Fall 2008: Volume 7, Number 2

Western Economics Forum

A Journal of the
Western Agricultural Economics
Association

Farm & Ranch Management

Marketing & Agribusiness

Natural Resources & the Environment

Policy & Institutions

Regional & Community Development

Western Economics Forum

Volume VII, Number 2

FALL 2008

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The Western Economics Forum

A peer-reviewed publication from the Western Agricultural Economics Association

Purpose

One of the consequences of regional associations nationalizing their journals is that professional agricultural economists in each region have lost one of their best forums for exchanging ideas unique to their area of the country. The purpose of this publication is to provide a forum for western issues.

Audience

The target audience is professional agricultural economists with a Masters degree, Ph.D. or equivalent understanding of the field that are working on agricultural and resource economic, business or policy issues in the West.

Subject

This publication is specifically targeted at informing professionals in the West about issues, methods, data, or other content addressing the following objectives:

- Summarize knowledge about issues of interest to western professionals
- To convey ideas and analysis techniques to non-academic, professional economists working on agricultural or resource issues
- To demonstrate methods and applications that can be adapted across fields in economics
- To facilitate open debate on western issues

Structure and Distribution

The *Western Economics Forum* is a peer reviewed publication. It usually contains three to five articles per issue, with approximately 2,500 words each (maximum 3,000), and as much diversity as possible across the following areas:

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- Marketing and agribusiness
- Natural resources and the environment
- Institutions and policy
- Regional and community development

There are two issues of the *Western Economics Forum* per year (Spring and Fall).

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Off-Road Vehicle Recreation in the West: Implications of a Wyoming Analysis

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Introduction and background

A national committee recently concluded that managers, policymakers and communities need additional research, education and outreach programs focused on outdoor recreation. The growing demand for outdoor recreation suggests such programs will help those working to manage resources for sustainable outdoor environments (USDA CSREES, 2007). One outdoor recreation activity that is growing in popularity and needs further study is off-road vehicle recreation. The term off-road vehicle (ORV) includes off-highway motorcycles and four-wheeled all-terrain vehicles also known as ATVs or "quads"[2]. ORVs have become a significant part of the recreational landscape in the past 25 years and their growth in use is a nationwide phenomenon. The industry introduced four-wheeled ATVs in the mid-1980s. ATV's are by far the predominant off-road vehicles in use today, accounting for some 88 percent of those in use. Moreover, ATV sales outnumber off-road motorcycle sales, 2.5 to 1(Cordell et al., 2005). Cordell et al. (2005) report that sales of off-highway vehicles (OHV) "more than tripled between 1995 and 2003, with 1.1 million vehicles sold in 2003. ATVs continue to account for more than 70 percent of the market" (Cordell et al, 2005).

The Western states, with their extensive public lands, are an important recreation destination for these visitors (Vanasselt and Layke, 2006). Cordell (1999) predicts OHV recreation days will continue to grow by as much as 54 percent in the Rocky Mountain region by the year 2050 (Silberman and Andereck, 2006). The combination of an affluent, aging population and low interest rates may be fueling the growth in ORV purchases and use. Hereafter OHV and ORV will be considered interchangeable or synonymous.

The increased use of ORVs in the West has brought controversy and regulation. Vanasselt and Layke (2006) recommend regulation of motorized travel as part of a broader management plan to improve conservation on BLM lands in the West. Currently, most public lands in the West have some restrictions on ORV use. Some ORV uses lead to environmental damages. However, ORVs also permit people of all ages to recreate in areas that they would not normally be physically capable of accessing.

As ORV use grows in the West, more conflicts between recreationists, land managers and environmentalists and sometimes even local communities are likely to ensue. Yet, relatively little

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[2] The United States Forest Service uses the Off-Highway Vehicle (OHV) definition which includes pickup trucks and jeeps. The State of Wyoming ORV definition excludes these vehicles. Our analysis focuses solely on ORVs defined this way.

is understood about benefits, costs and economic activity generated by ORV users. The purpose of this paper is to show the estimated potential economic impact of non-resident ORV users in Wyoming as a case analysis. Moreover, results of this research point toward the complexity of ORV use analyses.

Review of relevant literature

The first attempts to quantify outdoor recreation included national surveys, such as those done for the Outdoor Recreation Resources Review Commission. These began in 1960 with the most current data in the National Survey on Recreation and the Environment (NSRE) available as of 2007 (USDA, 2007). Motorized off-road vehicle use for recreational purposes does not appear in the early surveys. ATVs (three-wheeled) were not introduced until 1970 and recreational off-road motorcycle use was in its infancy. These surveys tended to be broad in scope focusing mainly on participation and management issues while lacking significant economic information.

Loomis et al (2006) used a survey and the travel cost method (TCM) to estimate visitor expenditures to several desirable ATV recreational sites in Colorado. Loomis estimated per day recreation expenditures at between $8.47 and $36.33, depending on the site visited. Englin et al (2006) estimated utility theoretic incomplete demand systems for four off-highway sites in North Carolina. The welfare estimates varied greatly across the specification restrictions analyzed. The authors conclude that researchers should test restrictions and impose those restrictions that best fit the data. Bowker et al. (1997) used TCM to estimate the consumer surplus of ORVs and conclude that motorized recreation is in great demand. Bowker did not estimate economic impacts, however.

Cordell et al. (2005) used data from the NSRE and focused on OHV participation, but again provided little economic data or analysis. Hazen and Sawyer (2001) estimated OHV's contribution to the Colorado economy to be between $140 million and $158 million (based upon data for both residents and non-residents).

Silberman (2003) estimated that nearly $3 billion in retail sales were generated by resident Arizona ORV users in 2002. Silberman (2003) goes on to estimate that this spending generated nearly 37,000 jobs, salaries and wages of $1.1 billion and $187 million in state tax revenues. Interestingly, Silberman (2003) did not survey non-resident users.

Silberman and Aldereck (2006) report contingent valuation estimates from the Arizona survey conducted in 2002. Silberman and Aldereck (2006) found that eighty-nine percent of respondents indicated they participated in at least one non-OHV recreation activity on their most recent trip which was the subject of the CVM question. The authors conclude that the majority of respondents gained surplus from multiple activities on their OHV trip, and that this presented a joint benefits issue for many respondents. The authors found willingness to pay (WTP) of $119.94 for OHV users after including dummy variables to capture non-OHV recreation activities on respondents' most recent trip. While the studies reported by Silberman (2003) and Silberman and Aldereck (2006) fill an important void in the literature, they are limited to Arizona.

Moreover, Silberman (2003) does not estimate economic activity generated in the state by non-residents.

Research Methods

A mail survey was used to gather expenditure, use, location and financial information from both residents and non-residents, who had purchased a Wyoming ORV permit in the previous year (2004). Information presented in this paper will focus only on non-resident tourists (for a report on residents see Foulke et al., 2006).

The mail survey was conducted using a modified Dillman design (Dillman, 2000). The Wyoming State Trails Program (permit administrator) drew a random sample of 1,000 non-residents (with only 947 having useable addresses) as well as 1,000 resident 2004 permit holders from their database of over 32,000 total permits. A trip diary was developed and mailed to the individuals in the sample in June 2005. The purpose of the trip diary was to inform respondents of the upcoming survey and allow them to keep accurate records of their ORV activities during the most active time of the year for ORV recreation. It was hoped that when respondents received the survey later in the year, the trip diary mitigated potential recall bias in the survey. Moreover, a question was added to the survey regarding ORV use within the last 12 months to address the issue of recall bias. If respondents indicated they had not used ORV's for recreational purposes within the last 12 months, they were deleted from the sample.

The survey instrument was pre-tested, in person, by a sample of ORV riders at a motor sports store in Laramie, Wyoming in September 2005. The finalized survey instrument was then mailed in October 2005. Two weeks after the initial survey mailing, a reminder postcard was sent to the entire sample. Two weeks following the postcard reminder, a second survey was mailed to those in the sample who had not yet responded. Responses were received over a three month period, from early November, 2005 until late January, 2006. Survey forms were entered into SPSS Data Entry and subsequent statistical analyses were performed using SPSS. Data were checked for accuracy and economic impact analysis was conducted using the IMPLAN software package (MIG, 2006). Expenditures were allocated based on survey results into the appropriate IMPLAN sectors and margined where necessary.

The initial response rate from non-residents was 41.5 percent (comparable to Hazen and Sawyer (2001) and Silberman (2003)). Respondents who had not answered positively to the screener question regarding ORV use within the last 12 months were removed. This resulted in 15.1 percent of returned surveys categorized as not useable. This suggests a substantial turnover in visitor ORV permit holders. Given the overall budget constraints, phone follow-up of non-respondents was not conducted.

Table 1. ORV visitor respondents by place of residence, top ten states.

1.	Colorado	22.0%
2.	Utah	12.0%
3.	Wisconsin	11.2%
4.	Minnesota	10.0%
5.	Nebraska	7.2%
6.	Montana	6.0%
7.	California	4.8%
8.	Iowa	2.8%
9.	Michigan	2.4%
10.	South Dakota	2.4%

Results

One third of Wyoming ORV non-resident respondents came from neighboring Colorado and Utah. This is quite likely due to the close urban populations located along the Front Range in Colorado and the Wasatch Range in Utah. The next highest frequency of responses came from Wisconsin (12 percent) and Minnesota (10 percent). Table 1 shows the top ten states represented by respondents. Average one-way travel distance for visitors was 575 miles with more than 56 percent reporting having traveled over 250 miles. The above distribution indicates that distance to recreate is important, but it is not the sole factor in the decision to come to Wyoming.

Educational attainment distributions for non-resident respondents are shown with national values for comparison in Table 2 (Census [2], 2007). These values represent the highest education level obtained by non-resident respondents. Twenty-four percent had a bachelor's or post-graduate degree. Nearly 46 percent had received some post high school education, and 29 percent had achieved a high school education. In comparison with the national values, more non-resident respondents had high school degrees and some college or technical training.

Table 2. Educational attainment distribution.

	Non-resident	Percent National*
Grades 1 to 8	0%	6.60%
Some high school	3.60%	13.80%
Finished high school	25.90%	30.10%
Technical college	14.60%	4.10%
Some college	21.50%	18.10%
Associate's degree	9.70%	3.50%
Bachelor's degree	17.40%	15.80%
Post graduate degree	7.30%	7.90%

(Census [2], 2007)

Table 3. Distribution of annual household financial resources of visitor respondents.

	Percent
Under $5,000	0.4%
$5,000 to $9,999	0.8%
$10,000 to $19,999	0.0%
$20,000 to $29,999	5.4%
$30,000 to $39,999	10.0%
$40,000 to $49,999	9.2%
$50,000 to $59,999	12.1%
$60,000 to $69,999	7.5%
$70,000 to $99,999	26.8%
$100,000 to $149,000	17.6%
$150,000 to $199,999	5.0%
Over $200,000	5.0%

Values for bachelor's and post graduate degrees were very similar to national levels. Table 3 shows the distribution of annual household financial resources. Frequency of non-resident respondents indicating income of between $50,000 and $149,999 totaled 64 percent. Those at the high end of the spectrum, respondents reporting *more than* $149,999 income totaled 10 percent. Respondents reporting *less than* $50,000 accounted for almost 26 percent. In comparison, median annual income for the nation was $46,071 in 2005 (Census [1], 2007). This indicates that ORV respondents were broadly distributed but with concentrations at relatively higher than national median household income levels. Tables 2 and 3 suggest that non-resident ORV recreationists coming to Wyoming tend to be relatively more educated and more affluent than the national population. This seems reasonable in that there may be considerable investment in ORVs, trailers and other equipment necessary to participate in this activity in Wyoming.

Table 4. Primary purpose of all ORV trips taken during 2005.

ORV Riding	37.1%
Camping	8.1%
Fishing	8.2%
Hunting	39.1%
Other Recreation	7.5%
Total	100.0%

Respondents were asked to list all the trips taken in Wyoming in 2005 based on their trip diary information. The average number of trips taken by non-residents to Wyoming was 10.5. Respondents were then asked how many of the total trips were taken primarily for ORV riding and then how many trips were taken where ORVs were used for transportation for another recreation activity. Table 4 indicates that only 37.1 percent of the total trips taken by non-residents were primarily for ORV riding. The other 62.9 percent of the trips were taken for other purposes such as camping, hunting or fishing and ORVs were a mode of transportation. This

percentage is not as high as that reported by Silberman and Aldereck (2006) It does suggest that the majority of non-resident ORV users were on joint purpose trips and received benefits from multiple recreation activities.

Table 5. Most recent trip expenditures–visitors.

	Total	***Wyoming***
Gasoline	$331.24	$147.74
Restaurant and bars	$137.12	$97.59
Groceries and liquor	$131.03	$86.20
Overnight accommodations	$121.23	$77.00
ORV guides/tour packages	$2.78	$2.71
Day user fees & donations	$11.28	$10.32
Oil/repairs/maintenance	$27.99	$16.22
Retail items	$79.32	$54.24
Entertainment	$29.17	$21.61
Other expenses	$93.14	$85.70
Total for trip	**$964.30**	**$599.33**
Per person per trip	$351.93	$218.73
Per person per day	$35.26	$26.81
Per person per ORV day (6.9 days)	$51.00	$31.70

Table 5 illustrates expenditures during non-resident visitors' most recent ORV trip to Wyoming. The traveling party spent an average of $964.30 while on the trip, with $599.33 (62 percent) being spent specifically in Wyoming. The largest categories of spending were: 1) Gasoline (includes both passenger vehicle and ORV) 2) Restaurants and bars 3) Groceries and liquor and 4) Overnight accommodations. The majority of all spending category amounts were made in Wyoming, except for gasoline (45 percent). This likely reflects the relatively long distances traveled to get to Wyoming transporting ORVs. Almost all trips involved an overnight stay.

