# LOCAL PERCEPTION OF PUBLIC GOODS: RECENT ASSESSMENTS OF WILLINGNESS-TO-PAY FOR ENDANGERED SPECIES

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*A contingent valuation mail survey was administered in late 2001 to better understand current public opinion about controversial endangered species preservation in Orange County, California. Questionnaire design focused on additional taxes residents would be willing to pay to support recovery plans. Habitat and recovery of a single species, the Riverside fairy shrimp, is valued at around $25 per household, and the valuation is significantly changed by the higher scope of the public good provided, with an annual willingness-to-pay of around $50–60 per household for all local endangered species. Across the whole county, the public valuation of biodiversity is substantial yet probably could not fund necessary land acquisition for critical habitat, so continued national support for species preservation remains logical.* (*JEL* Q51, Q57, Q58)

## I. INTRODUCTION

Biological diversity has become a controversial issue in Orange County, California. Recent Endangered Species Act (ESA) critical habitat designations covering some 85,000 acres in the county have been subject to several court cases.[1] Questions about both the direct and indirect costs of preserving endangered species are being raised, yet there has been little attention to the benefits of biodiversity. This study offers contingent valuation estimates of local residents' willingness to pay for several controversial species. It also provides estimates of the aggregate benefits from species protection for future policy discussion.

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1. Initially, a federal court ruling ordered habitat protections rewritten for the California gnatcatcher and the San Diego fairy shrimp. Since it appeared, the U.S. FWS did not fully consider the economic impact of the designation; an appeal led to critical habitat being upheld after further study. In April 2003 the FWS reduced the California gnatcatcher critical habitat designation by some 20,000 acres. Designations for other species have also been reduced.

2. Critical habitat is commonly defined as the land and natural resources essential for the survival of a species.

The critical habitat for the Arroyo toad,[2] the Riverside fairy shrimp, the California gnatcatcher, and the tidewater goby (originally designated in 2000) covered a large swath of coastal sage scrub and other grasslands, vernal pools, rivers, and streams of southern California. Some areas overlap those relevant to some of the other endangered species in Orange County, such as the Southern California steelhead trout, the Santa Ana sucker, the southwestern willow flycatcher, least Bell's vireo, and the Pacific pocket mouse, among others. Environmental organizations state that habitat designations are necessary to prevent fragmented species habitat, severed wildlife corridors, damaged watersheds, and further urban sprawl.

But clear opposition to the designations has arisen from some landowners, developers, and tollway planners. They suggest housing or road building projects—which require federal permits—may be halted because the land in question, although private, is now critical habitat. This could reduce the number of newly constructed units and raise the price of permitted building. Additional consultation costs could follow.

**ABBREVIATIONS**

CV: Contingent Valuation
ESA: Endangered Species Act
FWS: Fish and Wildlife Service
WTP: Willingness-to-Pay



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Broader debates about the future of the ESA are also emerging. The ESA, first passed in 1973, has aimed to address the market failure of the underpriced social benefits of endangered species. The Act allows staff of the U.S. Fish and Wildlife Service (FWS) or the National Marine Fisheries Service to list an animal or plant species as endangered or threatened. Critical habitat designations are supposed to follow promptly after listing (yet rarely do). These targeted species enjoy strong protections through the ESA's section 9 that prohibits any "taking" of the species; section 7 also requires federal agencies (or private parties obtaining federal permits) to ensure that any action they authorize, fund, or carry out will not jeopardize the existence of the species or adversely modify its critical habitat. The FWS aims to eventually delist endangered species through the implementation of recovery plans and restoration efforts written by scientists knowledgeable about species history, status, and threats.

Currently, traditional cost-benefit analyses of listing or habitat decisions do not occur. A 1978 amendment to the ESA requires some economic analysis at the critical habitat stage; areas may be excluded if the benefits of exclusion outweigh the benefits of specifying the area as habitat, unless the failure to designate leads to species extinction. Direct costs of species recovery appear quite modest in many of the published recovery plans. The recovery plans are vague regarding expensive private land acquisition with much of the cost to secure pools and other lands "to be determined." But the indirect (opportunity) costs of housing and transportation development opportunities forgone on critical habitat areas remain the largest source of controversy in the West. Changing land use designations represent a transfer of present producer/consumer surplus to future generations, and calculation difficulties usually preclude including these opportunity costs in policy making.[3]

Despite the press coverage of the spotted owl and Klamath River debates, little attention has been paid to the potential benefits of species preservation in southern California and other areas of the West affected by the recent habitat designations. Biodiversity is a typical nonmarket environmental amenity that can be enjoyed by county and nearby residents as well as future generations. The species' pure existence values, use values through their current recreational viewing and role in agricultural biological controls, and their possible future research value are the most common public good aspects of animal biodiversity (Bishop, 1978). Species' health also can serve as an indicator of the status of ecosystems that may affect humans. Finally, habitat designations could provide a positive externality of higher property values for existing homeowners by requiring more open space area; open space and critical habitat may be joint products (for the links between open space and property values see Irwin and Bockstael, 2001; Garrod and Willis, 1992).

The purpose of this article is to assess a broad set of benefits residents attach to preserving these controversial endangered species. A case study in Orange County offers several advantages, yet challenges, over previous contingent valuation (CV) studies of biodiversity. First, the county is a metropolitan area becoming increasingly urbanized yet retaining several diverse ecological areas as well as a wide ethnic diversity. The few actual surveys conducted in urban settings have relied primarily on direct personal or telephone interviews to raise response rates (Krupnick et al., 2001; Ludwig and Cook, 2001; Romer et al., 1998; Kwak et al., 2003; Shackley and Dixon, 2000). Use of the Dillman (1978) mail survey method is sparse, with the recent project by Champ et al. (2002) in the semi-urban Boulder County being the closest to our project. Second, the county's ethnically and economically diverse population could result in different willingness-to-pay numbers than those measured in more homogenous communities. This ethnic diversity also presents numerous challenges to the survey administration and response rates. Third, the study was undertaken during a recent period of recession and the international events of 11 September 2001 that put consumer confidence at a lower level than that of previous studies.

