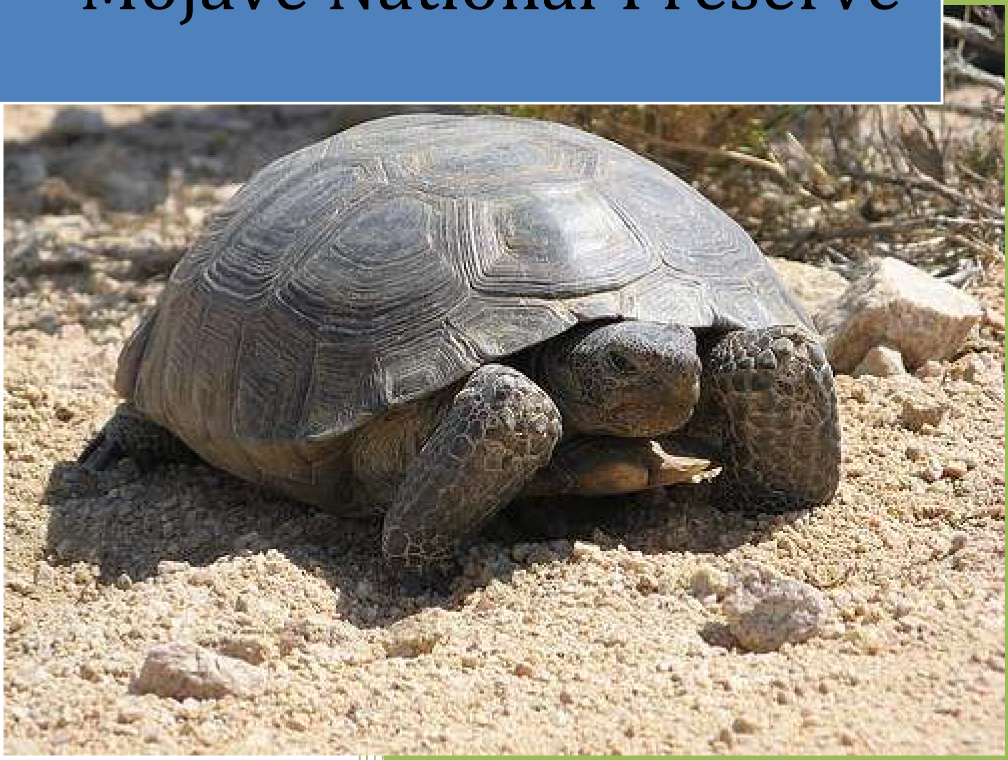
2009

Sustainable Transit Feasibility Study for the Mojave National Preserve



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Executive Summary

With the recent renovation of Kelso Depot located in the heart of Mojave National Preserve as an information center to promote tourism, there has been renewed interest in revitalizing the depot as a transit destination from Barstow.

The purpose of the study is to investigate the sustainability of several alternative transit systems from an environmental perspective as well as an economic one where possible.

A field visit was conducted to get a better understanding in defining the study area. Demographic information from earlier surveys was obtained to supplement the study. National parks from around the country were contacted to gather information on existing transit best practices. A survey was conducted in October, 2009 to gather information on visitors' preferences for transit.

Two competing transit options were considered, a train service or a bus service, both departing from Barstow and arriving at Kelso Depot. Shuttle alternatives for transit accessibility to the various sites within the Preserve needed to be considered. The demand for transit service was surveyed from visitors in the Preserve to relate it to different demographic factors for identifying management and marketing strategies. The air quality impact of the shift in visitors by automobile to transit was analyzed, as was a cost/benefit analysis of the transit operations.

An analysis of the survey conducted in October 2009 suggests several key findings:

1) There is a higher proportion of seniors visiting the Preserve than in earlier studies
2) There is a greater concentration of visitor activity at Kelso Depot than in earlier studies
3) The number of different activities pursued by visitors appears to have dropped by half from surveys conducted in 1997 and 2003
4) Preference for transit is positively influenced (from least to most) by the number of seniors in a group, visitors staying longer than one day, those coming from outside Southern California, those visiting MNP for the primary purpose, those seeking tourist-related activities as opposed to mobile activities such as hunting and dirt road driving, and non-repeat visitors
5) The average bus fare that visitors are willing to pay is $14 for 2 roundtrips per day service or $16 for 4 roundtrips per day; similarly the average train fare is $21 for 2 roundtrips per day service or $24 for 4 roundtrips per day
6) Approximately 44 percent of visitors would be positively influenced by an interpreter/ park ranger onboard the train or bus

7) The two primary reasons cited by visitors for not wanting to take transit are the presence of linked trips and the inconvenience of the Barstow location

Further analysis of the demand for transit resulted in estimates of 163 person-trips/day for bus service, and 314 person-trips/day for train service. The total number of vehicles displaced annually by demand for bus or train service was proportioned with existing emissions inventory. Given some broad assumptions, the conclusion is that a zero emissions "green" bus service in 2008 could have reduced mobile emissions from visitors by 10 percent, while "green" train service could have similarly reduced emissions by 19 percent.

However, these would be best case scenarios using clean technologies. If traditional diesel buses or trains were operated instead, the analysis suggests that this could even result in adverse impacts to the Preserve.

Bus and train operations were analyzed with the expected fare revenues obtained from the survey. Results indicate that a 2-roundtrip "green" train service from Barstow to Kelso Depot could potentially be both economically and environmentally sustainable, depending on some other cost factors such as intra-park shuttle service and higher costs of green technology. The train service would include a half price discount for seniors and children.

Supplementing this recommended transit service is an intra-park shuttle service with two separate tours served by a fleet of five "green" shuttle buses. The first tour handled by two shuttles would travel from Kelso Depot to the Lava Beds, Teutonia Peak Trail, and back to Kelso Depot. The second tour handled by three shuttles would travel from Kelso Depot to Kelso Dunes, Quail Basin, Vulcan Mine, Hole-in-the-Wall Center, and back to Kelso Depot. The expected headway of these tours is approximately 1 to 1.5 hours including alighting and boarding times.

Strategies to increase ridership include providing shuttle access to campgrounds in order to encourage overnight visitors who prefer to take transit into the Preserve, marketing to first time visitors, and improving signage and guide materials to draw in more visitors looking for a sightseeing experience.

Future efforts to expand on the transit survey should account for seasonal effects and include more observable variables differentiating preference between train and bus (or other alternatives) that include fare costs and accessibility measures such as travel time.

INTRODUCTION

Study Purpose

The objective of this project is to conduct a feasibility, marketing, and tourism study of public transportation that would connect visitors between Barstow and the Mojave National Preserve while reducing green house gas (GHG) emissions and energy consumption. The study would primarily focus on the restoration of the Barstow to Kelso Depot Railroad and/or having a clean fuel bus service from Barstow with a corresponding park shuttle system.

The result of this study should provide the National Parks Conservation Association (NPCA) with supportive material to present a rational preferred alternative for further study and design. The chosen preferred alternative should offer the best air quality, visitor access, and promotion of tourism among the different alternatives. In the case that the preferred alternative is funded for design and implementation, it is expected that a fully funded environmental impact report would be conducted to include planned projects around the study area or impacting the travel conditions – such as new developments in Las Vegas.

This initial study looks at two modes of transport – a revived train service and a bus service – under two different service frequencies and using clean versus traditional fuel technologies. This results in a study of several transit scenarios, not including the existing condition. To estimate the ridership demand for these two modes, a visitor preference survey was conducted during the month of October 2009. From the survey results, demand models were developed to provide sufficient estimates of mode shifts, fare prices, and primary demographics of the potential users.

Methodology

The methodology behind this study is composed of four main tasks: obtaining visitor demographic and transit preference data; analyzing the alternatives based on visitor demographics from multiple survey sources; conducting a transit sustainability analysis; and finally developing recommendations.

Data Sources

There are four data sources used in this report: visitor demographic studies from 1997 and 2003, an annual visitor volume survey from 2008, and a visitor preference survey conducted specifically for this study. From the 1997 and 2003 studies the following visitor demographic data was obtained: origin of visiting group, group size, activity participation, duration of stay, and sites visited within the park. From the 2008 survey, the total number of annual visitors was obtained. Finally, to measure visitor transit preference a survey was conducted specifically for this report in October 2009. The goal of this survey was to relate key demographic measures such as age, group size, and/or trip origin to a visitor's preference for using transit service. The 2009 Transit Preference Survey can be found in the appendix. The demand models developed from the 2009 survey data were then applied to the previous three studies (1997, 2003, and 2008) in an effort to estimate transit ridership.

For emission estimation, vehicle emissions were obtained from the National Park Service (NPS) Clip Tool Emissions Inventory Module. Emissions factors for buses were obtained from the Washington Metropolitan Area Transit Authority (WMATA) Life Cycle Cost and Emissions Study, which can be found in the appendix. The conversion from grams to metric tons of carbon was obtained from the Environmental Protection Agency (EPA) Greenhouse Gas Equivalencies Calculator (please see the list of references for more information on EPA and NPS emissions information). All emissions estimates and conversions were applied to the data discussed in the preceding paragraph.

Demand Modeling

Several demand models were estimated using the 2009 Transit Preference Survey and applied to the 2008, 2003, and 1997 demographic data to estimate transit ridership levels and emissions reductions. A disaggregate demand model was developed to estimate transit as a whole (i.e. bus *and* train rather than either bus or train preferences) based on demographic characteristics. The demand model was estimated simultaneously evaluating transit ridership demand as a function of the following demographics variables: whether origin of trip is in Southern California; number of senior citizens in the group; whether the visit involved mobile activities such as camping/backpacking, dirt road driving, or hunting; duration of stay; primary trip purpose; and whether the visitor is a repeat visitor. Average elasticities based on the demand model are computed to determine the sensitivity of the typical traveler to changes in policies regarding each of the variables.

Transit Sustainability Analysis

Upper and lower bounds of transit ridership determined by the demand models described above were used to determine the range of possible conversions of vehicle trips to transit trips. Combining these ranges with the stated willingness to pay (i.e. the average estimated fare) data from the 2009 Transit Preference Survey enabled us to determine the economic sustainability of providing transit service to the Preserve from the city of Barstow. Operational cost estimates were obtained from a qualitative survey of national parks with operating transit services.

Environmental sustainability of the proposed transit service was analyzed by estimating the reduced emissions that resulted from estimated switches to transit. Two scenarios were investigated: one in which the transit services would have zero emissions, and one in which they would be based on traditional fuel technologies.

Conclusions

The demand model allows for marketing analysis as it pertains to key demographic variables such as age, group size, activities, and trip purpose, for example. Critical markets/demographics can be targeted to increase transit ridership and those markets were determined with the data gathered in the 2009 Transit Preference Study. Final recommendations for future studies were made by identifying gaps in the current analysis.

EXISTING SCENARIO

Study Area

The Mojave National Preserve, located in Southern California, is bounded by Interstate 15 (I-15) at its northern edge and by Interstate 40 (I-40) on the southern edge. These two major interstates meet approximately 50 miles west of the Preserve's western boundary in the City of Barstow. The study area for this report is the area contained within the Mojave National Preserve boundaries.

Transportation Facilities

The two alternative transit modes of train and bus would operate between the City of Barstow and Kelso Depot inside the Preserve. The bus route would travel from Barstow, east on 1-40, into the Preserve via Kelbaker Road, with its final destination at Kelso Depot. The City of Barstow would be the hub for each the proposed transit modes, bus and train. As it is predicted that the selected transit modes will not have a high impact on the level of traffic along I-15 and I-40, these routes will not be included in the study area. The interior Preserve roads listed below shall be included in the study area for this report.

1. Kelbaker Road (southbound off I-15)
2. Cima Road (southbound off I-15)
3. Ivanpah Road (southbound off Nipton Road)
4. Kelbaker Road (northbound off I-40)
5. Essex Road (northbound off I-40)
6. Ivanpah Road (northbound off Goffs Road)

The map below depicts each of the Preserve's main entry location as they are labeled in the list. Traffic count data along these roads was provided by the National Park Service (in Appendix III) for 2008. As we will not be able to collect new traffic count data for this report, the 2008 data was used.

Preserve Attractions

Included in the study site are the main park attractions of Kelso Depot, Kelso Dunes, Cima Dome, Mid Hills Campground, Hole in the Wall Visitor Center, and Mitchell Caverns. These locations will be used to develop the interior park shuttle service.

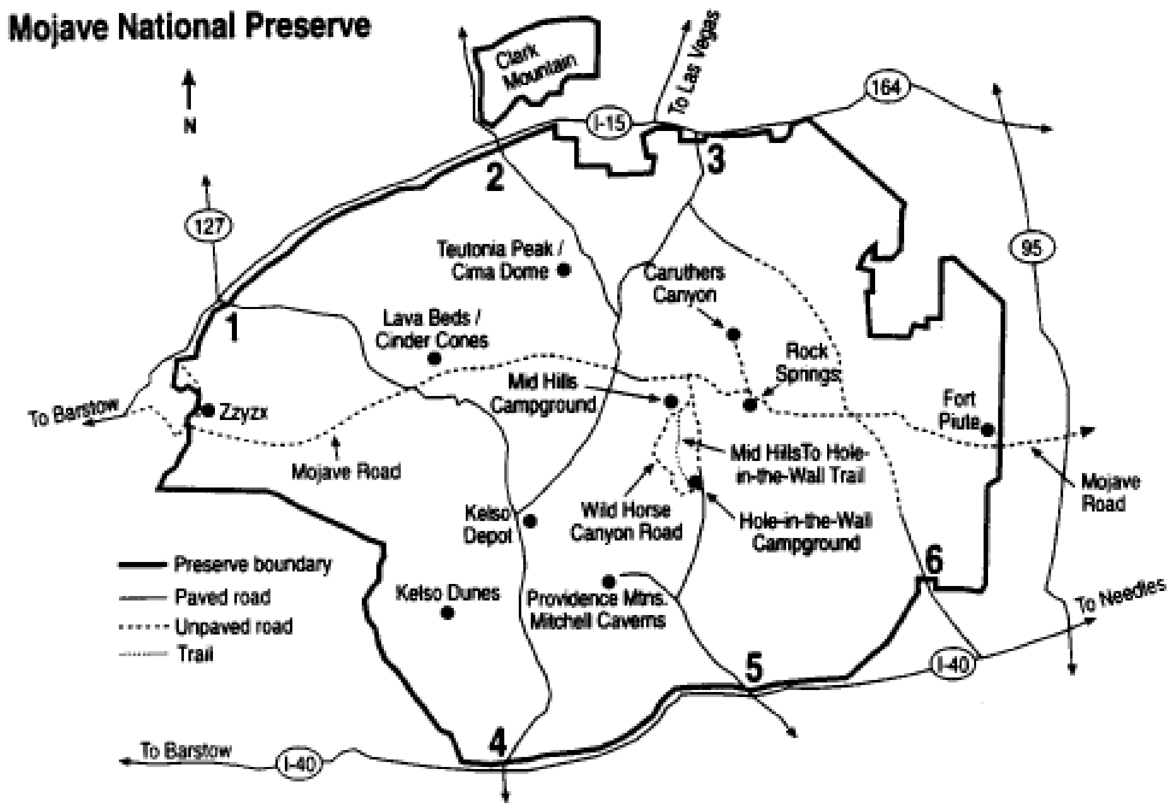

Figure 1. Study Area Map

Emissions Inventory

There are various types of air pollution sources and they are commonly classified as:

- *Stationary Source:* It is a fixed source of air pollutants, such as power plants and petroleum refineries.
- *Mobile Source:* It is a non-stationary source of air pollutants, such as cars, buses, trucks, trains, etc.