Expenditures were based on an average of 2.7 individuals per trip, according to respondents. This resulted in an estimate of $351.93 per person per trip, with $218.72 being spent in Wyoming (Table 5). Based on the average total trip length, the average total trip expenditure was estimated to be $35.26 per person per day. Based on the average number of days in Wyoming (8.16 days) per person, per day trip expenditures in Wyoming were $26.81. Per person per ORV-day expenditures were based on the number of days of actual ORV use during the trip (6.9 days). This expenditure per ORV-day was used in the economic impact analysis.

Table 6. Mean annual expenditures–visitors.

	Average **Total**	***Average*** **Wyoming**
New/Used ORV	$2,471.83	$469.39
ORV trailers	$646.36	$21.86
Safety equipment	$63.91	$8.30
Clothing	$43.93	$5.47
Accessories	$81.95	$10.19
Annual repairs	$144.38	$25.21
Registration/license/permit	$74.91	$26.24
Club dues	$4.96	$1.70
ORV mag. subscriptions	$3.48	$0.00
ORV storage costs	$34.85	$2.35
Other	$60.36	$24.71
Total	**$3,630.92**	**$595.42**
Per Person	$1,665.56	$273.13
Per ORV	$1,482.01	$243.03

Table 6 summarizes annual ORV expenditures. Visitors reported spending an average of $3,631 on their ORVs during the past 12 months. The largest categories of expenditures were: 1) Purchasing of new/used ORVs, 2) Purchasing ORV trailers, and 3) Annual repairs. As these were non-resident respondents, most of these expenditures (84 percent) were made outside of Wyoming. However, $595 of these annual expenditures were made in Wyoming. On a per person basis, annual ORV expenditures averaged to $1,666 with $273 being spent in Wyoming. On a per ORV basis, ORV expenditures averaged $1,482 with $243 being spent in Wyoming. This average ORV expenditure in Wyoming is comparable to the average ORV expenditure reported by residents (Foulke et al, 2006).

Economic contribution of visiting ORV riders

Because visitor expenditures represent new money to the Wyoming economy it is appropriate to consider the economic impact of the spending by non-resident ORV riders (Crompton, 2001). Visitor ORV rider spending is important because it creates additional jobs and income for Wyoming residents. A 2003 Wyoming IMPLAN model was used to estimate the economic impact of visitor spending (MIG, 2006).

Table 7 summarizes the economic contribution of visitor ORV riders to Wyoming's economy. Based on the 11,071 registered visitor ORVs in the current year (2005), survey estimates of 1.4 people per ORV, and a reported average of 11.6 days of ORV riding in Wyoming it is estimated that total recreation use for visitor registered ORV's in Wyoming was nearly 180,000 use-days representing an estimated $5.7 million in total visitor ORV trip expenditures in Wyoming. The survey results also indicate that visitors spend an average of approximately $243 per year in Wyoming on each ORV for equipment and other fixed expenditures. This yields an additional estimated $2.7 million in total visitor ORV annual expenditures in Wyoming for 2005. Combining

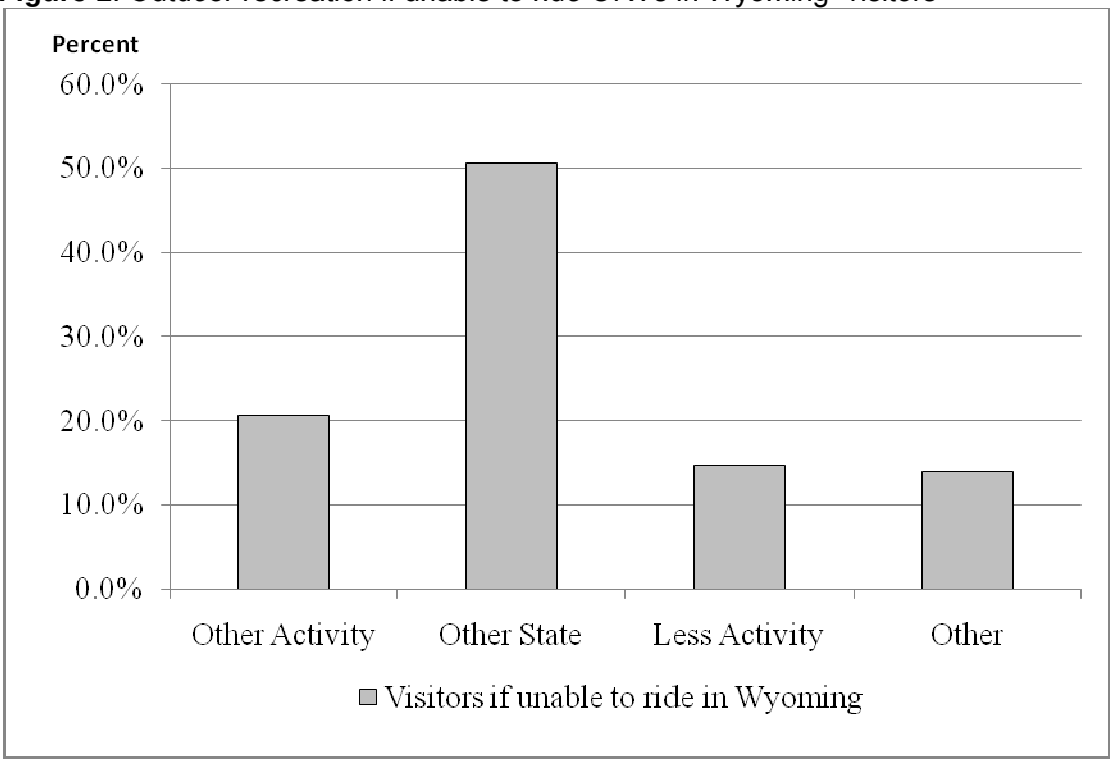
trip and annual expenditures indicates that visitors spent a total of $8.4 million to recreate on ORVs in Wyoming during 2005. These expenditures generated an estimated 127 jobs and $3.3 million in labor earnings.

Table 7. Economic contribution of visitor ORV riders in Wyoming.

	Based on Registrations
Estimated Expenditures	
Total visitor user-days	179,793
Daily trip expenditures in Wyoming	$31.70
Total visitor trip expenditures	$5,699,533
Number of visitor ORVs	11,071
Annual expenditures in Wyoming	$243.03
Total visitor annual expenditures	$2,690,569
Total visitor expenditures in WY	$8,390,102
Economic Impact	
Number of jobs	127
Earnings	$3,305,819
State & Local Government Revenue	
Sales tax revenue @ 5.2%	$302,031
Gas tax revenue @ $0.14 Per Gallon	$49,029
Lodging tax collections @ 2.0%	$14,645
Registration fee @ $15.00	$166,065
Total government revenue	$531,770

It was also asked what visitors might do, if for some reason, they were no longer able to ride ORVs in Wyoming. This could be an issue as there is growing pressure on land managers, particularly in the USFS and BLM to limit ORV usage on public lands. Already, most national forests have restrictions that require ORVs to stay on specific trails or roads. Fifty-one percent of visitors said that they would go to some other state to ride ORVs versus only 24 percent of residents (Figure 1). Additionally, 15 percent said that they would decrease overall participation in outdoor recreational activities, meaning that there could be an overall loss of approximately 51 percent of non-resident ORV recreational users, with another 15 percent reducing visits to Wyoming. From a travel and tourism perspective, this could translate into lost tourists and tourism dollars, representing approximately half of the expenditures and impacts from non-residents estimated for 2005.

Figure 1. Outdoor recreation if unable to ride ORVs in Wyoming–visitors



Summary and conclusions

Off-road vehicles have become a significant part of outdoor recreational activity in the past 25 years. Nearly half of Wyoming consists of public lands (49 percent) on which ORV users desire to recreate. The authors conducted a broad-based survey to try and understand ORV use and users in Wyoming. Specifically, this research focused on non-resident expenditure patterns and the associated economic impacts with implications for policy change.

Total non-resident ORV user expenditures in Wyoming in 2005 are estimated to be $8.4 million. Moreover, this created an estimated 127 jobs and labor earnings totaling $3.3 million. This suggests ORV recreation is significant to Wyoming's tourism economy.

The results here indicate that the majority of ORV trips were joint purpose in nature. This has important implications for benefit estimates as well as economic impact estimates. These results indicate that future analyses must consider potential joint purpose trips of ORV users. Our results also indicate that regulation of ORVs may also impact recreation benefits generated by other activities such as hunting, fishing and camping, given the number of joint purpose trips taken by respondents. Thus, an inescapable conclusion of this study is that ORVs are multiple-use vehicles that cross several activity boundaries, including camping, hunting and fishing. Any new regulations regarding their use will potentially have spillover effects and therefore, regulators should be cautious in their approach to new regulations as unintended economic consequences may result.

Better understanding of these joint-benefit relationships should be an issue for further research. For example, benefits estimates which determine the surplus associated with ORV use versus other uses on the trip could be used to determine the ratio of economic impacts associated with ORVs versus other activities. Moreover, estimates of surplus for hunting and fishing trips should address ORV use or risk inflating the benefits estimates for such activities.

The longer term effects of sustained higher fuel prices on ORV user's behavior and decision making are unknown. Rising fuels costs may impact both benefits received by recreators enjoying multiple ORV based activities and economies dependent on tourism using ORVs. Our survey was conducted right after Hurricane Katrina in October, 2005 when there had been an unprecedented $3 per gallon spike in gasoline prices. The results of a question on change of use by ORV riders showed a limited but measurable effect on ORV usage in the short run, but current fuel price levels may be having a larger impact at this time.

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Agritourism in the West: Exploring the Behavior of Colorado Farm and Ranch Visitors

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Introduction

Agritourism represents a significant part of the tourism industry in the Intermountain West, and is poised to become increasingly important in Colorado. Nationwide, 106 rural counties employed more than 1,000 people in travel and tourism jobs, with some recording 90% of total employment in that industry (Wilkerson, 2003). According to 2002 US Census of Agriculture data, farm and ranch businesses in Colorado derived over $12 million in income from recreational sources. Recreation contributes more than 5% to producers' total farm income in 6 Colorado counties (Wilson, Thilmany and Watson, 2006; US Census of Agriculture, 2002). Moreover, these are conservative estimates of agritourism-based income for Colorado, given that the USDA survey focused only on fishing- and wildlife-based activities, to the exclusion of agritainment, heritage, culinary and off-farm agritourism enterprises.

There has been limited empirical research on the agritourism industry to date. The majority has been somewhat anecdotal, relying primarily on case-studies and startup guides. Brown and Reeder (2007) use national data from the 2004 Agricultural Resource Management Survey to provide summary descriptive information about the extent of the farm recreation industry and the likelihood of farmer involvement in an on-farm recreation business. Carpio et al. (2006) use data from the 2000 National Survey on Recreation to develop a travel cost model to examine the value of the rural landscape. Bernardo et al. (2004) use the same national survey to explore visitor characteristics and various expenditure patterns for enterprises in Kansas; something we also try to address in our study of Colorado. The work of Wilson et al. (2006) focuses on unique characteristics of county-level agritourism data, including natural amenities and other perceived public goods that might add to each county's agritourism revenue stream.

The West has experienced growth in tourism planned around agricultural and food enterprises, as well as agricultural heritage sites. Colorado State University (CSU) researchers needed to understand the tastes and preferences of visitors to and within Colorado who participate in agritourism, as well as visitor incidence and travel expenditures to assist agritourism providers. Although this research was targeted at Colorado, the methods and findings will be useful to a broad set of Western researchers, agricultural businesses and regional economic development staff.

This paper will summarize CSU's consumer-based research on agritourism by providing the following: an overview of agritourism; a general description of travelers; an explanatory model of visitors' agritourism planning; a model analyzing factors affecting the level of travel party expenditures on agritourism; and a classification of agritourists that will better illustrate the diversity and priorities of those who visit agritourism enterprises.

[1] The authors are Graduate Research Assistant, Research Associate and Professor all at Department of Agricultural and Resource Economics Colorado State University

A Study of Colorado Agritourists

In 2007, Colorado State University worked with National Family Opinion (NFO; http://www.tns-us.com/) to implement a Web-based survey targeted at travelers to and within Colorado during 2005 and 2006. NFO distributed the survey to individuals already recruited to their panel, but filtered the samples to include only those who had visited Colorado during the 2005/06 timeframe. These samples were then stratified according to certain demographic characteristics such as age, income, race, and education. Data were not collected from visitors at agritourism sites, which reduces sample bias, but is also a limitation to the study.

Of 1,003 total survey respondents, 503 were from Colorado and 500 were from targeted metro areas in adjacent states (hereafter referred to as out-of-state). Overall, there was a 38% response rate to the Web survey. The targeted out-of-state areas were Salt Lake City, Utah, Albuquerque/Santa Fe, New Mexico, and Phoenix, Arizona—chosen because the Colorado Tourism Office reported that the incidence of travel to Colorado from these metro areas was very high (CTO, 2007). As a result, a fairly representative sample of visitors to Colorado was obtained (in terms of demographics such as income, education and gender). One exception is that those of Hispanic ethnicity were less likely to respond (as is the case with most surveys administered by this company). However, the under-reporting among Hispanics is not believed to significantly impact study outcomes.

