The Value of America's Greatest Idea:

Framework for Total Economic Valuation of National Park Service Operations and Assets

and

Joshua Tree National Park
Total Economic Value Case Study

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Contents

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Introduction

Since its inception in 1916, the National Park Service (NPS) has been the steward of the United States' National Parks, Monuments, and other historic, natural, and cultural sites. Even before NPS was established, Americans were greatly attuned to the value of preserving these public spaces to serve as national assets. In 1912, Theodore Roosevelt wrote that "the establishment of the National Park Service is justified by considerations of good administration, of the value of natural beauty as a National asset, and of the effectiveness of outdoor life and recreation in the production of good citizenship." (National Park Service, 2003)

Roosevelt's point still holds great weight today, but barely begins to capture the different values presented by the National Park Service in its modern form. With its responsibilities extended to preserve and protect historic sites then a greater expansion of programming, NPS provides values to users and non-users in areas that extend far beyond our traditional conceptions of what a National Park is.

Despite the growth of the organization and its responsibilities, there has been no comprehensive study of what the total economic value of the National Park Service is. Such a value would include the benefits accrued by consumers who directly use NPS units or programs. A total economic value should also include the benefits that Americans receive from knowing that the National Park Service exists, even if they don't use its services. As NPS Director Jonathan Jarvis states, "wilderness protection only exists by the will of the people... Thus we must advance our ability to quantify and describe the values of wilderness" (Vagias, 2012).

Environmental economists have developed methods for valuing all tangible and intangible benefits provided by NPS. However, in spite of some recent efforts, there is no satisfactory unifying framework for assessing the entire scope of value created by the Park Service. Additionally, research that did attempt to assess the value of the National Parks did utilize some of the methodologies described, such as the National Park Conservation Association's study in 2006, but didn't take note of the full range of services provided by the National Park Service outside of park unit boundaries (Hardner & McKenney, 2006).

Thus, a distinction needed to be drawn between what NPS produces within a park unit and what it produces outside of park boundaries. The mission statement of the organization served as a helpful guide in forming this distinction. The first sentence is dedicated to "[preserving] unimpaired the natural and cultural resources and values of the National Park system for the enjoyment, education, and inspiration of this and future generations." This is interpreted to represent values provided within NPS holdings, or what is referred to as the "National Park system." The second sentence declares that "the Park Service cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world." (National Park Service, 2012) We have interpreted this section to describe what NPS staff call "Cooperative Programming." In

order to conduct a valuation on all that NPS has to offer, we dedicate a section to describing what "Cooperative Programming" services are.

In our attempt to create a unifying framework, we cover a wide range of values that may be difficult to conceptualize without putting them in context. Therefore, we have also included a case study of a National Park unit which is organized by the framework described below. In all, this paper seeks to provide the following products:

1. **Economic valuation framework**: Create a framework for a total economic valuation of the National Park Service. This framework will be based upon a wide span of economic literature with a focus on environmental economics. The framework incorporates direct use and passive use values within park units, and a valuation category for cooperative programming outside the boundaries of those units. The framework includes a graphical representation of the valuation model and descriptors of each value field.

2. **Economic valuation case study**: We will demonstrate the applicability of the framework through a single case study. The case study will be based on Joshua Tree National Park, an NPS unit in the Southern California desert, and will categorize various resources and programs provided by the park in the value fields described in the framework. When data is present, we will provide rough, research-based calculations of value intended only to give ballpark estimates of actual values.

There are those who believe that the value of the National Parks is infinite, and who therefore may consider this research to be unseemly. While we acknowledge that the true value of some of these resources may rest in the realm of the unknowable, we believe that the necessity for re-allocation of resources to and within the Park service merits a duly diligent attempt at valuation. And yet we have undertaken this research in the spirit of advocacy for those for whom the worth of the parks is unimaginable, and in the pursuit of increased and stabilized funding for an American institution whose value runs deep.

Methodology

In creating our economic valuation framework, we consulted economics literature and interviewed multiple economists and subject matter experts. Our literature review encompassed over 80 works and covered several areas. The most applicable readings to developing a framework were those that described environmental values, from early literature that explored the concept of passive use values to contemporary studies on recreational values. Additionally, we covered several cases that applied valuation methodology. Relevant studies are noted as examples and some recommendations are provided where available on how best to construct a study or utilize specific valuation methodologies.

In addition to the framework, a case study was conducted to provide context and examples. Our selection of Joshua Tree National Park was due to the multiple advantages it provided, which are enumerated below:

1. Diverse natural resources: Joshua Tree is perhaps most famous for its desert landscapes but also contains mountainous regions, unique geological formations, and other types of resources.

2. Abundance of programming: from educational programs to campfire talks, park rangers are engaged with visitors on multiple levels throughout the entire calendar year.

3. Size: Joshua Tree is a destination attraction with nine campgrounds and surrounding cities. This setup is favorable for some of the economic valuation methodologies that may be used to assess local economic impacts. Its unique location also presents some novel issues regarding opportunity costs that are explained later.

4. Cultural resources: The park is the location for 4 different indigenous settlements before being resettled in the 1800s by cattle ranchers. As a result, the site hosts a bevy of archaeological sites, cultural landscapes, structure, and contains a museum dedicated to the history of the region. Each of these assets contains unique values.

5. Recreational opportunities: The park is widely patronized year-round and has various opportunities for outdoor recreation that can be evaluated using traditional cost-valuation techniques and methodologies.

6. Research value: In addition to research of cultural items, Joshua Tree also hosts multiple scientific studies focusing on air quality, rare and invasive species, and recreation use.

Multiple approaches were taken to amass the information presented in the case study. First, a literature review was conducted for historical documents, existing studies conducted at Joshua Tree National Park (JOTR), and economic literature pertaining to desert environments and regional areas, such as the Mojave Desert. Second, we interviewed over 25 National Park Service staffers at JOTR and associated personnel, such as supportive staff for coalition groups or non-profit organizations. Interviews were conducted in person at the park and both writers of this document had the opportunity

to become direct users of this valuable resource. Finally, we reviewed a number of park documents. Some publicly available documents, such as the General Management Plan and the 2011 Foundation Plan, served as useful roadmaps for services and challenges at JOTR. We also reviewed permit records, visitation statistics, and materials produced for visitors. The methodological approach was informed by Bruce Peacock's analysis and proposal for future work to examine values in the Lower Colorado River Basin includes describing values provided by NPS along the Lower Colorado River, a methodological step that this paper emulates in the case study section (Peacock, 2009).

Section 1:

Constructing an Economic Valuation Framework

The Hoh Rainforest in Olympic National Park, WA (Photo by Tim Marlowe)

Economic Methodological Foundations

The economic value created by most products or services is evident in the price assigned to them by the market. While this is true of select areas of the National Park Service framework, the majority of values created by NPS are not directly accounted for in market transactions. It is therefore necessary to use a number of economic methods to ascertain those values. What follows is a brief review of those methods, as they will be continuously cited throughout the explanation of the framework and case study[1].

Revealed Preference Methods

In spite of the fact that many economic goods bear no price, economists have created ways to derive the amount that people value these goods from their other economic actions. These methods are called revealed preference valuations.

1. Travel Cost Method (TCM):

   Originally suggested to the National Park Service in a 1947 letter from economist Harold Hotelling, the Travel Cost Method is a valuable technique for understanding the value of a visit to an un-priced attraction. It creates an estimation of value by utilizing the amount people pay to travel to an attraction to create a demand curve for that attraction (Heberling & Templeton, 2009). The initial "zonal" method, as outlined by Marion Clawson and Jack Knetsch, maps out visitors by origin zones and assigns travel costs (mostly opportunity costs of time) to each of those zones. Using this imputed travel cost, as well as the proportion of the population visiting from each zonal origin, the overall demand curve (and thus consumer surplus) for the good is calculated, given a range of hypothetical fees (Knetsch, 1963).

   As the zonal TCM presents many problems, including the fact that not all origins from a single zone will share the same demand curve (Knetsch, 1963) and the fact that travel costs are calculated and assigned by economists instead of consumers (Randall, 1994), an individual travel cost method has also been designed, in which survey methodology has been used to collect individual visitor travel data, background data, and preferences. These data are then regressed to create a linear or log-linear population demand curve (Willis & Garrod, 2008). The major difficulty with the individual TCM is that it relies on reported as opposed to revealed costs.

   While recent research has found troubling differences between the estimates provided by the individual and zonal TCMs (Willis & Garrod, 2008), both methods are still considered the gold standard in revealed preference methodology. As the individual TCM requires masses of

[1] This section of the paper owes a debt of gratitude to (Farber, Costanza, & Wilson, 2002) for its short overview of the types of non-price valuation.

information, the zonal TCM is still more widely used in environmental economics (Heberling & Templeton, 2009).

2. Hedonic Pricing Method (HPM):

Hedonic Pricing Methods propose that "the quality of a commodity can be regarded as a composite of a number of different characteristics." (Adelman & Grilliches, 1961) In other words, the price that people pay for any product can really be thought of as a combination of their payments for a number of different qualities. While this method was originally refined by Zvi Grilliches as a method for estimating the effect of changing products on the Consumer Price Index (Adelman & Grilliches, 1961), it can also be used to value non-market goods by isolating related qualities inherent in market goods. An example of this would be the valuation of open space by comparing the prices of houses near that open space to the prices of otherwise identical houses that are not near that open space. While there are not as many examples of the use of HPM within non-market and environmental economics, some scholars believe that this method could have wide use in the valuation of ecosystem functions and services (De Groot, Wilson, & Boumans, 2002). One oft-cited study combines HPM with TCM by regressing the travel-cost-constructed demand curves for multiple destinations by the characteristics of each of those destinations, uncovering values of the characteristics that make up each place (Brown Jr. & Mendelsohn, 1994).

Stated Preference Methods

In spite of the strides made in revealed preference methodologies, there are still some benefit values that are extremely difficult to measure. Two conditions of such values complicate these measurements. First, commodities such as clean air and open space are not bought and sold in an open market (Balson, Carson, & Mitchell, 1991). Second, the fees placed on some public services and goods not offered for profit (e.g. gate fees) do not necessarily represent market demand for those products. Therefore, when faced with no options for observing revealed preferences, economists must rely on stated preferences, in the form of surveys of people's willingness to pay for certain products. The two often-used stated preference methodologies that incorporate individual surveys are ***contingent valuation*** and ***conjoint analysis***. Our discussion of these methodologies will focus heavily on contingent valuation method as this tool has been used in multiple contexts by government agencies to assess environmental resource values, with the caveat that many studies have been used for the purpose of damage assessment.

1. Contingent Valuation Method (CVM)

Contingent valuation method (CVM) is a survey method used to determine participants' willingness to pay (WTP) for particular un-priced resources or services, particularly environmental "goods." As Cummings, et al. describe, "contingent valuation devices involve asking individuals, in survey or experimental settings, to reveal their personal valuations of increments (or decrements) in unpriced goods by using contingent markets" (Cummings, Brookshire, & Schulze, 1986).

Although now widely used, CVM has had multiple challenges that have been highlighted in economics literature. It should be noted that many of the described criticisms are specific to use of CVM as a measurement tool for regulatory analysis or damage claims, neither of which are related to the total economic valuation of the National Park System's assets and programming. We have highlighted several criticisms about CVM outcomes and methodology below:

a. ***Response Bias/Overestimation of Value:*** Respondents may not be indicating their true preferences in responding to a survey. Respondents may exhibit a "warm glow" effect by expressing support for a good cause, judging what is good for the country as opposed to their own willingness to pay or reacting to a specific event such as an oil spill instead of valuing a resource (Diamond & Hausman, 1994). A social desirability bias is another challenge, exemplified by a CV survey of willingness to pay to visit Fort Sumter National Monument. Leggett, et al. found that WTP for a visit is 23-29% higher when respondents had to submit anonymous responses in a box to the survey administrator versus an anonymous response that was mailed to the administrator (Leggett, Kleckner, Boyle, Duffield, & Mitchell, 2003). Such biases may lead to an overestimation of the intrinsic value of the asset.

b. ***Insensitivity to Scope:*** This problem is represented by estimates where respondents' valuation of an environmental change does not fluctuate relative to the magnitude of environmental change. For example, the National Oceanic and Atmospheric Administration criticized a report that found "estimates of non-use values that were insensitive to whether 2,000, 20,000 or 200,000 bird deaths were prevented in waste-oil holding ponds" (Boyle & Markowski, 2003).

c. ***Credibility Tests:*** Diamond and Hausman critique the common practice of removing responses that survey administrators deem as being unreasonably large or non-credible due to other factors (Diamond & Hausman, 1994). The removal of outliers and non-credible responses are subject to judgment and may skew final values.

d. ***Variations Across Responses or Surveys:*** Diamond and Hausman find inconsistencies across responses where one would expect similar survey results. The authors point out that true value, if assessed properly, should be consistent across different studies but point out that "when Tolley et al. (1983) asked for willingness-to-pay to preserve visibility at the Grand Canyon, the response was five times higher when this was the only question, as compared to its being the third such question" (Diamond & Hausman, 1994).

In general, most of these criticisms can be met with improved survey design methods that will increase soundness and validity of results. These include providing adequate and accurate information, making the survey balanced and impartial, insulating the survey from any general dislike of big business, reminding respondents of the availability of substitutes, and of their budget constraint, facilitating "don't know" responses, and allowing respondents to reconsider at the end of the interview (Hanneman, 1994; Portney, 1994).

CVM was established as an acceptable measurement of environmental resources by the United States government via promulgation of regulations by the Department of the Interior (DOI) and the National Oceanic and Atmospheric Administration (NOAA). NOAA uses CVM as an analysis tool to assess passive use values related to environmental damage claims in the aftermath of the Exxon Valdez oil spill (Portney, 1994)[2]. This usage, though contested, was later validated by a panel led by Nobel Laureate Kenneth Arrow (Arrow, et al., 1993). Since these applications, the Office of Management and Budget has approved of CVM as an economic value measurement method.

Michael Hanneman also provides some useful references to early examples of CVM applications below (Hanneman, 1994):

> Some notable examples of contingent valuation methodology are Randall, Ives and Eastman (1974) on air quality in the Four Corners area, the first major non-use value study; Brookshire et al. (1982) on air pollution in Southern California; Carson and Mitchell (1993) on national water quality benefits from the Clean Water Act; Smith and Desvousges (1986) on cleaning up the Monongahela River, Jones-Lee, Hammerton and Phillips (1985) on highway safety; Boyle, Welsh and Bishop (1993) on rafting in the Grand Canyon; Briscoe et al. (1990) on drinking water supply in Brazil; and the study on the Exxon Valdez oil spill I helped conduct for the State of Alaska (Carson et al., 1992).

2. Conjoint Analysis

Conjoint analysis (CJ) methodology is recommended by Boyle and Markowski in the context of providing a total economic valuation for damages and claims for National Park Service holdings. A key difference from CVM is that "conjoint analysis presents the change in terms of its component attributes" (Boyle & Markowski, 2003). In the context of valuing existing resources, conjoint analysis may be limited as the change in terms of component attributes is unknown as a result of the park system not existing. Since the counterfactual situation is highly speculative, even in a unit-by-unit analysis, conjoint analysis would have limited application in a total economic valuation of the entire NPS system.

Cost-Based Methods

Cost-based methods represent the marginal economic value of certain non-price products and services as the costs of protecting, enhancing, or replacing that marginal product.

1. Avoided Costs:

Utilizing research on damage and health effects of certain activities, the economic costs avoided in an action to prevent said activities can be found. An example of this may be the calculation of the avoided costs in acid rain damage attributable to a law against air pollution. Concerns about the approach include the dangers of "extrapolation of laboratory results to the true world," including risks of nonlinear damages and mis-aggregation of collective benefits (Waddell, 1974). It is also difficult to reconcile avoided cost approaches with standard consumer surplus-based welfare

[2] Passive use values will be discussed in the economic framework.

economics (Anderson & Kobrin, 1998). This is because damages represent costs imposed on an industry, which shift the supply curve, creating a dynamic consumer surplus whose hypothetical level in the presence or absence of damages is difficult to estimate. Therefore, avoided costs can only be integrated into a consumer surplus model when price changes caused by an action are small or nonexistent (Anderson & Kobrin, 1998). Finally, this method is more related to cost-effectiveness than to benefit-cost calculations, and thus, it is easy to mistake a cost avoided towards an unnecessary or undesirable goal as a benefit. To this end, avoided costs must meet the three criteria laid out below for replacement costs, and even then they are but baseline estimates of net benefit.

2. Replacement Costs:

The calculation of the cost of replacing a non-priced service with a man-made perfect market substitute is known as the replacement cost method. An example of this in use might be valuing the flood protection benefits of a wetlands by calculating the cost of constructing levies that would be equally protective (Sundberg, 2003). The conditions on this method, however, are strident, as any hypothetical man-made replacement must be a perfect functional substitute, be created in the most cost-effective manner, and have a cost that is less than people's aggregate willingness to pay (Shabman & Batie, 1978). As demonstrated in a meta-analysis, all three of these requirements have not been proven to be fulfilled by most historical and contemporary estimates utilizing this technique (Sundberg, 2003).

Other Methods

1. Factor Income:

The returns to inputs of the economic factors of production are known as income. When an un-priced service works together with a factor of production, the returns are a combination of factor income and returns to the service. An example of this would be the combination of human labor, capital, land, and ecosystem services like pest control and pollination working together to create agricultural production (Alexander, List, Margolis, & d'Arge, 1998). If one can calculate the rents due the other factors of production, the surplus income can theoretically be attributed to the un-priced service. Economists have had difficulty, however, separating factor income from that due to un-priced services in any but the most elementary of fashions (Alexander, List, Margolis, & d'Arge, 1998).

2. Benefits Transfer (BT):

Benefit transfer is "the adaptation and use of economic information derived from a specific site under certain resource and policy conditions to a site with similar resources and conditions." (Rosenberger & Loomis, 2001). In this sense, BT is a technique for application in lieu of measurement. Benefits transfer can be enacted at multiple levels of complexity, from a single point estimate taken from one study and applied to another, to a function utilizing multiple characteristics of valuations within other studies. BT is a popular methodology, as it is cheaper than all other

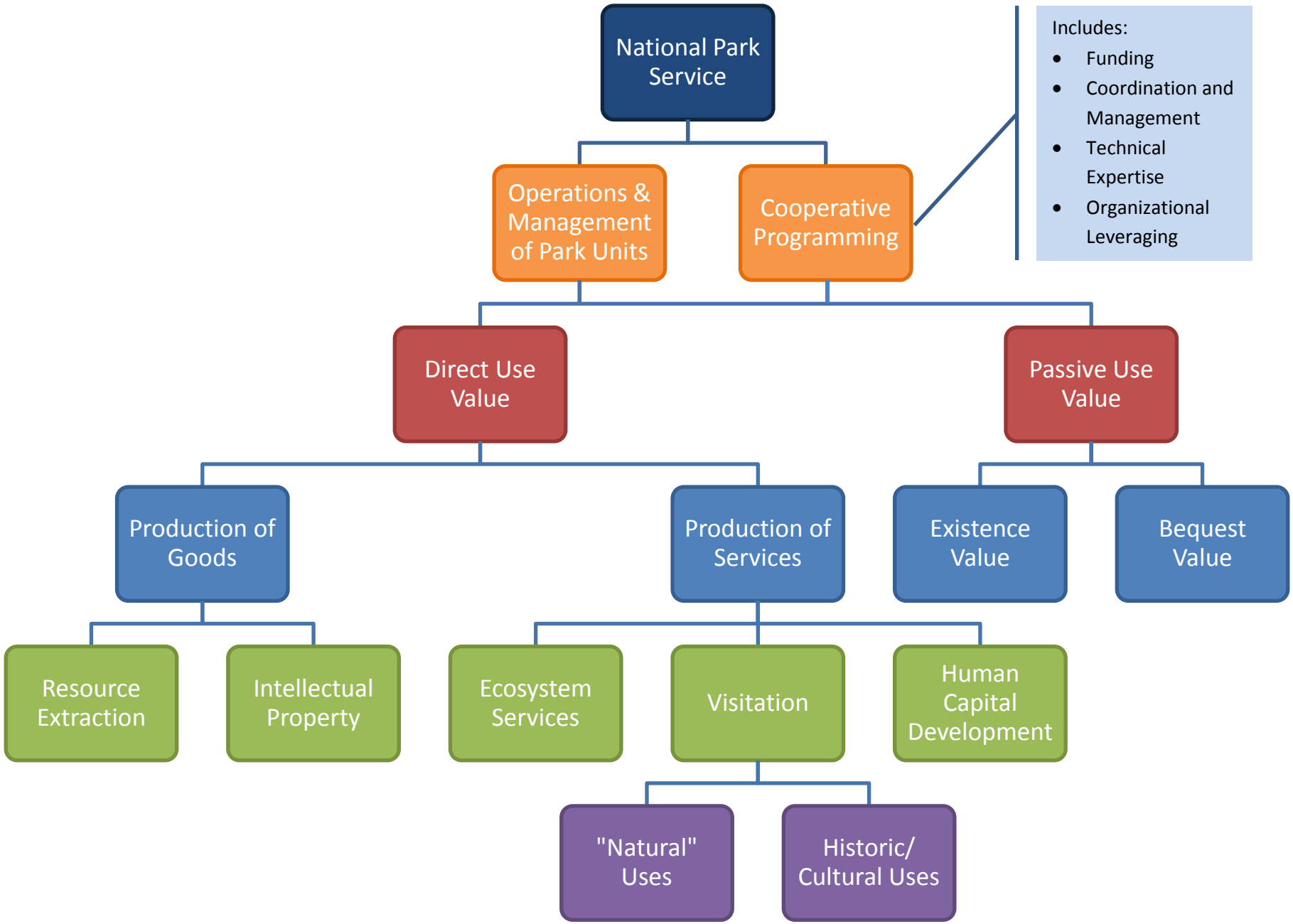
options, and it will be the basis for all estimations within the case study section of this paper. However, it can be used only when environmental resource quality and quantity, user markets, and quality of recreation are similar between the study site and the transfer site (Rosenberger & Loomis, 2001). This can be difficult, as differences in methodologies, data collection, economic substitutes, and values calculated are common between studies (Rosenberger & Loomis, 2001).

Introduction to the Economic Valuation Framework

Economic valuation of environmental goods and services has been well-covered in recent economic literature. Multiple frameworks have been created for the valuation of ecosystem services, wilderness preservation, and even public lands. However, for an entity whose structures and services are as complex and varied as the National Park Service, there is little in terms of valuation precedent.

