Final Report

Wolves and People in Yellowstone:
Impacts on the Regional Economy

September, 2006

Prepared for:

Yellowstone Park Foundation

by:

John Duffield, Chris Neher, and David Patterson
Department of Mathematical Sciences
The University of Montana.
Missoula, MT 59812

Table of Contents

List of Tables

List of Figures

Acknowledgements

This report would not have been possible without the support and contributions of many individuals. The Yellowstone Park Foundation provided the primary financial sponsorship which made the study possible. Glenn Plumb was Project Director and helped coordinate NPS participation in the project. Many Yellowstone National Park staff members played crucial roles in providing advice, data, personnel hours, and valuable feedback on the project during all phases. These individuals include Doug Smith, Wayne Brewster, John Varley, and Tammy Wert and her Entrance Station Staff. We are especially indebted to Becky Wyman for her work on the Lamar Valley data collection. The cooperation of Yellowstone Park was essential for completion of the study.

Of course, the approximately 3,000 Yellowstone National Park visitors who cooperated with our survey to one degree or another provide the backbone of the study. Their help was essential, and is much appreciated.

Executive Summary

Prior to reintroduction of wolves into the Yellowstone Ecosystem, an Environmental Impact Statement analysis presented predictions of a wide spectrum of impacts, including economic impacts, that would result from wolf recovery. Ten years following reintroduction, the wolf has reached recovered population levels. This study provides an *ex post* (after the fact) analysis of wolf-related economic impacts for comparison with the EIS predictions.

Original data was gathered from a random survey of Yellowstone National Park visitors between December 2004 and February 2006. The survey targeted two samples: all park visitors (sampled at park entrances) and Lamar Valley visitors (sampled randomly at parking locations throughout the valley). Throughout the sampling period a total of 2,992 surveys were distributed and 1,943 were completed and returned for an overall response rate of 66.4%. Respondents from the Lamar sample had higher response rates (74.2%) than did respondents from the entrance station sample (64.4%).

Estimates from the visitor survey indicate that conservatively 325,000 park visitors saw wolves in 2005 (95% C.I. 273,000-379,000). This is considerably higher than previous estimates. Additionally, 44% of visitors list wolves as one of the top three species they most would like to see on their trip (second only to grizzly bears). A majority of visitors favored reintroduction (61% to 68% across seasons) with only a small minority opposing the reintroduction (15% to 19%). The remaining visitors were unsure of their position on reintroduction (18% to 23%). This level of support for wolf reintroduction is similar to what was found prior to reintroduction. However, attitudes towards the reintroduction of wolves in Yellowstone are now more polarized. For example, the share of both hunters and ranchers supporting wolf reintroduction are now significantly lower compared to prior to reintroduction. Specifically, in 1991 56% of Yellowstone National Park visitors who were ranchers favored reintroduction, while in 2005 no more than 28% favored it.

Overall, it appears that the economic predictions made in the original EIS analysis have been relatively accurate. In terms of projections of changes in park visitation, the current estimated percentage increase due to wolf presence is somewhat lower than predicted (+3.7% estimated v. +4.9% predicted). However, the 1994 predictions were based on a survey of summer visitors to the park and the current estimate of the percent of summer visitation due to wolf presence is +4.8%, very similar to the EIS predictions.

Regarding changes in visitor spending in the local economy due to wolf presence, the current estimate of +$35.5 million (confidence interval of $22.4 to $48.6 million) is not significantly different from the 1994 EIS estimate of +$27.7 million (2005 dollars).

For the issue of wolf depredation of livestock, the EIS estimated losses, mostly for cattle and sheep, of $1,900 to $30,500 per year were based on assumptions of a recovered wolf population of 100 wolves. Depredation loss levels during the period when wolf numbers were near predicted levels were consistently within the range of predicted losses, and

averaged $11,300 in 1997-2000. In 2004 and 2005 when wolves numbered over 300, losses were twice the high-end estimate of losses predicted in the EIS, at $63,818 per year.

One of the most controversial issues currently surrounding wolf recovery in the GYA is that of big game predation and impacts on hunter opportunity and harvest. A review of the wildlife biology literature associated with wolf impacts on the northern Yellowstone elk herd shows a divergence of views on the impact wolf predation has had depending on whether wolf predation is viewed as largely additive or largely compensatory. Two peer-reviewed papers examining impacts of wolves on northern herd elk populations, however, have shown the impact of wolves on elk numbers to be either consistent with or below the impact predicted in the EIS, which was for a long-range hunter harvest reduction of elk of between 5% and 30%.

1.0 Introduction

In 1995 and 1996, 31 wolves were reintroduced to the Greater Yellowstone Ecosystem (GYE) and another 35 wolves were released in the Central Idaho Area in an attempt to restore the endangered gray wolf to the Rocky Mountains. The restoration of wolves to Yellowstone National Park has become one of the most successful wildlife conservation programs in the history of endangered species conservation. As of 2004 there were, approximately 301 wolves in the Yellowstone ecosystem and Yellowstone is now considered one of the best places in the world to watch wild wolves. Visibility of the wolves within the park and public interest in wolves and wolf-based education programs, have far exceeded initial expectations.

During the preparation of the Environmental Impact Statement (EIS) (US Fish and Wildlife Service 1994) that was completed by the National Park Service prior to wolf restoration, more than 170,000 public comments were reviewed to determine the public's key concerns. One of the main issues identified during this process was the concern about the possible economic effects of wolf restoration. Among the concerns of opponents were the expenditure of public federal funds for the restoration effort and the potential for negative economic effects on the regional economy. These assumed negative effects included the costs of wolf depredation on livestock; reduced big game populations resulting in lower economic returns to agencies and businesses that derive revenue from big game hunting; and an expected drop in visitation to Yellowstone and the surrounding ecosystem. Proponents, on the other hand, predicted increased visitation and positive regional net economic impacts caused by the presence of wolves.

Prior to the EIS, the National Park Service sponsored a series of studies on the biological, social, and economic implications of wolf recovery for the Yellowstone area. One of these studies (Duffield 1992) examined the possible economic consequences for the region based on a June 1991 survey of park visitors. This study predicted that the economic impact of wolf reintroduction on the three-state region would be positive (increased visitation and visitor expenditures would outweigh costs of livestock predation and reduced hunting opportunities). Additionally, the EIS included a benefit-cost analysis for the national population based on a national survey of attitudes and values associated with wolf recovery in Yellowstone. The findings of this study were that for a recovered population of 100 wolves benefits were estimated at $6 to $9 million per year, and costs were estimated at one million dollars per year. During the EIS process, estimates were made of the level of livestock depredations, changes in big game populations, and consequences to visitation. Positive economic benefits were predicted to be greater than negative ones. However, the projected positive economic benefits were not universally accepted by opponents to wolf restoration.

The wolf recovery program is now in its eleventh full year. Yellowstone National Park, in cooperation with state and federal agencies, have implemented a comprehensive research and monitoring program in the GYE to quantify the ecological effects of the restored wolf

population. Based on these recent studies, there is now data available to revisit, in part, the earlier analysis, and evaluate the overall economic effects of the initial recovery efforts and the ongoing wolf restoration program.

This report, funded by The Yellowstone Park Foundation with substantial cooperation from Yellowstone National Park, presents an *ex post* analysis of the impacts of wolf reintroduction on park visitation and spending, livestock depredation, big game populations, and non-market wildlife valuation.

1.1 Study Objectives

The primary objective of this study was to perform an *ex post* analysis of the economic impact of wolf reintroduction (and current wolf presence) in the Greater Yellowstone Area. This analysis was then to be compared to the analysis completed by the authors in 1993-94, predicting the impacts associated with the (then proposed) reintroduction.

A secondary objective was to gather information currently unavailable to park planners, including re-entry rates for Yellowstone National Park visitors on a seasonal and, if possible, entry gate level.

1.2 Definition of Study Area

The study area for this analysis is the 17-county Greater Yellowstone Area (GYA). This is the area addressed in the original wolf introduction EIS prepared by the National Park Service. Figure 1 shows the spatial extent of the GYA ecosystem. From an economic analysis standpoint the GYA is analyzed as the aggregation of the 17 counties wholly or partly included in the GYA ecosystem. These 17 counties include Bonneville, Fremont, Madison and Teton Counties in Idaho, Fremont, Hot Springs, Lincoln, Park, Sublette, and Teton Counties in Wyoming, and Beaverhead, Carbon, Gallatin, Madison, Park, Stillwater, and Sweetgrass Counties in Montana. Some results are also reported for the three-state region: Montana, Idaho and Montana.

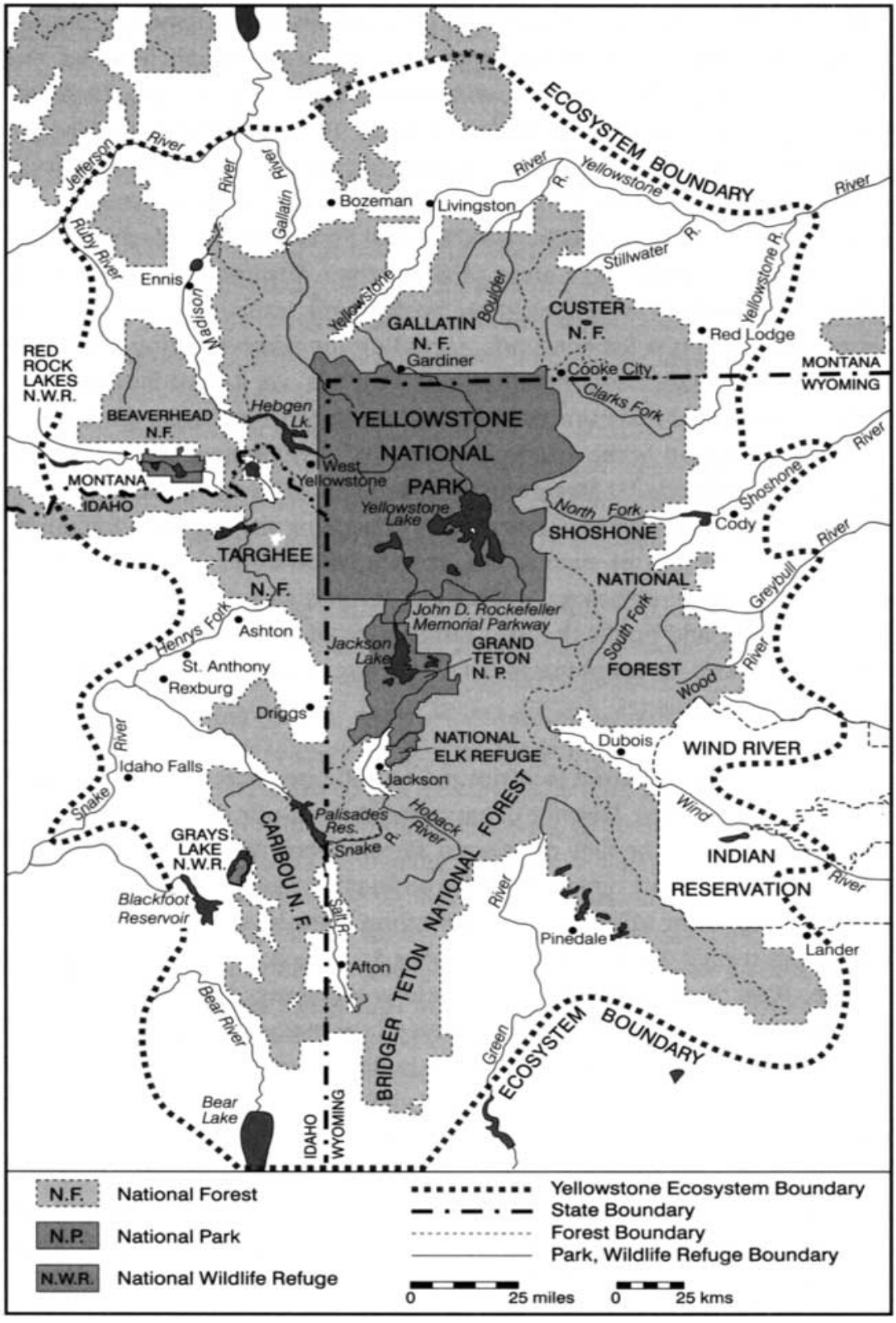

Figure 1. Map of Greater Yellowstone Ecosystem Boundaries,

1.3 Focus of Study-Economic Values

This study focuses on the economic values affected by recovered wolf populations in the Greater Yellowstone Area. These values include the benefits associated with increased visitation and enjoyment of the park, the local-area impact of increased visitor spending, and the local as well as national values associated with wolf recovery (Figure 2). On the negative side, relevant economic values include the costs associated with wolf predation on livestock and the value of any foregone hunter trips due to reduced populations of wolf prey species, including elk, deer, and moose.

Opportunities to view or hear wildlife are one example of what are termed ecosystem services, or the human uses that derive from natural systems. These include clean air, clean water, climate regulation, and nutrient cycling, as well as the services that derive from the presence of wildlife and other biota, including livestock grazing and hunting.

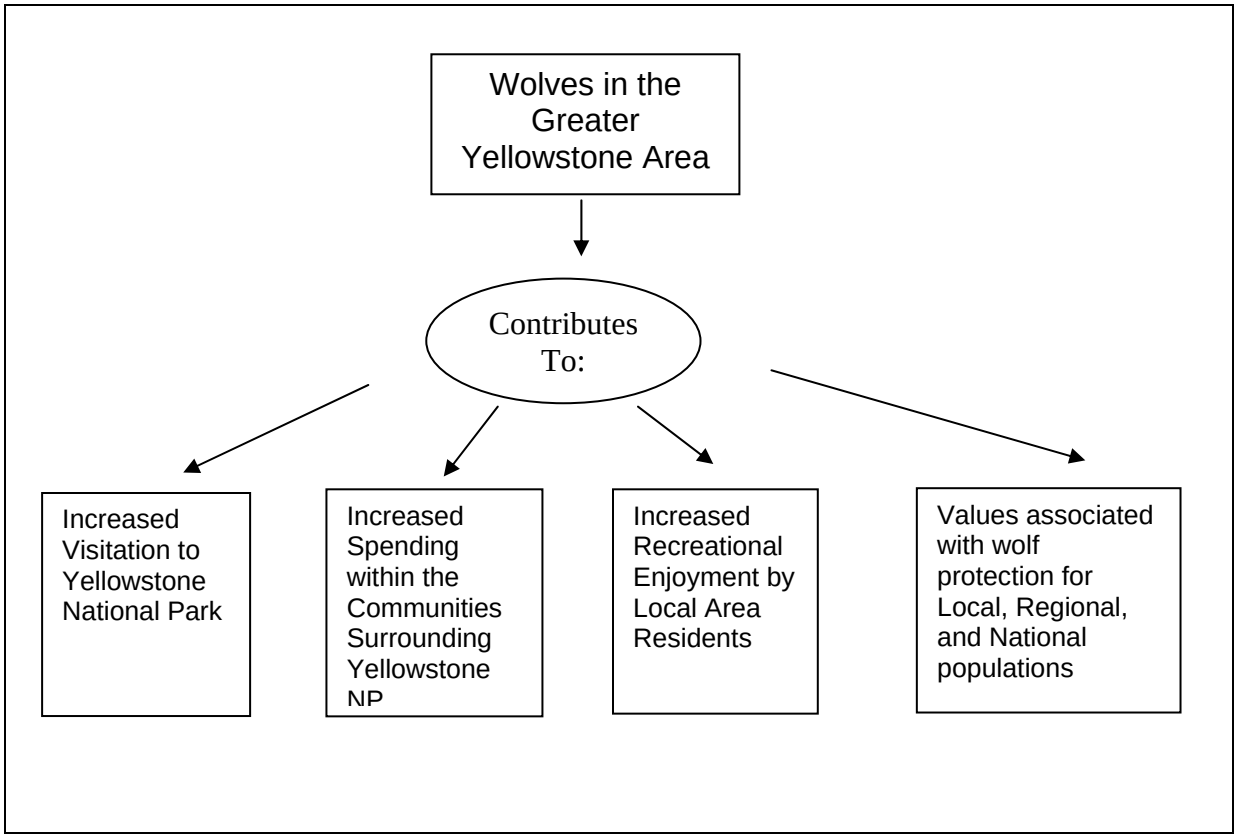

Figure 2. Linkage of Wolf Recovery to Positive Economic Values.

The National Research Council in their 2004 publication "Valuing Ecosystem Services: Toward Better Environmental Decision Making" provided a general overview of the benefits that derive from ecosystem services. Figure 3 diagrams this generic flow of ecosystem services.