Individuals were presented a nested question in which they were first asked if they had traveled to Colorado in 2005 or 2006. If they responded "yes," they were then eligible to take the survey. Subsequently, questions were posed about the respondents' agritourism experiences. Agritourism was defined for them as a variety of recreational, educational and other leisure activities and services, provided by farmers and ranchers that could take place on or off the farm or ranch. A list of activities was provided—including wildlife, food-based, educational tours, ranch/farm stays, heritage agriculture/cowboy/pioneer activities and agritainment (mazes, pumpkin patches, festivals), and respondents could refer to this definition during the course of the survey. Questions regarding agritourism expenditures referred to the respondents' most recent trip to Colorado during the referenced 2005/06 time period.

Overall, travelers who came to Colorado to participate in agritourism between 2005 and 2006 were characterized as follows:

- Age - 46 years on average
- Income
    - 37% earned incomes over $75,000 per year
    - 12% earned incomes under $30,000 per year
- Family characteristics
    - Marital status:
        - 73% of travelers were married
        - 27% were never married, or were divorced, widowed or separated
    - Family composition:
        - 28% were young couples with no children
        - 22% were families with children over six years of age
        - 20% were young families with children under six
        - 15% were retired couples
        - 15% were singles and of any age
- Race/ethnicity
    - 90% identified themselves as White (7% of whom specified Hispanic ethnicity)

- Provenance
    - Overall, 57% of agritourism travelers came from out-of-state (but within the Four Corners region), a slightly greater share than the broader sample would suggest

These numbers would suggest that travelers are more likely to be higher-income (consistent with other tourism studies) and from white households (a little surprising given the state's ethnic diversity). However, it should be noted that Hispanic households are under-represented among those who were recruited for the survey, given that recent population estimates place the proportion of Hispanics in Colorado at nearly 20% for 2006 (U.S. Census Bureau and the Pew Hispanic Trust), and undersampling of this group is a common challenge with surveys.

Among the respondents, 75% participated in at least one agricultural, food or heritage activity on their most recent trip to Colorado, with the majority of these travelers taking 3 or less trips a year. Of those who participated in at least one agritourism activity, more than one-third reported that agritourism was a primary or secondary reason for their trip; more than half of whom (56%) were Colorado residents. Furthermore, nearly one-fifth of all respondents participated in agriculture-related activities on their trips more than 3 times a year, a relevant target market for the state and any farm or ranch business seeking to increase revenue through alternative enterprises. While it is encouraging that such a large share of visitors already participated in agritourism, there may be opportunities to expand participation, the number of overall visitors or the length of visitors' stays by better understanding their motivations and travel behavior.

In understanding the role that agritourism plays in travel planning, the Colorado Department of Agriculture and Colorado State University Extension can help communities build economic development and marketing strategies, and provide information to improve farm and ranch enterprise management. First, knowing how pivotal agritourism is allows us to more accurately measure the degree to which the economic activity brought by travelers can be attributed to this sector (and, thus, the potential for improved economic activity through agritourism development). Second, enterprise and community planners need to understand how to differentially market to those who are seeking to engage in agritourism as the main purpose of their trip (primary visitors), or who may extend their stay to participate in agritourism (secondary), or who participate in agritourism based on a spur of the moment decision (unplanned), in order to attract agritourists.

Explanatory Model for "Agritourism Importance"

An econometric model was developed to determine the factors affecting travel planning by potential agritoursts. The model was based around the stated attribute of agritourism being a "primary," "secondary," or "unplanned activity" to one's trip, which respondents indicated on their survey, based on the descriptions given above. A multinomial logit model was selected to regress explanatory variables against these three agritourism classifications, with "unplanned" serving as the benchmark category for the dependent variable.

The relevant explanatory variables for this model fall into four broad categories that were expected to influence agritourism's draw to a visitor: (1) unique place aspects of each Colorado county to control for natural amenity quality differences (USDA-ERS natural amenities index, USDA-ERS, 1999) and proximity to urban areas (USDA-ERS urban influence codes, USDA-ERS, 2003), (2) selected demographics of the participant/household (i.e., gender, family size, race, life-stage, residence market size, and income), (3) trip characteristics found to be significant in past research (i.e., number of people in the travel party) (Seiler, et al., 2002), and

(4) trip planning resources referenced by the travelers (i.e., past experience(s), welcome centers, recommendations, Colorado Tourism Office, travel Web sites, personal Web searches, magazines, park brochures, and billboards/public signage). Further description of the survey and variables included can be viewed in Thilmany et al 2007(a) (http://dare.colostate.edu/pubs/edr07-16.pdf).

Because "unplanned" activity was designated as the baseline value, the model produces statistical results for agritourism when it serves as a "primary" and "secondary" activity. For brevity, the full set of results is not presented here, but a summary of significant factors provides an interesting complement to other findings from the survey.

Table 1: Multinomial Logit Regression Model Results

Number of observations = 363		Pseudo R^2 = 0.0787	
Primary importance (1)		**Secondary importance (2)**	
	Relative risk ratio (RRR)		RRR
Where relative risk ratio infers a higher (above 1.0) or lower probability (below 1.0) of a traveler participating in agritourism			
Middle-aged with no kids	** 0.3543	Natural amenity scale of county visited	* 1.2349
Parents	** 0.2719	Planned travel based on past experiences	** 2.4604
Number in travel party	** 1.1182		
Planned using national travel Web site(s)	** 0.3266		

** significant at 95%
* significant at 90%

We observe four significant variables for travelers who indicated that agritourism was of "primary" importance to their trip to Colorado: middle-aged household with no kids, parents, number in party, and use of travel planning resources on the Web (all at the 95 percent level). Estimates suggest that a middle-aged person with no children is less likely (≈65%) to have agritourism as the primary reason for his/her trip (holding all else constant). This is a reasonable conclusion as one would expect this group to have the flexibility to act more impulsively and plan activities during their trip. This hypothesis is strengthened by the positive estimates on the size of the travel party, which shows that larger groups participating in agritourism are more likely to plan their trip itinerary (and include agritourism activities) prior to travel. Among travel planning resources, only travel planning through national travel Web sites is negative and significant, indicating that these Web sites are less likely to be used by people planning their travel around agritourism activities (most likely because these sites have limited activity lists from which to choose, and they feature only major destination cities and resort areas).

For the group where agritourism was of "secondary" importance, two significant variables were observed—the natural amenities scale variable for the county visited and the dichotomous variable for whether the respondent has had a previous agritourism experience. The likelihood ratios show relative propensity, so that any fraction above 1 is a positive probability of greater incidence, and vice versa for those under 1.0. Results suggest that a one-unit increase in the natural amenities scale results in an approximate 23 percent increase in travelers to a county noting agritourism was of "secondary" importance, all else being equal (because 1.23-1.0 is equivalent to 23%). This result is encouraging because it reveals that people are attracted to an area by its natural amenities and this, in turn, spills over into participation in agritourism activities in these areas: good news for areas that have struggled to increase the economic contributions they can leverage from the beauty of their communities. It also highlights the importance of linking marketing for agritourism enterprises to natural parks, forests and recreation areas, such as representing them in park brochures and at visitor centers. Lastly, the results imply that private enterprises should describe the natural aspects of their operations in their marketing materials.

Travel Expenditure Model

A linear expenditure model was developed to measure demand and reveal plausible factors affecting travel party expenditures[2]. The dependent variable, total travel party expenditures per day, was regressed on a set of explanatory variables very similar to the multinomial logit model. The model was further refined to reflect the full set of travel spending choices, and showed that seven variables were significant, with the direction of the effect presented below (detailed results will be explored in a subsequent analysis).

Table 2: Generalized Linear Demand Model Results	
Number of observations = 358	
Variable	**Positive/Negative effect**
Urban influence on visited county	**++**
Natural amenity scale of visited county	**-**
Income level (categorical)	**++**
Planned travel based on past experiences	**-**
Planned travel through Colorado Tourism Office	**+**
Used no travel planning resources	**-**
Planned travel through magazines	**++**

++/-- significant at 95%
+/- significant at 90%

The relationship between agritourism expenditures and the urban influence codes was robust and positive. This suggests a get-a-way effect for people participating in agritourism in rural communities, a result that is consistent with Wilson, Thilmany and Watson (2006). The

[2] Due to some endogeneity issues with the variable for travel party size, the final linear model was generalized with this variable as an analytical weight.

coefficient on natural amenities was also highly significant; however, it was estimated to have a negative relationship on the dependent variable. While this result was a little unanticipated, it is often the case that travelers' expenditures are actually limited by the natural state of an area because there are fewer opportunities to spend money there. The model's result also reveals some plausible variable bias in using the natural amenities scale as a measure of "scenic beauty" as it incorporates inputs related to climate and topography. Results for income were robust and in line with a priori expectations of a positive relationship with demand/expenditure. The regression results also suggest a negative relationship on total expenditures per day for people who did not use any resources for their trip planning, or for those who used their previous agritourism experience for planning, instead of new resources. However, those travelers who referred to Colorado Tourism Office (CTO) resources before or during their travels showed increased expenditures. This result highlights the potential economic contribution the CTO can have for Colorado's expanding agritourism industry.

Agritourism Clusters

Another approach to understanding traveler behavior is by cluster analysis. This is a statistical technique that groups people with similar behavior and attitudes into distinguishable traveler segments. A factor analysis was used to identify the variables accounting for most of the variance among travelers. The k-means clustering algorithm in STATA 9.0 was then employed to group the sample. It should be noted that the sample was reduced to 897 observations due to incomplete responses. More details on this approach and findings are available at: http://dare.colostate.edu/pubs/edr07-16.pdf.

After examining differences across travelers in the survey, five groups of travelers who visited Colorado were identified, based on how their behavior is unique from other segments. A brief summary of these clusters shows the following:

- Cluster 1: The *Loyal Colorado Enthusiasts* make up 13% of the travelers analyzed in the cluster analysis. These visitors are parents of older children and couples who return often—based on their previous agritourism experiences. They represent the largest share of participants in outdoor recreation on farms and ranches during the summer. They are most likely to camp while traveling, and they stay within a few hundred miles of home. Loyal Colorado Enthusiasts plan to participate in a diverse set of agritourism activities and report more visits to agritourism enterprises relative to two years earlier.
- Cluster 2: *Family Ag Adventurers* make up 17% of the survey respondents and are among the most promising agritourism visitors. This segment plans their travels around specific agritourism outings, and also participates in unplanned activities several times per year. This group can be defined as middle-income, often traveling with children in bigger parties. They are willing to visit local enterprises, and travel long distances to reach a variety of agritourism destinations. They travel primarily in summer, but also plan trips for spring and fall, which extends the season for some agritourism operators.
- Cluster 3: *In-State Explorers* make up 30% of the 897 travelers analyzed. These are Coloradans who explore the state by car on short jaunts, but usually do not make trips specifically for agritourism purposes. Most of their travel occurs in winter and, to a lesser extent, in fall and summer. Although this group might be hard to target directly since they don't travel with agritourism activities in mind (they do participate in some unplanned activities, however), they travel frequently and are from upper-middle income households. Many planned to travel in the subsequent year and participate in some

agritourism, so the culinary events in which they currently participate may be the best means to extend their visitation and spending into other agritourism experiences.

- Cluster 4: The *Out-of-State Activity Seekers* represent about 4% of the survey panel and comprise those visitors to Colorado who traveled the farthest, did not plan to visit again in 2007, and who were more likely to spend longer trips in hotels, resorts, second-homes or bed and breakfast accommodations. They were primarily mid- to upper-middle class individuals, traveling in smaller parties (even though they are parents), who were more likely to engage in agritourism as a secondary or unplanned activity. They enjoy participating in numerous outdoor activities, and report some of the highest interest across all agritourism activity groups, relative to other survey respondents. Their travel is spread more evenly across all four seasons, relative to the other clusters.
- Cluster 5: The *Accidental Tourists* are 36% of the 897 survey respondents, and may be coming for non-recreational business, educational, or convention activities. In short, they are not seeking agritourism activities, and only a small share of their total agritourism-oriented activities takes place in Colorado. While this group is only in the state for a few days with small windows of time for leisure (for which they may not have planned), they may look for activities to occupy their free time. However, these activities need to be local, well-promoted and easily accessed due to their travel and time constraints.

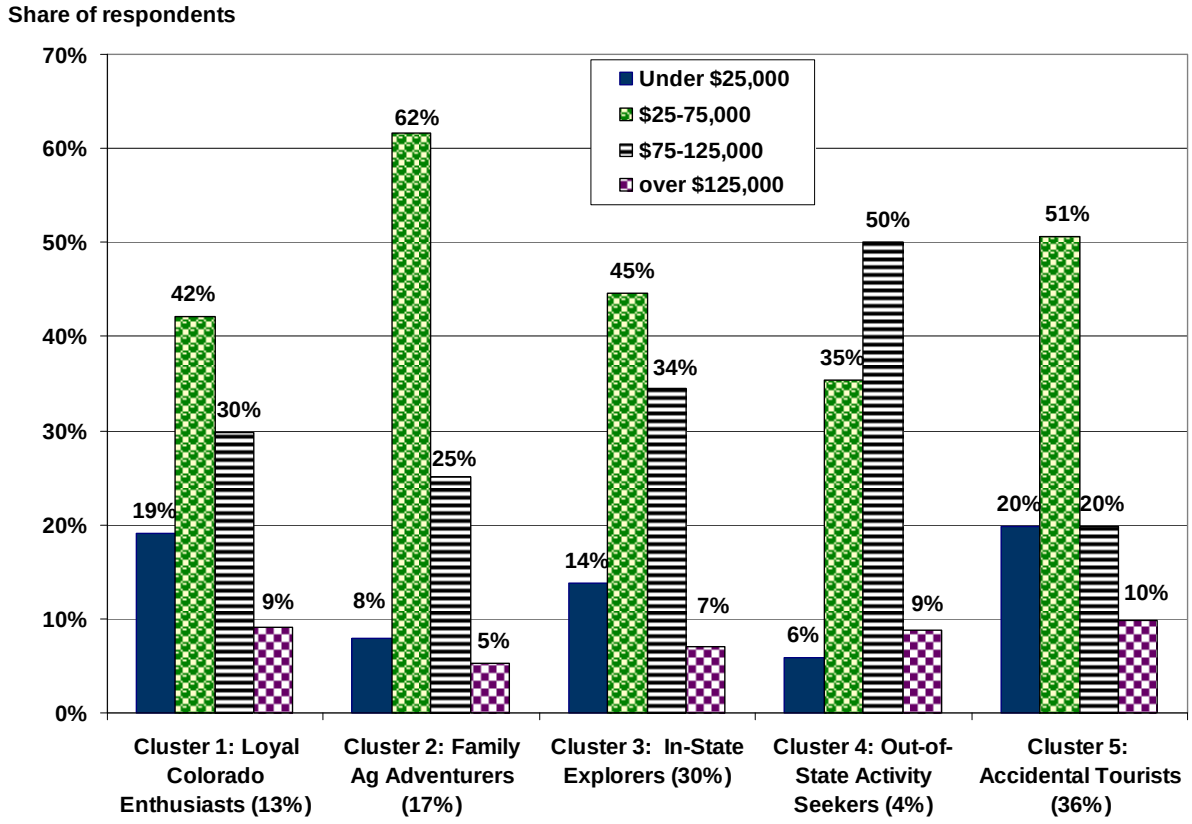
Some of the differences across clusters (including those that assisted us in naming the clusters) are more evident in the following figures and tables that examine demographics, travel behavior and choices across these consumer clusters.