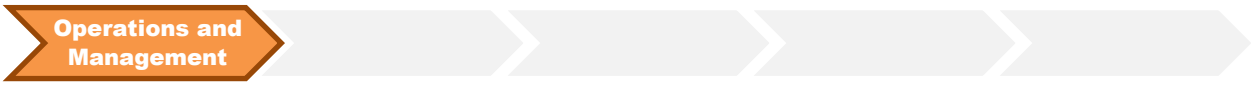
The framework that follows, therefore, is based on a close examination of the services provided by NPS operations, assets, and programming ascertained through interviews and consultation with Park Service administration, Park Service employees and environmental economists, as well as the aforementioned extensive literature review. The main differences between our framework and previous public lands frameworks is the emphasis we place not only on the services provided by the lands, but also the added services created through the maintenance and programming connected with these lands. The value of these services, in addition to the programmatic values created by the NPS outside of park boundaries, makes up the skeleton of our new framework.

Economic Valuation Framework

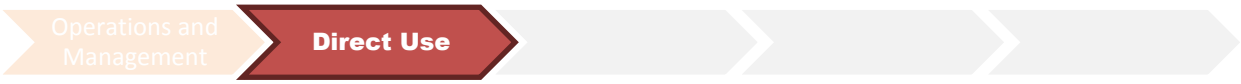


Explanation of Framework

The above framework attempts to categorize all values created by the National Park Service through its operations, services, and management of national assets. When consulting with multiple NPS officials, it became clear that there were two main categories of services that provide consumer value, ***Operations and Management*** within the National Park units, and ***Cooperative Programming*** outside of those borders (Fraser, 2011).



The category of Operations and Management is where one finds all of the values normally associated with National Parks. All visitation, use of, and interaction with the actual parks falls within this category. The creation of this branch of the framework relied heavily on the work of environmental economists Edward Barbier (1994) and Rudolf De Groot, Matthew Wilson, and Roelof Boumans (2002). Barbier's framework, in particular, cleanly classified the direct and passive use values created by ecosystems, and was the impetus for the similar framework created here for parks. Cultural and educational uses of areas were only indirectly addressed within the above ecosystem-based frameworks, and thus were a unique addition to our parks-based valuation outline[3]. As suggested, the values created within a park can be divided into ***Direct*** and ***Passive Use Values***.



Direct use values are those "derived from a direct use or interaction with a….resource or resource system" (European Environment Agency). For the purposes of this framework, this definition covers all consumptive economic activities, as well as those categories that sometimes fall under the heading of indirect use, such as general services provided by ecosystems. Within the direct use category, the National Park Service provides people with many uses, which can further be broken down into the categories of ***Production of Goods*** and ***Production of Services***[4].

Production of economic goods within U.S. National Parks can be subdivided into the two broad categories of ***Resource Extraction*** and ***Intellectual Property.*** Vending of food products, souvenirs, and guiding services that take place within the park will not be discussed in the framework as its value is

[3] For a different and interesting take on valuation of National Parks (which we chose not to incorporate due to lack of mutual exclusivity between the branches of the framework) see (Suh & Harrison, 2005).

[4] The framework runs into the difficulty of necessarily defining each of its categories as the National Park Service *production*, but measuring that *production* (in the tradition of welfare economics) by calculating the total value to the *consumer*. Therefore, while the sub-categories are labeled Production of Goods and Production of Services, they will be measured with the tools of *consumer surplus* calculation.

wrapped up in the consumer surplus that people obtain from visitation. This vending therefore does not represent individual use value created by the park, but can instead be considered as an amenity that contributes to other categories of use value.

Natural areas preserve resources that can be, and sometimes are, harvested. While most National Parks do not allow extraction of resources, there are some exceptions to this rule. In Big Cypress National Preserve, 99% of subsurface mineral rights are controlled by private entities, and its 14 oil wells have produced over 30 billion barrels of oil in their history (National Resource Program Center, 2008)[5]. Hunting is permitted seasonally in the Mojave National Preserve, along with 68 other NPS units (National Park Service). Finally, there are some parks, such as Denali National Park in Alaska, where timber and plant harvest for subsistence purposes is permitted (National Park Service). While the magnitude of extraction is small enough to be of little consequence, it is still necessary to account for these activities in and economic valuation, using their market prices. It has also been suggested that replacement costs, factor income, and contingent valuation might be used for valuation (De Groot, Wilson, & Boumans, 2002).

It is important to consider, however, whether preservation by the National Park Service helps or hinders resource extraction. If one believes that the park Service is actually a hindrance to extraction, then the resources foregone must be counted as a cost instead of a benefit of preservation (Dixon & Sherman, 1991). This calculus varies greatly with resource type. For marine and land protection areas, the commercial value of fishing and hunting foregone can be mitigated if the protection of healthy populations within the parks create spillover effects that improve hunting and fishing production in surrounding areas (Carter, 2003). A protected marine park in Kenya was found to have just such spillovers, increasing the biomass and size of fish caught by traps in the region sufficiently to compensate for the loss of fishing within the protected area (McClanahan & Mangi, 2000). Preservation can also be beneficial to extraction when sustainable activities have a higher return than unsustainable ones. A well-known 1989 study found that the value of all goods sustainably harvested from a region of Amazonian rainforest had a higher value per hectare of forest than its timber (Peters, Gentry, & Mendelsohn, 1989). In other cases, such as the Arctic National Wildlife Refuge, however, preservation comes at the cost of resource extraction.[6]

The next category of goods produced in or with the contribution of National Parks units is intellectual property (IP). For the purposes of this study, IP consists of two very different subcategories that we will label ***Research*** and ***Media.***

[5] Big Cypress National Preserve closely monitors extraction to ensure no harm is done.
[6] This is not to say that ANWR's preservation is a net cost, but only that foregone oil production must be tallied as a cost in the valuation of the preserve.

Research

Each year, NPS units give out over 4000 research permits in fields ranging from geology to botany to environmental impacts of human actions (National Park Service, 2012). This research creates value in the public, academic and corporate spheres, and NPS is seldom accounted for as a source of that value. In order to do so, we must be able to first value the research and then determine what part of the research's value originates in the park. We also must be certain that such research could not have been conducted if the park did not exist.

In his seminal piece on the economics of research, Richard R. Nelson makes the case that research is difficult to value for two reasons:

a. It is often highly discounted in value because returns on investment are often not seen for years.
b. There is a significant chance that any one project will produce no economic benefits.

He suggests that the more broadly based the research, the more likely it is to have value (Nelson, 1959).

More recently, researchers have revealed multiple findings. Jaffe (1989) found statistically significant spillovers from academic research to local productivity. Salter and Martin's meta-analysis (2001)suggests that private research and development brings 9%- 43% private returns and 10%-160% social returns on investment. They also note that large numbers of private executives rate public research in fields like biology, chemistry, mechanics, and computer science as important to their business. Mansfield (1991) finds that in the fields of Information Processing, Chemical, Electrical, Instruments, Drugs, Metal, and Oil, an average of 11% of products and 9% of processes could not have been developed without academic research. Richardson (2005)cites a 1996 paper (unable to confirm source) as placing a value of $350,000 (or $15,000 annual discounted value) on each academic research paper produced. However, this value was found through a calculation of time and money spent on the production of the research, and does not represent its value to the consumer.

However, with the exception of the last study mentioned, none of these comes close to a generalizable rule or methodology for valuation of research. And, as Nelson noted, there is such a time gap between research and effects, as well as such a difference in value between individual studies, that value may be difficult to assess its value through revealed preference methodologies or market-based methodologies such as direct market pricing or factor income. Instead, the best way to understand the value of the scientific contributions of National Parks may be by using contingent valuation methodology on a project by project or park by park basis.

Media

Artwork, photographs, books, calendars, music, feature films, documentaries, commercials, and even music videos are all created within or using the backdrop of National Parks. An Amazon search of "Movies and TV" containing National Parks returned 1270 results, and the same search in the books category returned more than 82,000 results (including multiple collections of photographs by Ansel Adams and other famous photographers) (Amazon.com, 2012). Granted, there are many guidebooks and other media whose value is contingent on the continued existence of the National Parks, but there are others (e.g. Ansel Adams) that generate new value using the parks.

Valuation of the contribution of the parks to these media is difficult. Multiple studies have used hedonic pricing methods to find that subject matter plays a role in the market value of artwork (Valsan, 2002), but none have indicated that it would be possible to value the contributions of individual place to these works (such a study would necessitate an extremely large sample size of place-specific art). Interestingly, one study noted that, among Canadian and American high-priced art, landscape paintings actually have lower values than non-landscapes, all other things held equal (Valsan, 2002).

The second difficulty with valuing media output from parks is that it is virtually impossible to know how much media is being put out at any one time. The NPS only requires a permit for commercial photography if there is filming, if the photography uses sets, models, or props, or if the park would "incur additional costs" (National Park Service, 2012). This means that there is no record of anyone taking still photographs, painting, writing, or anything else of the sort.

If one is able to track down all media created in a park, the best approach, as mentioned before, is utilizing HPM to ascertain the media value that parks create. However, as this is a difficult task, it may be best, once again, to fold this value into part of a larger contingent valuation study.

For the purposes of this framework, we will define services, as products that are simultaneously intangible, inseparable, perishable and heterogeneous (Fisk, Brown, & Bitner, 1993), although we may relax the assumption of heterogeneity when we review the physical processes of ecosystem services. The National Park Service provides three different service types that fit into this category: ***Ecosystem Services, Visitation,*** and ***Human Capital Development.***

Ecosystem services are defined as the intangible "benefits human populations derive, directly or indirectly, from ecosystem functions." (Costanza, et al., 1997) Economists have laid out up to 17 different services provided by ecosystems, in an exhaustive categorical list (Costanza, et al., 1997; De Groot, Wilson, & Boumans, 2002). For purposes of brevity, however, this report will examine the following shortened list of ecosystem services, which relies on the meta-analysis of Krieger (2001):

1. Climate Regulation
2. Watershed Services
3. Soil Formation, Erosion Control, and Air Quality
4. Biological Diversity
5. Open Space

The National Parks of the U.S. cover over 84 million acres of land and contain ecosystems of all sorts including forests, deserts, wetlands, plains, tidal zones and deep seas. It is therefore certain that the

ecosystem services provided by NPS units are vast and disparate. This report cannot hope to be comprehensive in this field, but instead to provide a framework and strategy for valuation.

1. Climate Regulation

National Park service units play a role in both local and global regulation of climates. Locally, forests transpire, producing local precipitation, and provide insulation, both holding heat in the winter and providing cooling shade during the summer (Costanza, et al., 1997; De Groot, Wilson, & Boumans, 2002; Krieger, 2001). Local climate regulation values can sometimes be ascertained through the avoided cost method, as with Tucson, AZ, which saved $20.75 per tree planted per year in building cooling costs (Krieger, 2001)[7]. Hedonic pricing methods and contingent valuation are also possibilities in this arena (De Groot, Wilson, & Boumans, 2002).

The global climate benefits (albeit differently) from the preserved presence of each type of ecosystem. The Nature Conservancy has estimated that federally protected coniferous and oak forests in Mexico store around 250 tons of CO2 per hectare per year, while protected desert and semi-arid areas store 15 tons per hectare per year annually (Bezaury-Creel & Pabon-Zamora, 2011). The U.S. Forest Service has calculated that willingness to pay for carbon storage in the forests of the Northwest is $65 per ton, meaning that (equating the three types of forest), protected forests in the Northwest produce $16,250 of value per acre in carbon storage alone (Talberth & Moskowitz, 1998; Krieger, 2001)[8]. For valuing global climate benefits, contingent valuation and avoided cost methods are suggested.

2. Watershed Services

"Watershed services" is, for the purposes of this report, a catchall category that includes waste treatment and water supply/regulation. Waste treatment (which is one of the largest ecosystem services in terms of value according to economists) includes water pollution control through ground filtration and detoxification of organic and inorganic materials (Costanza, et al., 1997). Krieger (2001) estimates that waste treatment by U.S. forests creates over $18 billion worth of value annually. Not all of this takes place through water processes, but as much does, it will remain classified here. These waste treatment services can best be valued through avoided, or in some cases, replacement costs. For all watershed services, HPM and contingent valuation are also appropriate methodologies (De Groot, Wilson, & Boumans, 2002).

As local populations grow, an increasingly important function of ecosystems, and to a large degree National Parks, is regulation and provision of water supply. We already discussed in the climate section how local ecosystems provide climate effects of temperature regulation and rainfall, but additionally, natural ecosystems regulate flows, filter and store large amounts of potable water. One way this can be valued is through avoided costs (and in some cases replacement costs), as is the case with New York City, which decided to spend $1-$1.5 billion to restore upstate watersheds, thereby avoiding the $6 to

[7] We recognize that costs avoided through trees planted is not equal to costs avoided through forest preserved, but there may be some transferability of these calculations.

[8] The USFS methodologies could not be confirmed as this specific part of their document was not available for public review, but their estimate was confirmed in the sources cited above.

$8 billion cost of financing a new water filtration system (National Research Council, 2005). Loomis estimates that the economic benefits to nearby towns from a wilderness watershed were in the range of $0.21 to $0.36 per acre annually (Loomis & Richardson, 2001).

3. Soil Formation, Air Quality and Erosion Control

The formation of new soils through organic processes is only valuable within National Parks if the benefits of those soils somehow transfer outside of the National Parks. While soil quality undoubtedly contributes to biodiversity (the benefits of which are assessed below) it probably has little economic value within National Parks in its own right.

The control of wind and water erosion within parks, however, is extremely valuable as it creates cleaner air and prevents undesirable sedimentation in waterways. Plants and other organic matter block wind and their structural integrity hold earth in place, preventing the release of fine grain particulates into the atmosphere. Dr. Jayne Belnap has found that highly developed undisturbed cryptobiotic soil crusts in the Colorado Plateau prevent nearly 100% of wind erosion (Belnap, 2012). Further, once particulates do enter the atmosphere, trees and plants filter out that dust (Krieger, 2001). Richardson (2005) noted that in the Riverside and San Bernardino areas of California, 1200 deaths and 5 million workdays can annually be attributed to particulate matter pollution, one of the largest causes of which is unpaved roads and desert disturbances. Plants and soil formation also prevent water erosion and its associated costs. Tucson, AZ estimated runoff prevention of 9 cubic feet per tree planted, calculating an avoided cost of $0.18 per tree annually (Krieger, 2001). Although it may be difficult to assess, the contribution of ecosystems in a National Park to the lessening of air pollution and erosion control can potentially be valued through avoidance costs taken to prevent similar effects, replacement costs for preventative measures, HPM of property value, or contingent valuation of a change in pollution/runoff levels (De Groot, Wilson, & Boumans, 2002).

4. Biological Diversity

Ecosystem biodiversity provides many present and future benefits to consumers, ranging from medicinal plants and animals to pollination (Costanza, et al., 1997). Species that make their home within "wildlands" ecosystems by humans, such as woodpeckers, have an estimated global pest control value of $11.4 billion per year (Talberth & Moskowitz, 1998). The U.S. Forest Service estimates that it would require $7 per wild acre to replace these species with pesticides (Krieger, 2001). Wild pollinators create an estimated $4-$7 billion worth of value in the U.S. alone. Finally, diverse and well-adapted plant species in much of the country have unique strategies for preventing massive wildfires that are not always shared by invasive species. Protected areas' management plans for non-native grasses have been shown to prevent frequent potentially costly forest fires in the Southwest U.S. (Archer & Predick, 2008). As is evident above, biological diversity can be valued through avoided costs, replacement costs, contingent valuation, HPM, and factor income methods (De Groot, Wilson, & Boumans, 2002).

5. Open Space

While open space values might reasonably be placed in the passive use section of the framework, they are currently categorized as an ecosystem service, as their use still involves interactions with the park. A hedonic regression modeling of home prices along and away from the Peconic Estuary in Long Island, NY demonstrated statistically significant values to open space through price premiums on those houses lining the estuary (Grigalunas, Opaluch, & Trandafir, 2004). It is unclear if HPM with be an appropriate methodology with the sparse populations bordering many National Parks, and for non-residents, open space values are captured in Visitation use values.

The Natural Capital Project has created an excellent tool for total valuation of ecosystem services that may be of aid in upcoming studies. With this tool, the user can calculate and model carbon sequestration, sediment retention, timber production, water purification, habitat risk and more. The tool can be found at www.naturalcapitalproject.org.

This category is divided into ***Natural Uses*** and ***Cultural/Historical Uses***, based on the way that NPS divides its units and sites between natural and cultural/historical resources. One confounder of this division is the fact that many parks provide both natural and cultural/historic uses, as will be seen in the case study. Economically, this is somewhat of a false dichotomy, as both types of uses are similar in their value calculations.

Natural use values are undoubtedly those that come to our minds first when we think of National Parks. Within the category of natural uses, one can find camping, hiking, sightseeing, climbing, boating, fishing, hunting, biking, wildlife viewing, and almost any other recreation available in the outdoors. There were over 279 million recreational visits to National Park Service Units in 2011, of which almost 70% were to areas where recreation might reasonably be classified as a "Natural Use" (National Park Service, 2012). While there is little data about the activities of visitors aggregated at the NPS-wide level, it is known that there were almost 2 million backcountry overnights and 3.2 million tent camping nights within the parks (National Park Service, 2012). Individual parks often have more in depth visitor use statistics, making it possible to pinpoint visitor origins and activities to a fairly specific level of granularity.

There is an extremely wide literature base focused on listing and measuring the benefits of outdoor recreation. This literature is well-summarized and classified in two databases of outdoor recreational use values (one for U.S. public lands, and one for North America as a whole), with each having catalogued at least 1200 use value estimations (Loomis J. , Updated Outdoor Recreation Use Values on National Forests and Other Public Lands, 2004; Rosenberger R. , 2011). The estimates were almost entirely gathered using contingent valuation and travel cost methods, the two most widely accepted methodologies for valuing recreational use.

The Rosenberger database, which is easily accessible to the public, can be used for some basic calculations (2011). The estimations in the database are split almost perfectly evenly between stated preference and revealed preference methodology. The average recreation use value across all subcategories is $59.60 per day, and, as can be seen in the figure below, revealed preference methodologies fluctuate less in the estimation of value. National Park usage makes up only a small part of studied use (44 out of 2703 estimates) and overall average recreation day value within them is $106, which is significantly higher than other types of public land (Rosenberger R. , 2011). It is possible, however, that this unexpectedly high average is attributable to the small number of estimates and the influence of outliers, as may be seen in the divergence of the stated and revealed preference estimations for the parks.

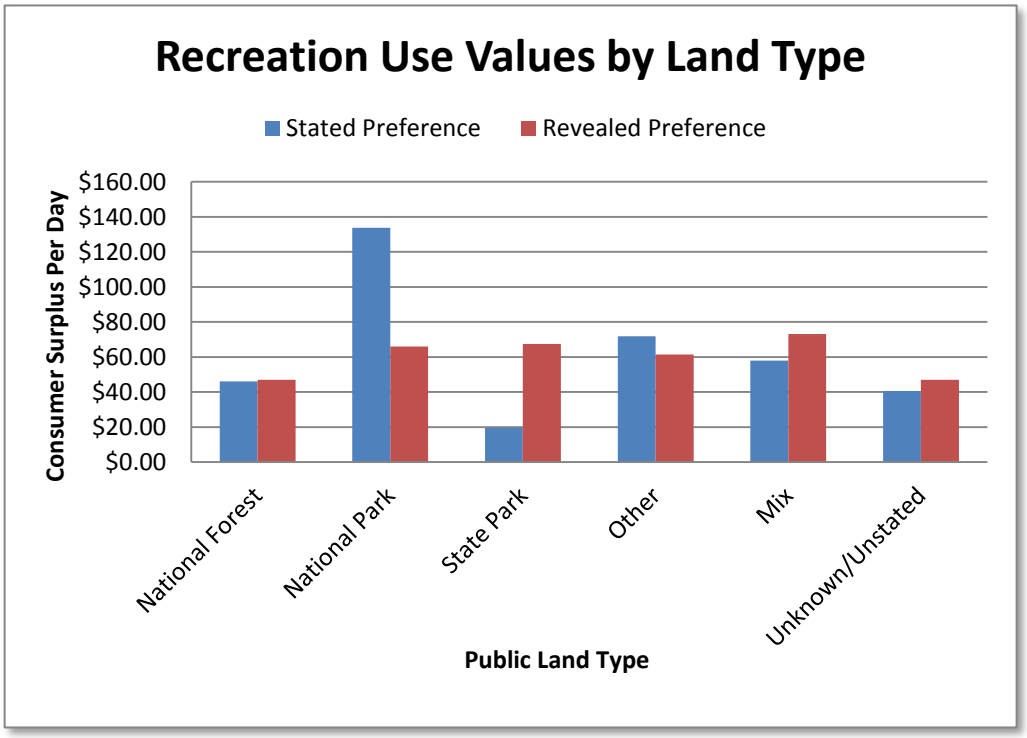


Figure 1: Recreation Use Values

Division by activity type also demonstrates some interesting results. Within the data set, mountain biking, fishing, hunting, and canoeing/kayaking were found to have the highest recreational consumer surpluses, while camping, backpacking, and picnicking were found to have lower recreational use values (Rosenberger R. , 2011). It is important, however, to note that variations in region, biome, and quality of resources can greatly affect all of these valuations, each of which is currently victim to a fairly small sample size of observations. Therefore, benefits transfer using this database should be calculated using regression, in order to best approximate the effects of these characteristics. It is highly advisable, however, to utilize TCM or CVM in estimation in place of benefits transfer. To that end, a highly encouraging recent study was able to utilize visitor data that the National Park had gathered for other purposes to estimate travel cost method recreation use values that were fairly consistent with other estimates (Heberling & Templeton, 2009).