The air pollutants that are emitted by Mobile sources are Carbon monoxide (CO), Carbon dioxide (CO_2), Nitrous oxides (NO_X), Sulfur oxides (SO_X), Volatile organic compounds (VOC's, these are generally mixture of various Hydrocarbons), Particulate matter ($PM_{2.5}$ and PM_{10}, i.e. particles which are < 2.5 micrometers and < 10 micrometers respectively.), Ozone (O_3) and Smog. The air pollutants emitted from mobile sources and their effects on human health is shown in Table 1. Detailed emissions inventory for the study area can be found in Appendix II.

Table 1. Air Pollutants from Mobile Sources

Pollutants	Effects on human health
Ozone (O3)	Aggravation of respiratory and cardiovascular disease, decreased lung function and increased respiratory symptoms, increased susceptibility to respiratory infection, and premature death.
Particulate Matter (PM)	Aggravation of respiratory and cardiovascular disease, reduced lung function, increased respiratory symptoms, and premature death.
Sulfur Oxides (SOx)	Aggravation of asthma and increased respiratory symptoms. Contributes to particle formation with associated health effects.
Nitrogen Oxides (NOx)	Aggravation of respiratory disease and increased susceptibility to respiratory infections. Contributes to ozone and particle formation with associated health effects.
Carbon Monoxide (CO)	Reduces the ability of blood to carry oxygen to body tissues including vital organs. Aggravation of cardiovascular disease.
Volatile Organic Compounds (VOC's)	Cancer (from some toxic air pollutants) and other serious health problems. Contributes to ozone formation with associated health effects.

*Source: 2007 National Air Quality Trend Report

Visitor Demographics

Visitor demographics are important for estimating the distribution of shifts toward transit alternatives based on the survey conducted. Multiple sources are available for this data. The National Park Service (NPS) conducts periodic surveys of visitor statistics, and published two such studies done in 1997 (Littlejohn) listed in the tables as the '1997 Study' and in 2004 (Le et al) listed in the tables as the '2003 Study'. A General Management Plan (GMP) was also created as part of an Environmental Impact Statement (EIS) developed by NPS in 2002 which references some of the data from the 1997 study. The statistics from each of the sources of data are compiled to define a range for each of the visitor demographics. These ranges are then used in the demand analysis section. The following visitor demographics were used in this report:

Monthly Visitor Counts

The visitor counts for a five year period from 2004 – 2008 are obtained from the National Park Service (NPS, 2009), and shown in Table 2. The 2008 total number of visitors is used in the demand and sustainability analyses.

Table 2. Monthly Visitor Counts

Month	2008 Visits	2007 Visits	2006 Visits	2005 Visits	2004 Visits
January	41,004	48,552	38,638	39,756	53,887
February	48,324	48,739	42,886	41,227	47,268
March	46,356	49,973	39,466	51,667	45,662
April	47,542	56,429	45,943	36,931	37,788
May	42,466	46,519	49,298	48,494	38,510
June	37,476	43,500	38,568	50,880	44,299
July	38,386	40,589	38,707	36,794	40,723
August	39,418	41,666	37,966	65,244	41,256
September	53,374	41,962	46,867	67,548	42,802
October	54,617	46,277	56,354	54,521	41,110
November	137,700	70,896	57,574	100,140	67,397
December	31,622	47,573	44,983	39,319	45,610
Total	**618,285**	**582,675**	**537,250**	**632,521**	**546,312**

Group Size

The group size distribution is shown in Table 3.

Table 3. Group Size

Group Size	1997 Study	2003 Study
1	20%	26%
2	48%	47%
3	10%	10%
4	11%	7%
5+	11%	10%

Age Category

The age group distribution is shown in Table 4. For the 2009 Transit Preference Survey, the age groups are reduced to different mixes of three categories (children, adults, and seniors). The four mixes (adults, seniors, adults and children, all three) were found to be sufficient for determining transit preference.

Table 4. Age Category

Age Category	1997 Study	2003 Study
0-15	12%	9%
16-25	6%	8%
26-35	13%	14%
36-45	22%	16%
46-55	22%	24%
56-65	13%	19%
66+	11%	12%

Frequency of Visit

The frequency of visit is important for determining the value of repeat visits. The two studies indicate that there's been an increase in the share of repeat visitors since the 1997 study to the 2003 study.

Table 5. Frequency of Visits

Number of Visits	1997 Study	2003 Study
1	46%	34%
2-10	40%	46%
10+	14%	19%

Number of Vehicles per Group

The number of vehicles per group is important to determine the number of vehicles that are expected to be displaced by the proposed transit. The 2003 study suggests an average rate of 1.21 vehicles per visitor group.

Table 6. Numbers of Vehicles per Group

Number of Vehicles	2003 Study
1	88%
2	6%
3	3%
4+	3%

State of Origin

The state of origin is the state where the visitor(s) stayed the night before. For the 2003 study, only the location of the destination after visiting the Preserve was provided, so that is assumed to be the state of origin. The results suggest that the number of visitors from California has increased since 1997, which supports a transit alternative from Barstow, CA.

Table 7. State of Origin

Origin	1997 Study	2003 Study
California	71%	77%
Nevada	24%	13%
Arizona	2%	8%
Utah	2%	1%
Other	1%	2%

Length of Stay

The 2003 study provided survey results on two scenarios: those who stayed less than one day and those who stayed for one or more days. However, the only information related to that distribution is the percent of people who stayed overnight (24%) versus those who did not (76%). Using that distribution, we obtained the values in the table for the 2003 study. Assuming that the estimate is correct, the results suggest that there has been an increase in the distribution of short term visitors to the Preserve.

Table 8. Length of Stay

Length of Stay	1997 Study	2003 Study	2003 Study Estimated Values
1-3 hrs	30%	75%*P(<24hrs)	57%
4-6 hrs	20%	14%*P(<24hrs)	11%
7+ hrs (< 1 day)	11%	10%*P(<24hrs)	8%
1-3 days	22%	71%*P(1day+)	17%
4+ days	17%	28%*P(1day+)	7%

Activities

Transit ridership will depend heavily on the activities that visitors are interested in partaking. Between the 1997 and 2003 studies, the trend suggests more visitors that are just "passing through" between southern California and Las Vegas. The 2003 study had an entry for "technical rock climbing" and one for "rock scrambling", which were combined into "rock climb" for the purposes of this study.

Table 9. Visitor Activities

Activities	1997 Study	2003 Study
Sightsee	61%	73%
Drive paved roads	56%	64%
Drive unpaved roads	51%	43%
Nature Study	49%	27%
Day Hike	41%	28%
Visit mine ruins/historic sites	32%	18%
Drive Thru Only	28%	48%
Camp in campground	22%	15%
View rock art	19%	12%
Camp along roadside	15%	17%
Rock climb	11%	11%
Bicycle	2%	4%
Overnight backpack	1%	2%
Horseback ride	<1%	2%
Other	19%	21%

Linked Trips

Linked trip information pertains to other places that the visitors visited or planned to visit in conjunction with their trip to Mojave National Preserve. This information is useful for marketing purposes as it helps to differentiate between whether or not visiting Mojave National Preserve is the primary purpose of the trip.

Table 10. Linked Trips

Places Visited	1997 Study	2003 Study
Las Vegas, NV	56%	63%
Joshua Tree NP, CA	35%	28%
Primm/Stateline	--	28%
Baker, CA	34%	17%
Death Valley NP, CA	27%	17%
Lake Mead NRA, NV	16%	16%
Nipton, CA	14%	11%
Grand Canyon NP, AZ	14%	16%
Barstow, CA	18%	4%
Needles, CA	12%	10%
Calico Ghost Town, CA	8%	7%
Other	42%	26%

Places Visited at Mojave National Preserve

It is important to know which particular locations are of more interest to visitors for intra-park shuttle planning purposes. The results appear to correspond with the higher percentage of visitors passing through, as shown by the shift towards a lower share of other activity locations besides Kelso Depot.

Table 11. Places Visited at Mojave National Preserve

Places Visited	1997 Study	2003 Study
Kelso Depot	66%	61%
Kelso Dunes	57%	31%
Hole-in-the-Wall Campground	35%	14%
Mid Hills Campground	25%	14%
Providence/Mitchell Cavern	22%	13%
Teutonia Peak/Cima Dome	21%	10%
Wild Horse Canyon Road	19%	10%
Mojave Road	16%	11%
Mid Hills to HITW Trail	15%	7%
Rock Springs	9%	6%
Caruthers Canyon	8%	9%
Fort Piute	5%	3%
Clark Mountain area	5%	9%
Zzyzx	4%	5%

Intra-Preserve Shuttle Service

In order to facilitate a transit service from outside the Preserve, a shuttle service is needed within the Preserve to access major sites. Based on communication with the Chief of Resource Interpretation at the Mojave National Preserve, the following sites were identified as primary locations to setup a shuttle service:

- Kelso Depot (Site A)
- Kelso Dunes (Site B)
- Lava Beds (Site C)
- Teutonia Peak Trail (Site D)

The following two locations were cited as secondary locations for a shuttle service.

- Quail Basin (Site E)
- Vulcan Mine (Site F)

An additional site is included for the Hole-in-the-Wall visitor center (Site G).

If a 4-wheel drive vehicle with off-road access is used for shuttle service, the following would also be included.

- Lava Tube/Cow Cove
- Devils Playground via Jackass Canyon
- Mojave Road through Marl Mountains and Joshua tree woodlands

There is a challenge to incorporating all of these sites while maintaining a reasonable level of service. For the purpose of this study, the 4-wheel drive alternative shuttle service will not be considered. It can be examined at a future date if the transit service is put in place and shows a degree of success.

The locations of the sites are shown in Figure 2, with proposed tours shown in YELLOW, RED, and GREEN. Details on each of the tours are provided below.

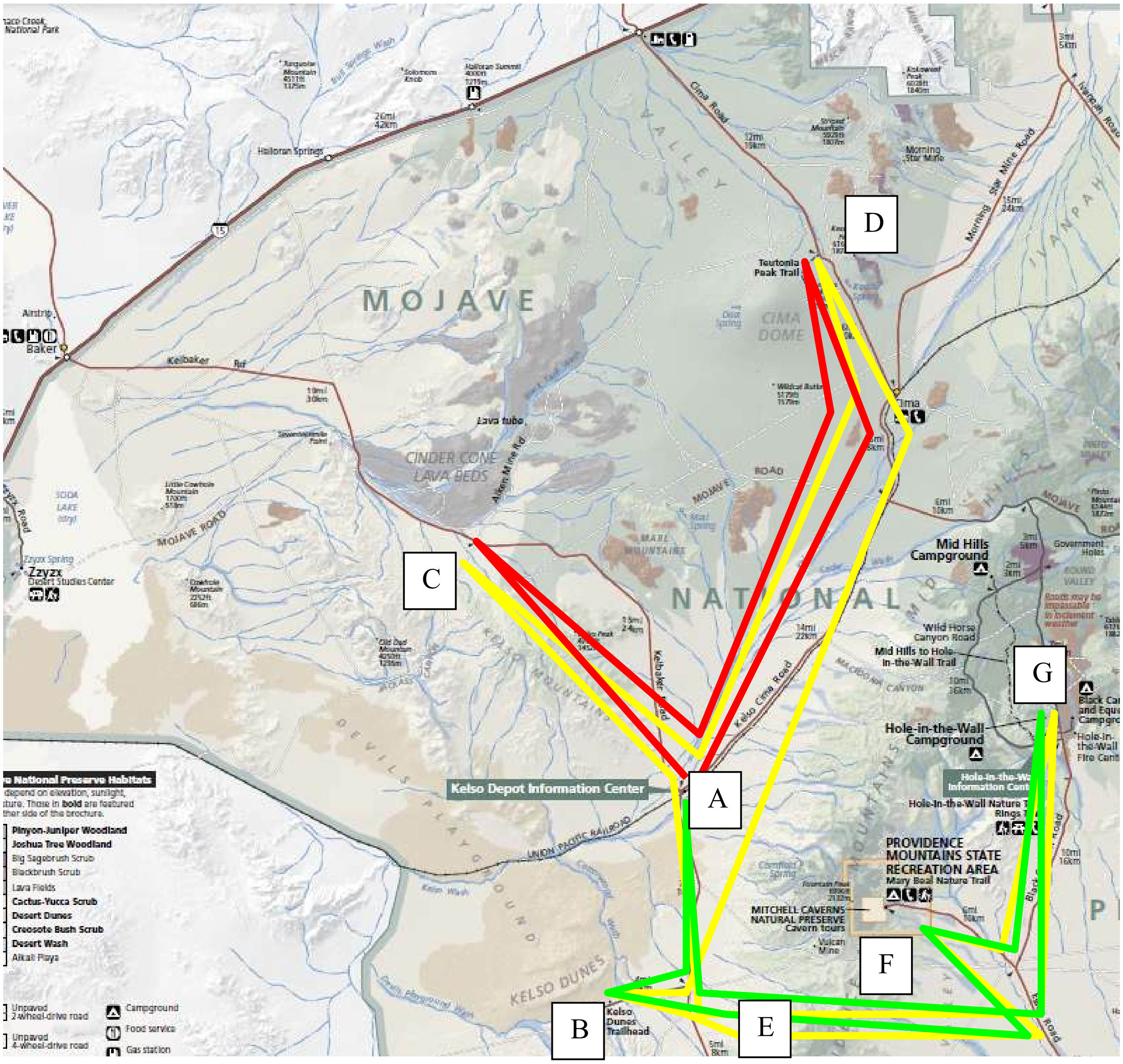

Figure 2. Intra Preserve Shuttle Service Attractions

Kelso Depot, mentioned earlier, would serve as the hub for the proposed shuttle service. The following travel distances are obtained from the figure and shown as a matrix of origins to destinations in terms of minutes of travel time. As stated previously, the Hole-in-the-Wall site would only be accessible from Kelso Depot if a 4-wheel drive shuttle is provided. Travel speeds are assumed to be 45 mph for local roads in the Preserve and 65 mph for I-40. Travel times are show below in Table 12.

