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Research, part of a Special Feature on Balancing Ecology and Community using Cumulative Effects Models

Cumulative Effects Planning: Finding the Balance Using Choice Experiments

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ABSTRACT. Cumulative effects management requires understanding the environmental impacts of development and finding the right balance between social, economic, and environmental objectives. We explored the use of choice experiments to elicit preferences for competing social, economic, and ecological outcomes in order to rank land and resource development options. The experiments were applied in the Southeast Yukon, a remote and resource rich region in Northern Canada with a relatively large aboriginal population. The case study addresses two issues of concern in cumulative effects management: the willingness to discount future environmental costs for immediate development benefits, and the existence of limits of acceptable change for communities affected by development. These issues are thought to be particularly relevant for First Nations in Northern Canada where cultural identify is tied to the land and continuity of the community is an important value. We found that residents of the Southeast Yukon value benefits from both development and conservation and must make trade-offs between these competing objectives in evaluating land use scenarios. Based on the preference information we evaluated four land use scenarios. Conservation scenarios ranked higher than development scenarios, however, there was significant heterogeneity around preferences for conservation outcomes suggesting a low degree of consensus around this result. We also found that residents did not discount the future highlighting the importance of intergenerational equity in resource development decisions. We did not find evidence of development thresholds or limits of acceptable change. Interestingly we found no difference in preferences between the aboriginal and non-aboriginal populations.

Key Words: *aboriginal preferences; choice experiments; cumulative effects; Northern Canada*

INTRODUCTION

Canada's North is undergoing enormous transformation with major new investments in oil and gas, hydroelectricity, mining, and forestry. The challenge is to ensure that development brings long-term benefits to Northern communities and maintains the well-being of current and future generations as measured along social, economic, and ecological dimensions (Adams 2006). In the Southeast Yukon resource development will provide jobs and revenues to communities but may also have a negative impact on traditional land uses such as fishing, hunting and trapping, as well as on the social cohesion of communities due to changes in population, income, and cultural practices. In order to incorporate all of these issues into land use planning, decision makers require information on the impacts of development on social, economic, and ecological indicators, as well as the community's evaluation of these changes.

In this study we use a choice experiment to estimate community preferences for competing social, economic, and ecological dimensions of land use change in the Southeast Yukon. The survey was carried out in 2005 as part of Environment Canada's Northern Ecosystem Initiative program, which was launched in recognition of the need to manage transformation of the Canadian North (Northern Ecosystem Initiative 2009). The purpose of this study was to work with the residents of the Southeast Yukon to identify relevant social, ecological, and economic indicators of land use change and develop cumulative effects assessment tools that the community could use for land use planning. Simulation models are often used by local resource planning agencies to explore the cumulative effects of different land development strategies on valued social, economic, and environmental outcomes (Peterson et al. 2003, Carlson et al. 2007). However, additional information is required to decide which development scenarios are preferred from society's perspective. The community preferences elicited from the choice experiment were used to construct measures of well-being and to rank preferred land use alternatives generated from hypothetical land use scenarios. The approach shows how community preferences can be linked to cumulative effects scenario analysis in order to assess and develop land use plans.

The study area is the traditional territory of the Kaska First Nation and includes the four communities of Faro, Ross River, Upper Liard, and Watson Lake, which have a combined population of about 2300 people of which approximately 30% are aboriginal (Statistics Canada 2001). The region, which is 83,968 km^2, is covered by boreal forest and holds most of the Yukon's mineral, energy, and marketable timber resources. Historically, forestry and mining were an important part of the commercial economy of the region, however, these sectors declined in the 1990s, leading to job losses and the out-migration of young adults (Yukon Economic Development 2005). Currently the main source of employment is the public

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sector, with the rest of the jobs coming from trapping, tourism, retail, construction, and manufacturing. Although past forestry and mining projects resulted in localized deforestation and watershed contamination, the overall industrial footprint on the landscape is relatively small and the region remains relatively pristine. Recent increases in commodity prices have resulted in new proposals for mining, forestry, and energy projects and the need for land use planning (e.g., Charles River Associates 2005, Holroyd and Retzer 2005, Peter et al. 2007). In 2002 the Kaska, Yukon, and Canadian governments signed a Memorandum of Understanding which led to the creation of the Kaska Forest Resources Stewardship Council whose mandate was to provide recommendations for forest management in the Southeast Yukon based on the ecological, social, cultural, traditional, and economic values of the region (LGL 2011).