As can be seen in Figure 3, several kinds of services, or uses, derive from natural systems. One dichotomy is between on-site use and passive use. On-site use includes seeing and hearing wolves. However, individuals who have no expectation to ever see or hear wolves may still place a value on knowing wolves are present in Yellowstone, and that Yellowstone has a complete ecosystem including all native carnivores. This was in fact demonstrated in 1992-93 national phone surveys, where some respondents said they placed a value on wolf reintroduction in the GYA area even when they had no expectation of ever seeing or hearing the wolves themselves. Such values are termed passive use values and are not dependent on direct on-site use. Several of the possible motives for nonuse values were first described by Weisbrod (1964) and Krutilla (1967), and include existence and bequest values. Existence values can derive from merely knowing that a given natural environment or population exists in a viable condition.

While use services may or may not have associated developed markets for them, nonuse services are exclusively non-market services. When nonuse and use values are estimated together, the estimate is referred to as total valuation. This concept was first introduced by Randall and Stoll (1983) and has been further developed by Hoehn and Randall (1989).

Some values associated with wolf recovery, both positive and negative, can be estimated from market data. This includes guided wolf-watching trips, and sales of wolf related goods (books, t-shirts, optical equipment), as well as the market value of cattle or sheep lost due to wolf depredation. However, many of the significant values associated with wildlife are not exchanged in markets and must be estimated using valuation methodologies specifically designed for valuing services not traded in traditional markets. The values associated with these services are referred to as nonmarket values. The specific nonmarket values at issue for this study include the value of the Yellowstone visitor experience, including wildlife viewing, as well as passive use values. Note that while visitors to Yellowstone National Park do pay an entrance fee, this is not a market price and may understate the full value of a park visit.

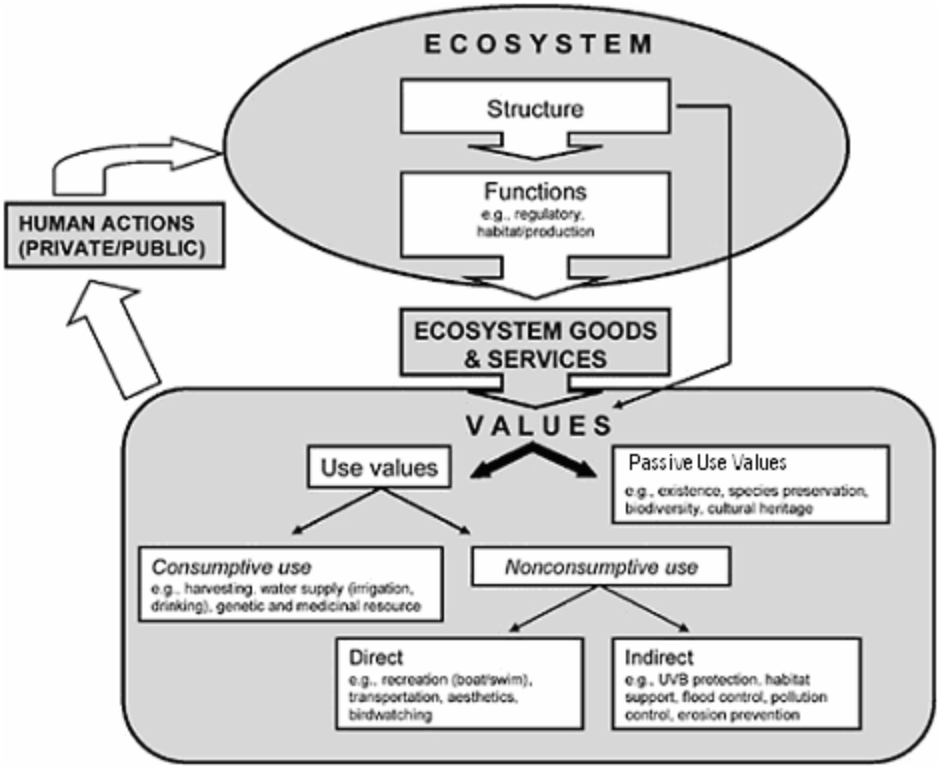

Figure 3. Flows of Ecosystem Services (adapted from NRC 2004)

A comprehensive economic evaluation of the contribution of wolves in the Yellowstone ecosystem needs to include two accounting frameworks. One is regional economics or economic significance, focused on identifying cash expenditures that drive income and job levels in the regional economy. The other is a net economic value framework that includes all potential costs and benefits from a broader social (usually national) perspective. The latter necessarily includes nonmarket and indirect benefits, such as the benefits wildlife viewers and hunters derive from their recreational activity, over and above their actual expenditure. Both perspectives are important for policy discussions and generally both accounting frameworks are utilized in evaluating public decisions, for example through an EIS process or in informing public opinion.

1.4 Previous Research

As noted earlier, between 1991 and 2005 there have been a number of visitor and resident population surveys conducted either within Yellowstone National Park or concerning issues specific to Yellowstone National Park or the Greater Yellowstone Area (GYA). These surveys, many conducted by the current authors, addressed issues including wolf reintroduction, winter use management, control of bison and brucellosis, and evaluation of the NPS fee demonstration program. This suite of population and visitor surveys is

somewhat unique in that across several surveys spanning 15 years, identical or near identical questions related to perceptions and attitudes towards wildlife were asked.

Table 1 outlines the previous visitor and population surveys undertaken by the authors that specifically targeted the issue of wolves and other Yellowstone area wildlife issues. The first of these studies was a 1991 study of Yellowstone National Park visitors specifically addressing the issue of possible reintroduction of wolves into the GYA (Duffield 1992).

In 1993 Duffield, Patterson and Neher conducted a study for the Liz Claiborne and Art Ortenberg Foundation of the likely economic consequences of reintroduction of wolves to the Yellowstone ecosystem (Duffield, Patterson and Neher 2004). This study included a national household phone survey in order to estimate total use (including passive use) value of associated with a recovered wolf population.

In 1994 the final EIS on the reintroduction of wolves to Yellowstone and central Idaho replicated and expanded upon the 1994 Duffield et al. study and estimated the economic impacts of wolf reintroduction within a cost/benefit framework. (U.S. Fish and Wildlife Service, 1994; Duffield and Neher 1996).

A recent issue of Yellowstone Science provides a summary of research, particularly with respect to wildlife management and wildlife biology, concerning the first 10 years of wolf recovery (in particular see Smith 2005 and White et al. 2005). A recent article (Montag, Patterson, and Freimund 2005), describes the wolf-viewing experience in Yellowstone National Park based on a 1999-2000 visitor survey.

In 1998-99 several Yellowstone area studies addressed issues ranging from winter park use and management, bison management in the context of the brucellosis issue (Duffield and Neher 2000a; Duffield, Patterson and Neher 2000b; Duffield and Neher 2000c), and initiation of a NPS entry fee demonstration program in the park (Duffield, Patterson and Neher 1999). Each of these issues/studies was associated with surveys of park visitors. The winter use/bison brucellosis studies included a suite of surveys including surveys of winter and summer visitors, and a local and national random phone survey.

In the context of current Yellowstone National Park visitor research the current study is unique for its emphasis on economics and because it includes a year-long survey of park visitors rather than the more commonly used sampling of visitors over a limited time period within one season.

Table 1. Previous Yellowstone-area Visitor and Population Surveys by Study Authors.

Year of Survey	*Population Surveyed*	*Survey Method*	*Survey Response Rate*	*Primary issue of Study*	*Sponsoring agency*
1991[a]	Yellowstone NP visitors	Mail	87%	Visitor characteristics, attitudes and values associated with wolves	National Park Service
1993[b]	National Household	Phone	45%	YNP Use, attitudes and values associated with wolves	Liz Claiborne & Art Ortenberg Foundation
1994[c]	National Household	Phone	49%	YNP Use, attitudes and values associated with wolves	US Fish and Wildlife Service
1998[d]	Yellowstone NP Visitors	Mail	81.7%	Fee Demonstration Program	National Park Service
1998-99[e]	Yellowstone NP Winter visitors	Mail	58.9%	Winter Use & Bison Management	National Park Service
1999[f]	Yellowstone NP summer visitors	Mail	68.4%	Winter Use & Bison Management	National Park Service
1999[g]	Population survey: Local, Regional, and National samples	Phone	47%	Winter Use & Bison Management	National Park Service

[a] Duffield (1992)

[b] Duffield, Patterson and Neher (1994)

[c] U.S. Fish and Wildlife Service (1994)

[d] Duffield, Patterson and Neher (1999)

[e] Duffield and Neher (2000a)

[f] Duffield, Patterson and Neher (2000b)

[g] Duffield and Neher (2000c)

2.0 Methods

2.1 Structure of the Yellowstone National Park Visitor Survey

The Yellowstone National Park 2005 Visitor Survey was designed to collect a broad spectrum of information and opinions from park visitors. The survey instrument was divided into four sections each addressing one general aspect of the visitors' trip or the visitors' attitudes and characteristics.

Section A of the survey asked questions specific to the respondents' visits to Yellowstone National Park in general and the current trip, in particular. This section included questions on the reasons for visiting the park, length of stay, other trips taken to the park in the past year, and other destinations on the current trip. Additionally, this first section of the survey asked visitors what activities they participated in on their trip, and how many separate times they entered the park on this particular trip.

Section B continued to ask questions about the visitors' current trip to the park, with emphasis on trip expenditures, where visitors stayed overnight, and details of any group tour package the visitor participated in. This section of the survey also included the nonmarket valuation questions designed to allow estimation of the net economic value of a trip to the park. That is the value over and above expenses that visitors place on trips to the park.

Section C of the visitor survey asks a series of questions specific to visitors' experiences and opinions regarding wildlife in the park. Specifically, visitors were asked what animal they saw on their trips, what animals they most wanted to see, and what animals they specifically came to the park to see. This section also asked respondents whether they agreed or disagreed with a series of statements regarding wildlife and wildlife management.

The final section of the survey (Section D) asked visitors a series of questions about themselves. This section included questions on residency, gender, age, education, ethnicity, and income. Additionally, this section asked respondents whether they worked in agriculture, hunted big game, belonged to a conservation organization, or were a professional wildlife photographer.

This section provides information on the statistical methods and modeling procedures utilized in the following analysis.

2.1 Sample Design Methods

The 2005 mail survey of Yellowstone National Park visitors was designed as a random sample of the entire population of park visitors. Park visitors in spring, summer, and fall were contacted at park entrance stations. Winter visitors traveling by car were also contacted at the North entrance station. Over-snow visitors were sampled through guide and outfitter lists. The resulting random sample was weighted appropriately to reflect the actual distribution of 2005 park visitation by entrance and season. As described below, a separate sample of visitors was contacted in the Lamar Valley to provide additional data on visitor wildlife viewing.

Survey responses were examined to detect the possibility of potential non-response bias.

The survey procedure followed a standard Dillman (1986) mail survey methodology using initial contact and repeat follow-ups. Further detail is presented below in Section 3.

All analysis and data manipulation was completed using SAS statistical software, and Microsoft Excel.

2.2 Net Economic Value Analysis Methods

Nonmarket values for visitor trips and for passive use values were estimated using the contingent valuation method (Mitchell and Carson 1989). In contingent valuation potential respondents are asked about their willingness to pay for the particular service at issue. To measure passive use values associated with wolf recovery, potential respondents were asked if they would be willing to donate to a hypothetical fund to support continued wolf recovery in the GYA. For current trip values, several question formats (dichotomous choice and payment card) and payment vehicles (travel cost and entrance fee) were used to examine the impact of survey methodology on estimated values. The estimation of willingness to pay models was implemented using a maximum likelihood interval approach (Welsh and Poe 1998; Cameron and Huppert 1989). Respondents were asked to choose the highest amount he or she was willing to pay from a list of possible amounts. It was inferred that the respondent's true willingness to pay was some amount located in the interval between the amount the respondent chose and the next highest amount presented. Let X_{iL} be the maximum amount that the ith person would be willing to pay and X_{iU} be the lowest presented amount that person would not pay. Given this, WTP (willingness to pay) must lie in the interval $\left[X_{iL}, X_{iU}\right]$ If $F\left(X_i;\beta\right)$ is the statistical distribution function for WTPi,

with parameter vector β then the probability that WTPi lies between two given payment bid amounts is $F\left(X_{iU}\ ;\beta\right)-F\left(X_{iL}\ ;\beta\right)$ and the associated log-likelihood function is:

(1)
$$\ln(L)=\sum_{i=1}^{n}\ln\left[F\left(X_{iU}\ ;\beta\right)-F\left(X_{iL}\ ;\beta\right)\right]$$

The SAS statistical procedure LIFEREG was used to estimate the parametric model of willingness to pay based on the underlying payment card responses.

3.0 Data Collection

The 2005 Yellowstone National Park Visitor Survey was a year-long survey of park visitors. This survey had two distinct target populations: 1) all park visitors entering through park entrances, and 2) park visitors who were stopped along the road within the portion of the Lamar valley most commonly associated with wolf watching. This section of the report details the design and implementation of the Yellowstone survey, including sample distribution statistics and response rates, sample weighting, and survey design.

3.1 Survey and Sampling Design

The 2005 Yellowstone Visitor Survey was designed as a year-long random survey of park visitors. As noted, the survey targeted two specific visitor groups: 1) the population of all park visitors, and 2) those visitors parked within the Lamar Valley. These samples are discussed in turn below.

The primary target population for the 2005 survey was the year-round population of Yellowstone National Park visitors. The sampling plan for this group was designed to survey a generally equal number of park visitors at park entry gates in each of the four seasons. In order to achieve this, the sampling interval was adjusted for each season to account for the very large differences in total park visitation in the different seasons. The goal of balanced sample sizes across seasons was chosen to yield sample sizes in non-summer seasons that would allow meaningful comparison of trip and visitor characteristics across seasons.

The second sample population was the group of visitors parked along the sections of the Lamar Valley most often used by wolf-watching park visitors. In order to ensure random sampling of this group, a detailed schedule of sampling periods was developed including random starting times, random starting locations along the Lamar road, varying sampling intervals to equalize sample sizes across seasons, and varying sample route locations to match the physical locations of probable visitors. Sampling this population was included in the study to ensure that an adequate sample of visitors specifically interested in wolf viewing was gathered in order to be able to compute meaningful estimates of expenditures, opinions, and preferences for this sub-population of all park visitors.

3.1.1 Yellowstone National Park Visitation Statistics

Sampling allocation and sampling intervals were based on total park recreational visitation, as estimated by the NPS. Table 2 shows the estimated 2005 by month and entrance station, totaling approximately 2.8 million visitors. The vast majority of those visitors (almost 2 million) visited during the three summer months of June, July, and August.

Table 2. 2005 Yellowstone National Park Recreational Visitation, By Month and Entrance

Month	*North*	*West*	*South*	*East*	*Northeast*	*Total*
January	10,354	7,697	3,880	366	-	**22,297**
February	13,980	10,156	4,603	279	-	**29,018**
March	11,748	3,221	2,292	63	-	**17,324**
April	16,310	9,806	-	-	-	**26,116**
May	47,779	99,784	41,295	25,052	11,902	**225,812**
June	88,310	241,914	141,124	60,116	28,550	**560,014**
July	107,826	326,507	194,690	75,193	38,949	**743,165**
August	100,227	275,308	168,559	69,026	34,169	**647,289**
September	72,077	161,554	95,389	40,242	24,099	**393,361**
October	30,400	59,709	30,514	14,020	8,269	**142,912**
November	7,403	2,557	758	336	450	**11,504**
December	8,074	5,942	2,643	180	-	**16,839**
TOTALS	**514,488**	**1,204,155**	**685,747**	**284,873**	**146,388**	**2,835,651**

Source: www2.nature.nps.gov/mpur/reports/reportlist.cfm

The 2004 Yellowstone National Park visitation was used as a basis for both allocating survey effort throughout the survey year, and for weighting final survey responses to more closely represent the distribution of actual visitation across seasons and entrances.

3.1.2 Yellowstone Visitor Survey Sample Allocation

Table 3 shows the actual distribution of survey responses across months and entrances. In total, the entrance sample yielded 1,512 completed surveys. Of these, approximately 97% could be matched with a specific entrance gate or month of visit.

Table 3. Distribution of Entrance Station Survey Responses by Entrance and Month.