Table 12. OD Matrix of Intra-Preserve Shuttle Services (minutes of travel time)

Travel Time (min)	Site A	Site B	Site C	Site D	Site E	Site F	Site G
Site A (Kelso Depot)	-	15	20	33	16	72	78
Site B (Kelso Dunes)		-	35	48	12	68	74
Site C (Lava Beds)			-	53	36	92	98
Site D (Teutonia Peak Trail)				-	49	106	111
Site E (Quail Basin)					-	56	62
Site F (Vulcan Mine)						-	21
Site G (Hole-in-the-Wall)							-

For a single shuttle service, the optimal tour would travel from A – C – D – B – E – F – G – A (Kelso Depot – Lava Beds – Teutonia Peak Trail – Kelso Dunes – Quail Basin – Vulcan Mine – Hole-in-the-Wall – Kelso Depot). This has a total tour time of 288 minutes or 4.8 hours, and is shown in YELLOW in Figure 2. This does include dwelling times at each stop. For a casual visitor who wants to see multiple sites in a day, this is not a feasible option.

Instead, two tours are proposed, one serving the sites A – C – D – A (Kelso Depot – Lava Beds – Teutonia Peak Trail – Kelso Depot) called Tour 1 (in RED in Figure 2), and the other serving A – B – E – F – G – A (Kelso Depot – Kelso Dunes – Quail Basin – Vulcan Mine – Hole-in-the-Wall – Kelso Depot) called Tour 2 (in GREEN in Figure 2). Tour 1 has a tour time of 106 minutes or approximately 2 hrs. Tour 2 has a tour time of 182 minutes or more than 3 hrs. If there are 2 vehicles in Tour 1 and 3 vehicles in Tour 2, the Tour 1 headway becomes 53 minutes while the headway for tour 2 becomes 61 minutes. This minimum fleet of 5 shuttles should be sufficient for approximately hourly (probably closer to 1.5 hrs after accounting for boarding and alighting times) service to the six locations indicated as significant sites at Mojave National Preserve. If there is sufficiently high demand, then this fleet size will be increased.

DEMAND ANALYSIS

In our study, the National Parks Conservation Association conducted a survey from October 10th to 24th, 2009, which was used to determine:

- Current year demographics
- Distribution of willingness to pay for train versus bus
- Distribution of preference for interpreter services on the transit service
- Reasons for not choosing to take transit
- Preference for train or bus service as a function of various demographic factors

Due to the sample size and quality of the survey results, a rigorous demand model for preference to take train versus bus by frequency of service cannot be estimated. Instead, the results were consolidated so that a more general model for "preference for transit" regardless of service frequency was adopted and a fixed proportion was used to estimate train and bus ridership. Out of 285 surveys distributed, 133 were filled out representing a 47% response rate. The surveys were conducted by the National Parks Conservation Association.

Survey Results Analysis

An analysis of the demographics results is shown below and compared to the earlier 1997 and 2003 survey results.

Age Group Distribution

Seniors are defined as visitor older than 62 years (listed as 62 + years in the survey). Children are defined to be visitors below the age of 16 years (listed as 0-15 years). Adults are defined as visitors between the ages of 16 and 62 years (listed as 16-62 years). 133 people responded, with the distribution of age groups shown in Figure 3. There appears to be a much larger group of seniors taking this survey compared to the earlier surveys in 1997 and 2003. The categories in the table refer to the composition of ages within each visitor group completing the survey. For example, a group with two adults and a child would be included in the 'Adults plus Children' category whereas a group with two adults, two children, and a senior would be included in the 'All Three Groups Present' category.

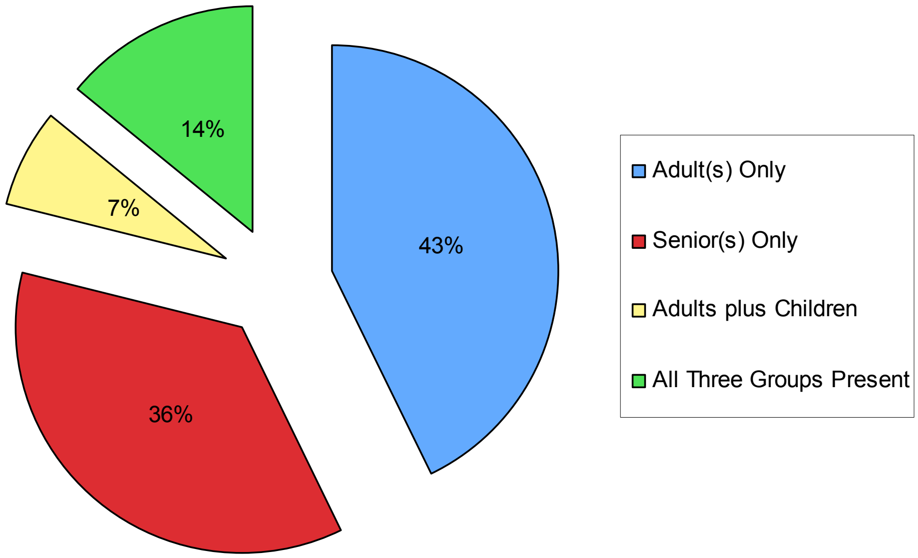

Figure 3. Age Group Distribution

Group Size

The number of visitors per group is included in Figure 4.

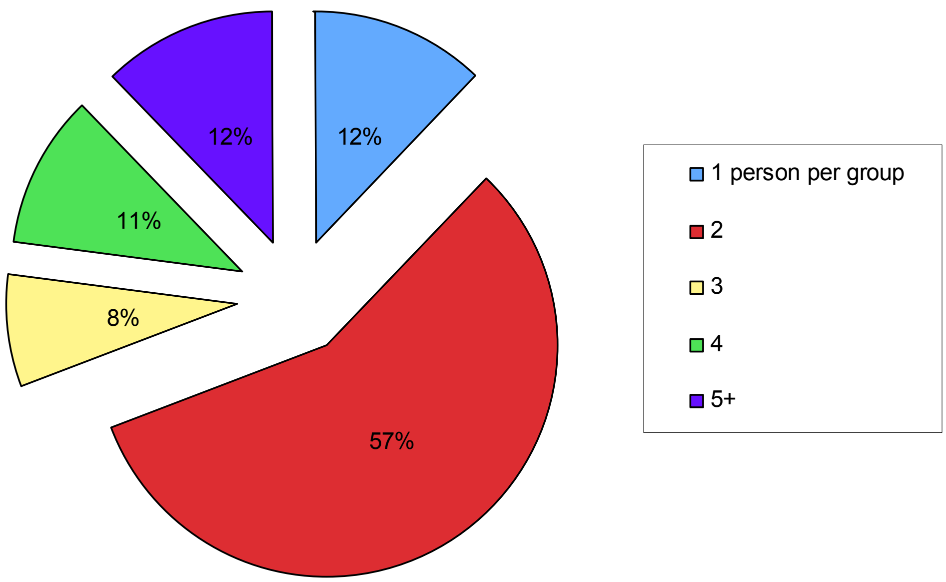

Figure 4. Group Size Distribution

Frequency of Visit

Figure 5 shows the proportion of first time to repeat visitors (or first time to non-first time visitors, as stated in the survey). There were 132 responses. This current survey shows more repeat visitors than in previous surveys which indicated 34-46% first timer visitors.

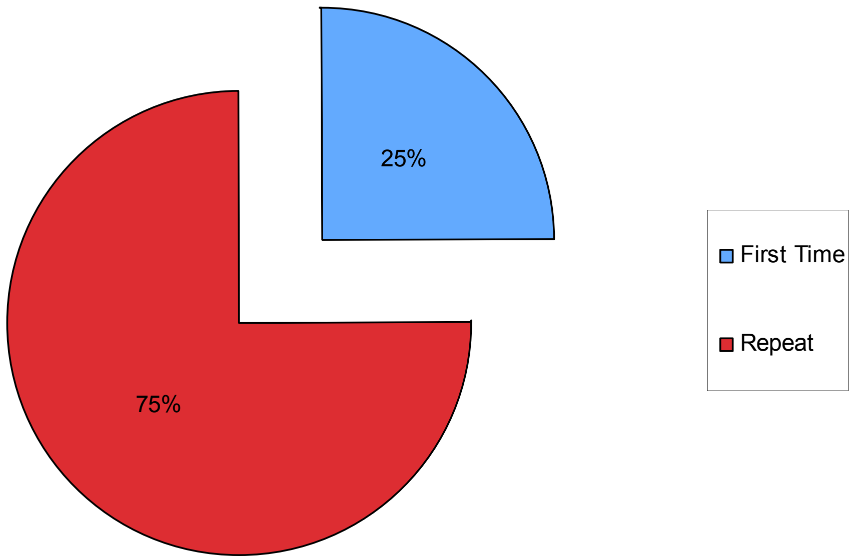

Figure 5. Frequency of Visits

Origin

A total of 81 people responded to the origin of trip question on the survey. Trip origin was divided into two categories by type of origin: home or other. The other category would mean the visitor was including a visit to the Preserve as part of another trip, which is referred to in this report as a linked trip. The results were further differentiated by location of origin divided into four categories: Southern California, Other California, Las Vegas, and Other States. These categories were chosen because they were expected to have the most influence on transit preference. Figure 6 depicts the State of Origin differentiated by home or non-home origin. The results differ from the 1997 and 2003 surveys; only approximately 60% came from California while 21% came from Las Vegas, NV and 19% came from other states, which make up 40% coming from non-Californian origins. The earlier surveys showed 77% California versus 23% non-California.

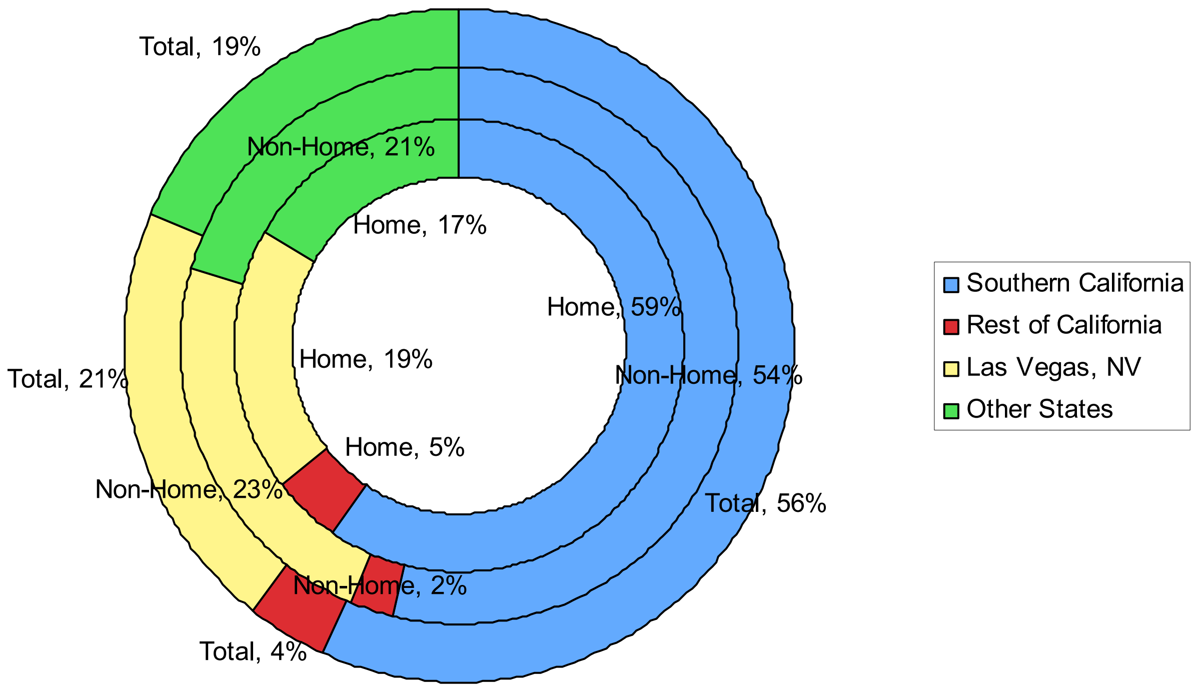

Figure 6. State of Origin

Length of Stay

A total of 123 people responded to the length of stay question which asked how long the visitor had stayed or planned to stay at the Preserve. Results were categorized into two classes: either less than one day or more than one day. From 2003 and 1997, the surveys indicate 61-76% less than one day. The 2009 survey results approximately fit the range from earlier surveys.

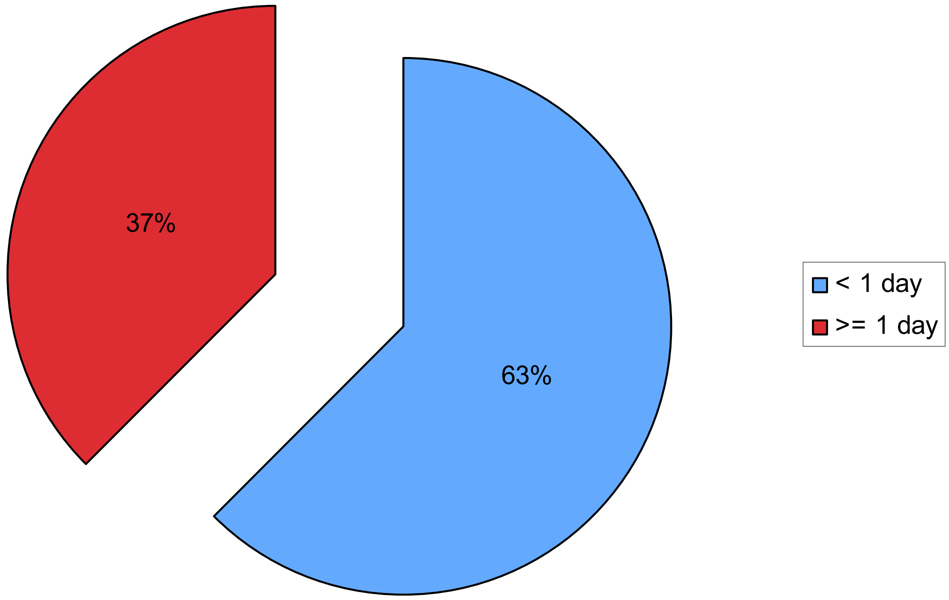

Figure 7. Length of Stay

Activities

A total of 130 people responded to the activities question which asked which activities the group participated in while visiting the Preserve. These activities were not mutually exclusive (i.e. visitors could participate in more than one activity during their visit). Based on previous survey results, participating in sightseeing dropped by 10-20%, day hiking dropped by 3-15%, camping dropped by 11-16%, dirt road driving dropped by 37-50%, nature study has dropped by 9-31%, visiting mines stayed approximately the same as the 2003 study, passing through is approximately the same as 2003, and hunting plus other is approximately the same as 1997 and 2003. Overall, the types of activities conducted by visitors at Mojave National Preserve have decreased by 50% from 1997 and 2003. This could likely be due to the season in which the survey was conducted (e.g. October is not a peak visiting season). Table 13 displays the responses obtained in the 2009 Survey.

