Oak Woodland Economics: A Contingent Valuation of Conversion Alternatives[1]

Richard P. Thompson,[2] Jay E. Noel,[2] and Sarah P. Cross[2]

Abstract

Decisions on how much land should be devoted to oak woodland preservation is ultimately determined by society's valuation of its benefits and relative scarcity. Scarcity value can be measured by people's willingness-to-pay (WTP) to prevent oak woodland conversion to higher value land uses. In this study, we used the contingent valuation (CV) method to estimate WTP for oak woodland preservation in San Luis Obispo County (over 700,000 acres). Estimates ranged between $75 and $83 per voter, providing only about $12 million for land or easement purchases.

Introduction

Oak woodlands are found on practically all land uses in San Luis Obispo (SLO) County and represent a key part of the natural aesthetic for which the County is known. Pressures from land use conversion are diminishing and fragmenting their range. The recent growth of the wine industry brought about a rapid use conversion of specific sites within the agricultural (ag) zoning from rangeland to vineyards resulting in numerous, highly publicized oak removals. A County oak ordinance passed a few years ago only requires replacement of oaks removed on rural lands, but it is poorly enforced.

Concerns over oak woodlands have also been integrated into the larger movement to stop urban sprawl. In 1995, the city of San Luis Obispo established an open space element in its general plan to create a "ring" around the city, but a bond measure to fund purchases of these lands failed. In 2000, a ballot measure ("Save Open Space and Agricultural Resources"), patterned after similar measures in Napa and Ventura counties designed to freeze zoning, also failed to pass with 66 percent opposed.

These failed efforts to implement policies to preserve the natural aesthetic oak woodlands suggest a gap between the perception of the problems and reality of the costs of proposed intervention. The perception of many activists is that growth pressures will inevitably destroy the natural beauty of the County. But most of the voting public may not perceive this to be a problem (Rowlands 2001). In economic terms, one would say that the scarcity value of oak woodlands has not risen high enough to overcome uncertainties and compete with other uses. From a public policy

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[2] Professor, Natural Resources Management; Professor, Agribusiness; and former graduate student, respectively; Cal Poly, San Luis Obispo, CA 93422 (e-mail: rpthomps@calpoly.edu)

perspective, another question is "will the expected losses be irreversible by the time these environmental values become economically competitive?"

Background and Objectives

In this study, we sought to estimate the monetary value county residents would place on preserving amenity values provided by oak woodlands and other extensive agricultural land uses. We agricultural practices are most extensive, i.e., rangeland since cattle grazing is compatible with oak woodland vegetation. We further hypothesize that these land uses have two alternatives: (1) intensive agriculture (e.g., row crops), or (2) residential-commercial. We attempt to estimate the willingness-to-pay (WTP) value that would prevent three types of land use changes:

1. Extensive agricultural land use (state 1) converting to intensive, agriculture (state 2),
2. Extensive agricultural land use (state 1) converting to residential/commercial (state 3),
3. Intensive agricultural land use (state 2) converting to residential/commercial (state 3).

To emphasize the conversion pressures, a report by Standiford (1999) cited land values per acre on the Central Coast at $300-$500, $8,000, and $20,000 for states 1, 2 and 3, respectively. The WTP results address the question whether the public is willing-to-pay landowners in order to compensate them from forgoing other profitable conversions.

In an opinion poll sponsored by the California Oak Foundation (Fairbank and others 2000), 77 percent of California voters indicated their willingness for the State to use tax dollars to protect oak woodlands. However, no dollar amounts were mentioned. These conversion compensation values cannot be estimated through traditional means using market data. Even if there were a sufficient number of market transactions of each type, this would not reveal society's tastes and preferences for the environmental values of oak woodlands, just the cases where public compensation exceeds commercial values.

Currently, the only tangible expression of these environmental values comes in the form of policy and regulation to preserve these values from being lost to commercial uses. Even with perfect policy instruments, these constraints represent only the opportunity costs and not the social optimal allocation. Because policy is not perfect, land use allocations may be grossly over- or under-constrained to satisfy people's preferences for environmental values such as provided by oak woodland.