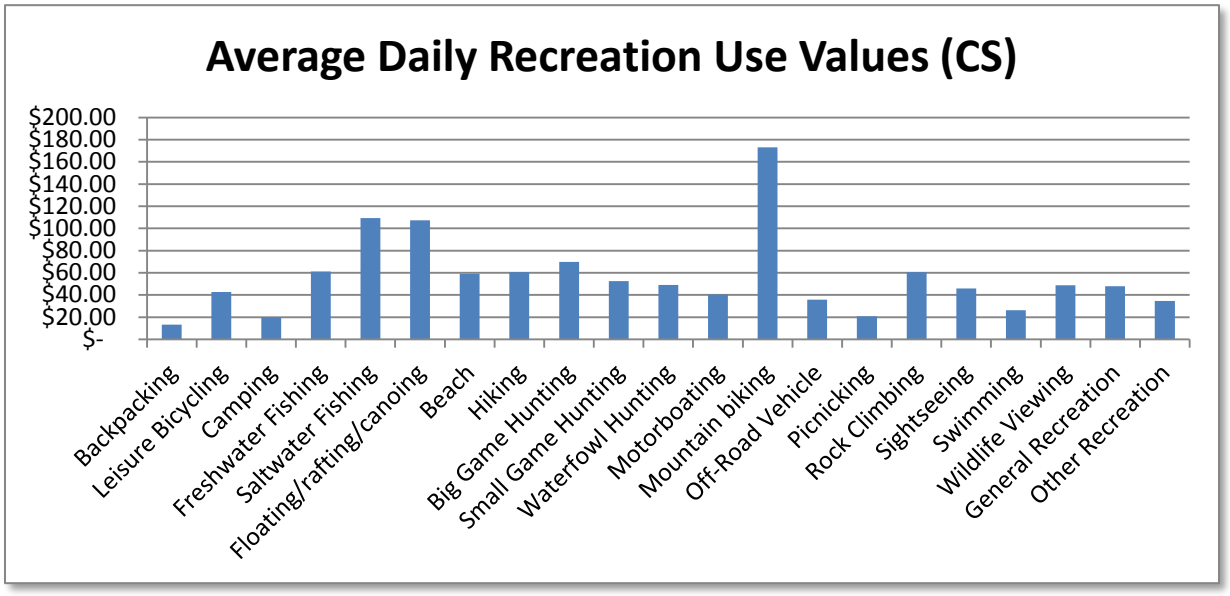


Figure 2: Consumer Surplus by Activity

Finally, the health externalities of the outdoor recreation available in the parks are likely high. Research has shown that outdoor recreation is a significant reducer of stress and obesity, and can also combat ADHD in children (Godbey, 2009). A study of Pennsylvania state parks found that 63% of visitors to these parks reported being moderately or vigorously physically active during their visit, a type of exercise that dramatically lessens cardiovascular risks (Godbey, 2009). The NPS has capitalized on this benefit by creating the Healthy Parks, Healthy People US Initiative, holding and summit and writing grants to National and state parks that create programs supporting the initiative (National Park Service, 2011). Little research, however, has been done on the economic benefits of healthy activities within the parks and it is unclear if some or much of this value is already represented within the contingent valuation and travel cost method approaches already in use.

Cultural use parks, including battlefields, historical sites, and some monuments, make up the remaining 30% of park visitor recreation days (National Park Service, 2012). Additionally, many National Parks and National Monuments host both natural and cultural uses[9]. Cultural uses have, in recent years, started to be valued in similar fashion to natural uses, using the travel cost and contingent valuation methods. A study of visitation to St. Mary's City in Maryland, a preserved historic town from the 17th and 18th centuries utilized both zonal and individual travel cost methodologies to calculate consumer surpluses ranging from $8 to $19 per visitor day, depending on the method used (Poor & Smith, 2004). A contingent valuation study of Mt. Kayasan, an important National Park of cultural and historical value

[9] An excellent example of this is Mesa Verde National Park, which is home to hiking, wildlife viewing and camping, as well as tours of the ancient villages of cliff dwelling Native Americans.

and a UNESCO World Heritage Site in South Korea, yielded consumer surplus values of $11.70 per visit, although the fact that there were also natural activities available in the park made it uncertain how much of that value was cultural/historical use-based (Lee & Han, 2002). In the relatively sparse literature of cultural use valuation, the estimates are significantly lower per day than are those for natural uses.

One problem in designing contingent valuation surveys for cultural resources is extracting the direct use values from the preservation/passive use values. Taking this into account, Navrud and Strand (2002) conducted their survey only among direct users of a cathedral, asking them to value improvements to this cathedral specifically in terms of how it would affect their use and enjoyment (direct use), as well as how the knowing of the renovation would affect their overall happiness (passive use). The book this study is found in, *Valuing Cultural Heritage: Applying Environmental Valuation Techniques to Historic Buildings, Monuments, and Artifacts* (Navrud & Ready, 2002), is an excellent resource for cultural use valuation techniques.

Each unit of the NPS runs myriad within-park interpretive and educational programs for both children and adults. Most parks presumably maintain data on the number of educational visits per year, but there is little data aggregated at the national level. Youths from ages 15 to 18 work in 22 NPS units, as well as the National Forest System, as part of the Youth Conservation Corps (YCC) in what is functionally a paid apprenticeship in preservation (National Park Service, 2012). Furthermore, 125,000 unpaid volunteers contribute hours towards NPS preservation and interpretation, and undoubtedly gain valuable skills and knowledge in the process (National Park Service, 2008).

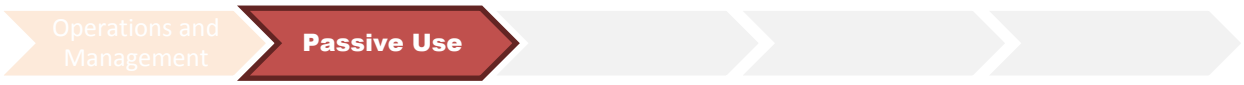
This human capital development can be difficult to value, as it is often unclear what value it contributes. Using quasi-experimental techniques such as regression discontinuity, researchers have found a general increase in future wages of 7 to 15 percentage points for each extra year of high school (Oreopoulos, 2006). Similar, if slightly varied, estimates are available for most grade levels. However, even if aggregated yearly student school days attributable to NPS educational programs is calculated, it is not clear that a 180 of these days is in any way equal to a year of standard schooling. Also, for direct education of school children, the NPS' program does not fully pass the counterfactual test, as the days of schooling provided to children through visits to National Parks units are replacing a service that would have been provided anyway by the school district. YCC and other adult education programs may pass the substitute test, but the quantity of benefit provided is difficult to capture.

One promising lead is the effect outdoor education creates on an individual's locus of control. The locus of control, which is a psychological concept indicating the extent to which individuals believe they can affect the world around them, has been positively correlated with school and job performance, (Neill, 2002). It has been found that outdoor education programs positively increase an individual's locus of control rating, with effect sizes ranging from .2 to .55 depending on the characteristics of the outdoor

education (Neill, 2002). This is, however, the impact of one very specific type of program that represents very little of the entire human development value created by the NPS.

Finally, there is the disputable value of human development for volunteers. While it is likely that many volunteers gain skill benefits from their involvement with the NPS (e.g. Citizen Scientists), it is difficult to impute value from this interaction. In fact, while there is a large amount of public information on the value to an organization of a volunteer hour worked (currently $21.36) (Independent Sector, 2012), there is little to no information on the economic value of that hour to the volunteers and their networks. The most accurate way to measure this would be through the estimation of increases in human and social capital due to increased volunteer hours (Wisener, 2009). The link between human capital and economic success that was developed earlier has also been used empirically to tie increased social capital to economic growth, therefore employing a human capital multiplier in estimating changes in GDP (Mayer, 2003). In practice, however, there is very little way to quantify units of social capital, or to attribute them solely to NPS volunteering.

At present, lacking further research, the most appropriate methodology for the value of human capital development within the National Parks is probably contingent valuation. While variable and prone to bias, this method has the advantageous ability to assess both use and existence values of these programs. One risk is that this methodology may not account for the positive externalities afforded by economic growth due to education.



Passive use values describe the benefit that individuals receive from a resource despite the fact that they do not directly consume goods produced from the resource. A simple example would be those who appreciate the fact that Yellowstone National Park is protected but have never nor will ever visit the park. In the context of environmental resources, NPS may protect or enhance the value of resources which cannot be created, may only be destroyed, and may hold passive values. Kevin Boyle and Marla Markowski find that these values "refer to all values that people hold for ecosystems, scenic wonders and historically significant resources in the Park Service that are not associated with the use of these sites" (Boyle & Markowski, 2003). Passive use values will be understood in this report as synonymous and interchangeable with non-use values.

Passive use values have been used to describe natural resources, such as wilderness areas, from early applications of economic concepts to the natural environment. In 1967 economist John Krutilla had the value of the Grand Canyon in mind when writing that "when the existence of a grand scenic wonder or a unique fragile ecosystem is involved, its preservation and continued availability are a significant part of the real income of many individuals" (Krutilla, 1967). He goes on to argue that these individuals include non-users when noting that "there are many persons who obtain satisfaction from the mere knowledge

that part of the wilderness of North America remains, even though they would be appalled by the prospect of being exposed to it" (Krutilla, 1967). Harpman, Welsh, and Bishop touch on a similar point in 1994 when asserting that "nonusers, or individuals who never visit or otherwise use a natural resource may nonetheless be affected by changes in its status or quality" (Harpman, Welsh, & Bishop, 1994). In the context of this study, passive use value measures the value to U.S. constituents of the sustained existence of the National Park Service's holdings, even without personal use. Harpman, et al. provide a useful distinction for thinking about passive use values in two separate categories. They describe ***existence value*** as "the benefit generated today by knowing that a resource exists even if no onsite use is anticipated" (1994). Additionally, "***bequest value*** is the value individuals gain from the preservation of the resource for use by their heirs" (Harpman, Welsh, & Bishop, 1994).

The magnitude of passive use values within the environmental context depends on the scarcity and uniqueness of the resource in question, as with valuation of other types of goods in economic theory. Krutilla argues that "by assumption, the resources used in a manner compatible with preserving the natural environment have no close substitutes; on the other hand, alternative sources of supply of natural resource commodities are available" (Krutilla, 1967). National Park Service holdings, at least those in the natural environment setting, may offer great examples of such unique resources with no substitutes. Boyle and Markowski theorize that "National Parks may be the penultimate example of resources that are considered to have unique attributes that give rise to substantial non-use values" (2003). Harpman, et al. expand on this concept in explaining that "the significance of nonuse value may depend on the irreversibility of the action; the irreplaceability of the resource; whether the resource is regionally, nationally, or internationally significant; whether threatened or endangered species or their habitats are involved; and whether use is rationed" (1994). Important to this understanding is the assumption that NPS holdings would look significantly different were it not for the service's stewardship of wilderness areas, historic holdings, and other units. These counterfactual conditions imply an opportunity cost to the maintenance of NPS lands as natural or historic spaces, which will be exemplified in the case study.

A particularly relevant example of contingent valuation method to assess the value of an environmental resource was supplied in a study on the Glen Canyon Dam Recreation Area. The nonuse value of Glen Canyon Dam ranged from $60.5 million to $81.4 million in aggregate annual value, depending on which of three water release options were selected. The four year effort to assess the value of the area included "extensive qualitative research, a number of focus groups, a survey design phase, two reviews by the Office of Management and Budget, a pilot-test phase, and a final survey of 8,000 households in the United States" (Welsh, Bishop, Phillips, & Baumgartner, 1997).

Cooperative Programming

The cooperative programming section is intended to describe *services* related to NPS activities as opposed to type of *values*, which has henceforth been the primary discussion. We felt that this discussion seemed necessary as many total economic valuation studies will examine consumer values within the park setting, but do not seek to capture those activities provided by the entire National Park

Service. Describing these services can help inform the construction of a tool for valuation such as a contingent valuation method approach. The term "Cooperative Programming" is used to describe activities and programs provided by the National Park Service that don't directly impact park holdings. Each of the following categories is representative of a type of NPS Cooperative Programming, and within each category one can find some or all of the values previously discussed in the framework (e.g. human capital development, ecosystem services, and visitation values). However, as the National Park Service is contributing solely the funding, technical expertise, coordination, or leveraging, and not, in fact, directly contributing the direct and passive use values. This status of the National Park Service as "once-removed" from the values conferred by its Cooperative Programming makes this set of categories extremely difficult to place a value on.

The National Park Service identifies 23 specific programs of this nature, listed comprehensively in Figure 3:

Figure 3: Programs Under NPS Administration

1. American Battlefield Protection Program
2. Federal Lands to parks Program
3. Federal Preservation Institute
4. Heritage Documentation Program
5. Heritage Education Services Program
6. Historic Lighthouse Preservation Program
7. Historic Preservation Tax Incentives Program
8. Hydropower Recreation Assistance Program
9. International Affairs Program
10. Land and Water Conservation Fund Program
11. Maritime Heritage Program
12. National Center for Preservation Technology and Training
13. National Heritage Areas Program
14. National Historic Landmarks Program
15. National Native American Graves Protection and Repatriation Act Program
16. National Natural Landmarks Program
17. National Register of Historic Places
18. National Trails System Program
19. National Underground Railroad Network to Freedom Program
20. National Wild and Scenic Rivers Program
21. Route 66 Corridor Preservation Program
22. Rivers, Trails, and Conservation Assistance Program
23. Shared Beringia Heritage Program

Additionally, employees of National Park Service units may perform functions not listed within the 23 programs above that create both direct use and passive use values. We will present some examples of such services in the case study. While this category of services has been subdivided into four separate areas, programs often serve multiple functions that may provide varied service types and values. For example, a funding program provided by NPS could very well play a role in coordinating amongst grant recipients as well as provide a funding avenue.

Coordination and Management

NPS often serves as a coordination agency when working on an issue or regional approach with other stakeholders. These can include other federal agencies, state agencies, non-profit organizations, and private entities amongst others. The coordination role involves working as the overarching manager of a project or system and can often be combined with their funding role.

Examples:

- **Land and Water Conservation Fund (LWCF) State Assistance Program:** The purpose of this mission is to assist states with planning outdoor recreation areas. Many examples are projects that NPS will partner with state and local governments to create public recreation in urban spaces, such as playing fields and skate parks. These conserved state and local areas provide citizens with similar ecosystem services (especially open space and watershed services) and the natural visitation values of outdoor recreation.

- **American Battlefield Protection Program:** Battlefield protection is accomplished both by assuming stewardship of historic sites, which can be run as units of the NPS, or working with other organizations so that they can acquire historic properties and protect them in perpetuity. In doing the latter, the NPS" encourages States, tribal governments, communities, nonprofit organizations, educational institutions, and individual citizens to become the stewards of significant historic battlefields" ("National Park Service Programs"). These programs have exhibited great success by producing significant direct use values. A 2006 study commissioned by The Civil War Preservation Trust found a willingness-to-pay of $51.13 for visiting a civil war battlefield (Davidson-Peterson Associates, 2006). There are also significant existence and bequest values associated with historical preservation of battlefields.

Funding

NPS administers several funding programs that provide tax incentives or grants to protect natural or historic resources. As noted above, this funding can often be combined with a

Examples:

- **Historic Preservation Tax Incentives Program:** "This program's mission is to work cooperatively with the Internal Revenue Service and State Historic Preservation Offices (SHPOs) to promote the use of tax credits as a means of encouraging private property owners to rehabilitate historic buildings"

("National Park Service Programs"). As is evident from the description, this responsibility falls under the headings of both Funding and Coordination and Management. The historic preservation encouraged by this program creates historical and cultural direct use values and likely some of the passive use values that often come with preservation.

- **The Land and Water Conservation Fund**: This is the largest program run by the NPS that provides funding for conservation. Funded programs can range from trail development, battlefield preservation, developing local parks, and other diverse uses. This program is broad enough that it encompasses all of the value categories from the framework.

Technical Expertise

Ever since its inception, the National Park Service's holdings have served as a unique place where groundbreaking science and research was conducted and shared with the world. From Adolph Murie's revolutionary research on wolf ecology in the 1930s and 1940s, which spurred conservation efforts across America, to the work of the National Center for Preservation Technology and Training today, NPS has provided a valuable technical resource that is consumed and appreciated inside and outside National Park units. NPS' expertise can be valued in many areas outside of science and research, including programming, organization, and preservation efforts.

Example:

- **National Center for Preservation Technology and Training:** The center was created by Congress to address the technical challenges of preserving historic properties. The mission of the center is to use science and technology to create solutions for such challenges and the reach of the program extends to "museums, universities and non-profits" ("National Park Service Programs"). The program also serves as a clearinghouse for research on preservation technology and methodology. The most primary of values created through this program is that of human capital development, but secondary values include the benefits of successful preservation performed by program trainees.

Organizational Leveraging

Prior to the existence of the National Parks, few institutionalized opportunities for protection of natural resources and preservation of historical resources were available. The mere existence of the parks themselves make it possible for other conservation and preservation efforts to occur. Sometimes, the National Park Service provides programmatic services to extend their core mission beyond park unit boundaries. At other times, NPS uses the weight of its organizational reputation to accomplish goals with only indirect action.

Examples:

- **National Natural Landmarks Program:** The mission of this program "is to encourage and support the voluntary preservation of sites that illustrate the geological and biological history of the United

States," which is accomplished by assisting private, municipal, State, and Federal landowners, all working together toward the conservation of important natural resource areas" ("National Park Service Programs"). This program is likely to have large direct and passive use benefits, centered in bequest and natural visitation values. The program could also be classified under Coordination and Management.

- **Federal Lands to parks Program:** The mission of this program is to transfer unused federal lands to state and local governments for the purpose of providing public access in perpetuity. While NPS may not have managed these lands before, the organization has facilitated the movement of over 1,500 properties to state and local governments for purposes such as creating recreation opportunities, public parks, access to waterways, and repurposing old forts and buildings ("National Park Service Programs"). NPS may be the best fit to administer such a program as there is no other federal agency whose primary purpose is the preservation of resources. Open space and visitation values are inherent in the parks created by this program
- **Federal Historic Properties:** Restoration and protection of a single unit can often lead to an expansion of other services that provide significant economic value. For example, "the National Park Service has out-leased buildings at Fort Hancock in New Jersey and at the Presidio in San Francisco, California [and] revenues from these leases create direct economic benefits, such as maintenance jobs, as well as indirect and induced benefits (Federal Preservation Institute, 2005).

Section 2:

Economic Valuation Case Study of Joshua Tree National Park

Joshua Tree at Dusk in Joshua Tree National Park, CA (Photo by Tim Marlowe)

Case Study Rationale

The framework of the previous section must be tested and honed before it can be applied to the National Park Service as a whole. The first step in this process is the case study that follows, in which we undertook the investigation of the values created by the Operations and Management and Cooperative Programming of a single unit. For the selection of this unit, we utilized two criteria:

1. ***Scope and scale of site***: The NPS oversees many different types of holdings and selecting the correct size for a case study was critical. As we are modeling a framework for total economic analysis, it was important to select a case study site with a variety of different visitation use values, programming values and ecosystem services. It was also necessary to choose a site that was well-known enough to present significant passive use values.
2. ***Logistical feasibility:*** It was necessary to choose a park that would still be accessible during the winter months during which we would be undertaking the case study. Given the inhospitable weather of many National Parks during this time, our field of potential sites was limited to a relatively narrow range of parks where winter climate did not present a logistical challenge. Proximity to a large metropolitan area was also an important factor in our decision-making, as it permitted lesser travel times to and from the site via a major airport.

Using these criteria, we were able to select Joshua Tree National Park (JOTR), which was established in 1994 and had been a National Monument since 1936. It is located in the Southern California Desert, about 170 miles east of downtown Los Angeles, and presented the following advantages:

1. ***Abundance of Natural and Cultural Resources*** – JOTR features pristine desert landscapes, miles of hiking trails, and thousands of rock-climbing routes. It is generally thought of as a "natural use" park. However, there are also multiple historical and cultural attractions, including dozens of mines, over one hundred historical structures, multiple archaeological sites from different eras, and a museum preserving thousands of cultural artifacts. The combination of natural and cultural uses of the park makes it particularly useful and intriguing from a valuation standpoint.
2. ***Proximity to Major Population Centers*** – Joshua Tree is within just a few hours' drive from multiple large cities including Los Angeles and San Diego, which has two major advantages. First, this proximity increases both direct and passive use, as large numbers of people utilize the park, and even larger numbers are aware of its presence. Second, this proximity enabled us to travel easily to the park for purposes of research.
3. ***Year-Round Visitor-Friendly Climate*** – As JOTR is located in Southern California and is made up almost entirely of desert, the high season for visitor use is during the winter months. This meant that programming and park use was running full-steam during our visits and was therefore easier to research first-hand.
4. ***Iconic/Unique Species and Ecosystems*** – Joshua Trees, desert tortoises, and desert bighorn sheep are three iconic species protected within the park. The protection of such species increases passive use values, even for those who have never set foot inside the park. Joshua Tree National Park also preserves a unique ecosystem at the intersection of two deserts which some believe is unlike any

other place on earth. This represents the presence of a large preservation bequest value that we felt privileged to research.

5. ***Desert Ecosystem Services*** – While there have been many investigations of forest ecosystem resources in the environmental economic literature, research on ecosystem services provided by deserts is notably lacking. The selection of Joshua Tree National Park enabled us to contribute to the base of knowledge on the value of services provided by untouched deserts.

With the help of Joshua Tree National Park's extremely accessible, knowledgeable, and competent administration and staff, we were able to successfully apply our economic framework to the categorization of the diverse goods and services provided by this park. Benefits transfer was used, whenever possible to provide ballpark numbers for valuation purposes, but the main benefit that comes from this section should not be seen as these calculated values. Instead, the classification of park uses and programming into types of benefits and recommendations for their future calculation are what we hope the reader will take away.

Joshua Tree National Park Case Study: Application of the Framework

The framework was discussed in interviews and consultations with JOTR staff and was altered in order to best fit the values created by the park. In fact, the Human Capital Development category originated in an interview with Andrea Compton, JOTR's Director of Resources (Compton, 2012). What follows is a direct application of this framework to Joshua Tree National Park.

Operations & Management

Joshua Tree National Park encompasses 794,000 preserved acres, located at the convergence of the Mojave and Colorado deserts (Street, 2010). The park was originally deemed a National Monument in 1936, thanks to the efforts of Minerva Hoyt, a citizen of Pasadena who was especially concerned about the preservation of desert plant species within the area (National Park Service, 2010). Fifty six years later, after multiple boundary changes to accommodate mining interests, Joshua Tree became a National Park (National Park Service, 2010).

Figure 4: Mural of Minerva Hoyt at Oasis of Mara Visitor Center (Photo by Tim Marlowe)

As of 2010 Joshua Tree National Park (JOTR) has an annual base budget of $6.2 million and employs a staff of 144 full-time and part-time employees (National Park Service, 2010). Within its management of the unit, the park Service operates three entrance stations, three visitor centers, one nature center, ten picnic areas, nine campgrounds, 199 miles of roads, and numerous solar power, maintenance, water treatment, and employee housing facilities (National Park Service, 2010). In 2010, over 1.4 million unique recreational visits were made to JOTR (Street, 2010). For a park map, see Appendix 1.

