Attitudes towards land use and development in the Mat-Su:

Empirical evidence on economic values of ecosystem services

ISER Working Paper

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April 25th, 2014

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Abstract

In communities that largely depend on the extraction of natural resources, attitudes towards conservation and development may seem at odds or particularly rigid. With an unprecedented wealth of natural capital, a growing mining sector, strong oil and gas industry, and a politically conservative population, Alaska serves as a case study to measure such attitudes. This research was motivated by a lack of primary ecosystem service valuation studies in Alaska that could be used to assess the public's perceived value of ecosystem services in order to guide future land use decisions and incentivize land use decisions that minimize negative externalities. A choice experiment was conducted with 224 households in the Matanuska-Susitna Borough, the fastest growing region in Alaska and one of the fastest growing regions in the U.S. Rapid development with few restrictions has led to changes for local ecosystems particularly important to salmon, negative effects on access related to recreation and tourism, and caused conversion of valuable farmland. Study results show that attitudes and values vary regarding future land use and economic development efforts. On average, policy action to improve conditions for local salmon stocks are most valuable to local residents followed by protecting farm and ranch lands as well as public access to recreation sites. Conversely, residents show negative preferences towards rapid population growth and developing local mining, oil and gas, and timber resources but support developing a professional and technical services sector. The quantified welfare changes related to different development scenarios show that focusing on conserving valuable ecosystem services is in the public's best interest.

Keywords: *consumer surplus, Alaska, development, conservation, choice experiment, Mat-Su, household survey, ecosystem services, non-market valuation,*

1. Introduction

A question of utmost importance for the success of conservation efforts is whether local stakeholders including private land owners benefit or lose from land use change (Martinez-Alier, 2001). This paper fills a critical information gap related to estimating local preferences and values on ecosystem services in places with extensive stores of intact natural capital such as Alaska. Local participation is essential for successful policy implementation, particularly in rural areas where conservation and development interests often conflict (Funtowicz and Ravetz, 1994). Local monetary value estimates can add to the concept of value pluralism, since they reflect local use and non-use preferences associated with benefits derived from nature. Voices of local people are easily lost in the debate over development rights such as for a coal mine or large scale hydro energy project. Quantifying the value of ecosystem services perceived by locals adds to a more pluralistic value perspective that not only addresses monetary value but also the values associated with environmental justice, human rights and local ties to land and biodiversity.

Natural ecosystems provide a range of benefits to human society directly through provisioning of water or food for human consumption, but also indirectly through regulating flood events or providing habitat for biodiversity (Daily, 1997). Increasingly, decision makers responsible for natural resource use recognize that the goods and services ecosystems provide have economic value (Farber et al., 2006). However, due to population growth and urban sprawl, natural ecosystems and their flow of benefits are altered through land use change, potentially damaging nature's ability to repair itself and thus often eliminating the goods and services provided to humans (Vitousek et al., 1997). On a global scale, transformations from natural systems to croplands, grazing lands, or urban areas eliminate many of the initial goods and services received by human society and demanding replacement of natural capital with human built capital (de Groot et al., 2002).

Accounting for how local residents value locally available ecosystem services is increasingly important for decision makers in regional and urban planning and provides a data-driven approach to decision making that includes the voice of the people. Urbanization increases the density of beneficiaries in relation to the remaining natural capital resulting in relatively high ecosystem service values at the urban fringe. If natural capital is being lost, it can create long-term costs to restore and maintain public services through built infrastructure. For example, wetlands that are being converted to other uses may require levies to provide flood regulating services for communities and industry that are being lost to development. Finally there are cultural and social value trade-offs that are often ignored in the planning context associated with people's altered sense for place, ecological knowledge, and a changing community identity and cohesion (Gómez-Baggethun and Barton, 2013; Haider and Rasid, 2002).

Urban society finds itself increasingly decoupled from the nature surrounding it. By 2050 more than two thirds of the world's population will live in cities (World Health Organization, 2014). Alaska, by contrast, remains fairly undeveloped and is characterized by vast wilderness area. However, in recent years, with increased population and development, Alaska has seen an influx of people to its population center in Southcentral Alaska.

Alaska is known for its vast stores of natural capital, pristine wilderness, and intact ecosystems supporting commercial fisheries, recreation, and other industries (Augerot and Smith, 2010; Hilborn et al., 2003). While it is difficult to estimate the total economic value of Alaska's natural capital, some metrics are more easily available. For example, commercial fisheries landings in Alaska ports are the highest in the U.S. and generated $1.7 billion, more than 33% of total U.S. landing value in 2012 (NOAA, 2012). At the same time the state is blessed with a wealth of sub-surface resources, has a growing mining sector, and collects more than 80% of state revenue through its oil and gas sector (Alaska Department of Revenue, 2013).

Not only are Alaskans and their economy dependent on natural resource extraction for financing state government, jobs, and income, Alaskans are also directly benefitting from their ecosystems mainly in non-market forms. Alaska 64% of the population engages in wildlife-related activities, which is the highest proportion among U.S. states (U.S. Fish and Wildlife Service and U.S. Census Bureau, 2013). In addition to recreational use of wild foods, subsistence hunting and fishing are important parts of the economy in rural Alaska and essential to Alaska Native culture (Nuttall et al., 2004). More than 86% of Alaska's rural households, most of which live far from any road, use wild game and 95% use locally harvested fish. The total harvest of wild foods in Alaska is approximately 3.5 billion lbs annually (Fall, 2012). Even though, natural capital and its flow of ecosystem services is important for Alaska's economy and people, there is little known about the preferences Alaskans perceive of the ecosystem services they depend on.

This study serves as a bench mark for ecosystem service valuation that is needed in areas of Alaska that are increasingly urbanized and areas where natural resource development decisions could benefit from information on how valuable residents perceive benefits derived from their natural surroundings. In order to implement successful conservation strategies, the calculation of marginal economic value is essential for understanding how net benefits change under changing environmental conditions (Pagiola et al., 2004). This study provides the first local willingness to pay (WTP) measure related to conservation of salmon, farmland, and access to recreation in Alaska and measures attitudes towards different types of local resource and economic development. In this regard, it informs the counterfactual for benefit cost analysis regarding development projects where local preferences have largely remained unmeasured in the past.

Concerns over the validity and wide range of accuracy in benefit transfer methods motivated this study and the measurement of local WTP (Rosenberger and Stanley, 2006). These more accurate local estimates will not only be able to raise public awareness but will enable agencies and local governments to put natural capital on their balance sheets and conduct benefit cost analysis to evaluate different development alternatives in the urban planning context requiring higher levels of accuracy and reliability (Gómez-Baggethun and Barton, 2013).

The paper is organized into five sections as follows: Section 2 introduces the reader to the study area, Section 3 is a description of the choice experiment, its theoretical underpinnings and illustrates research and experimental design process followed by data collection. Section 4 contains the results on implicit prices related to conservation and development. The analysis provides a detailed look at how values vary among different groups of residents. In addition, the analysis estimates the consumer surplus associated with individual land use policies and estimates social welfare changes associated with three development scenarios, each consisting of a varying mix of policies. Finally, the paper ends with conclusions and recommendations for future land use planning and decision making.

