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SUSTAINABLE VISITORSHIP AT THE ANGELES NATIONAL FOREST: STRATEGIES FOR SOLID WASTE MANAGEMENT

A Group Project submitted in partial satisfaction of the requirements for the degree of
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by

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The Group Project is required of all students in the Master's of Environmental Science and Management (MESM) Program. It is a three-quarter activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This Final Group Project Report is authored by MESM students and has been reviewed and approved by:

ADVISOR

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Contents

Definitions

ANF: The Angeles National Forest

Bren Group: The Bren School students working on this project (Kirstina Barry, Sally Johnson, Mike Schwartz, and Vicky Wiraatmadja)

Concentrated use area: Areas within the Forest that tend to have high numbers and density of visitors, whether or not the area has been officially designated for recreation

CRV: California Redemption Value, associated with aluminum cans, glass bottles, plastic bottles, and others

Dispersed recreation: Recreation that is not contained within designated, developed areas

Diversion: Removing or preventing waste from entering a landfill or dump, typically through recycling, composting, or reusing certain materials.

The Forest: In this report, typically refers to the Angeles National Forest, note context

Items of concern: Litter categories that - (1) appeared in large quantities, such as disposable dishware and flatware; (2) adversely affected designated habitat use in a clear manner, such as fishing nets; or (3) were specifically mentioned in the TMDL document as public health hazard, such as diapers

Litter: Uncontained waste (i.e., waste found strewn on the ground, or in bags away from trash bins or dumpsters)

All recyclables: Commonly recycled glass, metal, and plastic items with no CRV

Piped water: Water delivered via plumbing, distinguished from fresh, running water as exists in the San Gabriel River itself

River terrace: Area surrounding the river, in the East Fork this is typically the area between the river and the road, and the area used for recreation. In our data, this refers to anything within 60 feet (18.3 m) of the riverbank.

TMDL: Total maximum daily load

Ton: Measure of 2000 pounds (907 kilograms) of weight

Trash: Refers to contained waste (i.e., waste that is properly disposed of in trash bins and dumpsters)

Visitorship: Total numbers, concentration, demographics, and activities by visitors

Waste: Municipal solid waste, excluding human waste

Abstract

Within the Angeles National Forest, concentrated use areas experience high visitor rates and an associated high level of solid waste. To better understand the relationship between visitors and waste, we analyzed existing data on visitor demographics and rates, as well as trash volume and composition, along 6 miles of the East Fork of the San Gabriel Canyon. Using car counts from CalTrans to estimate the number of visitors, we found that between 8,000 and 12,000 people visit the East Fork during summer weekends. Data collected by the Forest Service showed visitors can produce over 1,000 pounds (450 kg) of uncontained litter each weekend. We characterized the composition of uncontained litter, and based on that composition, the Angeles National Forest could have diverted 9 tons (8200 kg) of common recyclables with California Redemption Values and collected $4300 from waste in the San Gabriel Canyon. Given that typical users are large, urban, family groups, many of whom have limited English, we developed a series of recommendations that aim to reduce overall waste amounts, increase diversion potential, and encourage better visitor behavior. We also created a tool that compares the expected costs and breadth of impact for each recommendation.

Executive Summary

The Angeles National Forest (ANF), located in Los Angeles, San Bernardino, and Ventura Counties, California, covers more than 650,000 acres (263,046 hectares) in the San Gabriel Mountains. The ANF has 3.1 million visitors per year, creating a need for the Angeles National Forest to balance accommodating recreational visitors with maintaining the resilience of the Forest's many ecosystems. In addition to this tension, as part of the United States Department of Agriculture, the Forest Service must address the goals of Executive Orders 13514, mandating that Federal agencies lead the nation in sustainability and reduce their environmental footprints across key areas. This calls for management strategies that support sustainable visitation of the Forest. In other words, the benefits enjoyed by today's visitors should not decrease the recreational benefits derived by future generations of visitors.

Our project focused on the key footprint area of waste prevention and recycling, one of the most important strategies for sustainable vistorship. Within the ANF, we focused our initial analysis on the East Fork of the San Gabriel River. The East Fork as a popular day use recreation destination, and suffers from excessive amounts of trash left behind from visitors. Due to the popularity of the area, the river has become polluted with solid waste and placed on the 303(d) list of polluted waterways by the California State Water Resources Control Board. To better understand and manage the problem, we used existing datasets on visitor demographics and rates, as well as litter surveys, to characterize the waste problem at the East Fork.