Joshua Tree National Park, the southernmost National Park in California, is situated between Interstate 10 and State Route 62, north of the Salton Sea and east of the Coachella Valley. Over 500,000 people live within 50 miles of the park, with around 400,000 of those living in the Coachella Valley and the other 100,000 living to the north of the park in and around the towns of Joshua Tree, Twentynine Palms, and Yucca Valley (Missouri Census Data Center, 2011)[10]. Many of the residents of these areas engage in direct use of Joshua Tree whether or not they visit, through multiple ecosystem services and amenities provided by park. Usage through visitation is conveniently accessible to a population of over twenty million people who live within 150 miles of the park (a three hour drive), including the major metropolitan areas of Los Angeles, San Diego, and Las Vegas, NV (See Appendix 2 for more detailed population accounting). For long distance travelers, there are fifteen major airports, including LAX within that radius.

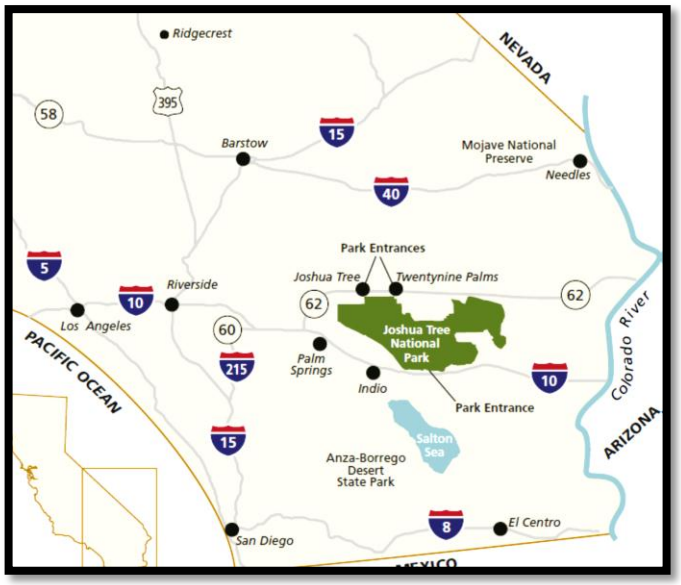


Figure 5: Joshua Tree National Park Location (taken from www.nps.gov)

While Production of Goods doubtless makes up a relatively small part of the valuation of Joshua Tree National Park, it still contains some very important benefits derived from the park, especially in the category of ***Research.*** In keeping with the original framework, we will divide ***Production of Goods*** into ***Resource Extraction*** and ***Intellectual Property.***

With the exception of scientific specimens, there is no legal extraction of resources within boundaries of Joshua Tree National Park (Butler, 2012). As noted in the framework, however, the value of concern in this category is the opportunity cost of foregone extraction due to preservation. For a detailed treatment of this subject, see the *Counterfactual* section of the case study on page 36.

[10] Population numbers calculated using the cited census tool, which calculates population within a specified radius of a certain point. The point we used to represent Joshua Tree National Park was an unnamed mountain of 4760 feet of elevation at the coordinates 33°52'17"N, 115°59'29"W. This point was used because it was reasonably close to the geographic center of the Park. A different point of reference will result in slightly different population numbers.

The writers of the Joshua Tree National Park Foundation Statement recognize the significance of the park's contribution to the development of intellectual property with the following words, taken from their Foundation Plan:

"*Joshua Tree National Park offers unparalleled opportunities for research of arid land ecosystems and processes, adaptations of and to desert life, sustainability, and indications of climate change. The proximity of the park to urban regions of Southern California and Nevada enhances its value for scientific research and education. Joshua Tree National Park Association publishes books such as 'Joshua Tree National Park Geology' and 'Joshua Tree Desert Reflections'*" (National Park Service, 2011)

As noted in this statement, as well as in the framework explanation on page 19 , intellectual property developed within the park can be divided into the categories of ***Research*** and ***Media.***

1. Research

In order to conduct scientific or cultural research within Joshua Tree National Park, one must apply to the park for a research permit (Vamstad, 2012). Park staff examines the environmental impact of this request and, provided that the project meets certain environmental guidelines, approves the permit (Vamstad, 2012). While park staff reported that permits were assigned on a yearly basis, a closer investigation of the permit database indicates that some permits are granted for much longer periods (National Park Service, 2012). Researchers must provide the park with yearly progress reports, otherwise known as Investigator Annual Reports (IARs), which can be found in a database that is searchable by the public. While final results of research are the shared property of the NPS and the researchers, there is no database of finalized research coming from specific parks, and thus, we must rely upon the IAR database for our about the research taking place in the park (Vamstad, 2012).

Between 2000 and 2004 (a representative subsample) 94 annual reports on research permits within Joshua Tree National Park were submitted to the park Service (National Park Service, 2012)[11]. The permits themselves averaged 397 days in length, but ranged from just 1 day to 10 years. While the number of final products this led to is unknown, these 94 permits belonged to 55 different leading authors, a number which may be a good proxy for that total (National Park Service, 2012). There were 23 different categories of research represented, ranging from Air Pollution to Geophysics to Vascular Plants. The most common category was Ecology, which over that time period was responsible for 17 of the 94 IARs (National Park Service, 2012).

The valuation of this research is difficult for a number of reasons, the first and most obvious of which is the lack of absolute certainty about the outcomes of these permits (with the exception of occasional permits that were marked "Terminated before Completion") (National Park Service, 2012). A Google Scholar search found 1170 published results for Joshua Tree National Park within the last decade, with

[11] A list and description of these permits can be found in Appendix 4.

the majority of the first 50 results focusing solely on the park and results further down the list being more likely to mention the park in some general capacity (Google Scholar, 2012). A more in-depth investigation would be needed to determine the amount of research based on or from the park over that time period.

However, even for outcomes that are known, we are only witnessing the short-term payoffs, and much of the return on investment will take place in the extremely long-term (Nelson, 1959). The second difficulty is the range of values that surely resulted from the differing studies. Using the rule presented in the framework, that research that is generally applicable to multiple uses is more valuable than that which is extremely field specific, much of the research permitted above (e.g. on behaviors of colonies of whiptail scorpions) can be counted as having minimal economic value (National Park Service, 2012). However, there are other studies that took place within the park that would seem to be extremely valuable, simply based on their funding levels and the integral part they play in an economic action. One especially potent example of this was the NASA's Martian subsurface exploration team, which from 2001 to 2004 tested its Ground Penetrating Radar (GPR) within the park. Funding levels for this research were over $242,000 per year (National Park Service, 2012).

Finally, even if the economic value of this research is understood, it requires another logical step to deduce the value that JOTR provided to that research project. This depends on the elasticity of the demand curve for park resources among researchers. The Mars GPR team wrote that they were "…in the process of calibrating [their] miniature GPR…., and [their] findings match well with the expected geophysical features of the park." (Kim, 2001) This suggests that the park provides the best research laboratory around for their purpose. Researchers' willingness to pay fees in JOTR would be a baseline in the private market, but seeing as most institutions researching in Joshua Tree are public, it is questionable as to whether the pursuit of this research always represents solely value-based decision making. Even if fees are used, they, like avoided costs, will not measure the consumer surplus, but simply a lower bound of willingness.

Joshua Tree National Park is also working to create intellectual property and scientific collaboration through its Biodiversity hunts, in which many scientists are gathered together to search for biological diversity in a specific area of the park. In the inaugural hunt, at the Oasis of Mara, 50 scientists found 674 species of animals (81% of which were insects) in a 24 hour span (Chang, 2012). There has been a push throughout the National Park Service to conduct these biodiversity hunts before climate change drastically changes the species makeups of parks, so the value of such research may only be known in posterity (Chang, 2012).

2. Media

Joshua Tree National Park has been the subject, backdrop, and/or location of numerous videos, photos, and works of art. Artists and businesses who wish to take non-still photography shots with crew involved must apply to the park for a permit (Imhoof, 2012). In the year of 2011, twenty nine of these permits were granted, with uses ranging from fashion shoots to documentaries to music videos (Joshua Tree National Park, 2011). The list and description of these permits can be found in Appendix 3. This was

reasonably similar to the 36 permits granted in 2003, at a fee price of $11,110 (Kroeger & Manalo, 2007)[12]. The majority of these permits were granted for one day, but some lasted as many as five. Fees paid once again would be a method for assessing the value created by the park, but only provide a baseline willingness to pay and in no way calculate consumer surplus.

If there is no disturbance created and no crew necessary for filming or photography, no permit is necessary, and thus the number of commercial photographs and films taken in JOTR over a period of time is difficult to assess. One example of an extremely valuable contribution of JOTR to commercial photography can be seen in the work of Wally Pacholka, a night sky photographer, whose images of comets, stars, and galaxies shot from Joshua Tree have been published in Time and National Geographic Magazines, and have become popular on the internet (Zarki, 2012).

Joshua Tree National Park has also been integral as an inspiration for other types of media, including painting, literature, and music. While still designated as a National Monument, Joshua Tree became a favorite spot of musicians including Graham Parsons and Keith Richards. John Lennon recorded an album called *The Joshua Tree Tapes* and the cover art for an Eagles album was created in and inspired by the park (Zarki, 2012). The park and the area surrounding it later became the inspiration for U2's iconic album, *The Joshua Tree* (Zarki, 2012). An Amazon search revealed 13 videos and 1052 books with Joshua Tree National Park as a keyword, including 337 travel books, 99 literature and fiction books, 144 arts and photography books, and 98 biographies and memoires, including many about musical inspirations JOTR (Amazon.com, 2012). A more exact accounting, however, would require investigation of each of these sources to determine whether JOTR could actually account for any of the value created by the product, as well as to avoid double counting of benefits such as those from visitation (which may be augmented by travel books, meaning that the travel book's value has already been accounted for).

[12] As the JOTR Commercial Permits Binder has not been digitized, it was difficult to collect multiple years' worth of data.

The services provided by Joshua Tree National Park have been organized, as in the framework, into the three categories of ***Ecosystem Services***, ***Visitation***, and ***Human Capital Development***. In each of these areas, the park and its operations and management create numerous types of values.

As with the framework, we will divide JOTR's Ecosystem services into the following five categories in order to best describe them:

1. Climate Regulation
2. Watershed Services
3. Soil Formation, Erosion Control, and Air Quality
4. Biological Diversity
5. Open Space Preservation

We do not pretend to have catalogued every ecosystem service created by JOTR, but instead to provide an overview of the services it creates.

1. Climate Regulation

Joshua Tree National Park's 794,000 acres are located at the intersection of the Colorado and Mojave Deserts. It was long thought that deserts played little role in preventing climate change – for example, Costanza et al (1997) valued world desert carbon sequestration at $0, in spite of the fact that deserts make up 1.925 billion hectares of the Earth's surface. This is not technically correct. Above-ground desert sequestration of carbon is low, especially when compared with the 2800 tons per hectare sequestered above ground by redwood forests, but it is not nonexistent (Welling & Gonzalez, 2012).

Figure 6: High Mojave Desert in Joshua Tree National Park (Photo by Tim Marlowe)

The deserts of Joshua Tree National Park sequester an estimated 15 tons of carbon per hectare, which is relatively high for a desert biome (Welling & Gonzalez, 2012)[13]. Most of the sequestration occurs in the plant life, such as Joshua trees, creosote bushes, and cholla cactuses, as well as the occasional fan palm oases that dot the desert. The level of sequestration varies depending on the vegetation alliance prominent in a specific section of desert (A map of these alliances can be found in Appendix 5). And while research is currently incomplete, it seems likely that the apparently larger amount of biomass occurring in the park's Mojave sector (the northwest section) also means a higher rate of sequestration than the relatively lower biomass Colorado Desert sector (the east and south of the park). There is, however, little known below ground carbon sequestration in Joshua Tree. While cryptogrammic crusts fix nitrogen in the soil and therefore allow for plants to grow and store carbon, the crusts themselves provide very little in the way of sequestration (Belnap, 2012).

Using the estimated willingness to pay of $65 per ton (taken from the framework research), the carbon sequestration in Joshua Tree National Park can be valued at $975 per hectare, or $384 per acre, for a grand total of $313 million worth of benefits. However, this calculation makes two assumptions. The first is that the willingness to pay of $65 is accurate and can easily be transferred from forest to desert. The second assumption is that all carbon sequestration in the area would be destroyed if Joshua Tree National Park did not exist. This is almost certainly untrue, as such a vast desert, with little access to water, would not be developed to its fullest extent. While areas such as solar farms and off-road vehicle tracks tend to decimate desert, clearing plants completely (Belnap, 2012), residential developments may plant trees, increasing sequestration over that of an untouched desert (Welling & Gonzalez, 2012). Therefore, all we can say is that the estimated $313 million should be considered an extreme upper bound of the benefits of climate regulation.

2. Watershed Services

Joshua Tree National Park receives on average .37 in of rain per month (Weather.com, 2012) and it has no major bodies of water within it, so there are no major watershed services within the park. It does, however, contain multiple small aquifers that are maintained by the park and recharged by yearly precipitation (Sabala, 2012). In one case, park staff believes that an aquifer in the southeastern part of the park is connected to a water source in the Eagle Basin, and would prospectively be drawn from if the basin were used for renewable energy development (see Appendix 7) (Sabala, 2012). With this exception, however, JOTR water resources are only used within the bounds of the park, and therefore confer no external benefits on their own.

3. Soil Formation, Erosion Control, and Air Quality

Wind erosion is one of the largest hazards of desert disturbance, especially in and around Joshua Tree National Park. Joshua Tree has some of the worst air quality of any National Park, in large part due to its proximity to Los Angeles (National Park Service, 2010). More than 1200 people die annually from

[13] This is only a rough estimate by climate scientist Patrick Gonzalez, who is currently working to map out carbon sequestration in southern California. He will have a more formal estimate when his report is finalized and published in a year and a half.

particulate pollution in Riverside and San Bernardino counties (the counties in which Joshua Tree is situated) (Richardson, 2005). Much of this pollution is due to industrial and automobile emissions from the L.A. metropolitan area, but the most prolific source of PM-10 (particulate matter that is up to 10 millionths of a meter in diameter and is extremely dangerous to human lungs) is dust from unpaved desert roads (Richardson, 2005).

Figure 7: Disturbed Desert along an ORV Road (Photo by Tim Marlowe)

The desert has developed mechanisms to protect itself from wind erosion if left in its natural state. Cryptobiotic crusts made up of microscopic cyanobacteria and macroscopic lichens and mosses, hold fine desert soils together at depths of up to 15 centimeters (Belnap, 2004). The plants in a desert also play a large role in erosion prevention, both through the holding in place of soils and the breaking up of wind before it hits the surface. These plants have a mutualistic relationship with the cryptobiotic crusts, which fix nitrogen in their roots and break down plant detritus into a reusable form (Belnap, 2004). The combination of desert plants and healthy crusts can withstand the highest of desert wind gusts with little to no erosion (Munson, Belnap, & Okin, 2011). However, the loss of cryptobiotic crusts and plant cover from an area of "shrubland" in the Colorado Plateau was found to increase wind erosion exponentially (Munson, Belnap, & Okin, 2011). The particles that are likely eroding are fine-grained dust, as this is the type of soil that crusts most often colonize and stabilize (Belnap, 2012). In highly disturbed areas (due to intentional clearing, development or repeated automobile or off road vehicle traffic) crusts can take up to 50 years to reform, and without the crusts, plants find it much more difficult to grow as well (Belnap, 2012).

Development of renewable energy sources is occurring on all sides of Joshua Tree National Park (see Appendix 7), and off road vehicle use is plentiful. As demand for air quality has been shown to be valued more highly as it becomes more scarce (Richardson, 2005), higher levels of development indicate that the prevention of pollution due to the preservation of undisturbed desert in Joshua Tree National Park would become all-the-more valuable. In addition to preserving undisturbed desert, the staff and administration of JOTR has also worked to rehabilitate desert crusts and plant-life that has been illegally disturbed (such as ORV roads created within the park) (Vamstad, 2012; Belnap, 2012). Finally, park Physical Scientist, Luke Sabala, maintains three air quality monitoring stations that give daily readings of nitrogen levels and particulate matter in Joshua Tree National Park's air, better enabling decision makers both within the National Park Service and in state and local governments to act in the best interests of public health (Messaros, 2012).

Figure 8: Off Road Trails near Joshua Tree National Park (Created using Google Earth)

The value of pollution control through the prevention and preservation activities of JOTR is unclear, as it is difficult to determine how much of the park would be developed without its protected status, and given a certain level of development, it is still difficult to calculate the level of particulate pollution that would occur. A more detailed avoided cost methodology could probably reach a lower bound, while contingent valuation by area residents of prevented pollution would be ideal, but would still require some certainty about levels of pollution prevented.

4. Biological Diversity

Joshua Tree National Park is home to 824 plant species, 40 reptile species, 41 mammal species, and 240 bird species (Joshua Tree National Park, 2005). Its location at the intersection of the Mojave and Colorado deserts creates a high level of diversity, according to park biologist Josh Hoines (2012). However, in and of itself, the anthropocentric enjoyment of the biological diversity present in Joshua Tree National Park falls into the visitation use and passive use value categories. Only the benefits to the surrounding ecosystem that affect humans can be classified as ecosystem services. The major example of this within Joshua Tree is fire prevention.

As the desert is an extremely dry place, fire is always a danger. In areas of native plant communities, fire usually does not spread far because of the lack of accessible fuel, as desert plants tend to grow far apart from each other (Joshua Tree National Park, 2005). However, increased nitrogen in the soil of the west half of the park, due to pollution from the L.A. metropolitan area, has led to the presence of non-native "invasive" grasses, which are better adapted to these man-made conditions (Messaros, 2012). These grasses' tendency to grow close together has fueled the growth of multiple park fires to levels previously unheard of within the past 40 years (Joshua Tree National Park, 2005). Park Management is currently undertaking an effort to eliminate these non-native species, which will lessen susceptibility of the park to major fires (Joshua Tree National Park, 2005).

Park operations to restore native ecosystems and prevent fire should be valued in terms of benefits to the surrounding communities that also become safer from fire. The expected value of avoided costs of fires due to this activity might be calculated to provide a baseline value, but it once again does not represent a consumer surplus.

5. Open Space Preservation

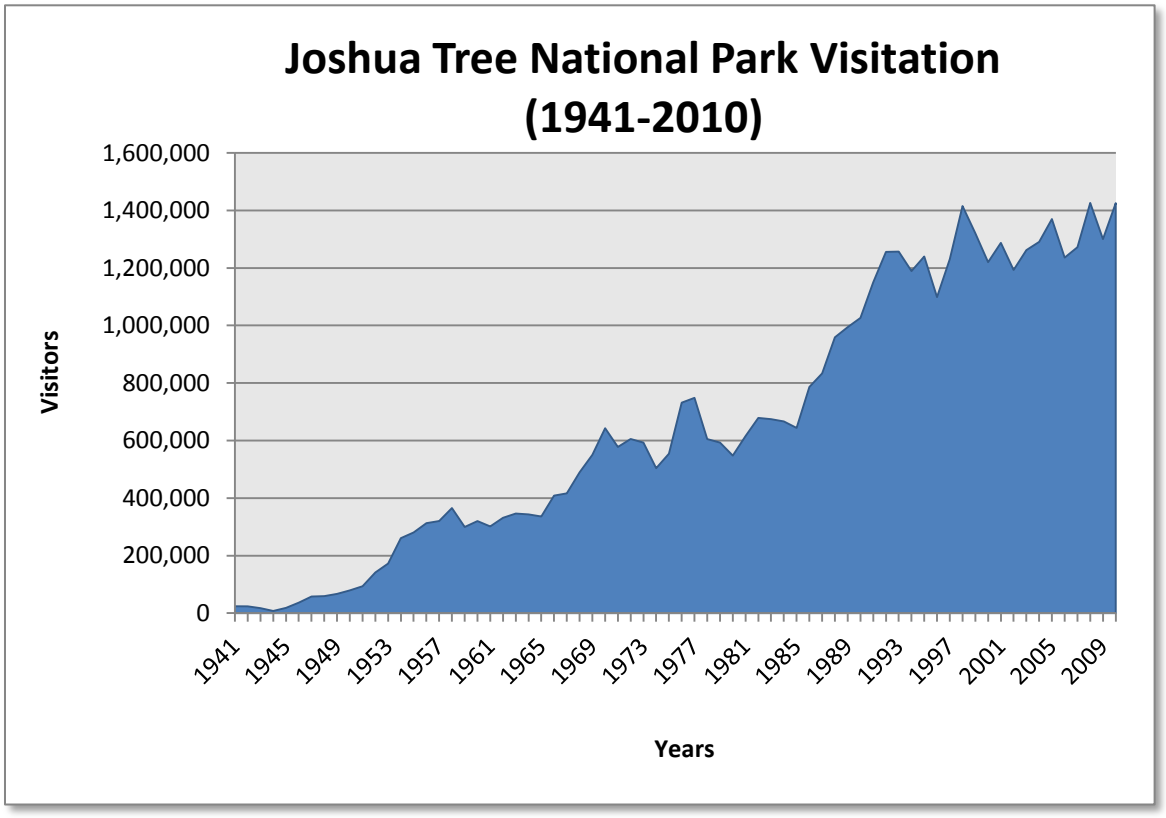
Many people who never set foot in Joshua Tree derive significant value from the protection of its landscapes and open space. Several park employees have noted that some nearby residents have never visited the park, including longtime lifelong residents in directly adjacent towns. Referencing non-visitors along the southern boundary, Director of Resources Andrea Compton asserted that many are unaware that the mountains they are looking at are part of a National Park (Compton, 2012). Superintendent Mark Butler notes that the beautiful mountain backdrop to Palm Springs is not covered with wind turbines because it is part of JOTR (Butler, 2012). The potentially huge value of open space and vista preservation can be measured, as noted in the framework, through hedonic pricing models. In an extremely small sample, Kroeger and Manalo found housing premiums of 35% for residences bordering Joshua Tree National Park and thus accessing its vistas and open space (2007)[14]. This is consistent with other values found near public lands with more robust samples (Kroeger & Manalo, 2007). Anecdotally, Superintendent Mark Butler tells of being involved in a bidding war for a house that bordered on the park, and eventually losing when the house went for $30,000 more than expected (Butler, 2012). While sufficient data is not present to run HPM for all of the towns surrounding Joshua Tree National Park, with the demonstrated premium placed on open space, and 500,000 people living within 20 miles of the park, the economic benefits of this service are bound to be in the millions of dollars.

Figure 9: The Town of Twentynine Palms (as viewed from JOTR) sits in the shadow of the Park (Photo by Tim Marlowe)

[14] The sample size of 6 was certainly too small for any definitive conclusions.

By the end of 2010, 1,425,430 individual visits were made to Joshua Tree National Park to enjoy its range of natural, cultural, and historical values.[15] Figure 10 displays the rise in visitation over a 70 year period with steep rises in the late 1980s and peaks in the past few years. The park's low season is summer and its high season is the spring, although it can become sporadically busy depending on multiple factors such as temperature, precipitation, and air quality (Zarki, 2012). The park offers various resources including visitor centers, nine campgrounds, interpretive programs and displays throughout the park, and a ranger staff dedicated to enhance the visitor experience.