Evaluation of the environmental and socioeconomic impacts for large resource development projects in the Yukon involves stakeholder meetings and public consultations (Yukon Environmental and Socio-Economic Assessment Board 2005). However, these approaches are not sufficient to provide an understanding of the public preferences for trade-offs between different social, economic, and environmental outcomes, or to compare preferences between different groups within communities. There are a number of methods for incorporating value trade-offs in land use planning processes (Gregory 2000*a*, Harrison and Qureshi 2000, Ananda and Herath 2003). Narrative and qualitative approaches, including multi-attribute approaches such as the Analytical Hierarchy Process, are suitable for group deliberation and prioritization (e.g., Duke and Aull-Hyde 2002, Curtis 2004, Hampton 2009) but are less suitable for environmental policy choices that require understanding the general public's preferences for trade-offs between competing values such as jobs, wildlife habitat, and cultural resources (Gregory 2000*a*).

One way to assess the public's preferences is to directly ask their willingness to pay or to accept compensation for land management alternatives. However, it can be difficult to assign single dollar values to management alternatives that affect multiple dimensions of well-being in competing ways. In addition, monetary valuation approaches may not be appropriate for aboriginal communities (Gregory and Trousdale 2009). Attribute based valuation approaches such as choice experiments allow decision makers to quantify the value trade-offs embedded in management alternatives in order to select between competing alternatives (Gregory 2000*b*). Choice experiments involve individuals making repeated hypothetical decisions over management alternatives represented by multiple attributes that take on different levels under each alternative. When surveyed over many people the choice between alternatives can be used to construct measures for ranking public preferences over management alternatives (Louviere et al. 2000, Hoyos 2010). These measures are important for evidence-based decision making in environmental policy decisions (e.g. Duke and Aull-Hyde 2002, Moran et al. 2007, Scarpa et al. 2007).

Two dimensions of value which are of particular interest for cumulative effects management are the intertemporal distribution of benefits and costs from development, and potential limits of acceptable change. Time preferences measure the degree to which individuals are willing to trade off or discount future well-being for present well-being. Because discounting shifts environmental costs on to future generations, it is sometimes argued that government discount rates should be lower than individual discount rates (Boardman et al. 2001). Many land use scenarios lead to cumulative impacts that play out over years and decades rather than immediately. Intergenerational equity has been identified as an important element of First Nation value systems so the concept of discounting the future may be unacceptable (Gregory and Trousdale 2009, Place and Hanlon 2009). These observations reinforce what we heard during workshops in the North where community members spoke about the need to plan for multiple generations and the linkage of their identity to what happens on the land. Therefore, it is important to understand how communities view scenarios that have different impacts over time, and how future costs and benefits are discounted.

Limits of Acceptable Change is a planning framework for management of wilderness recreation areas in the United States that involves defining minimal acceptable conditions beyond which change is unacceptable (Stankey and McCool 1984, Stankey et al. 1985). The framework has since been expanded to other contexts such as management of aquaculture (Zeldis et al. 2006). Ecological thresholds are defined as points where small changes in land use produce large non-linear ecosystem responses (e.g., Holling 1973, Groffman et al. 2006). We define limits of acceptable change or social thresholds as points where small changes in land use produce discrete non-linear responses in human well-being. The concept of social thresholds is motivated by potential losses from development that cannot be compensated by additional jobs and revenues. Values that are quantity insensitive, or viewed as infinitely more important than others often arise in environmental problems and may be associated with moral obligation (Baron and Spranca 1997, Adamowicz et al. 1998). Examples include protection of pristine ecosystems and the existence of wildlife, or a duty to exercise the precautionary principle (Baron and Leshner 2000, Tanner et al. 2008, Baron and Ritov 2009). What is important from the perspective of this study is that individuals express these values in valuation exercises by a reluctance to make certain trade-offs.

Protected values may be especially significant for losses to aboriginal communities resulting from resource development (Adamowicz et al. 1998, Gregory and Trousdale 2009).

McDaniels and Trousdale (2005) argue that the loss of spiritual sites and opportunities for cultural practice is equivalent to the loss of identify. In interviews with Metis in northern Alberta, they found that traditional skills and sites, and environmental values such as “respect for the land”, consistently ranked above other social and economic values with some community participants suggesting that money could only compensate for losses to traditional and environmental values if it was used to replace the original values lost. Similarly in interviews with the Tse Keh Nay First Nations over the Kemess Mine proposal in Northern British Columbia, Place and Hanlon (2009) found that the economic benefits accompanying development were counteracted by feelings of loss of cultural identity and disempowerment. Some of the Tse Keh Nay noted that jobs and training could not compensate for the long-term negative impacts of development and that reclamation could never replace lost artifacts or burial sites, or return sites to their original state.

