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University of Alberta

Three Papers in Natural Resource Valuation: Accounting for Cross Cultural Contexts

by

Darla Hatton MacDonald 

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfilment of the requirements for the degree of Doctor of Philosophy

in

Forest Economics

Department of Rural Economy

Edmonton, Alberta

Fall 1998

University of Alberta

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Degree: Doctor of Philosophy

Year This Degree Granted: 1998

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October 2, 1998

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Abstract

This is a three paper thesis concerned with environmental valuation in cross cultural contexts. The first paper tests some of the hypotheses outlined in Adamowicz *et al* (1998) concerning potential sources of bias and other problems that might enter the contingent valuation process. In particular, the potential for satiation and cultural differences in willingness to pay are explored. The paper concludes that there are differences in how Aboriginal and Non-Aboriginal people in northern Canada place values on natural resources such as the fishery. No strong tendencies to refuse to consider monetary - resource trade-offs were observed in either group. In general, satiation was found to be a negative influence on willingness to pay. Satiation with one's own use of a resource was a significant factor with the Non-Aboriginal population. Non-use values were isolated for the group of satiated respondents. The non-use values reflect the existence values, bequest values, altruism, etc.

The second paper examines how the random utility model could be adapted to model household firewood collection. Collecting fuelwood is first and foremost a resource allocation issue for the household. There are real opportunity costs in choosing one site for fuelwood collection over another. In the study areas of north-eastern Zimbabwe, households were observed to choose a variety of sites. The choice of any particular site was hypothesised to involve a trade-off of the various attributes of the sites which includes time, effort or calories as well as characteristics such as the availability of certain types of fuelwood at a site, whether the site passes by the garden or by the homestead of a friend. The closure of any particular site might represent a minor loss on average of 10 to 25 calories but for some households, the loss may be as high as 200 calories. This brings a spatial dimension to the analysis as the closure of a

site will be borne differently by households depending on their proximity and perception of site and trip attributes.

The third paper is an extension of the second paper where the problem of switching from wood to non-wood fuels is viewed in terms of the social and economic factors which influence the decision-making process. While the results are not conclusive, which may be due to a lack of variation in the data or the relatively low number of non-wood energy users in the dataset, there does appear to be merit in using the random utility framework. It is important to report these results, though tentative, as it lends some insight into the early stages of fuel switching and in turn, this may lead to an easing of the rate of deforestation in southern Africa. With the growing interest in establishing a global carbon permit trading system, more research will be required in this area.

Dedication

This thesis is dedicated to my daughter, Emily Miriro MacDonald, who was born 10 days after I defended these papers. How many babies are born with a Ph.D.?

Acknowledgements

My Ph.D. program took a lot longer than most and as a result my acknowledgements are longer than would seem possible. I would like to acknowledge the patience shown by my committee which included my supervisors Marty Luckert and Vic Adamowicz and committee members Eloise Murray, Terry Veeman, Michele Veeman, Mel Lerohl, Robert Hudson and the external examiner Tom Brown. Their comments and questions have resulted in a better set of papers.

Due to the erosion in the funding of graduate programs, I did not have a single source of funding for the duration of my program. My research was supported by a number of sources including the Canadian Forest Service under the Canada/Saskatchewan Partnership Agreement in Forestry, the International Development Research Centre Value of Trees Project, Alberta Forestry and of course the financial support of my husband. Thank you Marty for helping me to string together these various sources of funding to complete this degree.

These papers rely on primary data collected in the community of La Ronge in Saskatchewan and in the communal areas of Mutoko and Murewa, Zimbabwe. Data collection is a labour intensive endeavour and I taxed the patience of many people. Lois Jordan, a Band Councillor for the Lac La Ronge Indian Band, was instrumental in the success of the La Ronge project by completing translations, supervising the surveyors and helping with all the logistics of gathering data in a cross-cultural setting. A team of surveyors Grace Charles, Faye Charles, Genny Macleod, Dianne Korber and Laura Graham undertook the interviews. Thanks to Dianne and Laura for driving up from Edmonton and working 10 - 12 hour days so we could finish on time. In Zimbabwe, I owe special thanks to Bev Sithole for her patient introduction to PRA methods and to other staff at the Institute of Environmental Studies at the University of Zimbabwe for their support and assistance. The research in Zimbabwe was a success because the people of Danadara, Gondo, Katiyo-Muropa, Katiyo-Chikiwimbisa (also known as Katiyo-Chiranje), Rinomhota, Dzvengwe, Nyamakope I and Nyamakope II villages were so generous with their time. Thanks to Osmiso

Nyamakope, Peps Muswaka, Honoured Kavhumbura and Maxmos Motsi for their assistance. They served as translators, meeting facilitators and surveyors. I would also like to thank Chief Nyamakope, Roosevelt Chihwayi, as well as the Sebhuku for each of these villages who gave us permission and encouraged people to come out and participate in the learning process.

I have benefited from the kindness of people that I feel privileged to count as friends - thanks Marc Adams, Marian Weber, Janaki Alavalapati, Habib Salami, Atakelty Hailu and Godfrey Kundhlande for the hours you have spent helping me prepare for exams, reading papers, discussing ideas and helping me get through the countless hoops. There have also been the people who share my great passion for climbing and these people helped me clear my head - thanks Tamara Lamb, Dave Law, Karen Ilcisin, Marnie Wright, Derrick Comfort and Mike MacKenzie for being there to climb.

My husband, Gerard MacDonald, has been my comrade through all things. You have always been there whether it was to climb, bike, ski, hike or work with me.

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Chapter 1 - Introduction

Introduction to Non-market Valuation Techniques and Values

Many aspects of the natural, physical environment hold a place of great value to societies of peoples throughout the world. This thesis is concerned with how values placed on natural resources are best elicited from people in different cultural settings. The first task will be to introduce and explore the idea of economic valuation of natural resources. In the academic setting, the word "value" is broad and encompassing with variation in meanings across disciplinary perspectives. For a philosopher, the term value may imply a system of beliefs. For a sociologist, values also involve belief systems but the importance of values is largely understood through the actions of individuals and groups. For an economist, value can be inferred by the dollar amount, or the amount of goods that may be exchanged, to acquire the property right (or a subset of the rights) to a resource.

The importance of natural resources often may not be captured through formal markets of exchange due to the nature of the property rights in place for a resource. For instance, there may be difficulties in defining, establishing and enforcing a set of property rights concerning a natural resource. As a result, a market for the good may not exist. When markets are not well developed, placing an economic value on a resource becomes more complicated.

There are a number of scenarios that can emerge where it is necessary to compile the economic values of non-traded resources. Once the importance of a resource has been translated into a monetary value, a basis for comparison with market goods has been established. This is particularly important for public policy considerations where the costs and benefits of a project involving non-traded natural resources are considered. As well in the assessment of damages, it is important to have some common denominator for negotiating a settlement.

To address these types of situations, a number of non-market valuation techniques have been developed. Briefly these methods can be categorised as direct and indirect methods of valuation according to Freeman (1993). Under the category of direct methods, one might use bidding games or contingent valuation methods to elicit values. With indirect methods, one might employ travel cost models and hedonic pricing models to determine the value placed on a resource or an environmental amenity. This thesis is concerned with two of these methods: the travel cost approach and the contingent valuation method.

In natural resource economics, the travel cost approach has been largely used in recreational contexts where information contained in the behaviour of individuals choosing to visit recreational sites. Travel costs are used as a proxy for the cost of engaging in the recreational activity. The travel cost approach provides estimates of the use value that a site holds for an individual. The approach relies on using the actual behaviour of individuals where the cost of travelling to the site is used as a proxy for the price of the activity. However, a site may hold an intrinsic (or non-use) value for individuals who may never have the opportunity to visit the site. The contingent valuation method has been used to estimate total (use and non-use) values for the preservation or improvement of a site.

Contingent Valuation (CV) studies utilise household surveys to elicit responses from participants concerning the amount they would be willing to pay in order to obtain an environmental improvement or to maintain an environmental amenity. CV methods are based on the premise that it is possible to simulate a hypothetical market for the improvement by creating plausible scenarios. An example from Condon (1993) asks respondents whether they would be willing to pay $X per year into a public trust fund that would be used for setting aside mature forest to ensure the survival of the pine marten.

Non-market valuation of natural resources has a well established history in the market-based economies of the industrialised world. Hundreds of published and unpublished studies had accumulated when Carson *et al* (1993) prepared a listing of the CV studies that had been undertaken. However, a relatively small number of CV studies had been completed in cross cultural settings. Even fewer studies employing indirect methods have been used in the context of a developing country with local people.

In Adamowicz *et al* (1998), the appropriateness of using non-market valuation techniques on a cross cultural basis was examined on a conceptual level. The theory underlying non-market valuation was developed for use in the dominant cultures of North America and Europe where markets for many private goods function reasonably well. Adamowicz *et al* (1998) identifies three potential difficulties which may arise when attempting to use non-market valuation techniques on a cross-cultural basis. In broad strokes, there may be difficulties in eliciting individual responses to valuation questions, difficulties in aggregating over Aboriginal peoples, and difficulties in aggregating Aboriginal and Non-Aboriginal responses.

Many of the concerns identified in Adamowicz *et al* (1998) can be addressed by developing an understanding of the linkages between the cultural context and the economic systems which have evolved. A key example is the role of age and gender in the indigenous society, see Murray *et al*

(1995) and Underhill (1967). An example might be a case where the researcher must recognise the role gender plays in transfer of knowledge and beliefs. There may also be significant differences in how tasks are performed or what implements tend to be used by one gender versus another. As well, knowledge of particular practices or retention of certain beliefs may be more prevalent within a particular generation of men or women. Determining how age, gender and cultural context might influence how individuals assign values to resources is part and parcel of the research design problem.

Non-Market Valuation and Indigenous Economies

Scholars such as Hill (1970) and Chipeta (1981) have used the phrase indigenous economics to describe the subsistence and commercial activities as well as institutional arrangements where the prevailing culture is Non-European. Within indigenous societies, economic and social phenomena are intertwined in contrast to the industrialised world where the exchange economy is largely separate from the social setting. This does not imply that economic principles such as marginal analysis developed for the exchange economies of Europe and North America are not relevant to other contexts. Concepts such as public goods and common property problems are indeed relevant to the analysis of a developing economy. However, it is not possible to accept the notion of a universality of Western economic thought and the appropriateness of its application to every resource allocation decision within an indigenous economy. Instead, it is important to recognise where the substantive differences between the cultural contexts exist and the extent to which the differences have a bearing on the decision making processes.

Adamowicz *et al* (1998) explore the conflict between culture and natural resource allocation. The interaction of held values[1], the concepts or precepts about phenomena that individuals or groups share, with assigned values or preferences can have significant implications for CV studies. For instance, if a resource or geographic location is considered sacred, or in more extreme cases taboo, such that it is impossible for the individual to consider monetary or non-monetary substitutes, it will be difficult, if not impossible to design a hypothetical market to elicit the assigned values. As well, the potential for satiation in consumption of a natural resource, as part of an environmental ethic of respect for the natural world that is sometimes attributed to Aboriginal peoples in Canada, could also create difficulties in a CV study. If the range of proposed change in a CV study is beyond some satiation threshold, the value associated with the improvement could potentially be quite low. This does not

[1] See Brown (1984) and Brown and Manfredo (1987) who put forth these particular definitions of held values.

mean the resource is not valuable to the respondent. Instead the response may reflect satiation with the use of the resource but there remains an associated non-use value.

Other aspects of indigenous economies present interesting problems for the use of the more direct valuation techniques. Cultural practices or cultural institutions may make some prices unresponsive to demand and supply conditions. Chitepa (1981) cites the widespread practice of customary payment for the services of traditional healers, midwives and practitioners of traditional crafts which is dictated by age old practices rather than a market for services. In applied studies such as Whittington *et al* (1992), documented cultural practices concerning how respondents answer questions had to be taken into account as part of the survey and interview design for a CV study.

Other applications of the contingent valuation method in indigenous economies include studies such as Shyamasundar and Kramer (1996) where considerable care and attention was shown to the property rights and to the selection of a numeraire good since money was not a common vehicle for exchange. For instance, in the developing economy of Madagascar, the use of some numeraire good, in this case baskets of rice, was used as the reference point in a willingness to accept compensation study. Outside the field of natural resource economics, the CV approach has been used to study problems such as financing education [Thobani (1983) and Jimenez (1987)], and other primary services such as water and sanitation [Boadu (1992), Briscoe *et al* (1990) and Whittington *et al* (1990, 1991 and 1992)] in developing countries with reasonable success.

Indirect methods such as travel costs are not free of difficulties in application to the indigenous economy. In evaluating the potential for using travel cost models, Graham *et al* (1997) pointed out that the opportunity cost of time may be difficult to substantiate due to the lack of foregone opportunities that can be measured in dollar value terms. In the case of many developing countries, labour markets may be thin to non-existent.

Due to the subsistence nature of many indigenous economies, markets for many goods may not exist due to cultural prohibitions on the sale of particular goods.[2] Alternatively, due to resource constraints, producers may not be able to produce much beyond the requirements of the household and thus the market may be said to be thin due to the scarce number of trades that occur. In these situations, the problem of resource valuation may require consideration of the activities of the household in a broader framework. The household in a subsistence setting is both consumer and producer of many different goods but the household will only produce sufficient quantities of certain

[2] In Adamowicz *et al* (1998), prohibitions on the sale of wild fruits in Zimbabwe was cited as an example where held values are such that property rights prohibit the formation of a market. As a

goods in order to satisfy its needs due to the reasons listed above. In the case of a travel cost model, it may be necessary to consider the caloric cost of an activity rather than the opportunity cost of time as measured by a wage rate.

Summary of the Thesis

This is a three paper thesis which considers the applicability of non-market valuation techniques in two distinct cultural settings. In the first paper, the appropriateness of the contingent valuation method is investigated in a northern Canadian community with groups of Aboriginal and Non-Aboriginal people. A few of the hypotheses set out in the conceptual paper of Adamowicz *et al* (1998) are tested. For instance, differences in the willingness to pay by cultural group is considered for different restoration options. As well, the potential for satiation is explored by asking survey respondents to consider a hypothetical situation involving the restoration of the fishery and how much fishing they would want to do. This thought problem was designed to investigate whether there are statistically significant differences between Aboriginal and Non-Aboriginal peoples concerning satiation levels.

In the second paper, an indirect method of valuation is adapted for use in modelling the site selection process involved in fuelwood collection in rural Zimbabwe. The intent of the paper is to explore means of valuing collection sites in the communal areas of Zimbabwe. The fuelwood collection decision is initially framed as part of the overall household production process. The market for fuelwood in this subsistence economy is non-existent so the choice problem is reduced to that of site selection. The probabilistic framework of the random utility model underlying the choice model is adapted to incorporate the characteristics of this subsistence economy where travel costs are measured in terms of caloric expenditures. Average welfare measures for the community and the largest welfare loss for an individual household are presented in caloric terms. This paper represents one of the few applications of the indirect valuation methods in the context of a developing country.

The third paper is an extension of the second where wood and non-wood options for domestic energy are considered. Non-wood options such as solar panels and paraffin require certain investments in the panels or the stove (in the case of paraffin). For this reason, socio-economic factors may be factors in the choice of sources of energy for domestic energy. This is an important

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further example from the same country, there are strict prohibitions on the sale of firewood, see Hatton MacDonald and Weber (1998).

consideration for policy makers concerned with how to best achieve reductions in deforestation or decreasing carbon emissions.

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Chapter 2 - A Contingent Valuation Study with the Aboriginal and Non-Aboriginal People in the Lac La Ronge area of Saskatchewan

Introduction

Many of the conflicts in natural resource management can be characterised as conflicts of culture and values. Examples might include the conflicts that have developed in forest dependent communities between environmentalists who wish to preserve forests in their current state and resource workers who enjoy the economic benefits of employment provided by resource extraction. Conflicts are not limited to these groups. In Canadian history, there have been many conflicts, between persons of European descent and those who are Aboriginal, reflecting differences in the world views of how resources should or should not be managed over the long and short term. Many of the current conflicts centre on the rights of Aboriginal peoples to land and natural resources. Resolution of conflicts over the control of resources appears to be taking an evolutionary path through the interaction of the court system, negotiations between First Nations and the Crown[3] and gradual changes in the institutional structures[4] which govern the lives of people and the resources. As part of the process of resolving these conflicts, there is an opportunity for natural resource economics to play a role in identifying differences in the way people value resources.

Resource Valuation

Generally, resource valuation methods involve deriving money based measures concerning changes in the quantity or quality of the resource. Valuation methods can be divided into market and non-market methods. Market based methods use market data to obtain estimates of the value of the resource. These methods may be as straight forward as calculating the net present value of a resource e.g. the commercial value of the fishing stock. Alternatively hedonic price models might be employed to measure the marginal value of environmental quality such as traffic noise or air quality as embodied in the market selling price of a house or recreational property. This approach will result in meaningful values if the resource is traded on a competitive market as shown by Rosen (1974). If the resource is

[3] Recent examples of negotiations between First Nations and the Crown in Canada include the Financial Transfer Agreement with the Lac La Ronge Indian Band and the Agreement in Principle signed by the Nisga'a and the federal government of Canada on March 22, 1996. See the News releases issued by the Department of Indian and Northern Development on http://www.inac.gc.ca/news/jan96/index.html .

not traded on a market then non-market valuation techniques would be required to estimate the value, for example, of a quality change in a fishing stream. Adamowicz (1991) classifies non-market valuation methods as either direct or indirect approaches. The indirect method includes the travel cost method and hedonic travel cost models, while the direct approach includes the contingent valuation method.

The contingent valuation method according to Adamowicz (1991) is categorised as a direct method because it involves simulating the conditions of a market and directly eliciting a consumer's willingness to pay (willingness to accept compensation) for a non-market good or a quality change in the non-market good. A contingent valuation study will usually involve some sort of survey instrument where the survey might be conducted in person, over the telephone or through the postal system. Each approach has its own strengths and weaknesses in terms of data quality versus the per survey cost. Generally, it is easier to control the flow of questions and thereby improve the quality of information being transferred back and forth between the interviewer and the respondent in a personal interview. For instance, in an ideal setting, good interviewers will be able to pace the interview so as to maximise the attention and comprehension of the interviewee concerning the valuation problem. With mail-out surveys, one of the more inexpensive data collection methods, it is not as easy to guide the respondent through the questions in the proper order when there is a skip pattern in the survey.

The end product of the contingent valuation study are the economic welfare measures. The welfare measures, including the mean and median willingness to pay, provide money based values that can be used in cost benefit analysis. If we intend to use these methods to derive social values and the median and mean values are interpreted as the benefits to society, it is important that we investigate whether the method is able to elicit useful information from all groups in society. To this end, the paper explores a few of the potential problems with contingent valuation that may arise between Aboriginal and Non-Aboriginal people.

Generally it has become accepted by policy makers that resource allocation decisions should take into account the input of local people and attempts are being made to recognise Aboriginal value systems. Otherwise decisions may have numerous unintended effects including skewed income distributions, misuse of resources and unintended losses in social welfare. Applied economic research should, at a minimum, include a better understanding of the value systems of the groups involved and a recognition of the importance of cultural differences in the valuation of natural resources. The next step in a research agenda for studying the differences in how people from different cultures value

[4] There are at least sixty statues which affect different aspects of the lives of Aboriginal peoples in Canada, see http://www.inac.gc.ca/legisl/legisl.html, January 21, 1998.

resources might include testing some of the hypotheses identified in studies such as Adamowicz *et al* (1998) and Murray *et al* (1995). At issue is how useful or appropriate non-market valuation methods might be in cross-cultural settings. Many of the conflicts between Aboriginal and Non-Aboriginal people in Canada can be characterised as conflicts over how natural resources should be managed. Ultimately these conflicts may reflect the differences in how cultural groups assign values to resources.

Economic welfare measures are a means of valuing resources that are based on assumptions concerning the preference structure of individuals. Adamowicz *et al* (1998) considers some of the potential problems that might arise in eliciting and aggregating responses from Aboriginal and Non-Aboriginal individuals. For example, when eliciting values, there may be problems with substitutability, property rights or satiation. A revered or sacred good may have no real substitutes for some individuals. As well, differences in rights over a resource may be such that the individual has trouble imagining paying for an improvement in the resource. Economic theory about an individual's preferences is predicated on the principle of non-satiation which may be incompatible with cultural values of "not consuming too much". Finally, in terms of aggregating responses, it is important to explore the preferences of individuals in different cultures towards group decision making versus referendum voting where the latter is becoming more common in CV studies.

Overview of the Paper

Through the design of the survey, some of the conceptual problems from Adamowicz *et al* (1998) such as group versus individual sovereignty and the potential problem of satiation could be isolated and explored. To simplify the exercise, a non-sacred resource, the trout fishery, was selected. The complicated property rights of the various user groups[5] were accounted for in the design of scenarios that proposed various strategies for improving the fishery. These scenarios were used to simulate a market for the trout fishery and to probe the differences in how Aboriginal and Non-Aboriginal respondents value the resource. The potential for satiation is considered and is found to be significant in at least one case. Information from the debriefing questions is brought into the discussion to provide context to the valuation exercise. Finally, welfare measures are presented. The results are discussed and topics for future research are identified.

[5] Many of the important details of the property right arrangements were provided by Lois Jordan and Tom Charles from the Lac La Ronge Indian Band and Doug Walton from Saskatchewan Natural Resources.

The Study Site

To investigate these questions, a study was initiated in La Ronge, Saskatchewan which is a remote, northern community in close proximity to a fishery. In particular, the trout fishery was known to be an important but non-sacred resource. The research site was suitable for pursuing these questions in a number of respects. A substantial amount of biological information had been collected by the provincial government over time concerning the state of the trout fishery. Trout are a cold water fish that tend to inhabit the deep cold pockets of the lake and because of this characteristic, fishing for trout is different from other species. The residents of the community were familiar with the fishery and the depletion of the stock. The first nations people living in the area were willing to participate in the project development stages. The involvement of a band council representative greatly aided in community acceptance.

Survey Design

Identifying Property Rights

Mitchell and Carson (1989) discuss the property rights approach as part of the economic theory underlying the contingent valuation method. For a good such as fish stocks, a resource with varying rights of access by different groups of individuals, identifying the nature of the collective rights is an important issue. The development of credible contingent valuation scenarios relies on identifying the current property rights over the resource by the various user groups. The contingent valuation exercise hinges on developing a scenario which simulates a market. For instance, the respondent may reject a scenario involving any payment for an improvement in the resource because he/she believes that compensation should have been paid by either industry or government for the deterioration the resource to date.

In the northern Saskatchewan fishery, the focus of this contingent valuation study, there are three distinct user groups each with different property rights. The first group, sport anglers, may only fish at certain times of the year. They are required to purchase a license and to observe an overall catch limit as well as a limit on various species of game fish. There is no effective way to limit the number of anglers fishing on Lac La Ronge during the fishing season. Individuals in the second group, the commercial fishing industry, must belong to the co-operative. The co-operative is given various species limits by Saskatchewan Natural Resources. Individuals in the co-operative hold a

share (or partial share)[6] of the co-operative's species limit and therefore the individual commercial operator will only possess the right to catch up to a certain limit defined by total weight by species.

The property rights of the third group, Aboriginal peoples, are defined through the interaction of Treaties, the Indian Act and decisions handed down by the Canadian court system.[7] A distinction is usually made between Status Indians and people of Aboriginal descent in the delineation of property rights. The latter do not necessarily possess the full set of Treaty rights. With respect to the right to fish, Status Indians may fish at any time of the year as long as the body of water has not been closed for conservation purposes. Band members are issued Indian Fishing Permits at no cost by Saskatchewan Natural Resources. Non-Status Indians and Metis peoples are not accorded the full set of rights and privileges of Status Indians. However, court rulings in recent years cast a degree of uncertainty over the property rights of Non-Status Indians and Metis peoples.[8]

The Questionnaire

The questionnaire design was influenced by the multiple user nature of the resource and the property rights of the users. The potential "solutions" to the resource depletion might include restricting access by sport anglers and the commercial fishing industry or by restocking the lake. The nature of the property rights is such that the Aboriginal fishery could not be restricted. These solutions, whether restocking or restricting access, have the potential for restoring the fish stocks to levels observed in the past.

Respondents were asked first to choose between either a group representing the various divergent interests within the community arriving at a solution or each individual voting for a solution and the solution with the most votes is implemented. Once a political model is chosen, the respondent is asked about their willingness to support these solutions. The scenarios developed for the questionnaire had to accommodate the complicated property rights of the various user groups, treaty rights of the Band members as well as the political model. First of all, income earned on the reservation is not taxed. For this reason, questions involve either a contribution or reallocating public

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[6] Some of the older members of the co-operative will split their share into half-shares or quarter shares among their children when they retire.

[7] There was only one Aboriginal commercial fisherman at the time of the survey so the three groups are largely distinct.

[8] In the year prior to the study, the case of Regina vs. MacPhearson was heard in the Manitoba court system. The court threw out charges against MacPhearson, a Metis person who had been caught hunting moose out of season, on the basis of arguments that Metis hunting rights were not extinguished. It is difficult to assess whether this court decision would have had any bearing on the

resources. It was not possible to use a contribution for all scenarios though this would have been ideal. Requesting a contribution to a decision making group involving any government agency (biologists are usually government employees) would be met with distrust. It was felt that for the scenarios which involved a decision group could not involve an additional group to carry out the restoration. Thus the scenario with the group choosing the option, the respondent is asked whether he/she would support an investment of $X. The respondent is being asked essentially to ratify the group's decision. Note the contribution scheme under the referendum model is not the traditional voluntary donation vehicle that has been used in surveys. The WTP question contains the following statement: "at least 50% of the households in La Ronge would have to be willing to pay $X..." and then the individual is asked if they would be willing to make a one-time contribution. Figure 1 illustrates the flow of the first section of the questionnaire and Appendix I contains the full survey.

The second part of the survey contains a series of questions concerning satiation. A scenario is described where the fishery has been restored to levels observed in the past and the respondent is asked how much fish he/she would like to catch after the restoration. A series of debriefing questions followed this question to elicit more information about why the individual was or was not interested in catching more fish.

The final section of the survey contained the socio-economic questions concerning the involvement of the individual (or their family) in the fishery, age, education, household size, gender and income levels. The survey was designed to take no more than 15 minutes to complete with a trained interviewer. As a result, the number of research questions was restricted to a few key areas concerning differences in valuation by cultural group and satiation. A complete copy of the survey in English and Cree can be found in Hatton MacDonald *et al* (1995). An English version of the survey can be found in the Appendix I of this thesis.