Table 13. Visitor Activities

Activities	Survey Results
Sightseeing	53.1%
Day Hike	25.4%
Camping/Backpacking	20.8%
Off-Road Driving	6.2%
Nature Study	17.7%
Visit Mines	20.0%
Hunting	3.8%
Passing Through	47.7%
Other	16.2%

Places Visited at Mojave National Preserve

A total of 86 responses were collected for the visited locations question. For the purposes of transit preference analysis, the results were separated into three categories based on whether or not the respondent group visited Kelso Depot. Kelso Depot visits compose of 86% of all visits to the Preserve, which is 20 to 25% higher than 1997-2003 levels. Non-Kelso Depot visits comprise only 14% of the visits, which is 17 to 43% less than the highest alternative site, Kelso Dunes. However, this increase may be due to the distribution of surveys at the site; according to the survey log in the appendix, almost all the surveys were distributed at Kelso Depot. Figure 8 depicts the breakdown of Places visited within the Preserve.

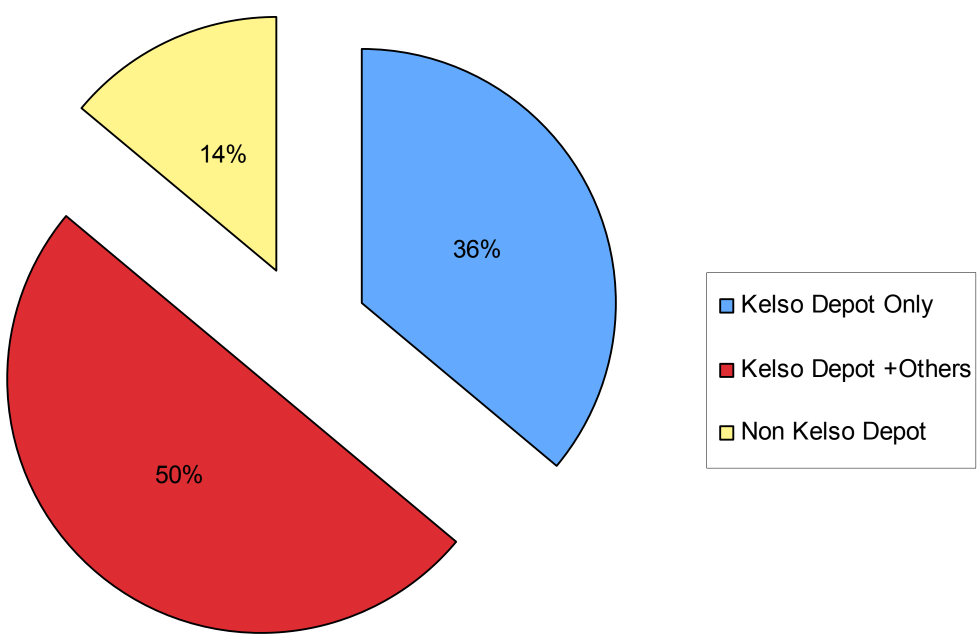

Figure 8. Places Visited at the Mojave National Preserve

Distribution of Preference for Transit

Visitors' preferences for some form of transit (either bus or train) are summarized in the table below. The total number of samples (i.e. the number of responses to the transit preference question on the 2009 Survey) and the number of positive responses to transit are shown in Table 14 below. Statistical upper and lower bounds, based on a 95% confidence interval, are given to demonstrate the range of possible responses.

Table 14. Statistics for Preferences for Transit Service

Statistic	Value
Number of Samples	118
Number that would take transit	27
Mean Proportion that would take transit	22.9%
Statistical Lower Bound	15.3%
Statistical Upper Bound	30.5%

Due to the lack of substantial data on train versus bus preference (i.e. no observable variable differentiating the two services for the survey), the fractions of visitors who prefer bus only, bus or train, and train only services are provided. Of the 27 total responses, 48.1% show preference for bus transit, while 92.6% show preference for train transit.

Table 15. Statistics for Preferences for Transit Service

Statistic	Value	Percent
Number Preferring Transit	27	100%
Number for Bus Only	2	7.4%
Number for Train Only	14	51.9%
Number for Bus or Train	11	40.7%

Distribution of Willingness-to-Pay for Train versus Bus by Frequency of Service

In the survey, respondents were asked how much they would be willing to pay for the given transit service depending on the frequency of service after being presented with pricing information for a similar transit system at Sequoia National Park (please see the survey in the appendix for the exact question). Table 16 provides a summary of the responses.

The average value of train service exceeds the average value of bus service by \$5 to \$9, depending on the frequency of service. For this question, it is important to account for non-response bias, meaning that those who did not respond are not included in the analysis. Although a typical bell-shaped curve is assumed for this analysis, it's very likely that people who provide a fare amount are likely to overstate their preference since it's conditional on them preferring transit. For this reason, the lower bound value should be used when evaluating transit fares. In that case, actual willingness-to-pay would probably be closer to $14.32 or $15.63 for bus and $20.96 or $23.73 for train depending on the service frequency.

Table 16. Statistics for Willingness-to-Pay for Transit Service

Statistic	Bus, 2 daily roundtrips	Bus, 4 daily roundtrips	Train, 2 daily roundtrips	Train, 4 daily roundtrips
Number of Samples	14	12	25	16
Mean	$21.07	$22.92	$26.90	$31.88
Median	$15.00	$20.00	$20.00	$27.50
Min	$10.00	$10.00	$10.00	$10.00
Max	$50.00	$60.00	$65.00	$65.00
Standard Deviation	$12.89	$12.87	$15.16	$16.62
Statistical Lower Bound	$14.32	$15.63	$20.96	$23.73
Statistical Upper Bound	$27.82	$30.20	$32.84	$40.02

Distribution of Preference for Interpreter Services on Transit Trip

The 2009 Survey included a question which asked if a visitor's preference for transit would increase if a park ranger was present on the bus or train. There were a total of 124 responses to this question, with 43.5% responding that the presence of a park ranger would increase their willingness to take transit. The statistics are shown below in Table 17. Based on the sample size and the responses, between 35-52% of the population is expected to be positively influenced by the presence of a park ranger to take transit.

Table 17. Statistics for Interpreter Preference

Statistic	Value
Number of Samples	124
Number Preferring Interpreter	54
Mean Proportion	43.5%
Statistical Lower Bound	34.8%
Statistical Upper Bound	52.3%

Reasons Not Interested in Transit

The 2009 Survey included a question which asked for the visitor's reasons for not preferring the transit alternatives. A leading reason for why people would not take transit is the presence of linked trips, i.e. trips involving other trips outside the park, and the origins not located near Barstow. This suggests that people more likely to take transit would be those who prefer to visit Mojave National Preserve as a primary purpose. Figure 9 depicts the results of the survey.

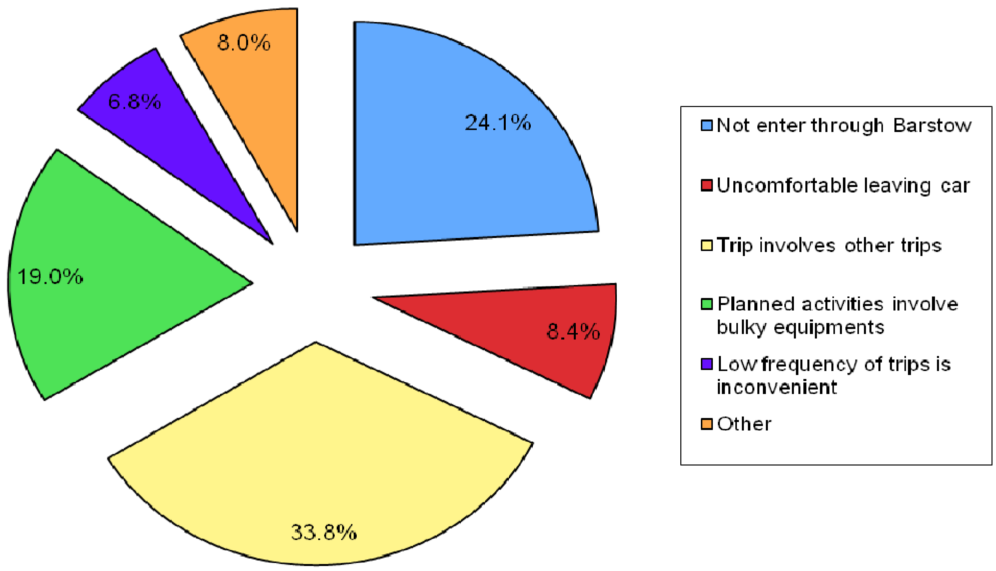

Figure 9. Statistics for Reasons Not Interested in Transit

Transit Demand Estimation

A discrete choice model is used to identify relationships between the preference for transit service and socioeconomic factors. Six variables were chosen as the dependent variables for determining the willingness to take transit, either bus or train. The results are presented in

The demand model showed statistically significant parameters, so the model was used to estimate average ridership for bus and train based on the fixed percentages, and to estimate the sensitivity of the average visitor's preference for transit to each variable.

Dependent: Willingness to Take Transit (Bus or Train)

Beta

Var #	Var Name	Coeff Est	t-Stat
1	Repeat (NR = 0; R = 1)	-1.701	-2.291
2	Primary Reason (MNP = 0, Other = 1)	-2.085	-1.641
3	Mobile Activity (Yes = 1) (i.e. camping/backpack, dirt road, hunting)	-2.510	-1.998
4	Stay (Less than one day = 0; One Day or more = 1)	1.758	1.746
5	Origin in Southern California (Yes = 1)	-1.001	-1.486
6	# of Seniors (0, 1, 2, 3, 4, 5+)	0.399	1.276

Summary Stats

# Obs:	60
LL	-23.031
LL(c)	-30.024
LL(0)	-41.589
rho^2	0.446
rho_bar^2	0.302
2008 Population	618,285
Mean% Taking Transit	0.20
Mean # Taking Transit	123,657
Mean #/day	339
Mean # Taking Bus/day	163
Mean # Taking Train/day	314

The first variable is whether a visitor is a repeat visitor or a first time visitor. The model shows that first time visitors tend to prefer taking transit, perhaps because they seek tourist activities as opposed to repeated, mobile activities such as hunting and dirt road driving. This conclusion agrees with the variable results for the third variable, Mobile Activity.

The second variable is the primary reason for the visit. If the visitor's primary reason is visiting MNP, there's a greater likelihood of taking transit. This also makes sense, as visitors who have other business or related trips are more likely to need a car.

The third variable is whether the visitor is at MNP for mobile activities such as hunting, camping/backpacking, or dirt road driving. These activities require mobility and equipment that are not convenient to transport by transit. The results indeed show that visitors performing mobile activities are less likely to take transit.

The fourth variable is length of stay, whether the visitor is staying for less than a day or more. The results indicate that visitors staying more than a day are more likely to take transit. This result seems to be counterintuitive, but it may be weighed heavily by the number of passing travelers who do not stay for more than a day and are not likely to take transit.

The fifth variable is whether the visitor's origin is in Southern California. Visitors from Southern California are less likely to take transit. Despite the greatest proximity to the Barstow station, it is likely that visitors from that region have cars, and are perhaps making joint trips to other locations such as Las Vegas.

The last variable is the number of seniors in a group. As the number of seniors increase from zero to five or higher, the likelihood of taking transit increases. This provides incentive to conduct tour groups for seniors.

Sensitivity Analysis

Average elasticity values are computed for each of the six variables, shown in Figure 10 below.

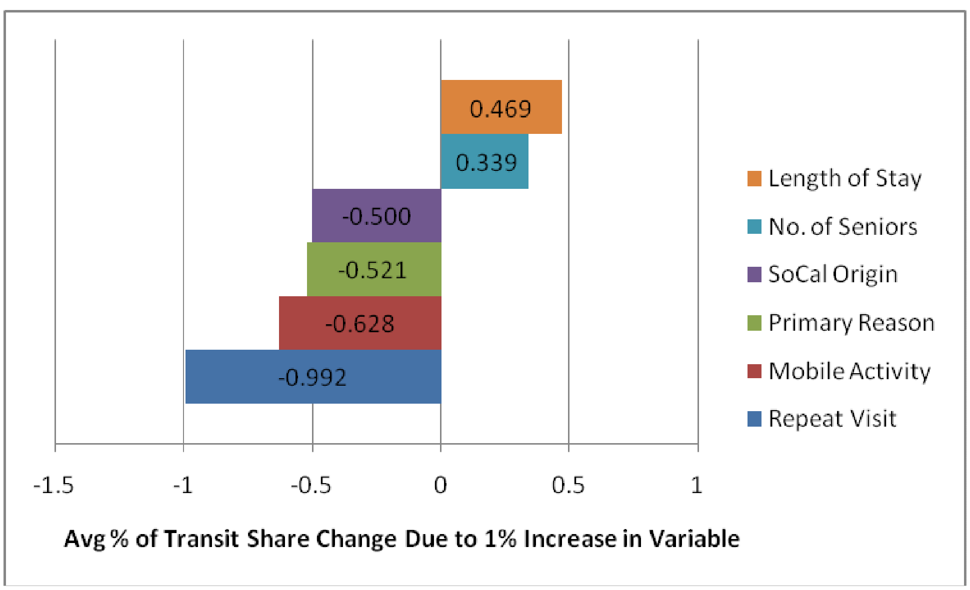

Figure 10. Sensitivity Analysis of Transit Preference to Variables

As the figure shows, the transit preference would benefit the most from attracting first time visitors, which is approximately three times more elastic than the number of seniors variable. In other words, increasing the share of first time visitors by 1% would increase the percent of transit ridership by 1%, whereas increasing the number of seniors per group of visitors by 1% would yield only a 0.33% increase in the percent of transit ridership.

These results also suggest that increasing the number of non-repeat visitors who prefer long stays, grouped seniors, from outside Southern California, headed primarily to MNP for tourist activities by 1% could potentially increase the percent of transit ridership by as much as 3.4%.

Summary of Transit Demand Models

The demand model predicts 163 bus passenger trips per day, or 59,479 trips per year. Similarly, there would be 314 train passenger trips per day to the site, or 114,506 trips per year. Note that these estimates are likely optimistic estimates in terms of percentage of visitors since there are likely biases to the limited data. A reasonable lower bound may be obtained from the pilot bus operation conducted from Barstow in 2008-9. It is also important to keep in mind that induced demand effect are not accounted for in this study. For example, having bus or train service would likely increase the appeal of MNP as a tourist site, which may draw additional visitors likely to be taking transit.

Based on data from the Mojave National Preserve for 2008, the total number of vehicles entering the Preserve was 232,954 and the total number of visitors was 618,285, annually. This means that there are approximately 2.654 people per vehicle. On an annual basis, 22,411 vehicles 59,479 people/2.654 people per vehicle) would have been displaced from the site in favor of bus service. Similarly, 43,145 vehicles would have been displaced for train service.