After reviewing the CV methodology, the author assesses the household valuation to fund recovery of a single species (the Riverside fairy shrimp) and a larger bundle of 32 species

3. Consultant reports commissioned by the Transportation Corridor Agencies (Haldane, 2000) estimated a loss of $1–5.5 billion economic activity across all of southern California due to California gnatcatcher habitat designation. Thus figures from the present survey (focused on Orange County) are not directly comparable in this regard. Additionally, how indirect costs are defined and whether they should apply to all stages of the endangered species protection remains debatable.

found in the county. Financing of the critical habitat and species recovery in the county alone was the environmental good under consideration as part of the overall effort to prevent extinction. Although this provides a more limited valuation of the public good, county-wide extrapolation efforts have been used to analyze some local environmental programs (Stumborg et al., 2000). Here local residents were most likely to obtain some consumptive tourism use of the species. Although direct endangered species recovery costs are paid at the federal level through the FWS programs, many of the indirect costs of housing and transportation opportunities forgone remain local.

## II. SURVEY DESIGN AND ADMINISTRATION

### *A. CV Methods and Issues*

CV surveys estimate the nonmarket user benefits of public goods by asking a sequence of questions to put monetary value on personal preferences. The CV method provides an estimate of consumers' total value of a public good and an environmental service or amenity in particular (Boyle and Bishop, 1987). Regarding biodiversity, it is hard to exclude people from enjoying the benefits of a species's existence, so the social benefits may be underpriced in the market and a classic public goods underprovision problem emerges.

There are numerous debates in the CV literature concerning content, construct, criterion validity, payment vehicles and question designs in particular (see, for instance, Garrod and Willis, 1999). This article focuses mainly on the content validity in this study by addressing concerns about the ambiguity of the good, the realism of the payment vehicle, and the avoidance of scope insensitivity problems. The author also addresses possible nonresponse bias through a technique first developed in Bateman et al. (2000).

### *B. Survey Design*

Two mail surveys were developed which were identical except that in one the WTP (willingness-to-pay) question was only for the Riverside fairy shrimp and the other was for all 32 endangered and threatened species existing in the county, including the shrimp. This follows the split-sample design method used in Loomis and Ekstrand (1997). The CV questionnaire includes information about the species in danger of extinction and offers a method for its preservation. The acquisition of critical habitat and implementation of the recovery plan are the specific goods being valued in the survey. These activities will decrease the likelihood of species extinction. The survey explained the county's current status of critical habitat designation and public–private partnerships. Additional protection would be afforded the species through the creation of a tax-funded program to allow habitat acquisition, research, and monitoring.

The ambiguous nature of biodiversity and its threats were remedied by providing extensive background information about species' reference levels, sources of change, and timing in the survey. Additionally, the author considers species that have some consumptive use and others that have pure existence value. The Riverside fairy shrimp is a "noncharismatic species" not well known by the general public, yet it has a level I priority for recovery needs and serves an important role in the food chain of migrating birds. It has largely nonconsumptive use (existence) values as the major part of its total value. Other key species within the whole group of 32 include the California gnatcatcher, the arroyo toad, and the tidewater goby. Most of these species live in coastal sage scrub habitat, thus offering the opportunity for ecosystem-based conservation. Although these also are not highly charismatic, there has been much more news coverage of their biology, endangered status, and threats posed by land development. They offer greater opportunities for viewing.[4]

This allows a natural test of the existence of scope insensitivity, when individuals do not value a larger or more inclusive good higher than a single good (Mitchell and Carson, 1989). Such part-whole biases would be inconsistent with consumer demand theory. The author follows a scope test similar to that in Loomis and Ekstrand (1997) and Reaves et al. (1999) in which a single endangered species is compared to a bundle of species using

4. The focus of the survey subsamples on the single Riverside fairy shrimp and the whole 32 species bundle was chosen after input from focus groups and FWS biologists. The fairy shrimp, although not the most charismatic species, represented that with the highest probability of extinction. *All* listed and endangered species in the county were put in the "bundle" because it was unclear which could be made into smaller groups by unique habitat or extinction priority.

a split-sample design. Thus the null hypothesis is

$$(1) \qquad \mathrm{WTP}_{\mathrm{RFS}} = \mathrm{WTP}_{32\ \mathrm{species}},$$

whereas consumer demand theory and rejection of scope insensitivity would suggest the right-hand side of equation (1) is greater than the left-hand side. Comparing the valuation function for the single and species group offers other evidence on scope.

An information sheet about the species and relevant legislation accompanied the survey booklet. A map and photographs of the species appeared on the covers to provide a clear picture of the species being valued. Critical habitat had not been assigned for all 32 threatened and endangered species, whereas a large designation for the California gnatcatcher has dominated the land use rules. Color codings were used to distinguish these species from the broader area. Information about the importance of the recovery plan was provided, with the assumption that if the plan were not implemented some species (including the Riverside fairy shrimp) would become extinct within 100 years. This was reasonable given biological criteria stated in the recovery plans.

Survey questions focus on the public's general environmental attitudes, WTP, and socioeconomic characteristics. Introductory and closing questions addressed environmental values and activities undertaken by the respondent. Following the National Oceanic and Atmospheric Administration recommendations (Arrow et al., 1993), a tax payment vehicle was chosen. Pretest focus group respondents questioned the legitimacy of "independent foundations" and pointed to possible free-riding issues. Although strategic biases may arise among respondents who dislike government programs, pretest of the survey suggested an equal reluctance to support private organization donations that may have free-riding effects. The specific type of tax was not stated because the sample included both property owners and apartment renters. The survey was focused at residents, who could be taxed through sales and income tax mechanisms.

Regarding the specific WTP question, open-ended and closed-end questions in static or iterative bidding frameworks have been tried with varying results. The author chose to use an open-ended payment card design because it offers easy understanding in a mail survey and was preferred by focus groups and pretest respondents. Despite its possible lack of incentive compatibility, the card design provides more efficient estimates from small samples and avoids the anchoring and "yea say" problems of discrete choice formats (Boyle, 2003). It generally eases the valuation task for respondents who have little knowledge of the good. Reaves et al. (1999) find that payment card surveys have higher response rates and lower protest rates than discrete choice instruments. Additionally, several studies have found that the dichotomous choice format yields larger estimates of hypothetical WTP figures compared to both the open-ended and payment card formats (Brown et al., 1996). The survey followed recommendations from Rowe et al. (1996) of using a payment card with an exponential response scale sufficiently large to avoid starting point biases and truncation effects.

