1. Introduction

In 1994, an angler caught a lake trout (*Salvelinus namaycush*) in Yellowstone Lake, Yellowstone National Park, Wyoming. Judging by the size of the trout, and from subsequent data provided by the U.S. Fish and Wildlife Service, biologists now believe that someone must have illegally planted lake trout in the lake some five years earlier. They blame humans for the introduction because natural movement of this nonnative species into Yellowstone Lake is improbable. Based on catch and mortality rates, biologists now estimate that thousands, maybe tens of thousands, of lake trout of several age classes, some capable of spawning, live in Yellowstone Lake (Kaeding et al., 1995).

Yellowstone Lake is a prime spot for lake trout to flourish, because they thrive in the cold, deep water. But the problem is that Yellowstone Lake is the last premier inland cutthroat trout fishery in North America. And after years of working to restore the native Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*) population back to viable levels, lake trout are putting the last cutthroat stronghold at risk. Experts have concluded that the lake trout population is likely to expand and cause a serious decline in the cutthroat population. If left unchecked, some biologists have predicted that these voracious exotic species could reduce the catchable-size cutthroat population to 250,000-500,000 from 2.5 million within the near future (Kaeding et al., 1995).
Lake trout eat cutthroat, but they do not replace them in the food chain. And as if putting native cutthroats at risk is not bad enough, lake trout also put another popular species at risk—the grizzly bear (*Ursus arctos*), currently listed under the U.S. Endangered Species Act as *endangered* since 1975 (see Anderson, 1998). Grizzly bears feed on cutthroat when the trout spawn in over half of the 124 tributary streams. For example, researchers observed an adult female grizzly harvest an average of 100 fish per day for 10 days (Schullery and Varley, 1995). Lake trout do not replace cutthroat in the food chain because they spawn in the cobble and rubble in the lake, far from any predators’ reach. Approximately forty other birds and mammals also depend on cutthroat trout for food—including the bald eagle (*Haleaeetus leucocephalus*) and the osprey (*Pandion haliatus*).

Reducing risks to wildlife is a priority in Yellowstone National Park given that wildlife viewing has been estimated to be the “single most important activity” for over 90 percent of park visitors (Varley and Schullery, 1995). Park officials have attempted to protect cutthroat by netting lake trout. Netters have removed half the lake trout from Yellowstone Lake, catching the trout that reach known spawning grounds in the West Thumb region of the Lake. Netting has kept the foreign species from spawning in any large numbers in the lake. The analysis suggests that while the netting program of the park has cut into the lake trout population, netting may have to continue indefinitely, and at great expense. Fewer lake trout catch is good, but it could also lead to questions about the value of the netting program (Casper Star-Tribune, 1999).

The risk to Yellowstone cutthroat and grizzly bears is one example of a growing issue in species protection—species put at risk from exotic invaders. Organisms that
move beyond their traditional natural range can have undesirable ecological and economic consequences. Scientists have documented numerous examples of exotic plant and animals causing unacceptable damages, both monetary and non-monetary. Exotic deer and livestock, for instance, have altered the structure and composition of native vegetation in the Nahuel Huapi National Park in Argentina (Veblen et al., 1992). Nile perch released into Africa's Lake Victoria have caused mass extinction of native fish, and induced water quality problems. Field bindweed is estimated to cause over $40 million in crop damages in Kansas every year (FICMNEW, 1998). Zebra mussels in the Great Lakes have led to serious biotic and abiotic effects, e.g., greatly diminished phytoplankton biomass and biofouling of man-made structures (MacIsaac, 1996).

Understanding the economic value of reducing these risks to wildlife remains a key part of any wildlife management strategy. This chapter explores how economists have and continue to use the contingent valuation method to measure the value of reduced risks to endangered species. Endangered species, like the Grizzly bear in Yellowstone, provide many services to society—ranging from aesthetic value to basic life support to new genetic material for pharmaceutical purposes. These species provide a broad set of valuable services, many of which remain unpriced by the market. Because these public services are rarely bought and sold on the auction block, they never enter into private markets and remain unpriced by the public sector. Because wildlife does not stay within the confines of either public or private property, many people enjoy the benefits or suffer the costs without compensation paid or received.