2. Background

Alaska's Matanuska-Susitna Basin (Mat-Su) serves as a socio-economic laboratory for land use planning and decision making with opportunities to incorporate a plethora of existing ecosystem services early in the development process. Located in Southcentral Alaska, the watersheds of the Matanuska and Susitna Rivers and its tributaries are largely undeveloped and encompass almost 25,000 square miles, equal to the size of West Virginia. The Mat-Su basin offers the entire range of 23 ecosystem functions as categorized by de Groot et al. (2002) and generates an even greater number of ecosystem goods and services. The glaciers of two of the largest mountain ranges in North America, the Alaska Range with North America's highest peak Denali (20,237ft) and the Chugach Range, are the main source to the basin's rivers, wetlands, and estuaries. The watershed drains into Upper Cook Inlet and provides habitat for many wildlife species, including large aggregations of waterfowl and shorebirds, moose, caribou, and their predators. The diverse freshwater and marine environments of the Mat-Su basin support all five species of Pacific salmon.

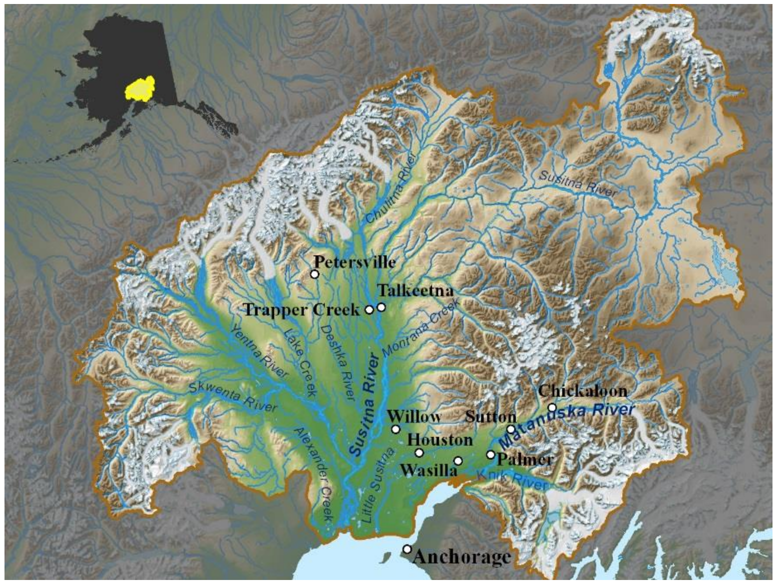


Fig. 1 Map of Matanuska-Susitna Borough, Alaska

Coinciding with the Mat-Su Basin's watershed boundary is the area encompassed by the Matanuska-Susitna Borough, the self-governing body equivalent to a county in most other U.S. states. Land in the basin is largely owned by the state and federal governments (63% and 30% respectively), followed by private land owners (4%) and the Mat-Su Borough (1%) (Mat-Su Salmon Partnership, 2013). More than 90% of Mat-Su's population of 89,000 live in the core area consisting of the communities of Knik-Fairview, Palmer, Wasilla, Meadow Lakes, and Houston. This population center is located 50 miles North of Alaska's largest city, Anchorage, with a population of roughly 292,000 (U.S. Census Bureau, 2012). More than one third of employed Mat-Su residents work in Anchorage (Fried, 2013).

Over the past two decades, the close vicinity to Anchorage and housing affordability are two of the reasons for population growth and residential development. Primarily caused by in-migration from other areas of Alaska, the Mat-Su population grew by 51% between 2000 and

2012 (from 59,000 to 89,000) constituting the fastest growing area in Alaska and one of the fastest growing in the U.S. (Fried, 2013; Lowe, 2013; U.S. Census Bureau, 2012).

Historically, farming and mining for gold and coal were the backbone of the Mat-Su economy. As new coal mines, a large hydroelectric project, and other extractive industries are making a comeback, these industries contribute less to the local economy today, but have vastly different impacts on the current natural capital, should the proposed projects move forward. The region also remains Alaska's agricultural center. Over the last decade most jobs were created in health care, government, tourism, and retail.

While the region continues to be the center of job and population growth in Alaska, development has increasingly put pressure on surrounding natural areas (Fried, 2013; Geist and Smith, 2011). Farmland is being converted to commercial and residential uses as it provides good building soils and clear flat ground (Barthel and Isendahl, 2013). Not surprisingly, growth in population coincides with an increase in impervious surfaces affecting water quality and flows particularly in the Mat-Su core area (Geist and Smith, 2011; Schueler et al., 2009). With riparian buffers disappearing, land use patterns changing hydrology, and other largely unknown drivers related to marine habitat changes and commercial fishing pressure, Mat-Su's salmon populations have experienced difficult times.

Over the past five years, seven salmon stocks from rivers and streams in the Mat-Su basin have been designated by the Alaska Department of Fish and Game as stocks of concern (Munro & Volk, 2013; Regnart & Swanton, 2013). A total of 13 stocks are currently listed in Alaska. This designation can take one of three levels of concern (yield, management, and conservation), with the latter being the most severe concern. In the region, three rivers are listed as stocks of yield concern and four are listed as being stocks of management concern. Yield concern means that even with the use of specific management actions such as sport fishing closures or restrictions for commercial fishing, the stock is unable to maintain specific yields or harvestable surplus. Management concern means that despite specific management action the stock is unable to maintain escapement goals or other specific management objectives (Alaska Department of Fish and Game, 2013).

With its vast endowment of multifunctional natural capital providing many rural amenities to households in the region, Alaskans, visitors, and other consumers, the Mat-Su is experiencing changes in land use patterns and development pressure. For example, many trails used for recreational and other purposes can be reached only by traditional but unprotected easements across private lands, that is, the easements are not publically owned. They exist only at the discretion of private land owners – and might be closed when property changes hands.

From a societal perspective, citizens, agencies, and developers are challenged to balance the adverse effects of population growth with conservation measures necessary for retaining the natural capital currently in place and for maintaining public access to recreation sites. Future land use decisions in the region will affect the quality of life for its households, public health, and the economy in foreseeable ways experienced in other regions of the U.S. that already went through some of these changes.

3. Methods

3.1. Choice modeling

Stated preference techniques can quantify the social preferences and values of local households and show whether changes in land use policy are justified socially in economic terms. In other words, the approach can illustrate whether the social benefits from a conservation policy will exceed its social costs and thus inform land use decision making as well as provide a bench mark for Payments for Environmental Services (PES) to compensate private land owners unable to internalize the social benefits in their decision to sell their farmland to developers. One particularly useful form of stated preference techniques, commonly used for policy analysis and valuation of non-market resources, is choice modeling (Hanley et al., 1998).

The choice experiment approach has been used to value preferences for many environmental amenities estimating the monetary value of ecosystem services that humans derive from salt marshes, wetlands, and rivers, to name a few (Bauer et al., 2004; Carlsson et al., 2003; Stithou et al., 2012). In the urban context, the method has also been applied to estimating the cultural value people place on aesthetics within urban areas (Alberini et al., 2003).

Choice experiments present alternative hypothetical policy scenarios to respondents by simulating a market-like situation in which the respondent decides among alternative policy outcomes differing in costs. Respondents' choices and trade-offs can then be analyzed to reveal respondents' preferences and values regarding an ecosystem service (Hanley et al., 1998;

Hoyos, 2010a). In this context, stated preference surveys can quantify social benefits of policies related to ecosystem goods and services and provide important information for land use decision making.