Demographics

In terms of life stage differences among clusters, there are a higher number of parents among the Family Ag Adventurers, especially relative to the Out-of-State Activity Seekers (who are older with no children). Although singles make up a large share of the In-State Explorers (20%) and the Accidental Tourists (23%), travel parties with parents and children are the majority (35% and 42%, respectively). In fact, families with children make up 39% of the sample as a whole.

Figure 1 shows that Loyal Colorado Enthusiasts, the Out-of-State Activity Seekers, and the Accidental Tourists have the highest share of high-income travelers (more than 8%, 9% and 11%, respectively), although the Accidental Tourists have the most diverse income levels. The Out-of-State Activity Seekers have a high number of upper-middle and upper-income households. It is interesting to note that the two segments that have the greatest interest in agritourism have more lower- and middle-income households, suggesting that agricultural, food and heritage activities may be perceived as a good value for vacationers with more limited budgets.

Figure 1: Income Levels of Colorado Visitors, by Cluster, n=897



Traveler Behavior

Although demographics lend some insight into traveler behavior, it is more relevant to consider how behaviors and attitudes differ among the segments. Out-of-State Activity Seekers spend, by far, the greatest amount of time in Colorado (nearly 6 days), while In-State Explorers make the shortest trips (4 days on average). All five groups travel in parties that average 3-4 people. The Loyal Colorado Enthusiasts participate in the greatest number of agritourism activities per trip (more than 4 activities), followed by the two segments with the most out-of-state visitors (Out-of-State Activity Seekers and Family Ag Adventurers). The types of agritourism activities in which travelers participate also vary among consumer segments. On-farm activities based on educational and nature experiences were the most popular among all respondents, followed by food and culinary activities. Food and culinary activities were the top agritourism choice for Loyal Colorado Enthusiasts and Family Ag Adventurers. Although In-State Explorers participated in relatively few agritourism activities relative to the Out-of-State Activity Seekers, Loyal Colorado Enthusiasts and the Family Ag Adventurers, they were most interested in food/culinary and on-farm activities.

Understanding the types of planning resources used by the different traveler segments can help the tourism industry and public officials who are considering investing more resources in agritourism promotion to reach the targeted audiences. Among all clusters, past experiences and recommendations were the most frequently mentioned, but personal experiences were particularly important for Loyal Enthusiasts and In-State Explorers, while Family Ag Adventurers relied more heavily on recommendations from friends and family than the other clusters (Table

3). The Colorado Tourism Office was also cited frequently, especially among the three segments that show the greatest interest in agritourism: a clear signal that even stronger partnerships with the Tourism Office would be fruitful in growing this segment. Out-of-State Activity Seekers generally did the most planning, and could be effectively targeted with good materials shared through Web sites or travel destination partners (such as state and national park visitor centers and Welcome Centers).

Table 3: Trip Planning Resources by Cluster, n=897

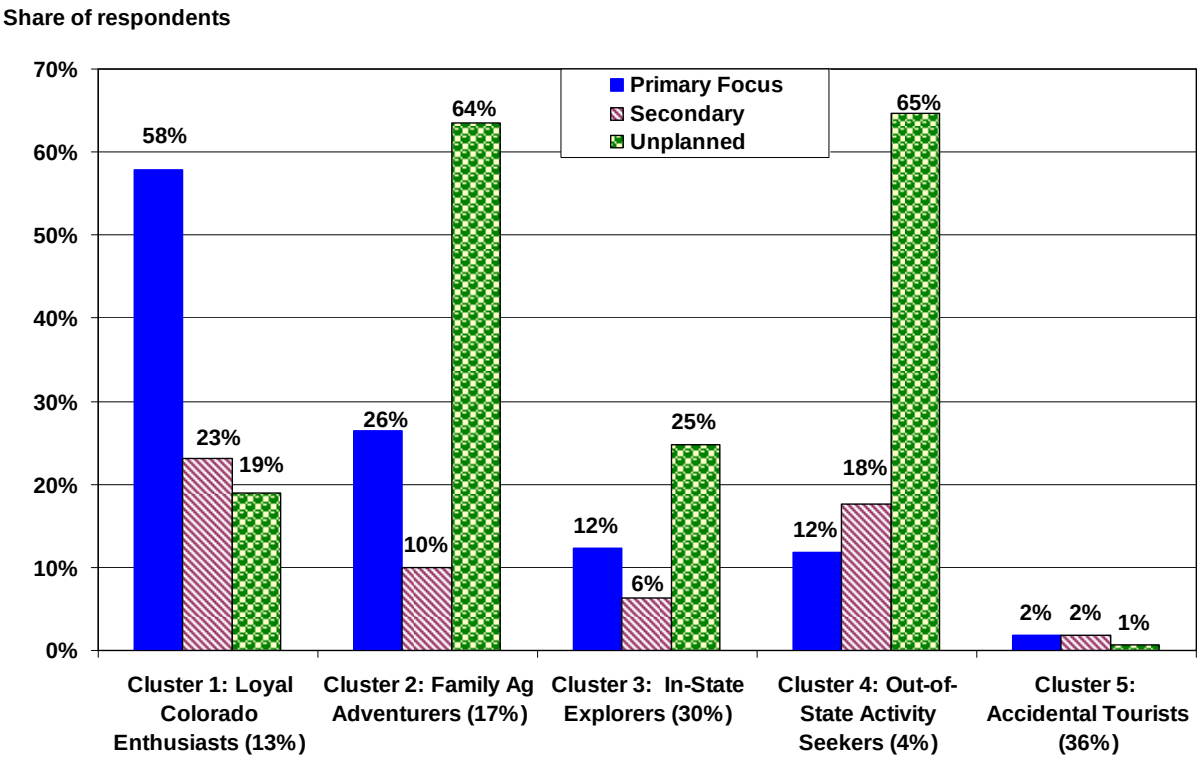
Resources Used to Plan Trip to Colorado*	Cluster 1: Loyal Colorado Enthusiasts (13%)	Cluster 2: Family Ag Adventurers (36%)	Cluster 3: In-State Explorers (4%)	Cluster 4: Out-of-State Activity Seekers (30%)	Cluster 5: Accidental Tourists (17%)
Past Experience	76%	56%	64%	35%	52%
Personal Web Search	24%	19%	15%	24%	15%
CO Tourism Office	17%	13%	8%	29%	2%
Park Brochures	17%	14%	4%	9%	2%
Recommendations	17%	30%	22%	21%	16%
Travel Association	12%	12%	8%	21%	7%
Welcome Center	9%	9%	6%	15%	2%
Regional Web site	7%	7%	6%	9%	2%
Travel Web site	4%	7%	13%	50%	14%
Magazines	3%	3%	4%	6%	3%
Signage	3%	1%	2%	0%	0%
Arranged by hotel	2%	2%	5%	6%	7%
Regional Brochure	2%	1%	2%	3%	1%
Mailing	1%	1%	1%	0%	1%
Other	1%	1%	4%	3%	3%
Travel Agency	0%	0%	0%	15%	1%

Note: Respondents checked all resources they used in their travel planning, so totals may sum to more than 100%.

The Role of Agritourism in Colorado Visits

The model results presented earlier in this paper suggest that it is important to understand the role of agritourism in trip planning in order to further develop agritourism visitation (Figure 2). The Family Ag Adventurers and, to a lesser degree, Out-of-State Activity Seekers and Loyal Colorado Enthusiasts, tend to note a very important role for agritourism activities in their travel plans—one of the main reasons they are considered great opportunities for growing the industry. The Out-of-State Activity Seekers and Family Ag Adventurers are particularly promising for growth since so many of their agritourism activities were also unplanned. This creates opportunities to increase their future visitation to agricultural, food and heritage based enterprises through the information channels they are most likely to use: word of mouth, Colorado Tourism Office promotions and Internet-based searches.

Figure 2: Importance of Agritourism to Visit, by Cluster, n=897



Note: The boxes for each cluster will not necessarily add to 100% since this graph only presents the share of each cluster that did participate in agritourism during their last trip.

Implications for Strategic Marketing and Partnerships

The overarching themes of any marketing plan should be how travelers will "find" an operation or tourism region, how to develop loyalty among visitors and what factors may influence their interest and willingness to spend on their visits. Taking these themes into consideration, three important elements for strategic marketing emerge from this analysis of travel behavior and interest in agritourism.

First, travelers who plan to participate in agritourism have some distinguishable characteristics compared to visitors who make unplanned trips to agritourism sites. Second, travel expenditures can be influenced by travel planning. Lastly, traveler characteristics provide insights into market potential, the role of targeted promotion based on identified opportunities, and how effective partnering might enhance agritourism industry growth.

Twenty-five percent of all visitors did some planned agritourism activities on their last trip to Colorado (primarily the Loyal Colorado Enthusiasts, the Out-of-State Activity Seekers and the Family Ag Adventurers). Another 23% of all visitors surveyed indicated that they participated in unplanned agritourism activities. There appears to be an untapped opportunity to reach these latter consumers and convert them into planned agritourists in subsequent trips. In contrast, those who plan for agritourism likely have travel constraints that impede the spontaneity of visiting a site on the spur of the moment, such as traveling in larger groups. In-State Explorers traveled in the largest groups. The research showed that these travelers relied on their own past experiences as a planning tool, but also on recommendations and Web searches to identify agritourism sites. These travelers might be encouraged to plan for agritourism by providing a broader set of travel planning resources at the agritourism site, offering testimonials on Web sites that provide reviews of the agritourism experience, as well as interactive blogs that provide more in-depth and current information.

The travel expenditure model showed that people who rely on their own previous experiences spend less on agritourism than those who use new information when planning their trips (for example, magazines or CTO resources). It appears that relatively small, well-targeted advertising investments in agritourism promotion could yield large returns for entrepreneurs and communities across Colorado, and create a large field of repeat visitors to businesses associated with the agritourism sector. This may be especially true for those who can promote the fact that their business is located in an area with high natural amenities, especially to travelers who are seeking complementary activities for their visits to such areas. The results suggest that this may have an even greater payoff for those agritourism businesses in more distant locales.

Partnerships with other travel-related organizations and media outlets are key to increasing the success of Colorado's agritourism sector. Only 9% of all those traveling to Colorado used Colorado Tourism Office materials when planning their trips. However, the consumer segments most likely to participate in agritourism relied more heavily on the CTO for information: Out-of-State Activity Seekers (29%), Loyal Colorado Enthusiasts (17%) and Family Ag Adventurers (13%). Further, magazine advertising and Welcome Centers played a relatively important role in attracting one group—the Out-of-State Activity Seekers (6%). This group also rented vehicles to travel around the state (82%), so brochures could be placed at car rental agencies in airports, or on travel association or industry partner Web sites. Lastly, the Accidental Tourists may not have much time for outside activities, but operations located near metropolitan areas could advertise in hotels and airports where these travelers can spontaneously plan for agritourism experiences as they embark on their Colorado travels (for example, the Colorado wine industry has effectively placed brochures in airport locations near baggage claim, shuttle and rental car counters).

For agritourism operators looking to leverage scarce advertising resources, an analysis of the most likely visitors will yield important information on how to balance investment in marketing materials, word of mouth referrals and loyalty programs. Cooperative and joint advertising partnerships with other travel-related stakeholders appear to be the most effective method of

targeting the greatest number of interested consumer segments and engaging both the planner and the spontaneous traveler in considering agritourism in their travel plans. As economic challenges lead some to consider traveling closer to home, agritourism operations may gain some advantage in attracting those who have an interest in the heritage, food aspects or education to be gained from Western farms and ranches. Therefore, thoughtful development of agritourism enterprises and strategic marketing to travelers may yield more return visitors and attract those who have only lightly considered these types of recreation and leisure activities in the past.

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Economics of Predator Control to Protect Agriculture: The Unanswered Questions

Benjamin S. Rashford, Jared M. Grant and Brian Strauch[1]

Introduction

For centuries humans have attempted to control populations of mammalian predators to protect livestock populations. The United States government officially entered the predator control arena in 1915, when Congress appropriated funds for the control of wolves and coyotes (GAO, 2001). Federal and state agencies have since invested significant public resources to control predators to protect and to compensate agricultural producers for incurred losses. In 2007, for example, USDA APHIS Wildlife Services invested over $39 million in predation programs (USDA, 2008). Concurrently, growth in the environmental movement has raised concerns about the efficacy and morality of such resource use (Connolly, 2001, Hewitt, 2001). Recent controversy surrounding the removal of endangered species status for the gray wolf (*Canis lupus*), specifically the negative public opinion of state management plans that would manage wolves similarly to coyotes, is a case in point.