Some people find the gains from endangered species protection so obvious that benefits need not be measured. The essential ecological services are so valuable that the
benefits of species preservation will always exceed the benefits of development (see, for example, Roughgarden 1995). To others, however, the benefits of species protection do not obviously outweigh the benefits of development. Epstein (1995, p. 278) illustrates this view stating:

> Some people believe that it is important to develop nature to the full, to overcome poverty and to ensure prosperity; others believe that nature should be left in its original condition to the extent that is possible, even if it means a cutback in overall standards of living. It is not within the power of either side to convert the doubters to the opposite position, and coercive systems of regulation are the worst possible way to achieve uniform social outcomes in the face of social disagreement. The interconnectedness of what goes on in one place and what goes on in another cannot be presumed on some dubious theory of necessary physical linkages for all events.

These people desire a pecuniary estimate of the potential benefits of endangered species protection. Valuing endangered species is a challenge, however, given the problems of assigning economic value to goods that most people never directly use, and the method—contingent valuation—used to estimate these values. Most economists now acknowledge that people might have preferences about protecting species and related services they will rarely ever, if at all, see or use (Krutilla, 1967). The main point of contention relates to linking a monetary value with these preferences. The primary tool for estimating use and nonuse values is contingent valuation, which is essentially public opinion surveys that use a sequence of questions to obtain a monetary value from stated preferences. The method is highly contentious, because people are responding to a survey rather than facing their own budget constraint and actually spending their own money.

Despite the analytical difficulties associated with measuring the social value that should be placed on preserving each species, determining at least a plausible range for these values is essential if we are to make judgments about the benefits of preservation.
The remainder of this chapter proceeds as follows. Section 2 follows the thread of earlier CVM efforts to value the protection of endangered species. Section 3 describes our case study, survey methods, empirical techniques, and empirical results. Section 4 concludes and discusses some important caveats to the general CVM literature for endangered species.

2. Previous Work

We now briefly focus on one critical thread in species valuation—valuing species alone, in groups, or within their habitat—for a select group of CVM endangered species surveys. We highlight methods used in these analyses to place our empirical estimates into perspective, and to provide the reader with references on the current state of the art. A common thread through many CVM studies is that they tend to focus only on one species, usually a charismatic megavertebrate. In doing so, these studies do not address important ecological complementarities since higher profile species may depend on the existence of other lower profile species, which may be an important link in biodiversity. Nevertheless, we note that an implicit value of other components of the ecosystem, such as plants and lower profile animals, could be retrieved when valuing one species near the top of the food chain (see Crocker and Tschirhart, 1993). The interested reader should also consult the survey of CVM species studies in Loomis and White (1996).

The estimation of anthropocentric values of endangered and threatened species has typically been carried out using a willingness to pay (WTP) approach. Although one could argue that the public owns the species and should be justly compensated for its extinction, the adopted measure of choice has been WTP (Just et al., 1982). Using a
WTP measure of value within a CVM survey, researchers have estimated a range of WTP for individual species as low as $6 for a striped shiner and as high as $95 for the northern spotted owl (Loomis and White, 1996).

Within this large range of values lies some interesting CVM studies that vary by geography and method. For example, examining a single species, Mediterranean monk seal (*Monachus-monachus*), Langford et al. (1998) used a multivariate binomial-log normal mixture model to develop a bid function whose level was determined by socio-demographic variables such as income, gender, age, and education. Amongst other findings, Langford et al. (1998) show that Greece households place a non-trivial dollar value on preserving the monk seals. Although the Langford et al. (1998) study uses an interesting empirical method to derive values, it is similar in nature to the majority of other CVM surveys in that it relies on the anthropocentric valuation model which elicits one species’ value, rather than examining the linkages of certain species and examining the entire habitat.

In contrast, Carson et al. (1994) and Walsh et al. (1985) use a more integrated valuation approach by examining multiple species. Carson et al. (1994) estimate the value for speeding up recovery of four species in California (bald eagle, peregrin falcon, kelp bass, white croaker), and find from a dichotomous choice survey that the mean individual is willing to pay around $63 in a one-time lump sum tax to expedite the recovery process. Walsh et al. (1985) examined 26 species in Colorado using an open-ended CVM survey and found that Colorado residents were willing to pay $58 as a one-time lump sum tax to protect the 26 species.
Along similar lines, Jakobsson and Dragun (1996) conducted a mail survey to Victorian residents in Australia concerning their WTP to avoid either a decline in a number of endangered species (flora and fauna) or the loss of Leadbeater’s possum. The aggregate mean estimates for protection of flora and fauna in dollars (per year) are as follows: Household minimum $160 million ($118 per household). Household maximum $386 million ($284 per household). Individual minimum $340 million ($118 per individual) and Individual maximum $821 million ($284 per individual). The aggregate mean estimates for protection of Leadbeater’s possum in dollars (per year) are as follows: Household minimum $39.7 million ($29.2 per household). Household maximum $103 million ($75.6 per household). Individual minimum $84.4 million ($29.19 per individual). Individual maximum $218 million ($75.6 per individual). The results show that the conservation of the Leadbeater’s possum is less than those values for the conservation of all endangered flora and fauna, suggesting that respondent’s value one individual endangered species significantly less than a collection of endangered species, which is consistent with intuition.