The uncontained litter found in the East Fork includes a variety of items, ranging from food containers to clothes, and even to the occasional illegally dumped car battery or mattress. Plastic, glass, and aluminum items are always found within this litter, representing a missed opportunity not only for proper disposal, but also for diversion through recycling. We assumed that the composition of litter at the East Fork represented the composition of all waste disposed in trash receptacles, and applied it to the waste hauled from the San Gabriel River Ranger District (of which the East Fork is a part). We

found that the ANF has the potential to recycle at least $4,000 worth of material from the San Gabriel District annually.

In creating management strategies, we found that visitor behavior is the chief contributor to the amount of waste at the East Fork. Visitors tend to come in large groups and spend the day at the river, bringing picnic and water play supplies with them. Waste from this recreation is often left behind, as there are no trashcans in the river terrace. Subsequent visitors merely add to the many piles of waste left by previous groups. As a result, there is a culture of improper waste disposal.

Recognizing that the root of the waste problem lies with behavior, we developed a set of management and education recommendations with the goal of improving behavior though education and site modification. We also developed a tool to compare the costs and potential breadth of impact of these recommendations against each other, giving managers at the ANF a way to support decision making. This tool scores actions based on the expected cost and labor inputs required by the Forest Service as well as the number of ways it address waste disposal issues. The tool can be used either to create sets of actions or to evaluate sets of actions against one another. Because this tool should not be used to dictate which actions are implemented, it is more suited towards the latter use of evaluating action scenarios against one another.

The tool was used to create the following sets of actions: a set that required the fewest inputs, a set that is anticipated to have the broadest impacts, and a set composed of actions that collectively cover all areas of impact while minimizing inputs. This provides the ANF with actions based on prioritizing minimal input and/or maximum impact. Additionally, it was used to evaluate suites of actions that we compiled based on what we believe to be effective approaches to the waste problem. These sets were compared against one another, demonstrating how the tool can be used to guide management decisions towards actions that are appropriate based on present needs and abilities.

Because the problems within the East Fork are similar elsewhere in the ANF, managers can use our findings as a basis for addressing waste prevention and recycling in other concentrated use areas. The tool, in particular, is designed to be flexible and can be used to compare possible management strategies intended for a different site. In this way,

we hope that these findings provide some basis for efforts to reduce waste and increase recycling throughout the Forest.

Project Significance

The United States Forest Service, part of the U.S. Department of Agriculture, has expressed concern over human impact on the health of our National Forests. In particular, Region 5 (California and the Pacific Islands) is interested in understanding and evaluating the impacts of visitorship (visitor numbers and behavior) on forests. One challenge for Region 5 is the diversity of both forests and users within the Region. However, it is also one of the most populous and ecologically diverse regions in the country. Thus, understanding visitor impacts is vital to managing these forests for optimal health while staying true to their mission and providing opportunities for interaction with our natural resources. In order to focus our efforts and provide useful analysis, the Forest Service directed our project towards the Angeles National Forest as a study site.

The Angeles National Forest is the most visited forest in Region 5. It is also uniquely situated adjacent to one of the largest urban areas in the country, and comprises approximately 70% of all open space in Los Angeles County. Though the visitors to the Forest use it as an escape from the heat and general conditions of Los Angeles and the surrounding communities, many do not show great concern or understanding of how their actions affect the health of the Forest. This appears particularly true for urban day-users picnicking in large groups in concentrated use areas, a common form of visitorship at the ANF. Visitor impacts along the East Fork of the San Gabriel River provide a distinct example of this mindset that is all too common in the Forest's concentrated use areas, especially in regards to solid waste.

This project aims to address concerns the Forest has regarding the large volume of waste and uncontained litter related to visitor use in this area. We seek to provide constructive strategies to help manage trash and reduce litter by achieving the objectives outlined below.

Project Objectives

Objective 1: Characterize the Problem

The Bren Group will use existing data and informational interviews to describe the current state of visitor use and waste impacts in the East Fork of the San Gabriel River concentrated use recreation areas.

Visitor rates: Determining visitor numbers will help assess the waste impacts associated with given levels of use.

Waste and management: By describing the amount and composition of trash and litter produced by recreation in the East Fork, we aim to inform the Forest Service on the nature of the problem and provide information on the diversion potential of the waste collected along the river.