The repeated pretest mailings and focus groups helped determine the appropriate range of dollar amounts to be presented on the payment card between \$0 and \$750. The payment card read as:

> Suppose the county and state governments wish to increase the protection of endangered and threatened species and proposes to raise the money through taxes.
>
> What is the most you would be willing to pay in additional yearly taxes for the Fund? You would be paying to acquire and manage critical habitat for endangered species.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| AMOUNT I WOULD PAY | | | | | \$_____ (please circle one amount) | | | |
| 0 | 2 | 7 | 20 | 50 | 150 | 375 | 1000 | |
| 0.5 | 3 | 10 | 25 | 75 | 200 | 500 | more than 1000 | |
| 1 | 5 | 15 | 35 | 100 | 250 | 750 | DK (don't know) | Other ____ |

## C. *Survey Administration*

The modified Dillman technique of mail surveys was used throughout the study (Dillman, 1978). The survey was revised extensively during the course of five focus group meetings and a pretest sent to 180 county residents. Four versions of the pretest survey focused on open and closed-end questions using a variety of payment vehicles. No financial incentives and language barriers in the county may have contributed to a low 20% response rate in the pretest. The U.S. Census reports that nearly 42% of county residents speak a language other

than English. After consultation with a variety of survey specialists, the author decided to include a Spanish- and Vietnamese-language response card in the final survey. The length of residence of the non–English speaking population also may impact their opinions about public goods and general acceptance of survey participation.

The final survey was mailed to 1,600 individuals, with 800 receiving the fairy shrimp alone survey and 800 receiving the multiple species instrument. The survey was mailed to a systematic random sample of Orange County residents drawn from the database of Accudata. The list offers the mailing addresses of a sample drawn from drivers' licenses, the postal service, and consumer application sources.[5] The author included a dollar and a beverage incentive in the first mailing to encourage responses. It is worth noting that the repeated survey mailings occurred during September and October 2001. This period coincides with a prolonged stock market decline, terrorist acts, and even an anthrax mail scare, events that could lower response rates and WTP amounts for environmental goods.[6] The survey included a cover letter addressing these issues and assurances of gratitude and respondent confidentiality.

Of the 1,600 surveys first mailed, it was determined that 90 respondents had moved from the area or identified themselves as non–English speakers.[7] Of the remaining 1,510 valid observations, 1,423 surveys were sent in a second round to those who had not returned the survey at that point; 523 were finally returned completed for a response rate of 35%. The rate for the fairy shrimp subsample was slightly lower. This falls within the range commonly cited for CV mail surveys (Jakobsson and Dragun, 1996). Of all responses, 242 were from individuals who received the fairy shrimp version and 281 were from those with the multispecies package.

5. The total number of dwelling units in the Accudata sampling frame was 969,586 units, whereas the actual total was 974,086 in 2000.

6. Indeed, reports on charitable donations note a meager 1.1% increase in inflation-adjusted contributions to environmental organizations during 2001 (AAFRC, 2002). Major campaigns by advocacy organizations in the first quarters supported this pattern, but fundraising efforts by environmental nonprofits after 11 September by these groups were seriously compromised by giving to relief and the poor economy (AAFRC, 2002, p. 50). Also at this point, the University of Michigan consumer confidence index had score of only 82, and the recession also significantly affected donations in this period (AAFRC, 2002). For comparison, during the period of the studies by Reaves et al. (1999) and Loomis and Ekstrand (1997), the confidence index was well over 105 points.

7. A total of 21 postcards were returned, indicating that the recipient only understood Vietnamese or Spanish, and no surveys were returned completed in a foreign language. This small level perhaps parallels the findings of Loomis and Larson's (1994) California study in which a "surprising" absence of English language difficulty among the sampling frame was found in follow-up phone calls to nonrespondents. A later study (Loomis et al., 2002) provided survey booklets in both Spanish and English and received similar response rates and insignificantly different levels for mean WTP bids.

## III. RESULTS

### A. *Sample Statistics*

Table 1 provides an overview of the survey respondents. Most are older, longer-term, college-educated, wealthy residents of Orange County. Most of the respondents lived about 30 miles on average from the most controversial area of critical habitat designations, Rancho Mission Viejo. There were no significant differences in the personal characteristics across the subsample of respondents. Background environmental knowledge also varied widely in responses to questions offered at the beginning of the survey; 59% of the respondents answering the 32-species survey had heard of the California gnatcatcher before receiving the mailing, whereas only 12–15% had heard of the Arroyo toad and the tidewater goby. Across the whole sample the fairy shrimp was virtually unknown—only 12% had heard of it before the survey. However, nearly 71% of the sample had heard of the ESA legislation, and 13% of the sample were members of an environmental organization (such as the Sierra Club).

Seven survey questions (related to species' importance to human, animal existence rights, visualizing species, lost housing construction, payment for protection, desire for open space, and job losses) assessed environmental values on a 1–5 Likert scale, with a 1 representing the most agreement and a 5 as strongly disagreeing for five of the questions. Five questions were worded so that a strongly agree *low* score would be more indicative of *proenvironmental* values (questions EI1, EI2, EI3, EI5, EI6), whereas two questions on the indirect costs of protection were worded so that a strongly agree *low* score would be indicative of *antienvironmental* values (EI4, EI7). The expected sign on WTP is negative in the first case and positive in the second.