The analysis of consumer choice is based on a set of alternatives, presented to individuals, observed socio-demographic characteristics of the individuals, and assumptions regarding the distribution and pattern of behavior for individuals and the population as a whole (McFadden, 1973). The random utility model provides the common theoretical framework for this approach where the indirect utility function per individual, i, takes the following form $U_{ij} = \beta_i X_{ij} + \varepsilon_{ij}$, where β_i is the vector of individual observed preferences, X_{ij} is the vector of associated attributes per alternative j, within each choice set, and ε is an independent and identically distributed random component of utility not being observed. This unobserved error term allows for probabilistic inference of the estimators. Random Utility Theory (RUT) assumes that individuals are rational in their decisions and maximize their utility across the choice decisions they face when presented with a set of alternatives $j = 1,...,I$ within a choice set. Further RUT assumes that individuals not only take their preferences but also their budget constraints into account.

The standard RUT model can take different forms with the Multinomial Logit (MNL) model and Mixed Logit (ML) model being considered for this study. The ML specification has advantages over traditional MNL as it is not subject to the undesirable independence of irrelevant alternatives assumption. Further the ML model allows the analysis to account for unobserved preference heterogeneity and can specify fixed and random parameters (Train, 2003). For fixed parameters, the standard deviation for each coefficient associated with an attribute is equal to zero so that all the behavioral information is captured by the mean of the coefficient. In contrast, if a parameter is set to be random, the mean and deviation are determined through simulation where each β_i is drawn from an independent distribution.

An additional assumption is that each individual's preferences, shown in β_i, do not change across the choice tasks observed in the questionnaire. Then, the probability of an individual's observed sequence of choices is equal to the following integral:

$$P_i = \int \dots \int \sum_{t=1}^{T} \left[\frac{\exp(\beta_i X_{ij})}{\sum_{j=1}^{J} \exp(\beta_i X_{ij})} \right] f\left(\beta \mid \psi\right) d\beta \quad ,$$

where $t = 1,...,T$ is the given choice set, and $f\left(\beta \mid \psi\right)$ is the probability density function of the population parameter, β, with ψ specifying the parameters of density. The above integral is not closed, requiring a simulation with random draws to estimate the choice probabilities (Hensher et al., 2005; Train, 2003).

3.2. Experimental design and data collection

3.2.1. Focus groups

In order to develop an appropriate questionnaire that specifies relevant scenarios and descriptions of alternate environments, the study included five focus groups in five communities of the study region. The application followed Morrison et al. (1997) who discuss the use of focus groups in designing choice experiments. Also, key informant interviews with land use planners and conservation organizations provided valuable information.

The recruitment for participants of the focus groups included flyers, public service announcements, advertisements in local newspapers and websites, as well as email list serves as outlined in Stewart et al. (2013). Forty four participants of the focus groups were screened for age, opinion on development versus conservation, hunting and fishing, household size, and gender. The screening process tried to assure representation of a wide variety of perspectives, ideas, and thoughts. Each focus group had between four and twelve participants. Individuals were screened out if they were employed in the field of resource management and regional planning to avoid conflict over confrontational land use topics. Each participant received a $50 gift certificate as an incentive.

An experienced moderator led the guided discussion that lasted approximately an hour and a half with recorded audio. The transcribed audio revealed a set of important topics or concerns indicated by the frequency of terms which informed the selection of attributes in the choice experiment (Table 1) (Morrison et al., 1996). With the selected attributes in hand, attribute levels were then determined through additional key informant interviews. Hensher, Rose, & Greene (2005) suggest that the attribute levels should be selected to reflect a range of likely observed levels outside the experienced range to provide predictive capabilities for when environmental conditions change. Table 2 presents the attributes and levels picked for the design of the choice experiment.

Table 1 Topics of concern by community and frequency of occurrence in focus groups

	Houston	Palmer	Wasilla	Sutton	Talkeetna	Total
Salmon, wildlife, other ecosystem services	55	38	29	52	52	**226**
Population growth, jobs, economic development	43	22	14	25	26	**130**
Recreation access	0	25	67	10	18	**83**
Farmland conversion to other uses	7	29	28	7	10	**81**
Regulation, noise, private property, public health	34	20	31	27	20	**132**
Number of participants	5	12	11	5	11	**44**

3.2.2. Experimental design

The experimental design considerations closely followed Hensher, Rose, & Greene (2005) and initially determined six main effects and three two-way interaction effects to be tested, resulting in a 44 degrees of freedom required for model estimation. The criteria for calculating the degrees of freedom were based on attributes and levels shown in Table 2, the constraint of a blocked design, and an unlabeled experiment allowing for non-linear effects to be estimated. The blocked design was meant to limit the number of choice sets per respondent to eleven in order to limit occurrence of respondent fatigue. The unlabeled design more likely meets the assumption of an independent identically distributed error term imposing the restriction that the alternatives used are uncorrelated. In addition, the analyst is not required to define each possible alternative to meet the global utility maximization rule (Hensher et al., 2005).

Table 2 Attributes and levels of the choice experiment

Attribute	**Levels**	**Variable**
Salmon	• No action preventing salmon decline*	
	• Keep current numbers by preventing further decline	*salFLAT*
	• Action for full salmon recovery	*salFULL*
Access to recreation	• No action protecting recreation access*	
	• Maintain current recreation access	*acCRT*
	• Expand both motorized and non-motorized access	*acALL*
	• Expand non-motorized recreation access only	*acNM*
	• Expand motorized recreation access only	*acM*
Farmland	• Allow continued conversion of farmland to other uses*	
	• Keep current farmland	*agFLAT*
	• Keep current and set aside potential future farmland	*agFULL*
Growing sectors	• Health care, tourism, and retail*	
	• Mining, timber, oil, and gas	*jobsRE*
	• Engineering, technology, and other professional services	*jobsPS*
Population by 2040	• 90,000*	
	• 180,000	*popMID*
	• 270,000	*popHI*
Annual cost to household	• $0*	
	• $50	
	• $100	*dollarcost*
	• $150	
	• $200	

Notes: *Level shown in status-quo alternative.

A blocked D-optimal design (efficiency 27.59%) with four blocks was created using an iterative search algorithm provided by MatLab's row exchange function (Mathworks, 2013). The optimal design optimizes the information obtained from respondents given the design and ignores correlation between attributes. Design orthogonality was not a consideration because orthogonality would have been likely lost in data analysis due to missing data, the use of blocks likely resulting in an unbalanced dataset, the inclusion of socio-demographic variables, the status-quo alternative, and attribute levels not being necessarily equidistant for the policy variables outlined in Table 2 (Hoyos, 2010b).

3.2.3. Choice sets

The generated design included two alternatives and a status-quo alternative. The unlabeled design allowed the levels of the second alterative to be a randomized version of the levels of the first alternative (Hensher et al., 2005). The levels of the status-quo alternative were set to equal the base-line levels outlined in Table 2, and thus were objectively determined through key informant interviews. The eleven choice sets per block were randomized in their order of appearance in the questionnaire to assure individual preference heterogeneity and for the covariates to remain independent.