MONTH	*NORTH*	*WEST*	*SOUTH*	*EAST*	*NE*	*Unknown*	*TOTAL*
January	16	-	1	4	-	25	**46**
February	66	8	2	-	-	2	**78**
March	33	-	-	-	-	-	**33**
April	23	-	-	-	-	-	**23**
May	90	14	113	23	-	4	**244**
June	57	67	86	59	19	13	**301**
July	42	101	40	31	21	15	**250**
August	15	78	33	29	-	-	**155**
September	36	87	13	35	-	10	**181**
October	21	73	6	17	-	8	**125**
November	6	-	-	-	-	-	**6**
December	1	-	-	-	-	29	**30**

While the 2005 Yellowstone visitor survey was designed to be a year-long random sample of all Yellowstone National Park visitors, several real-world constraints acted to limit the ability of the researchers to sample a "typical" group of visitors during portions of the year. The first constraint on sampling was a series of landslides along the Beartooth Highway which closed this primary access route from Red Lodge and I94 to the north between May 19th and October 7th 2005, and skewed visitation through the Northeast Entrance to the park from what could have been expected in a more typical year. The second, perhaps more constraining, factor concerned the changing management of winter visitation within the park. Previous winter visitor surveys in Yellowstone National Park (Duffield et. al 2000a) distributed survey packets to snowmobile riders and snowcoach passengers at the entrance stations. Under the current guided over-snow travel policy, however, most visitors purchase tickets prior to going through entrance stations, to minimize congestion and air pollution at the entrances. For the purposes of this survey, the only option available was to rely on the Yellowstone National Park guides and outfitters to follow a sampling protocol and having them collect contact information on a random sample of winter visitors. Unfortunately, cooperation from the guide and outfitter services was near zero. The result is that estimates for the winter season general visitor sample within this report are strictly applicable to North Entrance visitation only. In the following analysis, estimates of key parameters from the 1997-98 study of winter park visitors (Duffield and Neher 2000a) were utilized as a proxy for parkwide winter survey data from the current study. The 1997-98 survey and study was a large sample (1000+ completed surveys), peer reviewed study which provided high quality parkwide winter user data.

In addition to the entrance station sample survey responses, 431 completed surveys were received from visitors contacted within the Lamar Valley.

3.2 Survey Response Rates

Table 4 details the distribution of the survey sampling waves across the sampling year. The procedure followed in administering the survey included a 4-step process.

1. Yellowstone entrance station personnel (and Lamar survey personnel), following a specified schedule and sampling interval would intercept visitors and ask them to participate in the survey. Those who agreed were asked to supply their name and mailing information. This information was collected by the park personnel and periodically forwarded to the researchers in Missoula, MT.
2. The visitor contact information was entered into a database and an initial survey mailing was made including an explanatory letter, survey booklet, and postage paid return envelope.
3. Following the Dillman (1986) survey procedure, a reminder postcard was sent to respondents approximately one week after the survey.
4. A second complete survey package was mailed to those visitors who had not responded to the first two mailings

As shown in Table 4, there were 12 survey waves in total over the survey year which began on December 18, 2004 and ran through December 17, 2005 for the park entrance sample, and included February 10, 2005 through February 9, 2006 for the Lamar Valley sample.

Table 4. Distribution of Survey Sample across Survey Waves

Wave	*Begin date*	*End date*	*Sample*
1	12/18/2004	1/6/2005	62
2	1/7/2005	2/20/2005	195
3	2/21/2005	4/2/2005	125
4	4/3/2005	4/22/2005	39
5	4/23/2005	5/11/2005	158
6	5/12/2005	5/27/2005	217
7	5/28/2005	6/29/2005	534
8	6/30/2005	7/21/2005	358
9	7/22/2005	8/20/2005	398
10	8/21/2005	9/27/2005	441
11	9/28/2005	10/29/2005	256
12	10/30/2005	1/15/2006	105
13	1/16/2006	2/10/2006	104
Total			2992

Table 5 shows the combined survey response rates by survey wave. Overall, the response rate to the survey was 66.4%. Across waves this response varied from a low of 57.1% for the mid summer wave 9 to a high of over 75% for both the winter Lamar sample (wave 12) and the Spring sample (wave 5). In general, response rates were characterized by being highest in the shoulder and winter seasons and lowest in the summer season.

Table 5. Total Response Rates, by Survey Wave

Wave	*Mailed*	*Not Returned*	*Returned*	*Undeliverable*	*Response Rate*
1	62	18	44	0	71.0%
2	195	54	141	0	72.3%
3	125	37	86	2	69.9%
4	39	10	29	0	74.4%
5	158	38	117	3	75.5%
6	217	66	147	4	69.0%
7	534	174	345	15	66.5%
8	358	126	223	9	63.9%
9	398	165	220	13	57.1%
10	441	152	280	9	64.8%
11	256	87	161	8	64.9%
12	105	33	72	0	68.6%
13	104	25	78	1	75.7%
TOTAL	2992	985	1943	64	66.4%

Table 6 shows that survey response rates were significantly higher for visitors contacted in the Lamar Valley sample than for the general entrance station contacts. This likely reflects the greater interest the Lamar respondents had in the primary subject of the survey (wolf presence in the park). Overall, approximately 74% of visitors in the Lamar sample responded to the survey while 64% of visitors in the entrance station sample returned completed surveys.

Table 6. Survey Response Rates, by Survey Wave and Population Strata.

	Entrance Stations					*Lamar Sample*				
Wave	Mailed	Not Returned	Returned	Un-Deliverable	Response Rate	Mailed	Not Returned	Returned	Un-Deliverable	Response Rate
1	62	18	44	0	71.0%	0	0	0	0	-
2	195	54	141	0	72.3%	0	0	0	0	-
3	64	20	43	1	68.3%	61	17	43	1	71.7%
4	23	5	18	0	78.3%	16	5	11	0	68.8%
5	70	15	52	3	77.6%	88	23	65	0	73.9%
6	198	62	132	4	68.0%	19	4	15	0	78.9%
7	490	166	309	15	65.1%	44	8	36	0	81.8%
8	326	119	198	9	62.5%	32	7	25	0	78.1%
9	350	149	189	12	55.9%	48	16	31	1	66.0%
10	374	138	229	7	62.4%	67	14	51	2	78.5%
11	228	79	141	8	64.1%	28	8	20	0	71.4%
12	26	10	16	0	61.5%	79	23	56	0	70.9%
13	0	0	0	0		104	25	78	1	75.7%
Total	**2406**	**835**	**1512**	**59**	**64.4%**	**586**	**150**	**431**	**5**	**74.2%**

3.3 Sample Population and Non-response Weighting

While every effort was made to gather a sample of Yellowstone National Park visitation which mirrored the actual distribution of recreational visitation to the par in 2005, variations in distribution and response rates across months and entrances led to some over and under sampling of visitors during certain periods and at certain entrances. Prior to analyzing the survey responses, the sample distribution was examined and responses were weighted to correct for any over or under-sampling.

Table 7 shows the actual distribution of 2005 visitation to the park. This distribution was compared to the distribution of the survey responses from visitors contacted at entrances (Table 8) to look for persistent patterns of over or under sampling. In general, this comparison shows that among the entrances the North Entrance is over represented in the sample and the West Entrance is underrepresented. Across months, the summer months of June, July, and August are underrepresented in the sample. This result was expected as the sampling interval was varied to balance samples within the four seasons.

Table 7. Distribution of Actual 2005 Yellowstone National Park Recreational Visitation across Months and Entrances.

MONTH	*NORTH*	*WEST*	*SOUTH*	*EAST*	*NE*	*TOTAL*
January	0.37%	0.27%	0.14%	0.01%	0.00%	**0.8%**
February	0.49%	0.36%	0.16%	0.01%	0.00%	**1.0%**
March	0.41%	0.11%	0.08%	0.00%	0.00%	**0.6%**
April	0.58%	0.35%	0.00%	0.00%	0.00%	**0.9%**
May	1.68%	3.52%	1.46%	0.88%	0.42%	**8.0%**
June	3.11%	8.53%	4.98%	2.12%	1.01%	**19.7%**
July	3.80%	11.51%	6.87%	2.65%	1.37%	**26.2%**
August	3.53%	9.71%	5.94%	2.43%	1.20%	**22.8%**
September	2.54%	5.70%	3.36%	1.42%	0.85%	**13.9%**
October	1.07%	2.11%	1.08%	0.49%	0.29%	**5.0%**
November	0.26%	0.09%	0.03%	0.01%	0.02%	**0.4%**
December	0.28%	0.21%	0.09%	0.01%	0.00%	**0.6%**
TOTALS	**18.1%**	**42.5%**	**24.2%**	**10.0%**	**5.2%**	**100.0%**

Table 8. Distribution of Entrance Sample Responses across Months and Entrances.

MONTH	*NORTH*	*WEST*	*SOUTH*	*EAST*	*NE*	*TOTAL*
January	1.17%	0.00%	0.07%	0.29%	0.00%	**1.5%**
February	4.83%	0.59%	0.15%	0.00%	0.00%	**5.6%**
March	2.42%	0.00%	0.00%	0.00%	0.00%	**2.4%**
April	1.68%	0.00%	0.00%	0.00%	0.00%	**1.7%**
May	6.59%	1.02%	8.27%	1.68%	0.00%	**17.6%**
June	4.17%	4.90%	6.30%	4.32%	1.39%	**21.1%**
July	3.07%	7.39%	2.93%	2.27%	1.54%	**17.2%**
August	1.10%	5.71%	2.42%	2.12%	0.00%	**11.3%**
September	2.64%	6.37%	0.95%	2.56%	0.00%	**12.5%**
October	1.54%	5.34%	0.44%	1.24%	0.00%	**8.6%**
November	0.44%	0.00%	0.00%	0.00%	0.00%	**0.4%**
December	0.07%	0.00%	0.00%	0.00%	0.00%	**0.1%**
TOTALS	**29.7%**	**31.3%**	**21.5%**	**14.5%**	**2.9%**	**100.0%**

Table 9 shows the estimation of seasonal (and entrance specific) weights to balance survey responses to the actual distribution of visitation across entrances within each park season. These weights range from a low of 0.21 for the South Entrance in the Spring Season (indicating that this cell is overrepresented in the survey responses) to a high of 3.26 for the South Entrance in the fall season (indicating under representation in the sample). North entrance winter responses were given a weight of 1.00 to reflect that this was the only

entrance effectively sampled in the winter, and no effort is made to extrapolate these results to the other entrance winter visitation.

The Lamar Valley sample was not weighted in the same manner as the entrance sample. This sample was designed as a subsample of the population of park visitors who use the pullouts in the Lamar Valley. Results from this sample can not be extrapolated to the entire park visitor population.

Table 9. Calculation of Seasonal Population Weights for Entrance Sample Responses.

Distribution Of 2005 Yellowstone National Park Visitation						
	NORTH	**WEST**	**SOUTH**	**EAST**	**NE**	**TOTAL**
Winter	1.6%	0.01%	0.00%	0.01%	0.00%	1.6%
Spring	3.0%	5.9%	2.7%	1.4%	0.7%	13.7%
Summer	9.9%	28.2%	16.9%	6.8%	3.4%	65.1%
Fall	3.9%	8.0%	4.5%	2.0%	1.2%	19.6%
						100%
Distribution Of Survey Sample						
	NORTH	**WEST**	**SOUTH**	**EAST**	**NE**	**TOTAL**
Winter	8.5%	0.6%	0.2%	0.3%	0.0%	9.6%
Spring	10.6%	5.7%	12.5%	5.1%	0.4%	34.3%
Summer	5.9%	13.3%	7.4%	4.6%	2.5%	33.7%
Fall	4.7%	11.7%	1.4%	4.5%	0.0%	22.3%
						100%

Ratio Of Distributions - Weights					
	NORTH	**WEST**	**SOUTH**	**EAST**	**NE**
Winter	1.00				
Spring	0.29	1.04	0.21	0.28	1.51
Summer	1.66	2.11	2.28	1.48	1.37
Fall	0.84	0.68	3.26	0.43	

Responses were also weighted to correct for disproportionate probabilities of selection to participate in the survey. A second weight for the entrance sample was constructed which considered the number of times the respondent had entered the park on their trip, and the number of people in their vehicle when they were sampled. For the Lamar sample, this weight to correct for disproportional selection probabilities was calculated from the length of time the respondent reported they had been parked along the Lamar survey route.

Survey responses were also analyzed for non-response bias. Non-response bias occurs when those individuals who responded to the survey are significantly different (have significantly

different responses) from those who chose not to respond. Detection of non-response bias can be accomplished through undertaking a follow-up (often shortened) phone survey of a sample of non-respondents in order to compare their responses to those of respondents to the survey. An alternative method is to compare a limited amount of information collected on the entire sample pool between two groups: 1) those who have responded to the survey, and 2) the entire pool of possible respondents (respondents + non-respondents). Table 10 shows a comparison of these two groups for two variables collected on all potential respondents, gender and state of residency. As the comparison shows, there was no systematic significant difference between groups for these two variables. Non-response bias is likely to be more of a problem for studies with relatively low response rates.

Table 10. Non-response comparison, by sample

	Respondents	*Entire sample*
Wave 1 -Nonresidents		
% female	65.77%	67.71%
Sample size	1899	2905
% MT, WY, or ID residents	28.36%	27.53%
Sample size	1950	3000

Note: neither pair of means is significantly different at the 90% level of confidence

4.0 Results

Findings based on analysis of the 2005 Yellowstone visitor survey responses are presented in this section. This section is divided into 5 primary sub-sections: section 4.1 examines visitor activities within the park with an emphasis on wildlife-related activities. This section also looks at visitor opinions on which animals they come to the park to see, and which they most would like to see on their trips. Finally, this section looks at visitor opinions regarding wildlife in general and wolf-related issues more specifically. Section 4.2 describes reported visitor wildlife viewing on their trips to the park. Section 4.3 looks at how much money park visitors spend on their trips. Section 4.4 examines estimates of the net economic value of park visitation as well as wolf presence and protection in the park.

Sections 4.1 through 4.4 focuses on survey responses from Yellowstone visitors intercepted at the park entrances. Responses from this random sample of all visitors can be extrapolated to the entire population of Yellowstone National Park visitors within each season. One caveat to this extrapolation is in the case of the winter season. The winter season entrance sample was limited to wheeled entry into the park, specifically the North Entrance. Therefore, while the winter season results are representative of North Entrance visitors, these results can not be extrapolated to the entire population of winter season park visitors, which includes a large number of snowmobile and snowcoach visitors entering through other park entrances. Where appropriate, the discussion draws on results of the 1999 winter use survey (Duffield and Neher (2000a) that successfully sampled winter visitors at all entrances in December 1998 – March 1999.

The final topic addressed in Section 4 is the comparison of selected survey question responses between the park entrance sample, and those visitors intercepted while parked along the Lamar Valley. This comparison highlights the degree to which the Lamar visitors are more focused on wildlife observation including wolves and wolf watching than are the general park visitors.

4.1 Yellowstone Visitor Attitudes and Preferences Regarding Wildlife

Visitors to Yellowstone engage in a wide variety of activities throughout the year. One question in the visitor survey presented park visitors with a listing of possible activities and asked which ones they participated in on their trip. Figure 4 shows the percentage of park visitors in each of the seasons who participated in the three primary wildlife-related activities in the park: wildlife watching, bird-watching and wildlife photography. Over 85% of visitors in all seasons viewed wildlife, with percentage participation being over 90% in spring, summer, and fall. Bird-watching specifically was around 20% participation, being slightly higher in fall and slightly lower in winter. Approximately 45-50% of visitors year round participated in wildlife photography while in the park, with the highest percentage participation in spring.