Theory of Willingness to Pay

The importance of the resource to the local community was elicited through a series of questions concerning the willingness to pay for one restoration option selected from a series of options by the respondent (refer to Figure 1). Logit models based on utility formulations suggested by Hanemann (1984) were estimated for the various groupings of restoration options. The sign of the estimated coefficients and the significance of these coefficients are important for the section where welfare measures are presented.

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self-perceived property rights of Non-Status Indians and Metis peoples. Local residents seemed

The willingness to pay (WTP) concept was shown to be consistent with utility theory in Hanemann (1984). The consumer has an unknown utility function of the general form:

$$(1) \quad U = v(a, y; s)$$

where a = 1, 0 with 1 representing the environmental amenity being improved and 0 representing no change,

y is income and s is the socio-economic characteristics that are thought to influence preferences.

The individual's utility function can be partitioned into an observable and an unobservable portion where $v(.)$ is the observable portion of the utility function and ε is the random error in the researcher's ability to observe the individual's utility.

$$(2) \quad U = v(a, y; s) + \varepsilon_a \quad for\ a = 1, 0$$

The individual would be willing to pay \$X for the change in the environmental amenity if the resulting loss in income (plus the random error) exceeds the utility (plus the random error) from no change occurring.

$$v(1, y - X; s) + \varepsilon_1 \geq v(0, y; s) + \varepsilon_0$$

The probability that an individual would be willing to pay can be expressed as:

$$(3) \quad \begin{aligned} \Pr(yes) &= \Pr(v(1, y - X; s) + \varepsilon_1 \geq v(0, y; s) + \varepsilon_0) \\ &= F_\eta(\Delta v) \end{aligned}$$

where $F_\eta(\Delta v)$ is the cumulative density function, η is defined as $\varepsilon_1 - \varepsilon_0$ and (Δv) is the difference in observable utility.[9]

Hanemann (1984) suggests two functional specifications of the observable utility, linear and a logarithmic form:

$$(4) \quad v(a, y; s) = \alpha_a + \beta\ y \qquad for\ a = 1, 0$$

$$\begin{aligned} v(a, y; s) &= \alpha_1 + \beta\ (y - X) \quad for\ a = 1 \\ v(a, y; s) &= \alpha_0 + \beta\ (y) \quad for\ a = 0 \\ \Delta v &= (\alpha_1 - \alpha_0) - \beta X \end{aligned}$$

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unaware of these rulings at the time of the survey.

[9] Note that Pr (no) = 1 - Pr (yes)

$$(5) \qquad v(a,z;s) = \alpha_a + \beta \ln y \qquad for\ a = 1,0$$

$$\Delta v = (\alpha_1 - \alpha_0) + \beta\,(\ln(y - X) - \ln(y))$$

$$= (\alpha_1 - \alpha_0) + \beta\,(\ln(1 - \frac{X}{y})$$

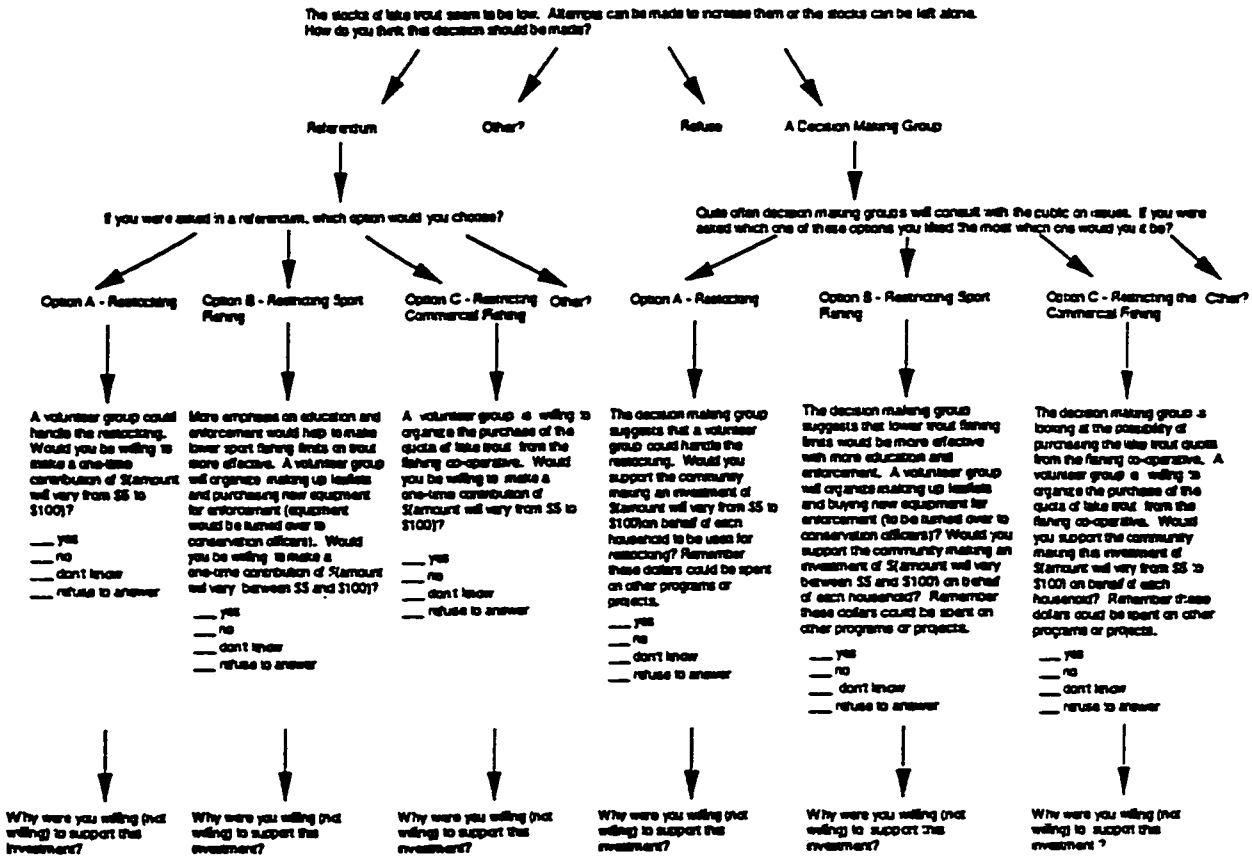

Figure 1: Flow of Survey Questions

Empirical Results

Six interviewers were used to interview 290 households.[10] The response rate was 89.5%. The rate on reserves was 99% and off-reserve was 80.1% The high response rate on the reservation was probably due to the involvement of a Band Counsellor in the project and the interviewers being well known to the Aboriginal community.

Approximately, 55% of the sample was Aboriginal respondents and 45% Non-Aboriginal respondents.[11] When asked about how decisions regarding the fishery restoration should be made approximately 73% of the sample favoured a group that reflected the interests of the various users, the Band and other experts. As well, Aboriginal and Non-Aboriginal both tended to support this political option strongly (on a proportional basis). This was a surprising result as the town and the Band had participated in referendums on controversial issues in the past. More detailed information on the responses can be found in Hatton MacDonald *et al* (1995).

The respondents were asked if they favoured restocking the fishery, restricting the sport fishery and restricting the commercial fishery. Respondents favoured restocking (36.5%), followed by a combination of options (32.3%), restricting the commercial fishery (24.1%) and restricting the sport fishery (7.1%). If respondents favoured a combination of options, the interviewers asked which option the respondent liked the most. From the group that wanted a combination of programs, restocking was favoured by most of the respondents.

In general, there were few refusals on any particular question. However, there was an observed tendency for Aboriginal respondents to state they "didn't know" how to answer a question when compared with Non-Aboriginal respondents, see Hatton MacDonald *et al* (1995).

Willingness to Pay for an Improvement in the Resource

Assuming these forms of utility expressed in equations (4) and (5), a linear and logarithmic model were estimated for several of the program options. Each model contains the same socio-

[10] The pre-test (n=25) was used as a training exercise and to refine the wording of questions. As well the pre-test was used to set the bid amounts. The data from the pre-test were set aside and not included in the empirical analysis that follows.

[11] The sampling strategy was to complete 50% of the surveys with randomly selected households on the reserves and 50% with randomly selected households off the reserves. Since some Aboriginal respondents live off the reservation, the proportion of Aboriginal and Non-Aboriginal respondents will not be equal.

economic variables of income, age, gender (female = 1) and Aboriginal status (Aboriginal = 1), the variables thought to be most significant in the willingness to pay decision.[12] At the outset, economic theory would suggest the relationship between income and willingness to pay for resource improvement is positive if resource improvement is a "normal good". If particular groups in society such as grand-parents, Aboriginal people and women have a greater concern for future generations then variables such as age, Aboriginal status and gender may have a positive impact on the willingness to pay.

In the contingent valuation question, the respondent was asked if he/she would be willing to donate (or support the decision making group making an investment on their behalf) $X, where X is the bid amount, a randomly assigned value between $5 and $100.[13] Economic theory would suggest that the probability of accepting the payment of the bid amount decreases as the bid amount increases. So one might expect the estimated coefficient on the bid amount to be negative.

Tables 2 - 1 and 2 - 2 summarise the results of the restocking program. Table 2 - 1 includes only the respondents who thought the decision about how to restore the fishery should be made by a group and then indicated a preference for restocking. Table 2 - 2 summarises the results from the dataset that combines the responses of those who thought the decision should be made by referendum and those who thought a group should make the decision. A dummy variable is used to control for the difference in the manner the WTP questions were asked between the two political models. Tables 2 - 3 and 2 - 4 summarise the results of the willingness to pay to restrict the commercial fishery. Table 2 - 5 includes all the program options. Dummy variables for two of the three program options (restocking and sport fishing) are included in the all program options model.

The models of the willingness to pay for a restocking program, in Tables 2 - 1 and 2 - 2, and restricting access to commercial fishing, Tables 2 - 3 and 2 - 4, had quite reasonable Cragg-Uhler R Squared values. The large model, summarised in Table 2 - 5, yielded the poorest results in the sense that most of the coefficients (with the exception of age) were insignificant and the Cragg-Uhler R Squared Values were extremely low for both the linear and logarithmic models. It would seem that the program options are viewed as being very different.

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[12] Socio-economic variables such as education and income are highly collinear. Given the assumed form of utility, only income is included in the logistic regression.

[13] The range of the bids was determined through pre-testing using bid amounts between $5 and $150. No one was willing to pay $150 to assist in restoring the fishery in the pre-test so the upper end of the range was reduced to $100.

Gender was found to have no real bearing on willingness to pay. Wouters (1995) reported that there are a limited number of studies concerning women and their attitudes towards preservation and the studies that do exist are inconclusive. However, whether a respondent is Aboriginal or Non-Aboriginal was significant (Tables 2 - 1, 2 - 2, 2 - 3 and 2 - 4). Finally, income had a positive (and significant) influence on the willingness to pay for restocking program but a negative (and significant) influence on the willingness to pay to restrict commercial fishing. It is important to be cautious about the results from Table 2-3 concerning the commercial fishery as the estimated coefficient on the bid amount was insignificant.

The debriefing questions that followed all of the WTP questions were useful for placing the responses in context. For respondents who were willing to support the improvement in the fishery, the most common reasons included that fish stocks are important and that increasing fish stocks might benefit their family. There were very few responses that could be attributed to being good cause donations or "saying yes without actually having to pay". With negative responses, it would appear that respondents felt that the fishing industry and the government should be held responsible. Thus total values associated with improving the fishery may be conservative in the sense that the welfare measures do not capture entirely the importance of the fishery. Details concerning debriefing questions can be found in Hatton MacDonald *et al* (1995).

Table 2 - 1
Summary of the Willingness to Pay Logarithmic and Linear Models
Restocking Program, Group Decision Only

Restocking Program - Group Decision n = 94		
	Linear Model	**Log Model**
Variable	Estimated Coefficient	Estimated Coefficient
	(t statistic)	(t statistic)
Constant	0.99901	-5.2553
	(0.87833)	(-1.0947)
Bid Amount	-0.034625*	-1.3121*
	(-3.3363)	(-3.1477)
Income	0.000030863*	0.89505*
	(2.269)	(2.3776)
Age	0.013614	0.50378
	(0.75344)	(0.68532)
Gender	0.23359	0.16626
female = 1	(0.43123)	(0.31172)
Aboriginal Status	-1.4540*	-1.2178*
Aboriginal = 1	(-2.6144)	(-2.1216)
Cragg-Uhler R Squared	0.2970	0.2957

* Significant at $\alpha = 5\%$

Table 2 - 2
Summary of the Willingness to Pay Logarithmic and Linear Models
Restocking Program, Group Decision and Referendum Combined

Restocking Program - Group and Referendum	**n = 121**	
	Linear Model	**Log Model**
Variable	Estimated Coefficient (t statistic)	Estimated Coefficient (t statistic)
Constant	1.0441 (1.0064)	-2.7911 (-0.71282)
Bid Amount	-0.028627* (-3.4999)	-1.1438* (-3.4361)
Dummy Variable for Group Decision	0.26328 (0.51649)	0.2006 (0.39241)
Income	0.000025876* (2.2629)	0.78156* (2.4357)
Age	-0.0015777 (-0.099803)	-0.12904 (-0.20731)
Gender female = 1	0.64528 (0.13908)	0.044517 (0.095328)
Aboriginal Status Aboriginal = 1	-0.97269* (-2.0535)	-0.82854 (-1.6917)
Cragg-Uhler R Squared	0.31606	0.31975

* Significant at $\alpha = 5\%$

Table 2 - 3
Summary of the Willingness to Pay Logarithmic and Linear Models
Commercial Fishing Program, Group Decision Only

Commercial Fishing - Group Decision	**n = 39**	
	Linear Model	**Log Model**
Variable	Estimated Coefficient (t statistic)	Estimated Coefficient (t statistic)
Constant	6.6460* (2.4642)	21.469* (2.1652)
Bid Amount	0.013216 (0.86339)	0.44613 (0.73073)
Income	-0.000077624* (-2.1668)	-1.4647* (-1.9564)
Age	-0.050786 (-1.6620)	-1.7146 (-1.4007)
Gender female = 1	-0.93437 (-1.1348)	-0.72704 (-0.93662)
Aboriginal Status Aboriginal = 1	-3.4676* (-2.1328)	-2.5013* (-2.0391)
Cragg-Uhler R Squared	0.38552	0.29181

* Significant at $\alpha = 5\%$

Table 2 - 4
Summary of the Willingness to Pay Logarithmic and Linear Models
Commercial Fishing Program, Group Decision and Referendum

Commercial Fishing - Group and Referendum n = 61

Variable	Linear Model Estimated Coefficient (t statistic)	Log Model Estimated Coefficient (t statistic)
Constant	-1.8473 (-1.2753)	-10.347 (-1.6348)
Bid Amount	-0.024156 (-1.9547)	-0.80376 (-1.6157)
Dummy Variable for Group Decision	-2.1683* (-2.6969)	-1.9820* (-2.5806)
Income	0.000038692 (1.9396)	0.73238 (1.316)
Age	0.050292* (1.9780)	1.7116 (1.7542)
Gender female = 1	0.13886 (0.22494)	0.14203 (0.23745)
Aboriginal Status Aboriginal = 1	2.1831* (2.2489)	1.7846 (1.9328)
Cragg-Uhler R Squared	0.33352	0.25909

* Significant at $\alpha = 5\%$

Table 2 - 5
Summary of the Willingness to Pay Logarithmic and Linear Models
All Program Options, Group Decision and Referendum

All Program Options n = 214

Variable	Linear Model Estimated Coefficient (t statistic)	Log Model Estimated Coefficient (t statistic)
Constant	-0.61453 (-0.66156)	-4.7069 (-1.3284)
Bid Amount	0.001202 (0.18373)	-0.96093 (-0.2263)
Dummy Variable for Restocking	0.44835 (1.1288)	0.46019 (1.1577)
Dummy Variable for Sport Fishing	0.72558 (1.1545)	0.70729 (1.1235)
Dummy Variable for Group Decision	0.13545 (0.36249)	0.084595 (0.2263)
Income	0.0000154435 (0.15298)	0.12316 (0.43564)
Age	0.40512* (2.5042)	1.3443* (2.4395)
Gender female = 1	0.030907 (0.07905)	0.032033 (0.081800)
Aboriginal Status Aboriginal = 1	0.099944 (0.22519)	0.22148 (0.48774)
Cragg-Uhler R Squared	0.04501	0.06850

* Significant at $\alpha = 5\%$

Tendencies to Refuse

As discussed as part of the general results of the survey, there were very few refusals to answer specific survey questions. A concern raised in the conceptual paper Adamowicz *et al* (1998) involved the problem of lack of substitutability due to belief systems that may result in a large number of refusals to participate or to answer questions. This might occur if aspects of the physical environment are held in such high regard, ranging from reverence, sacredness through to a taboo status such that the individuals would not be willing to associate monetary sums for the protection or improvement of these goods. Instead individuals may believe that these goods should simply be protected. Further, as part of the valuation process, individuals must believe that the proposed changes could occur, be able to perceive how the proposed changes will affect their individual utility and see how the changes will translate into some unit of currency given the perceived property rights. If respondents are used to thinking of property as something that is shared, the benefits of the proposed change may not translate into individual utility. Clearly, any of these difficulties would confound the attempts of the researcher to elicit values for environmental improvement. While firm conclusions may not be drawn about the full nature of the problem of substitutability, it would appear, at least for the case of the fishery and this community, the belief system did not present a significant obstacle for valuation of an improvement in the resource.

Satiation

The economic agent is assumed to maximise utility through the consumption or accumulation of goods though incremental gains in satisfaction may decrease after a certain level of consumption. It is recognised in undergraduate textbooks such as Varian (1993) that in theory there may be bliss points in the indifference surface, but this problem is usually dismissed for most practical applications. However, in simulating a market for an environmental improvement or an improvement in a natural resource, satiation may well be an issue. According to Mitchell and Carson (1989), there is a total value associated with each resource considered. This total value is thought to be composed of a use value and a non-use value. In the case of the fishery, the use value may reflect the satisfaction and enjoyment of fishing as well as an appreciation of the food the activity provides. The use value is associated with the actual consumption of the good or activity. The term non-use value of a resource captures a number of ideas. Individuals who never actually use the resource may place a value on knowing the resource exists (existence value). As well, individuals may place a value on the resource being available to future generations (bequest value). Non-use values can also involve various forms of altruism. In the case of fishing, it is easy to see how an individual may be satiated with the activity and as a result have zero use value associated with an improvement in the fishery. If the satiated

individual is asked about their willingness to pay for an improvement in the resource, a positive response reflects non-use values. Conversely, if the individual is not satiated with the resource, then a positive response to a willingness to pay question reflects non-negative use and non-use values. The effect of satiation on the mean and median willingness to pay will be discussed further in the next section.

In Adamowicz *et al* (1998), the differences in held values of Aboriginal and Non-Aboriginal peoples concerning accumulation of material goods are considered in some detail. Examples of Aboriginal peoples placing more emphasis on sharing goods than on the accumulation are cited. As a result, one might expect that due to the differences in cultural values towards accumulation, Aboriginal respondents are more likely to be satiated with the activity of fishing compared with Non-Aboriginal respondents. If this is indeed the case, the willingness to pay of Aboriginal respondents may be lower reflecting satiation with the use of the resource.

To explore the potential for satiation in use of the fishery, each respondent was asked to think about a situation where the number of fish in the lake had increased to levels observed in the past and then asked whether they would be interested in catching more fish. In Table 2 - 6, approximately 58% of all respondents in the community were not interested in catching more fish, 35% of all respondents indicated an interest in catching more fish and the remaining 7.3% refused to respond or did not know. There appear to be significant differences in the number of Aboriginal and Non-Aboriginal respondents who were interested in catching more fish.

Table 2 - 6

The Potential for Satiation

Would You Want to Catch More Fish	Aboriginal	Non-Aboriginal
yes	64	37
	(40.8%)	(27.8%)
no	74	94
	(47.1%)	(70.7%)
don't know or refuse	19	2
	(12.1%)	(1.6%)

A non-parametric test for comparing the preferences for more fish by these two groups can be constructed using a Chi-Square Test for independence in two way tables, see Sprent (1989). The null hypothesis for this problem is Aboriginal and Non-Aboriginal respondents have proportionately the same preferences for fish. The test statistic is:

$$(6) \quad \chi^2 = \sum_{i=1}^{k} \frac{[n_i - E(n_i)]^2}{E(n_i)}$$

where n_i is the observed cell frequency and E (n_i) is the expected value. The test statistic was calculated using only the yes and no responses of the two groups. The test statistic was calculated to be 9.425 which is greater than the critical value at a significance level of 5%. This suggests that the null hypothesis that preferences for fish are proportionally the same across cultural groups cannot be supported.[14]

A number of factors may contribute to an individual wanting to catch more fish, such as larger households have more mouths to feed and conversely, the desire to fish may decrease with age (possibly related to mobility). A binary logit model was constructed to explore the factors that may contribute to the desire to catch more fish and the results are explored in Table 2-7. Since many socio-economic variables such as education and income are negatively correlated with Aboriginal status (the correlation coefficient rho being -0.62 and -0.57 respectively), the information will be largely conveyed by including only Aboriginal status as an explanatory variable.

Table 2 - 7

Factors Contributing to Non-Satiation

Question: Would you like to catch more fish? YES = 1

Variable Name	Estimated Coefficient (t-statistic)	Marginal Effects
Constant	-0.89261	-0.20316
	(-1.4894)	
Aboriginal Status	0.52846	0.12028
	1.6470	
Age	-0.0230	-0.0052807
	(-1.9456)	
Household Size	0.12028	0.027375
	(1.5399)	
Perceive Fish as a Healthy Food	0.60264	0.13716
	(1.8365)	
Cragg - Uhler R Squared	0.093	

The estimated coefficients for a logit model are most easily interpreted in terms of marginal effects of the explanatory variables (Aboriginal status, age, household size, perception of fish as a

[14] A disproportionate number of don't know responses (a small number in total) were given by Aboriginal respondents indicating a discomfort answering this question.

healthy food upon the probability of being wanting to catch more fish). For example, the probability of the respondent wanting to catch more fish increases 13.7% if the respondent perceives fish to be a healthy food.

Respondents who were interested in catching more fish, were then asked how many fish they would like to catch. A difference of means test was also constructed to test for potential differences in the satiation levels of those who would like to catch more fish in the two groups. The mean number of fish that Aboriginal and Non-Aboriginal individuals would like to catch was calculated as 398 and 48.6 respectively with a pooled standard error of 71.7. The null hypothesis is that both groups would like to catch the same mean number of fish.

Hypothesis: $H_o: \quad \mu_A = \mu_{NA}$

$H_A: \quad \mu_A \neq \mu_{NA}$

where μ_A (μ_{NA}) is the mean number of fish that the Aboriginal (Non-Aboriginal) respondent wants to catch.

Test Statistic: $z = \dfrac{\bar{x}_A - \bar{x}_{NA}}{\sigma_{\Delta\bar{x}}} = 4.87$

At a level of significance of 5%, we would reject the null hypothesis. The Aboriginal respondents who want to catch more fish would like to catch significantly more fish on average than the Non-Aboriginal respondents. One possible explanation for this difference in catch amounts is that Aboriginal respondents may view fishing as a source of income in kind. Discussions with the interviewers suggested that fish were an important subsistence good[15] and that fish represented an important source of protein and nutrients for Aboriginal families. Non-Aboriginal respondents seemed to view fishing as a recreational good and therefore may reach a satiation level sooner than Aboriginal respondents.

In an effort to see what role satiation may play in the WTP, a dummy variable for satiation (would you like to catch more fish? Yes=1) was included in the linear and logarithmic models for the various restoration options. The estimated coefficient on the variable satiation was significant at α = 10% only in the case of the pooled restocking program data. The results are summarised in Table 2 - 8. The estimated coefficients in Table 2-8 are very similar to Table 2-2 even with the inclusion of the new variable and the change in the size of the dataset. Seven observations had to be deleted from the dataset due to "don't know" responses to the satiation question.

[15] There were considerable differences observed in the distribution of income between Aboriginal and Non-Aboriginal respondents. About 45% of Aboriginal households versus 4% of Non-Aboriginal households in the sample had an income less than $10,000 per year. As a result, Non-Aboriginal households are in a better position to afford recreational goods.

Table 2 - 8

Summary of the Willingness to Pay Logarithmic and Linear Models with a Satiation Variable

Restocking Program - Group and Referendum	**n = 114**	
	Linear Model	**Log Model**
Variable	Estimated Coefficient (t statistic)	Estimated Coefficient (t statistic)
Constant	0.9840	-1.3994
	(0.8831)	(-0.3242)
Bid Amount	-0.02881*	-1.1642*
	(-3.4048)	(-3.3934)
Dummy Variable for Group Decision	0.3444	0.2508
	(0.6650)	(0.4784)
Income	0.00002134	0.6444
	(1.8134)	(1.9226)
Age	-0.004780	-0.2046
	(-0.2822)	(-0.3022)
Gender	0.2086	0.2096
female = 1	(0.42057)	(0.4178)
Aboriginal Status	-1.0530	-0.9901
Aboriginal = 1	(-2.0845)	(-1.9050)
Satiation Would you like to catch more	0.81724	0.9432*
fish? Yes = 1	(1.7233)	(1.9723)
Cragg-Uhler R Squared	0.33133	0.3365

* Significant at $\alpha = 5\%$

Welfare Measures

Welfare measures provide a money measure representing the total value which includes non-use and use values associated with restoring the fishery. The welfare measure is estimated by finding the amount E which satisfies $v(1, y - E) = v(0, y)$. The amount E is the equivalent surplus that measures the area under the new Hicksian demand curve associated with the restoration of the fishery. Following Hanemann (1984), the probability that the individual is willing to donate or support the investment in a program option in equation (4) can be rewritten in terms of the equivalent surplus (E) as follows:

$$(7) \qquad \Pr(yes) = pr(E > X) = 1 - G_E(X) = F_\eta\ (\Delta v)$$

The change in utility, Δv, can be rewritten as:

$$(8) \quad E^{+} = \int_{0}^{\infty} [1 - G_E(X)]\,dx - \int_{-\infty}^{0} G_E(X)\,dx$$

If the observable portion of the utility function takes the form of (5) or (6) then $G_E(X)$ can be identified. The mean of $G_E(X)$ will be the expected mean willingness to pay of the sample. As Hanemann (1989) has stated, if X is restricted to be non-negative, then equation (8) reduces to:

$$(9) \quad E^{+} = \int_{0}^{\infty} [1 - G_E(X)]dx$$

$$where \ \lim_{x \to 0} G_E(X) = 0$$
$$\lim_{x \to \infty} G_E(X) = 1$$

If the cumulative density function in (9) is logistic and X is non-negative, the expected value of the Hicksian equivalent surplus for the linear utility function, equation (5) is:

$$(10) \quad E^{MEAN} = -\frac{1}{\beta} \ln(1 + e^{\alpha})$$

and the median is:

$$(11) \quad E^{MEDIAN} = -\alpha / \beta$$

If the utility function takes the form of equation (6) then the expected value of the equivalent surplus for the linear-log utility function will be:

$$(12) \quad E^{MEAN} = -\frac{y}{\beta} \ln(1 + e^{\alpha})$$

where $\bar{y}$ is the mean household income in the sample. The median willingness to pay for the linear-log utility function is:

$$(13) \quad E^{MEDIAN} = -\alpha \frac{y}{\beta}$$

From the estimated coefficients of the logistic regression, the mean and median willingness to pay welfare measures can be calculated. Since the respondent was allowed to choose the political model and the restoration scenario, the estimation results reflect only the preferences of the sample and cannot be extrapolated to the population. These measures can be used, though to, compare the welfare implications for the sample by gender, ethnicity or any other factor of interest holding income, age and all other variables constant. In this case, Table 2 - 9 summarises the welfare measures calculated for the community sample as well as the Aboriginal and Non-Aboriginal samples separately.