Although disagreements about predator control are unlikely to ever disappear, it may be time to cast the predator control debate in a new light. Recently there has been a growing recognition of the value of ecosystem services provided by private agricultural land. This is particularly true for wildlife habitat in the Rocky Mountain region (RM), where, despite large tracts of public land, wildlife depend on private lands for much of their habitat needs (Coupal, et al., 2004). Concurrently, rural and ex-urban development is placing increasing pressure on land historically shared between livestock and wildlife. As a result, profitable agricultural production may be the last line of defense protecting many valued ecosystems from being permanently altered by development.

Publicly subsidized predator control and compensation programs may be viewed as another tool to protect the provision of ecosystem services from private land. It is therefore increasingly important that policy makers have accurate scientific information about the effectiveness of such programs for protecting the profitability of agriculture. This information will help policy makers accurately assess the tradeoffs between agricultural sustainability and other social values (e.g. non-market values of predator populations). The purpose of this article is to review existing research in the light of this new context and to provide direction to target future research.

Financial Impacts of Livestock Depredation in the West

Predation continues to have a measurable financial impact on many sectors of the agricultural economy. This is particularly true for the production of sheep and lambs, where the value of losses due to predators, primarily coyotes, exceeded $6 million in 1994, 1999 and 2004 (Figure 1). These losses account for 2 – 11% of the annual total value of sheep production in these western states. Furthermore, predation routinely accounts for greater than 50% of the annual

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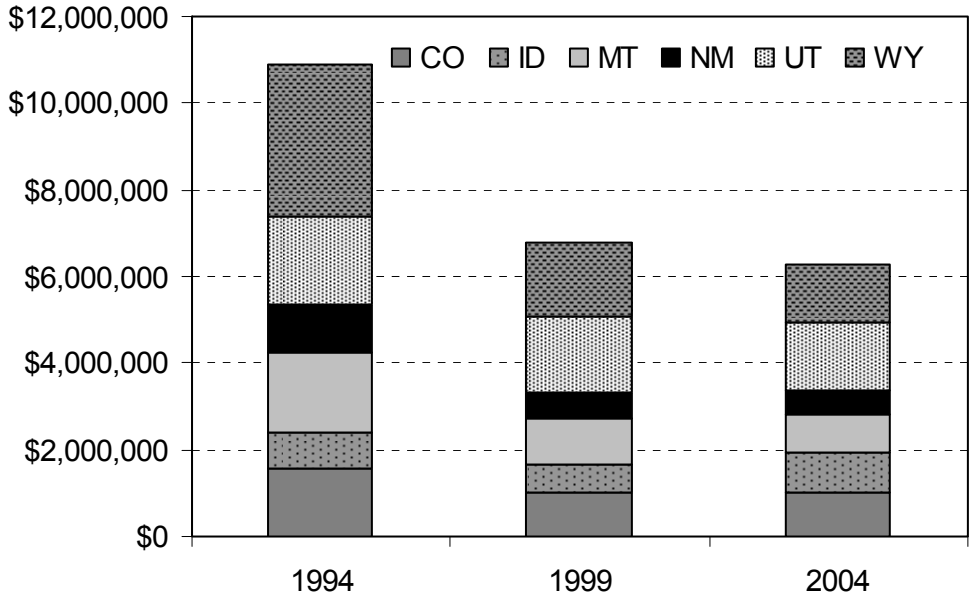
death loss of lambs in the RM region (National Agricultural Statistics Service, 1995, 2005, 2000).

Direct financial impacts of predation, however, are not limited to sheep and lambs. Predation losses generally account for 1-2% of total cattle inventory in the region and greater than 5% of total calf inventory (USDA, 2000). Additionally, in areas with robust populations of large predators (wolf and grizzly bear) predation on cattle and calves can be significant. The Upper Green River Cattle Allotment, located in the Greater Yellowstone Region of northwest Wyoming, confirmed predation by grizzly bears and wolves accounted for more than 50% of total death loss from 1995 to 2004 (Sommers, et al., 2008). An alternative study in the same region found that grizzly bears were responsible for 39% and 12% of total calf and adult cattle mortality, respectively (Anderson, et al., 2002).

Figure 1. Dollar value of sheep and lambs lost to predators by State, 1994, 1999 and 2004 [Source: National Agricultural Statistics Service (1995, 2005, 2000)]



Dollar figures are adjusted to real terms using the GDP deflator, base year 2004.

While the financial impacts of predation on livestock production are measurable, they remain small relative to the total value of production. As a result some have argued that federally subsidized predator control programs are unnecessary (e.g. Berger, 2006). Livestock operations in the west, however, routinely maintain slim to negative profit margins (Jones, 2004). Furthermore, the negative financial impacts of predation are not evenly distributed across the landscape. Thus, while the livestock industry in a given region may experience relatively small aggregate losses, those losses may primarily impact a few producers that operate in areas most prone to predation. If areas prone to high predation rates also coincide with agricultural land that is highly susceptible to land conversion (e.g. agricultural land into subdivision around the Greater Yellowstone Region), the financial impacts of predation may be an important factor threatening agricultural profitability. Thus, even small depredation losses

that reduce annual gross margins can threaten the economic sustainability of agricultural production and the associated ecosystem service provided from agricultural lands.

Lastly, in addition to the direct effects of predation, the financial impacts of predation also ripple through the broader regional economy due to employment and income linkages across economic sectors. Jones (2004), for example, estimated that predation in the RM region in 1999 caused approximately $7 million in direct losses to the livestock industry. These direct losses led to an additional $5.6 million dollars of indirect losses in allied sectors.

Economics of Predator Control to Protect Agricultural Lands: State of the Literature

Economic theory suggests that the conversion of agricultural land to development will occur if the present value of the stream of net returns from agriculture is less than the net returns from development (Irwin, et al., 2003). Thus, policy-makers must understand how predator control programs contribute to the long term net returns of agricultural production to assess the effect of these programs on land protection. This implies the need to understand the following: 1) the biological relationship between relevant predators and their prey, including livestock; 2) how predator control efforts affect predator-prey relationships and thus the effect of predator control on livestock production; 3) cost-effectiveness of alternative control methods; and 4) the economic efficiency of predator control relative to alternative agricultural support programs.

The literature contains numerous economic analyses related to predator control efforts. Surprisingly few, however, directly model the biological predator-prey relationships such that the effects of explicit control efforts on livestock production can be derived. Several studies have explicitly modeled predator-prey relationships with respect to wildlife species of concern (Rashford and Adams, 2007; Shwiff, et al., 2005; and Skonhoft, 2006). These studies use available data to parameterize or statistically estimate functional relationships between either predator and prey populations, or alternatively, predator populations and levels of predator control effort. Thus they develop functional representations of the biological predator-prey relationships, which can then be explicitly integrated into an economic optimization problem.

Few studies have developed similar predator-prey relationships for livestock depredation. Data on the interactions between predators and livestock and livestock losses relative to specific control efforts have been collected in biological experiments (e.g. Anderson, et al., 2002, Wagner and Conover, 1999). Alternatively, regression techniques have been used to examine correlations between predator populations or control efforts and livestock outputs (Berger, 2006, Conner, et al., 1998). These studies, however, do not attempt to develop functional relationships. Moreover, studies of this nature tend toward the following (often by necessity): 1) focus on a single pair of predator and prey species; 2) have limited temporal and spatial extent; and 3) focus on one of a large suite of predator control alternatives applied at a single (or a few) level(s) of intensity. These studies do not reveal the range of substitution possibilities among the set of controllable (e.g. predator control efforts) and uncontrollable (e.g. weather and alternative prey populations) inputs, and the associated response of livestock populations (see Matulich and Adams, 1987, for an in-depth discussion of this problem). An exception to this criticism can be found in the bio-economic analysis of feral pig predation on lambs in Australia by Choquenot and Hone (2000). This analysis uses dynamic models of predator populations and lamb predation to simulate the economic impacts of multiple control options in a bio-economic model that incorporates exogenous factors (e.g. rainfall) and inter-specific competition.

The general lack of explicit models of predator-prey relationships in the context of livestock production has forced studies of the economic efficiency of predator control to use aggregate data approaches. Several studies, for example, have used a benefit-cost approach to examine the efficiency of programmatic expenditures on predator control (Bodenchuck, et al., 2000, Collinge and Maycock, 1997, Shwiff and Merrell, 2004, Shwiff, et al., 2006). These papers account, as accurately as possible, for aggregate benefits and costs, including indirect benefits (e.g. spillovers to other economic sectors) and indirect costs (e.g. non-programmatic costs born by individual producers). However, there is no direct relationship between alternative control efforts and agricultural profitability due to the aggregate nature of the data. The benefits of predator control, for example, are often measured by damages avoided assuming a linear relationship between control efforts and predation rates (e.g. predation rates are 1-3% higher in the absence of control efforts).

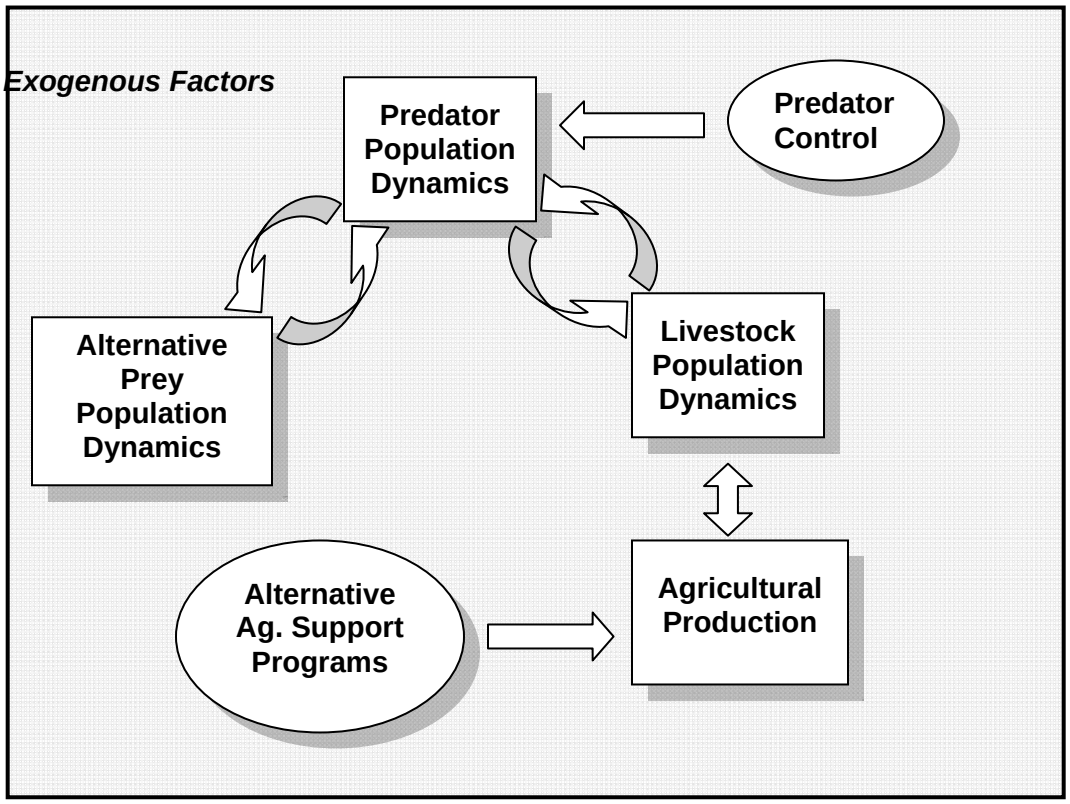
The aggregate benefit-cost approach is most useful for determining the aggregate net benefits of control expenditures and therefore justifying the existence of control program in general. This approach does not illicit the biological or economic tradeoffs between alternative control strategies and therefore cannot determine the cost-effectiveness of alternative control methods. It would be difficult to use this approach to compare predator control programs to alternative agricultural support programs as a means of preserving agricultural land because the aggregate benefit-cost approach does not directly link predator control to agricultural profitability.

Looking to the Future

Researchers and policy-makers appear to lack a firm understanding of the complex relationship between predator control programs and firm-level agricultural profitability. As a result, their currently exists no framework for analyzing the role that predator control programs can play in the broader effort to preserve agricultural land. Such a framework must explicitly model the population dynamics of predators and prey and these dynamics must be explicitly linked to agricultural production and policy decisions. The effects of predator control and alternative agricultural support programs can then be analyzed on the basis of how they impact agricultural profitability.

A general framework for integrating biological predator-prey models, agricultural production models and decision making is presented in Figure 2. The critical sub-systems are depicted with rectangles, while ovals represent inputs. These components are all incorporated within the larger rectangle indicating that each sub-system is a component of a larger integrated system. The integrated system includes exogenous factors, such as climate and public perception, that can influence each subsystem directly and the relationships between sub-systems. Climate, for example, will directly influence the population dynamics of individual species, which in turn will influence the relationships between related species. When threatened or endangered species are part of the system the exogenous factors, such as statutory limitations and public opinion, must be explicitly considered as these issues can significantly complicate the evaluation of predator control programs.