Figure 10: JOTR Visitation over Past 60 Years (Made with Data provided by Joe Zarki)



People visit Joshua Tree for a variety of reasons, with the most frequent ones being catalogued and measured via visitor use surveys. Figures 11 and 12 display the primary active purpose of visits to the park and the scope of activities done during park visitation, respectively. In this section, we will describe visitation activities as either "natural" uses or historic and cultural uses. While these uses may sometimes overlap, we have attempted to separate the types of values that consumers may receive

[15] All Park visitation and program usage figures were provided by Joshua Tree National Park and should be treated as primary data.

from each one. First, however, we must include a note on consumer values provided by the visitor centers and rangers, which increase the value of visitation to both natural and historical resources.

In fall of 2010, 59% of visitors patronized at least one visitor center, which offer interpretive displays, park materials, items for purchase, and perhaps most importantly, opportunities to interface with park staff (Jette, Blotkamp, Le, & Hollenhorst, 2011). Dave Carney, Supervisor of Interpretive Operations, hints at the value added by park staff in stating that "the three major visitor centers are jumping off points for visitors and when they enter, they want and expect to see a park ranger" (Carney, 2012).

Figure 11: Activities participated in during visit to JOTR in 2010

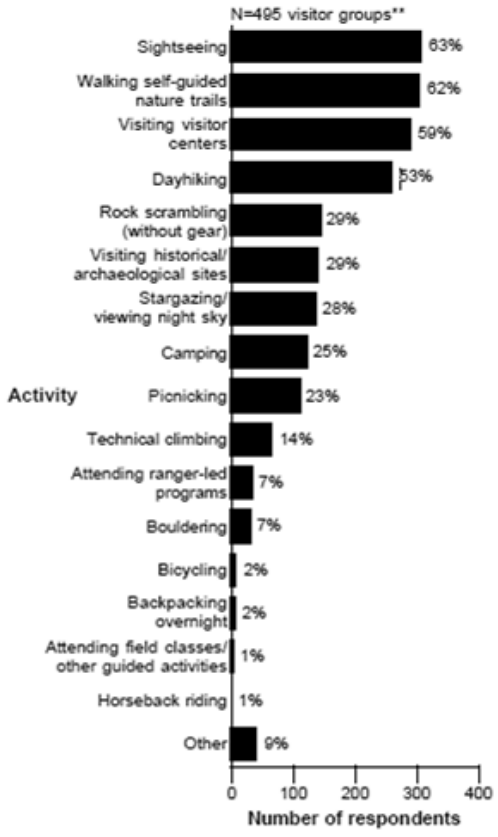
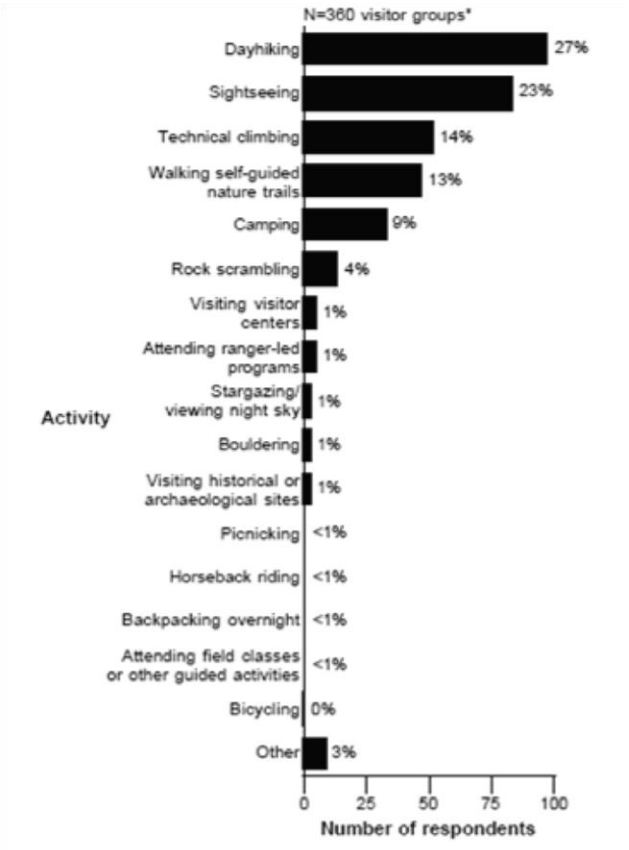


Figure 12: Primary reason for visit to JOTR in 2010



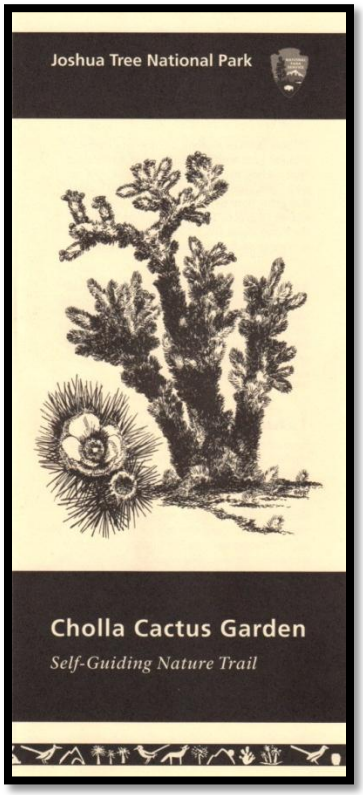
Both charts reproduced from (Jette, Blotkamp, Le, & Hollenhorst, 2011).

Chief of Interpretation Joe Zarki notes that "when (Joshua Tree) became a National Park in 1994, we had to shift to services that people expect from a National Park" (Zarki, 2012) Zarki points out an intrinsic difference in values and expectations for a National Park when saying that "people who look at National Park guidebooks don't see any mention of national monuments" (Zarki, 2012). As such, many of the resources offered today were nonexistent until the unit became a National Park.

Interpretive rangers also have contact with visitors via ranger-led walks through campsites and at key sites throughout Joshua Tree. In 2010, 20,457 contacts with visitors were made through programs and 21,253 were made while roving throughout the park.[16] Zarki notes that "ranger programs give the context for a visit but the true value is the experience of walking with a ranger" (Zarki, 2012).

"The biggest draw to Joshua Tree are broad open undeveloped landscapes" – Mark Butler, Superintendent (2012)

Figure 13: Interpretive trail map



Joshua Tree provides access to a variety of natural recreational activities that are available to users on a year-round basis. We will attempt within this section to summarize the most common natural pastimes within the park, but make no pretense of thoroughly exploring every natural use.

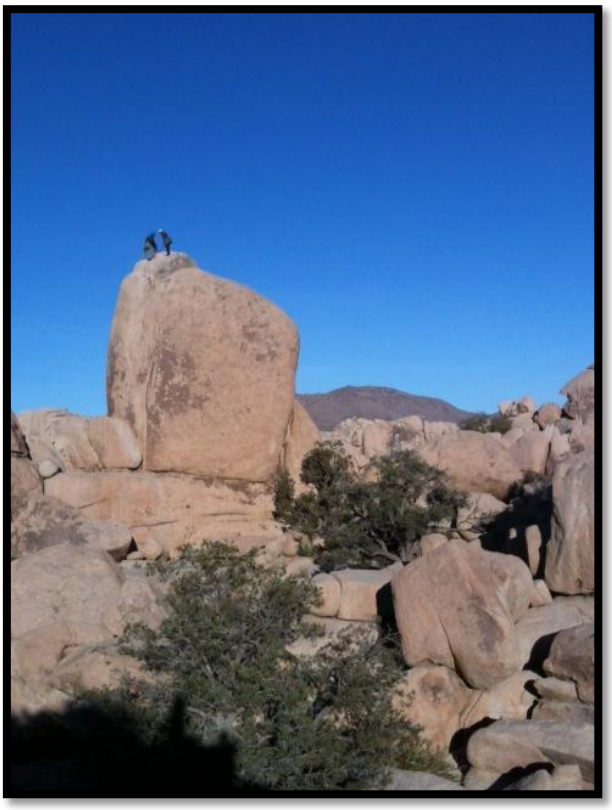
1. Day Use Sightseeing

A non-regular visitor use study last conducted in 2010 found that "the most common activities were sightseeing (63%), walking selfguided nature trails (62%), visiting visitor centers (59%), and dayhiking (53%)" (Jette, Blotkamp, Le, & Hollenhorst, 2011). In order to facilitate these activities and provide access to others, the trail crew maintains 420 miles of trail and produces signage, maintains infrastructure, trims brush, and removes graffiti (Rodriguez, 2012). Rangers lead interpretive walks at Hidden Valley, Black Rock, Indian Cove, Keys View, Arch Rock, Cottonwood Spring, Mastodon Peak, and Short Oasis, amongst other sites. At some popular destinations that are unattended by rangers, visitors are guided by interpretive displays or pamphlets offered at the trailhead. An excellent example of the facilitation of the park in this type of use can be seen in the Cholla Cactus Garden, a short (>1 mile) self-guided stroll through a large colony of Cholla "Teddy Bear" Cacti (Figure 13).

[16] Figures were taken from primary data provided by Joshua Tree National Park.

2. Climbing, Bouldering, and Scrambling

Figure 14: Technical climbing at Hidden Valley (Photo by Francis Choi)



Additionally, Joshua Tree provides unique recreational opportunities that are not available at many other wilderness areas or protected park spaces. JOTR has emerged as a premier destination for rock climbing due to its unique geological features and climate conditions that permit year-round visitation. There are 50 square miles of climbable rocks in Joshua Tree, crisscrossed by over 8000 climbing routes, almost all of which are located in the "topside" (northwestern) Mojave Desert section (Regan, 2012). According to Bernadette Regan, the climbing ranger, the majority of the climbers come from the California coast, but Joshua Tree is undoubtedly an international climbing destination (Regan, 2012). In addition to these climbing routes, there are more than 2000 bouldering "problems" (Regan, 2012)[17]. Fourteen percent of visitors partake in technical climbing and bouldering activities and they often enter the park for this sole reason. A further 29% of visitors partake in amateur rock "scrambling" opportunities, which don't require gear and are directly accessible from many sites such as Jumbo Rock or Hidden Valley campgrounds (Jette, Blotkamp, Le, & Hollenhorst, 2011). Hidden Valley Campground is a central hub for climbers, likely because of the large number of climbable rocks directly surrounding it. Park Ranger Regan runs a Climber's Coffee from this campground every Saturday morning (Regan, 2012).

Figure 15: Tents at Hidden Valley Campground (Photo by Tim Marlowe)

3. Camping

Twenty five percent of visitors camp within the park during their time at Joshua Tree not only enjoy the natural environment, but also ranger-led walks and talks. Some of these are climbers, many of whom will stay for the maximum 14 days of camping. Others are people who primarily day users who drive in with RVs. There are a total of 504 individual campsites and 22 group sites in the park (Joshua Tree National Park, 2011). Rangers host evening programs at Jumbo Rocks, Indian Cove, and Black Rock Campground which can range from 50-100 visitors a night in attendance

[17] Bouldering is climbing a fairly short route without a rope, and a "problem" is the name for a route of this type.

(Carney, 2012). Carney notes that "visitors may just be sitting around a campsite and will join a talk even if they weren't planning to because they'll see it walking by." Visitors who stay overnight are also treated to another natural resource that the park actively seeks to protect (Carney, 2012).

4. Night Skies and Stargazing

The relative seclusion of Joshua Tree compared to its far more populated neighbors in the Los Angeles metropolitan area also provides excellent opportunities for stargazing and enjoying the night sky. The 2010 Visitor Use Study found that 28% of visitors participated in such activities (Jette, Blotkamp, Le, & Hollenhorst, 2011). While the natural conditions for night sky viewing have not changed much from the days of Joshua Tree National Monument, it is a much popular attraction today than previously. Joe Zarki, Chief of Interpretation, notes that popularity has been increased by use of the park for famous telescopic photography and establishment of the Night Sky Program (Zarki, Chief of Interpretative Division - Joshua Tree National Park, 2012). The park also works with local governments and businesses to create light pollution control ordinances and management plans. For example, the park worked with the Home Depot in neighboring Yucca Valley to create a display on low light fixtures (Butler, 2012). Finally, the park monitors night sky and air pollution (Sabala, Chief Physical Scientist - Joshua Tree National Park, 2012). Chief Physical Scientist Luke Sabala gathers data on light pollution to produce maps like the one below in Figure 16. Joshua Tree National Park is also one of the participating organizations in the Morongo Basin Dark Skies Alliance, an advocacy group formed to promote light pollution control in the region.

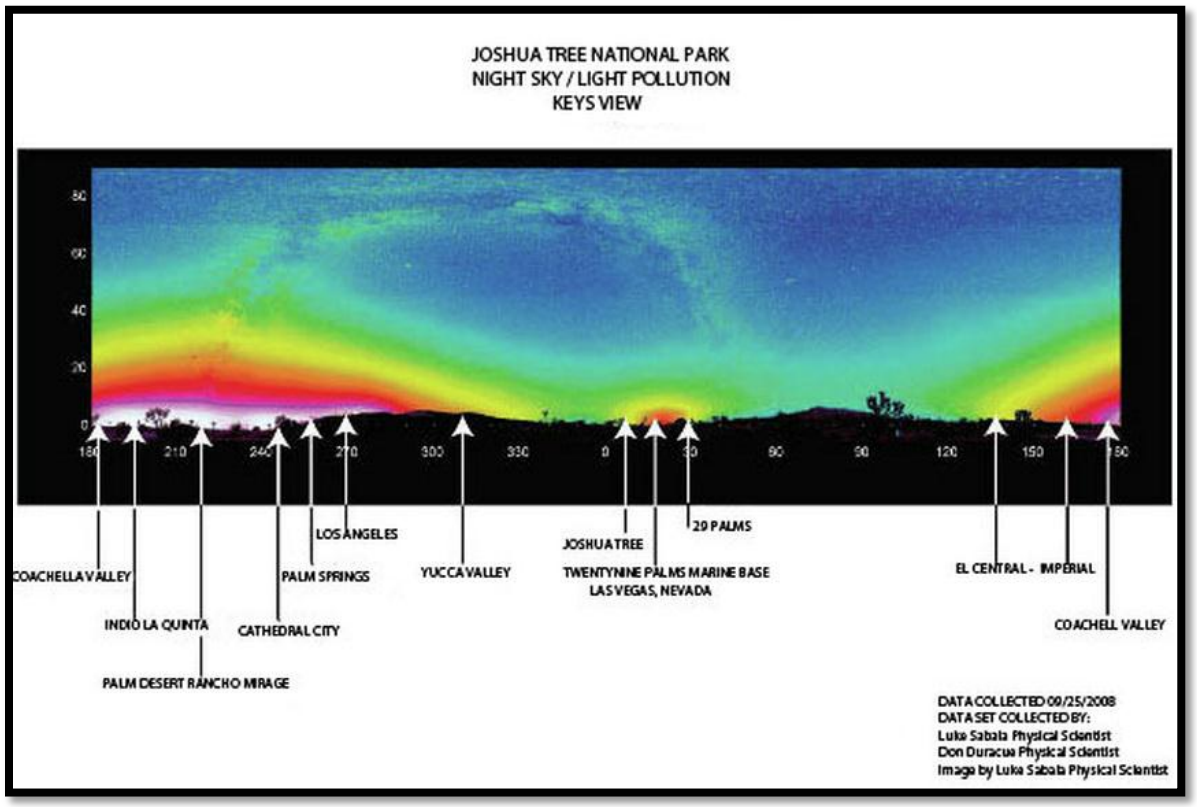


Figure 16: Night Sky Light Pollution from Keys View (Source: Luke Sabala)

5. Backcountry Use

While fewer than 2% of visitors enter the backcountry overnight, the time- and use-intensity of the activity makes it worth mentioning. The National Parks Conservation Association's Seth Shteir believes that one of the key values humans obtain from Joshua Tree National Park is the physical and mental challenge of self-sufficiency gained through interaction with wilderness (Shteir, 2012). This is also the most direct way (but not the only way) to enjoy the benefits of solitude and open space noted by Superintendent Mark Butler at the beginning of this section.

Externalities of Natural Use Visitation

Visitors to the park are likely to see a variety of plants and animals that they may not have seen before, including some threatened and endangered species such as the desert tortoise or the triple-ribbed milk-vetch (Hoines, 2012). It is not unusual, according to Josh Hoines, park botanist, to see people viewing and valuing these organisms in a whole new light after seeing them in person (Hoines, 2012). In economic terms, this then increases the passive use value of these species to the people who have seen them, as suddenly, the continued existence and health of these species is very important to them.

A second externality can be found in the beneficial mental and physical health effects of interaction with nature, as documented in the framework. Speaking generally about the benefits that visitors derive from the park, Zarki points to contemplative and mental health, as well as "very personal values – spiritual and aesthetic values… I know for a fact that's what people appreciate most" (Zarki, 2012). While this was not investigated in depth with regards to Joshua Tree National Park, it is certainly an area for deeper consideration in the future[18].

Calculation of Economic Benefits from Natural Use

Using the Oregon State database of economic studies of natural recreational activities, it is possible to attempt benefits transfer methodology to calculate a consumer surplus value for yearly natural recreational use of Joshua Tree National Park (Rosenberger R. , 2011). In the simplest model, one can take the average consumer surplus value from the database ($59.60) and multiply it times the number of visitor recreation days in Joshua Tree National Park in the latest year of record (892,331 recreation days spent in 2010 (Street, 2010)):

$$892{,}331 * \$59.60 = \$53{,}182{,}928$$

However, this estimate of $53 million is most likely off the mark, as there is no indication that the "average" natural recreational day is anything like what can be found in Joshua Tree. Instead, as per the instruction given in the methodology section, it is necessary to match the characteristics of the sites and recreation type in both the subject study and the research from which the benefits are transferred. We

[18] To some extent, this can be considered part of the Human Capital Development section of the framework, but the fact that we are speaking of an externality instead of an intentionally accrued benefit is why it is listed under natural use.

have done this by inputting characteristics of the 2703 consumer surplus calculations in the Oregon State database into the following simple linear regression function:

$$Consumer\ Surplus = \beta_0 + \delta_j * biome_j + \theta_k * public_k + \sigma_m * recreation_m + \alpha_p * region_p + \varepsilon$$

where biome, type of public land, region, and type of recreation are all sets of dummy variables, and δ, θ, α, and σ are coefficients that vary by dummy. Utilizing this regression model, we obtain the values to the left for each of these types of recreation, when done in National Parks of the Western U.S. desert[19]. As one can see, these values are significantly higher than the average natural recreation use value, a fact that seems due to the higher values found in the sample for recreation in National Parks and in the Western U.S.

Recreation in Desert National Parks of the West	
Activity	Daily CS ($)
Rockclimbing	$ 103.13
Camping	$ 84.42
Picnic	$ 81.60
Sightseeing	$ 101.75
Hiking	$ 115.86
Backpacking	$ 86.25
Wildlife	$ 112.15
General Recreation	$ 90.48

Figure 17: Calculated using Rosenberger Database

Before using these values in calculations, however, it is necessary to acknowledge that they are likely to be extremely imprecise. In spite of the sample's large size, it contained just 44 observations within National Parks, and the granularity of the data classification in general leaves many of the subcategories in question. For instance, there are no observations of the consumer surplus obtained from backpacking in a desert (Rosenberger R. , 2011). Nevertheless, as it stands, this is the most sophisticated approach we can take to benefits transfer of this sort.

It is unfortunate that the visitor use studies have not indicated the number of hours spent by consumers in each of several activities within the park. Because of this it is necessary to speculate as to the allocation of recreation over the 892 thousand days of visitation. Below are a few possibilities:

Scenario	Park Recreation Days	% Rock climbing	% Camping	% Sight Seeing	% Hiking	% Backpacking	% General Recreation	Total Consumer Surplus
Scenario 1	892331	5%	15%	50%	8%	2%	20%	$ 87,255,962.20
Scenario 2	892331	15%	30%	30%	15%	5%	5%	$ 87,034,396.42
Scenario 3	892331	5%	10%	64%	5%	1%	15%	$ 88,292,583.13
Scenario 4	892331	40%	10%	10%	20%	10%	10%	$ 89,870,224.33

Figure 18: Consumer Surplus Estimates

Scenario 1 represents what one might expect after examining the visitor use surveys with a high proportion of visitor time going towards sightseeing and general recreation such as picnicking, going to visitor centers, and participating in interpretive programming. Scenario 2 represents a significantly more adventurous set of visitors than Scenario 1, and Scenario 3 represents a less adventurous visitor set than either of the first two. Finally, Scenario 4 represents a completely unexpected use of visitor days.

[19] The full regression output can be found in Appendix 6.

These four scenarios make it clear that, because the regression outputs are so similar for each of the different recreation types in this setting, the visitor use profile makes almost no difference in total user value. In all four scenarios, the final consumer surplus value is between $87 and $90 million. This conclusion should be accepted only hesitantly, though, as numerous large assumptions were made to reach this point. It is also worth noting that this process supposed no visitation to cultural and historical landmarks within the park, an assumption that we know is incorrect.

The area that is now Joshua Tree National Park has been inhabited for at least 5,000 years and the documentation of human history in this area exists in the major interpretive themes of homesteading/ ranching, mining, and Native American history. In all, the park is responsible for the preservation and maintenance of 122 historical structures (Baird, 2012).

1. Cultural/Historical Site Visitation

The park maintains multiple sites frequented by tourists that feature 19th and 20th century settlement by homesteaders and entrepreneurs. The most popular historic site is Keys Ranch, which served as the home of successful homesteaders Bill and Frances Key and is now listed in the National Register of Historic Places. At Keys ranger-led tours are offered (for a fee of $5), on which visitors accompany a uniformed or costumed ranger in period piece through the ranch and its grounds (National Park Service; Zarki, 2012). Other homesteader exhibits include Ryan Ranch and the Desert Queen Mine, and other tours are available including a guided walk through Barker Dam. A sample of the historical sites can be seen on the map in Appendix 9, which is taken from the 1994 General Management Plan (Joshua Tree National Park, 1994).

2. Cultural/Historical Resources Interpretation

Another important function of the Cultural Resources Division is documenting the unwritten history of Joshua Tree inhabitants and providing resources for public consumption. The park actively collects oral histories from homesteaders and descendants as well as tracking administrative history of park. Some of these stories are featured in documents made for the public, such as the newsletter seen in Appendix 10. The park is also planning on producing interpretive packets similar to documents made for visitors at Denali National Park and Preserve (Nyala West, 2012; Spoo, 2012).