Table 2 - 9

Welfare Measures - Linear Models

	Community Sample	Aboriginal Sample	Non-Aboriginal Sample
Restocking - Group Decision Only (Table 2 - 1)			
mean	$57.00	$40.95	$77.03
median	$52.67	$32.94	$74.95
Restocking - Group Decision & Referendum Combined (Table 2-2)			
mean	$67.48	$54.86	$84.01
median	$62.01	$46.72	$80.70
Commercial Fishing - Group Decision and Referendum Combined (Table 2-4)			
mean	$51.48	$87.21	$24.65
median	$31.55	$81.84	n/a [16]

The calculated welfare measures reveal strong differences in the values attached to restoring the fishery. In general, the Aboriginal sample attached a lower dollar value to restoring the resource except in the case of restricting the commercial fishing. Note however, that Aboriginal respondents cited the government as being responsible for restoring the fishery. Thus the lower dollar value welfare measures may reflect the belief that the federal and provincial government agencies should be restoring the fishery, possibly using revenue from a larger national or provincial tax base.

Interpreting welfare measures generally has to be done with care. The welfare measures from the commercial fishing option must be viewed cautiously because the estimated coefficient on the bid amount was not significant. As well, the group decision willingness to pay questions were all framed in terms of a trade-off between community projects and the fishery. Thus, the respondent is being asked to trade-off investments in goods which have public good aspects. Given the limited number of referendum responses to the restocking option (n = 27), it is difficult to generalise beyond the observation that the mean willingness to pay increased when referendum responses were included in the calculation.

If welfare measures are used as a basis for a damage assessment, compensation in the form of a community project according to the priorities of the community, would be one method of payment by the offending party. Compensation paid directly to households may or may not return households

[16] The sum of the coefficients α is a negative number for the Non-Aboriginal sample and as a result the median value is negative and not reported.

to their base level of utility as it would depend on each household's preferences for community projects and money (a private good).

Finally the welfare measures can be recalculated to take into account the effect of satiation. In Table 2 - 10, for the households that are interested in catching more fish (satiation = 1), the mean WTP is higher reflecting the use value of the activity if the stocks were restored. For the households that are satiated, the improvement in the resource is valuable in terms of non-use value such as the continued existence of the fishery.

Table 2 - 10

Welfare Measures of Satiated and Non-Satiated Respondents

Restocking Option - Group and Referendum		
	satiation = 1	satiation = 0
mean	$75.49	$51.78
median	$71.29	$42.93

Satiation had the effect of reducing the mean and median WTP. This is an interesting result as it suggests a novel means of untangling use and non-use value. For individuals that are satiated in terms of use value, whether the good is a recreational good or a source of income in kind, the total values elicited from this study will be non-use values.

One cautionary note is warranted concerning the welfare measures of the satiated respondents if these values were to be used as the basis for compensation. Non-use values reflect existence values, bequest values, altruism, etc. The type of altruism may be of concern due to the economic ties of the community and the fishery. Usually altruism is discussed in the context of the general public's concern for the resource because it enhances the well-being of others. McConnell (1997) has demonstrated that the type of altruism should be considered if the non-values are to be used in compensation claims or cost-benefit analysis. In this study, the satiated respondents may be concerned with the continued use of the fishery by sport anglers and this would fit in with McConnell's paternalistic altruism where the altruist values others' use of the resource or mixed paternalism where the altruist values any service from the resource. If compensation was paid to the people in the La Ronge area as well as the users from other geographic locations, there would be some double counting of values. Restoration of the resource would be a straight forward method for compensating these individuals.

Conclusions and Suggestions for Further Research

The valuation exercises provided insights into how Aboriginal and Non-Aboriginal people place values on natural resources. For goods which are not enveloped in cultural taboos, many of the potential problems with contingent valuation identified in Adamowicz *et al* (1998) can be mitigated by sensitivity to cultural differences in the initial design of the questionnaire. However, the appropriateness of the CVM approach is yet to be tested with a controversial good or a resource central to the belief system of the people being queried.

This study has uncovered some issues which merit further investigation. Both the Aboriginal and Non-Aboriginal population demonstrated a strong preference for group decision making. This type of decision-making structure or political model has never been used in a contingent valuation study. It is likely that this type of decision making structure and the idea of trading off community investments would be necessary for studies conducted in northern communities where there are often complicated property rights and political systems for various resource users.

The interpretation of the information elicited from the group decision-making questions has to be done carefully. For instance, if the welfare measures are to be used as the basis for an assessment of damages (or a negotiation concerning damages), the information collected through group decision making scenarios would point to the size of a settlement for the community in the form of some community project rather than a settlement targeted to individuals. As a cautionary note, the decision making structure and investment vehicle developed for this study may only be useful as part of a personal interview where the trained interviewer is able to emphasise that a trade-off is being made between the fishery and other community projects. It is likely that this type of decision making structure and the complicated skip pattern employed would not work well with a mail-out survey.

From the empirical results, it would appear that Aboriginal respondents place less value on the fishery. However, there must be a number of caveats placed on this statement. Aboriginal respondents may be viewing the fishery as a subsistence good or a source of income in kind whereas the fishery is a recreational good for Non-Aboriginal respondents. As well, there seemed to be an underlying conflict in the community concerning who should pay for the restoring the fishery. Many Aboriginal respondents indicated in debriefing questions that the government or the sport and commercial fishing industry should pay for the restoration.

A significant portion of the sample was satiated with respect to catching more fish. It was interesting to note that Non-Aboriginal respondents indicated a greater tendency to be satiated. This

suggests that the issue of satiation may be important for CVM practitioners in general. Satiation seems to result in a lower mean and median willingness to pay. More work remains to confirm that satiation is indeed an issue in North American society. As well, there is significant room for exploring how satiation may be used to untangle use and non-use values.

A number of questions remain unanswered concerning cross-cultural applications of the contingent valuation method especially concerning sacred and taboo resources. The nature of the resource considered in this study, a non-sacred resource, provides baseline information about the ability of Aboriginal and Non-Aboriginal peoples to place values on environmental improvement. It would be premature to draw strong conclusions about the appropriateness of the contingent valuation method for all resources, but it would appear for commonly utilised resources, the problems can be largely overcome by involvement of the community and First Nations peoples in the research process.

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Chapter 3 - Valuing Fuelwood Resources using a Site Choice Model of Fuelwood Collection

Introduction

Wood is the primary source of household energy for many African countries. Fuelwood is used for cooking meals, heating homes (as the season requires), making charcoal, etc.. Much of the existing literature concerning fuelwood is broad in scope and does not provide insights into the microeconomic relationships that have evolved with fuelwood shortages. For instance, Dewees (1989) suggests that painfully little is known about even the role of urban fuelwood markets in the overall fuelwood scarcity situation.

Much literature seems to be motivated by a concern over the rate of deforestation that is occurring in many parts of the world. In recognition of the importance of fuelwood as a source of energy, planning tools such as energy gap models have been developed. The focus of the energy gap models has been on projecting demand and supply of wood where massive energy deficits are predicted. Leach and Mearns (1988, pp. 5-9) discuss how these gap models consider aggregate current and future energy consumption compared with the aggregate supply of fuelwood (stock of standing fuelwood and future growth). The policy solutions that fall out of this line of reasoning are expressed by Munslow *et al* (1988, p. 11). "*The fuelwood trap, into which governments and donor agencies fall,* ...[in which they] *assume that they have identified an obvious problem and consequently there has to be a simple solution. Unfortunately, this is not the case.*" (italics in original). The problem with these models is that the spatial nature of the problem is ignored. Fuelwood shortages can be very local in nature and thus large scale projects may not address local needs. Further, as wood scarcity increases, wood may be used more carefully and/or substitutions might occur.

Researchers such as Munslow *et al* (1988), Du Toit *et al* (1985), and the FAO (1978, 1991) suggest that deforestation is more closely associated with clearing land for agriculture and the cutting of green wood for the production of charcoal than with the collection of fuelwood by local people. It must be recognised that in some areas, potential fuelwood shortages have been alleviated temporarily by land clearing activities that produce dry wood. Clearing land allows for a short term increase in aggregate agricultural production, but the loss of woody biomass has implications for maintaining soil quality and watershed management. The loss of this biomass has negative implications for longer term agricultural productivity.

The problem of energy use as an economic decision is attracting the attention of applied economists. The standard approach is to extend the agricultural household production model to incorporate domestic fuel decisions. The advantage of this approach is that energy choices are viewed as one choice in the context of a series of consumption and production decisions. A small group of researchers have adapted the household production modelling framework to consider problems such as the adoption of improved stoves using a binary logit model [Amacher *et al* (1992)], the choice between agricultural residues and fuelwood for domestic use with switching regressions [Amacher *et al* (1993)] and the decision to purchase or collect fuelwood [Amacher *et al* (1996)] where the demand and supply equations are estimated. Issues surrounding deforestation have been the primary motivation for this literature. Understanding domestic energy choice is important not only for issues of deforestation in the developing world but as researchers and policy makers are beginning to realise, for the global environment. The prospects of global warming and the potential importance of carbon sequestration suggests that the economics of fuelwood collection needs to be better understood as part of exploring the potential options to address these problems.

This paper follows the same tradition of modelling as the Amacher *et al* papers in that the collection decision is seen as part of the household resource allocation decision. A micro approach is useful for isolating the nature of the trade-offs occurring in the household production process with respect to fuel choices. For rural areas in north-eastern Zimbabwe where the data for this study were collected, energy sources such as bottled gas and electricity for domestic use are not available outside urban areas. Since the sale of fuelwood is largely prohibited on communally held land, households are dependent on collecting their own fuelwood. Here is where the significant difference lies between this paper and Amacher *et al*: the decision to collect wood becomes a discrete choice problem concerning whether or not to collect wood at a particular site if the sale of wood is prohibited. This requires a very different approach to modelling the fuelwood collection decision. In this case, a behavioural choice approach is used to model the site choice problem. The various attributes of the site, as well as the measure of effort to get to each site, are likely to be important factors in the site choice. If the opportunity cost of time is not well described by wage rates due to the thinness of the labour market, the next best alternative may be to use a measure of effort such as time, difficulty ratings or an estimate of calorie expenditures. If calories are used in the estimation of models of choice, then calories provide an alternative means of expressing the welfare losses that the household or community may experience due to closure of the site. This is an alternative approach to measuring welfare effects that is consistent with the view of the rural household as a producer and consumer. Throughout this analysis, the interrelationship between agriculture, the preparation of food, the collection of fuelwood and the production of other goods is maintained as the behavioural choice model is an extension of the household production framework.

Household Production Models

In rural Zimbabwe, the rural household is both a producer and consumer of goods and services. The rural household, often headed by women, might grow staple crop for home consumption and sell the surplus on the market. The time of adults and older children will be divided between agricultural production, water and fuelwood collection, child-care, cooking meals and the production of crafts, etc. The standard approach to modelling the rural household is to concentrate on the allocation of time using the basic framework of Becker (1965) and to extend the model to incorporate the salient features of household agricultural production following Singh *et al* (1986). The basic idea is that the household allocates its labour towards the production of goods, some of which are intended for household consumption and some will be sold to generate cash income. A central feature of the simpler household production models is that the production decision is independent of the consumption decision. However, consumption decisions are influenced by production decisions through the sale of surplus goods, referred to as the 'profit effect'.[17] 'Profits' from the sale of surplus agricultural produce or other goods will increase the cash income of the household which then allows the household to purchase more goods. If the 'profit effect' is an unimportant factor in the consumption decision, then consumption and production can be modelled separately. In many cases, the profit effect can significantly alter the direction and the magnitude of the labour allocation and consumption decisions.

It is generally assumed in the household production literature that households are price takers for all inputs and outputs including labour and that markets exist for all the goods produced. Further, it is assumed commodities are homogeneous, i.e. hired labour is a perfect substitute for household labour. These assumptions are sufficient[18] for the model to be recursive, that is for production and consumption decisions to be treated as if they were sequential with production decisions being made first even though these decisions might be going on simultaneously. The next step is to derive the standard demand equations for basic goods required by the household. The specific circumstances of the study areas are considered and the modelling framework is extended to allow for the specific features of the study areas. The result is a fuller and richer framework that can be used to describe the economic framework within which households make choices.

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[17] The term profit is being used quite loosely in this literature. If all prices are determined through a competitive market then economic profits will be zero.

[18] See Singh et al (1986). Note these conditions are of course not necessary. For instance, commodity homogeneity can be relaxed but households must be restricted from corner solutions i.e. consuming all that they produce.

The household ***h*** obtains utility from basic goods and services where some of these goods are produced by the household (h superscript) and some are purchased (p superscript). The utility function can be written as:

$$(14) \quad U_h = U(X_d^h, X_d^p, X_o^h, X_m, X_l)$$

where X_d is household consumption of food which is made from the agricultural product. Food may be purchased or the agricultural staple might be transformed through the labour of the household into food. The agricultural product, X_a, may also be purchased or produced by the household.

X_O is household consumption of all other goods which are home-produced,

X_m is household consumption of goods that are purchased (often referred to in the literature as marketable goods) and

X_l is household leisure.

The goods are described in terms of household produced versus purchased because of the mark-up between value of the good to the household and the price at which the household, as producer, is able to sell the good. The price differential is due to marketing costs which might include transporting the good to market, economic profit for the marketer, etc..

The household has an endowment of household labour time. If labour, as measured by the amount of time spent working on particular tasks, is homogeneous for the purposes of production, then the labour constraint can be written as:

$$(15) \quad L_a^h + L_d^h + L_W^h + L_o^h + X_l = H$$

where household time is allotted to agricultural production, L_a^h , fuelwood collection, L_d^h food preparation L_W^h , the production of other goods L_o^h, and leisure X_l which must add-up to the total amount of household time H. In writing the constraint in this manner, it is implicitly assumed that all labour time is substitutable.

If there is a significant division of labour by gender, i.e. labour resources are not effectively homogeneous, then it is important to account for these difference in the labour allocation decision. There are numerous examples in the literature with studies such as Ahmed (1992), Tinker (1994), Tisch and Paris (1994) which suggest distinct roles for women in the indigenous economy. To account for substitutions in male/female labour, the activities of the household can be further

decomposed into labour time by gender with male and female labour time is denoted by m and f on the household superscript in equation (16).

$$(16)\quad L_a^{h_m} + L_a^{h_f}\, L_d^{h_m} + L_d^{h_f} + L_W^{h_m} + L_W^{h_f} + L_o^{h_m} + L_o^{h_f} + X_l^m + X_l^f = H$$

To allow for a more realistic representation, the labour constraint could be thought about as having a time and effort component. Some tasks, such as preparing the ground for seeding, will require more effort compared with tasks such as cleaning pots or brewing beer. The labour resources devoted to these various tasks must add up to the total human resources of the household.[19]

The household produces an agricultural staple according to the well-behaved production function:

$$(17)\quad A = f(L_a, \overline{N})$$

where L_a is the total amount of labour devoted to agriculture. The term L_a includes labour contributed by the household L_a^h and labour (L_a - L_a^h) which is hired. If $L_a < L_a^h$, then the household sells some of its surplus labour. (Total labour effort devoted to home production of food, other goods and to fuelwood collection can be hired or sold in a similar manner.) The fixed variable $\overline{N}$ is the total amount of arable land. The total amount of the agricultural product A may exceed household consumption X_a^h in which case the surplus could be sold to generate cash. If $A < X_a^h$ then the household purchases X_a^p to be used in the preparation of food.

The household uses fuelwood as a source of energy for heating and in preparing household meals. There would seem to be two important characteristics of the wood, whether it is green or dry.[20] However, if the wood from different trees and shrubs have different characteristics or desirable properties i.e. intensity and duration of how the material burns, then the analysis can be expanded to allow for species differentiation. The amount of green or wet fuelwood collected by the household will depend on the total amount of labour effort L_W and the stock of wood $\overline{S}_j$:

$$(18)\quad W_j = f(L_W, \overline{S}_j) \quad \textit{for } j = \textit{green or dry}$$

[19] The gender superscripts will not be carried throughout the equations but remain implied. An interesting extension would be to allow for wage differentials by task which would likely have some gender implications.

[20] The subscript denoting type of wood will be suppressed for the sake of brevity.

The household can choose to collect only the household's requirements, W^h, a surplus $W > W^h$ or choose a deficit level and purchase the rest.

The household prepares food according to the following well behaved production function:

(19) $$D = f(X_a^h, X_a^p, L_d, F_j, W^h)$$

The household uses the agricultural staple and the variable inputs labour, fuel F_j [21] (paraffin) or W^h in the production of heating and cooked food. If $D = X_d^h$, then prepared food is neither bought nor sold by the household. The production of food and other goods is likely to be at levels required by the household but this flexible model formulation will allow for the sale and purchase of goods and services.

The household produces an assortment of other goods and services such as child-care, water collection, etc. using the variable factor labour L_O.

(20) $$O = f(L_o)$$

The overall budget constraint ensures that all purchases add up to all cash earnings, plus any exogenous income. There are a few sources of cash income including: selling the surplus agricultural staple, selling surplus fuelwood, selling home-produced other goods or selling labour and through receiving remittances from extended family. In developing countries, remittances, included in E for exogenous income, can represent a significant source of income for rural households. Further, aid, whether in the form of food or in cash, can also represent an important source of exogenous income.

On the consumption side, the budget constraint is:

(21) $$Y = p_a^s X_a^h + p_a^p X_a^p + p_d^s X_d^h + p_d^p X_d^p + p_m X_m + p_o^s X_o^h + p_L X_L$$

where

p_i^s is the price at which the household is able to sell of good i i.e. the agricultural good or the other good,

X_i^h is the amount of good i produced by the household that is actually consumed by the household,

p_i^p is the price that the household is able to purchase the agricultural good,

[21] The subscript denoting type of fuel source will be also be suppressed after equation (19).

X_i^p is the amount of the good *i* that is purchased by the household

p_m is the price of the marketable good and

E is exogenous income.

On the production side, the household's full income would be:

$$(22)\quad Y = p_L H + (p_a^s A + p_d^s D + p_W^s W + p_o^s O) - (p_L(L_a - L_a^h) + p_L(L_d - L_d^h) + p_L(L_W - L_W^h) + p_L(L_o - L_o^h) + p_W^p W^h + p_f F) + E$$

where p_W^p is the price at which the household can purchase fuelwood, p_f is the price of other fuel.[22] Substituting (21) into (22) and re-arranging yields:

$$(23)\quad p_m X_m + p_L X_l = p_L H + p_a^s(A - X_a^h) - p_a^p X_a^p + p_d^s(D - X_d^h) - p_d^p X_d^p + p_W^s(W - W^h) - p_W^p W^p - p_f F + p_o^s(O - X_o^h) - p_L(L_a - L_a^h) - p_L(L_d - L_d^h) - p_L(L_W - L_W^h) - p_L(L_o - L_o^h) + E$$

The value of leisure has been included in the budget constraint because the household foregoes the market wage when a household member engages in leisure. The household may hire additional labour or sell its labour effort for agricultural production, fuelwood production or home-produced other goods. For example, if $L_O \geq L_o^h$ then the household will hire labour to assist in the home production of goods such as child care.

The household produces *D*, *O* using the agricultural output, labour and fuel, the variable inputs, and the fixed factors $\overline{N}$ and $\overline{S}$. The intermediate goods, outputs and inputs of household production can be summarised through the implicit production function *G*.

$$(24)\quad G(A, D, F, O, L_a, L_d, L_w, L_o, F, W^h, \overline{N}, \overline{S}) = 0$$

[22] The difference between the price the household is able to sell and the price the agricultural product, food, fuelwood or other goods and services can be purchased at is due to transportation costs, mark-up by merchants, risk premiums, etc. If the household's shadow price falls in between the selling and purchasing price, trades will not occur. The market will be thin or non-existent.

The implicit production function is assumed to be quasi-convex, increasing in outputs D and O and decreasing in L_a, L_d, L_W, L_O, F and W^h.

The constrained optimisation problem as the household allocates labour resources as follows:

$$
\begin{aligned}
&\textit{Maximize}\quad \Psi = \mathrm{U}(X_a, X_m, X_o, X_l) + \lambda\ \ (p_L H - p_m X_m + p_a^s(A - X_a^h) - \\
&p_a^p X_a^p + p_d^s(D - X_d^h) - p_d^p X_d^p + p_W^s(W - W^h) - p_W^p W^p - p_f F + p_o^s(O - X_o^h) \\
&- p_L(L_a - L_a^h) - p_L(L_d - L_d^h) - p_L(L_W - L_W^h) - p_L(L_o - L_o^h) - p_L X_l + E) \\
&+ \mu\, G(A, O, L_a, L_W, L_o, F, W^h, \overline{N}, \overline{S})
\end{aligned}
\qquad (25)
$$

The First Order Conditions

The first order conditions suggest that the household will maximise its utility and the profitability of its production activities if :

- it sets the ratio of marginal utilities for each pair of consumption goods equal to the ratio of the market price of the goods,
- it stays within its budget constraint and operates on its production frontier,
- it produces the optimal combination of goods, and
- it allocates variable factors, labour, purchased fuels and fuelwood, efficiently amongst potential uses.

$$
\begin{aligned}
&U_{X_a^h} - \lambda\, p_a^s = 0 \ \textit{or}\ U_{X_a^h} = \lambda\, p_a^s \qquad U_{X_a^p} = \lambda\, p_a^p \qquad U_{X_o^h} = \lambda\, p_o^s \\
&U_{X_m} = \lambda\, p_m \qquad U_{X_l} = \lambda\, p_L
\end{aligned}
\qquad (26)
$$

$$
\begin{aligned}
&p_L H + p_a^s(A - X_a^h) - p_a^p X_a^p + p_d^s(D - X_d^h) - p_d^p X_d^p + p_W^s(W - W^h) \\
&- p_W^p W^p - p_f F + p_o^s(O - X_o^h) - p_L(L_a - L_a^h) - p_L(L_d - L_d^h) \\
&- p_L(L_W - L_W^h) - p_L(L_o - L_o^h) - p_m X_m - p_L X_l + E = 0
\end{aligned}
\qquad (27)
$$

$$
G(A, O, L_a, L_W, L_o, F, W^h, \overline{N}, \overline{S}) = 0 \qquad (28)
$$

$$
\begin{aligned}
&\lambda\ p_a^s A_{La} - p_L + \mu\ G_{La} = 0 \\
&\lambda\ p_d^s A_{Ld} - p_L + \mu\ G_{Ld} = 0 \\
&\lambda\ p_W^s W_{L_W} - p_L + \mu\ G_{LW} = 0 \\
&\lambda\ p_o^s A_{Lo} - p_L + \mu\ G_{Lo} = 0 \\
&\lambda\ p_f D_f - p_f + \mu G_f = 0 \\
&\lambda\ p_w^s + \lambda p_d^s D_{W^h} + \mu\ G_{Ld} = 0
\end{aligned}
\qquad (29)
$$

The demand functions in general form will be:

$$
(30)\quad X_j^h = f\left(p_a^s, p_a^p, p_d^s, p_d^p, p_m, p_o^s, p_W^s, p_W^p, p_L, p_F, E\right)
$$

The household demand functions suggest that the demand for these goods will depend on its own price, the price of other goods, the price of inputs into the production process and exogenous income. The demand for inputs into the production process will similarly depend on the price of inputs and the price of outputs. For instance, the demand for fuelwood collected by the household will depend on the purchase price for fuelwood, the price of other fuels, the price of other goods and the wage paid to labour.

The market for any one of the inputs to the household production process may be thin or non-existent. As a result, many of the prices in equation (30) will not be observed. In the case of fuelwood, where the resource is often located on communally held land, property rights may be such that the sale of fuelwood is prohibited and strictly enforced through social institutions. Where the sale of fuelwood is possible, the marginal rate of substitution between purchased fuelwood and other purchased goods may exceed the price ratio resulting in a corner solution where no purchase of fuelwood occurs. The household, constrained to the collection of wood, must then consider the problem of where to collect wood. The household production model would suggest labour effort L_W and the availability of species of trees with particular characteristics might be important factors in the decision. The next step is to expand this framework to account for corner solutions using discrete choice theory.

Applying Discrete Choice Theory to Fuelwood Collection

A body of literature has developed in the transportation, marketing and recreation literature concerning discrete choice situations where the individual (or the household) makes a decision - yes or

no - to take the bus to work or not, to purchase a good or not, etc. The decision to collect fuelwood at a particular collection site fits in the general framework. First, let us consider the random utility model and then the investigate how useful it might be for explaining site choice in fuelwood collection.