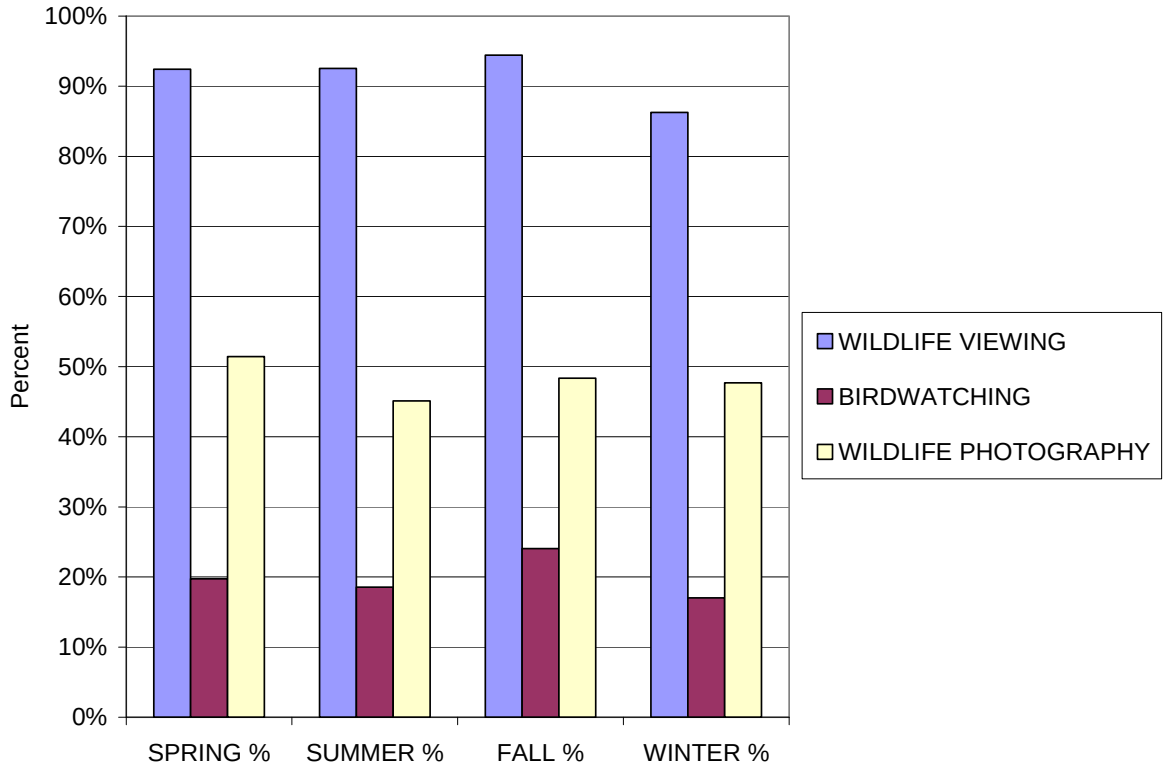

Figure 4. Yellowstone National Park Visitor Reported Participation in Wildlife-related Activities, by Season.

Survey participants were asked to indicate their primary activity in the park, and whether or not they would still have chosen to visit the park without the opportunity to participate in the activity. In spring and winter, wildlife viewing was the most often chosen primary activity (Figure 5); in summer and fall it was viewing scenery, with one third to one half of visitors listing it as the primary activity. The next activity in popularity was viewing geysers, with 14-18% of visitors in spring, summer, and fall indicated this was their primary activity. Snowmobiling, snowcoach tours, and cross-country skiing were, as one would expect, popular in winter and not in other seasons, and about 6-11% of winter visitors listed each of these as primary activities for North entrance winter visitors. Wildlife photography, hiking, and other activities were also of primary interest for 5% of more of visitors in various seasons. Based on a more complete winter sample from 1998-99, 61% of visitors participated in snowmobiling, 10% snowcoach travel, and 62% wildlife viewing. Currently, the winter activity mix for park visitors is in flux as management options for winter park use are being refined.

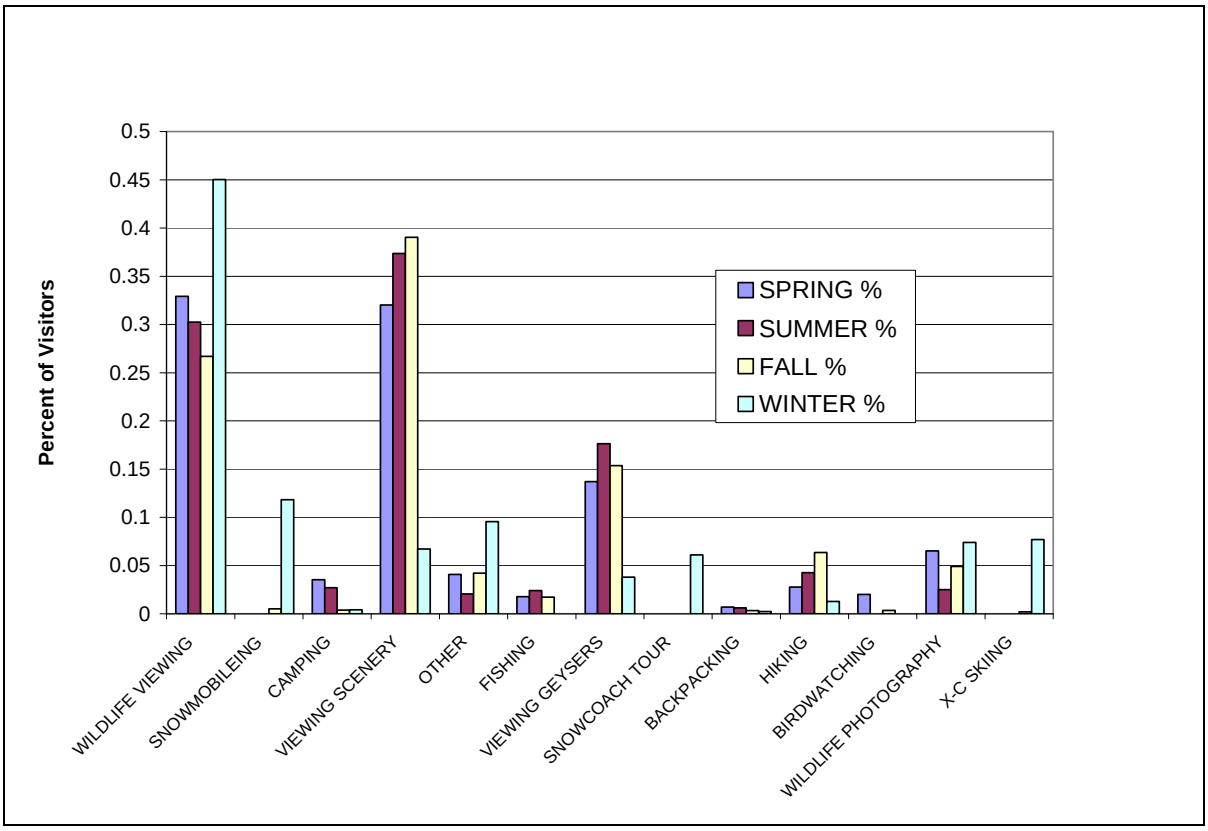

Figure 5. Percent of Yellowstone Visitors Listing Activities as their Primary Activity on their Trip to the Park.

Visitors were asked about their preferences for seeing different animals on their trips. Specifically, visitors were asked to list the three species of animals they would most like to see while in the park from a list of 16 species[1]. It is interesting to note that the "charismatic mega fauna", including large carnivores and ungulates, rank highest on the lists. Four of the top five species are consistently the large carnivores. The consistency in ranking across years (aside from wolves) is remarkable. A similar consistency is observed between resident and nonresident visitors. Table 11 shows a comparison of preferences for seeing different species across the three independent visitor surveys conducted in 1991, 1999, and the current 2005 survey. The data presented in Table 11 is for the summer season 2005 results, in order to be comparable to the 1991 and 1999 results which were estimated from summer visitor samples.

In a 1991 study, 15% of park visitors listed wolves as a species they would most like to see, even though at that time wolves were not present in the park. This percentage ranks them as number eight. Eight years later, and following the introduction of wolves in 1994, in a 1999 study, the number of visitors who had would like to see wolves had increased to 36%, and

[1] Antelope, Bald eagle, Bighorn sheep, Bison, Black bear, Canada Goose, Coyote, Deer, Fox, Grizzly bear, Moose, Mountain lion, Trumpeter swan, Wolf, Wolverine

the species was rated second only to grizzly bears. Based on the 2005 study, 44% of visitors listed wolves as a species they would most like to see on their Yellowstone trip and wolves are second only to grizzlies as a preferred species to see. This change in status of the wolf is demonstrated graphically in Figure 6.

Table 11. Comparison of Yellowstone National Park Visitor Ratings of the Animals the Most Would Like to See on their Trips to Yellowstone.

Rank	***1991 Study***		***1999 Summer Study***		***2005 Summer Study***	
	Species	**Percent**	**Species**	**Percent**	**Species**	**Percent**
1	Grizzly	0.550	Grizzly	0.58	Grizzly	0.55
2	Black Bear	0.332	**Wolf**	**0.36**	**Wolf**	**0.44**
3	Moose	0.332	Moose	0.35	Moose	0.41
4	Elk	0.239	Lion	0.31	Black Bear	0.26
5	Lion	0.229	Black Bear	0.29	Lion	0.25
6	Sheep	0.219	Sheep	0.23	Sheep	0.21
7	Eagle	0.187	Eagle	0.21	Eagle	0.21
8	Bison	0.160	Bison	0.19	Bison	0.21
9	**Wolf**	**0.154**	Elk	0.14	Elk	0.14
10	Wolverine	0.047	Wolverine	0.06	Wolverine	0.06

For the 2005 study, the remaining preferences to see species were Trumpeter swan (3%), Deer (2%), Fox (1.8%), Coyote (0.6%), Antelope (0.3%), and Goose (0.1%).

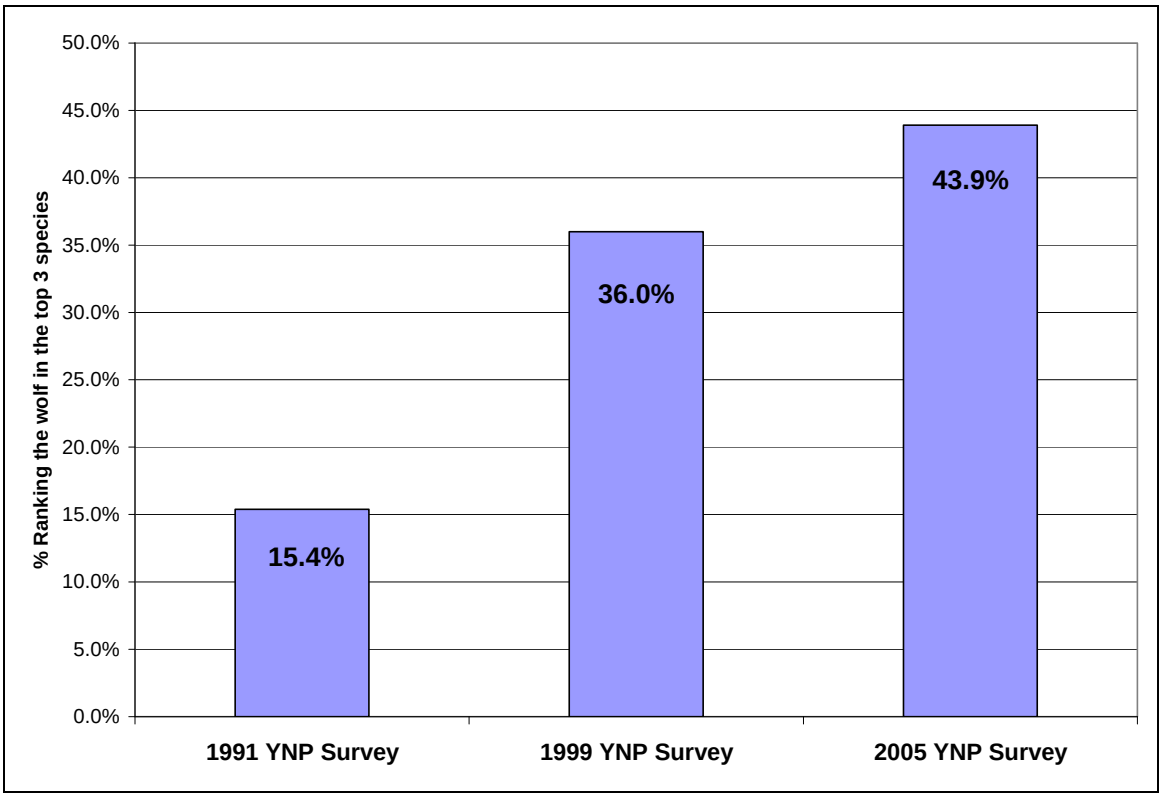

Figure 6. Comparison of Percent of Visitors Listing Wolves as One of the Animals they would most like to see: 1991-2005

The 2005 visitor survey included a series of Likert-scaled wildlife-related statements which visitors were asked to respond to. Visitors were given the opportunity to agree, disagree, neither agree or disagree, or say they didn't know their position in response to each of these statements. Overall, the responses to these statements (shown in Table 12) indicate a high degree of concern about ecological issues in general, and issues concerning Yellowstone National Park wildlife in particular. This concern for wildlife issues found in the 2005 survey responses is relatively consistent with the results of a 1999 survey of Yellowstone National Park visitors (Table 13). This comparison shows responses to two of the three statements to be not statistically significantly different. Responses to the statement "I have a great deal of concern for protecting wildlife habitat" are statistically different at the 99% level of confidence, with the 2005 summer respondents agreeing with this statement in marginally smaller proportions.

Table 12. Yellowstone Visitor Responses to Wildlife Statements: Percent of Respondents Who Either "Agree" or "Strongly Agree" with the Statements.

Statement	***Spring*** ***N=495***[b]	***Summer*** ***N=477***	***Fall*** ***N=322***	***Winter***[a] ***N=122***
I have a great deal of concern for protecting wildlife habitat	88.8%	94.8%	95.9%	98.6%
Wildlife species must be beneficial to humans to deserve protection	17.9%	23.2%	21.4%	16.4%
Current habitat is adequate for most wildlife species in the Yellowstone area	43.6%	53.3%	44.3%	34.2%
It's important to protect rare plants and animals to maintain genetic diversity	82.4%	90.4%	90.8%	92.6%
I derive satisfaction from just knowing that wolves are present in Yellowstone	51.7	58.8%	66.5%	--
I will get less enjoyment out of the park to the extent there are reduced numbers of elk, moose, and bison.	53.6%	61.3%	55.7%	--
I personally benefit from seeing or hearing wolves	38.3%	43.0%	44.3%	--
I experience reduced hunting opportunities with wolves present in Yellowstone NP	6.8%	6.7%	8.4%	--

a Winter sample is North entrance wheeled traffic only. The last 4 statements were not included in the winter version of the survey

[b] Sample sizes for individual questions may vary slightly from season sample size due to item non-response.

Table 13. Comparison of Level of Agreement with Wildlife-related Statements by Yellowstone National Park Visitors: 1999 and 2005 Survey Responses.

	Percent of Respondents who "agree" or "strongly agree"	
Statements	**1999 Summer**	**2005 Summer**
I have a great deal of concern for protecting wildlife habitat	97.7%	94.8%*
Wildlife species must be beneficial to humans to deserve protection	24.4%	23.2%
It's important to protect rare plants and animals to maintain genetic diversity	87.8%	90.4%
Sample Size	1,070	477

* Estimates are significantly different at the 99% level of confidence.

In addition to asking visitors about their preferences for seeing different wildlife species on their trips to the park, visitors were also asked which of a number of species they specifically came to the park to experience.

When asked whether the possibility of seeing specific species of animals was one of their reasons for visiting the park, 55-62% of visitors responded 'Yes' for Bison. Black or grizzly bears elicited a much wider range of interest, from 38% in winter, around 70% in spring and fall, to 80% in summer. The possibility of seeing elk influenced from 51% of visitors in the spring to 68% of visitors in fall. A large share (49-59%) of visitors, were interested in the possibility of seeing wolves in the park, and greatest interest was in the winter North entrance sample only. (Table 14)

An analysis of the responses presented in Table 14 show that it is rarely a single species which motivates visitors to come to the park. In comparing those visitors who said that seeing or hearing wolves was one of the reasons they came to the park with other survey responses, over 95% also said that seeing bears, elk, and bison were reasons they come to the park.

Table 14. Percent of Yellowstone Visitors Saying that Seeing Different Animals were One of the Reasons they Came to the Park.

Species of interest	Spring	Summer	Fall	Winter[1]
Bison	57.90%	62.14%	54.54%	60.70%
Black or Grizzly Bears	71.92%	80.12%	68.23%	37.70%
Elk	50.74%	62.10%	68.37%	67.30%
Wolves	48.85%	50.04%	55.70%	59.36%
Sample size	495	477	322	221

[1] winter sample includes only north entrance wheeled traffic

4.2 Yellowstone Visitor Wildlife Observation Experiences

One objective of the 2005 survey was to obtain an estimate of the number of Yellowstone National Park visitors who actually see wolves in the park throughout the year. One survey question asked respondents to indicate which species they actually saw on their trip to the park. Table 15 shows the percent of visitors reporting seeing a wide spectrum of species on their trips. As expected, nearly all visitors report seeing bison (93% to 98%), and a large share report seeing elk (85% to 92%). Also, as expected, very few visitors report seeing two rarely viewed species, mountain lions and wolverines (1.8% or less across seasons).