Methods

We used the contingent valuation (CV) method to estimate on these "non-market" oak woodland conservation values. Contingent valuation has been a controversial empirical tool since it does not identify revealed preferences that are known to be consistent with utility theory (Mitchell and Carson 1993). In other words, one is asking a person what they would be hypothetically willing-to-pay for something rather than observing their behavior. Nonetheless, CV has become the most popular method for such studies, due in part to recent advances in the theory and especially the testing methodology (Hanneman and Kanninen 1996, Stevens 1997, Rubin 1987) and its cost advantage over other methods.

The CV technique is best expressed by starting with the indirect utility function:

$V = V(p, q, y, X, \varepsilon)$,

where q = non-market good/service

p = price vector of market goods

y = individual's income

X = a vector of socio-demographic characteristics

ε = stochastic component of consumer's utility.

The value of q can be estimated by first offering the consumer the possibility of an improvement in their utility with a Δq such that $V(p, q^1, y, X, \varepsilon) \geq (V(p, q^o, y, X, \varepsilon)$. The probability of the consumer's willingness-to-pay (WTP) to increase their consumption from q^o to q^1 can be estimated by observing their reaction to a bid amount (A) that must hypothetically be paid:

$$P\{\text{response is "yes"}\} = P\{V(p, q^1, y, X, \varepsilon) \geq (V(p, q^o, y, X, \varepsilon)\}$$

A potentially more accurate CV method is to use a double-bound bid scheme. In the double-bound CV version, the consumer is first asked if they would pay a specific amount, say $100 (A), followed by a second offering, the amount of which depends upon their response to A (Hanemann and Kanninen 1996). If the response is "yes" to A then they are offered a larger value, A_u, or if "no" they are offered a smaller, A_l. Two or even three separate samples of a given size are obtained with each sample's double-bound bid structure different than the first in order to "map out" the probability (cumulative density function, cdf) of paying higher and higher amounts for the non-market resource. These "yes - no" response probabilities can then be converted to mean WTP estimates using a variety of statistical models.

Bid and Sample Design

The empirical approach to estimating the WTP involves

- Designing the double-bound bids (A, A_l, A_u),
- Designing the survey instrument,
- Determination of the number of sample consumers and their location
- The method for applying the instrument to sample consumers.

CV sample data collection requires a carefully designed survey instrument. Survey instrument design has a long tradition in many forms of social science research. The instrument consisted of three basic parts:

1. An introduction to the topic, designed to avoid leading the respondent,
2. A visual presentation of the three state changes for which respondents were asked their WTP to prevent the change from occurring, and

3. A set of questions eliciting information on the respondent's socio-economic and demographic characteristics (e.g., traditional ones like gender, age, income, education as well as political party, family size, renter or owner, lot size).

Images of the three states were provided so that the respondent had a reference during the survey. Example images used in the survey that characterize each state are present below *(figs.s 1-3)*.

To first learn about the WTP distribution, we conducted a pre-test involving open-ended CV questions (n=50) in order to set A to what seemed to be the median WTP. Hanneman's double-bound method requires dividing the sample into two or more sub-samples wherein different bid amounts are offered in order to adequately map the WTP cdf. Sample observations were collected for the double-bounded bid along with a set of socioeconomic characteristics using personal intercepts during the summer 1997. The County was stratified into three regions to obtain a well-distributed coverage (North County, North Coast, South County). Each survey took approximately 5 minutes to complete. Most surveys took place at the entrance to grocery stores or large retail outlet stores.

Figure 1—Typical state 1 image.

Figure 2—Typical state 2 image.