METHODS

Choice experiments are survey-based methods to elicit preferences for different attributes of decisions using hypothetical alternative scenarios (Louviere et al. 2000). Measurement of preferences from choice experiments relies on random utility theory, which assumes that an individual derives utility or satisfaction not from the scenario itself, but from the specific attributes that make up the scenario (Holmes and Adamowicz 2003). The utility or satisfaction of any particular scenario *i* is a function of deterministic and random components and can be expressed as

$$V_i = \beta_k X_{k,t,i} + e_i \quad (1)$$

where $X_{k,t,,i}$ are the *k* environmental, social, and economic attributes of a scenario or land use plan *i* that occurs at time *t*; β is a coefficient vector that shows how utility or satisfaction changes as attribute levels are varied; and *e* is a random error term that captures other elements of the scenario that are not reflected in the attributes ($X_{k,t,,i}$). Assuming that the error is independently and identically distributed with a type I extreme value distribution, the probability that an individual will choose an alternative can be expressed as a logit model, which is used to estimate Equation 1 (Ben-Akiva and Lerman 1985, Train 1998). The estimated coefficients represent the marginal contributions of each attribute to individual well-being and can be used to assess the trade-offs between attributes presented by different land use options. In particular, the ratio β_j / β_k illustrates the rate at which respondents are willing to trade one attribute for another.

In the empirical analysis presented, trade-offs between different social, economic, and environmental outcomes for the Southeast Yukon are examined through the selection of attributes and comparison of the marginal contributions of attributes to individual well-being. To examine whether individuals discount future costs and benefits, each attribute is varied over discrete time periods. This allows for the possibility that the attribute preferences (β) in each period may be discounted by a factor $\delta=(1+r)^{-t}$, where *r* is the discount rate. If outcomes in future time periods are viewed as having lower weight in choices than outcomes or attributes in earlier periods, the estimated discount rate will be positive. A maximum likelihood estimate of the discount rate suggests evidence of zero discounting. The question of thresholds is addressed by testing the significance of dummy variables for the lowest attribute levels, which would signify a discrete change in well-being. These tests did not provide significant evidence of thresholds. Community heterogeneity is similarly explored by incorporating dummy variables for observable demographic characteristics. While there was no evidence of observable heterogeneity, even between aboriginal and non-aboriginal groups, random parameter models suggest significant unobservable heterogeneity. Finally, the model coefficients and attribute levels are used to construct a utility index, which is used to evaluate community preferences for different land use change scenarios.

Experimental Design

In order to be effective for land use planning, the attributes in the choice experiment had to be meaningful to the respondents as well as appropriate for simulating future scenario outcomes (e.g. Gregory et al. 1993, Russell et al. 2001, Gregory and Trousdale 2009). The attribute descriptions were developed from focus groups held in Watson Lake in spring 2005. During the focus groups participants were shown a presentation depicting changes in social, economic, and ecological outcomes from land use scenarios and were asked to describe and discuss their aspirations and concerns about development. Participants were then asked to define issues and indicators, which were prioritized in a voting exercise.

Based on the focus groups, four attributes were selected for the experiment: (1) the percentage of local residents with jobs (JOBS); (2) the density of moose populations on the landscape (number of moose per km^2) (MOOSE); (3) daily fish catch rates (FISH); and (4) the total human population of the region (PEOPLE). Moose were prioritized by the focus group because of their value for hunting, and the moose density attribute was considered a proxy for hunting success. The population variable was included as a proxy for social change and community cohesion. These attributes correspond to values identified in other aboriginal land use studies, such as the impact of development on the health of species such as caribou, moose, and groundhog, and on traditional hunting (McDaniels and Trousdale 2005, Place and Hanlon 2009). While members of the community also expressed concerns about development impacts on human health, these attributes were not included in the experiment because of lack of information on project health outcomes from land use scenarios. The community also expressed a number of social and governance concerns about development that were not direct outcomes of alternative land use scenarios and that were not included in the experiment. The community recommended a 100 year planning horizon. The 100 years were divided into intervals representing the current period, 10 years, 50 years, and 100 years.