Table 16 shows the percent of entrance sample respondents who reported seeing wolves on their trips. The table also reports the percent who said they saw coyotes and the percent who reported seeing both wolves and coyotes on their trip. For purposes of conservatively estimating the number of Yellowstone National Park visitors who see wolves in a year we use the percent of visitors who reported seeing both coyotes and wolves. This conservative estimate is used to reduce the chance of counting visitors who misidentified coyotes as wolves.

Table 16 shows that in spring through fall between 9% and 19% of visitors reported seeing both wolves and coyotes. In the winter season about 37% of North Entrance visitors reported seeing wolves and coyotes. Applying these percentages to the actual 2005 recreational visitation levels reported by the NPS, yields an estimated 326,000 visitors who saw wolves in 2005. This is conservative for excluding winter visitors who enter through the West, East, and South entrances on over-snow vehicles. This is substantially higher than previous estimates of the number of visitors seeing wolves in the park. For example, Smith (2005) reports, based on field counts by Yellowstone National Park personnel, that about 20,000 park visitors per year view wolves.

The later estimate was based on occasions where Yellowstone National Park field personnel were able to observe visitors observing wolves. Given the size of Yellowstone National Park, the widespread distribution of wolves (Smith, 2005), and the limited presence of

Yellowstone National Park personnel in the field, it is possible that this method may be understating estimates by more than an order of magnitude.

Table 15. Percent of Yellowstone Visitors who reported seeing Different Species on their Trips.

Species (% reporting seeing)	*Spring N=495*	*Summer N=477*	*Fall N=322*	*Winter N=221*
Bison	98.1%	95.3%	96.0%	93.4%
Antelope	56.6%	48.9%	43.2%	47.4%
Bald Eagle	60.2%	51.3%	40.1%	65.9%
Bighorn Sheep	21.6%	12.4%	17.9%	36.7%
Black Bear	45.9%	31.6%	15.6%	1.4%
Coyote	45.3%	38.9%	40.4%	71.2%
Deer	71.3%	65.8%	49.6%	53.5%
Elk	84.4%	85.6%	92.1%	89.3%
Fox	16.6%	14.2%	14.0%	14.1%
Goose	56.5%	39.6%	39.0%	53.3%
Grizzly	22.0%	15.2%	7.7%	0.3%
Mountain Lion	1.4%	0.6%	0.1%	0.2%
Moose	44.0%	36.9%	24.1%	11.1%
Trumpeter Swan	44.9%	34.4%	22.0%	34.1%
Wolverine	1.8%	1.3%	0.2%	0.6%
Wolf	25.4%	15.2%	18.5%	42.4%

Table 16. Estimated Number of Yellowstone Visitors Seeing Wolves and Coyotes in the Park in 2005.

Statistic	*Spring N=495*	*Summer N=477*	*Fall N=322*	*Winter N=221*
% Seeing wolves	25.4%	15.2%	18.5%	42.4%
% Seeing coyotes	45.3%	38.9%	40.4%	71.2%
% seeing both	19.2%	9.1%	12.8%	36.7%
Recreational visitation (2005)	382,598	1,819,798	547,777	43,933
Number of visitors seeing wolves	73,382	166,330	70,335	16,123
Total estimated visitors sighting wolves (spring-fall)	**310,046 (95% C.I. 257,210 to 362,882)**			
Total estimated visitors sighting wolves and coyotes (year-round)	**326,170 (95% C.I. 273,277 to 379,097)**			

Note: winter and year-round estimate includes only North Entrance visitation.

While the estimated numbers of visitors seeing wolves (Table 16) is higher than earlier estimates, an examination of responses for bear sightings lends some support that visitors are

reporting their wildlife sightings accurately. Table 17 shows the percent of visitors reporting seeing bears, by season. As would be expected, the percent of reported sightings drops near zero in the winter season (when bears are hibernating). Additionally, since the winter season extends to April 1, those few bear sightings reported in winter are indeed possible.

Table 17. Percent of 2005 Yellowstone Visitors Reporting Seeing Black and Grizzly Bears on their Trips.

Statistic	*Spring N=495*	*Summer N=477*	*Fall N=322*	*Winter N=221*
% Seeing black bears	45.9%	31.6%	15.6%	1.4%
% Seeing grizzly	22.0%	15.2%	7.7%	0.3%

4.3 Yellowstone Visitor Trip Expenditure Patterns

Recreational travel to Yellowstone National Park includes spending by park visitors. A key measure of the significance of a regional resource such as Yellowstone to the local area economies is the amount of money visitors from outside of the local area spend in the area on their trips. For the sake of measuring local area spending, visitors were asked to list the amount of money they spent on their trips in total, as well as the amount they spent in the three states of Montana, Idaho, and Wyoming, and the amount they spent in the local GYA area. Figure 7 shows average total, three-state (Montana, Wyoming, and Idaho), and GYA spending by nonresident summer visitors. Nonresidents are defined as visitors who do not reside in the relevant analysis area, the 17-county GYA area or the three-state. For the 17-county population 47% of total trip spending was done in the three-state area and 29% was done in the smaller local GYA region.

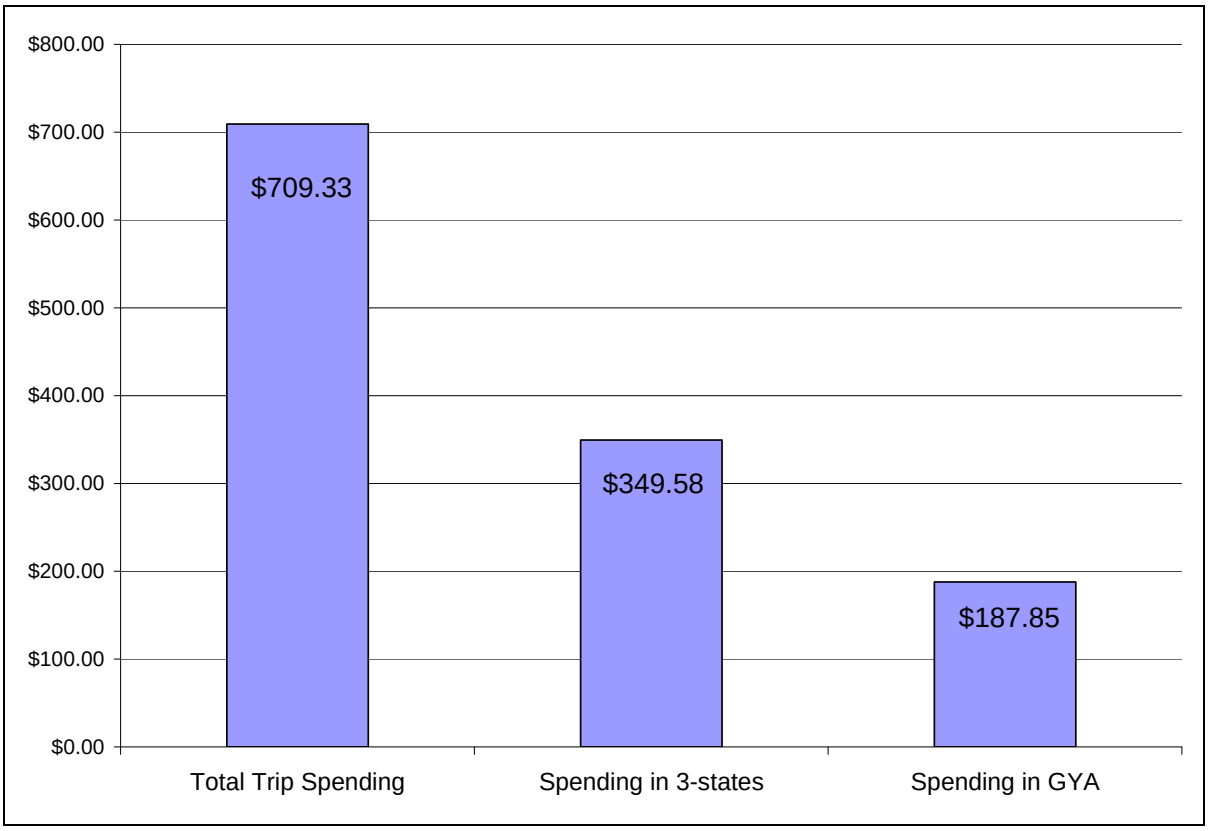

Figure 7. Summer Nonresident Trip Spending, by Area of Spending.

Table 18 shows reported average trip spending by season and residency for each of the geographic areas. As is expected, local GYA resident park visitors spend less on their trips to the park than do non-resident visitors. This pattern is consistent across seasons.

Table 18. Comparison of Visitor spending, by Season and Residency for the 17-county GYA Analysis Area.

Season / residency	*Amount spent in GYA*	*Amount spent in three-states*	*Total trip spending*	*Sample Size*
Spring – nonresident	$220.55	$320.24	$673.21	374
Spring – GYA resident	$72.87	$74.99	$105.66	70
Summer – nonresident	$187.85	$349.58	$709.33	369
Summer – GYA resident	$63.67	--	$117.28	22
Fall – nonresident	$279.56	$387.78	$762.19	241
Fall – GYA resident	$112.99	$150.03	$208.94	47

Note: winter results are only representative of wheeled access and are not presented.

When asked if they had made a purchase of wolf-related items on their trip, around 20% of visitors responded they had, as shown in Table 19. The average spent on these items was around $60, except in summer when it was much lower, around $36. Forty-three percent (winter) to 58% (summer) of visitors indicated they owned optical gear purchased primarily for observing wildlife, and the average amount spent on this gear ranged from almost $800 for summer visitors to over $1500 for North entrance winter visitors.

Table 19. Estimated Spending per Yellowstone Visitor on Wolf-related or Wolf Watching-related Items, (sample size).

Statistic	*Spring*	*Summer*	*Fall*	*Winter*
% who bought wolf-related items on trip	19.5%	19.2%	16.1%	24.0%
Average amount spent by those who bought wolf-related items	$58.63 (150)	$36.11 (159)	$61.63 (104)	$59.35 (135)
% who own optical gear purchased primarily for observing wildlife	50.4%	58.3%	47.4%	43.7%
Average amount spent on optical gear by those who purchased such gear[a]	$1,334 (340)	$790 (262)	$1,412 (227)	$1,541 (229)

Note: Winter estimate is for North entrance wheeled entries.

[a] spending on optical gear includes spending occurring outside the GYA or the 3-state region.

4.4 Net Economic Value of Yellowstone Visitation

The contingent valuation method (CVM) uses survey techniques to determine the values which people would place on traditionally nonmarket goods and services if markets did exist for these commodities. In this study, the values of two services are measured through the use of contingent valuation. Well established markets for many public land activities do not exist. Therefore, the basic problem faced in determining the economic value of services such as a trip to Yellowstone N.P. is measuring the nonmarket values. Contingent valuation has been widely applied (Mitchell and Carson 1989) and is recognized by the U.S. Water Resources Council (1983) as an appropriate method. This approach has also been designated in federal guidelines (U.S. Department of Interior 1986, 1991) as a best available procedure for valuation of damages arising in superfund natural resource damage cases. The contingent valuation method has been employed numerous times to inform state and federal agency decision makers on resource issues. Examples of applications similar to the case at hand include Boyle and Bishop (1987), and Champ et al. (1997). Walsh, Johnson, and McKean (1992) provide a literature review of recreational demand studies, including contingent valuation. For example, in Montana, CVM has been used by the state fish and wildlife agency to value coldwater fishing on major fisheries in the state (Duffield and Patterson 1991) and to examine the relationship between stream flow and recreation values on the Bitterroot and Bighole Rivers (Duffield et al. 1992). Additionally, federal agencies have used CVM to inform decision makers in several large-scale Environmental Impact Statements on wildlife issues such as wolf reintroduction to Yellowstone National Park (U.S. Fish and Wildlife Service 1994), and reintroduction of grizzlies to central Idaho and western Montana (U.S. Fish and Wildlife Service 2000). Other major Federal actions that rely on CVM include the decision to modify operations of Glen Canyon Dam, which was operated as a peaking facility and impacted downstream recreation and NPS resources in the Grand Canyon. Additionally, CVM was the basis of the State of Alaska's claim against Exxon in the *Exxon Valdez* oil spill case, which settled for $1 billion.

The essence of the CVM approach is to ask individuals their willingness to pay for a given service or commodity (WTP) contingent on their acceptance of a hypothetical but plausible and realistic payment situation that could range from a vote in a referendum to a decision to make a donation. The application of the CVM involves three elements: 1) a description of the resource which is to be valued; 2) the "payment vehicle," or method by which the respondent will pay for the resource; and, 3) the "question format" or specific method by which the value of the resource will be elicited. We will discuss how each of these elements is addressed in turn.

In the 2005 Yellowstone Visitor Survey, respondents were asked two specific contingent valuation questions: 1) how they value their overall trip to Yellowstone, and 2) how they value protection of wolves in the Yellowstone ecosystem.

A feature of all CVM applications is the method by which the resource value is elicited from respondents. There are several basic genres of CVM elicitation techniques including payment card CVM questions and dichotomous choice CVM questions. In the payment card CVM respondents are asked to identify the maximum amount they would be willing to pay for a

good or resource from a list of amounts presented to them in the survey. In the dichotomous choice method, respondents are asked a simple "yes" or "no" question: whether they would pay a specified amount for the specified good or resource. This study utilized both the payment card CVM and the dichotomous choice CVM in the current trip valuation question. The purpose of using both formats was to contribute to the economics literature by testing for the effect of question format in estimating values.

4.4.1 Net Economic Value of Trips to Yellowstone National Park

One of the contingent valuation questions included in the Yellowstone National Park visitor survey asked respondents their group's willingness to pay an additional amount in expenses to have made their trip to the GYA. The text of one version of the CV question reads:

> The costs of visiting and recreating in national parks change over time. For example, gas prices and other travel costs rise and fall.
>
> What is the largest <u>increase</u> in travel costs the group traveling in your vehicle would have paid to visit Yellowstone National Park during this trip? (Circle the amount)

$0 (would not pay more)	$10	$20
$30	$55	$80
$130	$180	$230
$480	$1000	$2000

The example above utilized a "payment card" question format, and a "travel cost" payment vehicle. There were methodological differences in the way the question was asked of different samples of visitors: 1) differing payment vehicles (increased park entry fees v. increased travel costs), and 2) differing question formats (payment card v. dichotomous choice). Table 20 shows the range of estimated group willingness to pay estimates derived from use of the increased travel cost payment vehicle (this is the vehicle used most frequently in previous Yellowstone National Park visitor CVM studies). These estimated values range from about $100 to $300 per trip, per visitor group. These findings are consistent with the economics literature, which generally shows that WTP measured by dichotomous choice questions is greater than that measured by payment card (Champ and Bishop 2006).

Table 20. Estimated Net Willingness to Pay per Person for a Trip to Yellowstone, by Season and Estimate

Estimate	*Spring N=418*	*Summer N=328*	*Fall N=286*	*Winter N=173*
Low estimate (payment card)	$161	$184	$140	$105
High Estimate (dichotomous choice)	$300	$297	$264	$201
Note: winter estimate is for North Entrance only				

4.4.2 Net Economic Value of Wolf Habitat Protection

A primary objective of the 2005 Yellowstone Visitor Survey was to measure attitudes and values associated with wolf presence in the Greater Yellowstone Area. The primary survey opinion question on support for wolf reintroduction asked visitors:

> Do you personally favor the re-introduction of wolves that has occurred in Yellowstone National Park?

Respondents had the choice to respond "No", "Yes", or "Not Sure." A similar question was also asked of visitors in the 1991 park visitor survey (Duffield, 1992) prior to wolf re-introduction. Table 21 shows the percent of Yellowstone visitors in each season who responded to each option associated with the question on support for wolf re-introduction. Across the year a strong majority of visitors support the reintroduction. Also across seasons, stated opposition to reintroduction is quite low (less than 20%).

Table 21. Percent of Yellowstone Visitors Favoring Wolf Reintroduction, by Season

	Spring N=485	*Summer N=471*	*Fall N=318*	*Winter N=219*
Favor Reintroduction	61.5%	61.4%	67.7%	66.3%
Oppose Reintroduction	15.9%	16.0%	15.0%	18.9%
Not Sure	22.6%	22.6%	17.3%	15.9%

The summer 1991 survey of Yellowstone visitors on the issue of wolf reintroduction also asked respondents whether they favored the reintroduction of wolves to the park. In that survey 68.1% of all respondents said they favored the proposed reintroduction. Because of a difference in the response categories between the two surveys, direct comparison of the

response proportions is not possible. While the 1991 survey offered only the options to respond "Yes" or "No", the 2005 survey added a "Not Sure" category. As can be seen from Table 21 a substantial proportion of respondents to the 2005 survey chose the "Not Sure" response (16% to 23% across the seasons). Overall, however, it appears that the 2005 response percentage for those favoring reintroduction is in the same range as for the 1991 survey, given the difference in question formats.