3. Cultural Resources Preservation

JOTR maintains a museum for historical artifacts and library for historical documents and research on parks (Nyala West, 2012; Spoo, 2012). The park itself has limited restoration capacity but is augmented by NPS facilities in Arizona and conservators at Harper's Ferry National Historic Park in West Virginia (Spoo, 2012). Materials are collected by partnerships with scientists and academics, donations from individuals, or via collection from visitors who see artifacts while recreating. The park has a cooperative agreement with Sonoma State University to conduct archaeological excavations and analysis with

collected items being cataloged in-house (Keswick, 2012). Additionally, the park has task agreements with Arizona State University to do cornerstones structural work and with the San Bernardino County Museum to do paleontological work (Keswick, 2012). JOTR has also hosted an archaeology program in the past, although many of today's artifacts come into possession when patrons contact the park and inform them that a relative died and cultural artifacts pertaining to the park were found in her possession (Spoo, 2012). Unfortunately, the park does not make its museum or library regularly available to the public, thus severely limiting their use values.

4. Public Safety and Historic Structures

While a primary function of the park is the preservation and protection of historical structures, it also serves to protect the public from the hazards of historical structures. Physical Scientist Luke Sabala is in charge of closing over 300 hazardous abandoned mines on park lands. Working on a matching grant from the state of California, JOTR used fee money to start closing mines (Sabala, Chief Physical Scientist - Joshua Tree National Park, 2012). Additionally, it leveraged its resources by soliciting volunteer assistance. In its most successful example, a retired sheriff helped catalog the mines on park premises.

Cultural Visitation Use Value

Cultural visitation use value can be, as demonstrated in the framework, measured using the same methodology as natural visitation use values, namely TCM and CVM. We know from visitor use statistics that 29% of visitors in the winter of 2010 went to see an archaeological or historical site. However, we also know that only 1% of visitors traveled to the park with cultural recreation as their main purpose (Jette, Blotkamp, Le, & Hollenhorst, 2011). This idiosyncrasy makes cultural use in a park such as this exceptionally difficult to value using the travel cost method. A more promising lead is CVM, though one must be careful to identify the direct use values (visitation) and passive use values (preservation for posterity) as distinct from one another. As for utilization of benefits transfer methodology, many of the cultural resource use values in Navrud and Ready (2002) were found to be between $5 and $20 per user day. However, it would be difficult to equate the cultural resources at the Keys Ranch in the Californian Desert to those of a Swedish cathedral. And even if it was possible, it is unclear how many user days were spent visiting cultural and historic resources within Joshua Tree.

Human capital development at Joshua Tree National Park occurs through three primary interfaces with the public

1. The educational programming offered by park staff and associates
2. Group programs such as the Youth Conservation Corps and Junior Rangers.
3. Volunteer Programs such as the Citizen Scientists

1a. K-12 Student Education

Joshua Tree provides extensive K-12 curriculum-based educational programming that focuses on 26 themes within key areas such as physical sciences, biology, and history (Lange, 2012). About 1/3 of programming occurs on park lands with the remainder occurring in classroom visits (Lange, Education Specialist, 2012). One of the largest student-based programs in the National Park system, Education Specialist Lorna Lange estimates that the program reaches an average of 18,000 students annually, with a high of nearly 23,000 students reached in the 2009-2010 school year (Lange, Education Specialist, 2012). Preschool and K-12 students who visit the park can be granted fee waivers for admission.

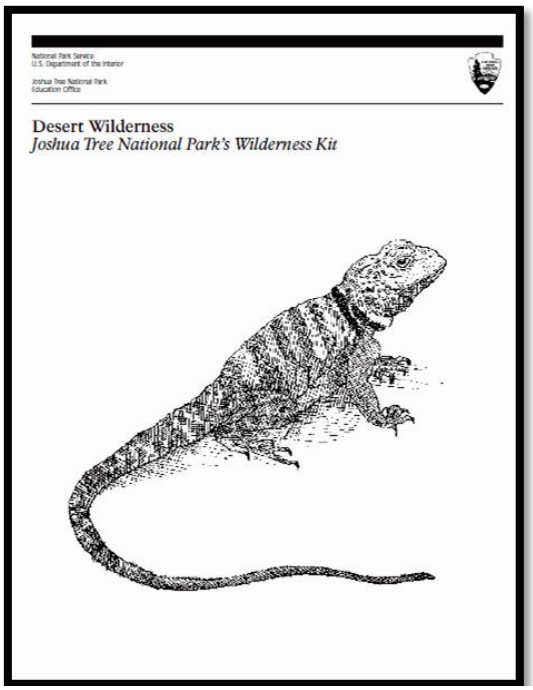


Figure 19: "Desert Wilderness Kit" developed for educators

The education staff writes activity programs, tests with students, revamps based upon feedback, then produce booklets for internal use as well as distribution to local schools. Some educational kits, such as JOTR's "Wilderness Kit (figure 19) are distributed or made available for educators. A critical aspect of the programs produced by the staff is that everything is done to meet state curriculum standards.

The staff also produces "trunks" that are used by teachers that include a lesson plan, instructional materials, and programming materials located in a box that can be given to schools (Lange, Education Specialist, 2012). Developed materials for the Desert Management Group and trained personnel at the Living Desert botanical garden and zoo and San Diego Zoo on teaching about desert tortoises.

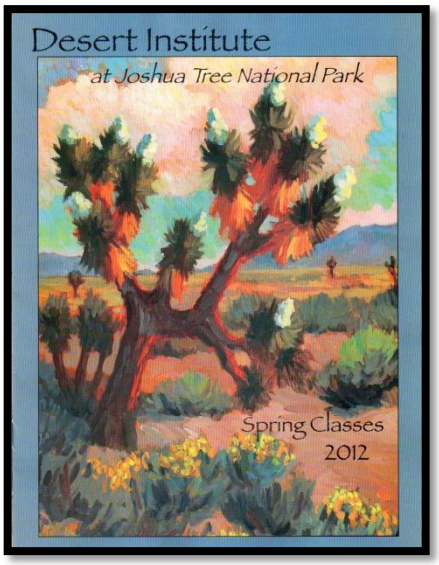


Figure 20: Spring 2012 class brochure for Desert Institute (Provided by Karina White)

Lange states that "having someone other than a ranger do the program devalues the program for [the students]" (Lange, Education Specialist, 2012). Pointing out the unique resource offered by park staff, Lange adds that "starting in 1976, we realized that we needed a group of people other than interpreters to work for kids, not all staff work well with children" (Lange, Education Specialist, 2012). The park also fulfills requests for information from students working on school projects. Lange estimates JOTR receives 400-500 letters per year (Lange, Education Specialist, 2012).

1b. Adult Education

The Desert Institute provides continuing education at the college level to adults and offers about 100 different courses and programs annually. While the programs are not run by the park itself, but rather the non-profit Joshua Tree National Park Association, JOTR provides an invaluable resource for programming to occur. Karina White, Desert Institute Director, states that the institute could not exist "if you don't have a large amount of land to teach on. Lots of people want to connect to pristine wilderness and most field programs spend at least half of their time in Joshua Tree National Park" (White, 2012)

Three types of programming are offered by the Desert Institute – field courses, lectures and custom-designed programming. Field course programming takes place in outdoors space and includes offerings in natural science, creative arts, cultural history, and survival training. Some courses may be taken for credit from the University of California Riverside. Lectures are provided in almost every gateway community adjacent to the park and sample topics include natural science and local history. Examples of custom-designed programming include five contract programs for the Road Scholar program, group and youth guides, and services for government agencies such as a training for the Environmental Protection Agency (White, 2012).

2. Youth Group Programs

Joshua Tree National Park is one of several units within NPS that administers the Youth Conservation Corps (YCC) program, which provides educational and vocational training for fifteen to eighteen year old students for 8-10 weeks during summer months. The park used to average around 12 students per summer but now has capacity to host 20-25 students, mostly from the local community (Rodriguez, 2012). Chris Rodriguez, who oversees the program notes that YCC "is a farm league in a lot of respects" and estimates that he personally knows 25-30 students who are now employed by NPS, the Forest Service, or the Bureau of Land Management (Rodriguez, 2012).

JOTR has partnerships with some schools to provide recreational opportunities while students provide volunteer hours. Rodriguez points out that the Urban School in San Francisco sends about 80 students every year and estimates that "10-20% have outdoor experience and the rest have little or no experience in an outdoors setting (Rodriguez, 2012).

Joshua Tree National Park also runs one of NPS' 237 "Junior Rangers" programs, offering students an opportunity to earn a badge by completing activities in a booklet or participating in a third-grade study unit. Over 27,000 students have participated in the program between 2001 and 2011 in Joshua Tree National Park.[20]

3. Volunteer Programs

In 2010, 1059 volunteers contributed more than 40,000 hours of work to Joshua Tree National Park (Office of the Superintendent - Joshua Tree National Park, 2011). Some of this value crosses over with

[20] Data provided by Joshua Tree National Park interpretive staff.

the group programs of the previous section, but much can be attributed to park volunteer visitor contacts and the park recycling program.

In 2011, the Citizen Science program, under the supervision of Vicky Chang, brought in multiple volunteers from universities and adults from the area to help in research within the park (Chang, 2012). These volunteers logged over 2600 hours of research time, including participation in the biodiversity hunt at the Oasis of Mara. The park continues to grow their citizen science program.

While much of the value flows from the volunteers into the park, the simple opportunity to develop research and preservation skills is counted by many volunteers as a value-added for them. It is unclear whether this should be labeled a benefit or simply a positive externality of volunteer labor.

Valuing Joshua Tree's Human Capital Development

As JOTR ranger time with each class varies from 30 minutes to 5 hours, it is necessary to make an assumption of average time per student, which we will conservatively place at 1 hour. Given that the program worked with over 18,000 students in 2011, we can confidently calculate student educational hours with rangers at a lower bound of 18,000 hours. Assuming that there are eight hours in a school day and that a school year is 180 days long, there are 1440 hours of school in a student year, and 18,000 hours is equivalent to 12.5 student years of schooling conducted by Joshua Tree National Park in 2011. It seems fairly clear, however, that these years of education are not equivalent to actual educational years, and therefore cannot be equated as such. An interesting quasi-experiment would be the comparison of the state science test scores of students undergoing Joshua Tree lesson plans with those who do not. If properly isolated, this effect could indicate the overall value of these educational programs.

Volunteer, Adult Education, and Youth Group Programs may need to be evaluated on a different metric, such as the previously suggested "locus of control" in order to be valued. There is also the possibility of utilizing contingent valuation to estimate the consumer surplus provided by these programs.

Although there are no specific studies performed to estimate passive use values of Joshua Tree National Park, estimates have been made for the Mojave Desert, one of two deserts that make up the park. Kroeger and Manalo estimate that non-users of the Mojave would be willing to pay $46.40 per household for a net of $136.3 million for California households that would hold some passive use value (Kroeger & Manalo, 2007). It should be noted that Kroeger and Manalo do not use a stated preference method for calculating this figure but rather use a benefits transfer figure adjusted from a 1984 study by Walsh, Loomis, and Gillman that conducted a contingent valuation survey to estimate the passive use of public lands in Colorado wilderness (Walsh, Loomis, & Gillman, 1984; Kroeger & Manalo, 2007). Therefore, we should not hold this figure in the same regard as a CVM-derived WTP figure.

While it is difficult to define what types of values are cherished by non-users of the park, we provide some examples in this section of benefits that non-users would be willing to pay to preserve beyond the use benefits indicated in the previous section. In addition, we will discuss some of the opportunity costs that the public forgoes in deciding to preserve the lands within park boundaries. These counterfactual examples are cited to present a contrast to the existing situation and suggest scenarios that may be useful in a stated preference study.

1. Open Space and Wildland Preservation

Joshua Tree National Park provides an abundance of open space where there is a rarity of this commodity in the region. The park has close proximity to several major metropolitan areas and is directly adjacent to three cities on the park boundary. Joshua Tree is one of three desert spaces protected in the U.S. southwest – Mojave National Preserve and Death Valley National Park are the other two – and 65% of the park is protected wilderness area.

The park is home to 585,000 acres of designated wilderness and passive use estimations of other wilderness areas point to significant non-use values. For example, Robert Richardson estimates $53.4 million of passive use values for 1.1 million acres of wilderness and natural areas in Riverside County, of which 471,733 acres lie within Joshua Tree National Park (Richardson, 2005). The estimate is derived from an assumption of a passive use value of $28.65 per household for 5 million acres of wilderness on public land in Colorado using similar methodology as the Kroeger and Manalo study described at the beginning of this section (Kroeger & Manalo, 2007).[21] While there is a question of whether this figure is externally valid for application to desert lands, Richardson's estimate at the least points to other studies using contingent valuation methodology that indicate a willingness to pay for wilderness areas and provides a conservative estimate for the area, if the reader accepts the assumptions made.

Bequest value

Andrea Compton, Director of Resources, says that the park has two broad goals – to manage natural and cultural resources "so that future generations can experience Joshua Tree National Park, although not necessarily in the same conditions as today." Dr. Victoria Chang believes that one of the reasons that the park was established was to be a scientific laboratory of a healthy desert ecosystem in the future. In essence, she believes in a scientific bequest value, saying that one of the main reasons we're protecting the park is so that we don't lose its mysteries, which our current scientific techniques are not yet advanced enough to solve (Chang, 2012). Park wildlife biologist Michael Vamstad echoes these sentiments, stating that it is hard to say what type of values will be created by the maintenance of this place. "It's possible that we will discover strategies for dealing with the climate change by studying these large open vegetated spaces," he says (Vamstad, 2012).

Much of the cultural preservation done in the park museum and library also likely creates a bequest value only measurable through contingent valuation. The more scarce the preserved evidence of Native

[21] The figure is derived from the 1984 study by Walsh, et al. as cited within the Richardson study and earlier in this section.

American settlement and the American homesteading lifestyle elsewhere in the U.S., the more value this particular preserved material will hold.

Wildlife Preservation

Numerous studies indicate that wildlife protection is highly valued by non-users through the demonstration of monetary willingness to pay for wildlife protection or willingness to accept damages (lost passive use values) to wildlife and their habitats. Carson, et al. included wildlife impacts in their examination of the Exxon Valdez oil spill, Kotchen and Burger noted impacts on Caribou in the Arctic National Wildlife Refuge, Loomis and Larson identified WTP for gray whales, and Loomis and White estimated economic benefits for 18 rare and endangered species. (Carson, et al., 1992; Kotchen & Burger, 2007; Loomis & Larson, 1994; Loomis & White, February 1996).

It would follow that similar values could be found for endangered species that inhabit JOTR and surrounding areas. These include two plants, the triple-ribbed milkvetch and Parish's fleabane, and one animal, the Desert Tortoise, whose range stretches across large portions of the park (Hoines, 2012). Specifically, the Mojave Desert portions of JOTR provide 266,000 acres of high-quality tortoise habitat (Joshua Tree National Park Foundation Statement, 2011). There are also numerous other charismatic species that capture the hearts and imaginations of park visitors, including the desert bighorn sheep, the cholla cactus, the Ocotillo, and the Joshua Tree (Hoines, 2012).

Figure 21: Coyotes Near Keys Ranch (Photo by Tim Marlowe)

Cooperative Programming

Technical Consulting

Educational consulting

As mentioned in the "Direct Use" section, JOTR's education staff creates many materials and informal education programming, which has made them a valuable resource for many groups outside of the park itself. As previously mentioned, Lorna Lange, the park's Education Specialist, has been called upon by the San Diego Zoo and The Living Desert to create lesson plans and other materials on Desert Tortoises. Furthermore, Lange has been asked to develop an air quality module for Project Learning Tree and a Gifted and Talented Education (GATE) program for nearby school districts. For the latter program, JOTR

staff were the only outside resource asked to come into the school district to partake in program design and implementation (Lange, Education Specialist, 2012).

Also, park education personnel serve in an advisory capacity for a number of institutions including non-profits that produce curriculum-based materials, a local observatory, other parks, and education organizations such as the California Science Teachers Association

Night Sky/Light Pollution Control advocacy

We earlier mentioned the work of JOTR in limiting regional light pollution on page 52. This effort is made possible by the monitoring of light pollution in the Morongo Basin by the physical scientist, Luke Sabala, at Joshua Tree National Park. The information gathered by the park is used by community advocates and partners, such as a local county supervisor, to advocate for controls in residential and commercial areas (Sabala, Chief Physical Scientist - Joshua Tree National Park, 2012).

Coordination and Management

Joshua Tree National Park leads or serves as a partner organization with many multiple-stakeholder groups that serve regional interests in the Southern California desert. While the list of their participatory activities is long, we have chosen a few examples to highlight the coordination capacity the park provides to various efforts.

Desert Managers Group Leadership

The Desert Managers Group is a collection of federal and state agencies that oversee and manage desert wildlands in Southern California. In 2005, DMG wanted to engage in an outreach project on Desert Tortoise recovery and management (Zarki, 2012). Joe Zarki, Chief of Interpretation, provided public communications skill and experience that other partners such as the BLM and Fish & Wildlife Service did not have. He states that, "it probably would not have happened were it not for NPS," despite the fact that multiple agency partners were involved and the Desert Tortoise habitat is only partially within Joshua Tree National Park (Zarki, 2012)[22].

Partner of Coachella Valley Multispecies Habitat Conservation Plan

This is a working group that addresses encroachment issues and creates wildlife management plans in the Coachella Valley. JOTR participates in advocacy efforts to protect wildlife habitat corridors that transcend political boundaries. Andrea Compton, Director of Resources at JOTR, notes that "the ecological boundary may not fit with the legal boundary of the park" (Compton, 2012). Further, Compton works with the Coachella Valley Association of Governments (CVAG) on its Reserve Management Oversight Committee (RMOC) to create a habitat management conservation plan for the desert tortoise. She has worked closely with this group to ensure that the HMCP reflects goals of CVAG but also of the park, which hints at a further role of organizational leveraging (Compton, 2012).

[22] A map of ideal tortoise habitat in and surrounding the park can be found in Appendix 11.

Work with MDLT and the DoD

Joshua Tree National Park, the non-profit Mojave Desert Land Trust, and the Department of Defense have found themselves sharing interests when it comes to land conservation. The Marine Corps, which has a base just north of park, needs clear air corridors for test missions while the MDLT and JTNP want to protect tortoise habitats and wildlife corridors. The three groups work together under the leadership of the National Park Service to purchase and preserve land through the following process. The Marine Corps gifts the money to the Mojave Desert Land Trust, which then purchases the sector of land and donates it to the park (Messaros, 2012).

The coordination and management listed within this section works mostly towards secondary benefits of ecosystem services and passive use preservation. It is unclear, however, whether the management itself creates benefits in its own right.

Funding

As a single unit of NPS, Joshua Tree National Park does not widely distribute funding or large program-based grants but does participate in various activities that assist entities outside of park boundaries.

In-kind Donations

The park headquarters mainly serves as a space for JOTR staff but also hosts other organizations that may depend on the park for their own existence. In particular, the offices for the Joshua Tree National Park Association (JTNPA) and the associated Desert Institute are housed within JOTR (Morton, 2012). The Desert Institute also benefits from sometimes using JOTR personnel as instructors for their own courses while they are on the clock (Compton, Director of Resources - Joshua Tree National Park, 2012). The Morongo Basin Open Space Group (MBOSG) is also housed within the headquarters and their relationship with the park is discussed further in the "Organizational Leveraging" section below (Weigel, 2012). Working within JOTR allows MBOSG to utilize GIS mapping resources from park staff, amongst other colocation benefits.

Grants and Fellowships

Research grants and fellowships offered to graduate and PhD level students conducting original historical, archaeological, and ethnological research. For example, the park hosted a PhD student as a fellow and allowed access to historical archives and resources for the purpose of constructing a 1,200 page thesis on the Cahuilla language, which was used by a local Native American band of the same name (Nyala West, 2012). Andrea Compton notes that JTNP used to offer matching grants in partnership with the Cooperative Ecosystem Studies Unit to researchers who were studying topics integral to the park, such as the effects of climate change on plants and animals. This is, however, no longer possible due to a change in the NPS funding system (Compton, 2012).

Organizational Leveraging

Since the ecology and environmental factors concerning the park often extend beyond the park boundaries, it follows that Joshua Tree National Park's cooperative programming efforts often give rise to larger efforts affecting areas outside of park boundaries. Superintendent Mark Butler mentions that recent years have required "a different playbook for addressing external issues" (Butler, 2012). Here we document some of JOTR's actions as part of a grander desert ecosystem and institutional network.

Advocacy Efforts to Protect Wildlife Habitat Corridor Linkages

Various wildlife that reside within Joshua Tree National Park also move between park boundaries and adjacent lands, all of which serve as natural habitats. In their efforts to protect these species, JOTR has engaged in advocacy efforts to fight displacement of wildlife and preservation of habitat corridor linkage. In particular, JOTR works with the Bureau of Land Management (BLM) and the Twentynine Palms Marine Corps Air Ground Combat Center, amongst other property holders and agencies, to dedicate lands for wildlife passages (Compton, 2012).

Furthermore, the park also responds to proposed development which may impact habitats or upset the ecological balance of the desert. One example is the response of JOTR to a proposed landfill for Los Angeles County in the vacated open pit iron mines on Eagle Mountain, which sits to the southeast of the park and used to lie within park boundaries. Superintendent Butler noted that a landfill would create grounds for developing a large raven population, which would then serve as predators of reptile eggs and threaten the endangered Desert Tortoise population. With a 31 km range from the landfill feeding grounds, about 75% of prime Desert Tortoise habitat in JOTR would be affected (Butler, 2012)

Open Space Advocacy

The park is a partner organization in Morongo Basin Open Space Group, a collaboration of multiple state and federal agencies, local government groups, and non-profit stakeholders with the mission to "plan for the long-term development and conservation of the Morongo Basin," of which JOTR is geographically located within. Stephanie Weigel, the Regional Land Use Planner for the Sonoran Institute staffs the planning partners and describes her objective as "working with landowners to determine appropriate land use, such as providing wildlife habitats and views." She justifies the mission and the group's purpose as "protection of intrinsic values" (Weigel, 2012).