Table 1. Attributes and Levels in the Choice Experiment

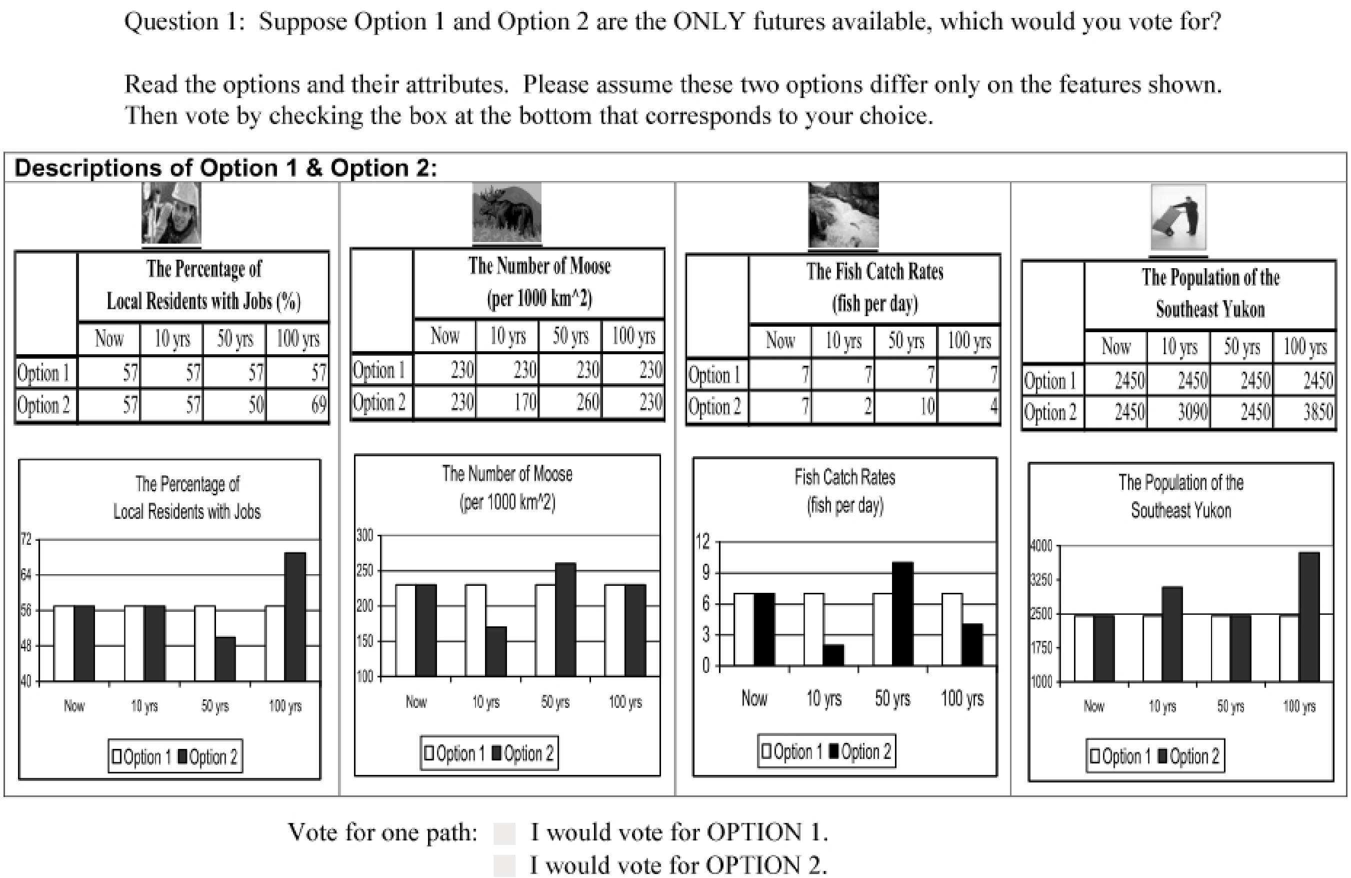
	Jobs (employment rate)		Moose (#/km^2)		Fish (catch/day)		People (population)	
No.	Level	Change	Level	Change	Level	Change	Level	Change
1	57	0	230	0	7	0	2450	0
2	50	-7	260	30	10	3	2298	-152
3	63	6	170	-60	4	-3	3090	640
4	69	12	140	-90	2	-5	3850	1400

Four attribute levels were constructed and presented in terms of deviation from baseline or current levels (Table 1). The JOBS attribute is based on a baseline employment rate of 57% (Statistics Canada 2001). The upper end of the employment rate was set at 69%, which is comparable to employment levels in Alberta, which has significant oil and gas deposits, under boom conditions. The lower end of the employment rate was set at 50%, which is comparable to the employment rate of 50.7% for Newfoundland, the province with Canada's highest unemployment (Statistics Canada 2005). The MOOSE attribute is based on baseline moose density numbers of 232/1000 km^2 (R. Ward, Department of Environment, Yukon Territorial Government, 2005, *personal communication*). For simplicity this number was rounded to 230/1000 km^2 for the experiment. Moose densities in the southern Yukon range from 150 to 250 per 1000 km^2 depending on the area (Yukon Fish and Wildlife 1996). This range was used for the high and low moose density levels. Levels for FISH were based on guidance from a local fishing elder and verified by other residents who also fish in the Southeast Yukon. According to local knowledge, the typical catch rate for a lake or a river in the area is about seven fish per day. A high catch rate, typical of a lake with lower access, is about 10 fish per day. The catch rate currently experienced in some lakes with higher access is four fish per day. Based on discussion with residents it was determined that a low level catch rate would be two fish per day. Finally, the current levels for POPULATION were based on data from the June 2005 Population Report (Yukon Bureau of Statistics 2005) while population attribute levels are based on historical ranges of population fluctuation for the last 10 years according to the 2004 edition of Yukon Community Profiles (Government of Canada et al. 2004). The 2005 population estimate of 2407 people was rounded up to 2450 for the baseline, and deviations were tied to the range of fluctuation over the last 10 years (Yukon Bureau of Statistics 2005). Due to the boom and bust cycle of mining, the region has experienced large fluctuations in population. For example, between 1996 and 2003, the population decreased by 1279 people.