Figure 3—Typical state 3 image

Optimal specification of the bids calls for the initial bid to be the supposed median value and follow-up bids are symmetrically placed around it to "bound" 50 percent to 75 percent of the observations (Hanemann and Kanninen 1996). Since the median value is not known a priori, it is suggested that a recursive approach be used to alter the initial bid. Also, it is important to define the method of payment so that the bid offerings are realistic and relevant to the respondent. We represented the bid as a one-time payment, not an annual increase in taxes. This was done to avoid confusing the respondent and the issue.

The Phase I sub-sample median bid was $100 (A), and A_l and A_u were set to $50 and $200 (50 percent quantiles). Observing the distribution of responses in Phase I, the Phase II median bid was increased to $150, retaining the 50 percent quantiles for the follow-up offerings. Each respondent was asked to provide a "yes" or "no" response to the bid scheme for each state change permutation (1 to 2, 1 to 3, or 2 to 3). After which they were asked to provide information on their socioeconomic characteristics *(table 1)*. The upper bound for state change 1 to 3 was set at $500 in phase 1 and $750 in phase 2 in response to evidence from the pilot study that there was a willingness-to-pay much higher amounts than the other state changes.

Table 1—*Survey bid structure and socioeconomic variable.*

Sample sizes and bid amounts offered were as follows:				
Bids	n	A_l	A	A_u
Phase 1	150	$50	$100	$200
Phase 2	151	$75	$150	$300

The demographic variables included:	
X Variable	Description
EDUC	1 = grades 0-8, 2 = 9-11, 3 = 12, 4 = 12 + some e college, 5 = college degree, 6 = post-grad. degree
GENDER	1= male, 2 = female
INCOME	1 = <$10,000, 2 = $10K-$20K, 3 = $20K-$30K, 4 = $30K-$40K, 5 = $40K-$50K, 6 = $50K-$60K, 7 = $60K-$70K, 8 = $70K-$80K, 9 = $80K-$90K, 10 = $100K +
MARRIED	1 = "yes", 2 = "no"
AGE	years
RENTOWN	1 = own, 2 = rent
PARTY	1= Republican, 2 = Democrat, 3 = Independent, 4 = Other

Results and WTP Estimates

Table 2 presents the responses to the double-bound bid offerings for each state change scenario by sub-sample phase. It is clear that a majority of county residents are willing-to-pay some positive value to prevent conversion under all three scenarios. Nevertheless, the question at the center of this study is whether that amount is sufficient to be effective. *Table 3* presents the logistic regression estimates for the three state-change scenarios. All three state change models fit quite well with the bid variables highly significant along with broad significance across the independent variable set. The most practical expression of overall model fit is the "percent of sample observations correctly classified," about 90 percent in all three cases.

Table 2—*Response percentages for double-bound offerings by sub-sample for the three state change scenarios.*

State Change Phase	no-no (percent)	no-yes (percent)	yes-no (percent)	yes-yes (percent)
Extensive to Intensive Ag. (1 → 2)				
1	39.6	12.1	28.8	19.5
2	51.7	6.6	23.2	18.5
Intensive to Resid./Comm. (2 → 3)				
1	36.9	9.4	24.8	28.9
2	32.5	4.0	28.5	35.1
Extensive to Resid./Comm. (1 → 3)				
1	27.5	10.8	40.9	20.8
2	31.1	4.6	39.7	24.5

Table 3—*Logistic regression estimates for the three state-change scenarios.*[1]

