creek Lake (Webster)		#___ (trips)	#___ (trips)	#_____
Carter Lake (Pottawattamie)		#___ (trips)	#___ (trips)	#_____
Casey Lake (aka Hickory Hills) (Tama)		#___ (trips)	#___ (trips)	#_____
Center Lake (Dickinson)		#___ (trips)	#___ (trips)	#_____
Central Park Lake (Jones)		#___ (trips)	#___ (trips)	#_____
Clear Lake (Cerro Gordo)		#___ (trips)	#___ (trips)	#_____
Cold Springs Lake (Cass)		#___ (trips)	#___ (trips)	#_____
Coralville Lake (Johnson)		#___ (trips)	#___ (trips)	#_____
Lake Cornelia (Wright)		#___ (trips)	#___ (trips)	#_____
Crawford Creek Impoundment (Ida)		#___ (trips)	#___ (trips)	#_____
Crystal Lake (Hancock)		#___ (trips)	#___ (trips)	#_____
Dale Maffitt Lake (Madison)		#___ (trips)	#___ (trips)	#_____
Lake Darling (Washington)		#___ (trips)	#___ (trips)	#_____
DeSoto Bend Lake (Harrison)		#___ (trips)	#___ (trips)	#_____
Diamond Lake (Poweshiek)		#___ (trips)	#___ (trips)	#_____
Dog Creek (Lake) (O'Brien)		#___ (trips)	#___ (trips)	#_____
Don Williams Lake (Boone)		#___ (trips)	#___ (trips)	#_____
East Lake (Osceola) (Clarke)		#___ (trips)	#___ (trips)	#_____
East Okoboji Lake (Dickinson)		#___ (trips)	#___ (trips)	#_____
Easter Lake (Polk)		#___ (trips)	#___ (trips)	#_____
Eldred Sherwood Lake (Hancock)		#___ (trips)	#___ (trips)	#_____
Five Island Lake (Palo Alto)		#___ (trips)	#___ (trips)	#_____
Fogle Lake (Ringgold)		#___ (trips)	#___ (trips)	#_____
Lake Geode (Henry)		#___ (trips)	#___ (trips)	#_____
George Wyth Lake (Black Hawk)		#___ (trips)	#___ (trips)	#_____
Green Belt Lake (Black Hawk)		#___ (trips)	#___ (trips)	#_____

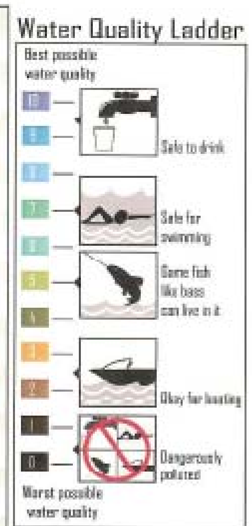


Name of lake (County)	Check if you have ever considered visiting this lake	Number of visits (January-December in 2005) Single day	Overnight	Water Quality Assessment
Green Castle Lake (Marshall)		#____(trips)	#____(trips)	#____
Green Valley Lake (Union)		#____(trips)	#____(trips)	#____
Greenfield Lake (Adair)		#____(trips)	#____(trips)	#____
Hannen Lake (Benton)		#____(trips)	#____(trips)	#____
Hawthorn Lake (aka Barnes City) (Mahaska)		#____(trips)	#____(trips)	#____
Lake Hendricks (Howard)		#____(trips)	#____(trips)	#____
Hickory Grove Lake (Story)		#____(trips)	#____(trips)	#____
Hooper Area Pond (Warren)		#____(trips)	#____(trips)	#____
Lake Icaria (Adams)		#____(trips)	#____(trips)	#____
Indian Lake (Van Buren)		#____(trips)	#____(trips)	#____
Ingham Lake (Emmet)		#____(trips)	#____(trips)	#____
Lake Iowa (Iowa)		#____(trips)	#____(trips)	#____
Kent Park Lake (Johnson)		#____(trips)	#____(trips)	#____
Lake Keomah (Mahaska)		#____(trips)	#____(trips)	#____
Lacey Keosauqua Park Lake (VanBuren)		#____(trips)	#____(trips)	#____
Lake of the Hills (Scott)		#____(trips)	#____(trips)	#____
Lake of Three Fires (Taylor)		#____(trips)	#____(trips)	#____
Little River (Decatur)		#____(trips)	#____(trips)	#____
Little Sioux Park Lake (Woodbury)		#____(trips)	#____(trips)	#____
Little Spirit Lake (Dickinson)		#____(trips)	#____(trips)	#____
Little Wall Lake (Hamilton)		#____(trips)	#____(trips)	#____
Littlefield Lake (Audubon)		#____(trips)	#____(trips)	#____
Lost Island Lake (Palo Alto)		#____(trips)	#____(trips)	#____
Lower Gar Lake (Dickinson)		#____(trips)	#____(trips)	#____
Lower Pine Lake (Hardin)		#____(trips)	#____(trips)	#____
Lake Manawa (Pottawattamie)		#____(trips)	#____(trips)	#____
Manteno Lake (Shelby)		#____(trips)	#____(trips)	#____
Lake Macbride (Johnson)		#____(trips)	#____(trips)	#____
Mariposa Lake (Jasper)		#____(trips)	#____(trips)	#____
Meadow Lake (Adair)		#____(trips)	#____(trips)	#____
Lake Meyer (Winneshiek)		#____(trips)	#____(trips)	#____
Meyers Lake (Black Hawk)		#____(trips)	#____(trips)	#____
Lake Miami (Monroe)		#____(trips)	#____(trips)	#____
Mill Creek (Lake) (O'Brien)		#____(trips)	#____(trips)	#____
Lake Minnewashta (Dickinson)		#____(trips)	#____(trips)	#____
Mitchell Lake (Black Hawk)		#____(trips)	#____(trips)	#____
Moorhead Lake (Ida)		#____(trips)	#____(trips)	#____
Mormon Trail Lake (Adair)		#____(trips)	#____(trips)	#____
Nelson Park Lake (Crawford)		#____(trips)	#____(trips)	#____
Nine Eagles Lake (Decatur)		#____(trips)	#____(trips)	#____
North Twin Lake (Calhoun)		#____(trips)	#____(trips)	#____
Oldham Lake (Monona)		#____(trips)	#____(trips)	#____
Lake Orient (Adair)		#____(trips)	#____(trips)	#____