**TABLE 1**
Summary Statistics of Survey Respondents and County Residents

| Characteristic/ Variable | Expected Impact on WTP | County Households ($n$ = 935,287) | Whole Sample ($n$ = 523) | All Species Subsample ($n$ = 281) | Fairy Shrimp Subsample ($n$ = 242) |
|---|---|---|---|---|---|
| Gender (1 = male, 0 = female) % | ? | 50.2 | 58.6 (adults) | 58.93 | 58.12 |
| Age (years of respondent) | ? | 33.3 | 50 (adults) | 50 | 50 |
| Residence (years) % > 5 years in county | + | 81% | 23.92, 88% | 23.77, 88.6% | 24.10, 87.6% |
| Income level at range midpoint | + | $77,543 (mean) | $84191 | $86,851 | $81,122 |
| Households earning < $50K (%) | | 42 | 26 | 27 | 24 |
| Households earning > $100K (%) | | 23 | 34 | 33 | 36 |
| Schooling (range completed) | + | | 4.2 (college) | 4.2 | 4.2 |
| % with bachelor degree or higher | + | 31 | 88 | 90 | 84 |
| Distance (miles from critical habitat) | − | | 30.25 | 29.94 | 30.60 |
| Member (1 = yes, 0 = no) | + | | 12.72 | 11.87 | 13.69 |
| Membership in environmental group (%) | | | | | |
| Direct attitude scores: | | | | | |
| EI1 | − | | 2.41 | 2.38 | 2.45 |
| EI2 | − | | 2.60 | 2.54 | 2.67 |
| EI3 | − | | 2.12 | 2.10 | 2.15 |
| EI5 | − | | 2.85 | 2.84 | 3.27 |
| EI6 | − | | 1.97 | 2.04 | 1.90 |
| Indirect scores: | | | | | |
| EI4 | + | | 3.24 | 3.22 | 3.27 |
| EI7 | + | | 3.20 | 3.17 | 3.23 |
| SURVEY (1 = all, 0 = fairy shrimp) | + | | 0.54 | 1 | 0 |
| Response rate (%) | | | 35 | 37.22 | 32.05 |

*Note:* County average census data from American FactFinder/StatUSA.

The hypothesis that aggregating the variables would be statistically equivalent to treating each variable independently was rejected; thus in the regressions that follow, variables are entered separately. The desire for more open space in Orange County (EI6) appears as one of the strongest underlying value, because nearly 80% of the respondents strongly agreed or agreed with the opening statement in the survey. Many continue to see critical habitat designations as providing benefits not only to animals but also to hikers and scenic viewing opportunities.

The table also reports the household income, education, and other demographic variables of the whole sample of those who returned the survey compared to county mean trends from the 2000 Census data. The respondents compare somewhat favorably to the broader population regarding gender and residency. But the household income and education levels are higher for the sample. These factors may cause some upward nonresponse bias in the WTP statistics if biodiversity is considered a normal good more appreciated by educated people. The mean age of the respondents was 50 years with a county residency of 24 years, but this variable precludes direct comparison because the survey instructions required completion by an adult over 18 years of age, whereas the Census reports ages for all household members.

Table 2 integrates data on important variables from the survey respondents compared to the nonrespondents, using data on all residents in the associated census tract. Cameron et al. (1996) first suggested using data averages across resident ZIP codes and Census tracts to model the differences between survey respondents and nonrespondents and control for nonresponse bias through a sample selection model. Considering if the survey respondents differ greatly from the nonrespondents is a salient issue because nonrespondents often are poorer, more likely foreign-born or linguistically challenged, and less educated (McDaniel et al., 1987), and these variables may directly affect WTP and response levels

**TABLE 2**
Background Characteristics Respondents and NonRespondents

| Characteristic/Variable | Mean of Respondent Group ($n = 478$)*** | Mean of Nonrespondent Group ($n = 990$) |
|---|---|---|
| *AGETRACT* age of household head | 36.81 | 36.04* |
| *HHSIZE* household size | 2.86 | 2.98** |
| *PCOLLEGE* % college-educated | 37.43 | 34.22** |
| *PHOUSE95* % residing in house in 1995 | 49.03 | 48.22 |
| *PLANISOL* % language-isolated | 14.26 | 17.80** |
| *MHHINC* mean household income | $69,651 | $65,964** |
| Residence in zones 1–4 (%) | 42 | 37.76 |
| Residence in zones 5–6 (%) | 58 | 62.24 |

*Notes:* Data from associated census tracts from American FactFinder/StatUSA. *, ** Statistically significant difference in subsample means with a 5% and 1% level significance using a *t*-test assuming unequal variances. ***Some respondents were anonymous, so their location could not be linked to census tract variables.

so that the sample is not representative of the total population being studied. Because personal data about nonrespondents is often not available, Cameron et al. (1996) merge data about the respondents' and nonrespondents' general neighborhoods (Census tract) to analyze the propensity to respond and observe any salient differences between the two subgroups.

Table 2 shows that in the Census tracts that had addresses, respondents indeed tend to be older, speak more English, and receive higher incomes. The original mailing list was then coded by the six districts identified by the U.S. Census. The zones are ordered in approximate distance from the major area of proposed critical habitat, which will affect housing development and tollway construction near Rancho Mission Viejo in the southern part of the county. Households in the zones nearer the focus point (zones 1–4) did exhibit slightly higher response rates compared to the farther households, so that their representation in the survey statistics could be higher than their proportionate importance in the county. This zonal representation is important because Table 3 shows residents in zones 1–4 (south and central Orange County) tend to be wealthier and better educated than those in zones 5–6. The large number of households in northern Orange County (zone 6) also reflects the core of the county's immigrant population.

However, attempts to model the propensity to respond using probit and logit specifications on the census tract data found only the language isolation variable significantly affecting response rates and difficulty in optimizing the maximum likelihood estimation (MLE) model. Thus an extension of zonal controls for respondent/nonrespondent differences in WTP estimates first suggested in Bateman et al. (2000) is presented below.

### *B. Mean WTP, Confidence Intervals, and Hypothesis Tests*

Returning to the trends of the respondents, Table 4 shows the frequency of occurrence of various bid amounts selected from the payment card. About 13% of each sample responded "don't know," which is comparable to other studies. Of those $0 WTP respondents, 12–14% may be classified as protest responses who disagreed generally with the evaluation process.[8] Only one individual in each of the survey subsamples choose the highest bid amounts, yet some concentrated on the large bid of $500. This may introduce an outlier effect in the data, so that a sample with top and bottom 2.5% truncated is also presented.

A simple univariate mean, mode, and median follow. Here the average WTP for just the fairy shrimp recovery was $24.85 per household, whereas the average WTP for all the species together was $52.12 per household. The confidence interval shows that there is a significant positive range of valuation for the species with corresponding *t*-statistics of 7.39 and 8.36 for the fairy shrimp and the species bundle, respectively. Also, the values are significantly different across the species subgroups, which

8. Following the protocol of Loomis and Ekstrand (1997), protesters responded by selecting phrases such as habitat payments being "unfair" or a general opposition to government programs. However, protestors are not excluded in the calculations to avoid an upward bias in the results.