Table 22 shows the percent of respondents to the 1991 and 2005 surveys who support reintroduction for a number of visitor subgroups. The 2005 survey responses are presented in two ways: 1) the percent of all respondents in the group who favor reintroduction, and 2) the percent of those who either responded "Yes" (favor) or "No" (don't favor) to the question. Table 22 shows that among hunters and farmers/ranchers, support for reintroduction has fallen since 1991, even though overall visitor support has remained relatively stable.

Table 22. Comparison of Percent of Visitors Favoring Wolf Reintroduction between 1991 and 2005, by Sub-population.

Population Sub-sample	*Percent "Yes" Favor Reintroduction*		
	1991 Study	*2005- all summer respondents*	*2005 - "not sure" responses excluded*
Big game hunters	66.3%	40.5%	53.4%
Non-hunters	75.6%	66.2%	85.4%
GYA hunters	66.0%	48.2%	52.0%
other hunters	66.1%	38.0%	53.3%
Farmers or ranchers	55.6%	21.2%	27.7%
Nonranchers	74.0%	65.4%	84.6%
Males	72.4%	64.6%	81.2%
Females	73.5%	55.4%	78.9%
High School	61.6%	48.2%	59.2%
Some college	74.4%	57.5%	76.3%
College graduate	78.4%	64.9%	87.6%
Post graduate	77.8%	65.1%	80.0%

Table 23 shows the results of an explanatory model that identifies visitor characteristics associated with support for wolf recovery for the sample of summer Yellowstone National Park visitors. The table shows both a complete model specification with all variables that were initially included in the specification, and a reduced specification using only those variables that were shown to be statistically significant. Overall, the model does a very good job of explaining support for reintroduction correctly predicting the responses to the question

on favoring reintroduction over 92% of the time based on the responses to the other explanatory variables. The reduced model shows that the more a person agrees with the statement "I derive satisfaction from just knowing wolves are present in Yellowstone" the more likely they are to support the reintroduction. Additionally, visitors who agreed with the statement "I will get less enjoyment out of the park to the extent there are reduced numbers of elk, moose, and bison" were less likely to support reintroduction. Three other statistically significant variables in the reduced model showed that GYA residents were more likely to support reintroduction than were nonresidents. Less expected is the finding that the greater the number of trips a visitor took to the park in 2005, the less likely they were to support reintroduction. Finally, men were more likely to oppose reintroduction than were women respondents.

Table 23. Estimated Multivariate Model of Yellowstone Summer Visitor Support for Wolf Reintroduction.

	Full Model		*Reduced Model*	
Variable / Statistic	*Coefficient*	*p-value*	*Coefficient*	*p-value*
intercept	-22.11	0.018	-12.33	0.0001
Ln(EXIST)	11.08	0.001	10.15	0.0001
Ln(SEE)	-0.44	0.723		
Ln(REDUCE)	-2.49	0.006	-2.638	0.0032
Ln(TRIPS)	-3.66	0.019	-3.218	0.011
Ln(EDUCATE)	-0.17	0.846		
Ln(INCOME)	0.78	0.259		
REGION	4.14	0.005	4.022	0.001
GENDER	1.69	0.081	1.319	0.086
HUNTER	-0.09	0.947		
Sample	193		193	
Percent Correct Predictions	92.5%		92.2%	

A second contingent valuation question asked of survey respondents was included in the spring, summer, and fall entrance sample survey. This question was designed to measure the total economic value, including passive use value, associated with wolf recovery in the GYA outside Yellowstone National Park. Earlier studies focused on passive use values associated with wolf recovery in the entire Yellowstone area. However, recovery has clearly been achieved within Yellowstone National Park where wolves are fully protected. This recovery is demonstrated by the USFWS decisions to transfer management of the wolves within Idaho and Montana to those states. The remaining issue is wolf management outside of protected areas. This question sought to determine the amount, if any, visitors would be willing to contribute to a fund to either 1) support wolf recovery in areas adjoining the park, or 2) help to offset the costs of wolf recovery to local ranchers. The two versions of this CVM question both proposed to use donations to support a fund to compensate ranchers for wolf

depredation of livestock, however the wording of the different questions (shown below) emphasized different aspects of this program.

1: Viability of Wolves outside the Park

An economic consequence of having wolves in Yellowstone National Park is that some of the wolves that disperse out of the park will prey on domestic livestock. To help overcome this problem, private conservation organizations have established **funds to compensate livestock owners** for any wolf predation. Suppose that a necessary condition for wolves to exist in areas adjoining the park is that ranchers are compensated for their losses. By having a larger overall wolf population and range in the Yellowstone wolf recovery area, the long term viability and genetic health of this population, both inside and outside of the park, is improved. Hypothetically, if you were contacted within the next month, **would you choose to donate $ _____** to support wolf recovery in areas adjoining the park?

2: Rancher Compensation Question

An economic consequence of having wolves in Yellowstone National Park is that some of the wolves that disperse out of the park will prey on domestic livestock. To help overcome this problem, funds could be administered by local ranchlands organizations to compensate livestock owners for any wolf predation. Hypothetically, if you were contacted within the next month, **would you choose to donate $_____** to help offset the costs of wolf recovery to area ranchers?

Table 24 shows an estimated model of willingness to pay to support a trust fund to compensate ranchers for livestock lost to wolf depredation and thus support wolf reintroduction. This model was estimated only for those who indicated they favored wolf reintroduction. Included in the estimated models was a variable indicating which version of the survey was used. The model results show that while there is consistency across seasons in that those visitors answering the second version of the CV question (number 2, above) had a lower willingness to pay than those answering version 1 of the question. This variable was only marginally significant, however, in the spring and summer samples, and not at all statistically significant in the fall sample. Overall, the estimated net willingness to pay to support wolf reintroduction for ranged from approximately $22 to $40. This compares to the 1991 study of passive use values for park visitors for wolf recovery in the entire GYA including Yellowstone National Park of $65.14, or in 2005 dollars $93.40.

Table 24. Estimated Models of Willingness to Pay to Support a Trust Fund for Wolf Protection.

	Spring		*Summer*		*Fall*	
Statistic	*Coefficient*	*p-value*	*Coefficient*	*p-value*	*Coefficient*	*p-value*
Intercept	1.1369	0.0498	0.5192	0.3472	0.9908	0.091
Log(BID)	-0.675	0.0001	-0.5488	0.0002	-0.568	0.0003
Question	-0.455	0.1497	-0.3807	0.1997	-0.0944	0.7684
% Concordant	0.638		0.585		0.617	
Sample size	304		362		229	
Truncated Mean WTP- Rancher compensation question	$ 22.97		$ 21.89		$ 37.76	
Truncated Mean WTP- Wolf viability outside the park	$ 32.78		$ 29.89		$ 40.52	

4.5 Characteristics of Lamar Valley Visitors

As discussed in Section 3, above, there were two separate visitor populations that were surveyed through the 2005 Yellowstone visitor survey: visitors entering the park through the main park entrance stations, and visitors that were parked along the primary Lamar Valley wolf watching area. This section discusses a selection of survey results from the Lamar Valley sample and compares those results to the entrance station results.

It was anticipated in designing the survey sampling plan that the visitors intercepted in the Lamar Valley would tend to be more interested in wildlife viewing in general and wolf watching in particular than the typical Yellowstone visitor. This expectation was confirmed by results from the Lamar sample surveys.

Table 25 shows the responses of visitors sampled in the Lamar Valley to several key questions related to wolves in the park and wolf reintroduction.

Table 26 shows a comparison of responses to these questions between visitors sampled at entrance stations during the summer season and those sampled in the Lamar Valley during the summer season. Clearly, by every measure presented in the table those visitors sampled in the Lamar are more interested in wildlife viewing activities in general and wolf watching in particular and are more supportive of wolf recovery than those visitors sampled randomly at park entrance stations. These results are consistent with findings by Montag et al. (2005) that Lamar Valley visitors are focused on wildlife observation.

Table 25. Lamar Valley Visitor Sample Responses to Key Wolf-related Survey Questions

Statistic	*Spring N=108*	*Summer N=76*	*Fall N=95*	*Winter N=152*
Percent of visitors listing "wildlife viewing" as the primary purpose for their trip	71.7%	64.3%	60.9%	71.0%
Percent saying seeing or hearing wolves was one of the reasons for visiting Yellowstone	83.3%	86.4%	85.3%	87.2%
Percent of those above who would not have made the trip if wolves were not present in the park	16.8%	15.0%	12.1%	30.7%
Percent who favor wolf reintroduction to the park	87.1%	87.7%	86.0%	91.1%

Table 26. Comparison of Summer Sample Lamar Valley and Entrance Station Visitor Responses to Key Wolf-related Questions.

Statistic	*Lamar Sample N=76*	*Entrance Sample N=477*
Percent of visitors listing "wildlife viewing" as the primary purpose for their trip	64.3%	30.3%
Percent saying seeing or hearing wolves was one of the reasons for visiting Yellowstone	86.4%	50.0%
Percent of those above who would not have made the trip if wolves were not present in the park	15.0%	7.18%
Percent who favor wolf reintroduction to the park	87.7%	61.4%

5.0 Regional Economic Impact Analysis

Section 5 of this report provides current estimates of a range of economic impacts associated with Yellowstone wolf reintroduction. These include estimates of Yellowstone visitor spending attributable to wolf presence in the park, estimates of economic losses due to wolf predation of livestock, and losses due to wolf predation of big game herds.

5.1 Percent of Yellowstone National Park Visitation Attributable to Wolves

The economic analysis associated with the Yellowstone area wolf reintroduction EIS included an estimate of how many new recreational visits per year would result from reintroduction of wolves to the park. The 2005 survey included a series of questions designed to allow the estimation of the percent of current Yellowstone National Park visitation attributable to wolf presence in the park. Survey respondents were asked the following questions:

> Was the possibility of seeing or hearing **wolves** one of the reasons for your visiting Yellowstone National Park on this trip?
> ⑧ NO ⑧ YES
>
> **IF YES**, would you still have chosen to take this trip even if **wolves** were not present in the Yellowstone National Park? (please check one)
> ⑧ DEFINITELY YES ⑧ DEFINITELY NO ⑧ NOT SURE

Table 27 shows the percentage of visitors who responded that one of the reasons for their trip to Yellowstone National Park was the possibility of seeing or hearing wolves, what percentage of visitors would not have come had it not been for the presence of wolves in Yellowstone, and the calculated percentage of park visitation attributable to wolves. The estimated percentage of Yellowstone visitation attributable to wolves ranges from 1.5% in the spring season to nearly 5% in the fall.

Table 27. Yellowstone Visitor Responses to Contingent Behavior Questions on the Importance of Wolf Presence in their Decision to Visit the Park.

Statistic	*Spring N=495*	*Summer N=477*	*Fall N=322*	*Winter[1] N=221*
Percent responding that "the possibility of seeing or hearing wolves was one of the reasons for visiting Yellowstone N.P. on this trip."	48.9%	50.04%	55.7%	35.9%
Percent of those above who said they would definitely not have taken trip if wolves were not present in Yellowstone N.P.	3.1%	7.18%	8.88%	10.2%
Percent of total visitation attributable to the presence of wolves	1.49%	3.59%	4.95%	3.66%

[1] Winter season statistics are from 1998-99 winter Yellowstone National Park survey results asking the same question.

5.2 Economic Impact to GYA of Increased Visitation Due to Wolf Presence

There are several primary pieces of information needed to estimate the contribution of Yellowstone wolf presence to park visitation and visitor spending:

1) Since only spending by visitors coming from outside the 17-county GYA area is considered, the proportion of visitation from outside the GYA is necessary.

2) The average spending per trip within the GYA by these non-residents is needed.

3) The percent of non-residents who would not have visited without the presence of wolves.

4) Total annual recreational visitation for the park.

Table 18 shows the reported distribution of visitor spending between geographic areas by season. On average, for the summer season sample, visitors from outside the Greater Yellowstone Area spent an average of $709 per person on their trips which included visits to Yellowstone National Park. Of this amount, about 49 % was reported as being spent within the three-state Idaho, Montana, and Wyoming region, and about 27% being spent in the 17-county Greater Yellowstone area. In estimating the impact of non-resident visitor spending on the GYA counties, it is this later amount (that spending within the GYA) that is relevant in calculating local-area expenditure impacts.

Estimation of the percent of Yellowstone National Park visitors who would not have visited the park without the presence of wolves is derived above in Table 27. This estimation, however, was for all Yellowstone National Park visitors. In order to estimate the local (GYA) economic expenditure impact of those visitors who would not travel to Yellowstone in the absence of wolves only the responses of those visitors living outside the GYA counties are considered. The following estimation of the GYA expenditure impact of wolf-dependent park visitation is based on the responses of visitors who do not reside in the GYA. For those park visitors coming from outside the GYA, between 2.5 percent and 4.5 percent (depending on the sample season) said they would not have made the trip if the opportunity to hear or see wolves had not been available to them in the park. As noted, the 2005 visitor survey is stratified by season of the year. Table 28 details the estimation of annual out-of-area visitor spending within the 17-county GYA that can be attributable to the presence of wolves.

As Table 28 shows, it is estimated that approximately $22.5 million in direct non-resident spending within the GYA is directly attributable to the presence of wolves in the park. Based on the estimated variability in the estimates used, the 95% confidence interval associated with estimated wolf-related visitor spending ranges from $14.5 to $30.6 million annually.

Table 28. Estimated Total 2005 Direct Spending Impact of Wolf Presence in the 17-county GYA Economy.

Statistic	*Spring*	*Summer*	*Fall*	*Winter*
Total recreational visitation to Yellowstone	382,598	1,819,798	547,777	85,478
% of visitors from outside the 17-county GYA	83.3%	92.02%	82.5%	82.2%[a]
(A) Recreational visitors from out of the GYA	318,704	1,674,578	451,916	70,289
(B) % of visitors who would not have visited without the presence of wolves	2.62%	4.58%	3.94%	3.66%[a]
(C) Average spending per visitor within the GYA by visitors from outside the GYA[b]	$220.55	$187.85	$279.55	$510.84[a]
(A) * (B) * (C) Total estimated annual GYA visitor spending attributable to wolves	$1,839,494	$14,416,720	$4,981,315	$1,314,167
Total estimated annual visitor spending in the GYA attributable to wolf presence	$22,551,697			
95% Confidence interval	$14,475,589 to $30,627,805			

[a] winter estimates utilize 1999 winter visitor survey estimates (Duffield and Neher 2000a).

[b] average spending was for all visitors from outside the analysis area. Average spending for those who only come for wolves was nearly identical, but due to a much smaller sample size, had a much higher variance.

Table 28, above, shows estimated total direct park visitor spending within the 17-county GYA by visitors from outside of the GYA that is directly attributable to the presence of wolves in the park. The analysis for the wolf reintroduction EIS examined the impact of wolf presence on park visitation and spending at the three-state level (MT, ID, and WY) rather than the 17-county GYA level. Table 29 shows the derivation of an estimate of impacts to the three-state region for comparison below to the estimate derived by Duffield (1992). In total, it is estimated that visitors coming from outside the three-state region, who are coming specifically to see or hear wolves in the park, spend $35.5 million annually.

Table 29. Estimated Three-State Direct Expenditure Impact Associated with Wolf Presence in Yellowstone National Park.

Statistic	*Spring*	*Summer*	*Fall*	*Winter*[a]
Total recreational visitation to Yellowstone	382,598	1,819,798	547,777	85,478
% of visitors from outside the three-state area	70.5%	83.68%	67.59%	82.2%
(A) Recreational visitors from out of the three states	269,770	1,522,807	370,242	70,289
(B) % of visitors who would not have visited without the presence of wolves	1.93%	4.78%	3.45%	3.66%
(C) Average spending per visitor within the three states by visitors from outside the area[b]	$361.89	$369.12	$425.50	$510.84
(A) * (B) * (C) Total estimated annual three-state visitor spending attributable to wolves	$1,885,178	$26,889,668	$5,431,916	$1,314,167
Total estimated annual visitor spending in the three states attributable to wolves	$35,520,929			
95% Confidence interval	$22,404,274 to $48,637,585			

[a] winter estimates utilize 1999 winter visitor survey estimates (Duffield and Neher 2000a).