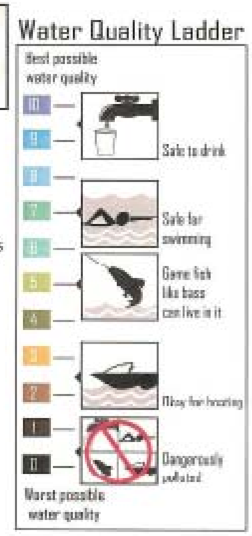
Water Quality Ladder



Name of lake (County)	Check if you have ever considered visiting this lake	Number of visits (January-December in 2005)		Water Quality Assessment
		Single day	Overnight	
Otter Creek Lake (Tama)		#___(trips)	#___(trips)	#______
Ottumwa Lagoon (Wapello)		#___(trips)	#___(trips)	#______
Lake Pahoja (Lyon)		#___(trips)	#___(trips)	#______
Pierce Creek Lake (Page)		#___(trips)	#___(trips)	#______
Pleasant Creek Lake (Linn)		#___(trips)	#___(trips)	#______
Pollmiller Park Lake (Lee)		#___(trips)	#___(trips)	#______
Prairie Rose Lake (Shelby)		#___(trips)	#___(trips)	#______
Rathbun Lake (Appanoose)		#___(trips)	#___(trips)	#______
Red Haw Lake (Lucas)		#___(trips)	#___(trips)	#______
Red Rock Lake (Marion)		#___(trips)	#___(trips)	#______
Roberts Creek Lake (Marion)		#___(trips)	#___(trips)	#______
Rock Creek Lake (Jasper)		#___(trips)	#___(trips)	#______
Rodgers Park Lake (Benton)		#___(trips)	#___(trips)	#______
Saylorville Lake (Polk)		#___(trips)	#___(trips)	#______
Silver Lake (Delaware)		#___(trips)	#___(trips)	#______
Silver Lake (Dickinson)		#___(trips)	#___(trips)	#______
Silver Lake (Palo Alto)		#___(trips)	#___(trips)	#______
Silver Lake (Worth)		#___(trips)	#___(trips)	#______
Slip Bluff Lake (Decatur)		#___(trips)	#___(trips)	#______
Lake Smith (Kossuth)		#___(trips)	#___(trips)	#______
South Prairie Lake (Black Hawk)		#___(trips)	#___(trips)	#______
Spring Lake (Greene)		#___(trips)	#___(trips)	#______
Springbrook Lake (Guthrie)		#___(trips)	#___(trips)	#______
Storm Lake including Little Storm Lake (Buena Vista)		#___(trips)	#___(trips)	#______
Lake Sugema (Van Buren)		#___(trips)	#___(trips)	#______
Swan Lake (Carroll)		#___(trips)	#___(trips)	#______
Thayer Lake (Union)		#___(trips)	#___(trips)	#______
Three Mile Lake (Union)		#___(trips)	#___(trips)	#______
Trumbull Lake (Clay)		#___(trips)	#___(trips)	#______
Tuttle Lake (Emmet)		#___(trips)	#___(trips)	#______
Twelve Mile Creek Lake (Union)		#___(trips)	#___(trips)	#______
Union Grove Lake (Tama)		#___(trips)	#___(trips)	#______
Upper Gar Lake (Dickinson)		#___(trips)	#___(trips)	#______
Upper Pine Lake (Hardin)		#___(trips)	#___(trips)	#______
Viking Lake (Montgomery)		#___(trips)	#___(trips)	#______
Volga Lake (Fayette)		#___(trips)	#___(trips)	#______
Lake Wapello (Davis)		#___(trips)	#___(trips)	#______
West Okoboji Lake (Dickinson)		#___(trips)	#___(trips)	#______
West Osceola Lake (Clarke)		#___(trips)	#___(trips)	#______
White Oak Lake (Mahaska)		#___(trips)	#___(trips)	#______
Williamson Pond (Lucas)		#___(trips)	#___(trips)	#______
Willow Lake (Harrison)		#___(trips)	#___(trips)	#______



Name of lake (County)	Check if you have ever considered visiting this lake	Number of visits (January-December in 2005) Single day	Overnight	Water Quality Assessment
Wilson Park Lake (Taylor)		#___ (trips)	#___ (trips)	#___
Windmill Lake (Taylor)		#___ (trips)	#___ (trips)	#___
Yellow Smoke Park Lake (Crawford)		#___ (trips)	#___ (trips)	#___
Other Lakes in Iowa___________		#___ (trips)	#___ (trips)	#___



2. Please indicate how often you or other members of your household visited lakes or rivers in each of the following locations this year.

	Single-day visits	Overnight visits
Lakes in Illinois		
Lakes in Minnesota		
Lakes in Missouri		
Lakes in Nebraska		
Lakes in South Dakota		
Lakes in Wisconsin		
The Missouri River		
The Mississippi River		
Other Lakes and Rivers		

3. What activities do you or members of your household typically participate in during your lake visits? Check all that apply.

❑Boating ❑Jet skiing ❑Nature Appreciation/wildlife viewing
❑Camping ❑Sailing ❑Snowmobiling and other winter recreation
❑Fishing ❑Canoeing ❑Swimming and beach use
❑Hunting ❑Picnicking ❑Other___________________________

In the following sections we will ask you some questions about potential changes to the water quality of Big Creek Lake located in Polk County. First, however, we will give you some information on the current condition of the lake. Please read this information carefully before answering the questions that follow.