These three studies have advantages over previous CVM efforts in that they consider the valuation of multiple species, rather than a species in isolation. The approach of Watts-Reaves et al. (2000) is another advance in this direction, as they value both species and the habitat that supports them. They use a three-way treatment design to value the red-cockaded woodpecker and the restoration of its habitat following a natural disaster, which could be viewed as much more holistic approach than previous efforts. Valuing both the species and its habitat allows Watts-Reaves et al. (2000) to measure benefits for more than one individual species, and also provides an indication of the merit
of estimating benefits within a habitat-based evaluation. Overall, Watts-Reaves et al. (2000) find that across each treatment all mean WTP values to preserve the woodpecker and restore its habitat are statistically different from zero and that the value distributions are centered around $10.

Overall, the reported estimates above, and in other reviews, suggest people say they will pay a nontrivial dollar value to preserve and protect endangered species, whether individually or in aggregate. More importantly, the literature is moving toward a more thorough recognition of the complementarity and substitution effects across species and habitat that can critically matter when valuing a species. In our view, this trend will continue, and in what follows we carry out a CVM study that links endangered species by examining preservation values for an ecosystem put at risk from exotic invaders.

3. Wildlife at Risk in Yellowstone Lake: The Survey and Findings

We now return to the case of the exotic invader in Yellowstone Lake. Surveys were distributed in person to visitors of Yellowstone and Teton National Parks in Jackson Hole, Wyoming. Respondents had approximately 40 days to return the surveys. We chose this approach because we are interested in visitor attitudes on the lake trout problem.

The survey had four sections: background, perception, valuation, and demographic. The background section contained the following passage to inform the

---

1 The entrance into Yellowstone and Teton National Park are the same so we treat the visitors in the two adjacent parks as the same.
2 Distribution covered three days while the closing date was fixed. Some respondents (2.2 percent) chose to complete the survey on site.
respondent with a short and thorough explanation of the cause and potential effects of Lake trout being present in Yellowstone Lake:

Lake trout were found in Yellowstone Lake in July of 1994. Lake trout are a non-native fish species to Yellowstone Lake and are predators of the lake’s native and popular fish species – Cutthroat trout. Cutthroat are not only a popular species for fishermen, but are also a main food source for natural predators such as Osprey, White Pelicans and Grizzly Bears. Unlike Cutthroat, Lake trout swim too deep for birds to prey on them and do not spawn upstream where bears can feed on them. Lake trout, in essence, consume Cutthroat without replacing them in the food chain.

Potential impacts from the presence of Lake trout in Yellowstone Lake are great. Left unchecked, Lake trout will flourish and greatly diminish or eliminate the native Cutthroat trout population. The impacts on the ecosystem will not end with the reduced numbers of Cutthroat. Ospreys, White Pelicans and Grizzly Bears will see an important food source diminish, and as a result, the numbers of these species will be diminished.

While fishermen will feel the impact of reduced numbers of Cutthroat trout, all visitors will experience reduced chances of seeing certain birds of prey and Grizzly Bears. So the presence of Lake trout may not only have a great impact on the Yellowstone Lake ecosystem but also the experience of visitors to this area. This survey will contribute to determining the best course of action for managing this problem. Your participation is crucial for this research effort to succeed.

The Perception section elicited how the respondent perceived the potential impacts of the exotic species in Yellowstone Lake, including how the possible changes would influence their decision to visit the park. Table 1 presents the perceptions and attitudes of respondents. With half of respondents (50.4 percent) indicating no familiarity with the Lake Trout problem, the clarity and accuracy of the description of the issue becomes vital. Subsequent responses, in addition to general feedback, indicate participants understood the explanation of the problem. Nearly 80 percent of our respondents agreed that the Lake Trout problem was either very serious (48 percent) or
moderately serious (30 percent), and responses were broadly consistent regarding the expected benefits and costs of visiting Yellowstone.