The Random Utility Model

The choice of where to collect fuelwood could be modelled in the random utility model (RUM) framework.[23] To illustrate, let us take the example of a fuelwood collector, a rational individual, who chooses a forested site i from his/her choice set C_h with probability equal to the probability that the utility associated with choice i is at least greater than or equal to the level of utility to be achieved with any of the other j alternatives in the choice set.

$$(31) \quad P(i \mid C_h) = \Pr(U_{ih} \geq U_{jh}) \qquad \forall\, j \in C_h$$

However, utility is not directly observed. Levels of indirect utility, denoted V(.), can be inferred by the choices observed with some random error. The utility from choice i of household h can be rewritten as:

$$(32) \quad U_{ih} = V(p_i, a_{ih}, s_h) + \varepsilon(a_{ih}, s_h)$$

where p_i is the price of alternative i, a_{ih} is the vector of attributes for alternative i influencing choice of the fuelwood collector h, s_h are the socio-economic characteristics of the fuelwood collectors' household and ε is the random component. P_j for $j = 1, \ldots J$ are the prices of all the alternatives or the prices in equation (30). Substituting (31) into (32) and rewriting leads to:

$$(33) \quad P(i \mid C_h) = \Pr(V_{ih} + \varepsilon_{ih}) \geq \Pr(V_{jh} + \varepsilon_{jh})$$

which means that the individual will collect at site i if the indirect utility from site i (plus some error) is greater than the utility from site j (plus some error).

If the error terms are distributed identically and independently as a Type I extreme value distribution, then the probability of collecting fuelwood at a site i is:

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[23] Fletcher *et al* (1990) and McLeod (1992) served as references for this section.

$$(34)\quad \Pr(i) = \frac{e^{V_i}}{\sum_{j=1}^{n} e^{V_j}}$$

where the denominator of (34) is the summation of the exponential of the indirect utility that could have been obtained from the j alternative sites.

Description of the Study Areas and the Collection of Data

The fuelwood collection survey was designed as part of a consultation process with local people in the villages. The primary purpose of the meetings was to become familiar with the local economy including the major agricultural crops and major activities of men and women. It was discovered through discussions that women were primarily responsible for wood collection activities. Women will tend to walk alone or in small groups to collect wood from the mountains and hills in the area. Sometimes men will engage in fuelwood collection but men will tend to employ a cart and oxen to carry a large load of wood back to the homestead. Results of a series of village meetings in the Mutoko area are reported in Hatton MacDonald and Weber (1998).

A household survey was conducted over a three month period of July through September, 1996 in the Mutoko and Murewa Communal Areas in Zimbabwe. The English translation of the surveys can be found in Appendix II. A map of Zimbabwe can be found in Appendix III where the location of the Mutoko Communal Area is highlighted. The Murewa Communal Area is immediately southwest of Mutoko in the same province, Mashonaland East. The surveys are specific to each of the research areas in terms of the names of collection sites but the body of questions are the same for all three study areas. In the Mutoko Communal Area, the two study areas lie in adjacent valleys connected by roads and paths between mountains and hills. These mountains and hills are relatively well forested. The choice sets for households in the two study areas contain a few of the same mountains but usually only one side of the hill or mountain will be accessible to households in a particular study area. These two study areas will be referred to as Nyamakope and Katiyo.[24] In the Murewa Communal Area, a large village, Dandara, was selected for the study. The stock of woodlands have been severely depleted in the immediate vicinity of Murewa study site and as a result people have to travel further to collect wood.

[24] The study areas were chosen in order to obtain a large enough sample to have sufficient degrees of freedom to estimate a model of choice.

The study areas have comparable features in terms of all being Miombo woodlands that have been cleared for agricultural use. These villages were organised on a grid system and each homestead is allocated a field for growing maize and if available, garden space near a source of water. Cattle are grazed in collectively held fields, often near the base of the surrounding mountains and hills. The people in these areas generally tend to collect fuelwood in hills and mountains as the immediate area near the homestead is cleared of most trees and shrubs.

Four research assistants visited the randomly selected households and queried 200 households concerning site attributes, fuelwood collection trips and socio-economic information about the household on three separate occasions.[25] With each weekly visit, the household[26] was asked to recall over the previous seven days how many trips to collect wood had taken place, how long the trip took and the mode of transportation involved. To avoid respondent fatigue, questions about site attributes and socio-economic status were spread across the first and third visits. Out of the 200 households surveyed, 194 respondents were able to participate in all three visits.

Site Attribute Information

Three species of trees (*Brachystegia glaucescens, Julbernardia globiflora, Brachstegia boehmii*) (or in the local dialects muunze, munhondo, mupfuti) were identified as excellent fuelwood for domestic use. Households were asked to rate how plentiful these species were on each collection site. Since other species are also used as fuelwood, though not as preferred, respondents were asked to rate how plentiful other fuelwood species are at these sites. To summarise the information in the data, effects codes[27] were set up following Louviere (1988). Table 3 - 1 lists the effects codes for the species Muunze. The attribute "plentiful", coded -1, is the benchmark for comparison.

Table 3 - 1
Effects Codes for Muunze

How plentiful is muunze?	Muunze1	Muunze2	Muunze3
exhausted	1	0	0
sparse	0	1	0
moderate	0	0	1
plentiful	-1	-1	-1

[25] Each research assistant was given a list of 60 randomly selected households and asked to contact 50 of these households. There were no refusals to participate in the household interview.
[26] Often there would be a collaborative effort in responding to the questions with several individuals, even neighbours being present for the interview. The research assistants had been cautioned in training to ensure that the women responsible for wood collection were present and that male voices did not dominate the discussion.
[27] Effects codes translate category-rating scales to a coding system based on statistical design principles.

Information was also collected from respondents regarding the difficulty of walking to each of the collection sites. Effects codes were set up to reflect the perceived difficulty for each trip (Table 3 - 2).

Table 3 - 2

Effects Codes for Difficulty

Difficulty of the Trip (level)	Difficulty1	Difficulty2
easy	1	0
moderate	0	1
difficult	-1	-1

Through group discussions with women, a number of additional factors which would make the trip to collect fuelwood more pleasant were identified. These site attributes included whether there were wild fruits available along the way (variable referred to as fruit), whether useful plants or barks could be found along the way (bark), whether the trip passed by the garden (garden), whether the trip passed by a friend's home (friend), whether there were sources of water for drinking (water), whether wild animals could be found along the way (wild) and whether there were good places to rest (rest). A series of dummy variables were assembled to represent these attributes. Finally, households were asked to estimate how long, in minutes, it would take to reach each collection site.

The dataset was completed by collecting information on the distance from the household compound to the base of the mountain or hill using detailed topographical maps. Calorie expenditures were calculated using the perceived difficulty rating[28] and the estimated time spent walking to calculate an estimate of calorie expenditure for each household to each site.[29] The range of calories may appear slim but walking is probably the most efficient act in which the human engages.[30] More difficult terrain requires greater muscular force but there will be a tendency to conserve energy by adapting the gait according to Scott (1963).

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[28] For an easy, moderate and difficult trip, an estimate of 211, 238 and 264 calories per hour respectively, were used.

[29] Caloric expenditures for various effort levels were based on the Calorie Calculator, see http://primusweb.com/fitnesspartner, October 4, 1997. Calorie expenditures were cross-checked using tables on p.98 and p.356 of Katch and McArdle (1979). Models of caloric expenditure are generally based on a North American model and some minor adjustment (up or down) may be required to more accurately reflect metabolic differences, altitudes and climate. Overall the estimates of welfare effects (found later in this chapter) should not be affected to any large extent.

[30] In a personal communication, Dr. Robert Hudson, Associate Dean, University of Alberta pointed out that North American models of fitness are based on ideas of caloric expenditure but in the third world there will be a tendency to conserve energy (April 27th, 1998).

In the recreation literature, the decision of whether or not to visit a site is thought to be a function of the cost of travel and the various attributes of the trip. In the case of the fuelwood collection trip, the attributes of the sites and of the trip, as well as measures of the travel cost, whether in terms of calories, time or distance should be a factor in site choice. For rural households, time is a valuable input in the household production process and presumably time not spent collecting wood could be used for other economic activities or in leisure activities. Thus the further away the site or the more difficult the trip, the less likely it is the collector will choose that particular site. The variable muunze1 (muunze2, muunze3) indicates that the site is exhausted of (sparsely stocked with, moderately stocked with) this species of wood and the estimated coefficient would be expected to be negative (negative, possibly positive). With the site attributes such as fruit, bark, friend, water, wild[31] and rest, the presence of these attributes are likely to be positive influences on choosing the site.

The choice of particular site *i* can be modelled as follows:

Trip to site i = f{travels costs (as measured by distance, time or calories), availability of the species good for firewood (effects codes for muunze, mupfuti, munhondo and other fuelwood species) and other site attributes}

Estimation Results

Estimation results for the study areas together and the study areas considered separately are summarised in Table 3 - 3. There a number of ways that travel costs might be expressed. Time and perceived difficulty are based on the perceptions of the respondents. McLeod (1995) reported that hunters' perceptions of site attributes were often more important variables than the "objective" measures of the site attributes collected by researchers. In this case, both the independently gathered information on distance and perceived travel costs[32] were significant explanatory variables. Travel cost, measured in terms of distance or calories, was a very important variable for the study areas pooled together and two of the three study areas when sites are considered separately. Calories being insignificant in the choice of site in the Dandara site is certainly an unexpected result. Households in

[31] In discussions, some women stated that the children liked to see wild animals while other women stated wild animals were frightening.

[32] Perceptions of travel costs by local residents were probably more accurate than the researcher's measurement of distance. Local residents utilise all the foot-paths that were not always visible on maps. Gathering information on the distance from the homestead to the base of a mountain was more of a precautionary step in case there were problems with the surveys questions on time since few people seemed to wear a watch.

Dandara have to walk long distances or take a cart to get to the few sites[33] which are not severely depleted. Travel costs being insignificant suggests that the fuelwood situation is more complicated than might first appear.

The choice process in Dandara may be complicated in comparison to the well-wooded sites in the Mutoko Communal area. For instance, some households are beginning to switch to alternative fuels such as paraffin and solar power. Alternatively, the decision of where to collect wood may be predetermined if the household takes (or hires) a scotch-cart. Access to some sites may be more difficult for a cart than a person walking. As well, the calorie costs will be largely irrelevant for the household that hires a cart and driver. The role of carts in the Dandara site will be investigated in future research with this dataset.

One might expect that limited availability of good quality firewood such as muunze is a deterrent to households at a particular site in the Dandara study area. This expectation is supported by the empirical results where the effects code on limited availability of muunze was negative and highly significant. This suggests that afforestation efforts in the area would be very beneficial to households. To date many of the afforestation efforts have concentrated on introducing fruit trees such as mango or fast growing, non-indigenous species such as eucalyptus.

Other site attributes such as the trip going past the homes of friends would usually be thought to have a positive effect on choosing a particular site. The estimated coefficient on the variable friend was positive and significant for most of the models. Similarly, having a place to rest along the trip was also considered a benefit in the Nyamakope and Katiyo sites, though not in Dandara where the estimated coefficient on the variable rest was negative though insignificant. Factors such as the journey taking the individual by their garden or the presence of wild animals were not very important and for this reason, these variables were dropped from the logistic regression and only the final set of selected variables were reported.

A larger number of models was estimated in total. The models seemed to be quite robust in the sense that the estimated coefficients did not change significantly and certainly did not change signs when other variables were included or excluded. Final models were selected for presentation based on identifying the significant variables common across study areas. Not all insignificant variables were dropped from the models in that the differences across study areas could be highlighted.

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[33] Taking a cart does not mean there will not be significant calorie expenditures as it is often necessary for the collector to walk beside the cart or be jostled about on the cart and considerable energy will be expended hanging onto the cart, yolk or the oxen.

Table 3 - 3

Estimation Results

Variable	Coefficient	T statistic (Asymptotic)
Model 1: All Study Areas		
Time	-0.0017*	-2.588
Difficulty1	1.7599*	25.903
Difficulty2	0.2000*	2.545
Muunze1	-1.0638*	-6.669
Muunze2	0.13562	1.425
Muunze3	0.1597	1.581
Model 2 - All Study Areas		
Calories	-0.0015*	-10.733
Muunze1	-1.1634*	-7.917
Muunze2	0.0160	0.184
Muunze3	0.3406*	3.732
Friends	0.8950*	7.483
Rest	1.3408*	10.923
Model 3 - Nyamakope		
Calories	-0.0067*	-8.961
Muunze1	-0.5820	-0.832
Muunze2	-0.2105	-0.644
Muunze3	-0.13562	-0.455
Friends	0.9951*	4.865
Rest	1.3662*	5.708
Model 4 - Katiyo		
Calories	-0.0161*	-10.918
Muunze1	-0.9047*	-2.679
Muunze2	-0.2478	-1.221
Muunze3	0.5949*	3.553
Friends	0.3731	1.670
Rest	0.6664*	3.510
Model 5 - Dandara		
Calories	-0.00005	-0.393
Muunze1	-0.89906*	-4.429
Muunze2	0.23635	1.557
Muunze3	0.21869	1.238
Friends	0.58914*	2.583
Rest	-0.10387	-0.459

* Significant at α=5%

Welfare Measures

Welfare measures in economic theory place a value on a change in quantity, quality or price of the good. A number of welfare measures have been developed including consumer surplus based on the Marshallian demand curve, and equivalent variation and compensating variation which are based on the income compensated Hicksian demand curve. In general, the measures based on the Hicksian demand curve are the preferred measures as the measures are not path dependent, see Boadway and Bruce (1984).

Small and Rosen (1981) report that the compensating variation for a travel model can be calculated as follows:

$$(35)\quad Compensating\ \ Variation = \frac{1}{\mu}\left[\left(\ln\sum_{i=1}^{N} e^{V_{i0}}\right) - \left(\ln\sum_{i=1}^{N} e^{V_{i1}}\right)\right]$$

where μ is the marginal utility of income,

N is the number of sites,

V_{i0} is the indirect utility for site *i* before a price (or quality) change and

V_{i1} is the indirect utility for site *i* after the price (or quality) change.

To simplify the welfare calculations, it is generally assumed that the marginal utility of income is constant.

$$(36)\quad V_i = \beta(Y - TC_i) + \alpha Q$$

where V_i is the indirect utility associated with site *i*,

Y is the household's income,

TC_i is the travel cost incurred in terms to get to the site *i*, and

Q is a vector of quality attributes.

The marginal utility of income in equation (35) is:

$$(37)\quad \frac{\partial V_i}{\partial Y} = \beta = \mu$$

In the household production framework, the travel cost TC_i in equation (36) might be thought of as time multiplied by the rural wage or fraction of the rural wage. However, the market for labour in rural Zimbabwe is thin so the rural wage may be a poor indicator of the value of time. Alternatively, we may wish to think of the household having a total caloric budget that can be allocated towards the

activities of the household that result in goods that yield household utility. In this case, the indirect household utility function, which is a function of the caloric cost of activities (everything other than fuelwood collection being suppressed), will be:

$$V_i = f(C - c_i, Q)$$

where V_i is the indirect utility associated with site *i*,

C is the household caloric budget,

c_i is the calories required to get to the site *i*, and

Q is a vector of quality attributes

The marginal utility of calories will be the term B.

$$dV_i = B\,dC$$

Welfare measures in caloric terms can be calculated using the estimated parameters in Table 3 - 3. In each of the study areas, the welfare effects were simulated by closing one site at a time and removing it from the choice set. This is a realistic policy simulation since access to sites is becoming an issue in these areas due to granite mining (Katiyo study site), property right disputes (Dandara study site) and ecological concerns.

Removing collection sites may result in households having to travel further to collect wood. Tables 3 - 4, 3 - 5 and 3 - 6 present the average cost per trip in caloric terms for each community. However, there can be considerable variation within the community. For many households, closing a particular site will have negligible caloric costs but for other households, site closure may have large welfare implications. To illustrate the variation in welfare implications the largest losses as well as the average welfare effects are presented.

Table 3 - 4

Welfare Measures for Nyamakope Study Site, Mutoko Communal Area

(calories per trip)

Site	Average Welfare Loss	Largest Welfare Loss
Gonye Mountain	4.58	61.50
Mashayamvura Mountain	3.48	44.72
Ndigamarombe Mountain	17.34	47.03
Vhumbika Mountain	24.94	165.20
Nyatsanza Mountain	5.98	15.81
Chidziro Mountain	10.73	50.08
Karunzviru Mountain	3.34	25.35
Chidzanya Hill	2.28	4.75
Mukangiranyemba Mountain	7.2	29.29
Hova Hill	5.21	63.40
Umba Mountain	13.26	56.70
Suswe Mountain	13.29	55.25
Ruchera Area	2.2	57.34
Marirangwe Mountain	28.77	172.98
Mudenyika Hill	13.55	105.09
Hova Area	1.25	208.77

Table 3 - 5

Welfare Measure for Katiyo Study Site, Mutoko Study

(calories per trip)

Site	Average Welfare Loss	Largest Welfare Loss
Tawani Mountain	10.22	65.63
Chijakata Mountain	4.67	38.19
Chindinye Tsvimbo Hill	1.80	12.97
Garireremakoso Mountain	8.78	42.42
Mashayamvura Mountain	6.19	37.24
Mbudziyatume Mountain	2.69	18.71
Rukwiza Mountain	9.74	70.50
Chipangare Mountain	1.23	20.42
Marirangwe Mountain	21.62	107.34
Chidziro Mountain	4.69	37.76
Chitupwana Mountain	8.69	118.44
Gonye Mountain	2.56	36.46

Table 3 - 6

Welfare measures for Dandara Study site, Murewa Communal Area

(calories per trip)

Site	Average Welfare Loss	Largest Welfare Loss
Mapunga Mountain	42.2	129.1
Chikwirandaombera Mountain	111.2	226.3
Chamapere Mountain	143.8	225.7
Ndemera Mountain	71.5	128.5
Mucheunje Mountain	74.3	146.0
Muchinijike Mountain	74.1	147.0
Mutaragume Mountain	66.7	117.3
Gugwa Mountain	63.2	103.9
Mazimi Mountain	67.6	116.7
Njedza Mountain	67.3	116.1
Runyange Mountain	65.9	115.2
Kapuka Mountain	63.6	146.5
Masaka Area	71.5	121.0
Bhidi Area	36.6	113.2
Chirozva Area	35.8	113.2
Gova Area	37.9	113.9
Chebhero Area	44.1	109.3
Butuku	44.3	114.4

In general, the distances for each fuelwood collection trip were much greater in the Dandara study site and thus the average losses per trip observed in Table 3 - 6 are considerably larger compared with Tables 3 - 4 and 3 - 5. Further, the maximum values in all three tables indicate that the potential welfare loss can be quite large for individual households. While the results in Table 3-6 look quite reasonable given the relatively longer distances that people must travel in the Dandara site, it is important to not place undue emphasis on the welfare estimates for this site due to the low t statistic on the calories variables.

Even if we restrict our attention to Tables 3 - 4 and 3 - 5, the welfare losses associated with closing a site can vary significantly. On average the welfare losses are under 30 calories per trip but closing a mountain such as Vhumbika or the Hova Area in Nyamakope could result in increased level of effort of 165 to 200 calories a trip for some households. If the average daily consumption of a Zimbabwean woman is 2000 calories a day, closing a site may not have an immediate effect on her well-being. Given that women are often observed to be the last to eat from the pot, it is unlikely that their intake of calories will be increased to accommodate their increase in effort. While it is possible that metabolic changes or decreases in other activities may allow a woman to increase fuelwood

collection effort for a period of time, over the long term there may be significant health consequences.[34]

Summary and Conclusions

The results of this study suggest that standard economic models of choice can be adapted to model the decision making processes of the subsistence agricultural household. The empirical results suggest that calories (reflecting distance and difficulty of the journey), and attributes of the site such as the availability of good quality fuelwood, are important factors in the choice of sites in the Mutoko Communal Area. However, more work remains to explain satisfactorily the choice behaviour in the Dandara study site in the Murewa Communal area.

There are some significant differences between the Communal Areas. As noted previously, households tend to make fewer trips to collect firewood in the Dandara study site. This may be due to a number of different strategies being employed by these households such as conserving fuelwood, using alternative fuels, or using carts to collect wood. The latter strategies involve substituting other fuels for wood or using a labour saving capital good to collect fuelwood. If this is in fact the case, there may be some potential for using nested models of choice to explain the choice between walking and taking a cart and the choice of fuels.

The welfare simulations reinforce the importance of the spatial context of fuelwood shortages. Closing sites may have a relatively small effect on the community but a large effect on the well-being of particular households. For example, the household collecting wood two or three times a week at Chitupwana Mountain in the Katiyo study site, the closure of this site would cost one household 118 calories per trip. When households in this area are making two to three trips a week, caloric expenditures on a day to day basis are of fundamental importance.

The welfare effects have broad policy implications that warrant discussion. For governments considering site closure to protect forested areas, the increased caloric expenditures by women will be a significant but less visible cost for the local population. A government or non-governmental agency which is mindful of these welfare implications has a few options available to redress the situation. For instance, compensation might be provided through deliveries of staple commodities (or cash equivalents) to increase caloric consumption. However, agencies must be cognisant that careful

[34] See Dasgupta (1993) for an extensive listing of studies which document the allocation rules used by households concerning access to food and resources of the household. Sen (1981) summarises the

targeting may be required because the customary allocation of food within the household may not benefit those most affected by the site closure.

Another way the welfare effects could have been simulated would be to change the availability of specific species of fuelwood. By making muunze more plentiful at particular sites, it would be possible to calculate whether there would be significant reductions in the energy women expend in fuelwood collection. This would provide insights into the welfare effects of an afforestation program.

The estimation results and the welfare effects may also be of interest to governments from the industrialised world. With recent attention to global warming, governments and industries are interested in the potential for carbon sequestration in the developing world. This research suggests the nature of the costs that would be borne by the local population if stocks of carbon in the form of forested areas were set aside for protection.

One alternative that seems to resurface periodically with governments and agencies is the potential for fuel switching to non-wood sources of domestic fuel. The next chapter considers the wood/non-wood choices and the underlying economic relationships of the choice behaviour.

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Chapter 4 - The Choice of Energy Sources

Introduction

The economics of energy has traditionally been concerned with the stock of energy resources and the economic activities that depend on the flow of these resources according to Eden, *et al* 1981. There has been renewed interest in the area of energy economics as the result of issues raised through the current debates regarding global warming and carbon based energy sources. As part of international discussions on this topic, the Intergovernmental Panel on Climate Change (IPCC) reviewed and summarised the scientific literature concerning the state of atmospheric science and its ability to predict climate change. Their conclusions suggest that the balance of evidence is tilted towards global warming being linked to human activity, specifically carbon based sources of energy and chemicals. However, there is considerable debate about the degree of certainty that can be placed on the extent of climate change and how quickly these temperature changes might occur, see Hasselmann (1997) and Kerr (1997).

Cline (1992) has suggested that an aggressive stance on reducing carbon emissions on a world wide basis is required to avert the consequences of global warming.[35] The National Academy of Science (1991) suggests that the initial reductions in carbon emissions can be achieved at minimal cost through the introduction of energy saving products and the correction of pricing rules of utilities which do not reward customers for saving energy. The next tier of carbon reduction options might include increased afforestation[36] (or reduction in deforestation) and a global carbon permit trading system. These latter options would involve higher costs per unit tonne of carbon but in the case of the permit system, carbon reduction activities could be shifted to low (or lower) cost locations.

The debate concerning policy options has moved from academic circles to larger international policy forums. As part of a strategy to reduce greenhouse gases, industrialised countries have been seeking to establish a framework for achieving goals set out at the Rio Summit. In an attempt to gain more flexibility in reaching targets, several industrialised countries, including the United States, wanted to bring developing countries into agreements at the Kyoto Summit. While this effort was unsuccessful, developing countries may be brought into global agreements in the future through a global permit system for carbon. Assuming a generous initial allocation of permits, developing

[35] Losses in agriculture, property damage from rising sea levels and reductions in fresh water supplies are cited as some of the examples of the potential costs of global warming.

countries may be in the position "to cash in" on unused credits, energy savings or reductions in carbon based fuels. Further, if the system of permits was linked to carbon sequestration, the land base available for afforestation might be also be increased by including developing countries.

For this reason, the decision making behaviour of households concerning energy needs to be investigated. Much of the developing world, including the area of concern for this study, Zimbabwe, is dependent on wood as the primary source of fuel. If households were able to switch to more efficient fuels, *ceteris paribus*, economic gains for the country may be captured through selling or exchanging credits for capital goods or technology. To investigate the potential for fuel switching, a dataset from Zimbabwe concerning fuel choices and fuelwood collection may shed some insight into the factors important in fuel-switching. The overall energy savings that could be achieved through fuel switching is not well understood even though initiatives have been mounted by governments and non-governmental agencies to introduce more efficient stoves and solar cookers. To date, the success of these programs has been limited due to "top-down" approaches to program delivery and lack of understanding of the social, cultural and economic factors of fuel choice in the day to day activities of rural women, see Agarwal (1986) and Morgan and Moss (1984).

Fuel Choice in Zimbabwe

Rural agricultural households in Zimbabwe have a few options regarding potential sources of energy. Wood can be collected from a number of sites, usually mountains in the surrounding landscape. Alternatively the household may elect to use paraffin or solar energy. As the previous chapter of this thesis suggests, the effort involved in collecting wood from various sites is an important variable in the choice of where to collect wood. If households are labour constrained, the economic theory of household production suggests there may be some room for substituting fuels and reallocating the labour time and effort to tasks where the marginal product of labour is higher. This chapter is concerned with the factors important in these wood and non-wood fuel choices.

Wood is the primary source of domestic energy in the rural areas of many African countries and Zimbabwe is no exception. Fuelwood is used for cooking meals, heating homes (as the season requires), burning bricks, brewing beer and numerous other uses as the rural household engages in day to day activities. Fuelwood collection is an age old task of women and children. With the evolution of

[36] This strategy would result in reducing net carbon emissions until the forest reaches a steady state and the decay equals new growth. Alternatively, the forest could continue to be used to sequester carbon if mature fibre was used in the production of goods which release carbon very slowly.

the cash economy, men may engage in wood collection in order to generate income. In Zimbabwe, where the sale of fuelwood is generally prohibited from communal lands, men are still observed collecting wood.[37] Men were usually observed employing some form of capital good, such as a cart, wheelbarrow or bicycle, to transport the wood.