The choice task for the survey was framed as a regional referendum in which citizens could vote on different development options for the region. In the instructions the participants are told that the land use planners in the Southeast Yukon are making decisions over alternative land development options and that the experiments are being used to understand the impacts of these developments on the community. Participants were told that the alternative scenarios were hypothetical and not based on specific land development options being considered by the Kaska Forest Resource Stewardship Council. They were also told and that each scenario represented just one of many possible future outcomes. Participants were not given information about scenario drivers (for example, increases in energy prices, or expansion of the forestry sector) to eliminate potential confounding effects due to preferences for certain drivers or lack of credibility between scenario drivers and the outcomes presented. Because no individual choice task is binding, it is possible that the incentive compatibility associated with multiple choice tasks is reduced relative to a single choice task. However, the trade-off is that much less information is collected using a single choice task. We opted to collect larger amounts of information, given the small population, and hope that the incentive compatibility effects are small. In the instructions respondents were asked to consider each "vote" independently in the hope that this would improve incentive compatibility.

The choice tasks in the experiment were developed using experimental design software to construct a set of choice tasks from the set of possible combinations of the attributes and levels. The four attributes were used to construct choices between a business-as-usual scenario, with constant attribute levels in each period based on the current state, and one alternative. The purpose of holding the status quo alternative constant is to keep the choice task as easy to understand as possible and to provide a business-as-usual benchmark for respondents to compare with other alternatives. Including all possible combinations from the four attributes and levels over three time periods would have resulted in a full factorial design of 4^{12} possible profiles, which was too large to implement. Instead a fractional factorial main effects design was used to construct the choice tasks resulting in 48 profiles. In order to ensure that the survey could be completed within a reasonable amount of time it was decided that eight profiles or scenarios was the maximum number that each respondent could be expected to assess. The business-as-usual scenario was removed from the experimental design and the remaining 47 profiles were divided into six sets of eight with one profile repeated so that all participants completed the same number of sets. An example of a choice task is provided in Figure 1.

Fig. 1. Illustration of the Choice Task



The survey was pilot tested three times in Watson Lake and Upper Liard with a total of 32 pilot surveys completed. After revisions the final survey was administered to 252 residents, or approximately 10% of the population, using a door-to-door random sampling method. With the assistance of local residents the survey sample was stratified to ensure adequate representation from different groups within the community including Kaska elders and local business and political leaders. Demographic targets were identified to track the "representativeness" of the sample in terms of ethnicity, gender, income, and location based on the 2001 Census (Statistics Canada 2001). The final sample included 16 elders and 12 business and political leaders. Surveys were hand delivered to the homes and picked up two or three days later. The final response rate was 196 out of 252 or 78%. Table 2 compares the demographic target for each category versus actual responses. About 50% of the respondents had some postsecondary education (university, college, or technical school training), while the other half had either a high school diploma (19%) or had not completed high school (30%). Approximately 17% of survey respondents were looking for work and 44% of the sample had a household income of less than $40,000 per year.

Table 2. Demographic characteristics of the sample

Demographic Characteristic	Target	Actual Survey Representation
Ethnicity:		
First Nations	30%	34%
Non-First Nations	70%	65%
Gender:		
Male	56%	51%
Female	44%	48%
Income:		
Average (household)	~ $36,600	$40,000 to $49,999
Community		
(percent of total):	63%	66%
Watson Lake	7%	9%
Upper Liard	14%	14%
Ross River	16%	11%
Faro		

Respondents were asked several debriefing questions about the survey. Overall, participants felt that their participation in the survey was important (79%), that they understood the information (85%), and that they understood what was being asked of them (87%).

RESULTS

Prior to completing the choice task, participants were asked a series of warm-up questions to get them thinking about land use and value trade-offs. Almost 74% of respondents reported that they paid attention to forestry or land use related issues, and the same percentage wanted more opportunities for public involvement in resource planning. Responses about land values were relatively homogeneous. Most respondents (88%) felt that forests helped them feel close to nature and rejuvenate the human spirit. Almost all respondents (93%) identified pure existence values for wilderness and about the same number (94%) agreed that it is important to maintain the forests in a sustainable way for future generations. Seventy-three percent of respondents thought humans could improve the forest through forest management including reducing water pollution (78%) and increasing fire suppression effort (67%). Most people (90%) agreed that economic development and jobs were important and 68% agreed that there are trade-offs between jobs and environmental quality. However, only 54% of respondents agreed that the primary function of the forest is to provide products and services to humans.