**TABLE 3**
CCD Zonal Differences in Characteristics and Survey Response

| | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5 | Zone 6 |
|---|---|---|---|---|---|---|
| Mean distance from main habitat (miles) | 14.31 | 15.21 | 24.05 | 28.29 | 35.04 | 38.11 |
| Total HH | 63,870 | 117,117 | 61,855 | 90,411 | 133,254 | 468,780 |
| Median HH income (U.S. census) | $80,182 | $66,021 | $77,634 | $62,343 | $60,135 | $51,658 |
| Survey response rates: | | | | | | |
| Total | 0.4 | 0.3 | 0.35 | 0.38 | 0.30 | 0.31 |
| Fairy shrimp | 0.40 | 0.22 | 0.31 | 0.28 | 0.30 | 0.32 |
| All species | 0.41 | 0.37 | 0.40 | 0.48 | 0.31 | 0.31 |

passes the scope test of equation (1) in which consumers should have a larger WTP for a bundle of goods than a single item.The *t*-statistic of 4.07 gave a significant difference in the means at $p = 0.000003$. Note also that the confidence intervals around the means of the two subgroups do not overlap, indicating a different value range for each bundle. Of course consumers are not putting a proportionally higher valuation of the larger bundle, as the ratio of the mean WTP figures is just over 2; some form of diminishing marginal valuation may exist (for similar trends, see Loomis and Larson, 1994). The WTP figures rise significantly when the protesters are excluded, but they fall when the top 2.5% high and low outliers are excluded in the truncated sample.

Yet in general these figures from Orange County compare to those found in other studies of the preservation of endangered species. Reaves et al. (1999) also used a payment card survey to calculate a $7.57 mean WTP for red cockaded woodpecker habitat restoration. Results were slightly higher for the dichotomous choice format, which is a general trend noted throughout the literature. In earlier studies using a variety of question formats, Boyle and Bishop (1987) value the "uncharismatic" striped shiner at $1–5 annually and the bald eagle between $10.62 and $75.31; Bowker and Stoll (1988) report WTP estimates from $21 to $42 for the whooping crane; and Stevens et al. (1991) report WTP values of $28.25 for bald eagles. California residents in particular have exhibited a mean WTP around $20 for increasing gray whale populations (Loomis and Larson, 1994). Rubin et al. (1991) value the northern spotted owl at $44 per household, whereas Hagen et al. (1992) mention $95. Loomis and Ekstrand (1997) found a mean WTP of $40.49 for the Mexican spotted owl and $48.70 for 62 species. More recently, Kotchen and Reiling (2000) find Maine residents are willing to pay $25.79 and $26.63 on average for preservation of the peregrine falcon and the shortnose sturgeon, respectively, with a strong association observed between bid amounts and environmental attitudes. Higher values are commonly reported in multiple species valuation surveys.

### *C. Explaining the Orange County WTP Trends*

Further statistical analysis can explain the wide differentiation in payment responses while also validating the overall survey results. Due to the large number of $0 responses and truncation at 0, a tobit model can best explore the factors influencing each household's WTP (Brown et al., 1996). Additionally, some households could even require a negative WTP bid (compensation to accept the animals' presence), which the author did not explore in the payment card, so that the sample is truncated.

Common explanatory variables in such models include the respondent's income, age, education level, residency period, past involvement in environmental groups, and environmental values. The survey variables of household income, schooling, and length of county residency (described in Table 1) should all be positively associated with a higher WTP for biodiversity. Wealthier, better-educated, and established residents with a sense of community should offer higher bids if species preservation is a normal good providing future and present day positive externalities (such as open space preservation). The age and gender variables have no predetermined sign because both younger and older residents, men or women, could have an environmental orientation. The author expects respondents who are already members of environmental organizations would respond favorably to

**TABLE 4**
Frequency of Bid Amounts and WTP Statistics by Subsample

| Bid Amount | Fairy Shrimp ($n = 242$) | All Species ($n = 281$) |
|---|---|---|
| 0 | 99 | 97 |
| 0.5 | 2 | 2 |
| 1 | 8 | 2 |
| 2 | 21 | 9 |
| 3 | 2 | |
| 5 | 6 | 10 |
| 7 | 6 | 3 |
| 10 | 13 | 8 |
| 15 | 2 | 2 |
| 20 | 25 | 28 |
| 25 | 7 | 12 |
| 35 | | 1 |
| 50 | 26 | 40 |
| 75 | | 6 |
| 100 | 11 | 31 |
| 150 | 10 | 15 |
| 200 | 2 | 5 |
| 250 | 1 | 1 |
| 375 | | 2 |
| 500 | 1 | 6 |
| 750 | | 1 |
| Percent bidding > \$0 | 59% | 65% |
| With protest \$0s ($n = 523$) | $n = 242$ | $n = 281$ |
| Mean \$ | 24.85 | 52.12 |
| SE | 3.36 | 5.82 |
| 95% confidence interval \$ | (18.23–31.42) | (40.67–63.57) |
| Median | 2 | 20 |
| Mode | 0 | 0 |
| Without protest \$0 ($n = 461$) | $n = 213$ | $n = 248$ |
| Mean \$ | 28.23 | 59.06 |
| SE | 2.23 | 2.97 |
| 95% confidence interval \$ | (23.77–32.69) | (53.22–65) |
| Median | 5 | 20 |
| Mode | 0 | 0 |
| Truncated sample ($n = 497$) | $n = 239$ | $n = 258$ |
| Mean \$ | 21.19 | 38.36 |
| SE | 2.48 | 3.07 |
| 95% confidence interval \$ | (16.23–26.15) | (32.22–44.50) |
| Median | 2 | 20 |
| Mode | 0 | 0 |

endangered species WTP initiatives. Additionally, a distance-decay function for the provision of environmental public goods would lead to a negative sign on the distance variable (Bateman et al., 2000). Finally, the responses to the environmental attitudinal questions could affect the bid function, as already discussed.