As previously stated, in the case where no transit service is provided, there would have been a total of 232,954 vehicles entering the Preserve, based on 2008 data. If a bus service was provided, assuming the expected number of removed vehicles calculated above, a total of 210,543 vehicles would have entered the Preserve. Similarly, if train service is provided, the number of entering vehicles would be further reduced to 189,809 vehicles. These vehicle reductions are show in Figure 11 below.

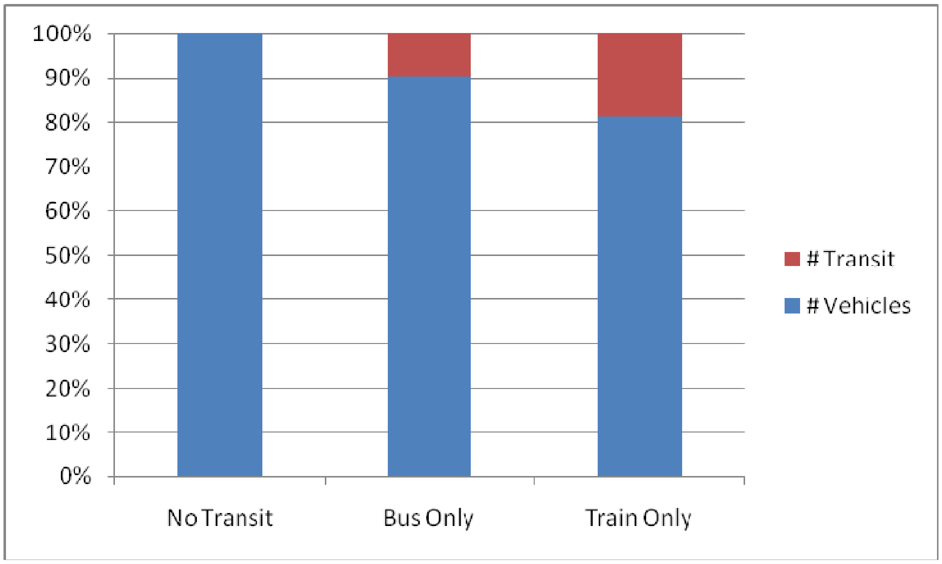

Figure 11. Percent Vehicles Reduced by Transit Service

SUSTAINABILITY ANALYSIS

In addition to estimating the level of transit ridership demand, this study also analyses the environmental and economic sustainability of providing transit service to and from the Mojave National Preserve. In this section of the report an analysis is conducted for the emissions reductions that result from visitor switches from private vehicles to transit, as well as the cost structure and expected profit from the provided transit service. Emissions reductions are compared against the existing scenario (i.e. there being no transit service within or to and from the Preserve) and emissions estimates have been calculated for the proposed scenario. Pricing information has been referenced from previous reports (see the appendix) and the average fare visitors reported in the 2009 Transit Preference Survey.

Two approaches were used to obtain some ballpark estimates of transit operational costs. The first method involves contacting other national parks and preserves for anecdotal information on costs and operations. The second method involves some initial research on benefit/cost estimates that may be available on web resources from the American Public Transit Association (APTA), Federal Transit Authority (FTA), and National Transit Database (NTD).

National Parks Survey

For this survey, the following parks were contacted by email. Listed below in Table 18 are the responses from each contacted park. This information was used as a base point for examining cost structures found from other sources.

Table 18. Contacted Parks

Park/Preserve/Lakeshore	**Response**
Big Bend National Park, Texas	- does not have any regularly scheduled public transportation to or from the park
Grand Canyon National Park, Arizona	NO RESPONSE
Denali National Park & Preserve, Alaska	NO RESPONSE
Wrangell-St. Elias National Park & Preserve, Alaska	NO RESPONSE
Arches National Park, Utah	NO RESPONSE
Canyonlands National Park, Utah	- doesn't have any type of transit service
Glacier National Park, Montana	- Glacier is entering its third transit season in 2009 - last year had 105,639 riders at a cost of $5.99 per rider - the shuttle system is free to the user and is paid for with entrance fees to the park
Yellowstone Nataionl Park, Wyoming	NO RESPONSE
Black Canyon of Gunnison National Park, Colorado	NO RESPONSE
Carlsbad Caverns National Park, New Mexico	NO RESPONSE
Baldlands National Park, South Dakota	NO RESPONSE
Theodore Roosevelt National Park, North Dakota	- don't have any kind of transit system in the park and mass transit is not available in the area
Pictured Rocks National Lakeshore, Michigan	- seasonal road - service begins Mid May until the end of October - Last year service was provided for 1220 different backpackers. - also provide daily trips to different sites within the Park for day use. - 52 bus loads - Group rate(where service is provided on the same day and time) or an individual rate for day and time they select - don't make a profit, we break even, it is a Public Service - have partnerships with the locals, state and Feds - the fares we collected from the users

	- put in dispatch, advertising, driver, around 1000 hours, total cost is around $25,000 - vehicles obtained through grants, not included in the cost above - in 2011 plans to increase service and secure a couple of Hybrid Electric vehicles and getting bike racks - also have a contract with the Forest Service where we provide a tour on a Island they own, along with transportation for hikers, people owning bicycles, etc. - first year did around 140 hours, $5000 cost
Biscayne National Park, Florida	NO RESPONSE
Hawaii Volcanoes National Park	NO RESPONSE
Sequoia and Kings Canyon National Park, California	NO RESPONSE
Redwood State and National Parks, California	NO RESPONSE
Yosemite National Park, California	NO RESPONSE
Olympic National Park, Washington	NO RESPONSE

Transit Online Resources

The NTD website has detailed statistics on operating costs of running different transit modes. Costs estimates can be obtained for both hybrid electric buses and trains. A case study of sustainable transit operations is provided for the Washington Metropolitan Area Transit Authority (WMATA) found in the Appendix. These values will be used as an approximation for bus operating costs.

"Green" Sustainable Transit Service

Assuming that train and bus are identical in preference, but different in fare price as provided by the survey responses, the best air quality scenario can be analyzed, that is, installing a bus or train service that has zero emissions. It is also assumed that if a transit service is provided to and from the Preserve, whether it be train or bus, an in-park shuttle service would also be provide which would operate with "green" buses.

Emissions

Assuming zero emissions, the impact of shifting visitors from automobile to transit can be determined by taking a direct proportion of vehicles visiting the Preserve and using that as a factor of the visitor mobile emissions inventory provided by NPS (see Appendix). Table 19 shows the three competing alternatives, assuming the transit services are both zero emissions. Using 2008 estimates of number of vehicles entering the Preserve and the visitor count, an estimate of the visitors per vehicle of 2.654 was obtained.

Dividing the expected bus and train ridership estimates by 2.654 would result in the number of vehicles removed from the total for each transit alternative. The results are a 9.6 percent reduction in mobile emissions from visitors for a "green" bus service and a 18.5 percent reduction for a "green" train service.

Table 19. Emissions Reductions with "Green" Transit

Alternative	Number of Equivalent Vehicles Displaced by Transit	Number of Vehicles	Mobile Combustion (MTCE)	% Reduction
No Transit	0	232,954	1497.0	0%
Bus Service	22,411	210,543	1353.0	7.7%
Train Service	43,145	189,809	1219.7	14.8%

Preliminary Benefit/Cost Analysis

A preliminary benefit/cost analysis is conducted for a bus service as well as a train service. For the analysis, no costs were included for the intra-park shuttle system. Further studies for implementation should explicitly consider the costs of operating the 5-shuttle, 2-tour shuttle system recommended in the earlier section above.

Bus Service

From the 2009 survey, a reasonable estimate of the bus fare is $14.32 per passenger for 2 roundtrips per day and $15.63 per passenger for 4 roundtrips per day. Based on the demand analysis for bus ridership in 2008, there should be 59,479 bus passengers. This would result in an annual bus fare of $851,739 or $929,657, depending on the service frequency.

The result assumes that a full fare is charged for everyone regardless of age or special category. In reality, it's likely that seniors, children, and some other demographics perhaps representing 40% of the population (since these demographics are more likely to take transit) would get a half-price discount. Using the same number of expected annual riders, this should result in an annual fare revenue of $681,000 to $744,000 after rounding to the nearest thousands.

The WMATA bus fleet study provides per-mile estimates of capital and operating costs for several categories of buses. Assuming a "green bus" has the same cost as a diesel bus (which is the most cost-effective for the same amount of emissions as the hybrid-electric and compressed natural gas buses), the total costs (without account for time value of money) and benefits assuming year-round service and 100 mile distance from Barstow to Kelso Depot can be determined for a bus service with 2 roundtrips per day and one with 4 roundtrips per day. These results are summarized in Table 20.

Table 20. Bus Service Benefit/Cost Breakdown

Type	Bus with 2 R/T per day	Bus with 4 R/T per day
Annual Miles	146,000	292,000
Capital Cost *	$118,000	$237,000
Operating Cost *	$174,000	$347,000
Annual Cost	$292,000	$584,000
Average Annual Revenue	$681,000	$744,000
Annual Total Cashflow**	$389,000	$160,000

*Costs are from the Appendix report provided by WMATA.

**Cashflow excludes intra-park shuttle system annual costs and higher premium for "green" technology.

Based on these preliminary estimates, a bus service with 4 roundtrips per day that is operated year-round would be economically sustainable only if a shuttle system has annual costs less than $160,000. In addition, this is not accounting for the likely higher costs of "green" bus technology, nor does it account for the cost of maintaining an interpreter onboard the bus.

Assuming these costs do not exceed double the annual cost, it would be more cost effective to operate a bus with 2 roundtrips per day year round, perhaps with variations in operations during peak and off-peak seasons. This would result in approximately 82 passengers per bus trip (perhaps a double-decker bus?). Since there would clearly be seasonal and weekly variations, further analysis of these variations would allow planning for an extra bus on certain peak days.

If the additional costs exceed double the annual cost of the bus shown above, then neither option would be economically feasible.

Train Service

Similarly, a reasonable estimate of the train fare from the 2009 survey is $20.96 per passenger for 2 roundtrips per day and $23.73 per passenger for 4 roundtrips per day. Based on the demand analysis for train ridership in 2008, there should be 114,506 train passengers. This would result in an annual bus fare of $2,400,046 or $2,717,227, depending on service frequency.

With the same discount program as discussed for the bus service, the adjusted annual fare revenues would be $1,920,000 or $2,174,000 after rounding to the nearest thousands. This fare revenue is 2.82 times greater than the expected bus fare revenue for 2-roundtrip service and 2.34 times for 4-roundtrip service.

Since Amtrak train service has run on the track from Barstow to Kelso Depot in the past, let's assume that there would not be any capital costs associated with reviving a train service there. However, purchasing "green" trains would likely be at least as expensive as the costs associated with a bus service. Savage (1997) reports a typical light rail rolling stock train to cost $2.5M. Vuchic (2005) shows that trains typically have a longer life cycle than buses, with an average life of 30 years compared to a life of less than 15 years for bus. The $2.5M is converted into annual costs of $182,000 assuming a 6% rate of interest. Viton (1980) estimated an average operating cost of train service, which Small and Verhoef (2007) converted to $5.34 per vehicle-mile in 2005 U.S. dollars. Based on such approximations, the operating cost would be in the ballpark of $390,000 per year for 2 R/T service and $780,000 for 4 R/T service, while the total costs would be $2,890,000 and $3,280,000, respectively. A similar breakdown of benefits and costs are shown in Table 21.

Table 21. Train Service Benefit/Cost Breakdown

Type	Train with 2 R/T per day	Train with 4 R/T per day
Annual Miles	146,000	292,000
Capital Cost *	$182,000	$182,000
Operating Cost **	$390,000	$780,000
Annual Cost	$572,000	$962,000
Average Annual Revenue	$1,920,000	$2,174,000
Annual Total Cashflow***	$1,348,000	$1,212,000

*Capital costs are assumed to be $2.5M based on Savage (1997) – costs of the track are assumed to be $0 since the track is already in place – with 6% interest rate for 30 year life cycle (Vuchic, 2005)

**Operating cost is approximated from Viton (1980) as $5.34 per veh-mile (in 2005 U.S. dollars, per Small and Verhoef (2007)

***Cashflow excludes intra-park shuttle system annual costs and higher premium for "green" technology.

Based on these preliminary results, a train service running with two round trips is preferred over both the train service with four round trips and the bus service. While these results appear promising for train service revival with subsidizes for capital cost, it needs to be kept in mind that these values are based on operating cost estimates from average national cost estimates under different technologies. In addition, the capacity on the existing track may become an issue with such a large volume of freight transported on the track now. More detailed cost estimates should be obtained for both the train and bus service with 2 roundtrips.

The benefit cost analysis assumes that the technology for "green" vehicles would cost the same as traditional vehicles, although in reality there would be higher premium. That is noted in the footnotes to the tables, in addition to the annual costs of operating intra-park shuttle service.

Traditional Fleet Transit Service

If a traditional transit service was used instead, emissions from the train or bus would need to be added on top the visitor emissions were included because a more traditional transit fleet is operated, they would lead to the following increases in emissions for buses. These values are based on WMATA estimates for diesel buses, hybrid buses and CNG buses. Emissions data for train operations is not available.

Operational costs and benefits are not expected to change.

Emissions

Emission Factor Models are easy and simple to use to estimate emissions but require intensive resources including large amounts of data. Also, the level of accuracy of these models is not high making it difficult to justify the large amount of data needed to run them. The laboratory based Federal Test Procedure (FTP) is used to derive baseline emission rates. These factors are calculated as a mean value of repeated measurement of total emissions over a given dynamometer cycle. Emission factors are expressed as mass of pollutant emitted per unit distance traveled (gram/vehicle-mile). The Emission Inventory is calculated as follows:

Emission Inventory = Emission Factor * Travel Activity

The Emission Factor is defined as the pollutant emission in grams/mile and, for this study, was obtained from the West Virginia University Dynamometer Results (found in the Appendix). Travel Activity is generally defined as vehicle miles traveled (VMT), trips/day, starts/day, etc. From the Emissions Inventory, the total emissions can be determined. Total emissions are calculated in terms of 'Metric Ton Carbon Equivalents' (MTCE).

Assuming 100 miles from Barstow to Kelso Depot once again, 2 traditional bus roundtrips would cover 400 miles/day and 4 bus roundtrips would cover 800 miles/day. Using the West Virginia University Dynamometer Emission Factors, annual pollutant emissions were calculated and shown in Table 22.