Big Creek Lake's Current Condition

The quality of a lake can be described in many ways. One measure of water quality is the clarity of the lake water. Water clarity is usually described in terms of how far down into the water an object remains visible. The clarity of Big Creek Lake is currently between 4 and 19 feet. This means that objects are visible down to about 4 to 19 feet under the surface of the water.

Another measure of water quality is the amount of nutrients and other contaminants contained in the water. Water degradation can result from a number of sources, including urban runoff, fertilizers used in agriculture, motor vehicles, and others. Currently nutrients contribute to the occurrence of algae blooms in the lake usually 2 to 5 times per year. Under some circumstances these blooms can be a health concern, causing skin rashes and allergic reactions. Big Creek Lake is currently monitored for bacteria levels by the Iowa Department of Natural Resources. Last summer, "swimming is not recommended" signs were never posted at the lake, but in a typical summer anywhere from 0 to 2 weeks of postings is possible.

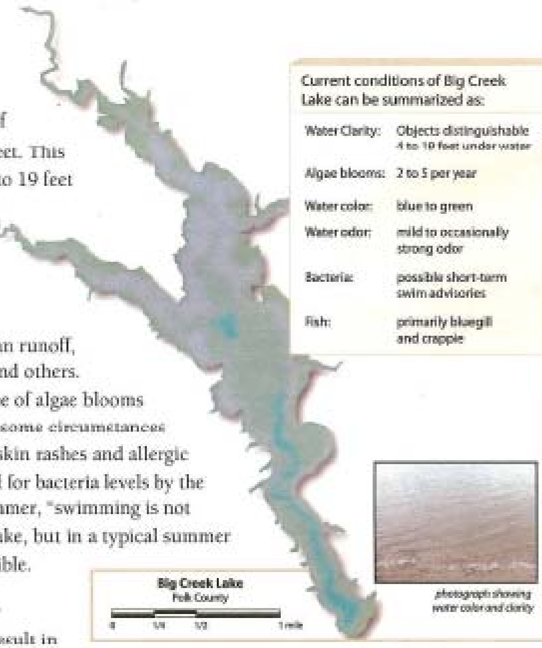


Figure 1. Current conditions of Big Creek Lake

The overall quality of the water can affect other conditions of the lake. Poor water quality can result in an undesirable color and odor to the lake water. Currently, the color of Big Creek Lake varies between blue and green. The water has a mild to occasionally strong odor that many describe as "fishy."

Finally, the quality of the water affects the variety and quantity of fish in the lake. A creel survey was conducted during 2002 and 2003 to access the current status of the fishery. Bluegill and crappie composed 96% of the fishery in 2002 and 98% in 2003. Mean catch rates increased from 0.35 fish per hour to 0.42 fish per hour for the two years. Overall, the fishery is improved considerably from the 1990's. The biggest change has been in the bluegill fishery, with an overall increase in the size and weight of fish. In addition, while the harvest of walleye was low, there was an excellent catch and release fishery for walleye 10-14 inches. Similarly, there appears to be a good number of smaller largemouth bass in the lake.

4. During the course of the next year (2006), how many trips do you expect to take to Big Creek Lake?
   ______trips in 2006 .

In the next question, we will be asking you how you would vote on a special ballot regarding the water quality of Big Creek Lake. While there is currently no such ballot initiative, we would like you to respond as if you were actually voting on the initiative and as if this were the only alternative available for improving water quality in the lake. (In particular, assume that no state action will be undertaken unless the referendum passes.)

When you think about your answer, it is important to keep in mind that people may indicate that they would be willing to pay more money when payment is hypothetical than when they are immediately expected to pay. It may be easy for people to say that they support a project when they are not sure they will ever have to pay any money based on their response. However, if the proposed payments are real and immediate, people may be more inclined to think about other options and what things they would have to give up to make this payment. So in answering the following questions, please keep in mind both the benefits of the water quality improvement and the impact that passage of such a referendum would have on your finances. In other words, **please answer as if this were a real referendum.**

Suppose that investments could be made to actually improve the quality of Big Creek Lake. These investments might include dredging, building protection strips along the edge of the lake to reduce runoff from the surrounding watershed or other structural changes to the lake and watershed. These changes would improve the lake over the next 5 years to the conditions described in Figure 2.

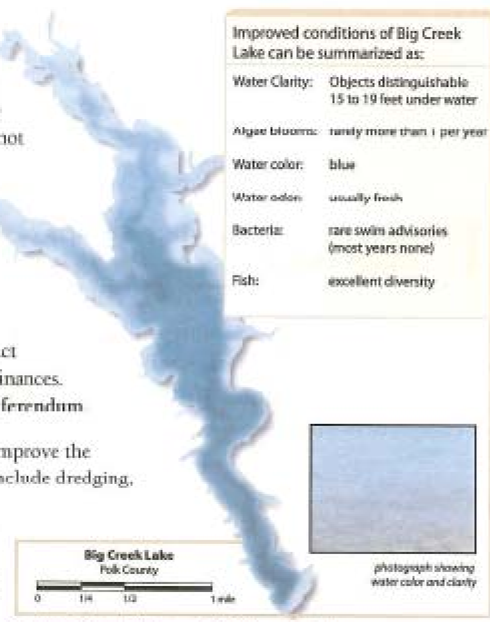


Figure 2. Conditions of Big Creek Lake following an improvement project

5. Would you vote "yes" on a referendum to improve the water quality in Big Creek Lake to the level described here? The proposed project would cost you $80.00 (payable in five $16.00 installments over a five year period.)