Results of the tobit bid functions using data from the full sample of survey respondents are summarized in Table 5. There were no significant differences on the sample excluding outliers. The results follow intuition and support the validity of the data set. The first specification focuses on demographic factors and survey type alone in explaining WTP. The age and income questions have the expected significant signs, apart from the survey type administered. On the margin, respondents were willing to pay about \$0.60 less for each year older.[9] Review of the income data suggested the middle-income group demonstrated the highest bids, so a quadratic function was chosen. Using the specification 1a coefficients, WTP increases with additional income up to a threshold of \$96,000 earnings, beyond which the species protection would not be a normal good. The next column (1b) shows the estimates corrected for heteroscedasticity, using an exponential function of the variance term as suggested in Greene (1993).[10] In each case the corrected model was preferred using a likelihood-ratio test. Most notably, the impact of survey type on WTP diminishes somewhat. The dummy coefficient shows those valuing protection for the 32-species bundle were willing to pay about \$18 more than those valuing just the fairy shrimp.

Surprisingly, the coefficients on environmental organization membership, gender, and distance were not significant. This indicates that intrinsic values may be more important in bid functions than the common distance decay assumption. The species being protected in this case (the fairy shrimp, and others such as the California gnatcatcher) are less charismatic than others and thus would perhaps be less associated with recreational visits.

How perceptions of open space affects bid functions appears in specification 2. Taking into account the respondent's scoring on the question "I want more open space." significantly affects the WTP factors. For each point in stronger disagreement with the statement the respondent would pay nearly \$20 less for habitat protection. This indicates that the demand for the public good of species protection is likely bundled with the desire for open space among residents. Taking this attitude

9. The marginal effects include the scaling factor of 0.56 for the probability the observation will fall in the uncensored region.

10. The constant variance term is replaced by a multiplicative error term which is a function of the regressors as $\sigma_i^2 = \sigma^2 \exp(\alpha x_i)$.

**TABLE 5**
Tobit MLE Parameter Estimates on Full Sample

| | Specification 1: No Attitude Questions | | Specification 2: w/ Open Space Question | | Specification 3: w/ All Attitude Questions | |
|---|---|---|---|---|---|---|
| **Variable** | **Tobit (1a)** | **Corrected Tobit (1b)** | **Tobit (2a)** | **Corrected Tobit (2b)** | **Tobit (3a)** | **Corrected Tobit (3b)** |
| Constant | −12.59 | 12.43 | 16.21 | 30.24 | 35.74 | 62.11 |
| Gender | −2.02 | −1.96 | −0.12 | 0.20 | 9.68 | 12.98 |
| Age | −1.08** | −0.6* | −0.86** | −0.5* | −0.32 | −0.23 |
| Income/1,000 | 1.09* | 0.98* | 1.27** | 0.96** | 1.36** | 1.41** |
| (Income/1,000)$^2$ | −0.006* | −0.006* | −0.007* | −0.006** | −0.007** | −0.008** |
| Distance | 0.63 | −0.13 | 0.75 | −0.07 | 0.72 | 0.25 |
| Membership | 27.58 | 7.47 | 29.49* | 12.91 | 9.70 | 4.88 |
| Attitudes: | | | | | | |
| EI1 | | | | | −3.02 | 0.55 |
| EI2 | | | | | 1.43 | 1.39 |
| EI3 | | | | | −16.70** | −16.73** |
| EI4 | | | | | 9.16* | 7.78 |
| EI5 | | | | | −31.35** | −28.18** |
| EI6 (open space) | | | −28.27** | −13.19** | −2.11 | −0.39 |
| EI7 | | | | | −4.43 | −9.42* |
| Survey type | 37.85** | 17.87* | 39.54** | 16.09* | 38.66** | 23.58** |
| No. observations | 444 | 444 | 444 | 444 | 444 | 444 |
| Sigma | 105.05** | 16.90** | 101.98** | 22.13** | 93.35** | 86.83** |
| Log-likelihood | −1,927.36 | −1,893.71 | −1,912.68 | −1,875.01 | −1,869.09 | −1,849 |

*Notes:* Point estimates; *t*-ratios in parentheses; dependent variable is WTP. *Indicates significant at 90% confidence, ** at 95% confidence.

factor into account lowers the impact of the age and income variables slightly while making the membership factor significant.

Inclusion of all the attitudinal questions follows in specification 3. All of the coefficients had the expected signs, except those with the second question related to animal existence rights and the last related to job creation costs. Responses to the third, fourth, and fifth questions had the largest significant effects on bid functions. For instance, a respondent moving from a "neutral " to "agree" response to the third "protect even if don't see species" question would be willing to pay about $16 more for protection on the margin. Greater agreement to the fourth "I am willing to pay for protection" question results in a large $30 additional bid. The fourth question dealt with the trade-offs involved with species protection, namely, the forgone housing construction. As respondents disagree more with the common news statement about protection reducing housing starts, they would be willing to pay more for habitat. Thus some group of residents in the county has begun to weigh perceived land use trade-offs.

Finally, Table 6 presents the regression subsample results. The quadratic income trend was more apparent for the fairy shrimp subsample while the desire for open space and first attitudinal variable were more significant for the 32-species bundle group. The table also shows the estimated WTP from the subsample regressions used for benefits aggregation. The last specification, controlling for all attitude questions, presents the lowest estimates. Compared to the survey means of Table 4, the Table 6 figures offer a higher WTP for the shrimp (and for the all-species bundle) and a larger confidence interval accounting for the heteroscedastic error terms. The possibility of negative (near zero) expected valuation from the tobit model appears for the fairy shrimp at the lower bound of the confidence interval. Finally, in each case the likelihood-ratio test statistic rejects the null hypothesis that the valuation process of the fairy shrimp is equal to