	State change 1 to 2		State change 1 to 3		State change 2 to 3	
Variable	β (s.e.)	Wald stat. (sig)	β (s.e.)	Wald stat. (sig)	β (s.e.)	Wald stat. (sig)
BID	.0738 (.0106)	48.5202 (.0000)	.0899 (.0134)	45.2535 (.0000)	.0841 (.0136)	38.2593 (.0000)
EDUC	0.243 (.1946)	.0156 (.9007)	–.1073 (.2323)	.21342 (.6442)	–.2218 (.2592)	.7320 (.3922)
REPUB	.6350 (.3821)	2.7621 (.0965)	1.4808 (.4817)	9.4497 (.0021)	1.1259 (.4851)	5.3859 (.0203)
AGE	–.0400 (.0133)	9.0713 (.0026)	–.0509 (.0158)	10.3812 (.0013)	–.0380 (.0163)	5.4593 (.0195)
GENDER	–.0465 (.3632)	.0164 (.8982)	.6977 (.4292)	2.6424 (.1040)	1.0686 (.4487)	4.6725 (.0172)
INCOME	–.0056 (.0750)	.0056 (.9405)	–.0574 (.0866)	.4389 (.5077)	.0794 (.0858)	.8561 (.3548)
constant	–4.7212 (1.3032)	13.1254 (.0003)	–5.4611 (1.5621)	12.2221 (.0005)	–6.6875 (1.6259)	16.9182 (.0000)
Goodness-of-Fit	243.525		164.2		174.885	
χ2	205.975		209.338		242.686	
Pct Correctly Classified	87.59		90.34		91.03	
df	290		290		290	

[1]The signs of the logistic coefficients have the opposite interpretation (P_{yy} {response is "yes" to A, "yes" to A_u} = 1 - $F_c(A_u; \beta, \theta)$). The standard t-test can be used by replacing the standard error of the estimate with the asymptotic standard error. The Wald test is used in this case, which is the square of the t-value.

State Change WTP Estimates

The practical end of these results is to reduce this empirical information to a single "summary" measure (1st moment) of WTP. Two summary statistics, the mean and median, have been debated at length in the CV literature (Jakobsson and Dragon 1996). Although much can be made of the theoretical differences in the two measures, they are practically the same value, at least in this study.

The mean WTPs for each state change are as follows (*fig. 4* illustrates the cdf's by state change):

1. Extensive ag. lands (state 1) to intensive ag (state 2) = $83
2. Extensive ag lands (state 1) to residential/commercial (state 3) = $75
3. Intensive ag lands (state 2) to residential/commercial (state 3) = $80.

Lacking a statistical analysis of these differences, little should be made of any perceived differences, despite the apparent lower valuation of converting extensive ag lands to residential/commercial than the other state change scenarios. Comparing the distribution of responses to the mean WTPs reveals the importance of the mean calculation *(table 3)*. Though a bond measure focused on oak woodland preservation would have the highest likelihood of passing, the borrowed funds at issue could not be very large in order for the measure to pass. In any case, the low magnitude of all three WTPs becomes the main issue.