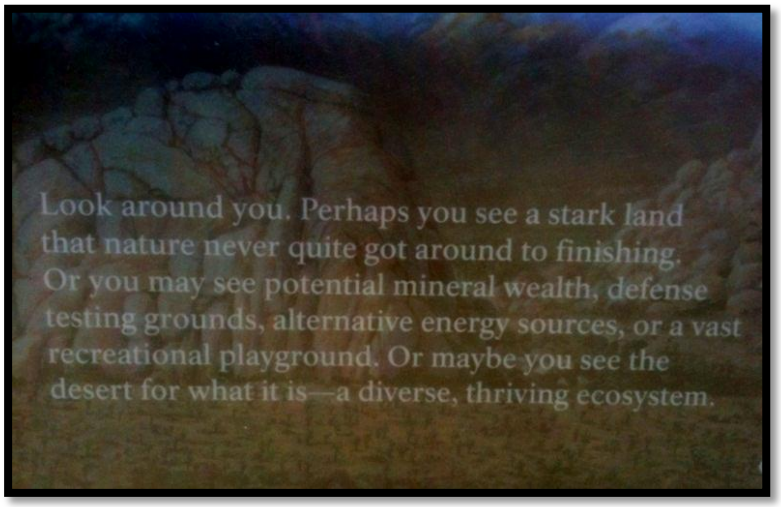
Joshua Tree is able to leverage their holdings and standing by providing resources as a primary partner – the Open Space Group is located within park headquarters and relies upon the park's in-house mapping expertise. More importantly, the park's interest in open space and coordinating land use policy grants MBOSG a firm basis to do their work, as exemplified by the parks actions mentioned in the previous section. The park's existence in many ways permits MBOSG's existence as a multi-group collaboration. Weigel describes the park as an "island of protected open space" which creates the impetus to preserve more lands (Weigel, 2012).

As part of its conservation efforts, Joshua Tree National Park commented on an Environmental Impact Statement (EIS) regarding Desert Sunlight's application to develop a solar photovoltaic farm on Bureau of Land Management holdings adjacent to park (Butler, 2012). While the proposal was ultimately successful (the farm has yet to be constructed as of the writing of this paper), NPS did enter into an MOA with the contractor, Desert Sunlight, to fund mitigation measures that include monitoring and signage. In its comments on the draft EIS, JOTR focused on "visibility of the project to park visitors and the indirect impacts of the project on park resources including wildlife, air quality, and visual resources e.g., dust and night sky/light pollution" (Bureau of Land Management, 2011). The park is engaged in continuing efforts to limit utility-scale energy development surrounding its boundaries in an effort to extend the open space it offers (Butler, 2012).

Joshua Tree National Park Counterfactuals

After enumerating the benefits provided Joshua Tree National Park, it is necessary to consider the costs of its existence.

Figure 22: Interpretive display at JOTR (photo by Francis Choi)



The statement to the right, taken from a roadside interpretive display in Joshua Tree National Park, speaks to the opportunity costs of preserving the desert environment and thus preventing other forms of land use. Unless we first understand those opportunity costs, we cannot understand the value of conservation and preservation. Much can be said about the land use potential for the space occupied by JOTR and surrounding public lands by looking at land use patterns for adjacent properties and lands that formerly fell under the park's jurisdiction.

Residential development

JOTR Superintendent Mark Butler notes that "Joshua Tree was a tourist destination before Palm Springs was," exemplifying its potential as a residential community and getaway destination (Butler, 2012). The three cities of Yucca Valley, Joshua Tree, and Twentynine Palms host a combined population of 53,162 residents according to the 2010 Census and sit directly adjacent to the northern boundary of the park. Moreover, the park cites residential expansion and boundary encroachment as issues of concern to the park (Joshua Tree National Park Foundation Statement, 2011). Examples of development patterns can be seen in Appendix 8. These anecdotes should be seen as more than concerns and should be viewed as legitimate examples of a counterfactual that would have residential development throughout the park. We see two compelling reasons why the Joshua Tree area would serve this purpose. First, existing development serves to support a community developed around Twentynine Palms Marine Corps Air Ground Combat Center. Second, residential development occurred in nearby Palm Springs despite the lack of natural resources such as water or a specific attraction or economic anchor. Karen Messaros, Deputy park Superintendent, believes that the Coachella Valley, where Palm Springs is located would feature "ridgeline to ridgeline" development were it not for the existence of the park (Messaros, 2012). Joe Zarki,Chief of Interpretation, states that water would be a limiting factor to residential expansion, but still believes that much of the park would feature low-density residential development (Zarki, 2012).

Mining

Mineral extraction has long been a feature in Joshua Tree National Park and surrounding areas. In the early 1940s, Henry Kaiser was granted access to mine Eagle Mountain, then located in the Southeastern section of Joshua Tree National Monument, to supply steel for the war effort (Butler, 2012). The Eagle Mountain iron ore mine was by far the largest in the western United States from 1948 to 1982, when it ceased mining operations (Force, 2001). Moreover, about 289,000 acres of land was deleted from the boundaries of the National Monument in 1950 pursuant to the Phillips Bill as "these were the acres where it was thought that minerals in commercial quantities might be developed" (King, 1954).

Mining was also prominent within the park although on a lesser scale from before and after the establishment of the area as a National Monument, as evidenced my many preserved locations visited by tourists today. While a comprehensive mineral survey has not been performed, mines in the park have produced approximately 12,000 troy ounces of gold, 16,000 troy ounces of silver, 33,000 troy ounces of by-product lead, and over 20 tons of bismuth ore (Joshua Tree National Park, 1994). There is still one active mining claim on the northern border of the park in the Pinto Mountains, owned by Bullion River Gold (Messaros, 2012).

Energy Development

The Southern California desert provides many opportunities for utility-scale energy development, exemplified by the many wind turbine farms sited alongside Interstate-10 on JOTR's southern boundary. The Mojave Desert already contains some of the largest renewable energy developments in the nation with more projects in the pipeline (Kroeger & Manalo, 2007). Key to the suitability of the area for solar and wind development are geographic, climatic, and political factors such as natural wind channels, little precipitation and cloud coverage, and wide swaths of undeveloped land. Given that many energy developments have been proposed on nearby properties (see Appendix 7), including land that used to belong to the park, it would not be surprising if park lands, especially the eastern parts would also be considered for development were it not for the existence of JOTR (Messaros, 2012).

Unmaintained Lands

As the roadside display indicates, Joshua Tree may be a vast recreational playground with or without the existence of the park itself and the services it provides in protecting and maintaining the natural environment. Even with the established boundaries, the natural environment faces many threats from public use. These include overcrowding, vandalism, illegal fires, and destructive recreation practices, such as outdoor recreational vehicle use (Joshua Tree National Park Foundation Statement, 2011). In response, District Ranger Jeff Ohlfs notes that law enforcement rangers fight the attitude from some local residents that the park is part of their backyard. For example, rangers remove graffiti and cite trespassers (Ohlfs, 2012). While the existence of the park may increase visitation to the area, unregulated or unpoliced use of the land may result in significant and irreversible damage to the natural environment.

Conclusion

The National Park Service holds an undetermined but significant amount of value for consumers and non-consumers. In individual units, passive use values may be greater than direct use values, although it is unclear that all direct use in parks is fully understood and categorized. Moreover, little work has been done to measure the value of "cooperative programming," a function of NPS that is often overlooked. In designing a valuation method to measure economic values, it may be helpful to assess both direct use values within the park and those outside individual unit boundaries. The most wide-reaching of methodologies is the contingent valuation method, but even that has its limits, as local and global health impacts of ecosystem services are difficult to evaluation in such a manner.

While we found a wide array of literature in environmental economics concepts useful for developing a valuation framework, we also found the amount of available information overwhelming. To the best of our ability, we have synthesized these readings into a format we hope was helpful to understanding a very broad field of research. We found that the case study we conducted on Joshua Tree National Park was helpful in providing specific examples for types of values. While it was useful to examine a single park unit, JOTR is not necessarily representative of all National Park units or other types of units within the system, such as National Historical Parks, National Monuments, Wild and Scenic Rivers and National Scenic Trails. Additionally, this case study may not be representative of the types of values provided by the 23 cooperative programs described by NPS, as Joshua Tree National Park only directly takes part in a small subset of those programs. Therefore, further case studies on different types of units and specific cooperative programs may provide a robust view of services provided by NPS and values held by the American public.

From the Grand Canyon to the Liberty Bell Center to wild and scenic rivers throughout the United States, the National Park Service touches the lives of many Americans who visit and enjoy our most important natural and historical sites. We hope this study has also illuminated the benefits afforded to those who do and do not interface with the National Park Service directly, but nevertheless value America's Greatest Idea – the National Park.

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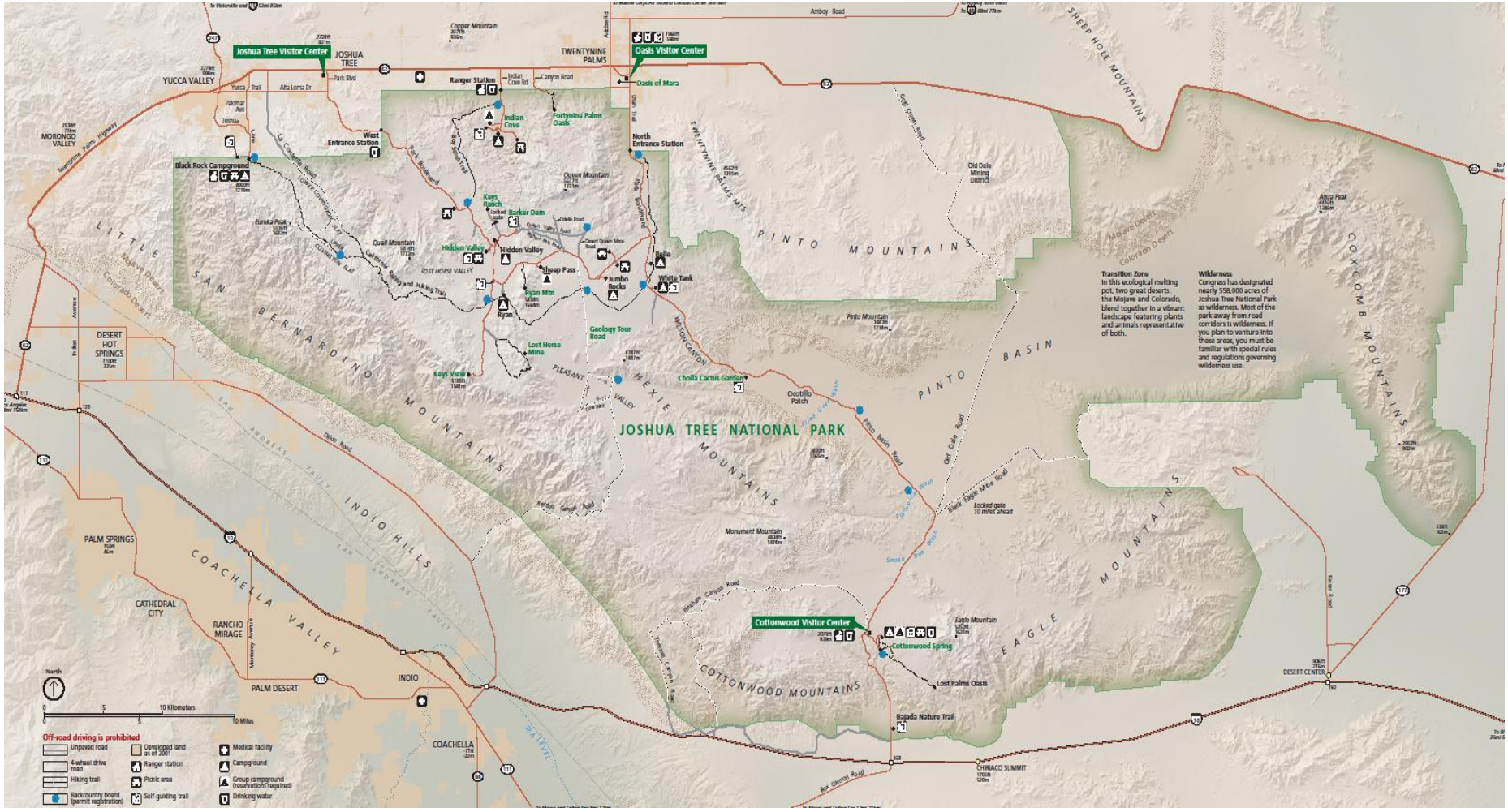
Appendix 1: Joshua Tree National Park Map (Murphy, 2012)



Appendix 2: Population within Specified Radii of Joshua Tree National Park (Missouri Census Data Center, 2011)

Auxiliary Report: Counties Contributing to Circular Areas, By Concentric Ring Areas
Coordinates: (33.871389 , 115.991389)

Additional Population: Outer radius of Ring (or circle) = 20 miles

County Cd	Total Pop
Riverside CA	151,032
San Bernardino CA	14,308
radius	**165,340**

Additional Population: Outer radius of Ring (or circle) = 30 miles

County Cd	Total Pop
Riverside CA	205,257
San Bernardino CA	25,998
radius	**231,255**

Additional Population: Outer radius of Ring (or circle) = 40 miles

County Cd	Total Pop
Imperial CA	4,307
Riverside CA	72,176
San Bernardino CA	17,878
radius	**94,361**

Additional Population: Outer radius of Ring (or circle) = 50 miles

County Cd	Total Pop
Imperial CA	2,730
Riverside CA	10,045
San Bernardino CA	11,079
San Diego CA	2,173
Radius	**26,027**

Additional Population: Outer radius of Ring (or circle) = 150 miles

County Cd	Total Pop
La Paz AZ	20,489
Mohave AZ	175,595
Yuma AZ	194,855
Imperial CA	167,491
Kern CA	41,262
Los Angeles CA	9,423,926
Orange CA	3,010,232
Riverside CA	1,751,131
San Bernardino CA	1,964,156
San Diego CA	3,093,140
Clark NV	25,681
Radius	**19,867,958**
	20,384,941

Appendix 3: Commercial Filming Permits in 2011 in JOTR (Joshua Tree National Park, 2011)

Permit Type	Date	# of Days	Description
Film	12-Jan	1	Film and Photo w/models
Photo	18-Jan	1	Photo w/model
Photo	4-Feb	1	Photo museum
Photo	7-Feb	1	Photo w/vehicle and model
Photo	28-Mar	3	Photo workshops
Photo	10-Mar	2	Photo with model and props
Photo	22-Mar	1	Photo scenery
Film	28-Mar	5	Film wildflowers
Film	20-May	1	Film landscape
Photo	19-May	1	Photo with vehicle and
Film	23-May	3	Fashion shoot with models
Photo	2-Jun	1	Fashion shoot with models
Film	26-Jun	1	Movie film
Photo	7-Jul	1	Fashion shoot with models
Film	5-Jul	2	Movie film
Photo	4-Aug	2	Fashion shoot with models
Photo	3-Dec	3	Photo workshops
Film	24-Sep	1	Music video
Photo	12-Oct	1	Fashion shoot with models
Photo	17-Oct	2	Photo with Models
Photo	20-Oct	2	Photo with Models
Film	4-Nov	1	Music video
Film	7-Nov	1	Commercial
Photo	8-Nov	1	Fashion shoot with models
Film	1-Dec	1	Fashion shoot with models
Film	28-Nov	2	Film Documentary
Photo	1-Dec	1	Fashion shoot with models
Film	30-Nov	1	Film Movie

Appendix 4: Academic Research Permits in JOTR from 2000-2004

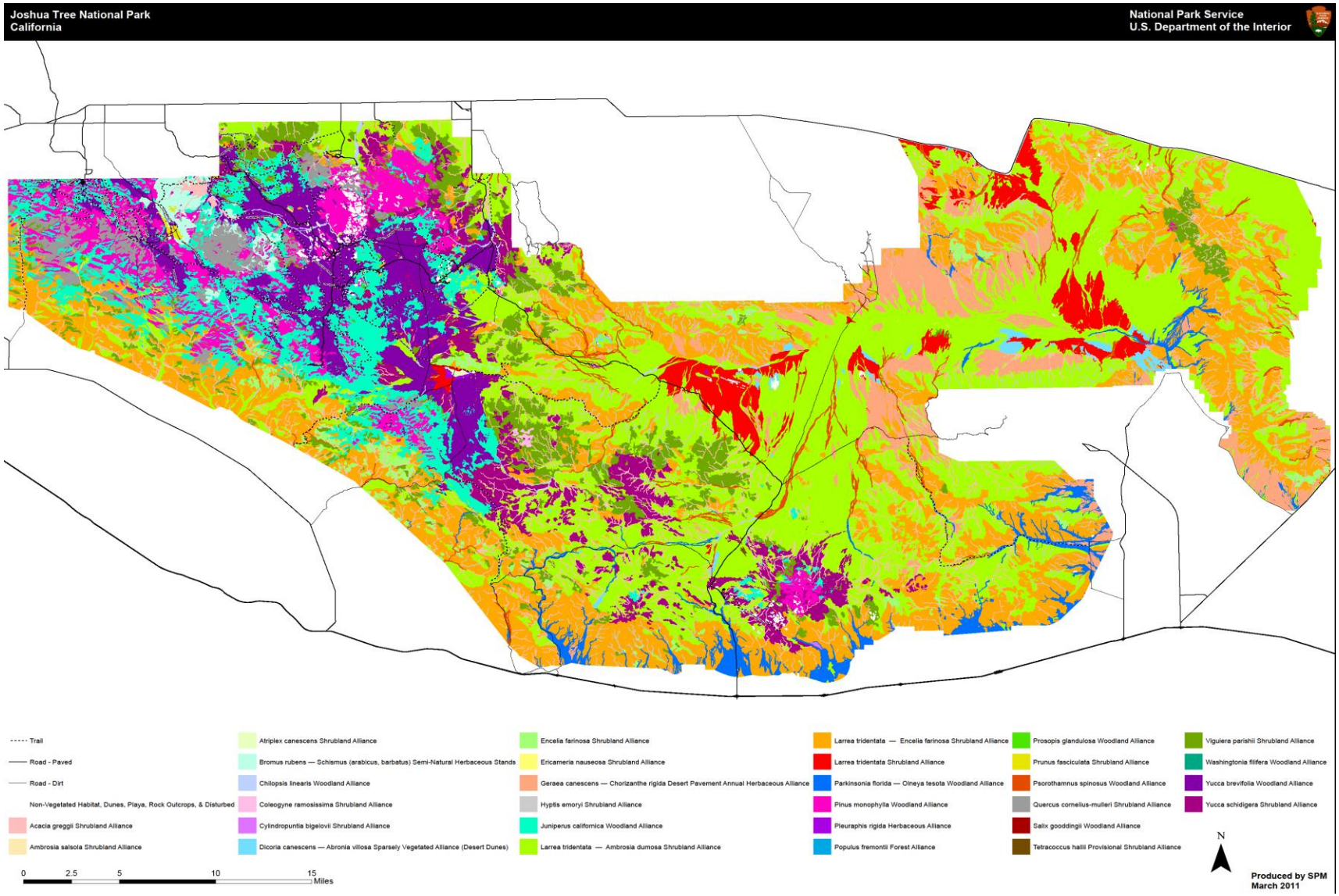
(National Park Service, 2012)

Author	Subject	Year	NPS Funding	Other Funding	Start Date	End Date
Anderson	Endangered Species	2000	0	18600	8/24/1999	8/31/2000
Johnson	Plant Communities	2000	32208	0	10/12/2000	12/31/2001
Cruzan	Mammals	2000	0	2000	1/5/2000	1/12/2000
Cornett	Ecology	2000	0	2500	11/15/1990	11/15/2000
Delisle	Herpetology	2000	0	100	1/1/2000	12/31/2000
Lutz	Invertebrates	2000	0	0	3/1/2001	1/1/2002
Freeman	Botany	2000	0	0	3/22/2001	3/22/2001
Vanier	Fire	2000	0	6000	1/1/2000	1/31/2000
Fahnestock	Soils	2000	0	0	4/10/2000	12/31/2000
Howe	Ecology	2000	0	9000	3/9/2000	3/19/2000
Manoukis	Climate Change	2000	0	1700	10/6/2000	12/31/2000
Burkhart	Animal Communities	2000	0	0	8/23/2000	12/31/2000
Kim	Geophysics	2001	0	130000	9/1/2001	12/31/2001
Johnson	Plant Communities	2001	23261	0	10/12/2000	12/31/2001
Barth	Minerology	2001	0	0	10/1/2001	12/31/2001
Lenz	Plant Communities	2001	0	0	4/26/2001	12/31/2001
Davies-Vollum	Geology	2001	0	900	9/1/2001	12/31/2001
Howard	Ecology	2001	0	0	5/7/2001	5/31/2001
Weller	Ecology	2001	0	0	10/13/2001	10/14/2001
Hawkins	Ecology	2001	0	0	10/27/2001	10/28/2001
Wilson	Ecology	2002	0	0	8/1/200	12/31/2003
Kim	Geophysics	2002	0	0	1/15/2002	12/31/2002
Cruzan	Mammals	2002	0	2200	1/1/2002	12/31/2002
Brooks	Fire	2002	0	0	10/1/2002	12/31/2002
Toulson	Plant Communities	2002	0	0	4/10/2002	12/31/2002
Barth	Geology	2002	0	0	10/12/2002	12/31/2002
Barth	Geology	2002	0	3960	3/7/2002	6/1/2002
Waggoner	Invertebrates	2002	0	0	9/18/2002	12/31/2002
Delisle	Herpetology	2002	0	0	1/3/2002	12/31/2002
Burkhart	Herpetology	2002	0	0	10/18/2002	10/28/2002
Zarki	Invertebrates	2002	0	0	4/1/2002	12/31/2002
Jaeger	Herpetology	2002	0	0	6/7/2002	12/31/2002
Epps	Mammals	2002	0	0	6/11/2002	9/30/2003
Esque	Fire	2002	9524	300	4/10/2002	12/31/2002
Fahnestock	Soils	2002	0	0	12/4/2002	5/31/2003
Doell	Lichens	2002	0	0	3/1/2002	12/31/2002
Longshore	Animal Communities	2002	0	0	10/16/2002	9/30/2005
Wilson	Ecology	2002	0	0	8/1/2002	12/12/2005
Kirkpatrick	Vascular Plants	2003	0	100	7/27/2003	12/31/2003
Rodriguez	Ecology	2003	0	1500	6/10/2003	12/31/2003
Wilson	Ecology	2003	0	0	8/1/2002	12/12/2005
Kim	Geophysics	2003	0	388390	1/15/2003	12/31/2003
Cruzan	Mammals	2003	0	1707	10/20/2002	1/31/2004
Bezy	Herpetology	2003	0	0	5/7/2003	5/20/2003
Fehlberg	Vascular Plants	2003	0	0	1/1/2003	12/31/2004
Blauth	Restoration - Natural	2003	0	585	9/22/2003	9/3/2004