A number of regression models were estimated using Limdep 3.0.1. The results are presented in Table 3. The basic linear model with 12 attributes (column 1) has positive and significant coefficients on the job and moose attributes. The constant and population coefficients are insignificant in all periods. A significant constant could indicate a preference for the business-as-usual alternative and be evidence of a rejection of the choice scenario or that the choice task is too complex. The insignificance of the constant provides some evidence that these effects are not present in the data. The estimated rho-squared for all of the models is low, suggesting significant unexplained variation, which is not surprising given the complexity of the instrument. However, for the hypotheses tested we are concerned with the significance of specific coefficients, which remain remarkably stable across model runs, and the difference in goodness of fit measures between models.

Discounting

The basic linear model provides estimates of coefficients on attributes for each time period. Zero discounting implies that the coefficients for the scenario attributes in each of the three time periods are equal as in Eq. 2:

$$\begin{aligned}
\beta_{jobs10} &= \beta_{jobs50} = \beta_{jobs100} = \beta_{Jobs} \\
\beta_{moose10} &= \beta_{moose50} = \beta_{moose100} = \beta_{Moose} \\
\beta_{fish10} &= \beta_{fish50} = \beta_{fish100} = \beta_{Fish} \\
\beta_{pop10} &= \beta_{pop50} = \beta_{pop100} = \beta_{Pop}
\end{aligned} \tag{2}$$

Table 3. Results from the regression models

	Basic 12 - linear	Basic Linear	Quadratic	Log Linear	Estimated Discount Rate
Adjusted R-squared	0.04364	0.04265	0.04147	0.03274	NA
Log Likelihood	-1017.68	-1023.98	-1022.62	-1034.58	1022.20
Variable	**Coefficient (t-ratio)**				
Constant	0.0056 (0.043)	0.0021 (0.016)	-0.2208 (0.760)	0.0717 (0.541)	-0.0938 (-0.972)
Discount Rate					-0.0054* (-2.197)
Jobs 10	0.0204** (2.710)	0.0263 ** (5.344)	0.1462 (1.407)	0.0146 ** (5.200)	0.0192** (3.963)
Jobs 50	0.0262** (3.135)				
Jobs 100	0.0330** (4.417)				
Moose 10	0.0058** (5.046)	0.0055 ** (7.698)	0.0157 (1.501)	0.0100 ** (6.485)	0.0041** (4.637)
Moose 50	0.0033** (2.838)				
Moose 100	0.0076** (6.648)				
Fish 10	-0.0043 (-0.244)	0.0228 * (2.208)	0.0079 (0,12)	0.0011 * (2.054)	0.0189* (2.379)
Fish 50	0.0360* (2.099)				
Fish 100	0.0369* (2.117)				
Pop 10	0.0001 (0.639)	0.0001 (1.058)	-0.0005 (0.057)	0.0021 (1.252)	
Pop 50	0.0000 (0.198)				
Pop 100	0.0001 (1.166)				
Jobs-squared			-0.0010 (1.16)		
Moose-squared			-0.0002 (0.972)		
Fish-squared			0.0013 (0.252)		
Population-squared			0.00000009 (0.621)		

$^*P<0.05$, $^{**}P<0.01$

The results from the restricted linear model are presented in Table 3, Column 2. A likelihood ratio test demonstrates that the basic linear model is not significantly different from the restricted linear model, suggesting the possibility of zero discounting. In order to explore discounting, a maximum likelihood procedure in Limdep was used to directly estimate the discount rate *r* given in Eq. 3:

$$V_i = \beta_0 + \beta_{i,1} / (1+r)^t (X_{i,t}) \quad (3)$$

For the analysis only five coefficients were estimated: the constant, jobs, moose, fish, and the discount rate. The population variable was dropped because it was insignificant in both the full and restricted linear model and because of the difficulty of handling six variables in the maximum likelihood estimation procedure. The results are presented in the Table 3, Column 3. The estimated discount rate of -0.0054% is statistically significant and negative suggesting that the community actually puts slightly higher weight on future outcomes than present outcomes. However, because the discount rate is so low, for practical purposes it can be treated as zero.

With zero discounting we can use the restricted model, which provides a clearer interpretation of trade-offs among attributes and allows sufficient degrees of freedom to test additional specifications. Quadratic and log linear specifications were tested in order to capture potential diminishing returns or satiation from incremental increases in attribute levels. The results are presented in Table 3, Columns 3 and 4 respectively. Although the coefficients on the non-linear variables are significant, the quadratic and log linear models do not provide more explanatory power than the linear model, thus in the remainder of the analysis we focus on the basic restricted linear utility model in order to maintain sufficient degrees of freedom to examine individual and interaction effects.