Table 22. Emissions from Alternative Traditional Bus Services

2 Round Trip (kilograms/year)			
Pollutant	**Diesel**	**Hybrid**	**CNG**
NOx (kg)	1325	1490	3240
PM_{10} (kg)	248	28	18
CO_2 (kg)	365,292	294,044	319,302
4 Round Trip (kilograms/year)			
Pollutant	**Diesel**	**Hybrid**	**CNG**
NOx (kg)	2650	2980	6480
PM_{10} (kg)	496	55	35
CO_2 (kg)	730,584	588,088	638,604

Due to lack of information on conversion rates for PM_{10} & NO_x to Carbon Equivalent, only CO_2 values from the above tables were used to get Carbon Equivalent (Metric Tones) values. EPA's Greenhouse Gas Equivalencies Calculator (EPA (1)) was used to compute the carbon emissions in terms of the number of round trips of bus service. The emission rates for train service were not available directly, but a relative comparison of rates were obtained from EPA (2) – 0.39 lbs/passenger-mile CO_2 for train and 0.24 lbs/passenger-mile CO_2 for bus – the ratio of the two rates was used with the diesel bus rates to estimate the emissions for train service.

Table 23. Metric Tons of Equivalent Carbon Emissions

2 Round Trip (MTCE/year)				
	BUS			**TRAIN**
Pollutant	**Diesel**	**Hybrid**	**CNG**	
CO_2	365	294	319	593
4 Round Trip (MTCE/year)				
	BUS			**TRAIN**
Pollutant	**Diesel**	**Hybrid**	**CNG**	
CO_2	731	588	639	1188

These emission values are added back onto the annual emissions of the "green" transit in Table 19 to obtain the net emissions from traditional transit services by roundtrip frequency. These results are shown in Table 24.

Table 24. Net Annual Emissions for Traditional Transit Services

Alternative	"Green" Mobile Combustion (MTCE)	Impact from Traditional Transit	Net Emissions from Traditional Transit	% Change
No Transit	1497	+0	1497	0%
Bus, 2 RT	1353	+365	1718	+14.8%
Bus, 4 RT	1353	+731	2084	+39.2%
Train, 2 RT	1220	+593	1813	+21.1%
Train, 4 RT	1220	+1188	2408	+60.9%

CONCLUSION

The objective of the study is to evaluate the feasibility of transit options for the Mojave National Preserve from a sustainability perspective: considering the environmental and socioeconomic impacts of alternative systems to the Preserve. As an initial study with limited dedicated funds, there are constraints in survey sampling, detailed operational information on some transit alternatives, and limitations to future scenario forecasts. However, some initial conclusions can be made with these constraints and objectives in mind.

Two competing transit options were considered, a train service or a bus service, both departing from Barstow and arriving at Kelso Depot. Shuttle alternatives for transit accessibility to the various sites within the Preserve needed to be considered. The demand for transit service was surveyed from visitors in the Preserve to relate it to different demographic factors for identifying management and marketing strategies. The air quality impact of the shift in visitors by automobile to transit was analyzed, as was a cost/benefit analysis of the transit operations.

Conclusions

An analysis of the survey conducted in October 2009 suggests several results:

- There is a higher proportion of seniors visiting the Preserve
- There is a greater concentration of visitor activity at Kelso Depot
- The number of different activities pursued by visitors appears to have dropped by half from surveys conducted in 1997 and 2003
- Preference for transit is positively influenced (from least to most) by the number of seniors in a group, visitors staying longer than one day, those coming from outside Southern California, those visiting MNP for the primary purpose, those seeking tourist-related activities as opposed to mobile activities such as hunting and dirt road driving, and non-repeat visitors
- The average bus fare that visitors are willing to pay is $14 for 2 roundtrips per day service or $16 for 4 roundtrips per day; similarly the average train fare is $21 for 2 roundtrips per day service or $24 for 4 roundtrips per day
- Approximately 44 percent of visitors would be positively influenced by an interpreter/ park ranger onboard the train or bus
- The two primary reasons cited by visitors for not wanting to take transit are 1) the presence of linked trips and 2) the inconvenience of the Barstow location

Although these results appear to be statistically significant, two reasons limit its conclusiveness. First, sample (133 out of 285 surveyed) is less than half the size of previous studies conducted in 1997 and 2003. Second, the survey was conducted at an off-peak time (October) that is adjacent to a month of significant visitor influx (November), so it may not be a very representative sample. Future studies should take note these potential shifts in visitor demographics.

Further analysis of the demand for transit resulted in estimates of 163 person-trips/day for bus service, and 314 person-trips/day for train service. Based on these figures and current person to vehicle conversion rates, the total number of vehicles displaced annually by demand for bus or train service was proportioned with existing emissions inventory. The conclusion is that a zero emissions “green” bus service in 2008 could reduce mobile emissions from visitors by 10 percent, while “green” train service could similarly reduce emissions by 19 percent.

However, these would be best case scenarios using clean technologies. If traditional diesel buses and trains were operated instead, the analysis suggests that this could even result in adverse impacts to the Preserve. Depending on the frequency of service, having two bus roundtrips per day could lead to an overall *increase* in carbon emissions by 15 percent, while four bus roundtrips per day could lead to 39 percent emissions increase. Alternatively, trains with two roundtrips per day could increase total mobile carbon emissions at the Preserve by 21 percent, while trains with four roundtrips per day could lead to 61 percent increase in emissions.

Bus and train operations were analyzed with the expected fare revenues obtained from the survey. Results indicate that a 2-roundtrip "green" train service from Barstow to Kelso Depot could be both economically and environmentally sustainable depending on the additional costs from intra-park shuttle, interpreter service, and higher cost premium for "green" technology. This service would include a half price discount for seniors and children.

Supplementing this recommended transit service is an intra-park shuttle service with two separate tours served by a fleet of five "green" shuttle buses. The first tour handled by two shuttles would travel from Kelso Depot to the Lava Beds, Teutonia Peak Trail, and back to Kelso Depot. The second tour handled by three shuttles would travel from Kelso Depot to Kelso Dunes, Quail Basin, Vulcan Mine, Hole-in-the-Wall Center, and back to Kelso Depot. The expected headway of these tours is approximately 1 to 1.5 hours.

Shuttle access to the vicinity of campgrounds in the Preserve is an important element because the survey results indicate a strong interest in transit from visitors who prefer to stay at the Preserve for long durations.

Marketing the Preserve to first time visitors, perhaps using strategies such as discounts for first time visits or for friends inviting newcomers, should increase transit ridership. Improving signage and guide materials for a better sightseeing experience may encourage visitors of that type, which have a strong preference for transit.

Next Steps

Given the limited survey results, a larger-scale effort taking into account lessons learned from the current survey would result in more statistical significant demographics. This future survey should consider:

1. Seasonal and day-of-week effects for use in identifying seasonal operational strategies; for example, operating transit only during peak seasons is a strategy adopted by several national parks

2. Selecting a more representative time period and issuing out more survey samples

3. Including observable variables in the survey that can differentiate preference for train and bus more clearly, or if one alternative is decided, to differentiate different operating strategies; in the current survey there was no differentiating factor and not enough people responded on the train preference question to get a statistically significant comparison between each alternative

While the recommendation for further detailed consideration is a “green” train service, future studies should consider both clean train and bus technology in more detail (given the politics surrounding train capacity on the existing track conflicting with freight volumes) before making a final decision on which alternative to adopt.

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APPENDIX

Appendix I: Intra-Preserve OD Matrix, Distance in Miles

	Site A	Site B	Site C	Site D	Site E	Site F	Site G
Site A	-	11	15	25	12	39+22	43+22
Site B		-	26	36	9	36+22	40+22
Site C			-	40	27	54+22	58+22
Site D				-	37	64+22	68+22
Site E					-	27+22	31+22
Site F						-	16
Site G							-

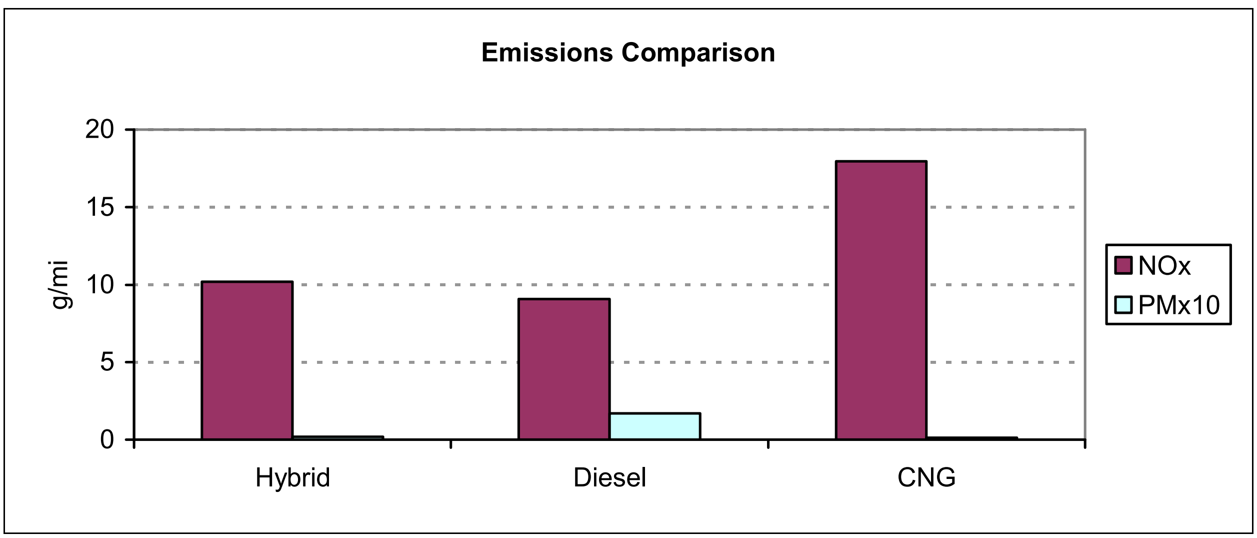
Appendix II: Lifecycle Cost and Emissions – Comparison of WMATA's Newest Bus Fleet

*Source: Nat Bottigheimer from Washington Metropolitan Area Transit Authority (WMATA)

Over 2005-2006 WMATA purchased 50 diesel-electric hybrids, 275 Compressed Natural Gas (CNG), and 117 Advanced Technology (AT) diesel buses. These buses represented the latest emission and powertrain technologies commercially available to the transit industry at the time. WMATA Bus Engineering Group (BENG) has been tracking the performance of these buses by measuring fuel economy, maintenance cost, and emissions. This report uses the most recent available data to compare emissions and costs of the various fleets.

EMISSIONS

EPA emission regulations are the driving factor in reducing emissions from heavy duty engines. Although there is some variability in the level of emission performance of each technology, it is important to note that all new buses decrease emissions by 90% or more compared to 2000 model year diesel buses. Through aggressive 'clean fleet' initiatives, as well as the normal procurement cycle, WMATA is well on its way to fulfill the goal of operating a fleet that virtually eliminates exhaust emissions.



As shown above, NOx emissions are lowest from the diesel engine, while particulate matter (PM) is lowest from CNG fuelled buses. In all cases, the emissions are low and differences are almost negligible. <u>Through regulation, total emissions are almost identical between technologies and therefore no longer a critical consideration for future procurement decisions.</u> The results presented above were measured by West Virginia University's mobile dynamometer over the course of two months in the summer of 2006. In addition to the regulated criteria emissions presented above, the table below includes CO_2 emissions which contribute to the greenhouse gas effect.

Dynamometer Results

	AT Diesel	Hybrid	CNG
NO_x (g/mi)	9.075	10.205	22.193
PM x10 (g/mi)	1.7	0.19	0.12
CO_2 (g/mi)*	2502	2014	2187

* CO_2 Emissions are not currently regulated by EPA

In general, CNG engines produce fewer particulate matter emission but greater NO_x than diesel engines. While this remains true today, by 2010 all engines must meet stricter emissions which will effectively eliminate any differences. Hybrids are able to improve upon either option by consuming less fuel and thus lowering their emissions.

LIFECYCLE COSTS

Emission reductions have come at increasing costs to the Authority. Capital and operating costs are studied below. In all instances, the life of the bus is assumed to be 15 years, with average accumulation of 37,000 miles per year. No time value of money is incorporated in this analysis.

Capital Costs

Capital costs are driven by the initial purchase cost of the vehicles and any infrastructure changes required (e.g. CNG fueling station). Hybrid buses remain significantly costlier, and although the price differential between technologies is expected to decrease, no significant reductions are evident yet.

Capital Costs

	AT Diesel	Hybrid	CNG
Vehicle Cost	$349,000	$521,980	$389,995
Mid Life Overhaul (includes battery replacement)	$100,000	$140,000	$100,000
Fuel Station*	-	-	$10,626,000
Depot Modification*	-	-	$6,002,000
Capital Cost per Bus	$449,000	$661,980	$539,883
Capital Cost per mile	**$0.81**	**$1.19**	**$0.97**

*Actual average cost of WMATA 200 bus facility amortized over 25 years.

Operating Costs

Not surprisingly, operating costs are primarily driven by the cost of the fuel and the fuel economy achieved. In the case of CNG, in addition to the cost of natural gas there are costs to compress the fuel (electricity) and to maintain the compression station. These costs are partly offset with a tax rebate that is due to expire on September 30, 2009. Operating costs incurred for calendar year 2007 are presented below.

Operating Costs ($/mi)

	AT Diesel	Hybrid	CNG
Fuel & Tire*	$1.00	$0.98	$1.21
Labor & Material*	$0.19	$0.15	$0.30
Fuel Compression			$0.038
Compression Station Maintenance	-	-	$0.060
Fuel Tax Rebate**	-	-	($0.172)
Operating Cost per mile	**$1.19**	**$1.13**	**$1.44**

*Actual costs from MAXIMO fleet maintenance management system

**Rebate is scheduled to expire 9/30/09. Total operating cost without rebate is $1.61.

The table below combines capital and operating costs and shows that diesel buses still have the lowest total lifecycle costs. The costs presented below assume stable fuel costs based on the 2007 average paid by WMATA. The lifecycle cost differential between each option is driven by the cost of fuel and tax incentives. Fluctuations in the future cost of fuel will likely outweigh any other cost differences.

Total Costs- 15 year life

	AT Diesel	Hybrid	CNG*	CNG**
Capital Cost ($/mi)	$0.81	$1.19	$0.97	$0.97
Operating Cost ($/mi)	$1.19	$1.13	$1.44/$1.61	$1.44
Subtotal ($/mi)	$2.00	$2.32	$2.41/$2.58	$2.41
Total 15 yr Cost	**$ 1,109,450**	**$ 1,289,130**	**$ 1,422,915**	**$ 1,337,049**
Cost Differential	**-**	**$ 179,680**	**$ 313,465**	**$ 227,599**

*Cost calculated with fuel rebate expiring 9/30/09.

**Cost calculated assuming rebate will be extended for the life of the bus

The data presented above is actual WMATA experience based on calendar year 2007 data. Local conditions in other areas may lead to different conclusions.