[b] average spending was for all visitors from outside the analysis area. Average spending for those who only come for wolves was nearly identical, but due to a much smaller sample size, had a much higher variance.

5.2.1 Net Economic Value of Wolf-related Increased Visitation

As detailed in the previous section, responses by Yellowstone visitors to the 2005 visitor survey indicate that in total 105,424 visitors would not have visited the park in 2005 had wolves not been present. Table 20, above, showed estimated ranges of net economic value per trip to Yellowstone National Park by season, based on contingent valuation questions responses included in the visitor survey. The ranges of estimated WTP (willingness to pay) within seasons in Table 20 are based on estimates using the two question formats for the contingent valuation question (dichotomous choice and payment card). In total, it is estimated that the presence of wolves in Yellowstone National Park in 2005 led to increased visitation to the park resulting in additional net economic value to visitors of between $18.3 and $30.6 million (Table 30). Depending on the time of year, there may be an offsetting increase in congestion costs to visitors. Another possible offset to the WTP estimates above is the possibility that trips to see of hear wolves in the park are substituted away from other sites and activities. Analysis of the possible offsetting costs and benefits to park visitors from this national perspective is beyond the scope of this analysis.

Table 30. Estimated Yellowstone National Park Net Economic Value of Visitor Trips Resulting from the Presence of Wolves in the Park.

Estimate	*Spring N=418*	*Summer N=328*	*Fall N=286*	*Winter N=173*
Net Willingness to Pay Estimates				
Low estimate (payment card)	$161	$184	$140	$105
High Estimate (dichotomous choice)	$300	$297	$264	$201
Estimated increase in visitation due to wolf presence	8,350	76,696	17,805	3,129
Low estimated Net Economic Value ($million 2005 dollars)	$1.34	$14.11	$2.49	$0.33
High estimated Net Economic Value	$2.50	$22.78	$4.70	$0.63
Total estimated Net Economic Value	$18.28 to $30.61 million			

Note: Winter Net willingness to pay estimates are based on North Entrance wheeled traffic visitors only. Winter visitation includes over-snow visits at all entrances.

5.3 Economic Impact of Wolf Livestock Predation

Estimation of the economic impact of wolf depredation on domestic livestock in the GYA is based on data collected and published by Defender's of Wildlife related to payments from their Wolf Compensation Fund (http://www.Defenders.org). Since 1996 the average annual payments for wolf depredation averaged about $27,000. In 2004 and 2005, however, payments increased dramatically averaging $63,818 in these two years.

It is possible that actual livestock depredation losses due to wolves were greater than indicated by compensation payments. Wolf kills may have gone un-found or un-verified, or ranchers may have chosen not to report depredation losses to the compensation fund. For example, Montag et. al (2003) found that a majority of livestock owners (63%) in a survey of four rural communities in MT, ID, and WY felt the verification standards for compensation were too strict. A similar majority (60%) were not confident they would be compensated in the event of wolf or bear depredation. The extent to which reported losses might understate actual losses is unknown.

Table 31. Defender's of Wildlife Wolf Compensation Fund Payments and Statistics for GYA Region: 1996-2005.

Statistic	*Value*
Total Defender's of Wildlife Wolf Compensation Fund Payments (1996-2005)	$270,435
Average annual payments	$27,044
2004-2005 average payments	$63,818
Total animals compensated for	967

5.4 Economic Impact of Wolf Predation on Big Game Herds

While a substantial body of recent literature on wolf-prey modeling in the Yellowstone ecosystem exists, the large majority of this work focuses on the Yellowstone Northern Range elk herd. Additionally, recent concern over wolf predation of big game has centered on this elk population and associated hunter permits and harvest. Figure 8 and Table 32 show the Northern herd elk population levels along with the levels of harvest in the late-season elk hunt, and in recent years, wolf population in the northern range. While elk populations are at 30-year lows, there have been substantial variations in this population, both following and prior to wolf reintroduction.

The prediction in the 1994 EIS was that reduced hunter harvest of elk, mule deer, and moose in the Greater Yellowstone Recovery Area could result in foregone hunter benefits of $187,000 to $465,000 per year. The first estimate is specific to Yellowstone's northern range and associated hunting districts in Montana. It was anticipated that a foregone harvest of up to 9 moose, 122 antlerless mule deer, and 280 elk in adjoining hunting districts in Montana would lead to a loss of 2,300 hunter days annually. The loss specific to elk hunting was estimated to be about $97,000 annually, or about 50% of the total value of foregone hunting opportunities. As in the original, a caveat to these estimates is that they do not account for any substitution behavior by hunters in response to changes in Gardiner late hunt opportunities. In other words, it is likely that these are overestimates of hunter losses for any given reduction in permits.

A summary of the hunter harvest data for the Gardiner late hunts is as follows. The long term average hunter harvest prior to wolf recovery was 1,014 during 1976-1994. For the period after wolf reintroduction, the average hunter harvest was actually higher at 1,372 for 1995 to 2004. Hunter success during 1995-2004 (with a mean of 65 percent and a range of 43-97 percent) was similar to success during 1976-1994 (mean of 64 percent and a range of 10 to 96 percent). However, Montana Fish Wildlife and Parks has recently been reducing antlerless permits in the late Gardiner hunt substantially from 2,882 to 1,400 during 2000 to 2004 and down to only 100 permits in 2006. However, there have been no reductions in the northern range for permits, animals harvested, or hunter success for mule deer or moose as a result of wolf restoration (White et al. 2005). The issue is interpreting the role of wolves, climate (a recent extended period of drought), and the unusually high hunter harvest levels in the last decade in explaining changes in elk populations and current hunter harvest opportunities.

In short, the primary question for our purposes is whether recent declines in elk populations are largely, moderately, or minimally due to corresponding increases in wolf numbers in the area.

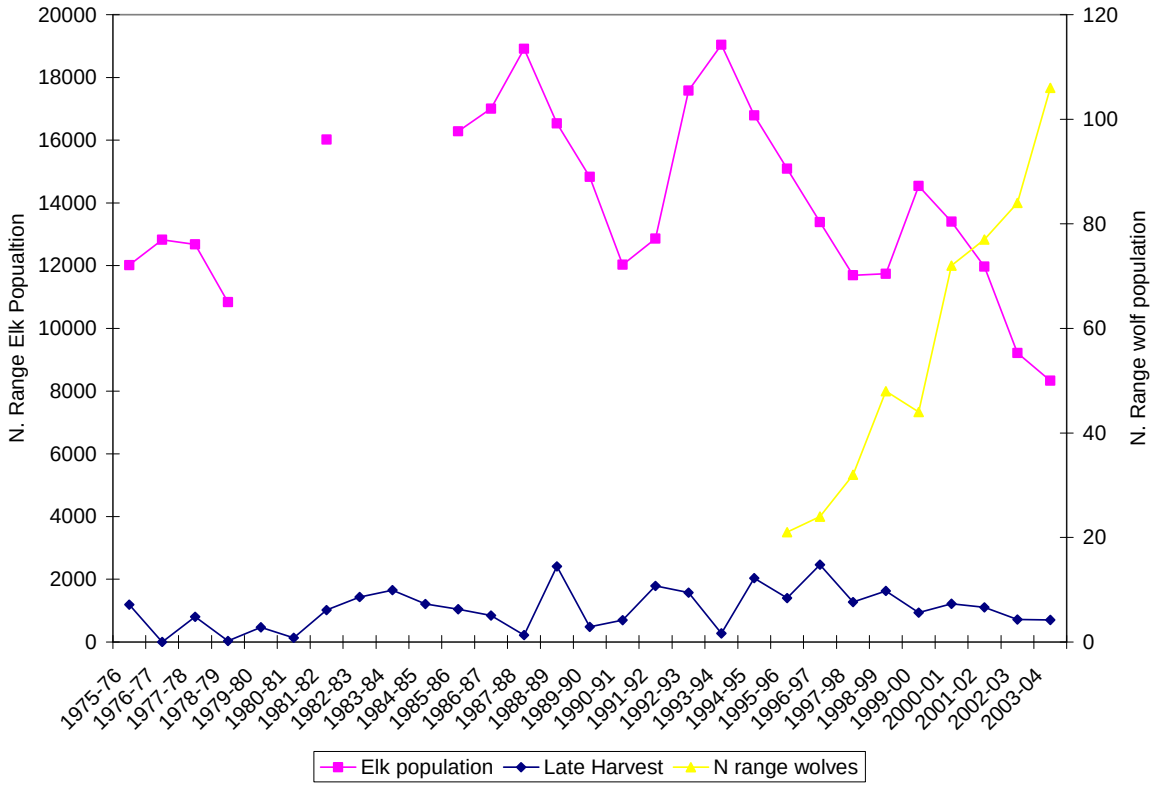

Figure 8. Time Series Plot of Northern Range Elk Populations, Late Season Elk Harvest, and Wolf Population.

Table 32 . Time Series Data, Northern Range Elk Populations, Late Season Elk Harvest, and Wolf Population.

Year	*Elk population*	*Late Harvest*	*N. range wolves*
1975-76	12,014	1,189	
1976-77	12,828	-	
1977-78	12,680	802	
1978-79	10,838	31	
1979-80		467	
1980-81		133	
1981-82	16,019	1,015	
1982-83		1,434	
1983-84		1,657	
1984-85		1,211	
1985-86	16,286	1,042	
1986-87	17,007	845	
1987-88	18,913	220	
1988-89	16,536	2,409	
1989-90	14,829	484	
1990-91	12,027	697	
1991-92	12,859	1,787	
1992-93	17,585	1,574	
1993-94	19,045	273	
1994-95	16,791	2,039	
1995-96	15,091	1,400	21
1996-97	13,391	2,465	24
1997-98	11,692	1,273	32
1998-99	11,742	1,626	48
1999-00	14,538	940	44
2000-01	13,400	1,221	72
2001-02	11,969	1,103	77
2002-03	9,215	718	84
2003-04	8,335	702	106

Source: Vucetich et al. 2005 and White and Garrott, 2005

Estimating the impact of wolf depredation on livestock in the GYA region is very straightforward, using published, detailed records of depredation fund payments to ranchers,. However, estimating impacts of wolves on big game populations is less clear-cut. There are two generally opposing views regarding the impact of Yellowstone wolves on big game (in this analysis, primarily elk) numbers. The first is that wolf predation is primarily compensatory. That is, wolves primarily take elk that would normally succumb to winter kill, disease, or old-age (Vucetich et al. 2005). Under this view Yellowstone wolves have

had little impact on Northern Yellowstone elk populations beyond that which would have occurred under no-wolf conditions.

The second view is that wolf predation of Northern Yellowstone elk is largely additive (White and Garrott, 2005). That is, wolves have preyed upon elk that by and large would not have succumbed to other causes of mortality, and thus substantially increased the rate of recent declines in elk populations.

A third, middle ground, view is that wolf predation of the Yellowstone Northern Range elk herd has been partly compensatory and partly additive (Varley and Boyce 2006). Under this view northern range elk populations have decreased due to wolf predation, but not fully to the extent that would be predicted from the number of elk killed by wolves.

5.4.1 Wolf Depredation is Largely Compensatory

In a study by Vucetich, Smith and Stahler (2005), population trends for the northern Yellowstone elk herd between 1961 and 1995 were modeled as a function of the late harvest rate, annual snowfall, and annual precipitation, and elk abundance, among other explanatory variables. The study authors then used their best model with the predictor variables of elk abundance, hunter harvest rate, annual snowfall and annual precipitation to predict elk population growth rates for the herd between 1995 and 2004 (the period following wolf reintroduction). They found that the model accounted for 64% of the variation in the elk population growth rates in the post 1995 period. The study authors' best performing model predicted that elk populations would have been expected to decline by 7.9% per year over the 1995-2004 period. Actual elk population counts have found an average 8.1% decline annually over the same 1995 to 2004 period. The conclusions of Vucetich et al. are that wolf predation of the northern elk herd since reintroduction has been largely compensatory with wolves preying upon elk that would have normally succumbed to weather, starvation, disease or hunter harvest anyway.

Under this view, wolf reintroduction has had a minimal effect on both hunter harvest and opportunity and on the northern range elk herd itself.

5.4.2 Wolf Predation is largely Additive

A study by White and Garrott (2005) examined the data on northern range elk populations and their relation to environmental and social (hunter harvest) conditions from a somewhat different perspective than did Vucetich et al. White and Garrott found that while pregnancy rates for prime age females was similar between the pre and post wolf reintroduction periods, the survival rate for prime age females were significantly lower than in earlier years when harvests were lower and wolves were absent. The authors found that prior to 2003 hunter harvests exceeded wolf depredation of elk in the northern herd, but in 2003 and 2004 wolf depredation had exceeded hunter harvest in impacting wolf numbers. This turn around was largely due to reduction in late season permits for the herd. The authors posit most predation

of adult females by wolves is likely additive (rather than compensatory) due to very high historical survival rates for prime age females at populations well below carrying capacity and in the absence of wolves.

Under this view, wolf predation was contributory to declining northern range elk populations prior to 2002, and now are a primary driver of population reductions.

5.4.3 Wolf Predation has a Moderate Impact on Elk Populations

A 2006 study of northern herd population dynamics by Varley and Boyce updated the WOLF[2] predictive population model used to predict wolf impacts on the Northern range elk populations prior to wolf reintroduction (Boyce and Gaillard, 1992). The earlier model was updated with new information on observed wolf predation behavior, age and sex structure for the elk population, and hunter harvest. The Varley and Boyce model predicts that a mean annual hunter harvest of 1,228 elk would lead to a 17% decrease in the 100-year predicted population mean. The addition of wolf predation to the model led to an additional 21% decrease in the predicted 100-year mean population to 9,713 elk.

The Varley study largely validates the predictions of the pre-reintroduction models of wolf predation, and in doing so presents a model of wolf impacts that lies between the "largely compensatory" and "largely additive" views presented above. Varley and Boyce predict that while predation has had a significant impact on northern range elk populations, both wolf predation and hunter harvest are elk density-dependent and thus are sustainable in the long run. If one accepts the Varley and Boyce estimate, actual declines in northern herd populations are in the range predicted by the 1994 EIS ($187 to $465 thousand per year (1994 dollars) or $268 to $667 thousand per year in 2005 dollars). The advantage of the Varley/Boyce model is that it allows one to project over a range of climate conditions, whereas the interpretation of recent wolf impacts are necessarily reflective of recent climactic conditions.

5.4.4 State of Wyoming Estimate of Costs of Wolf Predation

In their petition to de-list the wolf in Wyoming, the State of Wyoming (2005) provided an estimate of the fiscal and regional economic impact within Wyoming resulting from predation on big game by a population of 150 wolves in the state. The Wyoming report estimates that predation by these wolves could lead to a reduction in Wyoming big game hunters of 1,700, representing approximately $225,000 in license revenue and $2.9 million in hunter expenditures annually. These estimates, or others for the State of Wyoming, have not yet been reported in the peer-reviewed literature.

[2] The "WOLF" program was developed to project time series of wolf and ungulate populations for 100 years into the future.

6.0 Before and After: A Comparison of 1993 and 2005 Estimates of Yellowstone Wolf Economic Impacts

The Yellowstone wolf reintroduction presents a unique opportunity to compare economic estimates of the impacts of a federal action from both an *ex ante* (before) and *ex post* (after) perspective. The authors participated in the preparation of the estimates of wolf reintroduction impacts for the 1994 Yellowstone wolf reintroduction EIS. The 2005 Yellowstone survey was designed to allow the estimation of the impacts associated with wolf presence in the park now that recovery of the species is accomplished.

This section compares predictions made for the 1994 EIS with estimates of observed impacts from the 2005 survey along with other data, including records of wolf depredation on livestock, and impacts on hunter effort and harvest. Related findings are also reported in White et al. (2005) (Yellowstone Science Vol. 13(1).)

6.1 Impacts on Regional Yellowstone Visitor Spending

Prior to reintroduction Duffield (1992) estimated based on park visitor survey responses that a recovered wolf population in the park would lead to increased visitation from outside the three-state region resulting in an additional $19.35 million in direct visitor spending within the three-states. Between 1991 and 2005 the measure of consumer prices, the CPI-U has increased 43.4% (from 136.2 to 195.3). Adjusting the 1991 estimate for increases in prices leads to an inflation-adjusted 1991 estimate of $27.74 million per year. This estimate is below the 2005 estimate of $35.5 million (Table 29), but well within the 95% confidence interval for the estimate of $22.4 to $48.6 million. It appears that the 1991 methodology and estimate correspond well to current estimates of wolf impacts on visitor spending.