As fuelwood becomes more scarce, people are faced with choices on the energy ladder. Sources of energy are ordered on the basis of energy efficiency and the amount of labour required to use the source [Leach and Mearns (1988, p. 242)]. These choices include:

> Electricity - perhaps the most convenient source of energy for cooking. Due to cost considerations, many households in the high density suburbs will still use wood for slow-cooking stews even though an electric stove could be used. Availability will be a serious constraint in rural areas.
>
> χ
>
> Bottled Gas - must be purchased and access is often restricted because the containers are difficult to transport.
>
> χ
>
> Kerosene/Paraffin - must be purchased and requires special stoves. Kerosene and paraffin is more efficient than charcoal.
>
> χ
>
> Charcoal - produced in village based industries. Charcoal is a more efficient fuel than wood and is less variable in terms of heat production.[38]
>
> χ
>
> Fuelwood - dry fuelwood can be collected from cleared agricultural land, communal areas, etc. Markets in some areas may be thin or non-existent in some areas.
>
> χ
>
> Crop Residues, Animal Residues - less efficient fuel that requires more care and attention while cooking. In the Southern African Development Community (SADCC) region, crop residues are occasionally used as kindling or to supplement fuelwood, or sometimes for fast cooking according to Munslow (1988 p.13) These residues have important alternative uses. Crop residues can be used as animal fodder and animal droppings are a source of manure for garden plots.

Households may go up or down the ladder depending on prices, labour availability and cash constraints. For instance, a household with extremely limited cash reserves may be forced to use less

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[37] Campbell and Mangono (1994) report that purchasing fuelwood is common in urban areas. The source of this wood is commercial farming areas and resettlement areas where the property rights allow for the sale of fuelwood.

[38] Charcoal is not widely used or manufactured in Zimbabwe. It is more common in sub-Saharan Africa and Sahel countries.

wood and more agricultural residues when fuelwood becomes very scarce. In the previous chapter, the choices and substitutions that households make were formally modelled in the context of a household production model where the household allocates labour and resources to agriculture, collecting fuelwood and the provision of other goods and services. In this chapter, the analysis is expanded to consider the problem of wood and non-wood choices. The idea of an energy ladder fits in the general framework and, as Campbell and Mangano (1994) have shown, households often skip many rungs on the ladder in urban areas of Zimbabwe.

In rural areas, access to many of these options such as electricity and bottled gas may be very limited. The ladder may consist of only three or four rungs. At the bottom, agricultural residues such as dung, cotton stalks and maize cobs may be used exclusively or in combination with fuelwood, the next rung. Paraffin and solar power would complete the rural energy ladder. Both sources of energy involve an initial fixed cost with the investment in the paraffin stoves and solar panels. Use of paraffin involves an on-going operating cost with the purchase of fuels. Solar panels may involve maintenance and repair costs over the life of the panels.

The idea of an energy ladder is compatible with the household production framework. Restating the first order conditions from the previous chapter, the household, in choosing rungs of the ladder, maximises utility if it sets the ratio of marginal utilities for each pair of consumption goods equal to the ratio of the market price of the goods; it stays within its budget constraint and operates on its production frontier; it produces the optimal combination of goods; and it allocates variable factors, labour, purchased fuels and fuelwood, efficiently amongst potential uses. However, the market for fuelwood is largely non-existent in rural areas due to prohibitions on the sale of wood collected in the communal areas. As a result, the demand for fuels is not easily modelled as a system of demand equations. Instead the problem of choice of energy source can be approached as a nested discrete choice model where a number of interrelated choices are modelled.

A Model of Fuel Choice

As part of the fuelwood collection study described in the previous chapter, households were asked about the various energy sources they use on a day to day basis. In the two study areas in the Mutoko Communal Area, households were entirely dependent on fuelwood. Only in the Dandara study site in Murewa did households indicate that they regularly used non-wood sources although fuelwood is the primary source of domestic energy for most households for 90% of the sample (n=99). The various sources of energy used in the Dandara site are listed in Table 4 - 1. Households may use

one or more sources of energy in their day to day activities. Following the harvest of the maize crop, there is an abundance of maize cobs which can be used to supplement the household's wood supply. Though not a favoured source of fuel, maize cobs are readily available near the homestead. Women reported in discussions that the cobs burn too quickly and produce a lot of smoke and ash. Dung is used but it is not used as widely as it is in other areas of Africa or Asia. This fuel is most often used by households where the woman responsible for collecting fuels and cooking meals is very old and less agile.

The use of paraffin and solar panels is not very common, but where it is, it is used almost exclusively by the household. In the case of paraffin, there is an initial investment in the stove and the purchase of the fuel. Solar panels involve a higher initial capital cost with only minor operating costs. The "other" category included agricultural residues such as cotton stalks and old mango trees from an unproductive orchard.

For the purposes of modelling household choices, it is necessary to categorise choices in binary terms. It was decided that households that use wood, maize cobs and dung would be categorised as using wood (wood = 1) and if the household uses paraffin or solar panels, then the household was considered non-wood. Thus, the 39 households that use cobs and the 17 that use dung are included in the 91 fuelwood households.

Table 4 - 2

Sources of Domestic Energy Used in the Dandara Study Site

Source of Energy	Number (n = 99)
Fuelwood	91
Maize Cobs	39
Dung	17
Paraffin	7
Solar Panels	1
Other	7

In the previous chapter, the choice of sites from which wood might be collected was explained in part by the calories required to visit each site, by the perceived abundance of good quality firewood (species known as muunze in the local dialect), the trip taking the collector past the homes of

friends and there being good places to rest along the way to the site. This model explained the variation in the site choices of the households from Nyamakope and Katiyo study areas in the Mutoko Communal Area reasonably well. In Dandara, other choices might be available to households. One of the key differences between the Dandara study area, with regard to fuel choices, and the Mutoko areas is the number of options which are perceived to be available to households.

The choice between wood and non-wood sources was thought to be dependent on socio-economic variables such as age, cash income levels (income for the household and on a per person basis), total income variables (cash income plus the estimated value of gifts in kind remittances) and wealth estimates (measured for the household and on a per person), as well as the number of male and female adult persons in the household. Clearly some of these variables are likely to be collinear, so some experimentation was necessary to find the set of variables which explained the wood/non-wood choice the best. Fuelwood collection site choice was modelled as being some function of the effort involved in travelling to the site (whether summarised as an effects code for difficulty of the trip, calories or time) and attributes of the site. This implies a nested structure of the form of Figure 2.

Figure 2

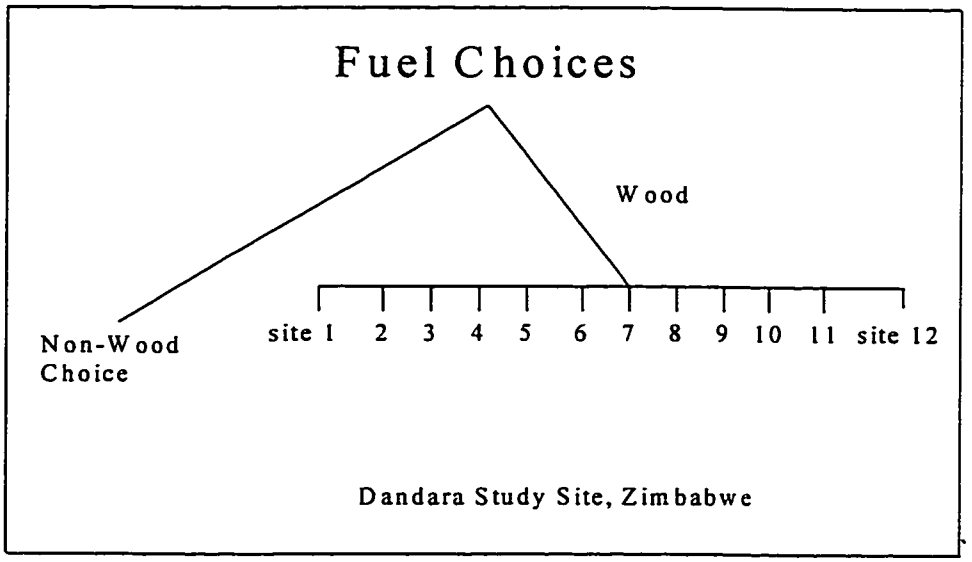

Figure 2 should not be interpreted as the individual making a sequential choice concerning fuels and then if wood is chosen, a site is chosen. Instead, the nested structure is used to account for the potential that there is a high degree of correlation amongst the random error terms. Introducing the non-wood choice into the choice set of sites might alter the probability of choosing a particular site and this would be a violation of the Independence of Irrelevant Alternatives (IIA) assumption

[McFadden (1981), Maddala (1983) or Morey (1994)]. To avoid this problem, a nested structure was developed where the probability of an individual choosing alternative *i* is:

$$(38)\quad P_{iw} = P(i|w)\,P(w)$$

where P(*i* | w) is the probability that an individual chooses alternative *i* conditioned on choosing the mode, w, for wood and non-wood fuel choices. If the error terms are distributed identically and independently as a generalised extreme value distribution, then the probability of *iw* where some of the alternatives will be collection sites will be:

$$(39)\quad P_{iw} = \frac{e^{V_{iw}/\alpha_w}\left[\sum_{j=1}^{n} e^{V_{jw}/\alpha_w}\right]^{(\alpha_w - 1)}}{\sum_{k=1}^{T}\left[\sum_{j=1}^{n} e^{V_{jk}/\alpha_k}\right]^{\alpha_k}}$$

where V_{iw} is the conditional indirect utility associated with collecting wood from site *i* in mode w,

α_w is a parameter that measures the degree of substitution (or the inclusive value) between the various modes,

n is the number of sites in mode w,

T is the number of modes.

If $\alpha_w = 1$ for all w modes, equation (39) collapses to equation (34 of the previous chapter) which is a flat multinomial logit model.

The choice problem can be modelled as:

choice of site i through 12 or non-wood[39] *= f {travels costs (as measured by distance, time or calories), availability of the species good for fuelwood (effects codes for muunze, mupfuti, munhondo and other types of fuelwood), other site attributes and demographic variables}*

The individual will choose site *i* if the utility is greater than the utility from the other sites or the non-wood option. Travel costs, the availability of fuelwood and other site attributes are alternative specific or specific to each collection site. For the non-wood option, the travel costs will be zero. Paraffin and solar energy do not involve one or more trips each week requiring significant effort. Usually households will purchase a supply of paraffin with other groceries and supplies when visiting the

[39] Due to the lack of variation in data, it was necessary to reduce the number of alternatives in order to estimated a nested model of choice.

nearest commercial centre. Clearly the availability of fuelwood and other site attributes will be zero for the non-wood option. The choice between wood and non-wood will be influenced by the demographic or socio-economic characteristics of the individuals.

The model presented in Figure 2 can be estimated by a Maximum Likelihood Method where the log likelihood function is defined as:

$$(40)\quad \lambda = \prod_{j=1}^{H} P_{hiw}$$

where h is a household in the total number of H households,

i subscript denotes the alternative

w is the mode.

Assuming an additive form of the indirect utility function, the matrix X is the site attributes and socio-economic characteristics of the households. The vector B is estimated using maximum likelihood techniques such that the log likelihood function is maximised.

$$(42)\quad P_{iw} = \frac{e^{B'X_{iw}/\alpha_w}\left[\sum_{j=1}^{n} e^{B'X_{jw}/\alpha_w}\right]^{(\alpha_w - 1)}}{\sum_{k=1}^{T}\left[\sum_{j=1}^{n} e^{B'X_{jk}/\alpha_k}\right]^{\alpha_k}}$$

In this nested model presented in Figure 2, there is only the one choice under the non-wood mode and twelve site choices under the wood mode. The size of the choice set was determined by examining how many households had gone to particular sites. An ad hoc rule of five visits or more was used to select the choice set. This effectively reduced the number of sites from nineteen to thirteen.

Estimation Results

Nested models are sometimes difficult to estimate. The criteria for grouping choices is the researcher's belief that the random error terms for a group of choices may be correlated. Often the site attributes associated with the group of sites may display a fair degree of collinearity as well. For this reason, relatively simple models with a few variables were estimated since adding parameters often leads to problems of collinearity.

The results of the eleven models, estimated using a Full Information Maximum Likelihood method, are presented in Table 4 - 2. Different measures of travel costs, site attribute information and socio-economic variables were used in these models. Thinking about each of these categories of variables, there are a series of hypotheses that one can formulate concerning these variables. Travel costs, whether measured in terms of time required to walk to the site,[40] calories expended to get to the site, or perceived difficulty rating,[41] should be an important factor in selecting a site. As the costs of choosing a particular site increase, the household would be less likely to choose a particular alternative and one might expect a negative sign on the estimated coefficients. Results from the last chapter suggest that attributes such as the availability of good quality fuelwood and amenities of the journey would be positive influences on the choice of particular sites. Demographic variables were thought to have an effect on the wood versus non-wood choice. For instance, variables such as income (cash income, the value of gifts in kind from family, etc.), age, wealth, household size, or number of women or men in the household may have an effect. Household income and wealth, especially measured on a per person basis, is likely to have a positive effect on switching to non-wood fuels, whereas an increased number of women in the household is likely to have a negative effect. Households with more women are less likely to be labour constrained. The effect of age is likely to be negative with older respondents being less likely to adopt new technologies such as solar power. Households with more adult males living at the homestead have found economic activities in the rural areas otherwise there is a tendency for males to migrate to the cities.

Due to the difficulties of estimating nested models, the models in Table 4 - 2 do not contain the effects code variable Muunze 3[42] or trip amenity dummy variables such as friends or resting places. It is likely that some collinearity exists between some of the variables. The tolerance for collinearity in the computation of the covariance matrix seems to be less for nested models compared with flat multinomial logit models of the previous chapter.

In estimating a nested logit model of the form presented in Figure 2, it is necessary to restrict one of the inclusive values, in this case $\tau_{\text{non-wood}}$, to one and estimate τ_{wood} as part of the model. If the τ_{wood} is not significantly different from one, then the model collapses to the flat logit model of the previous paper. The estimated coefficient on τ_{wood} significantly different from one in models 4, 5 and 11. This suggests there is some merit in exploring choice behaviour in this framework.

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[40] Time and calories were scaled in order for the variables to have a mean approximately centred on one.

[41] Effects codes were set up for the perceived difficulty of the trip to a site. Difficulty 1 is an easy trip; Difficulty 2 is a moderate trip; Difficulty 3 is a difficult trip. Difficulty 3 has been dropped from the regression and is the comparison point.

Table 4 - 2
Estimation Results

Variable Name	Parameter Estimate	t statistics
Model 1		
Time	-2.200*	-2.035
Total Income	0.194	0.574
τ_{wood}	1.3321	
Model 2		
Time	-2.201*	-2.039
Age	0.004	0.144
τ_{wood}	1.545	
Model 3		
Calories	-1.279*	-2.017
Total Income	0.216	0.646
τ_{wood}	1.306	
Model 4		
Calories	-1.227*	-2.012
Interaction term for Total Income and presence of the Husband	0.606	0.849
τ_{wood}	1.375 **	
Model 5		
Calories	-1.274*	-2.011
Wealth	0.014	0.0019
τ_{wood}	1.470 **	
Model 6		
Difficulty 1 (easy trip)	-0.162	-0.320
Difficulty 2 (moderate trip)	1.227*	2.959
Total Income	0.229	0.687
τ_{wood}	1.274	

[42] Muunze1 and Muunze2 were recoded and the basis for comparison is Muunze3 (coded -1) representing the level of moderate to plentiful muunze.

Model 7		
difficulty 1 (easy trip)	-0.161	-0.320
difficulty 2 (moderate trip)	1.226*	2.957
Interaction term for Cash Income and number of adult women	0.180	0.665
τ_{wood}	1.293	
Model 8		
Time	-1.395	-1.037
Muunze 1 (exhausted)	-1.162	-1.560
Muunze 2 (sparse)	0.600	0.981
per person household income	0.284	0.951
τ_{wood}	1.060	
Model 9		
calories	-0.954	-1.118
Muunze 1 (exhausted)	-1.086	-1.420
Muunze 2 (sparse)	0.691	1.069
per person household income	0.301	0.969
τ_{wood}	1.033	
Model 10		
difficulty 1 (easy trip)	-0.755	-0.921
difficulty 2 (moderate trip)	1.526*	2.729
Muunze 1 (exhausted)	-1.458*	-2.154
Muunze 2 (sparse)	0.084	0.154
per person household income	0.342	1.101
τ_{wood}	0.965	
Model 11		
difficulty 1 (easy trip)	-0.664	-0.705
difficulty 2 (moderate trip)	1.431*	2.170
Muunze 1 (exhausted)	-1.463*	-2.105
Muunze 2 (sparse)	0.018	-0.028
Number of Adult Males in Household	0.314	1.019
τ_{wood}	1.613 **	

* Indicates that the estimated coefficient is significantly different from zero at $\alpha = 5\%$
** Indicates that the estimated coefficient on τ_{wood} is significantly different from one at $\alpha = 5\%$

The estimated coefficients on the variables of calories and time are significant in the simple models of 1 through 5. However as more variables are added, such as in model 8 and 9, the estimated coefficients on time and calories become insignificant suggesting there may be collinearity amongst the alternative specific varaibles. With the trip difficulty, only the estimated coefficient on the variable Difficulty 2 proved to be significant in these regressions. The estimated coefficient on Difficulty 1 is consistently negative and while the coefficient is not significant, the sign is still of interest. The sign might be explained by considering that most of the sites that are easy to travel to by the people in Dandara are also depleted of wood. While it is largely speculative, the switching of signs between Difficulty 1 and Difficulty 2 (moving from an easy trip to a moderate trip) may indicate a threshold level has been reached where more accessible sites are exhausted and less accessible sites have fuelwood available. To explore the potential threshold effect, interaction terms between availability were used one at a time in a series of nested choice models similar to the models in Table 4-2. It was found that the interaction term between a moderate trip combined with more muunze was positive and significant. The other interaction terms were insignificant. A more general indicator of fuelwood availability than the specific species chosen may yield more insights.

Finally even though the socio-economic variables, including interaction terms, were not able to explain the wood/non-wood choice at any high level of significance, the basic modelling framework of energy choice seems to have merit. The problem of insignificant coefficients on wood/non-wood choice may simply be the result of the relatively low number of non-wood users in this dataset. In a related vein, there may not be not enough variation in the data to model fuel choices.

Conclusions

Considerable work remains to understand the full economic dimensions of fuel switching in this study area. It was interesting to note that per person household income and the number of males in the household were positive though not highly significant factors in fuel-switching. More research is required before strong conclusions can be made about strategies for encouraging households to switch to more efficient fuels such as paraffin or solar power.

For agencies concerned with reducing carbon emissions in the third world, there remains considerable scope for research. At the present time, it is not well understood why some households adopt new fuels but this methodology appears to hold some merit. It may be that the initial hypothesis of household income and number of males in the household as it is tied to rural development are critical factors in the choice of fuels

This study has raised some interesting and important questions. If it is determined that variables such as income are the critical factor in the adoption of fuels such as solar energy, the strategy may be to promote rural development through the present system of governmental and non-governmental organisations (NGOs). The current thrust of the NGOs has been to encourage the development and investment in the rural micro-enterprises (labour intensive, capital-saving small business or co-operative ventures). Otherwise direct provision of solar panels may be required to achieve lower carbon emission results. Presumably promoting rural development in general may promote a higher level of social welfare than the direct provision of a commodity and perhaps even less costly. However, the empirical results are simply too tentative at this time to base any policy initiative.

Finally, programs to introduce alternative fuels must take into account the implications for the work loads that women currently shoulder. Fuel collection is just one activity in the household production process. The effort involved in travelling to a particular site, whether measured in terms of time, calories or difficulty, is a factor in site choice for the household. If the alternative fuel used for domestic purposes requires considerable effort to use or maintain, then the fuel will be measured against the effort expenditures of wood collection.

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Chapter 5 - Summary and Conclusions

These studies were undertaken in an attempt to test the limits of applicability of direct and indirect non-market valuation techniques such as contingent valuation and travel cost models on a cross-cultural basis with Aboriginal peoples in Canada and with the Shona in a rural area of north-eastern Zimbabwe. A limited number of contingent valuation studies have been undertaken in the context of a developing country[43] with even fewer studies that target the views of Aboriginal peoples in North America. A very limited number of studies have employed indirect methods for use in a developing country in the published literature. These three papers represent an attempt to remedy these gaps in the literature.

Applied work in a cross-cultural setting requires more time and perhaps a greater sensitivity to potential sources of bias that can emerge due to cultural differences. Economists tend to have less experience than other disciplines in the social sciences in this regard. To this end, the research presented has benefited greatly from the expertise of other disciplines through interdisciplinary committees that have suggested directions for research such as Adamowicz *et al* (1998) which influenced many of the questions considered in the second chapter. As well, the adoption of participatory research techniques added in the development of research questions and a household survey that was acceptable to the researcher and to the people in the community in the third and fourth chapter.

The investigation of these research questions has probably lead to the identification of more unanswered questions than firm conclusions. For instance, it would appear that for goods which are not enveloped in cultural taboos, it is possible to design a believable scenario that simulates a market for an environmental improvement. However, selecting a good which is more central to the belief systems of a First Nations people and testing whether trades can be completed remains to be attempted. Further, the role of property rights in the contingent valuation method remains as a problem to be dealt with in future studies. A number of Aboriginal respondents were unwilling to make a trade-off in terms of community resources or personal resource because they felt that governments have a responsibility for restoring the fishery.[44]

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[43] See citations in Adamowicz *et al* (1998) and Graham *et al* (1997) concerning the use of contingent valuation studies in developing countries.

[44] Hatton MacDoanld et al (1995) identified through debriefing questions the perception that governments being responsible for restoring the fishery as a potential reason for the lower mean willingness to pay of Aboriginal respondents.

Both the Aboriginal and Non-Aboriginal population demonstrated a strong preference for group decision making. Currently, this type of decision making structure is not used in contingent valuation studies. Further, testing of this decision making structure is warranted to ensure that the manner in which decisions are made does not lead to over-estimating (or possibly under-estimating) the willingness to pay. Finally, satiation appeared to be an issue for both the Aboriginal and Non-Aboriginal respondents but a disproportionate number of non-Aboriginal households indicated that they were at a satiation point in terms of use value of the resource.

Indirect methods which employ behavioural data can be used to probe the problem of fuelwood collection. Each household faces different costs and experiences different benefits in choosing particular sites. In rural areas where labour markets are thin, the value of an individual's time is difficult to measure in monetary terms. Caloric expenditure is one way to view the opportunity cost of collecting fuelwood. The welfare measures, expressed in terms of calories, provides an estimate of the resource outlays by the household that might occur with the closure of particular collection sites. These techniques and empirical results will be useful for policy makers considering a problem such as setting aside protected areas and weighing up the interest of different resource users such as local people versus mining interests.

A choice approach has some potential in the investigation of fuel-switching. Economic factors such as income measured on a per person basis and the number of males present in the household were positive but only marginally significant factors in the choice of fuels. With the prospect of global warming and industrialised countries seeking low cost means of reducing carbon emissions, there will be a great need to explore the economic relationship underlying fuel choices.

References

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Graham, L., W. Phillips and K. Muir-Leresche (1997). "Empirical Approaches to the Valuation of Small Wildlife in Communal Areas in Zimbabwe". Department of Rural Economy, University of Alberta Staff Paper 97-04

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Appendix I

Questionnaire

TEXT IN CAPITAL LETTERS ARE REMINDERS FOR YOU, THE SURVEYOR - DON'T READ THIS OUT TO THE SURVEY RESPONDENT - YOU'LL SOUND SILLY!

Hi, I'm _____ . I'm surveying about attitudes and opinions of the people in the La Ronge area about fishing. Here is a letter from the research committee explaining what this research is about. HAND RESPONDENT LETTER ON UNIVERSITY LETTERHEAD.

The survey will help researchers understand how people make decisions and place values on natural resources. I will ask you a number of questions about how important preserving and possibly increasing fish stocks are to you. I will then ask a number of follow-up questions. There are no right or wrong answers in this survey.

Your answers to these questions will be treated confidentially. Please take your time answering these questions because your answers matter.

Lois Jordan from the Lac La Ronge Indian Band or Darla MacDonald from the University of Alberta will be calling a few people tomorrow to check that this interview was completed in a courteous manner. I would appreciate if you would give me your first name and phone number. I will tear off this sheet from the rest of the survey so your first name will not be associated with your answers. PLACE FRONT SHEET AND SIGNED LETTER IN SEPARATE ENVELOPE.

First Name: _____ Phone: _____
or house number if no phone

GO TO QUESTION 2 IF PERSON IS WILLING TO ANSWER SURVEY

ONLY IF THE RESPONDENT REFUSES TO ANSWER THE SURVEY AND DOESN'T VOLUNTEER A REASON, ASK THE FOLLOWING:

Q. 1 If you don't mind, I would like to know why you do not want to answer this survey.

RECORD REASON_____

_____

Q. 2 Some studies of the Lac La Ronge fishery say that the number of lake trout might be low compared to the past. Sport fishermen have also said that the number of lake trout seem to have decreased. The stocks of lake trout can be left alone or attempts can be made to increase the number of lake trout. **How** do you think this decision should be made?

CHECK OFF ONLY ONE

a. ___ by referendum - everyone votes for an option and the option with the most votes wins
b. ___ a group decides for the community. The group might include biologists and resource users such as outfitters, commercial fishermen, Band members and other interested individuals from the area
c. ___ you don't know
d. ___ RESPONDENT REFUSES TO ANSWER QUESTION
e. ___ other? _____

_____

IF "a", "c" or "e" GO TO Q. 4
IF "b" GO TO Q. 18, page 8
IF "d" GO TO Q. 3

Q. 3 Did you refuse to answer this question because you think:

TICK OFF ONE OR MORE ANSWERS

a. ___ the provincial government makes the rules for fishing and it doesn't matter what people in the community think
b. ___ this issue is too controversial
c. ___ you don't know
d. ___ RESPONDENT REFUSES TO ANSWER QUESTION
e. ___ other? _____

_____

GO TO Q. 4

Q. 4 Here are different options for increasing the number of lake trout in the main lake. These options will cost the community approximately the same amount. I will read these three options out loud and then ask you to pick the one you would support.

Option A - Restocking Program

Trout eggs or young trout could be put in good spawning spots in the main lake of Lac La Ronge. Extensive restocking over five years could increase the stocks of lake trout.

Option B - Restricting Sport Fishing

To allow the stocks of lake trout to recover, the daily sport fishing limit for lake trout could be significantly decreased to one lake trout under 26 inches and a possession limit of two lake trout. The daily limit and possession limit for all other species would stay the same.

Option C - Restricting the Commercial Fishery

To allow the stocks to recover, the overall quota for lake trout could be decreased substantially. The quota for other species, such as whitefish, walleye, northern pike, and burbot, would stay at relatively the same level as 1994 species quota.