   ❑no ❑yes

6. How sure are you of this answer?

   1 (not sure at all) 2 3 4 5 (certain)

6. To help us better understand your answer, please indicate the **single** most important reason for your response to the preceding question:

   ❑In general, the project is not a good use of my money

   ❑In general, the project is a good use of my money

   ❑The project is not realistic or unclear

   ❑The costs of the project should be paid for by those damaging the lake, not by me

   ❑I already contribute to environmental causes as much as I can afford

   ❑No one should have the right to damage the lake in the first place

   ❑Other____

7. How many trips to Big Creek Lake would you make next year (2006) if the water quality at Big Creek Lake was improved by the amount described in Figure 2?

   __________trips in 2006.

Information on you and other members of your household will help us better understand how household characteristics affect an individual's use of Iowa lakes and attitudes towards changes in them. It will also help us to determine how representative our sample is of the state of Iowa. All of your answers are strictly confidential. The information will only be used to report comparisons among groups of people. We will never identify individuals or households with their responses. Please be as complete in your answers as possible. Thank you.

8. What is your age?

   ❑Under 18 ❑26 – 34 ❑50 - 59 ❑76 +

   ❑18 – 25 ❑35 – 49 ❑60 - 75

9. Are you

   ❑male ❑female

10. What is the highest level of schooling that you have completed? (Please check only one)

    ❑Some high school or less ❑Some college or trade/vocational school ❑Advanced degree

    ❑High school graduate ❑College graduate

11. How many adults (including yourself) live in your household? _______

12. How many children live in your household (18 or under)?________

13. What is your current employment status?

    ❑full time ❑part time ❑student ❑unemployed ❑retired

14. If you are currently employed, how many hours a week do you typically work? _______

15. If you are currently employed, do you have the option of working additional hours to increase your total income?

❑no ❑yes—if so, what would your hourly wage be? $_______per hour

16. If you answered "no" to question 16, and you could have the option of working more or less hours, which would you prefer?

❑Work more hours ❑Work the same number of hours ❑Work fewer hours

17. What is your total household income (before taxes) for 2003?

❑Under $10,000	❑$25,000-$29,999	❑$50,000-$59,999	❑$125,000-$149,999
❑$10,000-$14,999	❑$30,000-$34,999	❑$60,000-$74,999	❑Over $150,000
❑$15,000-$19,999	❑$35,000-$39,999	❑$75,000-$99,999	
❑$20,000-$24,999	❑$40,000-$49,999	❑$100,000-$124,999	

18. Do you own a boat? ❑yes ❑no

Finally, we would appreciate a little more information on your reaction to this survey.

19. How likely do you think it is that the results of surveys such as this one will affect decisions about water quality in Iowa lakes?

1 (no effect at all) 2 3 4 5 (definite effects)

20. How well informed are you about the general state of water quality in Iowa's lakes?

1 (not well informed at all) 2 3 4 5 (very knowledgeable)

21. How would you assess your knowledge of water quality in Iowa's lakes now, relative to three or four years ago?

1 (I know much less) 2 3 (I know about the same) 4 5 (I know much more)

22. In this survey, we have asked you about your usage of Iowa's lakes and your views about water quality improvements. Do you believe that you are likely to have other opportunities to express your views about water quality projects and programs?

1 (not likely at all)2 3 4 5 (very likely)

Thank you for your participation in this survey. After completion, surveys should be returned to:
Catherine Kling
568 Heady Hall, Mailstop 08431
Iowa State University
Ames, IA 50011-1070

Appendix 3. Landscape Survey

Welcome!

Thank you for taking part in the future agricultural landscapes survey conducted by Iowa State University and the University of Michigan. In this questionnaire, you'll be asked to evaluate agricultural practices on different Iowa landscapes. Survey results will provide information to policy makers for future agricultural conservation programs.

- Participating in this survey should take you less than15 minutes. Please complete the entire questionnaire. If you do not complete a question on one page, the "next page" button will not appear, and you will not be able to go to the next page and complete the questionnaire. If you complete the questionnaire, you will have the choice to enter a cash prize drawing. One prize of $400 and two prizes of $250 will be awarded when the survey is complete.

- All of your responses are confidential and anonymous; no respondent will be identified or identifiable from survey data. None of these survey data will be used for any purpose other than this Iowa State University and University of Michigan research project.

- This questionnaire has three sections. In the first section, we'll ask a few questions about your farming operation. In the second section, you will see images of alternative future Iowa agricultural landscapes, practices, and programs, and will be asked to give your own opinions about these different options. In the third section, we will ask you a few questions about yourself.

If you have questions regarding your rights as a participant in research, please contact:

Institutional Review Board
Kate Keever
540 East Liberty Street, Suite 202
Ann Arbor, MI 48104-2210
734-936-0933
email: irbhsbs@umich.edu

Start survey

Please select all of the choices that describe your occupation(s) in 2005?

- o Full-time farm work on land owned or rented
- o Part-time farm work on land owned or rented
- o Hired farm manager
- o Retired
- o Work other than farming or ranching

In 2005, were you responsible for making the day-to-day decisions for a farm?

- o Yes
- o No

In what Iowa county was the majority of your farmland located? j32

(pull down menu of all Iowa counties = "not in Iowa" generates list of counties selected)

Survey Progress

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For the farm operation you manage, please report farm land owned, rented, or used by you, your spouse, or by the partnership, corporation or organization for which you are responding to this survey in 2005. (*Include all cropland, idle land, CRP, pastureland, woodland, wasteland, etc.*)

During the 2005 crop year, how many total acres did this operation

a. own?

b. rent **FROM** others?

c. rent **TO** others?

d. TOTAL acres in this operation including the farmstead, all cropland, pastureland, wasteland, wetland, woodland,and government program land is

e. Of the total acres in this operation (*item d above*), how many acres are cropland? (*Include land in government programs, but exclude wild hay and CRP acres*)

f. Enrolled in the Conservation Reserve Program (CRP) or Wetlands Reserve Program (WRP)?

g. Of the total acres in this operation, how many acres are "highly erodible land" (HEL)?