As Table 1 reports, respondents generally indicated that future visits would revolve around viewing wildlife rather than fishing within the park. This non-fishing slant corresponds to the lack of influence that decreased numbers of cutthroat trout would have on future decisions to visit the park. Conversely, responders indicate that subsequent effects of the decreased cutthroats on wildlife viewing would influence future visitation decisions. As a final consistency check, responders indicated that decreased lake trout numbers would have no significant impact on future decisions to visit the park. As such, even though responders were generally unfamiliar with the lake trout issue, their perceptions and preferences regarding the problem were internally consistent for each question.

In the Valuation section, we use a two-step process following Kriström’s (1997) spike model. The spike model allows for a nonzero probability of zero willingness to pay. First, the respondent is asked to accept or reject the scenario of paying a sum of money $A$. The scenario is represented as the change $z^0 \rightarrow z^1$, where $z^0$ denotes a scenario with less biodiversity while $z^1$ denotes a scenario with a sustained biodiversity. The willingness to pay ($WTP$) to sustain current biodiversity is defined as:

$$v(y - WTP, z^1) = v(y, z^0)$$

where $v(y, z)$ is the respondent’s indirect utility function and $y$ is income. The probability that an amount $A$ is at least as high as the respondent’s WTP is:

$$\Pr(\text{WTP} \leq A) = F_{wtp}(A),$$
where $F_{wp}(A)$ is a continuous nondecreasing function. The functional form of WTP is assumed to be:

$$F_{wp}(A) = \begin{cases} 0 & \text{if } A < 0 \\ p & \text{if } A = 0 \\ G_{wp}(A) & \text{if } A > 0, \end{cases}$$

where $p \in (0,1)$ and $G_{wp}$ is a continuous and increasing function such that $G_{wp}(0) = p$ and $\lim_{A \to \infty} G_{wp}(A) = 1$.

Second, the respondent was asked whether she was willing to pay anything at all to ensure the baseline level of preservation, that is:

$$S_i = 1 \text{ if } WTP > 0 \ (0 \text{ otherwise}).$$

$T_i$ indicates whether the respondent was willing to pay the suggested price:

$$T_i = 1 \text{ if } WTP \geq A \ (0 \text{ otherwise}).$$

The log likelihood for the sample is then equal to:

$$l = \sum S_i T_i \ln [1 - F_{wp}(A)] + S_i (1 - T_i) \ln \left[ F_{wp}(A) - F_{wp}(0) \right] + (1 - S_i) \ln \left[ F_{wp}(0) \right]$$

Following Hanemann (1984), assuming a linear utility function:

$$\nu(k, y; z) = \alpha_k + \beta y + \gamma s \quad \beta > 0, k = 0,1$$

where $\alpha$ and $\beta$ are coefficients, $y$ denotes income, $\gamma$ is a vector of coefficients, and $s$ denotes a vector of socio-economic and demographic characteristics gives:

$$\Delta \nu = (\alpha_i - \alpha_0) - \beta A,$$

where $\Delta \nu$ denotes an approximation of the utility change. Using a logistic distribution $G_{wp}$, we have:
\[ G_{wp} = \frac{1}{1 + \exp(-\Delta v)}. \]

Maximizing the log likelihood function, Kriström (1997) finds mean WTP:

\[ E(WTP) = \int_0^\infty (1 - F_{WTP}(A))dA = -\frac{1}{\beta} \ln(a + \exp(\alpha_1 - \alpha_0)). \]

The variance was computed using the Gauss approximation described in the LIMDEP (1992) manual, p.156.

Under Kriström’s (1997) framework, the Valuation section initially established a hypothetical payment mechanism with the following market construct:

*Suppose a special "Yellowstone Lake Preservation Fund" is established by the National Park Service. Money from the Trust would be used to fund a program to manage the Lake Trout problem in Yellowstone Lake. With the program, the Cutthroat Trout will likely remain a viable species in the lake and other species that depend on the presence of Cutthroat will also likely remain at natural levels in the surrounding ecosystem. Without the program, Cutthroat will likely disappear and other species will diminish in numbers from the ecosystem. In sum, the Yellowstone Lake ecosystem will likely continue its natural existence with the program and will likely be significantly altered without the program.*

The following question was posed to determine whether the respondent had a positive willingness to pay for the preservation fund:

*If you did not answer yes, would you be willing to contribute any amount of money each year to the "Yellowstone Lake Preservation Fund" in order to support the program?*

1 YES
2 NO

If respondents indicated a positive willingness to pay, they were asked the following DC question:
Suppose that a $X contribution from each United States household each year would be needed to support and fund the preservation program. Would you be willing to contribute $X each year to the "Yellowstone Lake Preservation Fund" in order to support the program?