CONCLUSIONS

Regulations have reduced diesel and CNG emissions of criteria pollutants to the point that differences are negligible. These small differences will be further reduced in 2010 to the point that criteria pollutants should not play a significant role in future procurement decisions.

The total lifecycle costs for alternative fuel/powertrain is strongly dependent on fuel cost and fuel economy. Current prices and incentives show that diesel buses continue to have the lowest total lifecycle costs. Hybrid buses benefit from higher fuel economy particularly when fuel prices are high, but are still hampered by their higher initial purchase cost. In addition to lowering lifecycle costs, environmental pressure to reduce greenhouse gases (closely linked to fuel consumption) may shift the focus of future bus procurements to improve fuel economy.

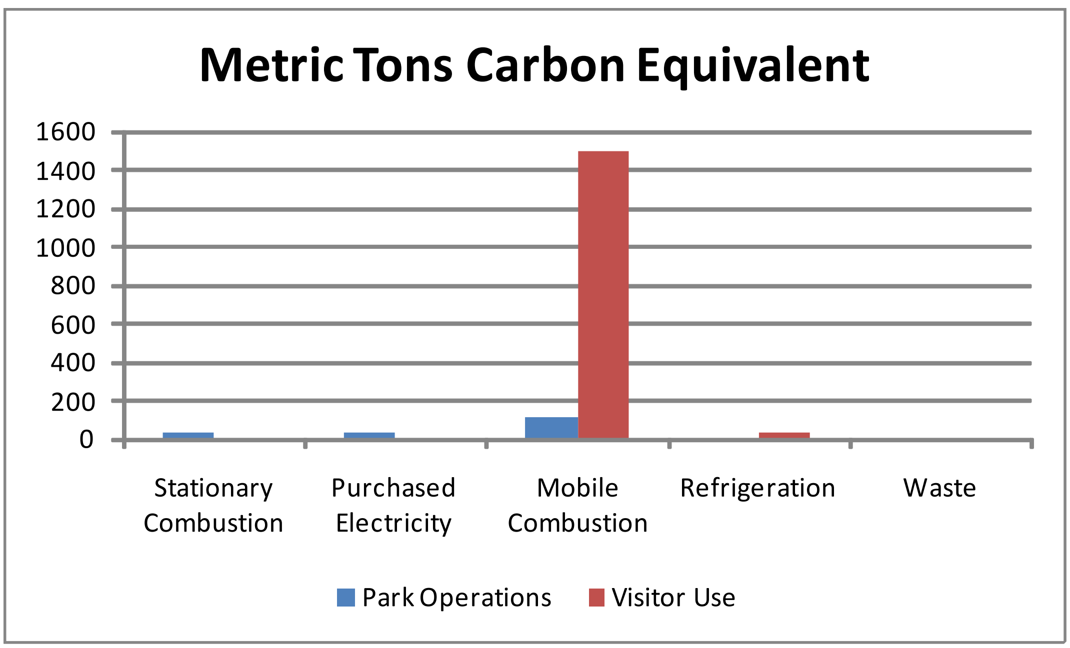
Appendix III CLIP Tool – Emission Inventory Module - Mojave National Preserve Summary

**The following material is provided by NPS.*

The following is a summary of the data entered into the CLIP tool for Mojave National Preserve for FY2008. The first table is the final summary and the next sections give some detail on each category. Total park operations Metric Tons Carbon Equivalent is 207.

EMISSION RESULTS BY SECTOR AND PARK UNIT
Metric Tons Carbon Equivalent (MTCE)

Park Unit	Stationary Combustion	Purchased Electricity	Mobile Combustion	Refrigeration	Waste
Park Operations	40	42	116	4	5
Visitors	0	0	1,497	29	0
Total Net Emissions	40	42	1,613	33	5



General Information

Current Emissions and Activities for FY 2008

Off-peak employee population (e.g. full-time employees)	56
Peak season employee population (e.g. full-time & seasonal employees)	48
Visitation in 2008	618,285
Length of Peak Season (in Months, from 1-12)	7
Length of Average Visitor Stay (in days)	1.0

Emissions are estimated for park operations and visitor use independently.

CO2, CH4, and N2O from Stationary Combustion, Park Operations

EMISSION RESULTS			Metric Tons of Carbon Equivalent (MTCE)			
Fuel	Consumption	Unit	CO2	CH4	N2O	Total
Diesel Fuel	4,523	gallons	12.4	0.0	0.0	12.5
Propane	17,761	gallons	27.8	0.1	0.1	27.9

CO2 Emissions from Purchased Electricity, Park Operations

EMISSION RESULTS		Metric Tons of Carbon Equivalent (MTCE)			
kilowatt-hours (kWh)	447,221* **	CO2	CH4	N2O	Total
		42.3	NE	NE	42.3

*Source: Southern California Edison Co

Sum of **field = 258821 kWh and **HQ = 188,400 kWh**.

CO2, CH4, and N2O Emissions from Mobile Combustion, Park Operations

EMISSION RESULTS			Metric Tons of Carbon Equivalent (MTCE)			
Vehicle miles traveled			CO2	CH4	N2O	Total
Light Trucks and SUVs	833,796 miles	17.69 mpg	113.0	0.1	2.4	115.6

CO_2, CH_4, and N_2O Emissions from Mobile Combustion, Visitor Use

We don't have actual mileage data on visitor use. I took the Special Use Data from the Monthly Public Use Report (http://www.nature.nps.gov/stats/index.cfm) for FY2008 and estimated mileage for each category.

Category	Count	Mileage	Total Miles
KELBAKER ROAD (SOUTHBOUND)	24583	56.7	1394620
LANFAIR ROAD (NORTHBOUND)	6083	56.5	343583
KELBAKER ROAD (NORTHBOUND)	93917	59.0	5538098
IVANPAH ROAD (SOUTHBOUND)	91114	46.7	4251824
ESSEX ROAD	11657	29.5	343333
CIMA ROAD	5600	58.3	326741

Total miles are then distributed by vehicle according to an algorithm in the CLIP tool.

EMISSION RESULTS					Metric Tons of Carbon Equivalent (MTCE)			
	Vehicle miles traveled		MPG		CO2	CH4	N2O	Total
Gasoline								
Cars	8,538,740	miles	22.15	mpg	924.5	0.9	18.1	943.6
Light Trucks and SUVs	2,927,568	miles	17.69	mpg	396.9	0.5	6.8	404.1
Heavy-Duty Vehicles	121,982	miles	7.61	mpg	38.1	0.0	1.3	39.4
Motorcycles	365,946	miles	50.00	mpg	17.4	0.1	0.2	17.7
Diesel								
Heavy-Duty Vehicles	243,964	miles	7.23	mpg	92.4	0.0	0.1	92.5
Highway Vehicles Total					1,469	1.6	26.5	1,497.4

CO2, N2O, and CH4 Emissions from Municipal Solid Waste Disposal and Incineration, Park Operations

Short tons of waste sent to a landfill in 2008 = 45.

EMISSION RESULTS

Metric Tons Carbon Equivalent (MTCE)			
CO2	CH4	N2O	Total
0.0	5.2	0.0	5.2

HFC from Refrigerant Use, Park Operations

EMISSION RESULTS	NUMBER OF EACH UNIT		Metric Tons Carbon Equivalent (MTCE)	
Refrigeration and A/C Type	HFC-134a	R-410	HFC-134a	R-410
Refrigerated Appliances	5	0	0.0	0.0
Residential Unitary	0	5	2.6	2.6

EMISSIONS (MTCE)*	Units	Vehicles by Age	Population	HFC	Total
Gasoline Cars	4	After 1993	33	1.6	1.6
Gasoline Trucks and SUVs	35	1993	1	0.0	0.0
Heavy Duty Gas Vehicles		1992	1	0.0	0.0
Diesel Cars		Before 1992	5	0.0	0.0
Heavy Duty Diesel Vehicles	Total 39				

*Optional Default Distribution

HFC from Refrigerant Use, Visitor Use

AGE DISTRIBUTION		EMISSIONS (MTCE)	
Vehicles by Age	Population	HFC	Total
After 1993	219,699	28.5	28.5
1993	5,112	0.4	0.4
1992	4,103	0.2	0.2
Before 1992	18,985	0.0	0.0
Total	247,899		

Appendix IV: 2009 Transit Preference Survey

Fold survey in half along crease to close. Staple along opened end to close. Return the survey by mail using provided postage, or hand back to survey distributor.

(1) Is this your first trip to the Mojave National Preserve? **Y N**
If **No**, how often do you visit?________________

(2) On this trip, what was the primary reason that you and your group visited the Mojave National Preserve area including Shoshone, Primm (State Line), Needles, Laughlin, Barstow, and Twenty-nine Palms, but not Las Vegas? Please check (✓) only **one**.

_____Visit Mojave National Preserve, if you visited a specific site within Mojave National Preserve, please **circle** the site where you visited:

Kelso Depot	Kelso Dunes
Mitchell Caverns	Zzyzx
Mid hills Campground	Rock Springs
Mojave Road	Caruthers Canyon
Clark Mountain Area	Fort Piute
Joshua Tree Forest	
Cima Dome/Teutonia Peak	
Hole-In-The-Wall Campground	

_____Visit other attractions in the area
_____Visit friends/relatives in the area
_____Business or Other reasons

(3) On this visit, how long did you and your group stay at Mojave National Preserve?

Days ____ Hours____

(4) On the list below, please check (✓) all of the activities that you and your group participated in at Mojave National Preserve during this visit.

_____Sightseeing
_____Day Hiking
_____Camping /Overnight Backpacking
_____Driving on Dirt Road (ATV's)
_____Nature Study (Observing wildlife)
_____Visiting Mine/Historic Sites
_____Hunting
_____Passing-through: shortcut between southern California and Las Vegas
_____Other (Please describe: ______________)

(5) Where did you and your group stay at night before coming to Mojave National Preserve?

City/Town______________ State_____
Please clarify if you were at home, with friends or relatives, hotel/motel, campground other?
____

(6) On this visit, how many people were in your personal group, including yourself?

Child (0-15 years): _____
Adult (16-62 years): _____
Seniors (62+ years): _____

(7) For this visit, please list the number of each type of vehicles in which you and your group arrived:

Passenger car(s) (cars, vans, SUVs): _____
Recreational Vehicle(s): _____
Other (Please include type of vehicle): _____

In Sequoia National Park a park-sponsored bus from a neighboring city (approximately 50 miles away from the park) into the park costs $15 per person for a roundtrip fare and includes the park entrance fee. This provides an alternative mode to entering the park in a private vehicle which costs $20 per vehicle. Once inside the park, a free shuttle runs throughout the day to the main attractions within the park.

A similar system is to be designed for the Mojave National Preserve in which a preserve-sponsored bus or train will provide service to Kelso Depot from the City of Barstow (approximately 100 miles from Kelso). A free shuttle service within Mojave would also be provided.

(8) FOR THIS VISIT, would you have been willing to take a **BUS** to the Kelso Depot inside the Preserve from Barstow if such a service existed?

YES➔ **Go to Part (a)** NO➔ **Go to Part (9)**

(a) What **reasonable amount** would you have been *willing to pay* for a roundtrip fare for **BUS** service from Barstow to the historic Kelso Depot?

For a BUS with TWO daily roundtrip services (to and from Kelso Depot twice daily), I would be willing to pay: $______

For a BUS with FOUR daily roundtrip services (to and from Kelso Depot twice daily), I would be willing to pay: $______

(9) FOR THIS VISIT, would you have been willing to take a **TRAIN**, instead of a bus, to the Kelso Depot inside the Preserve from Barstow if such a service existed?

YES➔ **Go to Part (a)** NO➔ **Go to Question (10)**

(a) What **reasonable amount** would you have been *willing to pay* for a roundtrip fare for **TRAIN** service from Barstow to the historic Kelso Depot?

For a TRAIN with TWO daily roundtrip services (to and from Kelso Depot twice daily), I would be willing to pay: $______

For a TRAIN with FOUR daily roundtrip services (to and from Kelso Depot twice daily), I would be willing to pay: $______

(10) Which factors would contribute to your decision **not** to take transit from Barstow to Kelso depot? Please check (✓) **all** that apply.

_____I would not enter the park through Barstow
_____I'm uncomfortable leaving my vehicle in Barstow
_____The low frequency of trips is inconvenient
_____My trip involves other trips outside the Mojave National Preserve
_____Planned activities in the park require equipment which I need to bring in my vehicle
_____Other (Please specify: ______________)

END OF SURVEY

Mojave National Preserve Transit Preference Study

Thank you for participating in this survey. The National Parks Conservation Association is in the process of evaluating various transportation options that will reduce greenhouse gases and other harmful emissions inside the National Parks. For the Mojave National Preserve, this means evaluating train and bus service into and within the Preserve. The goal of this survey is to evaluate transit preferences of visitors. Your completion of this survey will aid in determining the feasibility of the transit service in Mojave. For questions or concerns, please contact XXXXXXXXXXXXXXX at (XXX) XXX – XXXX.

www.npca.org

If you would like to help further by completing the longer version of this survey please visit:

XXXXX.its.uci.edu

FROM:

ATTN: Mojave Transit Project

Institute of Transportation Studies

University of California Irvine

4000 AIRB

Irvine, CA 92697

Appendix V: INDEPENDENT SCIENTIFIC RESEARCH AT MOJAVE NATIONAL PRESERVE

Thank you for your interest in conducting scientific research at Mojave National Preserve. Independent studies need not address specifically identified management issues but do require a permit and must conform to laws and National Park Service Policies. The Mojave National Preserve was created in 1994 with the passage of the California Desert Protection Act to, "preserve unrivaled scenic, geologic, and wildlife values" but also to "retain and enhance opportunities for scientific research in undisturbed ecosystems." The primary mission of the National Park Service, as laid out in the 1916 Organic Act, is "…to conserve the scenery and the natural and historic objects and the wildlife therein, and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations." The key phrases with respect to conduct of scientific research are "undisturbed ecosystems" and "unimpaired for the enjoyment of future generations." Collecting or removing natural, cultural, and historic objects from the Preserve or disturbing plants and wildlife is expressly forbidden unless specific exemptions are provided in the Scientific Research and Collecting Permit.

Scientific collecting is regulated under 36 CFR 2.5. Paragraph (b) states "A specimen collection permit may be issued only to an official representative of a reputable scientific or educational institution or a State or Federal agency for the purpose of research, baseline inventories, monitoring, impact analysis, group study, or museum display when the superintendent determines that the collection is necessary to the stated scientific or resource management goals of the institution or agency and that all applicable Federal and State permits have been acquired, and that the intended use of the specimens and their final disposal is in accordance with applicable law and Federal administrative policies." A permit will be issued only when the superintendent approves a written research proposal and determines that the collection will benefit science or has the potential for improving the management and protection of park resources. All permits require that the researcher file an Investigator's Annual Report. In addition, permits may include requirements that permittees provide copies of appropriate field notes, information about the data, progress reports, final reports, and publications derived from the permitted activities. Field data, objects, specimens, and features obtained for preservation during research projects, together with associated records and reports, will be curated and managed as a museum collection. Specimens that are not authorized for consumptive analysis will be labeled and cataloged according to National Park Service standards.