Figure 2. Conceptual framework for an integrated model of predator control



The sub-systems represent models of stand-alone systems that ultimately influence agricultural profitability within the integrated framework. The population dynamics sub-systems would include specie specific population growth models. These models, however, must be able to capture the relationships between individual species and the environment (e.g. forage for prey species), and relationships between species (e.g. predator-prey dynamics). Consider a simple model of coyote predation with two prey species, sheep and rabbits. Population models of each species in this simple model would need to relate changes in forage availability to population impacts on sheep and rabbits, which will impact coyote population dynamics and predation rates on each prey species. A model that excluded the population dynamics of rabbits in this system would likely overestimate the beneficial effects of predator control on sheep production. The oversimplified model would exclude the possibility that coyotes will substitute between alternative prey depending on availability.

The agricultural production sub-system would capture the agricultural decision making process. Standard farm level decision models (e.g. math programming) are well developed for this context (see Hazell and Norton, 1986). The agricultural decision model must explicitly account for livestock population dynamics, production response to alternative incentive programs and the effects of exogenous factors to fit in the integrated model. A farm level decision model that does not account for livestock population response to environmental changes would be difficult to integrate into the coyote example. The agricultural decision model must also be capable of modeling production response to alternative incentive programs and thus the relationship between alternative agricultural support programs and the effectiveness of predator control.

Support programs that provide incentives to increase livestock stocking rates, for example, may influence predator population dynamics and thereby affect the marginal benefits of predator control. Models that do not capture these complex relationships between incentive programs, incentive response, population dynamics and predator control may systematically misestimate the effectiveness of predator control for sustaining agricultural profitability.

The development of a framework that incorporates all of the components of figure 2 will require significant interdisciplinary cooperation. Biologists will need to collect data and build models of population dynamics, as well as conduct experiments on the biological effects of alternative predator control efforts. Animal scientists will need to build models of livestock population dynamics. Finally, economists must integrate these components into agricultural decision-making models. Factors key to the success of such a collaborative effort include the following: 1) the constituent models must be capable of capturing the effects of the full range of predator control and agricultural production inputs so that substitution possibilities and complementarities across inputs can be examined; 2) the effects of exogenous factors (e.g. weather) must be accounted for so that uncertainty can be explicitly modeled and so that the robustness of model conclusion can be tested under alternative scenarios, such as climate change; and 3) the constituent models must be developed in concert across disciplines so that they can be seamlessly integrated.

The integrated framework proposed here can serve as a long-term objective for researchers and policy-makers concerned with agricultural sustainability in the west. Interdisciplinary research of the scale required to develop this model, however, remain rare. Furthermore, integrating multiple dynamic models capable of being influenced by the same exogenous factors is highly sophisticated task. As a stop-gap researchers in each critical discipline can move forward independently in a manner consistent with the integrated framework. Each discipline only needs to consider the broader framework when designing research targeted to each sub-system. If each sub-system model includes variables and parameters that support linkages to other sub-systems, the integrated framework could evolve naturally.

The development of this integrated framework will require targeted, long-term research effort. The result, however, will be a model capable of eliciting the economic tradeoffs between alternative predator control activities at multiple scales and between predator control and alternative agricultural support programs. This will allow policy-makers to make informed decisions about the use of scarce resources and will allow the predator control debate to be analyzed in a new light.

Conclusions

Debates about the economic efficiency, biological efficacy and morality of predator control programs to protect agriculture are unlikely to be resolved in the near future. These programs, however, may be an important piece of comprehensive agricultural support programs that protect the sustainability of agriculture and the associated ecosystem services that agricultural lands provide. This view of predator control is fundamentally different than the perspectives represented in existing economic analyses of predator control. As a result, the evaluation of predator control as a component of agricultural land protection programs will require a new, more comprehensive and interdisciplinary, approach to predator control research. This new approach must explicitly integrate the population dynamics of predator and prey systems within an agricultural decision-making framework. In the absence of such research policy-makers will

be unable to fully evaluate the efficiency of predator control programs relative to alternative agricultural support programs.

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A Benefit Transfer Toolkit for Fish, Wildlife, Wetlands, and Open Space

John Loomis, Timm Kroeger, Leslie Richardson and Frank Casey[1]

Introduction

The application of existing non market valuation studies to quantify the economic benefits provided by unstudied areas or policies has been evolving for decades as more studies accumulate and advances have been made in benefit transfer methodologies. Entire valuation databases exist either on line for a variety of recreation activities (Loomis, 2005) or have been published (e.g., recreational fishing (Boyle, et al.)). The Environmental Valuation Reference Inventory (EVRI) is an international database of recreation valuation studies as well as values of air quality and water quality (www.EVRI.ca).

In addition to these databases of studies, there have been applications of meta analyses to summarize these recreation values (Smith and Karou, 1990; Walsh, et al., 1992; Rosenberger and Loomis, 2000). Meta analyses have also been performed for wetland values (Woodward and Wui (2001); Randall et al., 2007), and threatened and endangered species values (Loomis and White, 1996), to name a few non recreation examples.

Numerous journal articles test the accuracy of different approaches to benefit transfer (see the special issue of Ecological Economics by Wilson and Hoehn, (2006) for a summary). However, according to Moeltner and Woodward (2007) there have been only a few published accounts of economists using either databases or meta analyses in actual policy evaluation.

Public land management agencies, such as the U.S. Forest Service (USFS) and Bureau of Land Management (BLM), have been faulted for not incorporating values of fishing, hunting, wildlife viewing and natural environments into their economic analysis (Haefele, 2006). Even BLM recognizes that changing demographics around public land have "…increased the BLM's need for well-focused and credible socio-economic data and analysis" (BLM, 2008).

Even when public land management agencies do incorporate non market economic values into their analysis, their approaches do not reflect improvements made in benefit transfer methodology in the last two decades. USFS and BLM typically rely upon administratively approved standardized average value transfers (e.g., USFS Resource Planning Act average values calculated from the literature) or published averages others have calculated from the existing literature (e.g., Bergstrom and Cordell, 1991). There are several reasons agencies often have for reliance on these older methods Often public land management agencies lack access to the proprietary economic databases (e.g., EconLit) to locate more recent studies.

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Acknowledgements: Alan Randall, Ohio State University provided early direction and mid-course suggestions for framing the overall approach, and graciously shared with us wetland and habitat meta models. This research was funded by the National Council for Science and the Environment's Wildlife Habitat Policy Research Program (WHPRP) in association with the Doris Duke Charitable Foundation. We also thank the Editor and three anonymous reviewers for suggestions to shorten the paper and clarify several points. Any errors are those of the authors.

They may also lack the time or expertise to assemble and synthesize the existing valuation studies in the form of meta analyses. Finally, even those agencies aware of meta analyses are sometimes confounded by how to apply existing meta analysis equations to calculate benefits that fit their particular situation due to the myriad of methodological variables contained in these meta models. The benefit transfer toolkit is intended to facilitate the application of benefit transfer for wildlife recreation and habitat as well as improve the consistency of such benefit transfers.

Calculating a value per day for, say, wildlife viewing, is only half the job. Agencies need to estimate the number of wildlife viewing days in the current situation, and more importantly how those days would change with increases or decreases in wildlife habitat. These estimates of visitor use are not only needed for economic valuation but also for regional economic impact analysis. As such, the toolkit provides statistical models for visitor use estimation as well.

The purpose of this article is to summarize a new benefit transfer toolkit that contains databases, average value tables, meta analysis-based pre-programmed spreadsheets and visitor use estimation models for wildlife recreation and wildlife habitat. The format and interface can also serve as a template for other economists who might wish to develop similar spreadsheet models for valuing non-wildlife recreation such as hiking, camping, and reservoir recreation as well as natural environments such as wilderness.

Benefit Transfer and Use Estimation Toolkit for Wildlife Recreation and Habitat

Desvousges, Johnson and Banzhaf (1998:1) noted that "Transfer studies are the bedrock of practical policy analysis. Thus databases, average value tables and meta analyses for fishing, hunting, wildlife viewing, endangered species, open space, water quality and wetlands have been developed to improve the practice of benefit transfer by public agencies and consultants. Also contained in the toolkit are standardized spreadsheet templates that estimate values per unit (e.g., visitor day, acres, per household). The spreadsheet templates simplify the estimation of changes in visitor days resulting from changes in habitat acreage. Of course, the models are far from perfect and limited by the available data. Yet, these standardized tabular values and meta analysis equations should minimize errors in benefit transfers by economists, wildlife biologists and public land planners who do not have extensive experience with non market valuation and benefit transfer. These tools provide an opportunity for public land management agencies, county planners and others to incorporate non-market values into their planning and decision making.

Description of Types of Values Included in the Toolkit

The funding to develop the toolkit focused on fishing, hunting, wildlife viewing, endangered species, and wildlife habitat such as wetlands and aquatic species as well as open space. Table 1 presents the types of values analyzed in the toolkit. This table indicates whether there is a meta valuation model, average per unit tabular value, and standardized database of the original studies included in the toolkit.

Table 1: Values quantified, value models, tables and databases contained in the Toolkit

Value analyzed	*Value expressed as*	*Meta Valuation model*	*Average value table*	*Database table*
Open space property value premiums	% of property value total $ for all properties near site	✓	NA	✓
Terrestrial Habitat		✓	NA	NA
Aquatic improvements		✓	NA	NA
Ecosystem Services of Wetlands		✓	✓	✓
Wildlife-associated recreation benefits and visitor use estimator:	$/visitor day and change in # visitor days at site			
• Fishing		✓	✓	✓
• Hunting		✓	✓	✓
• Wildlife viewing		NA	✓	✓
T/E/Rare species values	$/household for species population change;	✓	NA	✓
Salmon	total $ for species population change	✓	✓	✓

Table 1 shows that the toolkit contains average values for species, habitat types, and recreation activities along with databases of individual study values. Users preferring to construct their own average values from the underlying database can exercise this option with the toolkit. All the value tables, meta analyses, hunting, angling and wildlife viewing estimation models, user manuals and technical documentation are available at: http://dare.colostate.edu/tools/benefittransfer.aspx or http://www.defenders.org/programs_and_policy/science_and_economics/conservation_economics/index.php.

Since the average value tables are fairly typical of past benefit transfer efforts (e.g., Rosenberger and Loomis, 2000; 2001) and the underlying database of original valuation studies are similar to what is available in Loomis (2005) they will not be discussed in detail. Rather, this article will concentrate on illustrating the user friendly pre-programmed spreadsheet programs that employ the meta analysis approach to benefit transfer and the visitor use estimating models.

Sources of Meta Analyses

This section describes the basic approach followed in developing the meta analyses used in the spreadsheet templates contained in the toolkit. The specific procedures for each meta analysis are described in more detail in the technical documentation (Loomis and Richardson (2008)) that is available at either website. First, we relied upon published meta analyses whenever available (e.g., Woodward and Wui (2001) wetlands). If more recent meta analyses were available they were used or included along with the published ones. Johnston, et al.'s (2005) article provided aquatic resource values. There was also a very thorough meta analysis of

recreation fishing performed by Boyle, et al. and one of their meta regressions was selected for the toolkit. Original meta analyses for hunting benefits, and total economic value of salmon were estimated for the toolkit. The Threatened and Endangered species meta analysis by Loomis and White (1996) was updated for the toolkit. The open space property premium model also represents an original meta analysis of the available hedonic property analyses. While each spreadsheet itself contains some documentation, as part of the overall toolkit, there are several PDF files that provide more complete documentation of data and statistical analysis than can be found in the spreadsheets themselves.

Example of Per Visitor Day Meta Analysis

Table 2 presents an example of a meta analysis-based pre-programmed spreadsheet for valuing a hunter day. The structure of the other wildlife recreation activities such as fishing and wildlife viewing are similar. The first layer (shown in Table 2) is the user interface that contains the key variables needed by the user to customize the meta analysis regression's estimate of value per day to their specific geographic area and specific type of wildlife activity. The second layer of the spreadsheet (not shown) is a more complete definition of each of the variables to provide guidance to the user. The last layer is the underlying estimated regression equation (coefficients, standard errors, and means) used in the meta analysis. In the case of hunting the regression is:

Value per Hunter Day=$\beta o-\beta_1$(DataYear)- β_2(InterMtnDum)- β_3(NoEastDum)- β_4 (PacificDum)

- β_5(SoEastDum)- β_6(LandOwnership)- β_7(Unit Conversion Dum)- β_8(ValueMethod)

- β_9(Waterfowl)+ε

where

Data Year is the year the data of the original study was collected;
InterMtnDum, NoEastDum, PacificDum and SoEastDum are regional dummy variables;
LandOwnership is a dummy variable for 1 if land is public and zero for private;
Unit Conversion Dummy is 1 if benefit units were converted to a per person per day from the original study units;
Value Method is 1 if contingent valuation and zero otherwise; and
Waterfowl is 1 if species hunted is waterfowl, zero otherwise.

For Table 2, the user changes only the regional dummies, land ownership type and species hunted to tailor the value estimate to their study area and activity. The methodological variables are set at the means of the original study database and do not require any user input. Following this protocol should improve consistency in benefit transfers across users.