A pretest questionnaire was sent out to 121 households of which 21 were participants of the focus groups willing to take the pretest, and a random sample of 100 property owners in the region. The 32 responses to this pilot study informed the final design of the questionnaire and collected feedback on the adequacy of attribute and attribute levels, attribute ambiguity, and the complexity of the choice task. Comments from pilot study participants indicated that the choice task, set of attributes and attribute levels were adequate but that the cost attribute could include a wider range of costs. The final design of the choice experiment attempted to minimize the influence of price insensitivity by including five levels for the cost attribute ranging from $0 to $200 per household per year instead of three levels as presented in the pilot study. The wider attribute level range also ensured that the resulting parameter estimates had smaller standard errors (Hoyos, 2010b).

3.2.4. Data collection

The data collection process followed Dillman's (2007) tailored design method and included sending out an introductory post card, followed by a first mailing, post card reminder with thank you, second mailing, and a phone follow up for non-respondents with known phone numbers (Dillman, 2007). A total of 1400 households received the mail questionnaire from a sample frame purchased through a marketing firm containing 92% of the 31,824 households counted in the 2010 Census (U.S. Census, 2010). The sample design used a disproportionate stratified random sample which allowed attainment of a more representative sample and ensured responses from small remote communities in the study region (Daniel, 2012). Table 3 shows how the stratification occurred by zip code and outlines the communities that were oversampled to achieve geographic representation.

Table 3 Stratified random sample with responses per ZIP code

Community	Zip code	Sample frame Frequency		Disproportionate stratified sample Frequency		Responses Frequency	
Big Lake, Houston, Wasilla	99623	2,782	10%	99	7%	27	8%
Wasilla	99629	572	2%	0	0%	0	0%
Palmer	99645	8,602	30%	272	19%	73	22%
Big Lake, Wasilla	99652	997	3%	37	3%	9	3%
Wasilla	99654	8,636	30%	302	22%	68	20%
Skwentna*	99667	20	<1%	34	2%	5	2%
Chickaloon*	99674	476	2%	86	6%	32	10%
Talkeetna*	99676	691	2%	108	8%	28	8%
Trapper Creek*	99683	185	<1%	35	3%	13	4%
Wasilla	99687	4,812	17%	174	12%	24	7%
Willow*	99688	1,033	4%	170	12%	41	12%
Houston*	99694	147	<1%	83	6%	12	4%
Total		29,134		1400		332	

Note: *Oversampled strata representing the remote, rural communities of the region.

The introductory mailing had 181 non-deliverable addresses. After the two questionnaire mailings, 313 households responded. A phone follow up with an online questionnaire version resulted in an additional 19 respondents, for a total of 332 responses. Of the 332 respondents, only 224 completed the entire questionnaire for an overall response rate of 19%. The large number of incompletes indicates that respondent fatigue was a problem, contrary to the feedback received during the pilot study. Two respondents indicated that they did not understand the questionnaire. The data collection period started on May 16th 2013 and lasted until September 18th 2013. As an incentive, respondents were entered into a drawing for twelve $50 gift certificates.

After data collection, the attributes in Table 2 were dummy-coded except for the cost attribute, allowing for the estimation of complex part-worth (marginal) utility functions. For analysis of this survey data, each observation was weighted by the inverse of the probability of selection of household to account for the different geographic strata in the sample and to achieve geographic representation of the survey across the region (Table 3).

4. Results and discussion

4.1. Sample characteristics

Table 4 describes the socio-demographic characteristics of the sample and compares these with the 2012 American Community Survey's Public Use Microdata Sample (PUMS). With respect to the distribution of income across the region's population, the sample is representative of the overall population including geographic representation shown in Table 3. Differences include that a disproportionate number of men, older residents, homeowners, and residents with higher education responded to the questionnaire. The sample contained 47% of respondents that earned at least a Bachelor's degree whereas only 22% of the population achieved this educational level. As expected, given the focus of the study, a disproportionately high number of hunters and anglers responded to the questionnaire.

Table 4 Socio-demographic characteristics of the sample, 2012

Socioeconomic characteristic	Sample Mean (n=224)	Population Mean
Gender (% women)	42.5	48.3
Age	58.4	46.7
Race (% white)	92.4	90.9
Educational attainment		
Did not complete High School	2%	8%
High School or similar	31%	29%
Vocational training	21%	42%
Bachelor's degree	30%	15%
Master's degree	17%	7%
Annual household income($)	77,925	81,319
Less than $25,000 (%)	15%	19%
$25,001-$50,000	21%	18%
$50,001-$75,000	21%	22%
$75,001-$100,000	17%	16%
$100,001-$125,000	11%	7%
$125,001-$150,000	5%	6%
$150,001-$200,000	4%	6%
$200,001-$250,000	2%	2%
Greater than $250,000	3%	3%
Home ownership (% owning)	93%	68%
Hunting	66%	30% [a]
Fishing	82%	46% [a]
Number of households	224	31,824
Total population		89,319
Population over 18 years		63,710

Sources: Alaska Department of Fish and Game (2012) and U.S. Census Bureau (2012)

a) licenses sold divided by population over 18 years

4.2. Model fitting

The analysis of the choice data included 224 completed questionnaires from which Multinomial Logit (MNL) and Mixed Logit (ML) specifications were created. In general ML models achieved lower values for the Akaike Information Criterion, indicating a better fit compared to the MNL model specification (Akaike, 1974). The ML Model relaxes the assumption of independence of irrelevant alternatives (IIA) and allows for taste heterogeneity among respondents by treating dependent variables as random. Each individual decision maker (respondent) is modeled to have its own individual-specific systematic and random components of utility related to each choice set. However, the ML Model specification requires better data in order to utilize the model's capabilities and results in challenges for the estimation of marginal WTP (Hensher et al., 2005).

The estimation of WTP in ML models is calculated as the ratio of two randomly distributed parameters, if the cost parameter is kept random. For reasons of modeling convenience, analysts often keep the cost parameter fixed resulting in an unreasonable assumption of constant marginal utility of income across the entire sample. This problem constitutes an undesirable trade-off between reality and ease of modeling (Hole and Kolstad, 2011). In addition, WTP measures are highly sensitive to the type of distribution chosen that represent the randomness in each parameter estimated through simulation (Hensher and Greene, 2003). Hensher & Greene (2003) point to this issue as the single most important problem concerning ML models and admit that unfortunately there is no single best distribution assumption.

Table 5 outlines how the random parameter distributions were specified for the ML model. Since deficiencies for WTP calculations often arise due to the length of the distribution tails, the distributions for the random parameters in this study were restricted to where the standard deviation of a triangular distribution equals the mean for most random parameters except *dollarcost* and *jobsRE* (Table 5) (Greene, 2012; Hensher and Greene, 2003).

The approach to constrain the distributions from which to draw from, also helps in dealing with price insensitive responses possibly related to attribute processing. This unattentiveness may have contributed to a low magnitude of the cost coefficient and resulted in the problem of infinite WTP under the RUT assumptions (Table 6) (Hensher, 2007). Even though WTP measures are becoming more realistic due to the constraint random parameter distribution, the constraints result in a lower AIC value indicating that the ML model does not fully capture the behavioral information. Since the calculation of WTP for conservation policies is the goal of the study, the constraint ML model is considered the model of choice for the remainder of the analysis.