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Survey Progress

Please indicate if your operation included any of the following crop rotations in 2005 (check all that apply).

- o Continuous Corn
- o Corn Soybean
- o Corn Corn Soybean
- o Corn Soybean Soybean
- o Corn Soybean Wheat
- o Corn Corn Oats with Alfalfa
- o Other

What was the tillage system used on the majority of your operation's cropland acres (check only one)?

- o No till, strip till (direct seed)
- o Ridge till
- o Mulch till
- o Conventional till

Back | Next page

Survey Progress

On the next six pages you will see six different Iowa agricultural landscapes and rate each landscape on **4 separate scales for attractiveness, profitability, conservation, and ease of management.** To rate each image, **just give *your own* perceptions – what you think based on the appearance of the landscape - compared with your own past experiences of Iowa agricultural landscapes.**

To help you compare these images, you can use the "back" button at the bottom of each page to review the images and change your ratings if you want.

Survey Progress

Next page

Rate the image to show your own perceptions of this landscape compared with your own past experiences of Iowa agricultural landscapes. You can go back and forth to compare these images and revise your ratings by using the "back" button.

	1	2	3	4	5	6	7	
Unattractive	○	○	○	○	○	○	○	Attractive
Difficult to manage	○	○	○	○	○	○	○	Easy to manage
Poor conservation	○	○	○	○	○	○	○	Good conservation
Unprofitable	○	○	○	○	○	○	○	Profitable

Back Next page

Survey Progress

Rate the image to show your own perceptions of this landscape compared with your own past experiences of Iowa agricultural landscapes. You can go back and forth to compare these images and revise your ratings by using the "back" button.

	1	2	3	4	5	6	7	
Unattractive	○	○	○	○	○	○	○	Attractive
Difficult to manage	○	○	○	○	○	○	○	Easy to manage
Poor conservation	○	○	○	○	○	○	○	Good conservation
Unprofitable	○	○	○	○	○	○	○	Profitable

Back Next page

Survey Progress

Rate the image to show your own perceptions of this landscape compared with your own past experiences of Iowa agricultural landscapes. You can go back and forth to compare these images and revise your ratings by using the "back" button.

	1	2	3	4	5	6	7	
Unattractive	○	○	○	○	○	○	○	Attractive
Difficult to manage	○	○	○	○	○	○	○	Easy to manage
Poor conservation	○	○	○	○	○	○	○	Good conservation
Unprofitable	○	○	○	○	○	○	○	Profitable

Back Next page

Survey Progress

Rate the image to show your own perceptions of this landscape compared with your own past experiences of Iowa agricultural landscapes. You can go back and forth to compare these images and revise your ratings by using the "back" button.

	1	2	3	4	5	6	7	
Unattractive	○	○	○	○	○	○	○	Attractive
Difficult to manage	○	○	○	○	○	○	○	Easy to manage
Poor conservation	○	○	○	○	○	○	○	Good conservation
Unprofitable	○	○	○	○	○	○	○	Profitable

Back Next page

Survey Progress

Rate the image to show your own perceptions of this landscape compared with your own past experiences of Iowa agricultural landscapes. You can go back and forth to compare these images and revise your ratings by using the "back" button.

	1	2	3	4	5	6	7	
Unattractive	○	○	○	○	○	○	○	Attractive
Difficult to manage	○	○	○	○	○	○	○	Easy to manage
Poor conservation	○	○	○	○	○	○	○	Good conservation
Unprofitable	○	○	○	○	○	○	○	Profitable

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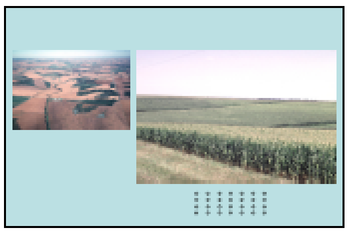
Survey Progress

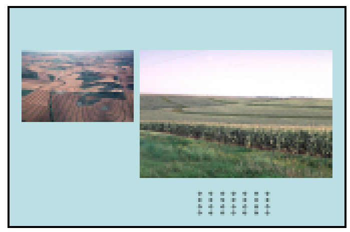
On the next 12 pages you'll see pictures of 12 different Iowa agricultural landscapes. The pictures show alternative landscape patterns and practices for the year 2025. Sample pages are shown below under different farm programs. On each page, the smaller picture shows the pattern as seen from the air. At the top of each page, you'll see information about the practices and program restrictions for the fields in the image

Pictures on different pages will look very similar, but they *are different* in their patterns and agricultural practices. For example, the two pages below show the same place with different patterns and practices. You can use the "back" button to compare different pictures and change your ratings.

Considering the overall pattern, please rate the landscape you see in the bigger picture on 4 separate scales for attractiveness, market profitability, conservation, and ease of management. To rate each image, just give *your own* perceptions – what you think based on the appearance of the landscape - compared with your own past experiences of Iowa agricultural landscapes.

Please rate all landscapes assuming that farmers' income will not be affected, that is, assume that farm policy will change to compensate farmers for any additional costs associated with these practices.





Sample survey pages

Survey Progress

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This farm program provides support for converting some or all cropland to native perennial cover, such as switchgrass, that is harvested for biofuel. No restrictions on pesticide and fertilizer.

	1	2	3	4	5	6	7	
Unattractive	○	○	○	○	○	○	○	Attractive
Difficult to manage	○	○	○	○	○	○	○	Easy to manage
Poor conservation	○	○	○	○	○	○	○	Good conservation
Unprofitable	○	○	○	○	○	○	○	Profitable

Survey Progress

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This is the current farm program. No restrictions on tillage, crop rotation or any other management operation or practice, other than those currently required (such as conservation compliance requirements, manure management plans, etc.). No restrictions on pesticide or fertilizer.