Objective 2: Identify Management Options for the East Fork of the San Gabriel River

The Bren Group will identify different management goals for the ANF and build solid waste management strategies to meet those goals. The different goals are applicable for waste reduction within the San Gabriel Canyon specifically, but the recommended management actions can be broadly applied to the Forest.

Objective 3: Provide a tool for evaluating relative costs and benefits of actions

The Bren Group will create a decision support tool to provide guidance in setting management priorities. This tool will accommodate estimated costs and benefits of each recommendation, and will easy to modify to suit the specific needs of the ANF management team, as well as other management units.

Objective 4: Report and Presentation

Lastly, the Bren Group will deliver a report and presentation detailing the results and strategies for the Angeles National Forest, including options that may apply outside the ANF.

1. Background

1.1 Angeles National Forest Overview

The United States Forest Service, under the U.S. Department of Agriculture, is charged with managing public forests and grasslands. Specifically, the Forest Service's mission is "to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations" (USFS). To this end, Forest Service lands are managed for multiple uses, including logging, grazing, recreation, and conservation.

As part of its mission to sustain the health, diversity, and productivity of forests and grasslands, the Forest Service maintains the land for public recreation and provides natural tourism opportunities nation-wide for 192 million visitors each year. The extensive recreation opportunities on National Forest System lands include hiking, mountain biking, driving off-highway vehicles, camping, and more. Often, heavy use of the forest can degrade fragile ecosystems. In addition, a high number of visitors can be costly for the Forest Service, which is responsible for maintaining the Forest's productivity and ecosystem services, as well as visitor facilities and trails.

The duality of the Forest Service's responsibility to both visitors and forest health is illustrated by the example of the Angeles National Forest (ANF) in Southern California (US Forest Service Region 5). The ANF comprises 655,390 acres (265, 230 hectares) in close proximity to many Southern California residents (Chavez and Olson, 2008). There is an inherent tension between the Forest Service's responsibilities of accommodating recreational visitors and maintaining the health of the Forest's ecosystems.

The ANF was established in 1892 and spans three counties in Southern California: Los Angeles, San Bernardino, and Ventura. Part of Region 5 of the Forest Service, the ANF is located north of Los Angeles, and provides recreation for upwards of 3.1 million visitors per year (NVUM, 2006). The first National Forest in California, the ANF represents over 70% of the open space in Los Angeles County, which has a population of nearly 10 million people and is expected to continue growing (US Census, 2010).

Initially managed for the protection of the watershed, the ANF is increasingly managed for recreation, conservation, and aesthetics (USFS, 2003,). The ANF'S proximity to a large urban area provides easy access for people and is a valuable resource to the

surrounding communities in terms of natural resources, open space, water quality protection, recreation, and tourism. The ANF has 557 miles (896 km) of hiking and equestrian trails for visitors to explore, in addition to other activities such as camping, fishing, hunting, water sports, and winter sports (National Forest Foundation, 2011). Visitors travel to the Forest from the greater Los Angeles area and around the world to experience the ANF'S beauty and recreation opportunities.

The ANF is divided into four districts: Santa Clara, Mojave Rivers, Los Angeles River, and San Gabriel River Ranger Districts (Figure 1.1). Within the ANF, Congress has set aside five wilderness areas; these wilderness areas are designated places where "the Earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain" (Wilderness Act, 1964). The wilderness areas within the ANF are Cucamonga, Magic Mountain, Pleasant View Ridge, San Gabriel Wilderness and Sheep Mountain Wilderness.

1.1.1 Financial Constraints

The ANF runs on an annual budget of approximately $30 million, but a significant portion, approximately $16 million per year, is allocated for firefighting efforts. Additionally, money can be taken from the ANF by the Forest Service to pay for fire suppression in other forests, including money not allocated for this purpose (USFS, 2003). With rising financial pressure and few viable options for increased funding beyond their share of annual appropriations, the ANF faces financial pressures. These pressures affect the ability of the ANF to implement management options due to cost and labor constraints. While partner groups and volunteers supplement the Forest's upkeep and maintenance, the current economic climate limits these valuable resources. Understanding which management choices will provide the most benefit for the least cost is imperative because of the limit on financial resources.