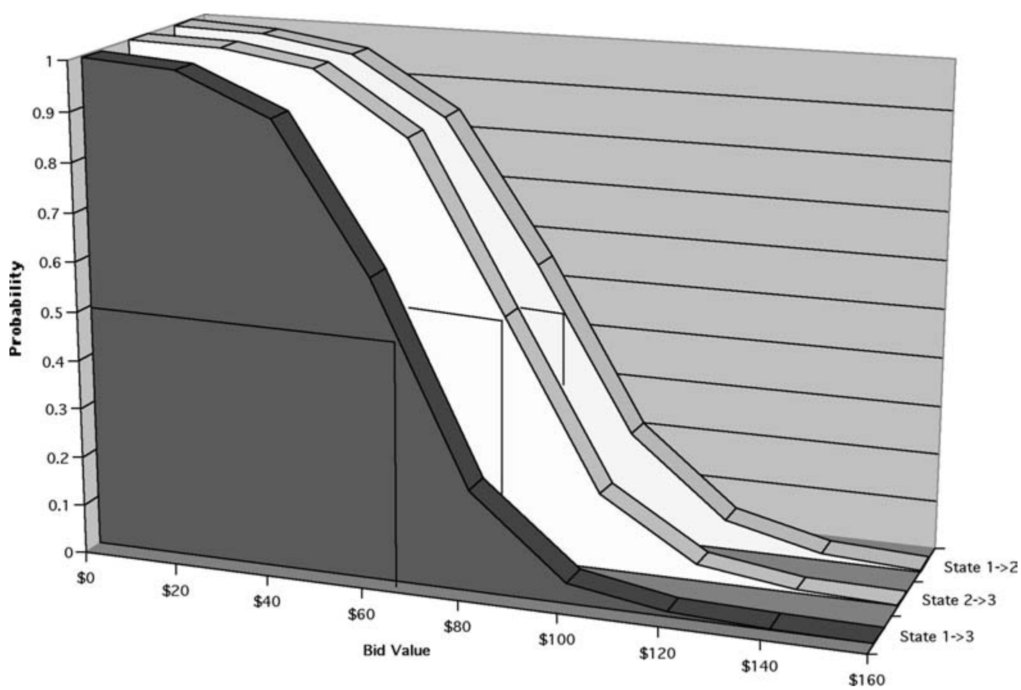

Figure 4—Cumulative density functions for each state change, showing median WTP estimates.

Summary and Conclusions

A number of preliminary conclusions can be drawn from the results. While a majority of residents did express a willingness-to-pay to prevent the conversion of oak woodlands, they also expressed a positive willingness to prevent the conversion of intensive agricultural lands to residential land use. Clearly, any voter financed fund for conservation easements could not be limited only to oak woodlands. The bid value associated with preventing the conversion of oak woodlands was lower than the two other conversion scenarios.

Again, these are hypothetical one-time payments. Multiplying these values by the county voters (142,000) could conceivably provide about $12 million for the purchase of lands or conservation easements. If a bond measure were passed, the available funding would generate only a small fraction of the funds needed. With nearly half million acres of woodlands at risk, only a few key properties could be selected for protection. Any attempt to preserve the much more costly intensive ag lands would quickly consume the funds. With values running around $20,000 per acre for lands under pressure for development, only 600 acres could be purchased.

These WTP estimates reflect a low level of tangible concern over oak woodland protection in SLO County. To explain the underlying reasons for such complacency is the subject of another study. Nevertheless, it could be that since urban sprawl has not reached the level of counties like Napa and Ventura, voters are less worried about threats to the County's aesthetic character. Intensive agricultural may also be viewed as a barrier to sprawl. Finally, the combination of steep topography and National Forest ownership within the viewshed of most SLO communities may be considered as making it unnecessary to pay for more protection against land use conversion.

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References

Fairbank, Maslin, Maullin and Associates. **California voters demand that the state protect native oaks.** Oaks. California Oak Foundation, Fall/Winter 2000.

Hanemann, M.; Kanninen, B. **The statistical analysis of discrete-response cv data**. California Agricultural Experiment Station. Working Paper No. 798. June, 1996.

Hanemann, M.; Loomis, J.; Kanninen, B. 1991. **Statistical efficiency of double-bounded dichotomous choice contingent valuation**. Amer. J. of Agric. Econ. 73: 1255-1263.

Jakobsson, K.M.; Dragun, A.K. 1996. **Contingent valuation and endangered species: methodological issues and applications**. UK: Edward Elgar Publ. Ltd.

Mitchell, R.C.; Carson, R.T. 1993. **Using surveys to value public goods: the contingent valuation method**. Resources for the Future, Washington, DC., 463 p.

Rowlands, Sophia. Spring 2001. **A structural and political analysis of the SOAR initiative.** Agribusiness Department, Cal Poly, Student paper.

Rubin, D. 1987. **Multiple imputation for nonresponse in surveys**. New York. John Wiley and Sons, Inc.

Standiford, Richard B. 1999. **California's hardwood tangelands production and conservation values**. Oaks 'n' Folks, Volume 14 (2): 2-3.

Statistical Package for the Social Sciences (SPSS). 1990. **SPSS advanced statistics student guide.** SPSS Inc., Chicago, IL.

Stevens, T.H.; DeCoteau, N.E.; Willis, C.E. 1997. **Sensitivity of contingent valuation to alternative payment schedules.** Land Econ. 73: 140-148.