With each of these options, the number of trout in the lake will be watched carefully to see if the program is working. Over time, these options have the potential to restore the stocks of lake trout to levels observed in the past.

Which of these options do you prefer? CHECK OFF ONLY ONE

a. ___ Option A - Restocking
b. ___ Option B - Restricting the sport fishery
c. ___ Option C - Restricting the commercial fishery
d. ___ Leave things as they are
e. ___ you don't know
f. ___ RESPONDENT REFUSES TO ANSWER QUESTION
g. ___ other? _____

_____

NOTE TO INTERVIEWERS: RESPONDENTS MAY WANT A COMBINATION OF OPTIONS - PLEASE RECORD UNDER "g. other?". IF THE COMBINATION INVOLVES RESTOCKING GO TO Q. 6. IF THE COMBINATION DOES NOT INVOLVE RESTOCKING, THEN GO TO Q. 10 IF RESTRICTING SPORT FISHING IS MENTIONED FIRST OR GO TO Q. 14 IF RESTRICTING COMMERCIAL FISHING IS MENTIONED FIRST. IF RESPONDENT WANTS SOMETHING ALL TOGETHER DIFFERENT, RECORD AND GO ONTO Q. 6.

IF "f" GO TO Q. 5
IF "a" or "e" GO TO Q. 6
IF "b" GO TO Q. 10, p. 5
IF "c" GO TO Q. 14, p. 6
IF "d" GO TO Q. 32, P.13

Q. 5 Did you refuse to answer this question because you think:
TICK OFF ONE OR MORE ANSWERS

a. ___ none of these options will solve the problem
b. ___ the fishery is too important to the local economy to restrict
c. ___ the stocks are too low to recover
d. ___ you don't believe trout stocks are low
e. ___ you don't know
f. ___ RESPONDENT REFUSES TO ANSWER QUESTION
g. ___ other? _____

_____

GO ON TO Q. 6

Q. 6 A volunteer conservation group could handle the restocking if there is enough local support. At least 50% of the households in the La Ronge area would have to be willing to pay $_____ per household for the restocking program to go ahead. If necessary, the volunteer conservation group will raise any additional funds required. Would you be willing to make a one-time contribution of $_____ to be used for restocking Lac La Ronge with lake trout? Remember, if you say yes, you are saying that you are willing to contribute $ _____ on behalf of your household and you recognize that your household would have less money to spend on groceries and other bills. CHECK OFF ONLY ONE

a. ___ yes
b. ___ no
c. ___ you don't know
d. ___ RESPONDENT REFUSES TO ANSWER QUESTION

IF "a" GO TO Q. 7
IF "b" GO TO Q. 8
IF "d" GO TO Q. 9
IF "c" GO TO Q. 32, p.13

Q. 7 Were you willing to contribute $_____ because: TICK OFF ONE OR MORE ANSWERS

a. ___ you often give to good causes
b. ___ you believe fish stocks are important
c. ___ saying yes means fish stocks are important without actually having to pay this amount
d. ___ increasing fish stocks might benefit your family
e. ___ you would like to do your fair share
f. ___ you don't know
g. ___ RESPONDENT REFUSES TO ANSWER QUESTION
h. ___ other? _____

_____

GO TO Q. 32, p.13

Q. 8 Did you say you were not willing to contribute $_____ because:
TICK OFF ONE OR MORE ANSWERS

a. ___ this amount is too much but you would be willing to volunteer your time or give a smaller amount
b. ___ you already pay enough in taxes or give enough to charity
c. ___ the government should pay the full cost of restocking the lake
d. ___ the sport fishermen or the commercial fishermen should pay restocking costs

e. ___ the quality or the taste of the fish has been decreasing over time
f. ___ you don't know
g. ___ RESPONDENT REFUSES TO ANSWER QUESTION
h. ___ other? _____

_____

GO TO Q. 32, p.13

Q. 9 Did you refuse to answer this question because:
TICK OFF ONE OR MORE ANSWERS

a. ___ it's wrong for conservation to be dependent on raising money locally
b. ___ you don't feel comfortable talking about this - there must be some sort of catch
c. ___ you already pay enough in taxes or give enough to charity
d. ___ you don't know
e. ___ RESPONDENT REFUSES TO ANSWER QUESTION
f. ___ other? _____

_____

GO TO Q. 32, p.13

Q. 10 Lower sport fishing limits are likely to be more effective in restoring fish stocks over time, if there is more emphasis on educating fishermen about the new limits and more enforcement of the limits. A volunteer conservation group is willing to organize making up leaflets on the new limits and buying equipment for conservation officers to use in catching poachers. For this project to go ahead, at least 50% of the residents of the La Ronge area would need to be willing to make a one-time contribution of $_____ per household. If necessary, the volunteer conservation group will raise any additional funds required. Would you be willing to make a one-time contribution of $_____ to be used for education and enforcement? Remember, if you say yes, you are saying that you are willing to contribute $_____ on behalf of your household and you recognize that your household would have less money to spend on groceries and other bills.

CHECK OFF ONLY ONE

a. ___ yes
b. ___ no
c. ___ you don't know
d. ___ RESPONDENT REFUSES TO ANSWER QUESTION

IF "a" GO TO Q. 11
IF "b" GO TO Q. 12
IF "d" GO TO Q. 13
IF "c" GO TO Q. 32, p.13

Q. 11 Were you willing to contribute $_____ because:
TICK OFF ONE OR MORE ANSWERS

a. ___ you often give to good causes
b. ___ you believe fish stocks are important
c. ___ saying yes means fish stocks are important without actually having to pay this amount
d. ___ increasing fish stocks might benefit your family
e. ___ you would like to do your fair share
f. ___ you don't know
g. ___ RESPONDENT REFUSES TO ANSWER QUESTION
h. ___ other? _____

GO TO Q. 32, p.13

Q. 12 Did you say you were not willing to contribute $_____ because:
TICK OFF ONE OR MORE ANSWERS

a. ___ this amount is too much but you would be willing to volunteer your time or give a smaller amount
b. ___ you already pay enough in taxes or give enough to charity
c. ___ the government should pay for this
d. ___ sport fishermen or commercial fishermen should pay the cost
e. ___ the quality or the taste of the fish has been decreasing over time
f. ___ you don't know
g. ___ RESPONDENT REFUSES TO ANSWER QUESTION
h. ___ other? _____

_____

GO TO Q. 32, p.13

Q. 13 Did you refuse to answer this question because:
TICK OFF ONE OR MORE ANSWERS

a. ___ it's wrong for conservation to depend on raising money locally
b. ___ you don't feel comfortable talking about this issue - there must be some sort of catch
c. ___ you already pay enough in taxes or give enough to charity
d. ___ you don't know
e. ___ RESPONDENT REFUSES TO ANSWER QUESTION
f. ___ other? _____

_____

GO TO Q. 32, p.13

Q. 14 To reduce permanently the number of lake trout caught by commercial fishermen, a volunteer conservation group is willing to organize the purchase of the quota for lake trout from the fishing co-operative. At least 50% of the residents in the La Ronge area would need to be willing to make a one-time contribution of $_____ per household for the project to go ahead. If necessary, the volunteer conservation group will raise any additional funds required. Would you make a one-time contribution of $_____ to be used for permanently reducing the commercial fishing quota for lake trout. Remember, if you say yes, you are saying that you are willing to contribute $ _____ on behalf of your household and you recognize that your household would have less money to spend on groceries and other bills. CHECK OFF ONLY ONE

a. ___ yes
b. ___ no
c. ___ you don't know
d. ___ RESPONDENT REFUSES TO ANSWER QUESTION

IF "a" GO TO Q. 15
IF "b" GO TO Q. 16
IF "d" GO TO Q. 17
IF "c" GO TO Q. 32, p.13

Q. 15 Were you willing to contribute $_____ because:
TICK OFF ONE OR MORE ANSWERS

a. ___ you often give to good causes
b. ___ you believe fish stocks are important
c. ___ saying yes means fish stocks are important without actually having to pay this amount
d. ___ increasing fish stocks might benefit your family
e. ___ you would like to do your fair share
f. ___ you don't know
g. ___ RESPONDENT REFUSES TO ANSWER QUESTION
h. ___ other? _____

GO TO Q. 32, p.13

Q. 16 Did you say you were not willing to contribute $_____ because:
TICK OFF ONE OR MORE ANSWERS

a. ___ the government should just reduce the quota
b. ___ this amount is too much but you would be willing to volunteer your time or give a smaller amount
c. ___ you already pay enough in taxes or give enough to charity
d. ___ sport fishermen or commercial fishermen should pay cost
e. ___ the quality or the taste of the fish has been decreasing over time
f. ___ you don't know
g. ___ RESPONDENT REFUSES TO ANSWER QUESTION
h. ___ other? _____

GO TO Q. 32, p.13

Q. 17 Did you refuse to answer this question because:
TICK OFF ONE OR MORE ANSWERS

a. ___ it's wrong for conservation to be dependent on raising money locally
b. ___ you don't feel comfortable talking about this issue - there must be some sort of catch
c. ___ you already pay enough in taxes or give enough to charity
d. ___ you don't know
e. ___ RESPONDENT REFUSES TO ANSWER QUESTION
f. ___ other? _____

GO TO Q. 32, p.13

Q. 18 Here are different options for increasing the number of lake trout in the main lake. These options will cost the community approximately the same amount. I will read these three options out loud and then ask you to pick the one you would support.

Option A - Restocking Program

Trout eggs or young trout could be put in good spawning spots in the main lake of Lac La Ronge. Extensive restocking over five years could increase the stocks of lake trout.

Option B - Restricting Sport Fishing

To allow the stocks of lake trout to recover, the daily sport fishing limit for lake trout could be significantly decreased to <u>one</u> lake trout under 26 inches and a possession limit of two lake trout. The daily limit and possession limit for all other species will stay the same.

Option C - Restricting the Commercial Fishery

To allow the stocks to recover, the overall quota for lake trout could be decreased substantially. The quota for other species, such as whitefish, walleye, northern pike, and burbot, would stay at relatively the same level as 1994 species quota.

With each of these options, the number of trout in the lake will be watched carefully to see if the program is working. Over time, these options have the potential to restore the stocks of lake trout to levels observed in the past.

Earlier you said you thought a decision making group should decide how the fishery should be restored. Quite often decision making groups consult with the public and ask people what they think of particular options. If you were asked which of these options you like the most, which one would it be? CHECK OFF ONLY ONE

a. ___ Option A - Restocking
b. ___ Option B - Restricting the sport fishery
c. ___ Option C - Restricting the commercial fishery
d. ___ Leave things as they are
e. ___ you don't know
f. ___ RESPONDENT REFUSES TO ANSWER QUESTION
g. ___ other? _____

NOTE TO INTERVIEWERS: RESPONDENTS MAY WANT A COMBINATION OF OPTIONS - PLEASE RECORD UNDER "g. other?". IF THE COMBINATION INVOLVES RESTOCKING GO TO Q. 20. IF THE COMBINATION DOES NOT INVOLVE RESTOCKING, THEN GO TO Q. 24 IF RESTRICTING SPORT FISHING IS MENTIONED FIRST OR GO TO Q. 28 IF RESTRICTING COMMERCIAL FISHING IS MENTIONED FIRST. IF RESPONDENT WANTS SOMETHING ALL TOGETHER DIFFERENT, RECORD AND GO ONTO Q. 20.

IF "f" GO TO Q. 19, p.9
IF "a" GO TO Q. 20, p.9
IF "b" GO TO Q. 24, p. 10
IF "c" GO TO Q. 28, p. 12
IF "d" GO TO Q. 32, p. 13

Q. 19 Did you refuse to answer this question because you think:
TICK OFF ONE OR MORE ANSWERS

a. ___ none of the options will solve the problem
b. ___ the fishery is too important to the local economy to restrict
c. ___ the stocks are too low to recover
d. ___ you don't believe trout stocks are low
e. ___ you don't know
f. ___ RESPONDENT REFUSES TO ANSWER QUESTION
g. ___ other? _____

_____

GO TO Q. 32, p.13

Q. 20 The decision making group suggests that the restocking program will cost about $_____ per household. A volunteer conservation group is willing to co-ordinate the project and if necessary raise any additional funds required. Before going ahead with this investment, the decision making group would like to know if people in the La Ronge area are in favour of this project. Remember this money could also be used in other local programs or projects. With this information, would you support investing $_____ per household to be used for restocking Lac La Ronge with lake trout? CHECK OFF ONLY ONE

a. ___ yes
b. ___ no
c. ___ you don't know
d. ___ RESPONDENT REFUSES TO ANSWER QUESTION

IF "a" GO TO Q. 21
IF "b" GO TO Q. 22
IF "d" GO TO Q. 23
IF "c" GO TO Q. 32, p.13

Q. 21 Would you support this investment because:
TICK OFF ONE OR MORE ANSWERS

a. ___ you often give to good causes
b. ___ you believe fish stocks are important
c. ___ your support means fish stocks are important without actually having to pay this amount
d. ___ increasing fish stocks might benefit your family
e. ___ you would like to do your fair share
f. ___ you don't know
g. ___ RESPONDENT REFUSES TO ANSWER QUESTION
h. ___ other? _____

_____

GO TO Q. 32, p.13

Q. 22 Did you not support this investment because:
TICK OFF ONE OR MORE ANSWERS

a. ___ there are more important things to invest in
b. ___ this amount is too much but you would be willing to volunteer your time or give a smaller amount
c. ___ the government should pay the full cost of restocking the lake
d. ___ the sport fishermen or the commercial fishermen should pay restocking costs
e. ___ the quality or the taste of the fish has been decreasing over time
f. ___ you don't know
g. ___ RESPONDENT REFUSES TO ANSWER QUESTION
h. ___ other?_____

_____

GO TO Q. 32, p.13

Q. 23 Did you refuse to answer this question because:
TICK OFF ONE OR MORE ANSWERS

a. ___ money should not enter into this
b. ___ you don't feel comfortable with this question - there must be a catch
c. ___ you already pay enough in taxes or give enough to charity
d. ___ you don't know
e. ___ RESPONDENT REFUSES TO ANSWER QUESTION
f. ___ other? _____

_____

GO TO Q. 32, p.13

Q. 24 The decision making group suggests that lower sport fishing limits are likely to be more effective if there is more emphasis on educating fishermen about the new limits and more enforcement of the limits. Making up leaflets on the new limits and buying equipment for conservation officers to use in catching poachers would cost about $_____ per household. A volunteer conservation group is willing to co-ordinate this project and if necessary, raise any additional funds required. Before going ahead with this investment, the decision making group would like to know if people in the La Ronge area are in favour of this project. Remember this money could be used for other local programs or projects. Would you support investing $_____ per household to be used for enforcement and education?
CHECK OFF ONLY ONE

a. ___ yes
b. ___ no
c. ___ you don't know
d. ___ RESPONDENT REFUSES TO ANSWER QUESTION

IF "a" GO TO Q. 25
IF "b" GO TO Q. 26
IF "d" GO TO Q. 27
IF "c" GO TO Q. 32, p.13

Q. 25 Would you support this investment of $_____ per household because:
TICK OFF ONE OR MORE ANSWERS

a. ___ you often give to good causes
b. ___ you believe fish stocks are important
c. ___ your support means fish stocks are important without actually having to pay this amount
d. ___ increasing fish stocks might benefit your family
e. ___ you want to do your fair share
f. ___ you don't know
g. ___ RESPONDENT REFUSES TO ANSWER QUESTION
h. ___ other? _____

_____

GO TO Q. 32, p.13

Q. 26 Did you not support this investment of $_____ because:
TICK OFF ONE OR MORE ANSWERS

a. ___ there are more important things to invest in
b. ___ this amount is too much but you would be willing to volunteer your time or give a smaller amount
c. ___ the government should pay for this
d. ___ the sport fishermen or the commercial fishermen should pay this cost
e. ___ the quality or the taste of the fish has been decreasing over time
f. ___ you don't know
g. ___ RESPONDENT REFUSES TO ANSWER QUESTION
h. ___ other? _____

_____

GO TO Q. 32, p.13

Q. 27 Did you refuse to answer this question because:
TICK OFF ONE OR MORE ANSWERS

a. ___ money should not enter into this decision
b. ___ you don't feel comfortable with this question - there must be a catch
c. ___ you already pay enough in tax or give enough to charity
d. ___ you don't know
e. ___ RESPONDENT REFUSES TO ANSWER QUESTION
f. ___ other?_____

_____

GO TO Q. 32, p.13

Q. 28 The decision making group suggests that the number of lake trout caught by commercial fishermen could be permanently reduced by purchasing the quota for lake trout. The decision making group believes that the voluntary sale of the lake trout quota would result in the least conflict amongst people in the community. A volunteer conservation group is willing to organize the purchase of the quota for lake trout from the fishing co-operative and if necessary, raise any additional funds required. Before going ahead with this investment, the decision making group would like to know if people in the La Ronge area are in favour of this project. Would you support investing $_____ per household to be used for reducing commercial fishing? Remember these funds could be used for other local programs or projects.

CHECK OFF ONLY ONE

a. ___ yes
b. ___ no
c. ___ you don't know
d. ___ RESPONDENT REFUSES TO ANSWER QUESTION

IF "a" GO TO Q. 29
IF "b" GO TO Q. 30
IF "d" GO TO Q. 31
IF "c" GO TO Q. 32, p.13

Q. 29 Would you support this investment of $_____ per household because:

TICK OFF ONE OR MORE ANSWERS

a. ___ you often give to good causes
b. ___ your support means fish stocks are important
c. ___ saying yes means fish stocks are important without actually having to pay
d. ___ increasing fish stocks might benefit your family
e. ___ you would like to do your fair share
f. ___ you don't know
g. ___ RESPONDENT REFUSES TO ANSWER QUESTION
h. ___ other? _____

_____

GO TO Q. 32, p.13

Q. 30 Did you not support this investment of $_____ per household because:

TICK OFF ONE OR MORE ANSWERS

a. ___ there are more important things to invest in
b. ___ the government should just reduce the quota
c. ___ this amount is too much but you would be willing to volunteer your time or give a smaller amount
d. ___ the sport fishermen or the commercial fishermen should pay this cost
e. ___ the quality or the taste of the fish has been decreasing over time
f. ___ you don't know
g. ___ RESPONDENT REFUSES TO ANSWER QUESTION
h. ___ other? _____

GO TO Q. 32, p.13

Q. 31 Did you refuse to answer this question because:
TICK OFF ONE OR MORE ANSWERS

a. ___ money should not enter into this decision
b. ___ you don't feel comfortable with this question - there must be a catch
c. ___ you pay enough in taxes or give enough to charity
d. ___ you don't know
e. ___ RESPONDENT REFUSES TO ANSWER QUESTION
f. ___ other? _____

GO TO Q. 32

Q. 32 Which of the following measures, if any, should be used to help restore the fishery?
TICK OFF ONE OR MORE ANSWERS

a. ___ stiffer fines for poaching
b. ___ better enforcement of rules
c. ___ require barbless hooks to make catch and release more effective
d. ___ encourage fish camps to limit catches
e. ___ money from licenses should come back to the community to be used for improving the fishery
f. ___ you don't know
g. ___ RESPONDENT REFUSES TO ANSWER QUESTION
h. ___ other? _____

Now, I will ask you to think about a situation where the number of fish in the lake increases a lot and it is easier to catch fish. While this hasn't happened, I want you to think about what you would do, if it did. (NOTE TO INTERVIEWERS, SAY NEXT SENTENCE IF YOU ARE TALKING TO A NON-BAND PERSON: I want you to imagine that there is no daily fishing limit).

Q. 33 Would you be interested in catching more fish if the levels of all species in the lake were to increase for some reason? CHECK ONLY ONE

a. ___ yes
b. ___ no
c. ___ you don't know
d. ___ RESPONDENT REFUSES TO ANSWER QUESTION

IF "a" GO TO Q. 34
IF "b" GO TO Q. 37
IF "c" GO TO Q. 39
IF "d" GO TO Q. 38

Q. 34 Why would you be interested in catching more fish?
TICK OFF ONE OR MORE ANSWERS

a. ___ your household could use more fish
b. ___ fish is a healthy food
c. ___ fishing is important to your way of life / you enjoy fishing
d. ___ you could give fish to relatives
e. ___ you don't know
f. ___ RESPONDENT REFUSES TO ANSWER QUESTION

GO TO Q. 35

Q. 35 If you were able to catch as much fish as you wanted, how many fish do you think you would want to catch in a given year? You might talk about this in terms of the number of fish, tubs of fish or lbs/kgs of fish. ASK RESPONDENT TO TALK OUT LOUD AND RECORD HOW THEY ARRIVED AT THIS NUMBER - FOR EXAMPLE - 2 TUBS ONCE A WEEK ON AVERAGE, 6 FISH ONCE A MONTH ON AVERAGE, ETC

_____

_____

GO TO Q. 36

Q. 36 In answering the last question, I asked you how much fish you would catch if you could catch all that you wanted. In figuring out how much this would be, what sorts of things influenced your answer: TICK OFF ONE OR MORE ANSWERS

a. ___ the number of people in your family
b. ___ whether you can store or smoke the fish properly
c. ___ the number of dogs (or other pets) that need to be fed
d. ___ the amount of time, energy or equipment you have to fish
e. ___ you would only catch what you could use
f. ___ you don't know
g. ___ RESPONDENT REFUSES TO ANSWER QUESTION
h. ___ other? _____

_____

GO TO Q. 39

Q. 37 Why would you not catch more fish? TICK OFF ONE OR MORE ANSWERS

a. ___ you don't fish
b. ___ you don't have enough time, energy or equipment to catch more fish
c. ___ you don't like fish / the quality or the taste of the fish isn't as good as it used to be
d. ___ you just catch enough for a couple of meals
e. ___ you want more variety in your diet / you don't need more fish
f. ___ you have no way to store any extra (no freezer or can't smoke fish, etc.)
g. ___ you think it is wrong to take too much from nature
h. ___ people in the community would think badly of you if you caught too much
i. ___ this is simply unrealistic
j. ___ you don't know
k. ___ RESPONDENT REFUSES TO ANSWER QUESTION
l. ___ other? _____

_____

GO TO Q. 39

Q. 38 Why did you refuse to answer this question? TICK OFF ONE OR MORE ANSWERS

a. ___ this is too unrealistic
b. ___ there is no hope that fish levels would increase
c. ___ you don't like fishing
d. ___ it would be wrong to take too much from nature
e. ___ you don't know
f. ___ RESPONDENT REFUSES TO ANSWER QUESTION
g. ___ other? _____

_____

GO TO Q. 39

Socio-economic Questions - Last Set of Questions

Q. 39 Have you or a member of your family ever been a guide for a fish camp?

a. ___ yes
b. ___ no
c. ___ you don't know
d. ___ RESPONDENT REFUSES TO ANSWER QUESTION

Q. 40 Have you or a member of your family worked in the commercial fishery?

a. ___ yes
b. ___ no
c. ___ you don't know
d. ___ RESPONDENT REFUSES TO ANSWER QUESTION

Q. 41 Did you eat fish, that you or a member of your family had caught, more than four times in the last month?

a. ___ yes
b. ___ no
c. ___ you don't know
d. ___ RESPONDENT REFUSES TO ANSWER QUESTION

Q. 42 Do you eat fish because:

a. ___ it's healthy
b. ___ it's inexpensive
c. ___ it's important to your way of life
d. ___ you don't know
e. ___ RESPONDENT REFUSES TO ANSWER QUESTION
f. ___ other? _____

_____

Q. 43 How long have you lived in the Lac La Ronge area?

a. ___ all your life
b. ___ all your life except for a few years
c. ___ last ten years
d. ___ last five years
e. ___ less than a year
f. ___ other? _____

Q. 44 From which ethnic group or groups are you descended from? (i.e. Aboriginal-Canadian, French-Canadian, Chinese-Canadian, etc.)

_____

Q. 45 Are you a member of the Lac La Ronge Indian Band?

a. ___ yes
b. ___ no
c. ___ you don't know
d. ___ RESPONDENT REFUSES TO ANSWER QUESTION

Q. 46 How many people live in your house as of today?

___ adults ___ children ___ RESPONDENT REFUSES TO ANSWER QUESTION

Q. 47 How old are you?

___ years of age ___ RESPONDENT REFUSES TO ANSWER QUESTION

Q. 48 What level of education did you finish?

___ elementary school 1 2 3 4 5 6 7 8
___ high school 9 10 11 12
___ university/technical School 1 2 3 4
___ post-graduate 1 2 3 4 5 6
___ RESPONDENT REFUSES TO ANSWER QUESTION

Q. 49 Are you: ___ male ___ female

WITH THIS QUESTION, YOU MAY WANT TO HAND PEOPLE THE SURVEY AND LET THEM CHECK OFF THE AMOUNT OR YOU MAY NEED TO HELP RESPONDENT ESTIMATE AMOUNT - IF SO, SHOW CALCULATION IN WHITE SPACES SO I KNOW IT IS YOUR ESTIMATE.

Q. 50 What was your household income level (before taxes, if applicable) in 1994?

a. ___ under $10, 000
b. ___ $10, 000 to $14, 999
c. ___ $15, 000 to $19, 999
d. ___ $20, 000 to $24, 999
e. ___ $25, 000 to $29, 999
f. ___ $30, 000 to $34, 999
g. ___ $35, 000 to $39, 999
h. ___ $40, 000 to $49, 999
i. ___ $50, 000 to $59, 999
j. ___ $60, 000 to $69, 999
k. ___ $70, 000 and over
l. ___ REFUSES TO ANSWER QUESTION

Appendix II

Firewood Collection Survey - Week 1
Dandara Village

Introduction Points

1. ***This is a University of Zimbabwe study and you are helping a student - Darla MacDonald***
2. ***Individual responses are confidential***
3. ***Participation is voluntary***
4. ***Three visits will occur***
5. ***The proper leaders have been contacted***

Household Serial Number _____

Name of Communal Area _____

Name of Village _____

Date that Household was contacted: _____

Start Time: _____

Observations by the Enumerator

How many houses (excluding storage huts) are there on the compound? ____

The best house on the compound is best described as:

1 pole and dagga covered by thatch
2 brick and thatch
3 brick and asbestos/corrugated iron

Certification

I certify on my honour that this interview was conducted by me honestly and completely and if found guilty of falsifying the interview, will be subject to outright dismal and I will forfeit my wages.

_____
Printed Name of Enumerator

_____ _____
Signature of Enumerator Date Completed

<u>Supervisor's Observations</u>

Questionnaire Checked _____ researcher's initials

How many errors were found in checking? _____

Is this survey satisfactory? yes
no

The wages of the enumerator will be reduced by $3 for each survey which is unsatisfactory.