	1	2	3	4	5	6	7	
Unattractive	○	○	○	○	○	○	○	Attractive
Difficult to manage	○	○	○	○	○	○	○	East to manage
Poor conservation	○	○	○	○	○	○	○	Good conservation
Unprofitable	○	○	○	○	○	○	○	Profitable

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Survey Progress

This farm program provides support for strips of annual crops alternating with perennial plant strips. Perennial strips = 15 ft wide, Crop strips = 120 ft. wide. No restrictions on choice of crop rotation in the annual strips. No tillage restrictions for non-HEL acres. Tillage restrictions and BMP's remain on HEL acres. No restrictions on pesticide or fertilizer.

	1	2	3	4	5	6	7	
Unattractive	○	○	○	○	○	○	○	Attractive
Difficult to manage	○	○	○	○	○	○	○	Easy to manage
Poor conservation	○	○	○	○	○	○	○	Good conservation
Unprofitable	○	○	○	○	○	○	○	Profitable

Back Next page

Survey Progress

This farm program provides support for strips of annual crops alternating with perennial plant strips. Perennial strips = 30 ft wide. Crop strips = 120 ft. wide. No restrictions on the choice of crop rotation in the annual strips. No tillage restrictions for non-HEL acres. Tillage restrictions and BMP's remain on HEL acres. No restrictions on pesticide and fertilizer.

	1	2	3	4	5	6	7	
Unattractive	○	○	○	○	○	○	○	Attractive
Difficult to manage	○	○	○	○	○	○	○	Easy to manage
Poor conservation	○	○	○	○	○	○	○	Good conservation
Unprofitable	○	○	○	○	○	○	○	Profitable

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Survey Progress

This farm program supports partial conversion of cropland, that is HEL acres or land near streams, to pasture with rotational grazing. If there are waterways within the fields, the waterways must be protected from cattle. Herd size and type can be chosen by the farmer. No restrictions on pesticide and fertilizer.

	1	2	3	4	5	6	7	
Unattractive	○	○	○	○	○	○	○	Attractive
Difficult to manage	○	○	○	○	○	○	○	Easy to manage
Poor conservation	○	○	○	○	○	○	○	Good conservation
Unprofitable	○	○	○	○	○	○	○	Profitable

Back Next page

Survey Progress

This farm program purchases HEL acres or wetlands for biodiversity reserves of about 640 acres in every township. Reserves enhance habitat and water quality. The program also supports converting HEL acres to rotating strips of corn and soybeans (59 ft. wide) that alternate with non-rotating perennial prairie mix strips (19 ft. wide). Prairie seed from the strips could be marketed. No tillage restrictions for non-HEL acres. Reduced tillage requirements continue for HEL acres. No restrictions on pesticide and fertilizer.

	1	2	3	4	5	6	7	
Unattractive	○	○	○	○	○	○	○	Attractive
Difficult to manage	○	○	○	○	○	○	○	Easy to manage
Poor conservation	○	○	○	○	○	○	○	Good conservation
Unprofitable	○	○	○	○	○	○	○	Profitable

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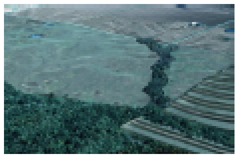
Survey Progress

Now you will see the same set of six different alternative farm programs and practices for a different Iowa landscape.

Next page

Survey Progress

This farm program purchases HEL acres or wetlands for biodiversity reserves of about 640 acres in every township. Reserves enhance habitat and water quality. The program supports converting HEL acres to rotating strips of corn and soybeans (59 ft. wide) that alternate with non-rotating perennial prairie mix strips (19 ft. wide). Prairie seed from the strips could be marketed. No tillage restrictions for non-HEL acres. Reduced tillage requirements continue for HEL acres. No restrictions on pesticide and fertilizer.



	1	2	3	4	5	6	7	
Unattractive	○	○	○	○	○	○	○	Attractive
Difficult to manage	○	○	○	○	○	○	○	Easy to manage
Poor conservation	○	○	○	○	○	○	○	Good conservation
Unprofitable	○	○	○	○	○	○	○	Profitable

Back   Next page

Survey Progress

This farm program provides support for strips of annual crops alternating with perennial plant strips. Perennial strips = 15 ft wide, crop strips = 120 ft. wide. No restrictions on choice of crop rotation in the annual strips. No tillage restrictions for non-HEL acres. Tillage restrictions and BMP's remain on HEL acres. No restrictions on pesticide or fertilizer.

	1	2	3	4	5	6	7	
Unattractive	○	○	○	○	○	○	○	Attractive
Difficult to manage	○	○	○	○	○	○	○	Easy to manage
Poor conservation	○	○	○	○	○	○	○	Good conservation
Unprofitable	○	○	○	○	○	○	○	Profitable

Back   Next page

Survey Progress

This farm program provides support for converting some or all cropland to native perennial cover, such as switchgrass, that is harvested for biofuel. No restrictions on pesticide and fertilizer.

	1	2	3	4	5	6	7	
Unattractive	○	○	○	○	○	○	○	Attractive
Difficult to manage	○	○	○	○	○	○	○	Easy to manage
Poor conservation	○	○	○	○	○	○	○	Good conservation
Unprofitable	○	○	○	○	○	○	○	Profitable

Back | Next page

Survey Progress

This is the current farm program. No restrictions on tillage, crop rotation or any other management operation or practice, other than those currently required (such as conservation compliance requirements, manure management plans, etc.). No restrictions on pesticide or fertilizer.

	1	2	3	4	5	6	7	
Unattractive	○	○	○	○	○	○	○	Attractive
Difficult to manage	○	○	○	○	○	○	○	Easy to manage
Poor conservation	○	○	○	○	○	○	○	Good conservation
Unprofitable	○	○	○	○	○	○	○	Profitable

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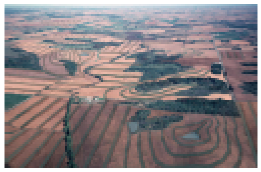
Survey Progress

This farm program provides support for strips of annual crops alternating with perennial plant strips. Perennial strips = 30 ft wide. Crop strips =120 ft. wide. No restrictions on the choice of crop rotation in the annual strips. No tillage restrictions for non-HEL acres. Tillage restrictions and BMP's remain on HEL acres. No restrictions on pesticide and fertilizer.