Figure 1.1: Map of the Angeles National Forest, showing the four districts. (Source: the U.S. Forest Service, Region 5, Angeles National Forest)

1.1.2 Ecosystems Overview

The ANF is situated in the San Gabriel Mountains and ranges in elevation from 1,200 to over 10,000 feet (370-3,050 meters), and features a number of distinct vegetation types, including mixed chaparral, upland conifer forest, and riparian and upland oak woodlands. The San Gabriel Mountains act as the dividing line between two distinct ecosystems: a desert and an urban environment. Sandwiched between the urban ecosystem of the greater Los Angeles area and the deserts of Southern California, the habitats and species in the ANF are relatively insular. Because the ANF ecosystems are not connected over a wide range, the Forest supports numerous endemic species, including the endangered California Condor (*Gymnogyps californianus*), Peninsular Big Horn sheep (*Ovis canadensis*), Least Bell's vireo (*Vireo bellii pusillus*), and the Mountain Yellow-legged Frog (*Rana muscosa*).

The ANF supports and maintains four watersheds (San Gabriel River, Los Angeles River, Santa Clara River, and the Antelope Valley) and portions of seven major groundwater

basins. On average, these groundwater basins provide 23% of the region's water supply, and up to 29% during drought years to the 13 million residents of the Los Angeles Basin (Los Angeles County Department of Public Works, 2006a and 2006b).

1.2 Sustainable Tourism

Sustainability is defined by the World Tourism Organization (WTO) as the current management of resources in such a way that economic, social, and aesthetic needs can be fulfilled while not compromising essential ecological processes, biological diversity, and life-support systems into the future (UNWTO, 1996 from Bricker et al., 2007). Furthermore, sustainable tourism is defined by the WTO as meeting the needs of present visitors and host agencies while protecting and enhancing opportunities for future generations.

1.3 Economic Importance of Recreation on Federal Lands

Anywhere from 30-50% of spending from tourists visiting National Parks in California goes to personal incomes of California workers. Thousands of jobs are created to support visitors to natural spaces, and more communities are affected by the draw of public lands than just the one in which the Park or Forest is located (Garret and Wu, 2002). While National Forests are managed for both extractive and recreational uses, it is important to acknowledge the large economic role recreation plays in income to the Forest. The Angeles National Forest receives more money from recreation activities than any other Region 5 Forest, and as tourism increases, the percentage of revenue generated from recreation will surpass that from extractive industry (Garret and Wu, 2002). This highlights the challenge that Forest Supervisors face when balancing the ecological value of natural systems with increased income resulting from increased visitorship.

1.4 Cultural Considerations

Population demographics play a large role in the likelihood of an individual visiting an nature area. For a resource such as the ANF, which is in close proximity to a large and diverse urban area, demographics can affect the activities visitors engage in while at the Forest. According to a 1998 study, the largest factors that correlated with visitation of an undeveloped nature area were income, assimilation, perceived discrimination and ethnic

group identity; though overall visitation was not correlated with citizenship status (Tierney et al., 1998).

A more recent study from 2009 emphasized the importance of California's growing minority populations when considering management options for recreation activities (Roberts et al., 2009). Ethnic groups use natural areas differently – some prefer facilities that allow for large, social, extended family visits, while others preferred trails for hiking and walking activities. Regardless of the preferred activity, it is important to provide information in multiple languages and have rangers, employees and volunteers with varied language skills visible and approachable to make parks and forests more accessible and to promote a connection between people and place. Perceived discrimination remains a barrier to use, as do income and time constraints (Roberts et al., 2009). Education and outreach programs are considered the best ways to increase diversity of visitors and ensure that everyone can access the resources of public recreation areas (Roberts et al., 2009; Tierney et al., 1998). The East Fork of the San Gabriel River is predominately used by visitors in large groups averaging eight people per group for day use on weekends (California Regional Water Quality Control Board, 2000).

1.5 Forest Service adaptation of EO 13514

On October 5, 2009, President Obama signed Executive Order (EO) 13514, setting sustainability goals for all Federal agencies. These goals focus on improving energy, environmental, and economic performance of Federal facilities by reducing greenhouse gas emissions, increasing energy efficiency, conserving water, reducing waste and petroleum consumption, and supporting the purchase of environmentally-preferred products. Each agency must implement and annually update a Strategic Sustainability Performance Plan, detailing prioritized agency actions based on return on investment.

The Forest Service focused on the six environmental footprint areas outlined in Executive Order 13423 to categorize and implement the changes outlined in EO 13514. These footprint areas are each intended to create a more financially and environmentally sustainable Forest Service.

The six footprint areas are energy, water, green purchasing, fleet and transportation, waste prevention and recycling, and sustainability leadership. Some specific goals and details for each area are outlined below.