Notes for Enumerator: Remember this questionnaire has several sections. The first section on site choice can be answered by both men and women. Section II is for women only. Section III can be answered by whoever is responsible for firewood collection using a scotch-cart. Section IV can be answered by men and women. Remember it is important to return to the household and get the responses of men and women. The only acceptable reasons for not obtaining the responses of the appropriate men and women is that the respondent was unwilling to participate or was away from the homestead for an extended period of time.

Section I - Site Choice Men and Women May Answer - Indicate the number and gender of respondents to each section.

1. What fuel is used for cooking and heating in this household? *circle the response number*

1	firewood	5	gas
2	maize cobs	6	electricity
3	dung	7	petrol/diesel
4	paraffin	8	solar
		9	other (specify)_____

2. Please name all the places that you might go to collect firewood?
circle the response number of the sites that the individual names without help

1 Mapunga Mountain
2 Chikwirandaombera Mountain
3 Chamapere Mountain
4 Ndemera Mountain
5 Mucheunje Mountain
6 Muchinjike Mountain
7 Mutaragume Mountain
8 Gugwa Mountain
9 Mazimi Mountain
10 Njedza Mountain
11 Chemakudo Mountain
12 Runyange Mountain
13 Kapuka Mountain
14 other _____
15 other _____

3 I will read you a list of places, some of them you may have all ready named, and ask you whether you would consider going to any of these sites to collect firewood?
for each site, enumerator, please circle the response number for yes, no, or don't know. Be sure to write the reason in the white space beside.

Mapunga Mountain
1 yes - why?
2 no - why?
9 don't know

Chikwirandaombera Mountain
1 yes - why?
2 no - why?
9 don't know

Chamapere Mountain
1 yes - why?
2 no - why?
9 don't know

Ndemera Mountain
1 yes - why?

2 no - why?
9 don't know

Mucheunje Mountain
1 yes - why?
2 no - why?
9 don't know

Muchinjike Mountain
1 yes - why?
2 no - why?
9 don't know

Mutaragume Mountain
1 yes - why?
2 no - why?
9 don't know

Gugwa Mountain
1 yes - why?
2 no - why?
9 don't know

Mazimi Mountain
1 yes - why?
2 no - why?
9 don't know

Njedza Mountain
1 yes - why?
2 no - why?
9 don't know

Chemakudo Mountain
1 yes - why?
2 no - why?
9 don't know

Runyange Mountain
1 yes - why?
2 no - why?
9 don't know

Kapuka Mountain
1 yes - why?
2 no - why?
9 don't know

For questions 4, 5, 6 and 7 lay out the cards with the names of the mountains and go through the questions with the respondent.

4. How long would it take you to walk to the base of

Collection Site	Time
Mapunga Mountain	
Chikwirandaombera Mountain	
Chamapere Mountain	
Ndemera Mountain	
Mucheunje Mountain	
Muchinjike Mountain	
Mutaragume Mountain	
Gugwa Mountain	
Mazimi Mountain	
Njedza Mountain	
Chemakudo Mountain	
Runyange Mountain	
Kapuka Mountain	
any other site - specify	

Enumerator - please include the unit of time.

5. Rank the degree of difficulty of firewood collection trips to the following places using the following categories: difficult, moderate or easy.

Collection Site	Level of Difficulty
Mapunga Mountain	
Chikwirandaombera Mountain	
Chamapere Mountain	
Ndemera Mountain	
Mucheunje Mountain	
Muchinjike Mountain	
Mutaragume Mountain	
Gugwa Mountain	
Mazimi Mountain	
Njedza Mountain	
Chemakudo Mountain	
Runyange Mountain	
Kapuka Mountain	
any other site - specify	

Enumerators - Use the initials d (difficult), m (moderate), e (easy), or dk (don't know).

6. How plentiful is firewood on each mountain? Would you say that muunze is plentiful, moderate, sparse, or exhauated on these mountains? *(point to the cards with mountain names)* **Would you say that monhundo is plentiful, moderate, sparse or exhausted on these mountains?** *(point to the cards with mountain names)* **Would you say that mupfuti is plentiful, moderate, sparse or exhausted on these mountains?** *(point to the cards with mountain names)* **Would you say that all other types of firewood are plentiful, moderate or sparse on these mountains?** *(point to the cards with mountain names) Enumerators - have the person rate the availability on each mountain. Use the initials p (plentiful), m (moderate), s (sparse), e (exhausted) or dk (don't know).*

Collection Site	muunze	munhondo	mupfuti	all other types
Mapunga Mountain				
Chikwirandaombera Mountain				
Chamapere Mountain				
Ndemera Mountain				
Mucheunje Mountain				
Muchinjike Mountain				
Mutaragume Mountain				
Gugwa Mountain				
Mazimi Mountain				
Njedza Mountain				
Chemakudo Mountain				
Runyange Mountain				
Kapuka Mountain				
any other site -				

7. On the way to these mountains, there might be pleasant or useful things to do. Are wild fruits available along the way to this collection site? Are there useful plants or barks and fibres from trees available along the way to this collection site? Would a trip to these collection sites take you close to your fields or garden? Do you have friends along the way to this collection site? Is there anything else pleasant such as seeing wild animals, water or a good place to rest? *Enumerators - put an X for yes, a - for no and a dk for don't know*

Collection Site	wild fruits	useful plants	gardens	friends	water	wild animals	good place to rest
Mapunga Mountain							
Chikwirandaombera Mountain							
Chamapere Mountain							
Ndemera Mountain							
Mucheunje Mountain							
Muchinjike Mountain							
Mutaragume Mountain							
Gugwa Mountain							
Mazimi Mountain							
Njedza Mountain							
Chemakudo Mountain							
Runyange Mountain							
Kapuka Mountain							
any other site -							

Enumerator: If Household does not use firewood skip sections II & III and start at question #49

Section II - Firewood Collection by Women - Women Only

8. How many trips to collect firewood for cooking and heating did you make last week between _____ *(fill in current day of the week)* **and** _____ *(fill in day - one week previous)*? *Enumerator - fill in the number of trips* _____ trips. *If the number of trips is 0 skip question #9 to #48 and start at question #49*

9. Did you walk to collect a headload of firewood last week?

1 yes - *if yes, go to question 11*
2 no - *if no, ask question 9*
9 don't know

Enumerator - if the answer is no skip questions #10 to #40 and start at question #41

10. Which days of the previous week did you go out and collect firewood?
Enumerator - fill in the days of the week that the person collected firewood.

Trip #1 _____ **Trip #4** _____

Trip #2 _____ **Trip #5** _____

Trip #3 _____ **Trip #6** _____

11. If I had collected your firewood for you last week, what would you have done with your time?
Enumerator - write in the response in the space provided.

Trip #1

12. Where did you go to collect firewood? *Enumerator - circle the appropriate response number and where required fill in other locations.*

1	Mapunga Mountain
2	Chikwirandaombera Mountain
3	Chamapere Mountain
4	Ndemera Mountain
5	Mucheunje Mountain
6	Muchinjike Mountain
7	Mutaragume Mountain
8	Gugwa Mountain
9	Mazimi Mountain
10	Njedza Mountain
11	Chemakudo Mountain
12	Runyange Mountain
13	Kapuka Mountain
14	other _____
15	other _____

13. I will read you a list of trees. Did you have any of these trees in your headload? Can you show me what proportion of each you had in your headload? *Enumerator - circle the appropriate response number for each species. Pick out the cards for each species and place on the ground. Give the person 25 sticks to distribute amongst the cards. Write in the number in the space beside each species.*

	proportion of headload			proportion of headload	
1	mupfuti	_____	9	mupangara	_____
2	munhondo	_____	10	mukute	_____
3	muunze	_____	11	mucherekesi	_____
4	muvanga	_____	12	muzeze	_____
5	musasa	_____	13	mubvamaropa	_____
6	mukuyazvigo	_____	14	mutukutu	_____
7	muhacha	_____	15	other - specify	_____ _____
8	mukonono	_____	16	other - specify	_____ _____

14. Did you walk with anyone to collect wood?

1	yes
2	no
9	don't know

15. Did you deliver something on this trip to the collection site?

1	yes
2	no
9	don't know

16. How long did it take you to walk there?

_____ *Enumerators please include the unit of time (minutes or hours)*

17. Once you arrived at the spot where you wanted to collect wood, how long did it take you to collect your headload? _____ *Enumerators please include the unit of time (minutes or hours)*

18. How far do you think you walked there and back? _____ kilometers

Trip # 2

19. Where did you go to collect firewood? *Enumerator - circle the appropriate response number and where required fill in other locations.*

1 Mapunga Mountain
2 Chikwirandaombera Mountain
3 Chamapere Mountain
4 Ndemera Mountain
5 Mucheunje Mountain
6 Muchinjike Mountain
7 Mutaragume Mountain
8 Gugwa Mountain
9 Mazimi Mountain
10 Njedza Mountain
11 Chemakudo Mountain
12 Runyange Mountain
13 Kapuka Mountain
14 other _____
15 other _____

20. I will read you a list of trees. Did you have any of these trees in your headload? Can you show me what proportion of each you had in your headload? *Enumerator - circle the appropriate response number for each species. Pick out the cards for each species and place on the ground. Give the person 25 sticks to distribute amongst the cards. Write in the number in the space beside each species.*

	proportion of headload			proportion of headload	
1 mupfuti	_____	9	mupangara	_____	
2 munhondo	_____	10	mukute	_____	
3 muunze	_____	11	mucherekesi	_____	
4 muvanga	_____	12	muzeze	_____	
5 musasa	_____	13	mubvamaropa	_____	
6 mukuyazvigo	_____	14	mutukutu	_____	
7 muhacha	_____	15	other - specify	_____	_____
8 mukonono	_____	16	other - specify	_____	_____

21. Did you walk with anyone to collect wood?

1 yes
2 no
9 don't know

22. Did you deliver something on this trip to the collection site?

1 yes
2 no
9 don't know

23. How long did it take you to walk there?

_____ *Enumerators please include the unit of time (minutes or hours)*

24. Once you arrived at the spot where you wanted to collect wood, how long did it take you to collect your headload? _____ *Enumerators please include the unit of time (minutes or hours)*

25. How far do you think you walked there and back? _____ kilometers

Trip # 3

26. Where did you go to collect firewood? *Enumerator - circle the appropriate response number and where required fill in other locations.*

1	Mapunga Mountain
2	Chikwirandaombera Mountain
3	Chamapere Mountain
4	Ndemera Mountain
5	Mucheunje Mountain
6	Muchinjike Mountain
7	Mutaragume Mountain
8	Gugwa Mountain
9	Mazimi Mountain
10	Njedza Mountain
11	Chemakudo Mountain
12	Runyange Mountain
13	Kapuka Mountain
14	other _____
15	other _____

27. I will read you a list of trees. Did you have any of these trees in your headload? Can you show me what proportion of each you had in your headload? *Enumerator - circle the appropriate response number for each species. Pick out the cards for each species and place on the ground. Give the person 25 sticks to distribute amongst the cards. Write in the number in the space beside each species.*

	proportion of headload			proportion of headload		
1	mupfuti	_____	9	mupangara	_____	
2	munhondo	_____	10	mukute	_____	
3	muunze	_____	11	mucherekesi	_____	
4	muvanga	_____	12	muzeze	_____	
5	musasa	_____	13	mubvamaropa	_____	
6	mukuyazvigo	_____	14	mutukutu	_____	
7	muhacha	_____	15	other - specify	_____	_____
8	mukonono	_____	16	other - specify	_____	_____

28. Did you walk with anyone to collect wood?

1	yes
2	no
9	don't know

29. Did you deliver something on this trip to the collection site?

1	yes
2	no
9	don't know

30. How long did it take you to walk there?

_____ *Enumerators please include the unit of time (minutes or hours)*

31. Once you arrived at the spot where you wanted to collect wood, how long did it take you to collect your headload? _____ *Enumerators please include the unit of time (minutes or hours)*

32. How far do you think you walked there and back? _____ kilometers

Trip # 4

33. Where did you go to collect firewood? *Enumerator - circle the appropriate response number and where required fill in other locations.*

1 Mapunga Mountain
2 Chikwirandaombera Mountain
3 Chamapere Mountain
4 Ndemera Mountain
5 Mucheunje Mountain
6 Muchinjike Mountain
7 Mutaragume Mountain
8 Gugwa Mountain
9 Mazimi Mountain
10 Njedza Mountain
11 Chemakudo Mountain
12 Runyange Mountain
13 Kapuka Mountain
14 other _____
15 other _____

34. I will read you a list of trees. Did you have any of these trees in your headload? Can you show me what proportion of each you had in your headload? *Enumerator - circle the appropriate response number for each species. Pick out the cards for each species and place on the ground. Give the person 25 sticks to distribute amongst the cards. Write in the number in the space beside each species.*

		proportion of headload			proportion of headload
1	mupfuti	_____	9	mupangara	_____
2	munhondo	_____	10	mukute	_____
3	muunze	_____	11	mucherekesi	_____
4	muvanga	_____	12	muzeze	_____
5	musasa	_____	13	mubvamaropa	_____
6	mukuyazvigo	_____	14	mutukutu	_____
7	muhacha	_____	15	other - specify	_____
8	mukonono	_____	16	other - specify	_____

35. Did you walk with anyone to collect wood?

1 yes
2 no
9 don't know

36. Did you deliver something on this trip to the collection site?

1 yes
2 no
9 don't know

37. How long did it take you to walk there?

_____ *Enumerators please include the unit of time (minutes or hours)*

38. Once you arrived at the spot where you wanted to collect wood, how long did it take you to collect your headload? _____ *Enumerators please include the unit of time (minutes or hours)*

39. How far do you think you walked there and back? _____ kilometers

Section III - Firewood Collection Using a Scotch-Cart

40. Did anyone from this household go and collect wood using a scotch-cart?

1 yes
2 no
9 don't know

41. Did anyone hire a scotch-cart for collecting wood?

1 yes
2 no
9 don't know

Enumerator: If the answers to questions #40 & #41 are no, then skip questions #43 to #48 and start at question #49

42. What was this scotch-cart load intended to be used for?

1 domestic purposes (cooking, ironing, heating)
2 beer brewing
3 brick-burning
4 other specify _____
9 don't know

43. Where did the scotch-cart go to collect firewood? *Enumerator - circle the appropriate response number and where required fill in other locations.*

1 Mapunga Mountain
2 Chikwirandaombera Mountain
3 Chamapere Mountain
4 Ndemera Mountain
5 Mucheunje Mountain
6 Muchinjike Mountain
7 Mutaragume Mountain
8 Gugwa Mountain
9 Mazimi Mountain
10 Njedza Mountain
11 Chemakudo Mountain
12 Runyange Mountain
13 Kapuka Mountain
14 other _____
15 other _____

44. I will read you a list of trees. Were any of these trees in the scotch-cart load? Can you show me what proportion of each you had in the scotch-cart load? *Enumerator - circle the appropriate response number for each species. Pick out the cards for each species and place on the ground. Give the person 25 sticks to distribute amongst the cards. Write in the number in the space beside each species.*

	proportion of headload			proportion of headload	
1 mupfuti	_____		9 mupangara	_____	
2 munhondo	_____		10 mukute	_____	
3 muunze	_____		11 mucherekesi	_____	
4 muvanga	_____		12 munyada	_____	
5 musasa	_____		13 mubvamaropa	_____	
6 mukuyazvigo	_____		14 mutukutu	_____	
7 muhacha	_____		15 other - specify	_____	_____
8 mukonono	_____		16 other - specify	_____	_____

45. Did you deliver something on this trip to the collection site?

1 yes
2 no
9 don't know

46. How long did it take you to harness the oxen and drive them to the spot where you were collecting the wood? _____ *Enumerator - include the appropriate unit of time.*

47. How long did it take you to collect the cartload of wood? _____
Enumerator - include the appropriate unit of time.

48. How far do you think the scotch-cart traveled? _____ kilometers

Section IV - Household Information - Men and Women may answer

49. How old are you?

	Age of Respondent 1
< 18 years of age	1
18 - 25	2
26 - 34	3
35 - 44	4
45 - 54	5
55 - 64	6
65+	7
	Age of Respondent 2
< 18 years of age	1
18 - 25	2
26 - 34	3
35 - 44	4
45 - 54	5
55 - 64	6
65+	7

50. How many people (adults - over 18 years of age and children - under 18 years of age) live in this household? _____ persons

How many adult women? _____
How many adult men? _____
How many children? _____

51. Are there members of your household that are living somewhere else?

1 yes - how many? _____
2 no
9 don't know

52. What is your marital status?

1 married
2 separated
3 divorced
4 widowed
5 other

53. In what year did your household settle in this village? _____

54. How many cattle does this household own? _____ cattle

55. Does this household own a scotch-cart? yes 1

	no	2

If response is no, ask the following question:

Does this household usually rent a scotch-cart?

yes	1
no	2

If yes, how much per load? _____

56. Does this household own a plough?

yes	1
no	2
don't know	9

57. Net Income Calculation

Source of Income in the last year	$
Crops (Maize, Sorghum, Millet Cotton, Sunflower, Groundnuts, etc.)	
Gardens - Vegetables	
Beer Brewing	
Crafts	
Making Peanut Butter	
Brickmaking/Building	
other - specify	
Wages	
Remittances Received	
Gifts (Remittances) to other family members	

Was your total annual household income between August, 1995 and July 1996?

1	less than $100/month (<$1200/year)
2	between $100 to $299 per month ($1200/year - $3600/year)
3	between $300 to $499 per month ($3600/year - $6000/year)
4	between $500 to $799 per month ($6000/year - $9600/year)
5	greater than $800/month (>9600/year)
9	don't know

finish time _____

Gender of Respondents 1 Female 2 Male 3 Both Male and Female were interviewed

If survey is incomplete explain:

Firewood Collection Survey - Week 2
Dandara Village

Introduction Points

1. ***This is a co-operative project between the University of Zimbabwe and the University of Alberta and you are helping a student - Darla MacDonald***
2. ***Individual responses are confidential***
3. ***Participation is voluntary***
4. ***Three visits will occur***
5. ***The proper leaders have been contacted***

Household Serial Number _____

Name of Communal Area _____

Name of Village _____

Date that Household was contacted: _____

Start Time: _____

Certification

I certify on my honour that this interview was conducted by me honestly and completely and if found guilty of falsifying the interview, will be subject to outright dismal and I will forfeit my wages.

_____
Printed Name of Enumerator

_____ _____
Signature of Enumerator Date Completed

Supervisor's Observations

Questionnaire Checked _____ researcher's initials

How many errors were found in checking? _____

Is this survey satisfactory? yes
no

The wages of the enumerator will be reduced by $3 for each survey which is unsatisfactory.

Notes for Enumerator: It is important to interview the person responsible for firewood collection. The only acceptable reasons for not obtaining the responses of the appropriate men and women is that the respondent was unwilling to participate or was away from the homestead for an extended period of time.

Section I - Firewood Collection by Foot

1. How many trips by foot to collect firewood for cooking and heating did you make last week between

_____ *(fill in current day of the week)* **and** _____ *(fill in day - one week previous)*? *Enumerator - fill in the number of trips* _____ trips. *If the number of trips is 0 skip question #2 to #32 and start at question #33*

2. Did you walk to collect a headload of firewood last week?

1 yes - *if yes, go to question 3*
2 no - *if no, ask question 33*
9 don't know

3. Which days of the previous week did you go out and collect firewood?
Enumerator - fill in the days of the week that the person collected firewood.

Trip #1 _____ **Trip #4** _____

Trip #2 _____ **Trip #5** _____

Trip #3 _____ **Trip #6** _____

4. If I had collected your firewood for you last week, what would you have done with your time?
Enumerator - write in the response in the space provided.

Trip #1

5. Where did you go to collect firewood? *Enumerator - circle the appropriate response number and where required fill in other locations.*

1 Mapunga Mountain
2 Chikwirandaombera Mountain
3 Chamapere Mountain
4 Ndemera Mountain
5 Mucheunje Mountain
6 Muchinjike Mountain
7 Mutaragume Mountain
8 Gugwa Mountain
9 Mazimi Mountain
10 Njedza Mountain
11 Chemakudo Mountain
12 Runyange Mountain
13 Kapuka Mountain
14 other _____
15 other _____

6. I will read you a list of trees. Did you have any of these trees in your headload? Can you show me what proportion of each you had in your headload? *Enumerator - circle the appropriate response number for each species. Pick out the cards for each species and place on the ground. Give the person 25 sticks to distribute amongst the cards. Write in the number in the space beside each species.*

	proportion of headload			proportion of headload	
1 mupfuti	_____	9	mupangara	_____	
2 munhondo	_____	10	mukute	_____	
3 muunze	_____	11	mucherekesi	_____	
4 muvanga	_____	12	muzeze	_____	
5 musasa	_____	13	mubvamaropa	_____	
6 mukuyazvigo	_____	14	mutukutu	_____	
7 muhacha	_____	15	other - specify	_____	_____
8 mukonono	_____	16	other - specify	_____	_____

7. Did you walk with anyone to collect wood?

1 yes
2 no
9 don't know

8. Did you deliver something on this trip to the collection site?

1 yes
2 no
9 don't know

9. How long did it take you to walk there?

_____ *Enumerators please include the unit of time (minutes or hours)*

10. Once you arrived at the spot where you wanted to collect wood, how long did it take you to collect your headload? _____ *Enumerators please include the unit of time (minutes or hours)*

11. How far do you think you walked there and back? _____ kilometers

Trip # 2

12. Where did you go to collect firewood? *Enumerator - circle the appropriate response number and where required fill in other locations.*

1 Mapunga Mountain
2 Chikwirandaombera Mountain
3 Chamapere Mountain
4 Ndemera Mountain
5 Mucheunje Mountain
6 Muchinjike Mountain
7 Mutaragume Mountain
8 Gugwa Mountain
9 Mazimi Mountain
10 Njedza Mountain
11 Chemakudo Mountain
12 Runyange Mountain
13 Kapuka Mountain
14 other _____
15 other _____

13. I will read you a list of trees. Did you have any of these trees in your headload? Can you show me what proportion of each you had in your headload? *Enumerator - circle the appropriate response number for each species. Pick out the cards for each species and place on the ground. Give the person 25 sticks to distribute amongst the cards. Write in the number in the space beside each species.*

	proportion of headload			proportion of headload	
1 mupfuti	_____	9	mupangara	_____	
2 munhondo	_____	10	mukute	_____	
3 muunze	_____	11	mucherekesi	_____	
4 muvanga	_____	12	muzeze	_____	
5 musasa	_____	13	mubvamaropa	_____	
6 mukuyazvigo	_____	14	mutukutu	_____	
7 muhacha	_____	15	other - specify	_____	_____
8 mukonono	_____	16	other - specify	_____	_____

14. Did you walk with anyone to collect wood?

1 yes
2 no
9 don't know

15. Did you deliver something on this trip to the collection site?

1 yes
2 no
9 don't know

16. How long did it take you to walk there?

_____ *Enumerators please include the unit of time (minutes or hours)*

17. Once you arrived at the spot where you wanted to collect wood, how long did it take you to collect your headload? _____ *Enumerators please include the unit of time (minutes or hours)*

18. How far do you think you walked there and back? _____ kilometers

Trip # 3

19. Where did you go to collect firewood? *Enumerator - circle the appropriate response number and where required fill in other locations.*

1 Mapunga Mountain
2 Chikwirandaombera Mountain
3 Chamapere Mountain
4 Ndemera Mountain
5 Mucheunje Mountain
6 Muchinjike Mountain
7 Mutaragume Mountain
8 Gugwa Mountain
9 Mazimi Mountain
10 Njedza Mountain
11 Chemakudo Mountain
12 Runyange Mountain
13 Kapuka Mountain
14 other _____
15 other _____

20. I will read you a list of trees. Did you have any of these trees in your headload? Can you show me what proportion of each you had in your headload? *Enumerator - circle the appropriate response number for each species. Pick out the cards for each species and place on the ground. Give the person 25 sticks to distribute amongst the cards. Write in the number in the space beside each species.*

	proportion of headload			proportion of headload	
1 mupfuti	_____	9	mupangara	_____	
2 munhondo	_____	10	mukute	_____	
3 muunze	_____	11	mucherekesi	_____	
4 muvanga	_____	12	muzeze	_____	
5 musasa	_____	13	mubvamaropa	_____	
6 mukuyazvigo	_____	14	mutukutu	_____	
7 muhacha	_____	15	other - specify	_____	_____
8 mukonono	_____	16	other - specify	_____	_____

21. Did you walk with anyone to collect wood?

1 yes
2 no
9 don't know

22. Did you deliver something on this trip to the collection site?

1 yes
2 no
9 don't know

23. How long did it take you to walk there?

_____ *Enumerators please include the unit of time (minutes or hours)*

24. Once you arrived at the spot where you wanted to collect wood, how long did it take you to collect your headload? _____ *Enumerators please include the unit of time (minutes or hours)*

25. How far do you think you walked there and back? _____ kilometers

Trip # 4

26. Where did you go to collect firewood? *Enumerator - circle the appropriate response number and where required fill in other locations.*

1 Mapunga Mountain
2 Chikwirandaombera Mountain
3 Chamapere Mountain
4 Ndemera Mountain
5 Mucheunje Mountain
6 Muchinjike Mountain
7 Mutaragume Mountain
8 Gugwa Mountain
9 Mazimi Mountain
10 Njedza Mountain
11 Chemakudo Mountain
12 Runyange Mountain
13 Kapuka Mountain
14 other _____
15 other _____

27. I will read you a list of trees. Did you have any of these trees in your headload? Can you show me what proportion of each you had in your headload? *Enumerator - circle the appropriate response number for each species. Pick out the cards for each species and place on the ground. Give the person 25 sticks to distribute amongst the cards. Write in the number in the space beside each species.*

	proportion of headload			proportion of headload	
1	mupfuti	_____	9	mupangara	_____
2	munhondo	_____	10	mukute	_____
3	muunze	_____	11	mucherekesi	_____
4	muvanga	_____	12	munyada	_____
5	musasa	_____	13	mubvamaropa	_____
6	mukuyazvigo	_____	14	mutukutu	_____
7	muhacha	_____	15	other - specify	_____ _____
8	mukonono	_____	16	other - specify	_____ _____

28. Did you walk with anyone to collect wood?

1 yes
2 no
9 don't know

29. Did you deliver something on this trip to the collection site?

1 yes
2 no
9 don't know

30. How long did it take you to walk there?

_____ *Enumerators please include the unit of time (minutes or hours)*

31. Once you arrived at the spot where you wanted to collect wood, how long did it take you to collect your headload? _____ *Enumerators please include the unit of time (minutes or hours)*

32. How far do you think you walked there and back? _____ kilometers

Section II - Firewood Collection Using a Scotch-Cart

33. Did anyone from this household go and collect wood using a scotch-cart?

1 yes
2 no
9 don't know

34. Did anyone hire a scotch-cart for collecting wood?

1 yes
2 no
9 don't know

Enumerator: If the answers to questions #33 & #34 are no, then skip questions #34 to #40 and start at question #41

35. What was this scotch-cart load intended to be used for?

1 domestic purposes (cooking, ironing, heating)
2 beer brewing
3 brick-burning
4 other specify _____
9 don't know

35. Where did the scotch-cart go to collect firewood? *Enumerator - circle the appropriate response number and where required fill in other locations.*

1 Mapunga Mountain
2 Chikwirandaombera Mountain
3 Chamapere Mountain
4 Ndemera Mountain
5 Mucheunje Mountain
6 Muchinjike Mountain
7 Mutaragume Mountain
8 Gugwa Mountain
9 Mazimi Mountain
10 Njedza Mountain
11 Chemakudo Mountain
12 Runyange Mountain
13 Kapuka Mountain
14 other _____
15 other _____

37. I will read you a list of trees. Were any of these trees in the scotch-cart load? Can you show me what proportion of each you had in the scotch-cart load? *Enumerator - circle the appropriate response number for each species. Pick out the cards for each species and place on the ground. Give the person 25 sticks to distribute amongst the cards. Write in the number in the space beside each species.*

	proportion of headload			proportion of headload	
1 mupfuti	_____	9	mupangara	_____	
2 munhondo	_____	10	mukute	_____	
3 muunze	_____	11	mucherekesi	_____	
4 muvanga	_____	12	munyada	_____	
5 musasa	_____	13	mubvamaropa	_____	
6 mukuyazvigo	_____	14	mutukutu	_____	
7 muhacha	_____	15	other - specify	_____	_____
8 mukonono	_____	16	other - specify	_____	_____

38. Did you deliver something on this trip to the collection site?

1 yes
2 no
9 don't know

39. How long did it take you to harness the oxen and drive them to the spot where you were collecting the wood? _____ *Enumerator - include the appropriate unit of time.*

40. How long did it take you to collect the cartload of wood? _____
Enumerator - include the appropriate unit of time.

41. How far do you think the scotch-cart traveled?
_____ kilometers

Section III - Household Information

42. How many goats do this household own? _____ **goats**

43. Does this household keep chickens?

1 yes
2 no

44. Does this household have its own borehole?

1 yes
2 no

45. Does this household own a bicycle?

1 yes
2 no

46. Does this household own a radio?

1 yes
2 no

47. Does this household own a wheelbarrow?

1 yes
2 no

48. Did other family members give this household fertliser, agricultural implements or clothing in the last year and if so, could you try to estimate the value of this gift?