Approximately 44% of Mojave National Preserve is designated wilderness. The 1964 Wilderness Act prohibits certain uses. Specifically, "…there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area." Wilderness is marked by signs at most commonly visited areas but it is the researcher's responsibility to know where wilderness areas are located and to abide by the conditions of the Wilderness Act. Wilderness stipulations attached to your research permit are:

1. All motorized vehicles shall remain on existing roads, designated routes and vehicle ways. Vehicles shall remain on established roads or parking areas. No off-road (i.e., cross-country) travel by motorized vehicles is allowed. Vehicle use is prohibited in wilderness areas. Observe speed limits. Watch for tortoises on the road or road shoulder area. Driving off the established roadways and parking outside of designated parking areas is prohibited.
2. No motorized vehicles may be operated in wilderness. No motorized or mechanized equipment may be operated in wilderness. In general, Wilderness begins: 100' to either side of the centerline of all maintained roads (e.g., Kelbaker Road, Cedar Canyon Road, Black Canyon Road, Ivanpah Road, Morningstar Mine Road, Kelso Dunes Road, etc.) 30' to either side of unmaintained roads
3. Vehicles will use only existing roads or previously disturbed areas outside of wilderness. Permittee shall not in any way harm or damage any vegetation or wildlife. Parking along the roadway shall occur on previously disturbed sites only.
4. The permittee shall follow, and provide information to and ask each of their participants to become familiar with and follow the Special Conditions of this permit and the "Leave No Trace" philosophy.

The Mojave National Preserve is home to a portion of the Mojave population of desert tortoise, listed as threatened by the U.S. Fish and Wildlife Service since 1990. Proposed research in areas designated as critical desert tortoise habitat will be intensively reviewed and may be subject to strict limitations. Vehicles are allowed only on existing roads, camping and parking areas. Researchers are strongly encouraged to manage refuse, food, and water supplies so as to avoid subsidizing ravens.

Prior to conducting scientific research activities at Mojave National Preserve, investigators must apply for a research and collecting permit via the online system operated by the National Park Service. Please apply a minimum of 90 days prior to the time you wish to begin fieldwork; otherwise your permit may not be reviewed or approved in time. Your application should be accompanied by a written study proposal describing scientific hypotheses to be tested, methods, equipment, and location of fieldwork. Guidelines for developing the study proposal can also be found online. Research projects can have an indefinite time frame but permits will be renewed annually. At the end of each year you must file an Investigator's Annual Report using the online system. Natural history specimens collected require cataloging and curation according to National Park Service standards. Cataloging and curation instructions are provided in the Park Specific Conditions and can be found online.

National Park Service Webpages for Scientific Research

For permit applications, renewals, and Investigator's Annual Reports

http://science.nature.nps.gov

Information about applications procedures and guidelines for study proposals

http://science.nature.nps.gov/nps_permits/html/introduction.html

Map of Mojave National Preserve showing wilderness areas and tortoise critical habitat

http://www.nps.gov/moja/mojamap.htm

Museum handbook for cataloging and curation of natural history collections

http://www.cr.nps.gov/museum/publications/

PARK-SPECIFIC CONDITIONS

for

SCIENTIFIC RESEARCH AND COLLECTING PERMIT

United States Department of the Interior

National Park Service

MOJAVE NATIONAL PRESERVE

1. **Notification** – Notify the Kelso Depot Visitor Center when entering and leaving the park. Please provide your vehicle description including year, color, make, model, state, and license number and locations where you will be working.

2. **Interpretive Programs** - Scientific information is important to park management and staff and may also be of interest to park visitors. We encourage you to contact Science Advisor Debra Hughson at 760 252-6105 to arrange for a presentation of your research to park management and staff.

3. **Hardware** - No hardware (field markers, pin flags, stakes, rock cairns, recorders, signs, caches, traps, nets, cameras, weather stations, data loggers, radar reflectors, equipment, etc.) may be left in the park unless specified on the permit. Any such permitted items must be identified with a minimum of (1) the principal investigator's last name, (2) the date of establishment, and (3) the name of the study, e.g., "Darwin, 04 July 2002, Finch Genetics." Unmarked hardware will be removed as abandoned or unknown.

4. **Report Unusual Circumstances** - Help the park rangers by reporting observed violations, off-road driving, destruction of park resources (contact San Bernardino County Dispatch at 909-383-5654), locations of exotic plants, burros, rare wildlife, rare plants, desert tortoise sightings, road kill and archeological sites .

5. **Park Rules** – The following apply throughout the entire Preserve

- All areas are open 24 hours a day.
- Camping, whether within designated campgrounds or backcountry or roadside, is limited to a maximum of 14 consecutive days.
- Camping is not allowed within 0.25 miles of paved roads, along Kelso Dunes and ZYZZX access roads, or within 0.5 miles of Ft. Piute and Kelso Depot.
- Camping is allowed in previously used sites outside of the day use only areas.
- Campsites must be more than 200 yards from any natural or constructed water source.
- Collecting firewood is not allowed. Visitors must bring their own firewood.
- Fires must be attended at all times and completely extinguished prior to leaving a campsite.
- Target shooting or "plinking" is prohibited.
- All food and food containers must be stored in a manner that will prevent access by wildlife, especially ravens.
- Dispose of human waste in individual catholes dug 6 to 8 inches deep at least 200 yards from water, camp, and trails. Cover and disguise when finished.
- Pack out all toilet paper and hygiene products.
- Pet excrement must be collected and disposed of in garbage receptacles.

- Driving off established roads is prohibited.
- Vehicles must be street-licensed.

6. **Wilderness** – Approximately 44% of Mojave National Preserve is designated wilderness. Please familiarize yourself with the locations of wilderness area boundaries where you will be working. No wheeled vehicles, other forms of mechanical transport (except wheelchairs for physically disabled), motorized equipment (except battery-powered hand-held equipment), and no structures or installations are allowed in wilderness areas. Special exceptions for use of motorized equipment in wilderness can be made only if the research will benefit the area as wilderness.

7. **Leave No Trace** - Practice "Leave No Trace" outdoor skills and ethics, and teach these to your students. See the "Leave No Trace" web page at *www.lnt.org*.

- Plan ahead and prepare.
- Concentrate use in resistant areas.
- Avoid places where impact is just beginning.
- Protect and conserve water resources (don't camp near water).
- Pack it in, pack it out.
- Leave what you find.

8. **Collection of specimens or materials –** 36 CFR 2.5(g), outlines specific conditions that govern specimens and related data. If the researcher or permittee collects specimens that are to be permanently retained – regardless of where they are kept – those specimens must be accessioned and cataloged into the National Park Service (NPS) *National Catalog*, and must bear official NPS museum labels. In addition, reports, publications, and other data resulting from specimen collecting must be filed with the Park Superintendent.

a) Before specimen collecting begins, the researcher must contact the Park's Collections Coordinator (see below) to obtain a Park accession number for the collection. This number must appear on all reports, field records, correspondence, and permit(s) relating to the collection, and, on the label of each specimen or material that will be permanently retained.

b) When specimen collecting is finished, the researcher must contact the Collections Coordinator to obtain a block of Park catalog numbers for the specimens that will be permanently retained. Specimens that are consumed in the course of analysis or research need not be cataloged. The Collections Coordinator will have a copy of the permit to which to refer. The researcher will provide the Collections Coordinator with the following information:

- Park accession number
- Collection date(s)
- Number of specimens collected (estimates are acceptable for large collections)
- If the collected specimens are to be curated at a non-NPS institution, the researcher will provide the name, address, and telephone number (and email address if available), of the institution, and, the name and title of the individual who will be responsible for the curation of the specimens.

c) The Collections Coordinator will either provide NPS specimen labels to the researcher, or, will approve the electronic scanning or writing, and completion of NPS specimen labels. The Collections Coordinator will also provide instructions for label completion. The labels must be completed in permanent ink and appropriately affixed to specimens or their containers, even if the researcher applied their own or their institution's labels. If the size of the specimen or the container precludes completion of another label, the researcher's label must at minimum include the Park accession and catalog number, in permanent ink, in the following format:

MOJA-1234 (for the accession number, must include a hyphen)
MOJA 99999 (for the catalog number, do not include a hyphen)

The accession number must appear on all reports, correspondence, and permit(s) regarding the collection. Catalog numbers must be referenced in the final report or publication when individual specimens are referred to.

d) The Collections Coordinator will provide the researcher -- or the non-NPS institution responsible for curating the specimens collected -- catalog worksheets and instructions. The researcher or cataloger may also submit data in either Microsoft Excel or Access formats, but the catalog fields must have the same field attributes as ANCS+ (size, numeric, text, etc.). Specimen catalog data must include:

- Classification
- Specimen Name (scientific and common name)
- Quantity or item count
- Collection Site
- Township/Range/Section **or** UTM Coordinates **or** Latitude/Longitude (if GPS is used, include the datum)
- Collector
- Collection Number
- Collection Date
- Collection Method (chisel, shovel, net, hand, etc.)
- Identified By and Date
- Formation (for geology)
- Period/System (for geology and paleontology)
- Condition
- Type (if designated)
- Description
- Preservative and/or preparation
- Accession number
- Catalog number

e) If the collected specimens are to be curated at a non-NPS institution, the Collections Coordinator will send the institution an *Outgoing Loan* form, referencing the collection's Park accession and catalog numbers. The form is to be signed by the individual who will be responsible for the curation of the specimens. All specimens, as well as their derivatives and byproducts, shall remain Government property.

f) The researcher must submit to the Collections Coordinator within one (1) year of the final date of collecting:

- Associated catalog documentation (catalog worksheets and/or electronic data) for all specimens that are to be permanently retained in a non-NPS institution
- Copies of all field records (notes, maps, recordings, reports, etc.), printed or copied onto archival or acid-free quality paper
- Copies of final reports or publications

g) If the researcher cannot meet the one-year submission deadline, please call or write the Collections Coordinator to make other arrangements. The researcher is responsible for annually reporting the status of their collection cataloging and curation. Research and collecting projects are considered complete when most, if not all, of the above conditions are fully met.

h) Researchers are encouraged to contact the Collections Coordinator's office at any time during this process with any questions that may arise. Park. Please contact:

Debra Hughson, Science Advisor

Mojave National Preserve

2701 Barstow Road
Barstow, CA 92311

Tel: 760 252-6105
Fax: 760 252-6174
Email: debra_hughson@nps.gov

Appendix VI 2009 Transit Preference Survey Results Summary

Results Summary:

1. Is this your first trip to the Mojave National Preserve?

Yes	-	33	25.00%
No	-	99	75.00%
Total Answers	-	132	

2. On this trip, what was the primary reason that you and your group visited the Mojave National Preserve area including Shoshone, Primm (State Line), Needles, Laughlin, Barstow, and Twenty-nine Palms, but not Las Vegas?

Visit Mojave National Preserve	-	83
Visit other attractions in the area	-	19
Visit friends/relatives in the area	-	11
Business or Other reasons	-	25
Total Answers	-	138

3. If you visited a specific site within Mojave National Preserve, please select the sites where you visited:

Caruthers Canyon	-	0	0.00%
Cima Dome/Teutonia Peak	-	9	4.79%
Clark Mountain Area	-	0	0.00%
Fort Piute	-	2	1.06%
Hole-In-The-Wall Campground	-	17	9.04%
Joshua Tree Forest	-	29	15.43%
Kelso Depot	-	74	39.36%
Kelso Dunes	-	23	12.23%
Mid hills Campground	-	9	4.79%
Mitchell Caverns	-	8	4.26%
Mojave Road	-	8	4.26%
Rock Springs	-	2	1.06%
Zzyzx	-	5	2.66%
Other	-	2	1.06%
Total Answers	-	188	

4. On this visit, how many days did you and your group stay at Mojave National Preserve? (Please enter 0 if less than one day)

Average	-	2.2 days
Total Answers	-	46

5. If less than one day, how many HOURS did you and your group stay?

Average	-	2.9 hours
Total Answers	-	78

6. On the list below, please check all of the activities that you and your group participated in at Mojave National Preserve during this visit.

Sightseeing	-	69	25.18%
Day Hiking	-	33	12.04%
Camping /Overnight Backpacking	-	27	9.85%

Driving on Dirt Road (ATV's)	-	8	2.92%
Nature Study (Observing wildlife)	-	23	8.39%
Visiting Mine/Historic Sites	-	26	9.49%
Hunting	-	5	1.82%
Passing-through Shortcut: SoCal and Las Vegas	-	62	22.63%
Other	-	21	7.66%
Total Answers	-	274	

7,8,9. On this visit, how many people were in your personal group, including yourself?

7. Number of Children (0-15 years old):

Average	-	2.41
Total Answers	-	12

8. Number of Adults (16-62 years):

Average	-	3.13
Total Answers	-	85

9. Number of Seniors (62+ years):

Average	-	2.09
Total Answers	-	67

10. FOR THIS VISIT, would you have been willing to take a BUS to the Kelso Depot inside the Preserve from Barstow if such a service existed?

Yes	-	13	11.21%
No	-	103	88.79%
Total Answers	-	116	

11. FOR THIS VISIT, would you have been willing to take a TRAIN, instead of a bus, to the Kelso Depot inside the Preserve from Barstow if such a service existed?

Yes	-	25	65.79%
No	-	13	34.21%
Total Answers	-	38	

12. Which factors would contribute to your decision not to take transit from Barstow to Kelso depot? Please check all that apply.

I would not enter the park through Barstow	-	57
I'm uncomfortable leaving my vehicle in Barstow	-	20
My trip involves other trips outside the Mojave National Preserve	-	80
Planned activities in the park require equipment which I need to bring in my vehicle	-	45
The low frequency of trips is inconvenient	-	16
Other (Please specify below)	-	19
Total Answers	-	237

13. Would having a Parker Ranger on the train or bus increase your likelihood of choosing to take the train or bus?

Yes	-	54	43.55%
No	-	70	56.45%
Total Answers	-	124	

Appendix VII 2009 Transit Preference Survey Log

Place	Date	Wkend	Wkday	# of Surveys	Time
Kelso	10-Oct	Sat		31	11:30-3:30
Kelso	12-Oct		Mon	24	9:00-1:00
Kelso	14-Oct		Wed	18	9:00-1:00
Kelso	16-Oct		Fri	37	9:00-1:00
Kelso	17-Oct	Sat		23	9:00-1:00
MidHills/Hole-in-the-Wall	18-Oct	Sun		28	9:00-1:00
Kelso	19-Oct		Mon	20	8:30-12:30
Kelso	21-Oct		Wed	25	8:30-12:30
Kelso	23-Oct		Fri	30	8:30-12:31
Kelso	24-Oct		Sat	49	11:15-3:15