Table 33. Comparison of 1991 and 2005 Wolf-related Direct Visitor Expenditure Estimates

Statistic	*1991 estimate*	*2005 estimate*
Direct spending increase in three-state region attributable to wolf presence	$19.35 million	$35.5 million
Consumer price index (BLS estimate)	136.2	195.3
Estimated direct spending (2005 dollars)	**$27.74 million**	**$35.5 million**
2005 95% C.I. Lower bound estimate		$22.4 million
2005 95% C.I. Upper bound estimate		$48.6 million

6.2 Impacts on Livestock Depredation

Table 34 shows a comparison of predicted and observed livestock losses in the GYA region due to wolf predation. Three interesting points are shown in the table. First, the EIS estimates were predicated on a wolf population of 100 wolves, whereas the actual population in 2004 was 301 wolves. The second point of note is that during the period when wolf numbers were in the general range of that which was predicted for the final wolf population (the period between 1997 to 2000); the value of lost livestock due to wolves fell well within the predicted range. Finally, although depredation losses in the most recent two years (2004-2005) have been twice the upper end estimate made prior to wolf reintroduction, the wolf population in the area is three times that which the loss projections were based on. Therefore, the depredation loss levels per wolf continue to fall in the range projected prior to reintroduction.

Table 34. Comparison of Predicted and Observed Livestock Losses to Wolf Predation in the GYA.

Statistic	*1993 predicted*	*1997 - 2000*	*2004-2005*
Number of wolves in the GYA	100	80-175	301
Livestock losses due to wolf depredation[a]	$1,900 to $30,500	$11,300	$63,818

[a] Year of estimate dollars. Adjustment for inflation is not appropriate due to trends in livestock prices over period.

6.3 Impacts on Big Game Hunting and Harvest

The economic impact projections associated with big game hunting and harvest, contained in the 1994 EIS, were based on biologists' projections of the impact of wolf predation on big game populations. Table 35 shows a comparison of the EIS original projections of impacts to populations of several GYA species and current data on the observed impacts through 2004. Three of the species examined in the EIS (deer, moose, and bison) either have seen no reduction in population levels (as was predicted in the EIS), or, in the case of moose, have inadequate data to evaluate current population levels. Impacts in the Upper Gallatin Drainage are not quantified in this report.

Table 35. Comparison of EIS Predictions and Current Estimates of Big Game Populations in the GYA

Species	*EIS Prediction*	*Current Estimate*
Northern Yellowstone Elk	5-30% reduction with 27% reduction in antlerless elk Harvest	21% reduction in population
Mule Deer	3-19% reduction	No apparent reduction
Moose	7-13% reduction	No reliable estimates
Bison	< 15% reduction	Bison populations increased by 15%/year between 1998 and 2003

Sources: Yellowstone Science Vol. 13(1); Varley and Boyce (2005).

The remaining species, elk (particularly northern herd elk), has provoked substantial concern in recent years as populations have dropped dramatically at the same time as wolf numbers have risen. As described above in Section 5.4, a significant amount of research has been done on explaining recent trends in northern range elk populations in the context of wolf reintroduction. While opinions of biologists differ on the impact of wolf predation on elk numbers, the several models of elk populations have found wolves either having a minor impact on elk numbers (Vucetich et al. 2005) or having an impact similar to that predicted in the EIS (21% decrease in elk numbers, Varley and Boyce, 2006). From these studies it appears that the original EIS predictions were generally accurate for northern herd elk populations and likely significantly overstated impacts on other GYA big game species (mule deer, bison, and moose).

Across the major classes of impacts (changes in visitor spending, livestock losses, and predation losses for hunters) the EIS predictions appear to have been verified based on the 2005 visitor sample data, wolf compensation fund payments, and peer-reviewed biological assessments of big game herds. One estimate presented in the original EIS which was not replicated in the current study was that of the total use value (including passive use) for the U.S. population as a whole. This estimate was originally derived through a national phone survey of households. Such a survey was not a component of this study.

6.4 Summary Comparison of EIS Projections and Current Estimates

Table 36 presents a comparison of the economic forecasts of likely impacts associated with wolf reintroduction in Yellowstone with current estimates. Overall, it appears that the economic predictions made in the original EIS analysis were relatively accurate. In terms of projections of changes in park visitation, the current estimated percentage increase due to wolf presence is somewhat lower than predicted (+3.7% estimated v. +4.93% predicted). However, the 1994 predictions were based on a survey of summer visitors to the park and the

current estimate of the percent of summer visitation due to wolf presence is +4.78%, very similar to the EIS predictions.

Regarding changes in visitor spending in the local economy due to wolf presence, the current estimate of +35.5 million (confidence interval of $22.4 to $48.6 million) is consistent with the 1994 EIS estimate of +27.7 million (2005 dollars).

For the issue of wolf depredation of livestock, the EIS estimates were based on assumptions of a recovered wolf population of 100 wolves. Depredation loss levels during the period when wolf numbers were near predictions were consistently below predicted losses. In 2004 and 2005 when wolves numbered over 300, losses were twice the high-end estimate of losses predicted in the EIS.

One of the most controversial issues currently surrounding wolf recovery in the GYA is that of big game predation and impacts on hunter opportunity and harvest. A review of literature associated with wolf impacts on the northern Yellowstone elk herd shows a divergence of views on the impact wolf predation has had. Two peer-reviewed models of northern herd elk populations, however, have shown the impact of wolves on elk numbers to be either consistent with or below the impact predicted in the EIS.

Table 36. Comparison of EIS Projections and Current Estimates of Wolf Economic Impacts. (dollar figures are in 2005 dollars)

Estimate	EIS Projection	Current Estimate	Comparison
% change in visitation from outside the three-state region due to wolf presence	+4.93 %	+3.7 %	Current estimated is lower than projected but current estimated summer (+4.78%) is consistent with 1991 summer projection.
% change in visitor spending in the Region by out-of-region visitors due to wolf presence	+$27.7 million	+35.5 million	Estimates are consistent with the EIS estimate falling well within the estimated 95% confidence interval of the current estimate.
Annual wolf depredation of livestock	$1900 - $30,500	$63,818	2004 and 2005 losses are roughly twice the maximum projected. However, wolf numbers are more than 3 times projections.
Annual wolf predation losses to big game hunters	$187,000 to $464,000	Recent peer-reviewed estimates of impacts to big game indicate consistency with EIS projections. State of WY estimate of reduced hunter spending in de-listing petition (~$2.9 million) implies EIS understated costs.	

7.0 Study Limitations and Future Research

Any study of human behavior is subject to unforeseen real-world events that can frustrate the most carefully designed study protocols. This yearlong study of Yellowstone National Park visitors was no exception. The landslide along the Beartooth highway that closed one access to the North East Entrance to the park for a significant portion of 2005 likely skewed visitation to the park from what would be seen in other more representative years. Additionally, the park winter use management policy was still somewhat in flux during the survey year, and recent changes in winter permitting and access left the researchers with limited ability to sample over-snow visitors. Finally, during some high use summer periods entrance personnel found it necessary to relax the strict sampling protocol and increase the sample interval so as not to unreasonable delay traffic into the park.

The primary limitation of this study is found in the winter season estimates. These estimates are applicable only to North Entrance visitors, as that entrance was the only one effectively sampled during winter. Where estimates were needed for winter visitors, estimates were used from the 1999 survey of Yellowstone National Park winter park visitors (Duffield et. al 2000a).

One population that was sampled for the wolf reintroduction EIS but not in the 2005 study was the general population of the local area, the region, and the nation. These populations were originally sampled to derive estimates of the passive use values which the general population attached to wolf presence in the park. In order to perform an *ex post* analysis of this economic value, a future study could undertake a national household phone survey to compare current estimates of Yellowstone area passive values associated with wolves with those estimated in 1992.

References

Boyce, M. and J. Gaillard. 1992. Wolves in Yellowstone, Jackson Hole, and the North Fork of the Shoshone River: Simulating Ungulate Consequences of Wolf Recovery, In Varley, J., Brewster, W. (Eds.), Wolves for Yellowstone? A Report to the United States Congress, vol 4, Research and Analysis, National Park Service, Yellowstone National Park, Wyo. Pp. 4/71-4/111.

Boyle, Kevin J. and Richard C. Bishop. 1987. Valuing Wildlife in Cost-Benefit Analysis: A Case Study Involving Endangered Species. Water Resources Research 23(5): 943-950.

Cameron, Trudy Ann, and Daniel D. Huppert. 1989. "OLS versus ML Estimation of Non-market Resource Values with Payment Card Interval Data." Journal of Environmental Economics and Management 17:230-246.

Champ, Patricia A., Richard C. Bishop, Thomas C. Brown, and Daniel W. McCollum. 1997. Using Donation Mechanisms to Value Nonuse Benefits to Public Goods. Journal of Environmental Economics and Management 33:151-162.

Champ, P. and R. Bishop. 2006. "Is Willingness to Pay for a Public Good Sensitive to Elicitation Format?" Land Economics 82(2) 162-73.

Defenders of Wildlife Compensation Fund Data. http://www.defenders.org

Dillman, D. 2000. Mail and Internet Surveys: the Tailored Design Method, New York. John Wiley and Sons.

Duffield, John. 1992. An Economic Analysis of Wolf Recovery in Yellowstone: Park Visitor Attitudes and Values. Report for Yellowstone National Park.

Duffield, J., D. Patterson, and C. Neher. 1994. Wolves and People in Yellowstone: A Case Study in the New Resource Economics. Report to the Liz Claiborne and Art Ortenberg Foundation.

Duffield, John W., Thomas C. Brown and Chris J. Neher. 1992. Recreation Benefits of Instream Flow: Application to Montana's Big Hole and Bitterroot Rivers. Water Resources Research. 28(9):2169-2181.

Duffield, John W. and David A. Patterson. 1991. Field Testing Existence Values: An Instream Flow Trust Fund for Montana Rivers. AERE contributed paper session, ASSA meetings New Orleans, January.

Duffield, John W. and David A. Patterson. 1992. Field Testing Existence Values: Comparison of Hypothetical and Cash Transaction Values in R. Bruce Rettig, ed., Benefits and Costs in Natural Resource Planning, Oregon State University.

Duffield, John, David Patterson and Christopher Neher. 1999. Evaluation of the National Park Service Fee Demonstration Program: 1998 Visitor Services. Washington, DC: National Park Service.

Duffield, John, David Patterson, and Christopher Neher. 2000c. Final Report. National Telephone Survey of Attitudes toward Management of Yellowstone National Park. Denver: National Park Service.

Duffield, John and Chris Neher. 1996. Economics of Wolf Recovery in Yellowstone National Park. Trans. 61st No. Am. Wildl. and Natur. Resour. Conf. (1996): 285-292.

Duffield, John and Chris Neher. 2000a. Final Report. Winter 1998-99 Visitor Survey: Yellowstone N.P., Grand Teton N.P. and the Greater Yellowstone Area. Denver: National Park Service.

Duffield, John, David Patterson, and Christopher Neher. 2000b. Final Report. Yellowstone National Park Visitor Survey: Summer 1999. Denver: National Park Service.

Duffield, J., D. Patterson, and C. Neher. 1999. Evaluation of the National Park Service Fee Demonstration Program: 1998 Visitor Surveys. Washington, DC: National Park Service.

Duffield, J., D. Patterson, and C. Neher 2005. Interim Data from 2005 Yellowstone N.P. Visitor Survey. Yellowstone Park Foundation, Bozeman, MT.

Duffield, J. 1997. "Nonmarket Valuation and the Courts: The Case of the Exxon Valdez." Contemporary Economic Policy. V. XV. Pp. 98-109.

U.S. Environmental Protection Agency (U.S. EPA). 2000. Guidelines for Preparing Economic Analyses. EPA 240-R-00-003.

Fall, J., D. Holen, B. Davis, T. Krieg, and D. Koster. 2006. "Subsistence Harvests and Uses of Wild Resources in Iliamna, Newhalen, Nondalton, Pedro Bay, and Pork Alsworth, Alaska." Technical Paper 302. Division of Subsistence, Alaska Department of Fish and Game. Juneau, Alaska.

Hoehn, J., and A. Randall. 1989. "Too Many Proposals Pass the Benefit Cost Test." American Economic Review. Pp.544-551.

Krutilla, J. 1967. "Conservation Reconsidered." American Economic Review.

Mitchell, R.C., and R.T. Carson. 1989. Using Surveys to Value Public Goods: the Contingent Valuation Method. Resources for the Future, Washington, D.C. 463pp.

Montag, J., M. Patterson, and W. Freimund. 2005. The Wolf Viewing Experience in the Lamar Valley of Yellowstone National Park. Human Dimensions of Wildlife 10:273-284.

Montag, J., M. Patterson, and B. Sutton. 2003. Political and Social Viability of Predator Compensation Programs in the West. University of Montana School of Forestry. Missoula, MT. 140 pp.

National Research Council. 2005. Valuing Ecosystem Services: Toward Better Environmental Decision Making. National Academy Press, Washington, D.C.

National Park Service Visitation Statistics. http://www2.nature.nps.gov/mpur/reports/reportlist.cfm

U.S. Bureau of the Census. 2006. http://quickfacts.census.gov/

U.S. Fish and Wildlife Service. 1994. The Reintroduction of Gray Wolves to Yellowstone National Park and Central Idaho: Final Environmental Impact Statement. Helena, MT.

U.S. Fish and Wildlife Service. 1997. Grizzly Bear Recovery in the Bitterroot Ecosystem: Draft Environmental Impact Statement.

Randall, A. and J. Stoll. 1983. "Existence Value in a Total Valuation Framework." IN Managing Air Quality and Scenic Resources at National Parks and Wilderness Areas. (Rowe and Chestnut, Eds. 1983).

Smith, D. 2005. Ten Years of Yellowstone Wolves 1995-2005: an Intimate Account of the Yellowstone Wolf Story. Yellowstone Science Vol. 13(1) pp. 7-21.

State of Wyoming, Office of the Governor. 2005. Petition to Revise the Listed Status of the Gray Wolf. Petition submitted to the U.S. Fish and Wildlife Service June 28, 2005.

U.S. Environmental Protection Agency (U.S. EPA). 2000. Guidelines for Preparing Economic Analyses. EPA 240-R-00-003.

U. S. Department of Interior, Water Resources Council. 1983. Economic and environmental principles for water and related land resources implementation studies. U. S. Government Printing Office, Washington, D. C. 137pp.

U.S. Water Resources Council. 1983. "Economic and Environmental Principles for Water and Related Land Resource Implementation Studies." U.S. Govt. printing Office, Washington, D.C.

Varley, N. and M. Boyce. 2006. Adaptive Management for Reintroductions: Updating a Wolf Recovery Model for Yellowstone National Park. Ecological Modeling 193 (2006) 315-339.

Vucetich, J., D. Smith, and D. Stahler. 2005. Influence of Harvest, Climate and Wolf Predation on Yellowstone Elk, 1961-2004. OKIOS 111: 259-270.

Walsh, R., J. Loomis, and R. Gillman. 1984. "Valuing Option, Existence, and Bequest Demands for Wilderness." Land Economics, Vol. 60, No. 1, pp. 14-29.

Walsh, R, R. Bjonback, D. Rosenthal, and R. Aiken. 1985. "Public Benefits of Programs to Protect Endangered Wildlife in Colorado, Symposium on Issues and Technology in Management of Impacted Western Wildlife." Thorne Ecological Institute, Glenwood Springs, CO.

Walsh, M. and G. Poe. 1998. "Elicitation Effects in Contingent Valuation: Comparisons to a Multiple-bounded Discrete Choice Approach." Journal of Environmental Economics and Management 36(2): 170-185.

Ward, K. and J. Duffield. 1992. Natural Resource Damages: Law and Economics John Wiley and Sons, Inc.

Weisbrod, B. 1964. "Collective Consumption Services of Individual Consumption Goods." Quarterly Journal of Economics. 78 pp. 471-477.

Weitzman, M.L. 2001. Gamma Discounting. American Economic Review 91(1): 260-271.

White, P. and R. Garrott. 2005. Northern Yellowstone Elk after Wolf Restoration. Wildlife Society Bulletin 2005, 33(3):942-955.

White, P., D. Smith, J. Duffield, M. Jimenez. T. McEneaney, and G. Plumb. 2005. Yellowstone After Wolves, Environmental Impact Statement Predictions and Ten-Year Appraisals. Yellowstone Science Vol. 13(1) pp. 34-41.