	1	2	3	4	5	6	7	
Unattractive	○	○	○	○	○	○	○	Attractive
Difficult to manage	○	○	○	○	○	○	○	Easy to manage
Poor conservation	○	○	○	○	○	○	○	Good conservation
Unprofitable	○	○	○	○	○	○	○	Profitable

Back Next page

Survey Progress

This farm program supports partial conversion of cropland, that is HEL acres or land near streams, to pasture with rotational grazing. If there are waterways within the fields, the waterways must be protected from cattle. Herd size and type can be chosen by the farmer. No restrictions on pesticide and fertilizer.

	1	2	3	4	5	6	7	
Unattractive	○	○	○	○	○	○	○	Attractive
Difficult to manage	○	○	○	○	○	○	○	Easy to manage
Poor conservation	○	○	○	○	○	○	○	Good conservation
Unprofitable	○	○	○	○	○	○	○	Profitable

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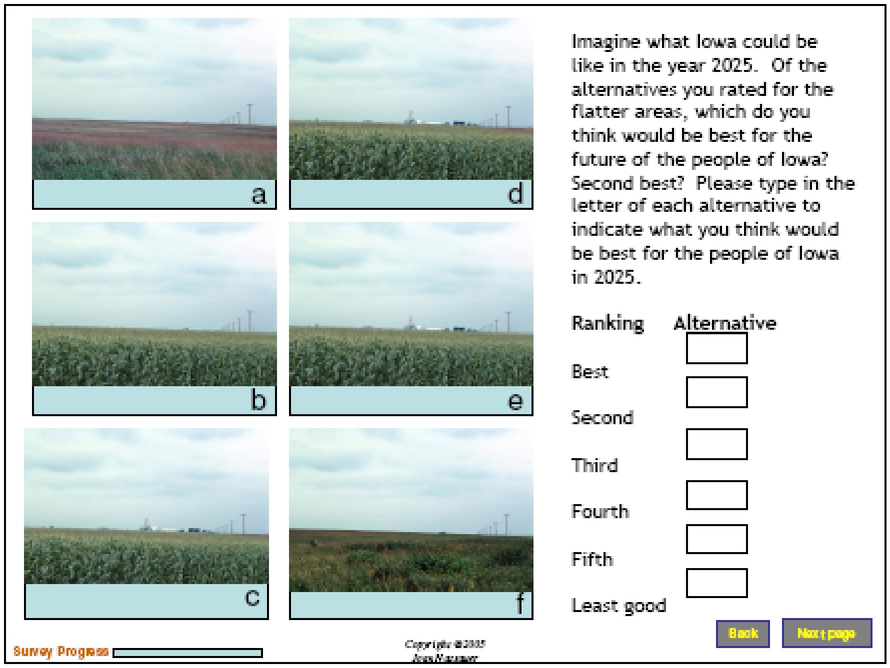
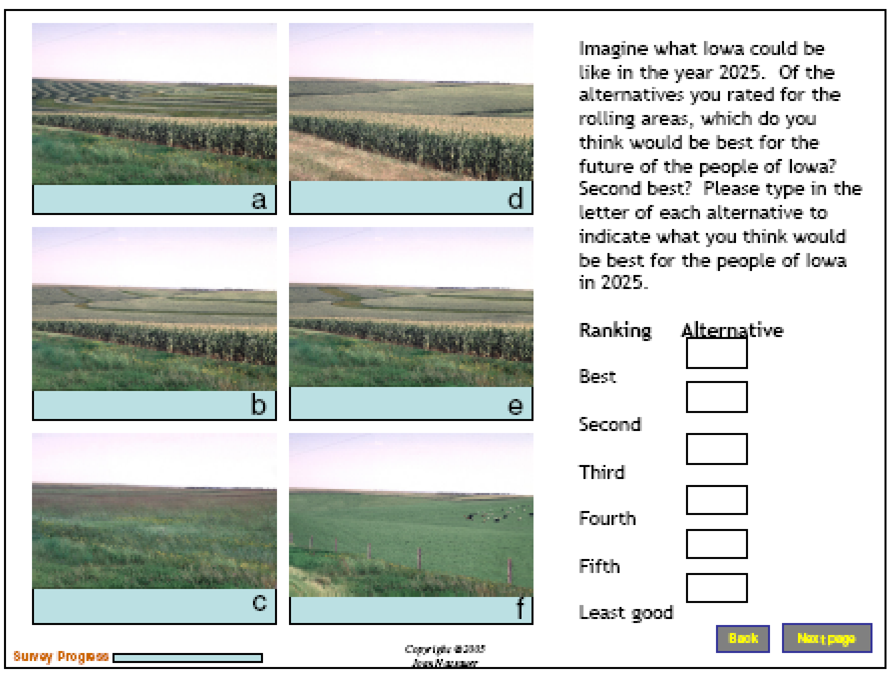
Survey Progress


a
d
b
e
c
f
Imagine what Iowa could be like in the year 2025. Of the alternatives you rated for the flatter areas, which do you think would be best for the future of the people of Iowa? Second best? Please type in the letter of each alternative to indicate what you think would be best for the people of Iowa in 2025.
Ranking
Alternative
Best
Second
Third
Fourth
Fifth
Least good
Back
Next page
Survey Progress


a
d
b
e
c
f
Imagine what Iowa could be like in the year 2025. Of the alternatives you rated for the rolling areas, which do you think would be best for the future of the people of Iowa? Second best? Please type in the letter of each alternative to indicate what you think would be best for the people of Iowa in 2025.
Ranking
Alternative
Best
Second
Third
Fourth
Fifth
Least good
Back
Next page
Survey Progress