**TABLE 6**
Tobit MLE Parameter Estimates on Subsamples

| | Specification 1: No Attitude Questions | | Specification 2L w/ Open Space Question | | Specification 3: w/ All Attitude Questions | |
|---|---|---|---|---|---|---|
| **Variable** | **RFS** | **All Species** | **RFS** | **All Species** | **RFS** | **All Species** |
| Constant | 20.68 | 62.32 | 27.16 | 82.78* | 5.46 | 114.45** |
| Gender | −9.0 | 14.03 | −2.30 | 11.47 | 5.81 | 14.0* |
| Age | −0.33 | −1.16** | −0.22 | −0.52 | −0.45* | −0.04 |
| Income/1,000 | 0.62* | −0.11 | 0.65* | −0.004 | 1.36** | −0.24 |
| $(\text{Income}/1{,}000)^2$ | −0.004* | 0.0009 | −0.004* | 0.0006 | −0.008** | 0.002 |
| Distance | −0.25 | 0.52 | −0.42 | 0.40 | −0.1 | 0.21 |
| Membership | 9.11 | 1.83 | 8.52 | −2.62 | 5.82 | −2.80 |
| Attitudes: | | | | | | |
| EI1 | | | | | −1.64 | −9.73** |
| EI2 | | | | | 5.81 | 3.53 |
| EI3 | | | | | −9.24 | −7.33 |
| EI4 | | | | | 4.48 | −1.18 |
| EI5 | | | | | −10.04* | −15.61** |
| EI6 (open space) | | | −6.51 | −26.91** | 0.54 | −2.88 |
| EI7 | | | | | 0.71 | −1.82 |
| No. observations | 210 | 234 | 210 | 234 | 210 | 234 |
| Sigma | 18.86** | 52.56** | 28.56** | 46.07** | 308.1** | 85.70** |
| Log-likelihood | −803.75 | −1055.61 | −795.01 | −1041.21 | −767 | −995.90 |
| | $X^2 = 503.72$ | | $X^2 = 492.40$ | | $X^2 = 457.80$ | |
| Est. WTP (95% confidence interval) | $31.42 (9.37–53.47) | $63.80 (25.04–102.57) | $30.57 (7.57–53.58) | $64.17 (24.24–104.11) | $29.56 (−0.78–59.89) | $56.41 (23.49–89.34) |

*Notes:* Point estimates; *t*-ratios in parentheses; corrected errors; dependent variable is WTP. *Indicates significant at 90% confidence, ** at 95% confidence.

the valuation of the total species bundle. Again this means insensitivity to scope likely did not occur among the respondents.

## IV. BENEFITS AGGREGATION

To assess the total benefit of a public good, it is common to aggregate mean WTP figures over a relevant market, which in this case is Orange County. This represents an underestimate of benefits because endangered species are a potential national and even global public good. Loomis (2000) suggests the economic and political jurisdiction of preservation policy rarely overlaps because some WTP, and national benefits from the species existence, can occur even up to 3,000 miles from the wildlife habitat area. State aggregation may represent only 20% of the total true benefits. The extent to which a local aggregation underestimates the true value of the public good depends on the nature of the distance-decay function and the concentration of population around the habitat area (Loomis, 2000). If there is large evidence of distance decay in WTP figures, the extent of underestimation of total benefits by ignoring far-off national residents is reduced. Aggregation in states or counties with an extremely low population density would likely lead to a greater underestimation of total benefits (Loomis, 2000). In the present study there was no significant relationship on distance, so it would be difficult to either impute the county average WTP to a larger national population or extend a distance-decay function for the national area. Additionally, Orange County represents a densely populated area around the critical habitat zone, which reduces the underestimation impact.

Numerous controversies exist around benefits aggregation and the overestimate of the economic values of environmental goods. Method 1a of Table 7 provides a generous figure of benefits by extrapolating countywide estimates from summary statistics of the survey data. The author first assumes nonrespondents reflect the general population and assigns the mean WTP (Jackobsson and Dragun, 1996).

**TABLE 7**
Aggregation of Annual Benefits ($n$ = 935,287 Households in Orange County)

1a: WTP on all species and Riverside fairy shrimp from survey means (see Table 4)

| All 26 species WTP: | Riverside fairy shrimp WTP: |
|---|---|
| $48,747,158 | $23,241,882 |
| ($38,075,534–59,418,783) | ($17,050,282–29,433,482) |
| 95% confidence interval | 95% confidence interval |

1b. Estimated WTP from tobit regression analysis (Table 5)

| All species WTP: | Riverside fairy shrimp WTP: |
|---|---|
| $52,759,540 | $27,647,084 |
| ($21,969,892-$83,558,541) | ($0-$56,014,338) |
| 95% confidence interval | 95% confidence interval |

1c. Assuming nonrespondents WTP = 0, adjusted subsample mean WTP figures

All 26 species WTP: $18,144,568 — Riverside fairy shrimp WTP: $7,449,716

1d. Use of subsample median WTP on all species and fairy shrimp alone

All 26 Species WTP: $18,705,740 — Riverside fairy shrimp WTP: $1,870,574

2. WTP across zone and differential response rates

| Zone | Mean WTP All Species | Mean WTP Fairy Shrimp | Aggregation Population (HH * response) | Annual Benefits 32 sp. ($000) | Annual Benefits Fairy Shrimp ($000) |
|---|---|---|---|---|---|
| 1 | 28.17 | 20.27 | 25,867 | 728.79 | 524.40 |
| 2 | 51.94 | 30.30 | 35,135 | 1824.77 | 1064.75 |
| 3 | 45.97 | 22.37 | 21,649 | 995.14 | 484.28 |
| 4 | 72.70 | 31.12 | 34,356 | 2497.69 | 1069.10 |
| 5 | 45.47 | 30.18 | 40,642 | 1747.88 | 1226.53 |
| 6 | 55.22 | 25.83 | 146,728 | 8101.86 | 3790.05 |
| | | | Total WTP for all species | $15,996,134 | |
| | | | Total WTP for fairy shrimp | $ 8,159,099 | |

Simple survey subsample means are multiplied by the number of county households and the survey response rate. This provides the highest aggregate estimates of the county residents' WTP over $23 million annually to support the fairy shrimp and $49 million annually for the bundle of 32 species. Use of the estimated WTP figures from Table 6 follows in row 1b. Given the proximity of the estimated means to the sample mean WTP, the aggregate figures are nearly replicated, with the exception of the much wider confidence intervals and lower possible bound on the fairy shrimp valuation.