- Energy
  - Achieve energy neutrality by 2020
  - Reduce four main sources of energy: electricity, natural gas, propane, and fuel oil
- Water
  - Be world leader in water conservation and water source protection by 2020
  - Decrease the estimated 440,000,000+ gallons (1,670,000,000 liters) of water used in 2004 by 2% per year
  - Establish better methods to quantify water use
- Green purchasing
  - Implement system for tracking and reporting environmental purchases
  - Shift to more environmentally-sound and bio-based goods and service
- Fleet and transportation
  - Increase the utilization of alternative fuels in new vehicle purchases based on market availability
  - Reduce petroleum consumption by 2% per year
  - Achieve zero emissions in fleet and transportation by 2015
- Waste prevention and recycling
  - Achieve 40% waste reduction by 2010
  - Exceed sustainable waste prevention and recycling business standards
  - Reduce use and purchasing of toxic chemicals
- Sustainability leadership
  - Model sustainability practices throughout the Forest Service
  - Implement Environmental Management Systems (EMS) at all appropriate levels to inform every decision and action taken by the Forest Service
  - Create an informed citizenry by advancing environmental literacy

1.6 Sustainability within Federal Lands

Past efforts to increase sustainability and sustainable tourism within the U.S. Forest Service and the U.S. National Parks systems have emphasized increased recycling efforts and decreased greenhouse gas emissions from vehicles. For example, the Yosemite Valley has partnered with local trash companies to decrease the amount of compostable waste entering landfills from Yosemite National Park, and has increased the number and visibility of recycling options within the park to encourage visitor participation in recycling programs (National Park Service, 2008). The Region 5 offices within the U.S. Forest Service

have also promoted strong recycling programs internally, and have initiated ride-share and public transportation programs for employees (Winter, 2008).

Recent studies have shown that programs like these have decreased the impact of federal agencies on the environment, but also that more steps can be taken to further improve these efforts. Improved signage, appropriate reminders, assistance in taking advantage of sustainable options, and centralized, easy-to-access information could all potentially benefit efforts to increase sustainability (Winter, 2008).

1.7 Focus on Waste Management

Since its inception, our project has focused on visitorship and impacts at National Forests. However, it has undergone substantial revision over the months following its introduction to the Bren School in December 2010. This section outlines the current focus of this project while documenting its evolution over the past year.

Waste prevention and recycling was the only footprint area not deemed outside the scope of the project and, as such, has become the focal point of research. The East Fork of the San Gabriel River is an especially littered area, and provided a targeted sample site. This project aims to reduce the quantity of waste produced by visitors, increase the rate of waste being removed from the Forest through reduction of litter, and increase the rate of diversion from the landfill via recycling and others.

The initial idea for this project described a two-dimensional problem as characterized by the Region 5 office of the Forest Service (per. comm. Lara Polansky, US Forest Service Regional Sustainable Operations & Climate Change Coordinator, 2010). The first dimension was to determine the areas and activities of Forests that are most directly tied to visitor related revenue generation and to evaluate the economic potential for enhancing them. The second dimension was an analysis of National Forest sustainable operations practices and how they might better be incorporated into the visitor experience. The result of early conversations about visitorship led to a shift from visitor related revenues to visitor impacts. This shift was coupled with a partnership between the Bren Group and the ANF, the most visited forest in Region 5. Discussion of sustainable operations practices in the ANF focused on the footprint areas from EO 13423 outlined above.

1.7.1 Excluded Footprint Areas

Of the six footprint areas designated by EO 13423, two were withdrawn from the project shortly after the initial project proposal. Green purchasing falls largely outside the expected realm of influence for our project and refers to agency wide decision-making regarding all products and services paid for by the Forest Service. Some level of green purchasing is already mandated of all federal agencies (EO 13423). For this reason, green purchasing was excluded from this project.

Sustainability leadership primarily focuses on the actions of high-ranking officials in the Forest Service and their ability to make an impact through leading by example. Since this project is intended to focus on visitor impacts, sustainability leadership was excluded with one exception. The one aspect of sustainability leadership, as described on the Forest Service website, that remains relevant is promotion of environmental literacy among the general public. This aspect of sustainability leadership fits well with the educational component of our project.

The project was further refined based on relevance to the Forest Service and availability of data. By focusing on the Angeles National Forest, the Bren Group was able to evaluate the visitor facilities and needs therein. The Bren Group found that the availability and type of facilities in many areas of the Forest were not applicable to the project as it was initially conceived. The Forest's facilities are not highly developed (e.g., many primitive campgrounds, picnicking facilities), so they correspond with limited visitor impacts. Because of this, three more footprint areas were eliminated from the project.