Table 5 Random parameter specifications for constraint ML model

Random Parameter	**Distribution Assumption**	**SD equals Mean**
Cost to household, *dollarcost*	uniform	
Salmon – full recovery, *salFULL*	triangular	✓
Salmon – prevent decline, *salFLAT*	triangular	✓
Farmland – increase, *agFULL*	triangular	✓
Farmland – keep current, *agFLAT*	triangular	✓
Rec. access – expand both, *acALL*	triangular	✓
Rec. access – non-motorized, *acNM*	triangular	✓
Rec. access – maintain current, *acCRT*	triangular	✓
Jobs – resource extraction, *jobsRE*	normal	
Jobs – engineering, prof. services, *jobsPS*	triangular	✓

The parameters *jobsRE* and *dollarcost* deserve particular attention as the former was modeled with a normal distribution and the latter used a uniform distribution to fit the ML model (Table 5). Based on anecdotal information through key informant interviews, for example, it was known that local resident's views on development are divided particularly related to extractive industries like coal mining playing an increasing role in the region. A constraint triangular distribution for the *jobsRE* parameter was thus found not to represent preferences very well compared to a normal unconstraint distribution. Lastly, the best fitting model, according to AIC, was found when the *dollarcost* variable took an unconstraint uniform distribution.

4.3. Model results

The iterative maximum likelihood estimation for mean parameter coefficients and standard errors applied simulations with 1000 Halton draws using NLOGIT (Greene, 2012). Table 6 compares model output for the MNL model and the ML model. The parameter values can be interpreted as decision weights for each independent variable and show their relative importance to the average person in the sample. The larger the coefficient, the more important the associated attribute was in the decision of the respondent to select an alternative within a choice set. The sign of each coefficient, if negative, indicates that across the sample, the variable resulted in negative preferences or dislike, whereas a positive coefficient shows positive preferences or likes. The signs of all parameters in both models met a priori expectations.

Table 6 Choice experiment results by model specification

Parameter	MNL	ML
Cost to household, *dollarcost*	-0.0015*** (0.0005)	-0.0014** (0.0007)
Salmon – full recovery, *salFULL*	1.3723*** (0.0821)	1.7255*** (0.1166)
Salmon – prevent decline, *salFLAT*	0.9087*** (0.0813)	1.0556*** (0.1034)
Farmland – increase, *agFULL*	0.8504*** (0.0868)	1.2053*** (0.1135)
Farmland – keep current, *agFLAT*	0.7788*** (0.0845)	1.1343*** (0.1119)
Population – 270,000 by 2040, *popHI*	-0.5982*** (0.0864)	-0.7582*** (0.1094)
Population – 180,000 by 2040, *popMID*	-0.1036 (0.0818)	-0.0001 (0.1047)
Rec. access – expand both, *acALL*	0.6011*** (0.0964)	0.9168*** (0.1209)
Rec. access – expand non-motorized, *acNM*	0.6060*** (0.0950)	0.8244*** (0.1236)
Rec. access – expand motorized, *acM*	0.2453** (0.1041)	0.2036 (0.1248)
Rec. access – maintain current, *acCRT*	0.6990*** (0.0980)	0.8410*** (0.1159)
Jobs – resource extraction, *jobsRE*	-0.1041 (0.0796)	-0.2877** (0.1441)
Jobs – engineering, prof. services, *jobsPS*	0.3145*** (0.0747)	0.3269*** (0.0961)
Household income > $75,000/year, *highIN*	0.4205** (0.1898)	0.6103** (0.2259)
Hunting, *HUNT*	0.3567 (0.2557)	0.6244** (0.3072)
Fishing, *FISH*	-0.5026** (0.2481)	-0.8808*** (0.3109)
Log likelihood	-2036	-1888
AIC	4111	3817
McFadden Pseudo R^2	0.25	0.28
Observations	2563	2563

Note: Parameter values indicating * are significant at 10% level, ** significant at 5% level, and *** significant at 1% level. The figures in parentheses are standard errors.

Remaining coefficients are all statistically significant except the coefficient for expanding motorized access to recreation and the coefficient for the population doubling by 2040. Since these two coefficients are not statistically significant, it means that respondents were indifferent to expanding motorized recreation and a doubling population. This result shows that respondents have accepted continued population influx to the region to a level that would double the current population by 2040. Also, access to motorized recreation may have reached a saturation point since most of the region is already open to motorized vehicles particularly in winter months, which may limit demand to open additional areas for motorized recreation.

Of particular interest is the negative coefficient related to a tripling population by 2040, which shows aversion towards more rapid population growth and shows respondents have a threshold beyond a doubling population level. Also, if comparing the different policy alternatives, salmon conservation policies are the most important to local households followed by farmland conservation policies, all of which show highly significant coefficients at the 1% level and relatively high magnitudes.

Actions towards expanding or ensuring continued recreation access are also statistically significant at the 1% level. While respondents are indifferent about expansion of motorized access, they fairly equally prefer expansion of non-motorized access and support policies that would improve access for all types of recreation, as well as action towards maintaining current access.

The future job growth variable was used as an indicator for attitudes towards contrasting types of economic development that are often leading to controversies in local politics but are important for strategic planning. Overall, the types of future job opportunities are statistically significant at the 1% level but counted less in respondent's decision of alternatives compared to the attributes related to ecosystem services. The coefficient for jobs in resource extraction is statistically significant at the 1% level and negative, showing respondents' aversion towards expanding the region's extractive resources industries like coal mining, timber, and oil and gas. Conversely, the coefficient on jobs in the professional services sector is positive and statistically significant at the 1% level, thus providing evidence that respondents are in favor of economic development strategies that attract businesses in the professional and technical services sector.

Finally, coefficients related to socio-demographic variables show that the choice of alternative was positively influenced by households earning more than $75,000 annually pointing towards an observed income effect, meaning respondents were conscious of budget constraints in selecting alternatives. The results below, analyzing how WTP varies among high and low income levels, supports this claim.

4.4. Implicit pricing

Deriving marginal WTP for conservation policies can be a foundation for designing market-based mechanisms like PES that provide continued financing to maintain ecosystem services (Engel et al., 2008). In a PES scheme, the beneficiaries would pay for the environmental service they benefit from. For example, a payment towards salmon conservation could be in form of an environmental subsidy paid by sport fishing businesses and aimed at improving salmon habitat. Also, farmland provides a number of benefits including scenic views, historical, and cultural value. But since farmland is private, those lands can also be very valuable for development.

Farmers may need incentives to hold onto rather than sell such valuable property. Public and private entities would need to work together to find ways of creating such incentives. In the context of PES, marginal WTP per respondent provides a useful monetary measure of actual demand for the environmental service.

Table 7 Annual WTP per household by select type of action on local resource issues

Type of Action	Mean	95% Confidence Interval		
		Low	High	Width
Action towards full recovery of salmon	**$109.37**	$26.53	$194.43	$167.90
Keep current & set aside more farmland	**$96.67**	$46.20	$148.50	$102.30
Expand non-motorized access to recreation	**$59.74**	$17.50	$103.12	$85.62
Growth in professional services jobs	**$40.45**	$25.15	$56.16	$31.01
Growth in resource extraction jobs	**-$6.33**	-$184.97	$177.10	$362.07
Population triples in 2040	**-$43.82**	-$79.70	-$6.90	$72.80

The model result presented above showed that households have strong preferences towards land use policies related to salmon and farmland conservation, as well as improved access to recreation. The analysis estimates conditional and constrained parameter estimates specific to each of the 224 respondents (Hensher et al., 2005). Table 7 illustrates the mean WTP as well as the upper and lower limits of a 95% confidence interval around the mean generated via parametric bootstrapping using 1000 replications. These estimated implicit prices are approximately within range of the magnitude of the cost attribute and thus are considered behaviorally realistic (Hensher and Greene, 2003).