1 YES
2 DON'T KNOW
3 NO

Three DC bids X ($5, 15 and 30) were randomly distributed among the sampled individuals. The bids were chosen to provide sufficient information about the tails of the empirical survival distribution. In our survey, 60 percent of the respondents were willing to pay a positive amount for preservation. The large number of respondents unwilling to pay a positive amount shows the importance of using a distribution that allows for a zero WTP. Popular distributional assumptions such as log-logistic, lognormal or Weibull imply that all respondents have a positive WTP. Use of such an assumption may, therefore, result in a biased benefit estimate.

Finally, the Demographic section obtained respondent and household characteristics. The responses provided additional regressors for the valuation function estimates, which also allow consistency tests for our data. Demographic information is indicative of our unique target population of national park visitors–fifty-six percent of respondents were male with an average age of 46.7 years. While only 10 percent of the respondents lived alone, 60 percent of the represented households had no children. As expected, the targeted sample had relatively high education and income levels with nearly 70 percent of the sample having 4 years or more of college and 53 percent earning more than $50,000 annually.
Two hundred and eighty-four of the 496 distributed surveys were returned within 30 days. The response rate of 57.3 percent arose amid conflicting pressures: (1) the rate is higher due to the non-inclusion of the people who refused to take a survey (sometimes with emphasis) and the potential of greater interest by the selected sample and (2) the rate is lower due to the inability to use follow-up measures that often significantly increase the sample size. Of the 284 returned surveys, 28 (5.6 percent) failed to respond to the WTP question; thereby eliminating them from the sample. Sixty-eight, or 13.7 percent, responded ‘do not know’ to the WTP question and were coded as negative responses for estimation. Finally, the sample was trimmed further due to respondents not completing questions related to our regressors, such as age, income, gender, etc. The final sample included 238 observations.

Table 2 presents the estimated value function. Coefficient estimates generally follow intuition as well as previous results. For example, income and fishing interest regressors have positive coefficients that are significant at conventional levels. Furthermore, men tend to have higher values than women, and respondents that consider the cut-throat problem ‘very serious’ also place considerably higher values on the Yellowstone Lake ecosystem than their peers. Although these effects are only significant at p < .19 level using a one-sided alternative, they are suggestive of underlying preference patterns. Concerning estimated aggregate values, we compute a mean WTP equal to $11.16 (s.d. = $3.25). This value estimate is significantly different from zero at conventional levels and suggests the average park visitor will pay about $11 per year to fund a program to help protect the Yellowstone Lake ecosystem, which includes cutthroats, eagles and grizzly bears.
The aggregate value estimate is enlightening when placed into a management context. Park officials recently extended the current management scheme of deep netting that has decreased the lake trout population by 50 percent since 1996. In addition, officials substantially increased funding of deep netting to $1 million over the next four years. The annual cost of $250,000 includes a commercial grade vessel and a crew solely dedicated to the thinning of lake trout numbers. Distributing the annual cost over the estimated three million visitors in calendar year 2000 would entail each person paying about nine cents—less than one percent of the estimated $11 mean. In fact, collecting the estimated WTP from one percent of the visitors, akin to only charging visitors from an average July day (about a $20 entrance fee per vehicle), would cover the costs associated with the deep netting program. Our results indicate that visitor benefits clearly outweigh the cost of current policy.