Appendix 4 (continued): Academic Research Permits in JOTR from 2000-2004

Author	Subject	Year	NPS Funding	Other Funding	Start Date	End Date
McAuliffe	Plant Communities	2003	0	0	3/15/2003	3/21/2003
Guarnaccia	Inventory Natural Resou	2003	0	0	5/1/2003	12/31/2003
Smith	Ecology	2003	0	5000	8/1/2003	12/31/2003
Barth	Geology	2003	2500	2000	5/13/2003	12/31/2003
Barth	Geology	2003	0	0	10/6/2003	12/31/2003
Allen	Air Pollution	2003	14024	4500	12/23/2002	12/31/2003
Delisle	Herpetology	2003	0	3000	1/3/2003	12/31/2005
Esque	Ecology	2003	0	1000	8/18/2003	12/31/2003
Knaus	Threatened/Endangerec	2003	0	12114	2/28/2003	6/30/2007
Zarki	Invertebrates	2003	0	18	4/1/2003	12/31/2003
Scott	Paleontology	2003	2500	3000	1/29/2003	5/31/2003
Hansen	Vascular Plants	2003	0	0	8/20/2003	8/20/2005
Epps	Mammals	2003	0	20000	6/11/2002	9/30/2003
Esque	Fire	2003	0	1000	4/1/2003	12/31/2003
Halama	Birds	2003	0	100000	7/21/2003	12/31/2003
Fahnestock	Soils	2003	0	0	12/4/2002	5/31/2003
Rowland	Threatened/Endangerec	2003	0	0	5/20/2003	12/31/2003
Paterson	Geophysics	2003	10000	10000	5/1/2003	12/30/2003
Thomas	Ecology	2003	0	0	7/15/2003	12/31/2003
Longshore	Mammals	2003	19000	0	10/16/2002	9/30/2005
Wilson	Paleontology	2003	0	0	8/10/2002	12/12/2005
Redfern	Plant Communities	2004	0	500	3/13/2004	12/31/2004
Rodriguez	Ecology	2004	0	1500	3/15/2004	12/30/2005
Kim	Geophysics	2004	0	453550	1/10/2004	12/31/2004
Rifkind	Invertebrates	2004	0	0	4/1/2004	12/31/2004
Fehlberg	Vascular Plants	2004	0	470	1/1/2003	12/31/2004
Foldi	Invertebrates	2004	0	3072	2/21/2004	12/31/2004
Blauth	Restoration - Natural	2004	0	5929	9/22/2003	9/3/2004
McAuliffe	Ecology	2004	0	0	4/19/2004	12/31/2004
Butler	Air Pollution	2004	0	654	3/5/2004	9/30/2004
Barth	Geology	2004	0	0	1/1/2004	12/31/2004
Allen	Air Pollution	2004	16755	0	12/1/2003	9/30/2006
Delisle	Herpetology	2004	0	0	1/3/2004	12/31/2004
Hanks	Invertebrates	2004	0	0	4/1/2004	12/31/2004
Esque	Ecology	2004	0	2000	1/20/2004	12/31/2005
Knaus	Vascular Plants	2004	0	36572	2/28/2003	6/30/2007
Zarki	Invertebrates	2004	0	30	4/1/2004	12/31/2004
Springer	Paleontology	2004	2500	12500	3/5/2004	12/31/2004
Hansen	Vascular Plants	2004	0	0	8/20/2003	8/20/2005
Phillipsen	Herpetology	2004	0	4500	2/28/2004	12/31/2004
Johansen	Geography	2004	0	0	1/1/2004	12/312004
Belnap	Ecology	2004	0	10000	9/10/2004	12/31/2004
Esque	Fire	2004	0	2000	2/15/2004	12/31/2005
Halama	Birds	2004	0	106000	6/11/2004	12/31/2004
Fahnestock	Soils	2004	0	0	2/21/2004	12/31/2004
Thomas	Ecology	2004	0	0	1/15/2004	12/31/2004
Longshore	Mammals	2004	17000	0	10/16/2002	9/30/2005
Russell	Invertebrates	2004	0	2000	3/19/2004	12/31/2004

Appendix 5: Vegetation Alliance Map of Joshua Tree National Park (Murphy, 2012)



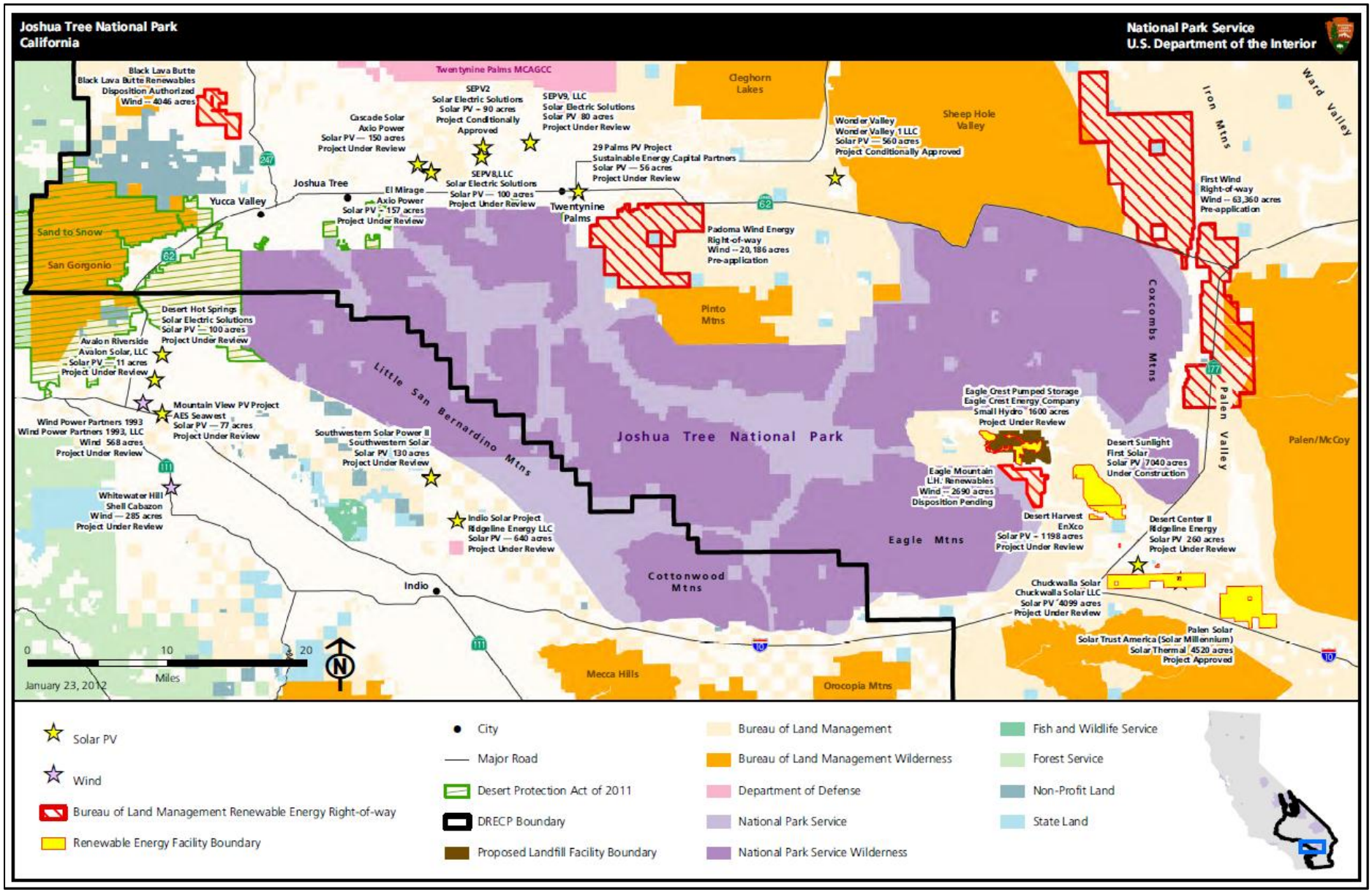
Appendix 6: Linear Regression of Real Daily Consumer Surplus on Natural Recreation Characteristics (Source: (Rosenberger R. , 2011))

Dependent Variable	Estimate	SE	t	p
backpacking	-0.79	13.48	-0.06	0.95
bicycling	16.83	16.48	1.02	0.31
camping	-2.62	9.73	-0.27	0.79
fishing	35.87	7.05	5.08	0
rafting	66.28	10.27	6.45	0
beach	21.06	11.11	1.9	0.06
hiking	28.82	9.61	3	0
hunting	39.06	7.19	5.44	0
motorboat	27.72	10.17	2.72	0.01
mtnbiking	121.78	17.8	6.84	0
orv	-15.49	21.66	-0.72	0.47
picnic	-5.44	15.76	-0.35	0.73
rockclimbing	16.09	18.71	0.86	0.39
sightseeing	14.71	14.74	1	0.32
swimming	3.32	17.7	0.19	0.85
wildlife	25.11	7.66	3.28	0
genrec	3.44	8.61	0.4	0.69
nationalfo~t	-15.45	5.01	-3.08	0
stateforest	22.53	22.63	1	0.32
nationalpark	26.98	10.54	2.56	0.01
statepark	0.99	8.77	0.11	0.91
blm	29.76	35.88	0.83	0.41
nwr	-36.78	20.69	-1.78	0.08
Natlrec	1.11	35.53	0.03	0.98
otherland	-3.45	3.67	-0.94	0.35
lake	-14.83	4.43	-3.35	0
alpine	35.56	10.78	3.3	0
wetlands	196.42	20.63	9.52	0
estuary	11.62	6.51	1.78	0.07
ocean	58.23	6.53	8.91	0
river	16.24	5.23	3.11	0
desert	24.85	11.21	2.22	0.03
grassland	28.06	19.27	1.46	0.15
steppe	99.36	36.04	2.76	0.01
woodland	4.08	6.57	0.62	0.53
taiga	5.91	5.59	1.06	0.29
midwest	27.13	7.21	3.76	0
south	45.23	7.16	6.32	0
west	49.29	6.78	7.27	0
multiple	49.93	9.47	5.27	0
northeast	36.26	7.27	4.99	0
_cons	-14.08	9.9	-1.42	0.16

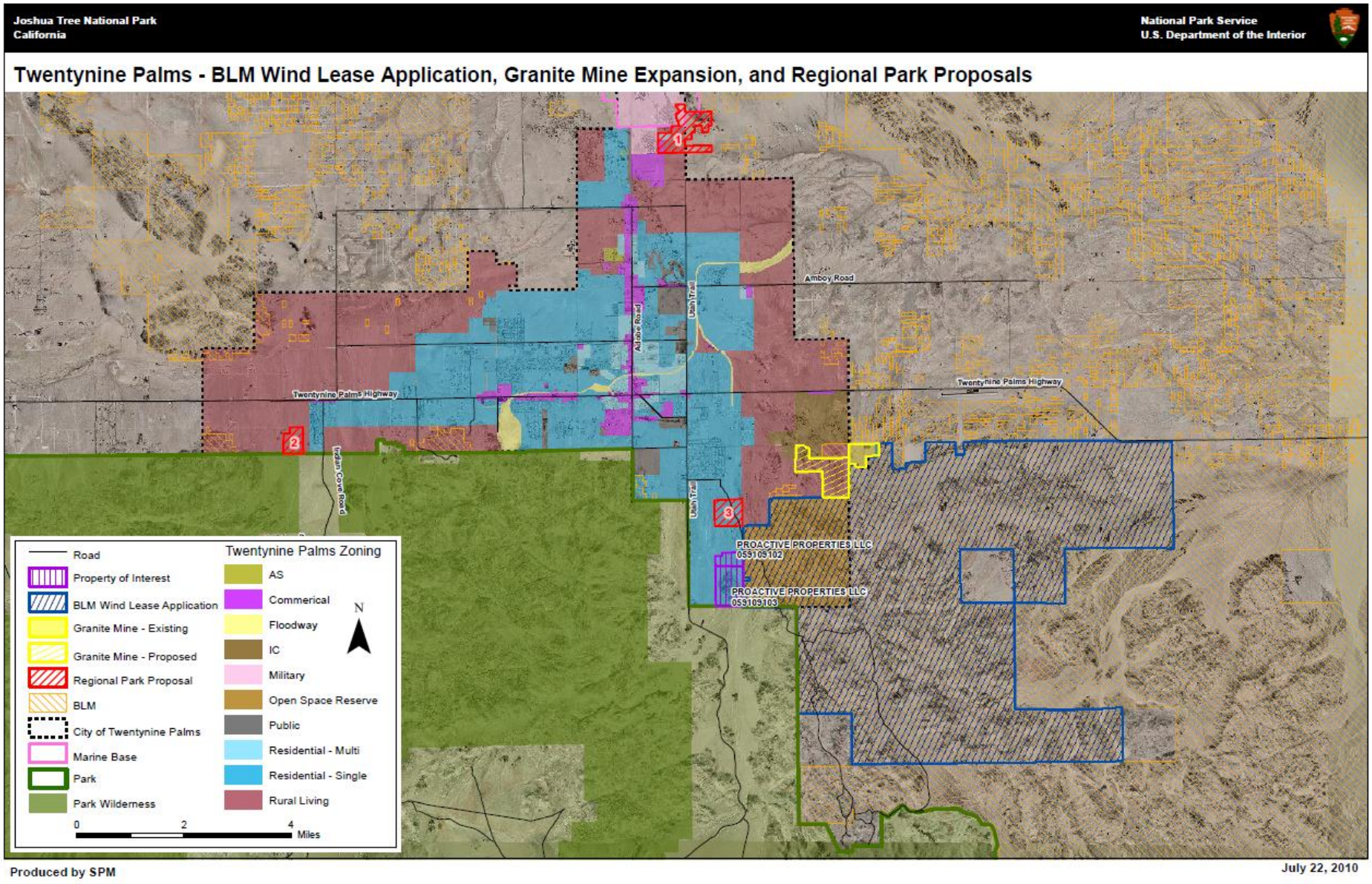
Appendix 6 Continued: Linear Regression of Consumer Surplus on Natural Recreation Variables without Other Controls

Dependent Variable	Estimate	se	t	p
desert	27.52	10.78	2.55	0.01
west	15.66	2.73	5.74	0
nationalpark	46.31	10.28	4.51	0
sightseeing	-27.42	14.27	-1.92	0.05
rockclimbing	-4.69	17.78	-0.26	0.79
genrec	-25.1	5.78	-4.35	0
wildlife	-15.31	3.99	-3.84	0
picnic	-44.39	15.28	-2.91	0
hiking	-13.3	7.41	-1.8	0.07
backpacking	-45.99	10.89	-4.22	0
camping	-51.13	7.61	-6.72	0
_cons	58.49	1.81	32.29	0

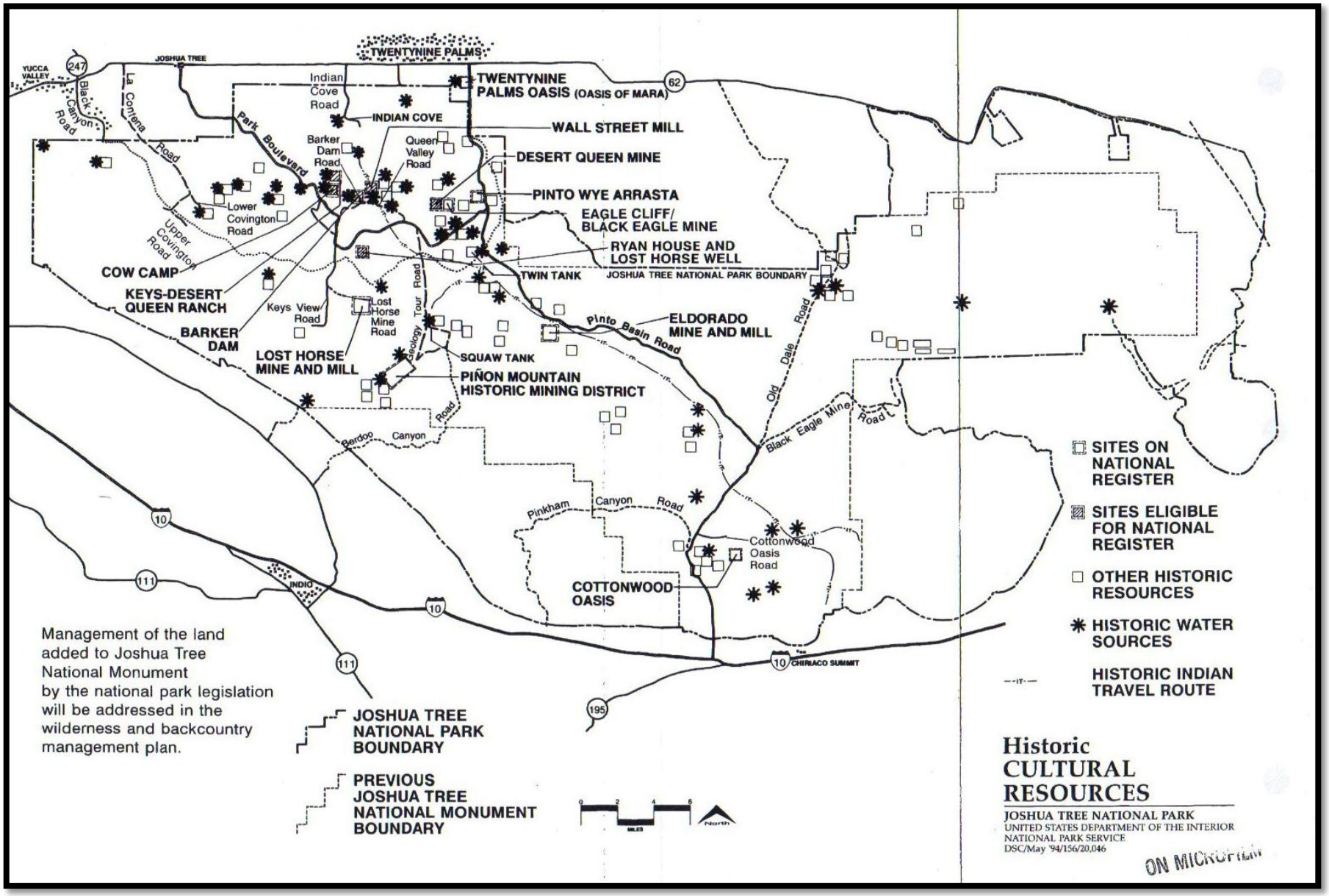
Appendix 7: Proposed Renewable Energy Development Around JOTR (provided by JOTR)



Appendix 8: Proposed and Existing Development Around Twentynine Palms, CA (provided by JOTR)



Appendix 9: Cultural Resources Map of Joshua Tree National Park (Joshua Tree National Park, 1994)



Appendix 10: Cultural Resources News, distributed by Joshua Tree National Park (Spoo, 2012)

JOTR Cultural Resources News

National Park Service
U.S. Department of the Interior

Communicating Cultural Resources

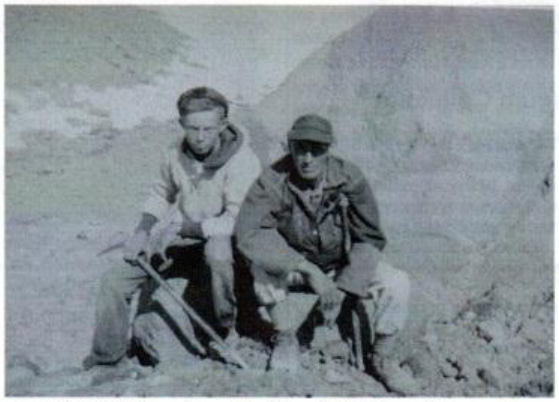
Desert Voices: The Joshua Tree Oral History Project Gears Up

Would you be surprised to learn that the Boy Scout Trail was established partially along an historic Indian path in the 1960s by Paul Broyles, the son of a park ranger here at Joshua Tree? Or that Paul earned his Eagle Scout badge for that project and Horace Albright, family friend and former director of the NPS, came to 29 Palms to speak at his award ceremony?

Perhaps you already know that a young woman from Missouri, Mary Benito, became entranced by the Mojave Desert in the early 1920s, came to Queen Valley in 1927, fell passionately in love with a giant Joshua tree, filed the next morning for a homestead beside that tree, and moved lock, stock, and kitchen sink—house, husband, three dogs, three children, and 3,000 chickens—to that land in October of that year? "If it hadn't been for that tree," Jan Benito Owen muses of her mother's decision, "I don't know what would've happened to us. We would've wound up in *Victorville*!"

Maybe you've heard Jim Pine's 1908 recording of traditional bird songs—two minutes long and no translations? Or listened to Joe and Gail Benitez recount stories of their Chemehuevi ancestors and the Oasis of Mara?

Perhaps you've run into tales of the "early days" (the 1950s), when one superintendent ordered all rangers to clear the Monument by dark? His reasoning was sound: the NPS had a lot of land to protect and few rangers to do the protecting; young Marines needed a safe place to party hard and the Monument fit that bill; and no superintendant could risk having an unarmed lone ranger stroll up to a campfire and ignite a potentially violent intergovernmental confrontation."Clear by dark" made good sense. (Weapons unloaded and locked into briefcases also did.) Then along came the park's first naturalist, Bruce Black, who followed the rule to the letter at work. On lieu days, however, Bruce and his wife Barbara took their children up into the Monument, chose campsites right alongside the enlisted men, and made eye contact and friendly connections with the soldiers in broad daylight—deliberately making a point of learning the young men's names. Not once did the Black family come close to any kind of confrontation, and the relationships they fostered soon negated the need for a "clear by dark" rule. A small decision made at the local level by an employee and a spouse, then, created possibilities for the NPS and US military that no one in Washington, D.C. could have engineered in a month of Sunday legislatings. Nor, in fact, could such a change have been wrought by even the sternest combined will of a park superintendant and base general.



Rodney H. (Rod) Smith, age 13, and his father, Phil Smith, a noted mountaineer who began a maintenance job in Joshua Tree in 1938. Phil sited and built the Lost Palms Trail during his tenure in the Monument. Photo taken during a summer climb of E. Ridge, Mt. Hood, 1947.

Each of these stories could serve as a basis for an historical monograph. Each one, if viewed from a wider perspective, offers unique insights into the enduring past present we all inhabit—not just of the lands we now call Joshua Tree National Park, but of the United States in the world. Collecting oral narratives is a complex, rewarding, and often painful job. It requires ordinary people to summon the courage to allow their lives to serve as evidence of their moment in time. That, in a nutshell, is what we're up to this year in *Desert Voices*, the oral history project at Joshua Tree

Hannah NyalaWest

Appendix 11: Desert Tortoise Habitat In and Around JOTR (Murphy, 2012)