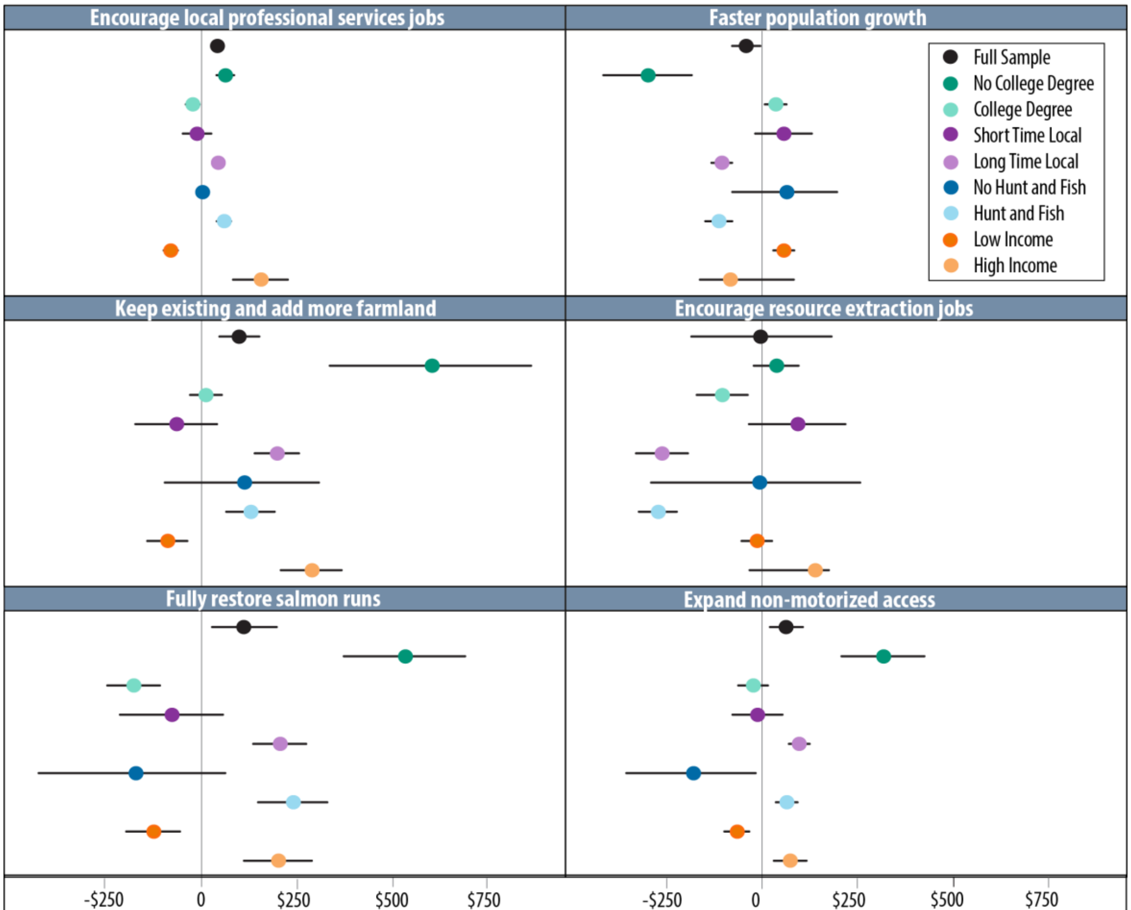
The implicit annual WTP per household is highest for action targeted at full salmon recovery consisting of a mean value of $109 annually (Table 7). Slightly of less value to local households are policies that would protect current farmland and set aside potential future farmland, equaling a mean WTP of $97 annually per household. Mat-Su households further stated that they would be willing to contribute $60 towards expanding non-motorized recreation access. The marginal WTP for economic development strategies supporting the settlement of a professional services sector in the region equaled $40 annually, while strategies to encourage more resource extraction like coal mining as well as a higher and faster population growth are disliked by the average resident as indicated by the negative mean WTP measures of -$6 and - $40 per household per year respectively.

Comparing the mean marginal WTP estimates with the respective size of their confidence intervals provides additional information on how preferences and values vary among households in the region (Table 7). Public opinion varies most in regards to policies related to job growth in resource extraction and least with respect to job growth in the professional services sector. Since the professional services sector in Alaska is highly dependent on resource development, these results could mean that the public is not necessarily against resource development in the region but does not want it to happen in their neighborhoods or recreation sites.

To test the robustness of the implicit price results, the model was tested on different sub samples selected according to the following socio-demographics observed through the questionnaire: participation in hunting and fishing, income level (more or less than $75,000 annual household income), educational attainment (college or no college), and the number of years the respondent has been a resident of the region (more or less than 19 years, the mean longevity observed in the sample). For each household in each group, the implicit WTP by policy and by group was calculated as well as a 95% confidence interval constructed around the mean, using parametric bootstrap sampling. Figure 2 illustrates the estimated WTP values by group for each policy and Figure 3 presents WTP values by policy action for each group. Two results are of particular interest to determine the validity of the estimates. First, in Figure 2, for most of the policies, the mean WTP values for the entire sample fall in between the mean WTP values measured for each of the groups. Second, Figure 3 shows that the estimated WTP for each policy action is lower for the low income group compared to the high income group, suggesting that an income effect is present. The two results indicate that the WTP estimates are robust and that the model does well in accounting for heterogeneity in preferences across the sample.

The WTP for action towards full recovery of local salmon stocks is highest among high income households ($198.66) and as expected households participating in hunting and fishing ($237.47), and lowest (-$170.00) for households that do not hunt or fish (Figure 2). Due to the small sample size of households not participating in any hunting and fishing, the confidence interval is very large indicating that preferences vary a lot.

The variation in WTP for policy action on farmland conservation is mainly driven by differences in income. While low income households were very price sensitive in their choice of alternatives that included farmland conservation as part of their farmland policies, high income households placed a very high value on farmland being protected.



Mean willingness to pay shown in circles with bar representing 95% confidence interval. Sample sizes: Full sample (n=224), college (n=118), no college (n=106), short time local (< 19 years in Mat-Su)(n=96), long time local (> 19 years)(n=128), Not hunt or fish(n=41), hunt or fish(n=183), high income (>$75,000)(n=114), and low income(n=110).

Fig. 2 Annual WTP per household for land use policies - grouped by policy (mean, 95% CI)

Resource extraction in the Mat-Su region is known to be a divisive issue. The results of this analysis underline the contention through the wide confidence interval for the variable measuring attitudes towards growth in resource extraction jobs (Figure 2 and Table 7). While most high income households prefer the growth of jobs in local resource extraction, even though preferences for this development policy also vary quite a bit within this group, low income households seem to be rather indifferent. Contrary, households participating in hunting and fishing strongly dislike this development policy with preferences well aligned within this group as indicated by the rather small confidence interval.