Nonresponse bias could be altering these figures. Method 1c takes the most conservative approach to correct this by assuming nonrespondents had a $0 WTP for endangered species protection. This assumes 37% of households valuing an all-species bundle would be willing to pay $52.12 per year on average, whereas the remaining 63% would pay nothing; likewise, 32% of those valuing the fairy shrimp would be willing to pay $24.85 and others nothing. This results in lower subsample means ($19.40 for the species bundle and $7.97 for the shrimp) and lower aggregate benefits between $7 and $18 million. Method 1d uses the median. Actually, Garrod and Willis (1999) argue that the median of survey data offers the closest to what the common voter would pay. As mentioned, the large number of $0 bids lowers the median significantly for all species mentioned in the survey. The county's WTP for the 32 species would be around $18 million, with the fairy shrimp worth about $2 million. Clearly methods 1c and 1d provide the most conservative estimates of aggregate benefits, and the fairy shrimp estimates fall within the lower bound of the confidence intervals derived from the estimated WTP.

Method 2 addresses the possible sample selection bias in the survey responses by estimating county resident WTP from the census CCD zone divisions outlined in Table 3. As already mentioned, strong differences across residency zone by income and other factors could

drive subregional survey response rates and respondent WTP. Thus following Bateman et al. (2000), the author first determines the average WTP for each good in each zone. Estimates of WTP from specification 1 in Table 6 would be logical because the environmental attitudinal variables are omitted, but the signs and predictions for the 26-species bundle are counterintuitive, and the coefficient on distance is not significant. Thus the author uses the average WTP from each group of respondents in the different CCD zones, which are in order of distance. The relevant aggregation population is determined from data listed on the bottom of Table 3, namely, the total households in each zone and the zonal response rate.

Little direct linear relationship between zonal distance and declining WTP appears. In fact, the very wealthy residents nearest the habitat area (Trabuco Canyon CC) actually were willing to pay *less* than those at a moderate distance. This is surprising because this group would most likely enjoy an open space positive externality from the designation of critical habitat. Much like residents associated directly alongside public transit, this group may be reflecting some nuisance effects associated with the public good. The WTP for the species bundle group increases, then declines, with distance but remain fairly consistent around $25 per household for the fairy shrimp. Yet across each zonal subgroup an increase in the level of the public good protected appears in higher WTP for the all species bundle compared to the single fairy shrimp.

Aggregating the estimated WTP amount across each zone's relevant aggregation population provides countywide figures of a total yearly WTP of over $8 million for the fairy shrimp and $16 million for the 32-species bundle. Interestingly, this correction for nonresponse provides a valuation of the 32-species bundle, which is only a bit lower to that using the most conservative method of imputing a $0 valuation to all nonrespondents. Estimates for the fairy shrimp are slightly higher given its consistent valuation across all zones. These lower estimates of 1c,1d, and 2 offer the most plausible figures for policy use given the trend of nonresponse bias.

## V. CONCLUSIONS

Orange County has been at the center of debates about the indirect costs of development opportunities forgone by critical habitat designations and the benefits of endangered species preservation. Results here suggest that there is a substantial positive valuation of the public good of critical habitat designations among a majority of randomly selected sample of county residents. However, there is a wide variation of bids, which is a clear indication of the continued controversy of the issue. Inherent environmental attitudes, household income, and age levels are significant bid factors that vary greatly among county residents; in terms of education, income and residency, patterns are varied between the survey respondents and nonrespondents.

Thus the possible mean household annual WTP figures could vary between $0 to $60 for the Riverside fairy shrimp and $23–104 for the bundle of 32 species. Incorporating the response rates provides the most conservative and logical aggregation of benefits, in the range of $7.5–8 million annual WTP for funding recovery plans to support the fairy shrimp and $16–18.7 million annually for a broader group of species frequently associated with coastal sage scrub habitat. Discounted present values of the annual streams, using a plausible five-year projection and 5% discount rate, could be close to $32 million of local funding for a regional shrimp recovery effort and $70 million for a multispecies effort.

These benefit figures often are compared to the direct costs of species recovery. But as mentioned, numerous problems have precluded many formal cost-benefit analyses of species protection. First, total direct recovery costs are probably underestimated because residents in neighboring counties will also be responsible for the future recovery costs with critical habitat units and economic impacts. Additionally, recovery plans only exist for 3 of the 32 species studied here: the Arroyo toad, Pacific pocket mouse, and the Riverside fairy shrimp as part of the southern California vernal pools recovery. The toad recovery plan impacts some 22 river basins and 193,616 ha in southern California (for a cost of $3.32 million), of which 8% of the area falls in Orange County (U.S. FWS, 1999). The total cost of the southern California vernal pools (with the Riverside fairy shrimp) is a small $1 million, and Orange County represents about 12% of the total impacted management areas for that species (U.S. FWS, 1998). These figures are well below the estimated benefits

derived from aggregate WTP in Table 7. In a similar effort, Loomis and Ekstrand (1997) find that the estimates of benefits of preserving the 4.6 million ha critical habitat for the Mexican spotted owl are greater than the recovery plan costs.

Second, the true economic cost of recovery would incorporate both direct and indirect costs, but it is nearly impossible to accurately assess the later. Valuation of forgone land use opportunities on area designated as critical habitat remains speculative at best and highly charged in the current real estate market. One novel approach to incorporate the indirect costs is to measure the willingness-to-accept compensation values of those most directly impacted by the changed land-use designation (Amigues et al., 2002). However in this county one critical habitat area for the Pacific pocket mouse (one of the 32 species) includes prime ocean-view real estate worth nearly $30 million (Mehta, 2002). Ultimately this is why federal taxation and support of critical habitat will remain necessary.

Although lawsuits will continue over the nature of the indirect costs of species protection in Orange County, the current study shows there is a positive valuation of the benefits of public goods, even in a period of economic uncertainty. The results from only a small part of the total consumers of the studied biodiversity suggest that its direct recovery costs can be supported; however, reliance on national economic support could be required to cover all land acquisition and indirect costs. It also appears that the public holds higher values for a group of species in an ecosystem, suggesting that habitat-based conservation programs are most likely to garner support. The results indicate additional calculations of the positive externalities of critical habitat designations, such as open space preservation, increasing housing values, and improving social indicators, must also be brought into the current debate.

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