In the next section consider the alternative landscapes you have just seen. This time consider them with regard to how much compensation you would need each year to be willing to implement these practices on all or part of ***your farm.***

On the following pages you will see smaller versions of the images you just rated. **Each image is accompanied by a potential per-acre conservation payment and a summary of the farm program that would accompany it. Consider all alternatives and then select the one single alternative you would most like to see offered in the next farm bill.**

Assume that current farm programs would continue to be available, except that the alternative you choose would replace existing programs that specifically apply to **those land management choices.**

Survey Progress

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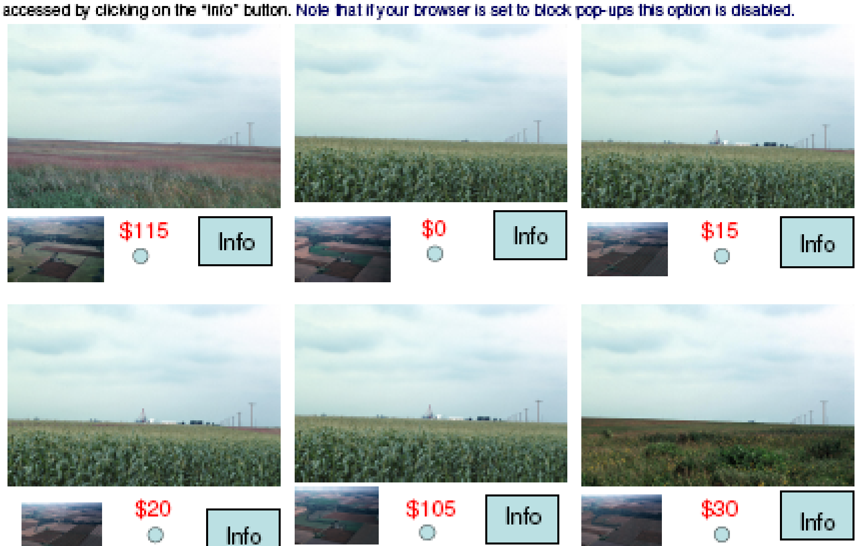
Considering the per acre conservation payment given below each picture, click on the circle for the conservation program you would most like to see offered in the next farm bill.
To enlarge the aerial image of that conservation program, click on it. Information about each conservation practice can be accessed by clicking on the "Info" button. Note that if your browser is set to block pop-ups this option is disabled.



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Survey Progress

Considering the per acre conservation payment given below each picture, click on the circle for the conservation program you would most like to see offered in the next farm bill.
To enlarge the aerial image of that conservation program, click on it. Information about each conservation practice can be accessed by clicking on the "Info" button. Note that if your browser is set to block pop-ups this option is disabled.

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Survey Progress

You're nearly finished. In this final section we would like to ask you a few questions about yourself. All of your answers are confidential and anonymous.

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Survey Progress

What was your age on December 31, 2005?

For how many years have you been farming, whether in this operation or elsewhere?

What is your gender?

- Male
- Female

What is the *highest* level of formal education you have completed?

- Less than high school diploma
- High school diploma or equivalency (GED)
- Some college
- Completed college undergraduate degree (BA or BS)
- More than an undergraduate degree

Survey Progress

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Considering
• all crops sold,
• all livestock, poultry and products sold,
• all sales of crops, livestock or poultry, produced under contract,
• all sales of any miscellaneous agricultural products,
• all government payments received,
• landlord's share of government payments and crops sold in 2004;

What was the total gross value of sales for your operation in 2005?

- $ 0 -- $ 24,999
- $ 25,000 -- $ 249,999
- $ 250,000 -- $ 999,999
- $ 1,000,000 and over

Which of these represents the largest portion of your operation's 2005 gross farm income?

- Grains, and oilseeds
- Other crops and hay, CRP and pasture
- Hogs and pigs
- Milk and other dairy products from cows
- Cattle and calves
- Poultry and eggs
- Other animals and other animal products

Survey Progress

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Please click on the circle if the conservation practices listed were present on the farm you operated in 2005.
If so, please click the next box if you received any sort of incentive payments for that practice in 2005.
(*Please include conservation practices present in all or part of the farm. The incentive programs include but are not limited to EQIP, CSP, and EPA 319 funds)*

Type of practice	Present ?	Incentive payments received?
Terraces	o	o
Grassed waterways	o	o
Vegetative buffers (in field)	o	o
Stream side herbaceous or forest buffers	o	o
Contour buffers (in field)	o	o
Field borders	o	o
Filter strips	o	o
Contour farming	o	o
Strip cropping	o	o
Nutrient management plan	o	o

Survey Progress

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Do you belong to any environmental groups?
- o Yes
- o No

If yes, please list:

Do you live on or adjacent to any of the land you manage?
- o Yes
- o No

Which of the following are nearby any of the land you manage? Check all that apply.

- o Farms
- o Single family homes
- o Multi-family homes like apartments, duplexes or condominiums
- o Retail businesses
- o Manufacturing or warehouse businesses

Survey Progress

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During the past year, about how often did you participate in the each of the following activities?

Activity	Never	1-2 times	3-6 times	More than 6 times
Bird watching	o	o	o	o
Camping	o	o	o	o
Hiking, biking, walking on a nature trail	o	o	o	o
Hunting	o	o	o	o
Canoeing, fishing or swimming in rivers or lakes	o	o	o	o
Scenic viewing of natural or scenic areas	o	o	o	o
Having picnic or barbecue in parks	o	o	o	o
Engaging in outdoor sports, e.g. golfing, tennis, football, basketball	o	o	o	o
Driving for pleasure near the land I manage	o	o	o	o

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Survey Progress