Preferences regarding the expansion and improvement of non-motorized recreation access in the region is positive and originates with the high income part of the population as well as households who would benefit from this expansion such as households that are hunting and fishing. As expected, low income households and households not engaged in hunting and fishing place much lower (negative) value on this land use policy. This result may not necessarily show that these groups dislike improvements to non-motorized access but rather shows their price sensitivity to these land use option.

Contrary to preferences regarding job growth in resource extraction, Mat-Su residents are more aligned in their views on job growth in the professional services sector. For the entire sample Figure 2 and Table 7 show a tight confidence interval of $31 regarding WTP to support development alternatives that encourage a professional services sector to establish in the region versus a much wider confidence interval of $362 for resource extraction. Comparing resource extraction with professional services, the group of hunters and fishers completely swing from negative to positive preferences whereas the low income group changes in the opposite direction. In addition, the high income group seems to place slightly higher value on professional services jobs ($154.00) compared to jobs in resource extraction ($135.65).

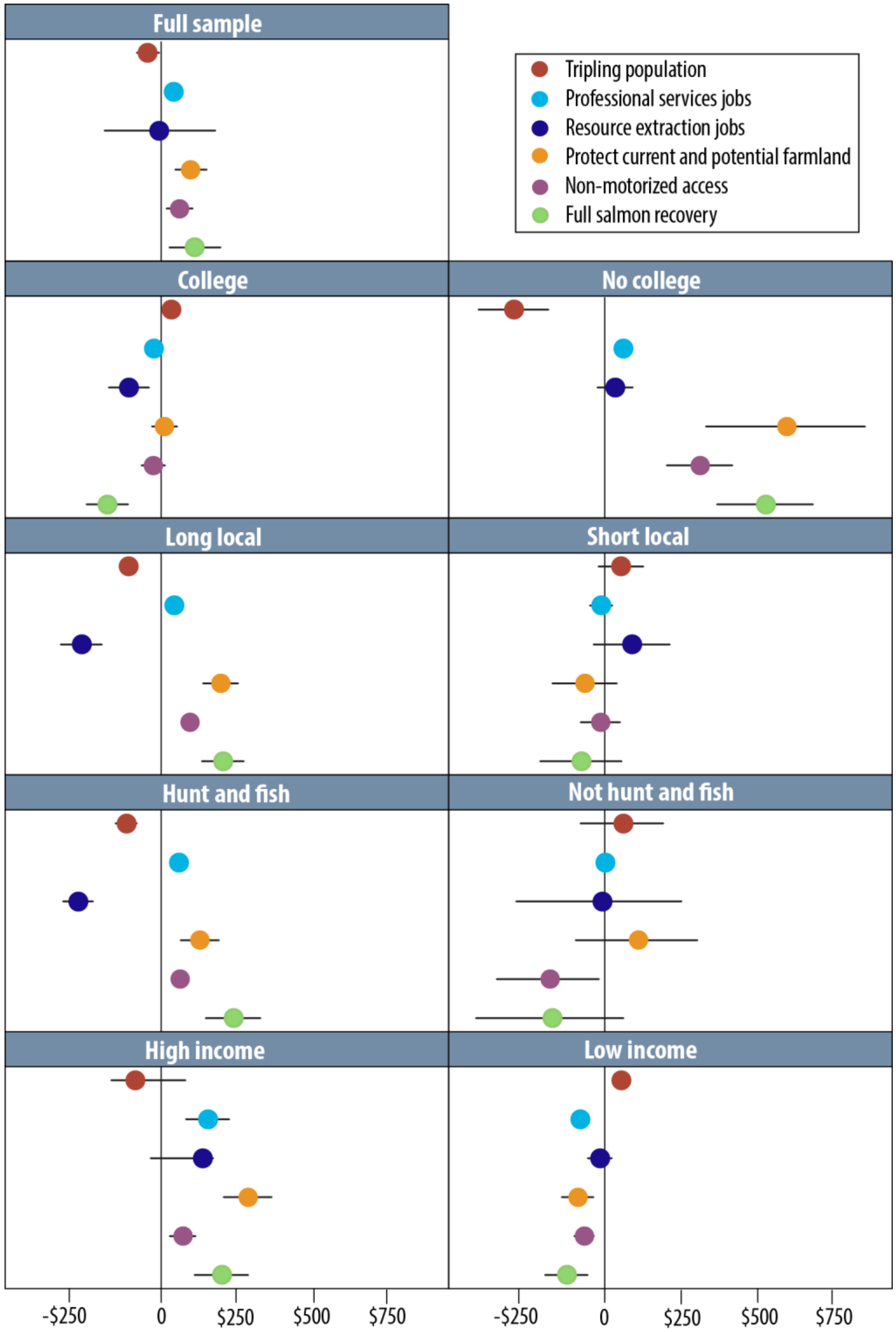


Fig. 3 Annual WTP per household – grouped by socio-demographics (mean, 95% CI)

Overall, Mat-Su residents dislike a tripling Mat-Su population by 2040. Particularly the high income and hunting and fishing groups dislike this kind of population growth in the region, whereas low income households and households not participating in hunting and fishing slightly favor alternatives that show faster population growth. One reason may be that low income households associate more benefits and potential opportunities with population growth which may outweigh some of the negative consequences they may not be aware of or that are less important to them.

Figure 3 depicts WTP estimates grouped by socio-demographic characteristics. The groups that are more aligned in their values related to development and land use alternatives show tighter confidence intervals and include the groups of college educated respondents, long time locals, hunters and fishers, and low income households. It seems that these groups are more homogeneous without much variation in each of the WTP estimates for each policy. On the other hand, the groups of short time locals, and households not participating in hunting and fishing, show a wider range of WTP estimates for each policy, indicating that these groups are more heterogeneous in their values related to land use and development.

4.5. Consumer surplus for individual policies and for development scenarios

Besides the measure of marginal WTP, estimates of compensating surplus provide respondents' average WTP to move from a baseline (status-quo) to a new changed state of the environment by implementing a set of policy actions, rather than just one. There are several advantages to this measure. The first advantage is purely methodological, because the impacts of scale heterogeneity on the calculation of marginal WTP are cancelled out when calculating compensating surplus (Colombo et al., 2009). The second advantage relates to the practicality of the approach, as compensating surplus provides a welfare measure associated with different development paths the region can take. The approach ranks a set of future development scenarios by their overall value and therefore can provide critical information to decision makers. For regional planners, the ranking of development options can help with balancing different types of future land use by directly incorporating values and preferences of the public (Domínguez-Torreiro and Soliño, 2011; Pagiola et al., 2004). The results reveal potential trade-offs between employment opportunities and a change or rather decrease in the current level of ecosystem services households of the region momentarily enjoy. In addition, this data-driven approach allows planners to justify their actions via a data-driven approach.

Hanemann (1984) calculates the Hicksian compensating welfare measure as the negative difference of utility after the implemented policy scenario, U_1, and utility associated with the baseline, U_o. Consumer surplus then equals the difference in utility divided by the cost parameter, β_{cost}, mathematically stated: $CS = -\frac{U_1 - U_0}{\beta_{\text{cost}}}$.