Thresholds

Social thresholds were tested by looking for discontinuities or negative shifts in the coefficients for low attribute levels, which would indicate a significant negative shift in community well-being. In order to test for the existence of thresholds, dummy variables were developed for the lowest attribute levels for each of the four attributes and included in the basic model. The results are presented in Table 4. The coefficients on the low-level dummy variables for jobs in 50 years and moose in 100 years are both statistically significant and negative. However, the model does not perform well. No other coefficients were significant including the previously significant coefficients on the restricted linear model. Furthermore, a chi-square test did not find a significant improvement of the thresholds model over the basic linear model. Investigation of choices from scenarios that involved the lowest levels of the attributes showed that on average respondents did not avoid choosing these options, supporting the idea that none of the levels presented in the experiment exceeded a social threshold.

Heterogeneity

Based on focus groups and discussions with community members, we expected heterogeneity between aboriginal and non-aboriginal groups as well as other demographic groups. Heterogeneity between aboriginal and non-aboriginal groups was tested for by interacting a dummy variable term for First Nations with the regressors. The results are shown in Table 4, Columns 3 and 4. Interestingly none of the dummy variables are significant, suggesting that there is little difference in preferences between aboriginal and non-aboriginal residents. Additional tests for community heterogeneity showed little evidence of heterogeneity between any observable demographic groups (Spyce 2006). Women were slightly more likely than men to desire increased population in the region while public servants were more likely to desire increased fish populations. Not surprisingly, individuals looking for work had a stronger preference for increased employment. At the same time, age, education, and income interaction terms were all insignificant.

Even without heterogeneity between observable groups there still may be heterogeneity in the community preferences driven by unobservable individual characteristics. A mixed logit model was used to estimate the effects of unobserved heterogeneity. The model assumes that individual-specific effects on the attribute coefficients (β) are distributed across the population according to a normal distribution. Based on this assumption it is possible to estimate both a mean and a variance for each coefficient (e.g., Popkowski et al. 1998, Train 1998). The results are presented in Table 4, Columns 5 and 6.

The mean estimates for the attributes of jobs, moose, and fish are statistically significant while population continues to be insignificant. The estimated standard deviation provides information about the distribution of preferences around the mean. The standard deviations for the moose, fish, and population attributes are statistically significant indicating a lack of consensus around these values. The lack of consensus does not follow observable group characteristics such as gender, ethnicity, employment status, or education. Note that for the population attribute the mean suggests that on average the community is indifferent toward population increase or decrease. However, the significant standard deviation suggests that this interpretation is misleading and in fact some respondents may have strong preferences for increases in population while other respondents may have a strong preference for decreases in population. The standard deviation of the jobs variable was only slightly statistically significant suggesting a degree of consensus for increased jobs.

Land Use Change Preferences

Preferences for alternative land use scenarios can be ranked by multiplying the coefficients for each of the attributes by the respective scenario levels given in Table 1. Hypothetical land use scenarios were generated from the attribute levels presented in Table 1, with Level 1 representing a moderate conservation scenario, Level 2 representing a strong conservation scenario, Level 3 representing a moderate

Table 4. Thresholds and heterogeneity models

Thresholds Model			Aboriginal Heterogeneity Model			Random Parameter Mixed Logit Model		
Adjusted Rho-Squared		0.04237	Adjusted Rho-Squared		0.04014	Adjusted Rho-Squared		0.04014
Log Likelihood		-1016.413	Log Likelihood		-1009.256	Log Likelihood		-1009.256
Variable	Coefficient	(t-ratio)	Variable	Coefficient	(t-ratio)	Variable	Coefficient	(t-ratio)
Constant	-0.1958	(-0.629)	Constant	-0.02573	(-0.193)	Constant Mean	-0.0297	(-0.146)
Jobs	0.0171*	(2.000)	Jobs	0.02169**	(3.577)	Jobs Mean	0.0457**	(5.901)
Moose	0.0050**	(4.942)	Moose	0.00526**	(6.315)	Moose Mean	0.0089**	(6.610)
Fish	0.0265	(1.650)	Fish	0.02319	(1.867)	Fish Mean	0.0471**	(2.678)
Population	0.0001	(1.115)	Population	0.00002	(0.257)	Population Mean	0.0001	(0.864)
Jobs 10=50	-0.1289	(-0.749)	FN*Jobs 10	0.00392	(0.279)	Jobs Standard Deviation	0.0239	(0.997)
Jobs 50=50	-0.307	(-1.725)	FN*Jobs 50	0.02434	(1.638)			
Jobs 100=50	-0.2155	(-1.273)	FN*Jobs 100	0.01010	(0.718)			
Moose 10=140	-0.2212	(-1.468)	FN*Moose 10	-0.00004	(-0.020)	Moose Standard Deviation	0.0095**	(6.097)
Moose 50=140	0.1222	(0.790)	FN*Moose 50	0.00009	(-0.044)			
Moose 100=140	-0.2993*	(-2.007)	FN*Moose 100	0.00304	(1.549)			
Fish 10=2	0.1264	(0.838)	FN*Fish 10	-0.00669	(-0.209)	Fish Standard Deviation	0.0989**	(4.213)
Fish 50=2	0.0226	(0.146)	FN*Fish 50	-0.00290	(-0.095)			
Fish 100=2	-0.1253	(-0.797)	FN*Fish 100	0.01473	(0.458)			
Population 10=2298	0.1595	(1.144)	FN*Population 10	0.00010	(0.702)	Population Standard Deviation	0.0009**	(6.333)
Population 50=2298	0.1184	(0.819)	FN*Population 50	0.00021	(1.457)			
Population 100=2298	-0.0885	(-0.624)	FN*Population 100	0.00005	(0.308)			