5. Conclusion and caveats

This chapter provides new value estimates to protect the Yellowstone lake ecosystem from lake trout—an exotic invader that puts other key native species at risk, namely the threatened Yellowstone cutthroat and the endangered grizzly bear. Using data collected from visitors at Yellowstone and Teton National Parks in Jackson Hole, Wyoming, our estimates using Kriström’s (1997) spike model suggest the average person states that he will pay about $11 to help fund a program to manage the lake trout problem. These computed benefits are found to substantially exceed the costs of protecting Yellowstone Lake through a managed strategy of gill netting lake trout.
We conclude by highlighting some open questions in CVM, both in our study and in the current state of the art. First, a piecemeal species-by-species approach most likely will overestimate economic benefits. To illustrate, if one summed the stated preferences from various endangered species surveys in Loomis and White (1996) as a crude measure of benefits, the average person was willing to pay about $1000 to protect 18 different species. Multiplying $1000 by the number of U.S. households, suggest that we would be willing to pay over 1 percent of GDP to preserve less than 2 percent of the endangered species. Many will find these values to be high; others might not (Smith, 1993; Brown and Shogren, 1998).

Second, critics also complain that hypothetical surveys elicit surrogate preferences for species protection in general, rather than for the specific species in question. Rather a person’s stated willingness to pay acts as surrogate measure of general preferences toward the environment—a “warm glow” effect. That is, eliciting existence values with a CVM survey provides respondents with a chance to state their general preferences toward the entire gamut of endangered species, not just for the specific species in question. This is often the first, if not only, occasion a person has been asked to reveal a public opinion on the environment, and as such, the value revealed may reflect his or her overall desire to save the environment. For example, Hoehn and Loomis (1993) find that independent aggregation of the benefits of only two programs overstates their total benefits by 27 percent, the overstatement with three programs is 54 percent.

The exchange between Kahneman and Knetsch (1992) and Smith (1992) illustrates this issue. Kahneman and Knetsch observed that the average person’s willingness to pay to clean up one lake in Ontario was about the same as his willingness
to pay to clean up all the lakes in the province. They cite this as evidence that people are not responding to the specific good, but rather to the idea of contributing to environmental preservation in general—the warm glow. Smith questioned this view, arguing that incremental willingness to pay should diminish with the amount of the good already available, and that the evidence is therefore consistent with economic theory.

But other reports support the warm glow argument; Desvousges et al. (1992) find evidence that the average willingness to pay to prevent 2,000 birds from dying in oil-filled ponds was about the same as the value to prevent 20,000 or 200,000 birds from dying. After examining numerous CVM studies on all types of environmental resources, Arrow et al. (1993) note the bimodal distribution of benefit estimates—zero or a positive benefit around $30 to $50. This finding suggests these values serve a function similar to charitable contributions (Brown and Shogren, 1998). In another example, McClelland et al. (1992) found that up to one-half of the reported values for a specific environmental charge can be attributed to surrogate values. The fraction appears to depend on the contextual information provided in the survey.

Finally, most people are unfamiliar with the services provided by endangered species. A recent survey suggested that over 70 percent of Scottish citizens were completely unfamiliar with the meaning of biodiversity (Hanley and Spash, 1993), and there is little reason to expect substantially more knowledge in the United States (Coursey, 2000). These three issues suggest that the future of estimating the benefits of endangered species protection will remain elusive and contentious.
Figure 1 – Diagram of Species at Risk in Yellowstone Lake