Table 8 and Table 9 show the consumer surplus related to the entire population. Consumer surplus was scaled up to the region's current population level and based on the conditional parameter coefficients for each of the 224 individual households in the sample. For each household the utility functions were weighted to represent the characteristics of all 31,824 households in the region. The weighting occurred in accordance to the statistically significant socio-demographic variables *highIN*, *HUNT*, and *FISH* (Table 6) and the proportions observed in

Table 4. Table 8 shows the consumer surplus related to each individual land use or development policy holding all other policies at the current baseline level. The standard deviation in the estimate was calculated based on the standard deviation for individual household specific coefficients. Table 9 shows three development and land use scenarios that consist of a mix of policies and illustrates how consumer surplus changes given several policies change compared to the current trend (Table 9).

Table 8 Consumer surplus related to each type of individual action

Existing Trend	New Action to Change Trend	Mean Consumer Surplus	Standard Deviation
No action to stop salmon decline	Fully restore runs	$54 million	±$11 million
	Maintain current fish numbers	$27 million	±$5 million
Conversion of farmland continues	Keep all existing and add more	$34 million	±$7 million
	Keep all existing farmland	$28 million	±$6 million
No action to protect recreation access	Expand all access to recreation [a]	$22 million	±$4 million
	Protect current access	$20 million	±$3 million
No policies to encourage specific industries	Encourage local professional jobs	$3 million	±$4 million
	Encourage local resource extraction jobs	-$16 million	±$22 million
Population grows at current rate, doubling by 2040	Population growth faster, tripling by 2040	-$33 million	n/a[b]

Note, total consumer surplus rounded to closest $1 million. a) $20 million (SD=±$3 million) for non-motorized access. b) fixed parameter

The three development scenarios in Table 9 vary in the degrees of land conservation policies and economic development strategies. The base case scenario is assumed to be representative of current land use policies and is followed by three hypothetical scenarios, Scenario 1, 2, and 3. Scenario 1 and 2 would allow continued conversion of farmland for residential, commercial, and other uses with no limits to population growth. Scenario 3 would limit population growth to no more than 180,000 by 2040 and set aside potential farmland in addition to protecting current farmland. Economic development strategies would also differ among the three scenarios. In Scenario 1, the economic development strategy would target tourism, conservation of valuable salmon and other sport fisheries, and expand recreational opportunities. For Scenario 2, the economic development strategy would focus on expanding the region's coal and mineral mining industries and oil and gas leasing. Motorized access to recreation would be the focus but no conservation of salmon. The goal of Scenario 3 is to limit land use and encourage economic development targeted towards having professional and technical services companies locate in the region. In order to attract these businesses, importance would be placed on retaining a high quality of living in the region by conserving current and potential future farmland, protecting valuable salmon sport fishing opportunities, and expanding non-motorized recreation options.

Results in Table 9 show that high population growth and locally occurring extractive resource development would result in a negative welfare change, meaning society would be worse off by $10 million annually with Scenario 2. On the other hand Scenario 1, with unlimited population growth and focus on tourism values is positive with $32 million annually, but does not maximize social preferences if compared to the presented scenarios. The sustainable development path in Scenario 3 leads to the maximum benefit for society and is in the best interest of the public. Annually, development scenario 3 could achieve net social returns of more than $134 million to the population of the Mat-Su region (Table 9).

Table 9 Consumer surplus related to three development scenarios

	Baseline	**Scenario 1** Extensive land use & tourism	**Scenario 2** Extensive land use & resource extraction	**Scenario 3** Low density land use
Farmland	Continued conversion	Continued conversion	Continued conversion	Set aside more
Population by 2040	180,000	270,000	270,000	180,000
Job growth sector	Health, tourism, retail	Health, tourism, retail	Mining, timber, oil, and gas	Professional, tech. services
Salmon	No action	Action to keep current numbers	No action	Action towards full recovery
Access to recreation	No action	Expand both	Expand motorized	Expand non-motorized
Total consumer surplus	**$0**	**$32,350,000**	**-$10,767,000**	**$134,078,000**
Standard deviation	$0	±$7,897,000	±$8,955,000	±$41,536,000

Note, total consumer surplus rounded to closest $1,000.

5. Conclusions

This study measured the wide array of attitudes and monetary values related to land use and development in the Mat-Su Borough and was based on a geographically representative sample, including respondents from all parts of the region. The results show that residents place a high dollar value on the rural character of the Mat-Su and are willing to contribute to changing current trends in land use and development. In particular, residents have shown strong preferences towards conservation of farmland, action on dwindling salmon stocks, and protection of recreation access – valuable community assets that are changing with rapid population growth. This study serves as a foundation for creating economic incentive mechanisms that would maintain and restore the community assets that attracted residents to the Mat-Su in the first place.

Overall respondents placed higher monetary value towards maintaining and restoring these community assets compared to actions that would encourage jobs and economic development. However, preferences within and among segments of the population vary more or less depending on the type of land use and development policy. On average, Mat-Su residents are willing to pay for economic development in the professional and technical services sector but would want to be compensated if development focuses on local resource extraction. While residents' attitudes towards encouraging jobs in the professional services sector are well aligned, people are much more divided when it comes to local resource extraction in the Mat-Su.

The estimates of implicit prices and consumer surplus presented in this study show how much Mat-Su households and Mat-Su residents as a whole would be willing to pay for restoration and maintenance of the community assets residents benefit from. These estimates serve as a benchmark for creating the economic incentives needed to keep the rural profile of the Mat-Su. Forming public-private partnerships is one way to put in place actions people say they want, for example retaining farm and ranch land which provides many public benefits including open space and view shed. Farmers may need incentives to hold onto rather than sell such valuable property through a system of payments to private landowners.

Also, methods other than taxes could support specific land use policies – for example preservation of salmon habitat along streams. Payments for activities that benefit directly from the maintenance of these community assets, such as sport and commercial fishing, could support restoration or maintenance of habitat through adjustments in the fee structures related to these economic activities. Also, recreation related payments could be used to purchase easements to protect traditional recreation access across private land and ensure private land owners are compensated for providing access. Other potential strategies for internalizing the negative externalities of land use include development taxes or urban growth boundaries which are known to be effective policy tools if appropriately sized and selectively applied. This research serves as a benchmark for designing such policy tools effectively.

Acknowledgments

This working paper has benefitted greatly from the critical readings and insightful comments from colleagues at the UAA Institute of Social and Economic Research, UAA College of Business and Public Policy, The Nature Conservancy, and the U.S. Fish and Wildlife Service. The author is indebted to the many residents of the Mat-Su who provided insightful comments and were critical in the design of the study. The author is especially thankful to 44 participants in focus groups, 30 respondents to the pilot study, and 332 respondents to the final questionnaire. Their local information was essential for the success of the study. Insights and helpful comments were also received from the Matanuska-Susitna Borough. This project was funded with support from the Bullitt Foundation, Gordon and Betty Moore Foundation, and U.S. Fish and Wildlife Service. Project funding was intended to be used for publication of the results in a peer-reviewed academic journal. The funding organizations did not have input to the writing of this working paper, analysis of the data, and neither will take part in the decision to submit this article for peer-reviewed publication. Any errors are the sole responsibility of the author.

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