Table 2. Example of Recreation Use Meta Analysis Pre-Programmed Spreadsheet

Value of Hunting per Hunter Day			
Instructions:	Fill in relevant cells marked "ENTER >" associated with the region the hunting value is for,		
	the land ownership type, and if the type of species being valued is waterfowl.		
	See accompanying user manual for detailed instructions and documentation.		
STEP 1:	**Enter a 1 next to the site location; 0 otherwise**		
	ENTER >	1	Intermountain region (AZ, CO, ID, KS, MT, ND, NE, NM, NV, SD, UT, WY)
	ENTER >	0	Northeast region (CT, DE, IA, IL, IN, MA, MD, ME, MI, MN, MO, NH, NJ, NY, OH, PA, RI, VT, WI, WV)
	ENTER >	0	Pacific region (CA, HI, OR, WA)
	ENTER >	0	Southeast region (AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, VA)
STEP 2:	**Enter a 1 if land ownership is public; 0 if private or mixed public private)**		
	ENTER >	1	
STEP 3:			
	ENTER >		**Enter "BIG" if the site supports BIG GAME hunting**
	ENTER >	SMALL	**Enter "SMALL" if the site supports SMALL GAME hunting**
	ENTER >		**Enter"WATER" if the site supports WATERFOWL hunting**
OUTPUT: Big Game		$0.00	**$/ Hunter Day (2006 base year)**
OUTPUT: Small Game:		$62.95	**$/ Hunter Day (2006 base year)**
OUTPUT: Waterfowl:		$0.00	**$/ Hunter Day (2006 base year)**

Estimating Hunting, Fishing and Wildlife Viewing Use

As noted above, a complete benefit transfer not only involves per-unit values but an estimate of total use (e.g., visitor days for recreation, acres for habitat preservation, etc.). For hunting, fishing and wildlife viewing two sets of seven recreation use regressions were developed as follows: (a) one set applicable to lands designated as USFWS National Wildlife Refuges--NWR/State Wildlife Management Areas--WMA (based on data from the USFWS Banking on Nature, 2004); (b) one set applicable to all types of lands in each state (based on USFWS National Survey of Fishing, Hunting and Wildlife Associated Recreation (2002) and the USDA National Resource Inventory (NRI)). The specific recreation activities for NWR/WMA and the state level include the following:

(1) big game hunting; (2) small game hunting; (3) migratory bird hunting; (4) total hunting (sum of 1, 2 and 3); (5) freshwater fishing; (6) saltwater fishing and (7) nonconsumptive/viewing visitor use.

Like the meta analysis-based pre-programmed spreadsheets, these visitor use regressions are pre-programmed and allow users to predict use conditional on the regressions statistically significant site attributes. For the Refuge models, acres of the Refuge is often a statistically

significant attribute. In the state level models, acres of particular types of lands that were statistically significant in the state visitor use regressions are included. Based on the NRI data, the candidate land types that were tested in the state models include private forestland, state public forestland, wetlands, cropland, pasture land, federal land, and rangeland.

Table 3. Example of Estimating the Reduction in State Level Wildlife Viewing Days due to Development of Private Forest Land

STEP 1: Enter the current acres of each type of land within the state of interest (use the 'State Variable Input Values' Tab)		
ENTER >	186,000	State Forest Land
ENTER >	21,559,800	Private Forest Land
STEP 2: Enter household median income for the state of interest (use the 'State Variable Input Values' Tab)		
ENTER >	$46,840	
STEP 3: Enter the state population (use the 'State Variable Input Values' Tab)		
ENTER >	8,186,453	
	8,267,286	**Wildlife Viewing Days / year in Georgia**

STATE VALUES WITH MANAGEMENT/POLICY ACTION

STEP 1a: Enter the acres of each type of land within the site of interest		
ENTER >	186,000	State Forest Land
ENTER >	20,059,800	Private Forest Land
	8,155,585	**Wildlife Viewing Days / year in Georgia with policy action**

CHANGE

	-111,701	**Change in Wildlife Viewing Days / year**

Table 3 presents an example of the pre-programmed wildlife viewing estimation model at the state level. This table illustrates the "with versus without" computation of the change in wildlife viewing for a hypothetical loss of one million acres of private forest land that is currently being used as de-facto wildlife habitat. As can be seen in Step 1a the number of acres of State Forest

Land does not change from the current situation, but the private forest land acres is now 20,059,800; one million acres less than the current situation.

As may be evident from the cells in this spreadsheet, the model estimates wildlife viewing days as a function of the two habitat types that were statistically significant in this model (State Forest Land and Private Forest Land) as well as state median income and state population. The second layer of the spreadsheet (not shown) provides values for state median income and population. The third layer of the visitor use estimation spreadsheets is an example spreadsheet, the fourth layer provides variable definitions and the last layer presents the regression coefficients, standard errors and means of the variables.

Property Values Premiums Related to Open Space

Another feature of the toolkit is the ability to calculate the open space-related residential property value premiums for homes located near open space. The meta analysis equation underlying the regression model was estimated using 55 observations of open space premiums obtained from peer-reviewed studies across the U.S. that focused on county and large urban natural area parks, state parks and forests, national forests, parks and wildlife refuges, and private forest lands, or mixed forest and pasture lands. The model allows the user to tailor the estimate of the open space-related percent increase in property values to the variables identified as significant in the meta analysis, namely, the size of the open space (expressed as the corresponding percentage the open space accounts for within the area of analysis) and open space characteristics like land cover type, ownership and protection. Once the property value premium has been calculated by the spreadsheet, the user can enter information on the number and average price of single family homes in the analysis area. The spreadsheet will then calculate the estimated aggregate value of all homes in the user-defined analysis area that is attributable to the open space in question. Table 4 presents the user interface for the Property Value Premium Estimator Model. Users also can consult the provided database of open space property value studies in order to check for studies close to their area of interest that might serve as suitable sources for point or average value transfers.

Table 4. Example of Property Value Premium Estimator Model

Property value premium estimator model

Instructions: Fill in all cells marked "ENTER >". (See accompanying user manual for detailed instructions and documentation.)

STEP 1: Select shape of area of analysis in which property value premiums are analyzed

ENTER >	C	Enter "C" for circular and "R" for rectangular shape of area

STEP 2: Enter the radius (circular area) or length and width (rectangular area) of the area of analysis

ENTER >	2640	Radius of area in feet
OUTPUT:	503	Size of study area (acres)

STEP 3: Enter the size of the open space

ENTER >	50	Size in acres of the open space whose property value impact is to be estimated
OUTPUT:	9.9	**%OSChange.** Percentage of the study area occupied by the open space of interest. Example: A 20 percent increase in open space in the area of interest is indicated as "20".

STEP 4: Enter the appropriate values for the indicator variables

ENTER >	1	**FOR**. Enter "1" if the open space is a forest. Otherwise, enter "0".
ENTER >	0	**PARK**. Enter "1" if the open space is a park. Otherwise, enter "0".
ENTER >	0	**AG**. Enter "1" if the open space is agricultural land. Otherwise, enter "0".
ENTER >	1	**PROT**. Enter "1" if the open space is protected. Otherwise, enter "0". Protection is defined as the absence of the possibility of development (i.e., easement, public ownership).
ENTER >	1	**PRIV**. Enter "1" if the open space is privately owned. Otherwise, enter "0".
P_{OS} =	8.5	**% increase in average residential property value from open space of interest**

STEP 5: Enter the number of residential properties located in the area

ENTER >	137	Number of properties located in study area. NOTE: Include only single-family homes.
ENTER >	$462,731	Average value of properties ($)
OUTPUT:	$5,415,004	**Estimated total property premium in study area attributable to open space of interest**

Conclusion

The examples above illustrate easy-to-use, pre-programmed meta analyses-based valuation and use estimating models. These can facilitate a quick benefit transfer analysis that is tailored to the particulars of a study area. The benefit estimation toolkit also contains tables of average values by species, habitat type and recreation activity along with a database of individual study values underlying each of these average value tables. Thus, users preferring to calculate their own average values from the underlying database can also exercise this option with the toolkit. The toolkit also provides several spreadsheet models to calculate the economic value of wetlands, aquatic habitat improvements, wildlife habitat and open space.

Typically value estimates from benefits transfer models have less precision than benefit estimates from carefully conducted original studies. On any single benefit transfer, the percentage error that results from using benefit transfer relative to a single original study can be quite large. Average value transfers have an average absolute error of 10% to 180% with a median error of 4% to 87% (Rosenberger and Loomis, 2003). By contrast, benefit function transfers (which include meta analyses) have a smaller absolute average error of 5% to 135% with a median error of 1.5% to 68% (calculated from Rosenberger and Loomis, 2003: 458). The toolkit T & E species meta analysis has an absolute error of 35% for studies measuring annual total economic value, and 45% for studies measuring one-time total economic value.

Whether or not these benefit transfer estimates are “close enough” depends on several factors. They are certainly close enough if the alternative is to completely omit an estimate of recreation or total economic values from land management plans or Environmental Impact Statements. The toolkit’s average value tables are also far more reflective of economic values received by society than the ancient U.S. Water Resources Council unit-day values many federal agencies currently use as a simplistic form of benefit transfer. While benefit transfer is not perfect, it is more accurate than adjusting the 1979 unit-day values for inflation every year.

The range of average errors with benefit transfer can also be informative to the decision maker. How much risk of being wrong is the decision maker willing to take? In part this depends on how important the non market values are in the overall benefit-cost analysis and decision. This leads to the third factor, the magnitude of the values at risk in the decision. In the case of a multi-million dollar irreversible decision, it is very likely that a more accurate original study of non market values is warranted. Allen and Loomis (2008) provide guidance on balancing the cost of an original study versus using a less precise benefit transfer.

The geographic scope of the value tables and meta analyses are limited by the available literature. Thus, for recreational activities such as wildlife viewing there are some regions for which the value estimates are based on very small sample sizes. Thus another use of the toolkit value tables and databases is to identify high priority gaps where future agency original valuation studies might be best targeted.

Economists and agency personnel should find these models useful enough that it increases the likelihood of including non-market values in public decision making. It is hoped that these examples will spur agencies such as BLM, USFS, USFWS, Natural Resources Conservation Service, Bureau of Reclamation, and U.S. Army Corps of Engineers to pool their resources to expand the toolkit to include other recreation activities and natural environments such as wilderness, scenic visibility, etc. Further, as new empirical studies are performed, it is important to keep the valuation databases current and periodically update the meta analyses as well. We

hope users find these value tables and spreadsheet templates useful enough to support keeping them up to date.

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The Evolving Agricultural Marketplace: Selected Results and Implications for the West from the Laboratory

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Introduction

Agricultural markets continue to evolve creating issues of interest for market participants, analysts, and policy makers. Issues of interest in changing agricultural markets in the West include the following: 1) price discovery and transactions – shifting from open markets and auctions to tighter vertical linkages and private negotiation (Barkema, Drabenstott, and Welch 1991); 2) collusive behavior and market power of firms purchasing agricultural outputs (Barkema, Drabenstott, and Novack 2001); and 3) market impacts of new agricultural policies (Orden 2007). The effects of these changes on market outcomes/performance are difficult to determine using traditional methods of analysis such as econometrics, as data may not be available or because it is challenging to isolate the confounding influences of relevant variables. A baseline performance measure, such as the competitive equilibrium, is not observable in naturally occurring markets. One approach that addresses these issues is laboratory markets.[2] The focus of this paper is to explain how induced laboratory market experiments are conducted and how results from the laboratory can provide insights and policy prescriptions related to the above market issues. Results from selected studies are reported to demonstrate the application and contribution of experiments to policy development.

Laboratory Market Procedures

Isolating the impacts of marketplace changes in the laboratory involves creating a market. Four buyers and four sellers are sufficient to create a competitive environment. Buyers and sellers, respectively, are given a set of redemption values and unit costs for units traded in the market. Buyers make money by purchasing units at a price less than their assigned unit redemption value. Sellers earn a profit by selling units at a price greater than unit costs. Control, which is essential in experimental studies, is achieved by three conditions (Friedman and Sunder 1994, p.13) – monotonicity, more reward is preferred to less; salience, the reward depends on actions as defined by the institutional rules; and dominance, utility from the experiment comes from the reward medium and other influences are negligible. The experiment is set up to reward participants based on their decisions.[3]

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[2] Another approach is the use of laboratory market simulation such as the Fed Cattle Market Simulator (FCMS). Applications of the FCMS are reported by Ward et al. (2001). "The primary difference between experimental simulation using the FCMS and experimental economics is the degree of control over market participant behavior" (Ward et al. 1996, p. 464). There are numerous experimental studies in the literature related to a broad set of issues such as natural resources, environmental valuation, and value elicitation for product attributes (see Davis and Holt 1993 ; Kagel and Roth 1995, for different experiment examples).

[3] Friedman and Sunder (1994, p.17) provide basic practical guidelines for conducting economic experiments. Their guidelines focus on creating a controlled and simple economic environment in the laboratory and motivating subjects by monetary rewards based on their economic decisions in the experiment.

Consider a market demand where each buyer may purchase eight units. The redemption value for the first unit is 130 tokens. This value decreases incrementally by 10 tokens to 60 tokens for the eighth unit. Similarly, on the supply curve, unit costs begin at 30 tokens and increase by 10 tokens for each unit to 100 tokens for the eighth unit. Summing horizontally over four buyers and four sellers result in induced market demand and supply relations (figure 1). The predicted competitive equilibrium price is 80 tokens and the equilibrium quantity is 20 – 24 units. The earnings level at equilibrium prices and trades is 150 tokens for each buyer and seller. This translates to 1200 tokens total surplus for the market. These competitive predictions can serve as base comparators for market outcomes, which include prices; number of trades; and buyer, seller and total earnings.