The Visitor’s Experience at Yellowstone National Park

Grizzlies Feed on Spawning Cutthroat

Birds of Prey Feed on Shallow Swimming Cutthroat

Stream

Cutthroat Swim Near the Surface and Spawn Upstream

Lake Trout Feed on Cutthroat Trout

Lake Trout Swim and Spawn Deep within the Lake

Lake
Table 1 – Visitor Perceptions of the Lake Trout Issue

<table>
<thead>
<tr>
<th>Question/Answer</th>
<th>Percent of Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>How familiar were you with this problem:</strong></td>
<td></td>
</tr>
<tr>
<td>Well Informed</td>
<td>14.8</td>
</tr>
<tr>
<td>Moderately Informed</td>
<td>22.4</td>
</tr>
<tr>
<td>Barely Informed</td>
<td>12.4</td>
</tr>
<tr>
<td>Not Informed at All</td>
<td>50.4</td>
</tr>
<tr>
<td><strong>How serious do you consider this problem:</strong></td>
<td></td>
</tr>
<tr>
<td>Very Serious</td>
<td>48.0</td>
</tr>
<tr>
<td>Moderately Serious</td>
<td>30.0</td>
</tr>
<tr>
<td>Barely Serious</td>
<td>11.6</td>
</tr>
<tr>
<td>Not a Problem at All</td>
<td>3.6</td>
</tr>
<tr>
<td>No Opinion</td>
<td>8.0</td>
</tr>
<tr>
<td><strong>Do you expect to visit YNP to view wildlife in the future:</strong></td>
<td></td>
</tr>
<tr>
<td>Definitely Will</td>
<td>45.7</td>
</tr>
<tr>
<td>Probably Will</td>
<td>33.9</td>
</tr>
<tr>
<td>I Don’t Know</td>
<td>15.0</td>
</tr>
<tr>
<td>Probably Will Not</td>
<td>4.7</td>
</tr>
<tr>
<td>Definitely Will Not</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Do you expect to visit YNP to fish in the future:</strong></td>
<td></td>
</tr>
<tr>
<td>Definitely Will</td>
<td>12.3</td>
</tr>
<tr>
<td>Probably Will</td>
<td>15.5</td>
</tr>
<tr>
<td>I Don’t Know</td>
<td>13.1</td>
</tr>
<tr>
<td>Probably Will Not</td>
<td>30.6</td>
</tr>
<tr>
<td>Definitely Will Not</td>
<td>28.6</td>
</tr>
<tr>
<td><strong>Would a decreased chance of catching Cutthroat Trout affect your decision to visit YNP?</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>12.7</td>
</tr>
<tr>
<td>No</td>
<td>87.3</td>
</tr>
<tr>
<td><strong>Would a decreased chance of viewing Birds of Prey affect your decision to visit YNP?</strong></td>
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<td>Yes</td>
<td>39.5</td>
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<tr>
<td>No</td>
<td>60.5</td>
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<td><strong>Would a decreased chance of viewing Grizzly Bears affect your decision to visit YNP?</strong></td>
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</tr>
<tr>
<td>Yes</td>
<td>54.3</td>
</tr>
<tr>
<td>No</td>
<td>45.7</td>
</tr>
<tr>
<td><strong>Would a decreased chance of catching Lake Trout affect your decision to visit YNP?</strong></td>
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<tr>
<td>Yes</td>
<td>3.6</td>
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<td>No</td>
<td>96.4</td>
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Table 2 – Estimated Value Function

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<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>P-Value</th>
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</thead>
<tbody>
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<td>Intercept</td>
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<td>0.00078</td>
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<td>0.01303</td>
<td>0.33615</td>
</tr>
<tr>
<td>Kids</td>
<td>-0.03724</td>
<td>0.02110</td>
<td>0.84377</td>
</tr>
<tr>
<td>Gender</td>
<td>0.30234</td>
<td>0.33989</td>
<td>0.37371</td>
</tr>
<tr>
<td>Fisherman</td>
<td>-1.27290</td>
<td>0.52608</td>
<td>0.01554</td>
</tr>
<tr>
<td>Serious: very</td>
<td>0.09033</td>
<td>0.71488</td>
<td>0.32902</td>
</tr>
<tr>
<td>moderately</td>
<td>-0.69778</td>
<td>0.71488</td>
<td>0.32902</td>
</tr>
<tr>
<td>not at all</td>
<td>0.01425</td>
<td>0.62734</td>
<td>0.99819</td>
</tr>
<tr>
<td>no opinion</td>
<td>1.96560</td>
<td>1.4362</td>
<td>0.17114</td>
</tr>
</tbody>
</table>

For a definition of the variables used, see the Appendix of this paper.
### Appendix A

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bid</td>
<td>The DC bid given to the respondent</td>
</tr>
<tr>
<td>Kids</td>
<td>Number of children in household</td>
</tr>
<tr>
<td>Gender</td>
<td>1 - male 0 - female</td>
</tr>
<tr>
<td>Age</td>
<td>Years</td>
</tr>
</tbody>
</table>
| Income   | 1 - less than $20,000  
2 - 20,001 to 30,000  
3 - 30,001 to 40,000  
4 - 40,001 to 50,000  
5 - 50,001 or more |
| Fisherman| What are the chances that you will visit YNP in the future with a purpose of fishing for species such as the Cutthroat Trout?  
1. Definitely will  
2. Probably will  
3. Don’t know  
4. Probably will not  
5. Definitely will not  
Coded as 1 if any of the two first alternatives were chosen, otherwise coded as a zero. |
| Serious  | How serious do you consider the consequences of having non-native Lake Trout in Yellowstone Lake? (coded as 1 if selected)  
1. Very  
2. Moderately  
3. Barely  
4. Not a problem at all  
5. I have no opinion at all |
References


Casper Star-Tribune, 1999