Item	Received - yes or no	Dollar Value - Estimate Value only if received
fertliser		
agricultural implements - specify		
clothing		
other - specify		

finish time _____

Gender of Respondents

1 Female
2 Male
3 Both Male and Female were interviewed

If survey is incomplete explain:

Comments/Observations

Firewood Collection Survey - Week 3
Dandara Village

Introduction Points

1. ***This is a University of Zimbabwe study and you are helping a student - Darla MacDonald***
2. ***Individual responses are confidential***
3. ***Participation is voluntary***
4. ***Three visits will occur***
5. ***The proper leaders have been contacted***

Household Serial Number _____

Name of Communal Area _____

Name of Village _____

Date that Household was contacted: _____

Start Time: _____

Certification

I certify on my honour that this interview was conducted by me honestly and completely and if found guilty of falsifying the interview, will be subject to outright dismal and I will forfeit my wages.

_____
Printed Name of Enumerator

_____ _____
Signature of Enumerator Date Completed

Supervisor's Observations

Questionnaire Checked _____ researcher's initials

How many errors were found in checking? _____

Is this survey satisfactory? yes
no

The wages of the enumerator will be reduced by $3 for each survey which is unsatisfactory.

Notes for Enumerator: Remember this questionnaire has several sections. Remember it is important to return to the household and get the responses of men and women. The only acceptable reasons for not obtaining the responses of the appropriate men and women is that the respondent was unwilling to participate or was away from the homestead for an extended period of time.

Section I - Site Choice

1. **How would your rate each of these types of trees for use as firewood for cooking?**
   e = excellent f = fair or moderate p = poor

Species	Rating as Firewood	Species	Rating as Firewood
mupangara		muhacha	
munhondo		mukonono	
mukute		mupfuti	
mucherekesi		mango	
muvanga		mungando	
muzeze		mutowa	
musasa		muguruzuzu	
mubvamaropa		mugodo	
muunze		muunga	
mukuyazvigo		muzhanje	
mutukutu			

2. **How would you rate maize cobs, cotton stalks or dung for use in cooking?**
   e = excellent f = fair or moderate p = poor

Fuel	Rating as Fuel
maize cobs	
cotton stalks	
dung	

3. **Would you consider going to any of these sites to collect firewood?**
   for each site, enumerator, please circle the response number for yes, no, or don't know. Be sure to write the reason in the white space beside.

Masaka
1 yes - why?
2 no - why?
9 don't know

Bhidi
1 yes - why?
2 no - why?
9 don't know

Chirozva Hill
1 yes - why?
2 no - why?
9 don't know

Gova Mountain
1 yes - why?
2 no - why?
9 don't know

Chebhero Hill
1 yes - why?
2 no - why?
9 don't know

Butuku
1 yes - why?
2 no - why?
9 don't know

Gova
1 yes - why?
2 no - why?
9 don't know

4. How long would it take you to walk to the base of

Collection Site	Time
Masaka	
Bhidi	
Chirozva Hill	
Gova Mountain	
Chebhero Hill	
Butuku	
Gova	

Enumerator - please include the unit of time.

5. Rank the degree of difficulty of firewood collection trips to the following places using the following categories: difficult, moderate or easy. *Enumerators - Use the initials d (difficult), m (moderate), e (easy), or dk (don't know).*

Collection Site	Level of Difficulty
Masaka	
Bhidi	
Chirozva Hill	
Gova Mountain	
Chebhero Hill	
Butuku	
Gova	

6. How plentiful is firewood on each mountain? Would you say that muunze is plentiful, moderate, sparse, or exhauated on these mountains? *(point to the cards with mountain names for each question)* **Would you say that monhundo is plentiful, moderate, sparse or exhausted on these mountains? Would you say that mupfuti is plentiful, moderate, sparse or exhausted on these mountains? Would you say that all other types of firewood are plentiful, moderate or sparse on these mountains?** *Enumerators - have the person rate the availability on each mountain. Use the initials p (plentiful), m (moderate), s (sparse), e (exhausted) or dk (don't know).*

Collection Site	muunze	munhondo	mupfuti	all other types
Masaka				
Bhidi				
Chirozva Hill				
Gova Mountain				
Chebhero Hill				
Butuku				
Gova				

7. On the way to these mountains, there might be pleasant or useful things to do. Are wild fruits available along the way to this collection site? Are there useful plants or barks and fibres from trees available along the way to this collection site? Would a trip to these collection sites take you close to your fields or garden? Do you have friends along the way to this collection site? Is there anything else pleasant such as seeing wild animals, water or a good place to rest? *Enumerators - put an X for yes, a - for no and a dk for don't know*

Collection Site	wild fruits	useful plants	gardens	friends	water	wild animals	place to rest
Masaka							
Bhidi							
Chirozva Hill							
Gova Mountain							
Chebhero Hill							
Butuku							
Gova							

Enumerator: If Household does not use firewood then skip questions 8 through 48 and ask question 49.

Section II - Firewood Collection by Foot

8. How many trips to collect firewood for cooking and heating did you make last week between _____ *(fill in current day of the week)* **and** _____ *(fill in day - one week previous)*? *Enumerator - fill in the number of trips* _____ trips. *If the number of trips is 0 skip question #9 to #40 and start at question #41*

9. Did you walk to collect a headload of firewood last week?

1 yes - *if yes, go to question 10*
2 no - *if no, ask question 41*
9 don't know

10. Which days of the previous week did you go out and collect firewood?
Enumerator - fill in the days of the week that the person collected firewood.

Trip #1 _____ **Trip #4** _____

Trip #2 _____ **Trip #5** _____

Trip #3 _____ **Trip #6** _____

11. If I had collected your firewood for you last week, what would you have done with your time? *Enumerator - write in the response in the space provided.*

Trip #1

12. Where did you go to collect firewood? *Enumerator - circle the appropriate response number and where required fill in other locations.*

1 Mapunga Mountain
2 Chikwirandaombera Mountain
3 Chamapere Mountain
4 Ndemera Mountain
5 Mucheunje Mountain
6 Muchinjike Mountain
7 Mutaragume Mountain
8 Gugwa Mountain
9 Mazimi Mountain
10 Njedza Mountain
11 Chemakudo Mountain
12 Runyange Mountain
13 Kapuka Mountain
14 other _____
15 other _____

13. I will read you a list of trees. Did you have any of these trees in your headload? Can you show me what proportion of each you had in your headload? *Enumerator - circle the appropriate response number for each species. Pick out the cards for each species and place on the ground. Give the person 25 sticks to distribute amongst the cards. Write in the number in the space beside each species.*

	proportion of headload			proportion of headload	
1 mupfuti	_____	9	mupangara	_____	
2 munhondo	_____	10	mukute	_____	
3 muunze	_____	11	mucherekesi	_____	
4 muvanga	_____	12	munyada	_____	
5 musasa	_____	13	mubvamaropa	_____	
6 mukuyazvigo	_____	14	mutukutu	_____	
7 muhacha	_____	15	other - specify	_____	_____
8 mukonono	_____	16	other - specify	_____	_____

14. Did you walk with anyone to collect wood?

1 yes
2 no
9 don't know

15. Did you deliver something on this trip to the collection site?

1 yes
2 no
9 don't know

16. How long did it take you to walk there?

_____ *Enumerators please include the unit of time (minutes or hours)*

17. Once you arrived at the spot where you wanted to collect wood, how long did it take you to collect your headload? _____ *Enumerators please include the unit of time (minutes or hours)*

18. How far do you think you walked there and back? _____ kilometers

Trip # 2

19. Where did you go to collect firewood? *Enumerator - circle the appropriate response number and where required fill in other locations.*

1 Mapunga Mountain
2 Chikwirandaombera Mountain
3 Chamapere Mountain
4 Ndemera Mountain
5 Mucheunje Mountain
6 Muchinjike Mountain
7 Mutaragume Mountain
8 Gugwa Mountain
9 Mazimi Mountain
10 Njedza Mountain
11 Chemakudo Mountain
12 Runyange Mountain
13 Kapuka Mountain
14 other _____
15 other _____

20. I will read you a list of trees. Did you have any of these trees in your headload? Can you show me what proportion of each you had in your headload? *Enumerator - circle the appropriate response number for each species. Pick out the cards for each species and place on the ground. Give the person 25 sticks to distribute amongst the cards. Write in the number in the space beside each species.*

	proportion of headload			proportion of headload	
1 mupfuti	_____	9	mupangara	_____	
2 munhondo	_____	10	mukute	_____	
3 muunze	_____	11	mucherekesi	_____	
4 muvanga	_____	12	munyada	_____	
5 musasa	_____	13	mubvamaropa	_____	
6 mukuyazvigo	_____	14	mutukutu	_____	
7 muhacha	_____	15	other - specify	_____	_____
8 mukonono	_____	16	other - specify	_____	_____

21. Did you walk with anyone to collect wood?

1 yes
2 no
9 don't know

22. Did you deliver something on this trip to the collection site?

1 yes
2 no
9 don't know

23. How long did it take you to walk there?

_____ *Enumerators please include the unit of time (minutes or hours)*

24. Once you arrived at the spot where you wanted to collect wood, how long did it take you to collect your headload? _____ *Enumerators please include the unit of time (minutes or hours)*

25. How far do you think you walked there and back? _____ kilometers

Trip # 3

26. Where did you go to collect firewood? *Enumerator - circle the appropriate response number and where required fill in other locations.*

1 Mapunga Mountain
2 Chikwirandaombera Mountain
3 Chamapere Mountain
4 Ndemera Mountain
5 Mucheunje Mountain
6 Muchinjike Mountain
7 Mutaragume Mountain
8 Gugwa Mountain
9 Mazimi Mountain
10 Njedza Mountain
11 Chemakudo Mountain
12 Runyange Mountain
13 Kapuka Mountain
14 other _____
15 other _____

27. I will read you a list of trees. Did you have any of these trees in your headload? Can you show me what proportion of each you had in your headload? *Enumerator - circle the appropriate response number for each species. Pick out the cards for each species and place on the ground. Give the person 25 sticks to distribute amongst the cards. Write in the number in the space beside each species.*

		proportion of headload			proportion of headload
1	mupfuti	_____	9	mupangara	_____
2	munhondo	_____	10	mukute	_____
3	muunze	_____	11	mucherekesi	_____
4	muvanga	_____	12	munyada	_____
5	musasa	_____	13	mubvamaropa	_____
6	mukuyazvigo	_____	14	mutukutu	_____
7	muhacha	_____	15	other - specify	_____ _____
8	mukonono	_____	16	other - specify	_____ _____

28. Did you walk with anyone to collect wood?

1 yes
2 no
9 don't know

29. Did you deliver something on this trip to the collection site?

1 yes
2 no
9 don't know

30. How long did it take you to walk there?

_____ *Enumerators please include the unit of time (minutes or hours)*

31. Once you arrived at the spot where you wanted to collect wood, how long did it take you to collect your headload? _____ *Enumerators please include the unit of time (minutes or hours)*

32. How far do you think you walked there and back? _____ kilometers

Trip # 4

33. Where did you go to collect firewood? *Enumerator - circle the appropriate response number and where required fill in other locations.*

1 Mapunga Mountain
2 Chikwirandaombera Mountain
3 Chamapere Mountain
4 Ndemera Mountain
5 Mucheunje Mountain
6 Muchinjike Mountain
7 Mutaragume Mountain
8 Gugwa Mountain
9 Mazimi Mountain
10 Njedza Mountain
11 Chemakudo Mountain
12 Runyange Mountain
13 Kapuka Mountain
14 other _____
15 other _____

34. I will read you a list of trees. Did you have any of these trees in your headload? Can you show me what proportion of each you had in your headload? *Enumerator - circle the appropriate response number for each species. Pick out the cards for each species and place on the ground. Give the person 25 sticks to distribute amongst the cards. Write in the number in the space beside each species.*

		proportion of headload			proportion of headload
1	mupfuti	_____	9	mupangara	_____
2	munhondo	_____	10	mukute	_____
3	muunze	_____	11	mucherekesi	_____
4	muvanga	_____	12	munyada	_____
5	musasa	_____	13	mubvamaropa	_____
6	mukuyazvigo	_____	14	mutukutu	_____
7	muhacha	_____	15	other - specify	_____ _____
8	mukonono	_____	16	other - specify	_____ _____

35. Did you walk with anyone to collect wood?

1 yes
2 no
9 don't know

36. Did you deliver something on this trip to the collection site?

1 yes
2 no
9 don't know

37. How long did it take you to walk there?

_____ *Enumerators please include the unit of time (minutes or hours)*

38. Once you arrived at the spot where you wanted to collect wood, how long did it take you to collect your headload? _____ *Enumerators please include the unit of time (minutes or hours)*

39. How far do you think you walked there and back? _____ kilometers

Section III - Firewood Collection Using a Scotch-Cart

40. Did anyone from this household go and collect wood using a scotch-cart last week?

1 yes
2 no
9 don't know

41. Did anyone hire a scotch-cart for collecting wood last week?

1 yes
2 no
9 don't know

Enumerator: If the answers to questions #40 & #41 are no, then go to question 49.

42. What was this scotch-cart load intended to be used for?

1 domestic purposes (cooking, ironing, heating)
2 beer brewing
3 brick-burning
4 other specify _____
9 don't know

43. Where did the scotch-cart go to collect firewood? *Enumerator - circle the appropriate response number and where required fill in other locations.*

1	Mapunga Mountain
2	Chikwirandaombera Mountain
3	Chamapere Mountain
4	Ndemera Mountain
5	Mucheunje Mountain
6	Muchinjike Mountain
7	Mutaragume Mountain
8	Gugwa Mountain
9	Mazimi Mountain
10	Njedza Mountain
11	Chemakudo Mountain
12	Runyange Mountain
13	Kapuka Mountain
14	other _____
15	other _____

44. I will read you a list of trees. Were any of these trees in the scotch-cart load? Can you show me what proportion of each you had in the scotch-cart load? *Enumerator - circle the appropriate response number for each species. Pick out the cards for each species and place on the ground. Give the person 25 sticks to distribute amongst the cards. Write in the number in the space beside each species.*

	proportion of headload			proportion of headload	
1 mupfuti	_____	9	mupangara	_____	
2 munhondo	_____	10	mukute	_____	
3 muunze	_____	11	mucherekesi	_____	
4 muvanga	_____	12	munyada	_____	
5 musasa	_____	13	mubvamaropa	_____	
6 mukuyazvigo	_____	14	mutukutu	_____	
7 muhacha	_____	15	other - specify	_____	_____
8 mukonono	_____	16	other - specify	_____	_____

45. Did you deliver something on this trip to the collection site?

1	yes
2	no
9	don't know

46. How long did it take you to harness the oxen and drive them to the spot where you were collecting the wood? _____ *Enumerator - include the appropriate unit of time.*

47. How long did it take you to collect the cartload of wood? _____
Enumerator - include the appropriate unit of time.

48. How far do you think the scotch-cart traveled?
_____ kilometers

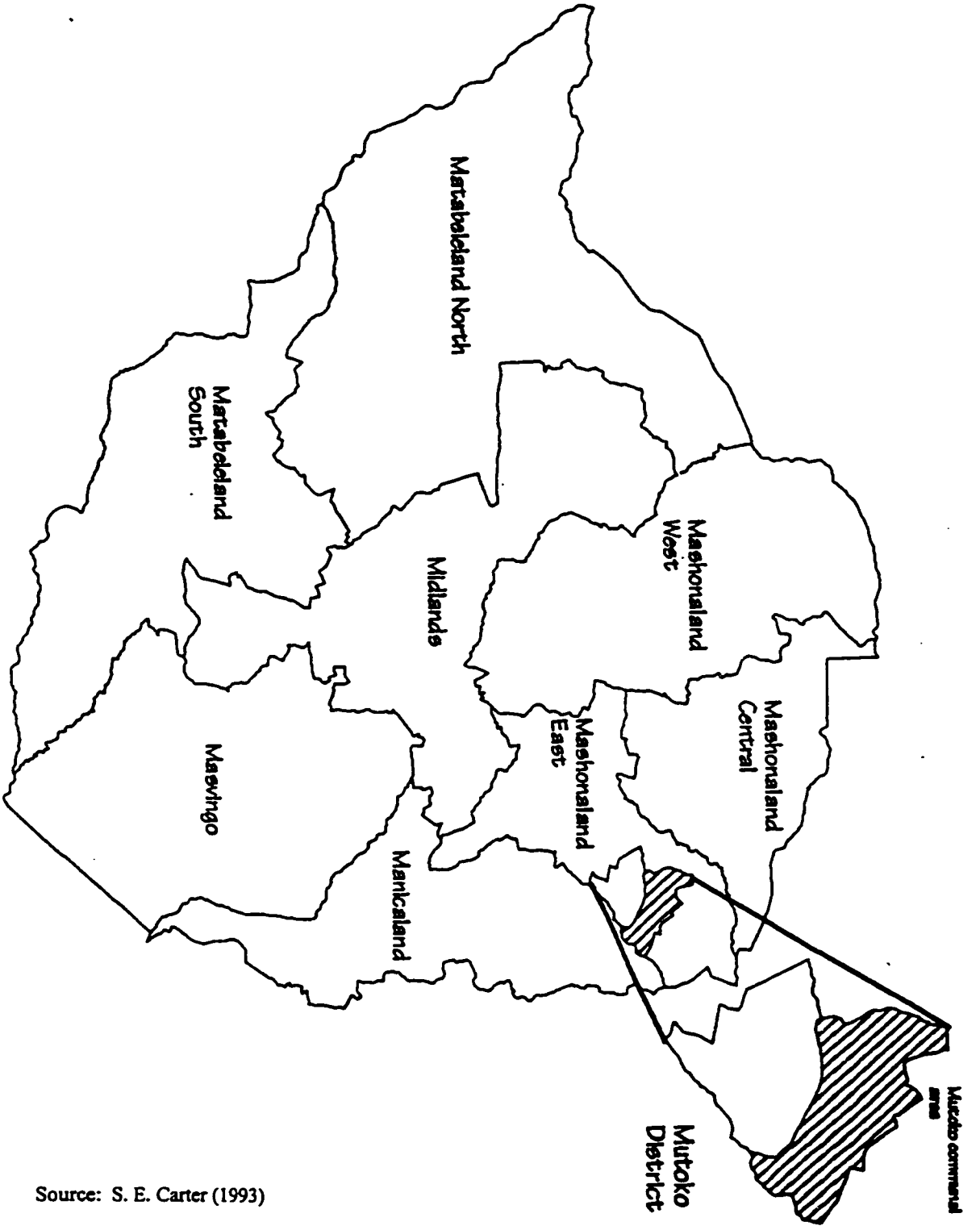
49. Does the husband usually live at the homestead?

1	not applicable - not married, widowed or divorced
2	married - spouse present
3	married - spouse not present (lives and works elsewhere most of the time)

finish time _____

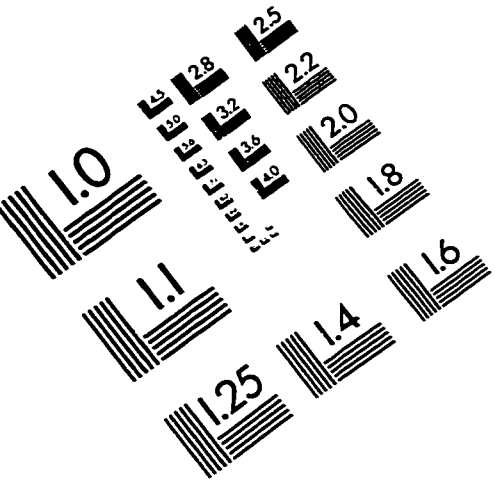
Gender of Respondents 1 Female 2 Male 3 Both Male and Female were interviewed

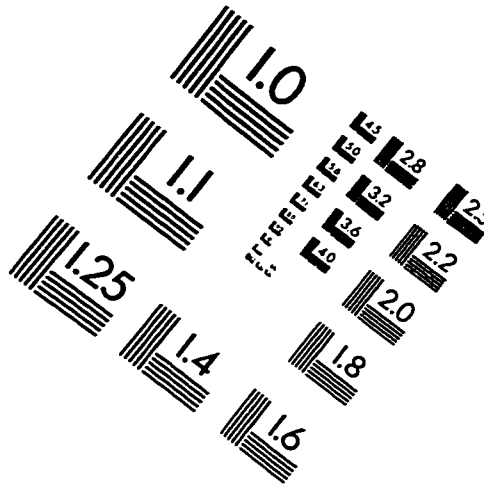
Appendix III

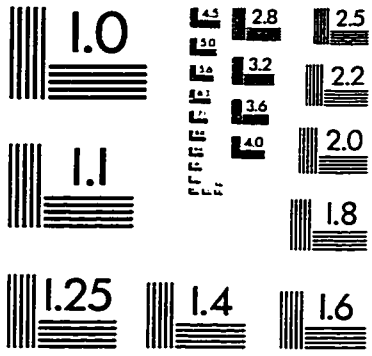


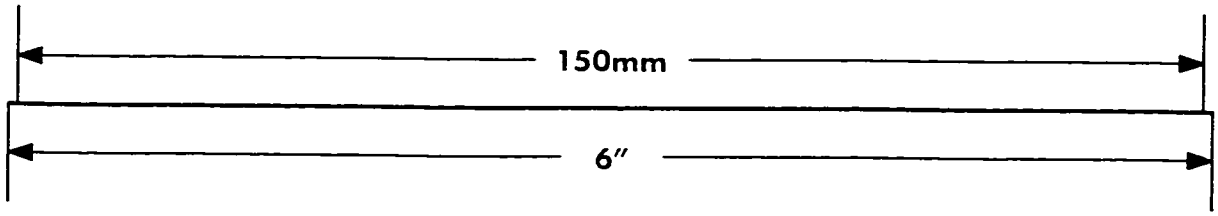
Source: S. E. Carter (1993)

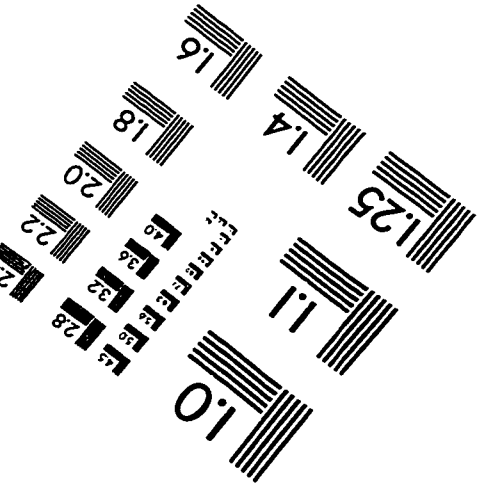
IMAGE EVALUATION TEST TARGET (QA-3)

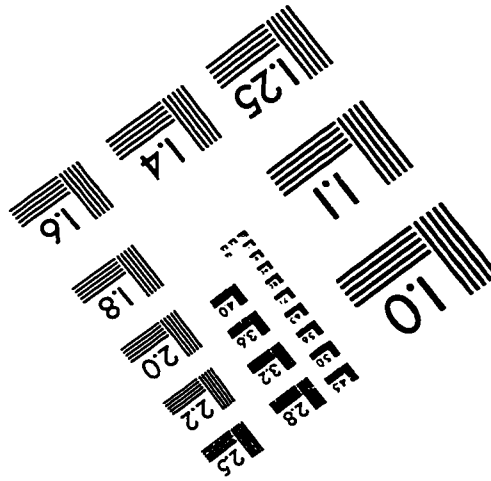












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