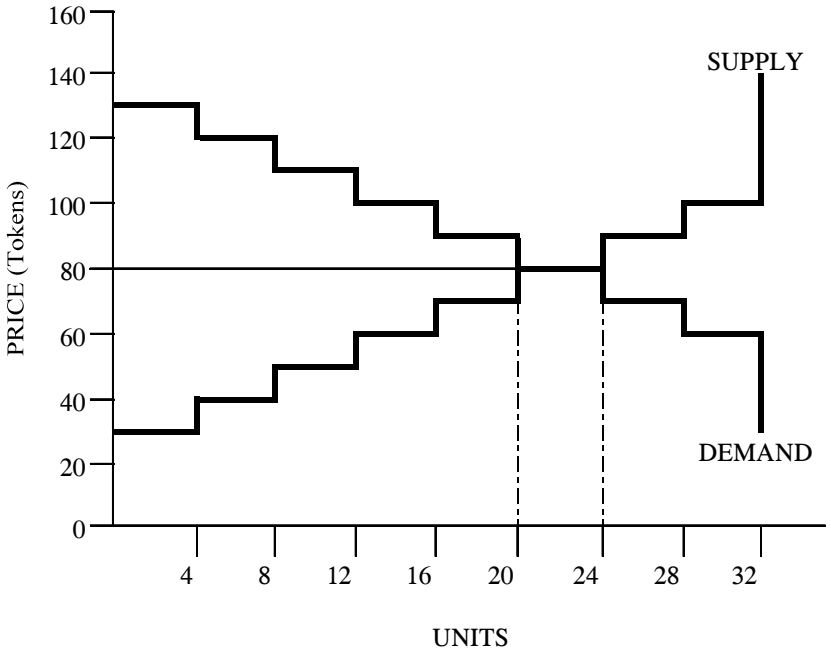

Figure 1. Induced market demand and supply

Recruited participants come to a computer laboratory where they are presented instructions for the specific experiment. Trial runs, using different unit values and costs than in the main experiment, are conducted until all participants are comfortable with the procedures. Multiple trading periods (15 – 20) are conducted for each treatment to allow for learning and convergence of market outcomes. Subjects are paid in cash at the end of the session. Treatments are repeated, with the number of replications depending on the variability of results across replications. Market outcomes are analyzed over the replications to separate out individual agent influences.

Results from the experiment sessions often are graphed. An additional description of the data and statistical analysis can be conducted by means of a convergence model (Noussair, Plott, and Reizman 1995), which is estimated by the Parks (1967) method, given the time-series and cross-sections in the data. The convergence model explains the path of market outcomes over

trading periods. It can be used to test statistical significance of asymptotes/convergence levels of the variables of interest between treatments. Davis and Holt (1993) provide additional details on conducting market experiments.

Laboratory Market Experiments as a Source of Data

The strength of laboratory methods is control, allowing the investigator to isolate the effects of a particular variable of interest. This may be viewed by some as a weakness because reality is compromised. An appropriate experimental design will vary only by a few, or perhaps only by one, variable. Usually phenomena proceed such that variables are changing simultaneously. Inquiries into complex choice occasions may require that numerous experiments be conducted before final results are obtained.

Agricultural economists trained in applied analysis techniques may question experiments as a source of valid data. There is no basis necessarily to accept implications from a mathematical specification of human behavior as more accurate than those derived from direct observation of human behavior from the laboratory. Theoretical analyses can be augmented with observation of human behavior from the laboratory, particularly if data from naturally occurring markets are unavailable. Examples include market outcomes from privately negotiated transactions, outcomes from potential policies that have not been implemented, and the inability to ascertain competitive equilibria for comparison with actual market data.

Selected Studies Using Laboratory Markets/Experimental Auctions

The following offers a summary of the results and implications from laboratory market studies that address selected issues in agricultural markets in the West. These studies are discussed as per the behavioral/policy relevance of results rather than procedures.

Price Discovery and the Environment in which Transactions Occur

Price discovery occurs in alternative trading institutions and methods of delivery, which may result in different market outcomes and performance. Common trading institutions include private negotiation, English auction, posted bid auction, and posted offer auction. In the West, the English auction is used primarily in the sale of cattle. However, there is increasing reliance on private negotiation trading. Private negotiation of prices also is prevalent between processors and retailers. Posted bid pricing is used at grain elevators and posted offer is typical for food retailing procurement. The double auction characterizes the trading institution used in the exchange of futures contracts (i.e., buyers and sellers are simultaneously posting calls (bids) and puts (asks)).

Two methods of delivery are possible. The first, forward or PTD delivery means the transaction price and quantity are agreed upon before the product is produced. The alternative, spot delivery, requires inventory in stock before negotiation/trading begins. This has costs/risks that are not present in PTD delivery. The spot seller incurs sunk production cost before trading begins. Inventories must equal or exceed sales in order to make a trade if carry-over to the next production period is not possible (e.g., the case of perishable food products).

Producer concerns have arisen about price discovery in cattle markets as individually negotiated pricing has become the most common method used to establish prices for fed cattle purchases (Taylor et al. 2007). Menkhaus, Phillips, and Bastian (2003) report results related to market outcomes across alternative price discovery institutions and delivery methods in

response to this concern (table 1). Sellers do well in an auction-spot setting, in both double and English auctions, but particularly in a competitive English auction. Sellers are passive in the English auction, while buyers actively bid against each other as in the traditional sale barn setting. Mestelman, Welland, and Welland (1987) and Bastian et al. (2008) find market prices and trades in spot posted-offer and posted-bid auctions, respectively, to be near the predicted competitive equilibrium levels. These results suggest agricultural producers as commodity sellers may be better off in competitive auctions as compared to private negotiation.

The distribution of earnings changes dramatically in private negotiation trading with spot delivery. As reported in table 1, the advantage goes to the buyer, leaving the seller with the lowest earnings among all of the trading scenarios studied. Two risks affect earnings in the private negotiation spot market environment – matching risk, which is faced by both buyers and sellers, and advance production risk faced by sellers. Advance production risk results in fewer trades and a bargaining disadvantage for sellers, relative to buyers. Unlike private negotiation, auctions provide many matches. Limited matches (matching risk), and the associated bargaining advantage by buyers when there is advance production, may facilitate monopsony power (Menkhaus et al. 2007). Sellers have a bargaining disadvantage in the environment just described highlighting the impacts of advance production risk. If the risk between sellers and buyers is reversed or equal, the results are expected to be affected accordingly.

Table 1. Estimated Convergence Levels of Market Outcomes for Alternative Trading Institutions and Methods of Delivery and the Competitive Base.

Treatment	Trades	Prices	Total Surplus	Buyer Earnings	Seller Earnings
Base	20.00	80.00	1200.00	150.00	150.00
Forward					
Double Auction	22.60*	76.68*	1200.00	166.49*	135.61*
Private Negotiation	16.58*	82.20*	1076.63*	124.80*	143.86*
Spot					
Double Auction	20.20	83.34*	1162.80*	130.51*	160.25*
Private Negotiation	14.59*	72.21*	1013.09*	155.82*	97.91*
English Auction	18.72*	93.25*	1153.76*	77.07*	211.50*

Source: Calculated from results presented in Menkhaus, Phillips, and Bastian 2003.
Notes: Experiment sessions for each treatment were conducted for 15 periods. Private negotiation was for limited matches (three).
* Significantly different from the base, competitive equilibrium, 99 percent confidence level from the convergence model.

These results suggest the trend away from auctions toward more private negotiation, in some sectors of the food industry, may result in lower returns for sellers of agricultural commodities/products. This is particularly relevant when price negotiation follows production and sellers incur greater risk compared to buyers, as is the case in many agricultural markets. Total market surplus, also deviates from the competitive model most in private negotiation trading for both forward and spot delivery (advance production) with limited matches. Thus,

trading institution and method of delivery can influence market outcomes.

These results offer evidence useful to researchers and policy makers regarding agricultural markets becoming more concentrated and dominated by private negotiation. Ward et al. (1996) indicate that in private negotiation trading bargaining ability of agents impacts market outcomes. As private negotiation becomes more dominant and concentration of buyers increases, the risk of sellers being matched with buyers that have improved bargaining power is increased. Two industry practices in the fed cattle market that may exacerbate this phenomenon include grid marketing and short trading windows. Increased use of grid marketing and increased incidences of captive supplies being held by buyers, which potentially creates short trading windows in cattle markets, both may reduce the ability of sellers to be matched with buyers willing to pay higher prices for cattle in a private negotiation setting (Menkhaus et al. 2007).

Collusive Behavior in English Auctions

While the auction environment is generally advantageous for sellers, repeated English auctions are susceptible to cooperative behavior among buyers, which can be detrimental to seller earnings (Milgrom 1989). Buyers are able to acquire knowledge of rivals' bidding strategies and reservation prices by observing their bidding behavior, especially in repeated auctions of multiple items such as in livestock auctions. An example of this is the use of shared agents in livestock auctions. This has the potential to increase concentration of bidders within an auction setting. Several studies provide evidence of price depression resulting from increased concentration of bidders in a single English auction market (Bailey, Brorsen, and Fawson 1993; Adam et al. 1991).

Laboratory markets were used to study collusion in a series of sequential English auctions in which participants (either two or six buyers) were only bidders and quantities for sale were exogenously determined (Phillips, Menkhaus, and Coatney 2003; Menkhaus, Phillips, and Coatney 2003). Several facilitating influences were examined – the same set of bidders over a series of seven auctions (base treatment); knowledge of the number of units for sale; communication via an online chat; and the provision of multiple buy orders by competing principals to the same agent buyer. Another set of treatments involved analyzing how trade prices were impacted as the market evolved to a more concentrated state via a buyer selection process designed to retain the most successful agents throughout all auction rounds. These treatments mimic behavior at many livestock auctions. Auction participants observe cattle quality and quantity prior to the auction and may in some cases converse with other buyers regarding their intentions. The industry practice of using shared agents with multiple buy orders from several packer principals results in increased market concentration at livestock auctions.

Results indicate that market practices in multiple-unit, repeated English auctions may facilitate collusive behavior when there are two buyers, as well as when there are six buyers. Moreover, the knowledge of the number of units for sale in an upcoming auction was found to be at least as effective in helping two agents cooperate as open communication. Without facilitating influences, two buyers were about as competitive in their bidding behavior as six buyers in this auction setting. A comparison of two-buyer auctions with six-buyer auctions reveals how cooperative six buyers can become. Knowledge of quantity for sale did not coordinate six buyers as well as two. Communication, however, helped six buyers coordinate at least as much as in the two-buyer case. A simple bid-sharing plan that let bidders alternate taking the low bid was focal and allowed for successful collusion among six buyers. Simple turn taking became focal for two buyers when quantity for sale was announced, which contributes to stability for the bidding ring. A decreasing number of firms, and a greater concentration of buyers, suggest

opportunities for collusive behavior. The evolution of concentration that left the most successful buyers in a sequence of laboratory auction sessions depressed price to levels about 26% below the competitive prediction – about the same amount as when two buyers participated in the sequence of auctions with quantity for sale known.

Quantities in naturally occurring livestock auctions are often known. Historical trends indicate increased concentration among agent-buyers. This changing auction environment suggests an increased risk of collusive behavior in livestock auctions.

Ex Ante Evaluation of Alternative Agricultural Policies – The Case of Decoupled Subsidies

As agricultural markets adapt to globalization, increasing scrutiny of traditional agricultural policies that provide income transfers to producers has occurred. This indicates the need to investigate the policy alternatives *apriori* (OECD 2006). The use of subsidy payments decoupled from output has been proposed to meet the World Trade Organization goal of not distorting production and trade (Orden 2007; Orden and Diaz-Bonilla, 2006). The question becomes how to investigate potential market impacts of a decoupled policy when little or no data exist for use in economic analyses. Research reported by Bastian et al. (2008) investigated the issue using laboratory market experiments.

A posted-bid auction, used for price discovery in grain markets, was chosen as the trading institution for the laboratory sessions. Four alternative treatments were investigated: 1) no policy; 2) coupled support price and deficiency payment; 3) coupled support price and switch to lump sum subsidy (decoupled); and, 4) coupled support price and switch to period or annual subsidy (decoupled). Sellers were made aware of policy treatments via instructions prior to conducting each experiment. Sellers were informed of the policy change before the period in which the switch occurred (treatments three and four).

Results indicate the stylized coupled support price and deficiency payment treatment produced market outcomes consistent with those from known target-price policy effects. Relative earnings suggested the subsidy was largely passed on to buyers through lower prices under the coupled deficiency payment policy treatment. Despite identical total payment amounts, buyers did not do as well under decoupled policies (lump sum or annual subsidy) as in deficiency payment treatments. Buyer earnings were still higher than in the no policy treatment since prices were lower. Production levels in the decoupled treatments (three and four) were similar in production levels as compared to that in the no policy treatment. Thus, the experiments confirmed theoretical predictions by Tangermann (1991) that decoupled policies do not distort production. Experiment results also indicated a potential moral hazard issue related to price negotiation when subsidies (both coupled and decoupled) are given to sellers. Producers were less aggressive in negotiating price when receiving a subsidy, thereby transferring a portion of income to buyers. Policy makers continue to investigate alternative policies that are decoupled. These results suggest some policy alternatives may be more efficient at transferring income while reducing market distortions.

Conclusion

These results show experiments can provide insights for Western agricultural market trends. Spot sellers likely will become increasingly disadvantaged as agricultural markets become dominated by private negotiation. The impacts of regulations and programs designed to address competitiveness and transparency must be studied under this new trading environment.

The experiments provide powerful predictions of the role certain factors may play in facilitating potential collusive behavior in cattle markets. The use of shared agents representing multiple principals requires further scrutiny.

It appears that policy analysts are increasingly interested in results from laboratory studies. They view experimental economics as a potential tool for *ex-ante* policy analyses. This is not surprising as policy analysts often do not have access to relevant data to address questions raised by decision makers and legislators. As structural change in the food supply chain and budget constraints for gathering agricultural statistics continue, the interest in the use of experimental methods seems likely to increase.

As markets in the West become less transparent, agricultural economists will continue to be called upon to provide policy relevant analyses. New research methods will be needed to conduct investigations with limited data. Experimental economics techniques will become an increasingly relevant methodology. It should be noted that wherever possible, additional analyses that complement experimental results will be of increasing interest.

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