*P<0.05, **P<0.01

development scenario, and Level 4 representing a strong development scenario. The calculated utilities associated with these scenarios are presented in Table 5. In order to highlight the trade-offs between conservation and development outcomes, we assume that the outcomes from each scenario occur instantaneously and ignore the impact of the development path. Without discounting it is only necessary to compare outcomes for one period. The coefficients used in the utility calculations are based on the basic linear model from Table 3.

The results suggest that the community prefers conservation to development, with strong conservation ranking the highest. The strong development path is preferred to the moderate development path indicating that the increase in employment under strong development is sufficient to compensate for additional losses in moose and fish once the landscape is already somewhat developed. Given significant community heterogeneity around the moose, fish, and population attributes one must be cautious about interpreting these results, and these preferences may be reversed for some members of the community. Another caution is that the ranking of scenarios assumes that other variables that contribute to utility, such as income, are held constant. Thus, it is important to consider how additional attributes that are not included in the experiment might affect the ranking. Finally it is possible that some respondents did not view the attributes as being fully independent as assumed.

CONCLUSIONS

This case study enriches our understanding of the degree to which employment and other benefits from resource development may offset environmental losses and how choice experiments can be used by decision makers to understand the social acceptability of alternative resource development options. Cumulative impact assessments that focus on technical models of social and ecological impacts ignore the preferences of communities for these changes. A number of issues of interest to planners are explored in the case study including preferences between current and future benefits and costs; whether or not there are limits of acceptable change or social thresholds; and the degree of consensus in community values, particularly between aboriginal and non-aboriginal groups.

The results show that residents place positive values on jobs and opportunities for hunting and fishing, and are relatively indifferent to changes in population. When comparing scenarios we found that the community preferred scenarios that emphasized conservation, with the strong conservation scenario ranking the highest. Although the community preferred a strong conservation path, there was no evidence of a threshold effect whereby intensive development would result in a discontinuous negative shift in utility from decreased conservation; in fact the intensive development scenario ranked higher than the moderate development scenario. One potential limitation of the result is that residents

Table 5. Comparison of scenarios

Attributes	Coefficients	Levels of Attributes and Utility Index in Each Scenario			
		Moderate Conservation	Strong Conservation	Moderate Development	Strong Development
Jobs	0.0263	57	50	63	69
Moose	0.0055	230	260	170	140
Fish	0.0228	7	10	4	2
Population	0.0001	2450	2298	3090	3850
Constant	0.0021	1	1	1	1
Utility (Rank) of Each Scenario		3.1708 (2)	3.2049 (1)	2.9942 (4)	3.0174 (3)

may not have been provided with severe enough scenarios in terms of ecological losses to identify threshold effects. However, extreme scenarios were not presented in order to maintain plausibility. While the strong conservation scenario received the highest ranking in our scenario comparisons we found considerable variance around the benefits of conservation outcomes and less variance around employment outcomes. This suggests that there may still be strong community opposition to increased conservation even though on average the community prefers this option. In addition, the heterogeneity is across individuals rather than identifiable groups, making it difficult to identify and compensate policy winners and losers.

The appropriate choice of discount rate for resource development projects is a subject of ongoing debate. Some economists argue that a low or zero discount rate is appropriate to address intergenerational equity concerns, particularly in First Nations communities in which the nature of intertemporal losses may violate underlying value systems. Using multiperiod scenarios we found a slightly negative but close to zero discount rate for communities in the Southeast Yukon, confirming that residents value intergenerational equity. Interestingly we did not observe significant differences in preferences between aboriginal and non-aboriginal groups. One possible explanation is that non-aboriginal community residents may have moved to the region because they share the values of the aboriginal community.

Land use planning involves making decisions over multiple competing benefits. Planning processes can often result in conflicts between economic development and the environment. This study illustrates a methodology for uncovering the preferences of stakeholders for land use alternatives, and identifying areas of conflict and consensus within the community. These methods can be used in conjunction with other forms of stakeholder engagement such as narrative and multicriteria analysis, which do not provide sufficient information to rank resource management options when there are conflicting benefits.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/vol17/iss1/art22/responses/

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