Energy was deemed not appropriate for our project. In recent years, environmental footprints and sustainability have often been coupled with carbon emissions and energy. While this association remains valid, this project focuses on visitor impacts. Within the Forest, the largest energy sinks related to visitors are the visitor centers, which use minimal electricity for lighting, heating, and basic computing equipment. Moreover, many of these facilities already employ energy efficient technologies such as low wattage lighting required of all branches of federal government.

Water was withdrawn as a focus of this project because visitors at the ANF have limited interaction with piped water (pers. comm. Justin Seastrand, US Forest Service

Environmental Coordinator, November 2011). Most toilets are pit toilets, and there are limited sinks and spigots. Some visitor areas do include natural running water, but impacts in these areas relate to degradation of water quality, and that type of analysis is beyond the scope of this project.

Transportation was also not included. The largest component of transportation related to visitorship is the mass of private vehicles that bring visitors to the forest. Discussions of these private vehicles led to a two-part realization that: 1) significant research would be needed to attempt to determine the number and make-up of these private vehicles and 2) even if the private vehicle fleet could be characterized, the Forest Service has little power to reduce it (pers. comm. L'Tanga Watson, US Forest Service Forest Recreation and Lands Officer, October 2011).

In summary, the project focused on visitor waste impacts with the other five footprint areas designated as secondary goals or set aside altogether. Each of the five footprint areas that were not the focus of this project maintains relevance for the Forest, however, waste management presented the greatest opportunity for change in relation to visitor impact. Should the Forest Service decide to revisit the question of forest impacts, these five areas would be appropriate starting points for continued research.

1.8 Recycling

In addition to considering ways in which the ANF may reduce visitor waste, we also explored ways to minimize the percent of waste that ends up in a landfill. This diversion potential includes any activity that will turn materials that were previously considered trash into some sort of functional material. Because the ANF is evaluating its current practice of using Forest vehicles to haul waste to a landfill, we deemed it appropriate to provide some considerations of other options for the Forest's waste stream and their associated cost implications.

Recycling is the diversion method that would have the most potential to minimize the waste stream and the greatest potential to decrease costs for the Forest. The underlying principle is that, unlike waste, which is a liability, recyclable materials are valued commodities (pers. comm. Jeff Simeon, Recycling Program Specialist for the County of Santa Barbara, February 2012). Aluminum cans, plastic bottles, and glass bottles in

particular may reduce costs because, in addition to their value as recyclables, they hold a California Refund Value (CRV) which recyclers are able to collect.

1.9 Overview of solid waste management practices

Before analyzing and suggesting improvements to any of the Angeles National Forest's practices, the current state of waste management must be characterized. This section provides a brief description of the Forest's approach to waste management. For additional information and background regarding the Forest's solid waste management practices, the Bren Group interviewed ANF employees, which are summarized in the Results.

There are a varieties of ways in which visitors introduce waste into the Forest. The most straightforward is what to do with a used product at the moment it becomes waste. At all major highway turn-offs and high use areas, the Forest provides waste receptacles for visitors to dispose of their trash. There are two standard types of receptacles throughout the Forest: smaller cans with special attachments to protect against bears and larger, industrial-size dumpsters. These receptacles are prominently located and it is impossible to arrive at most major recreation areas without passing them (pers. obs. Bren Group, 2011). Along East Fork Road, there are approximately 100 trashcans and dumpsters (pers. comm. Mike Hansen, 2012).

Once the receptacles have been filled, Forest Service personnel must empty them. Emptying is comprised of walking or driving from point to point, emptying the receptacles, replacing the bags, and depositing the accumulated waste at the dump. Depending on the source and time, recyclable items are occasionally sorted out (pers comm. Forest Service personnel, 2011). The frequency of these collections ideally mirrors the level of visitorship over a given period.

As mentioned above, the Forest has its own fleet of vehicles, which play a sizeable role in the emptying of receptacles. Light duty trucks are used to empty smaller receptacles, while the Forest's two dump trucks are used to empty large dumpsters and bring collected waste from all receptacles to the Puente Hills Landfill (pers. comm. Mike Hansen, 2012). This process is currently under review and Forest managers are seeking to

determine if it is more economically viable to outsource the role of the large trucks to a dedicated waste management company.

Efficient waste management is dependent on visitor understanding and cooperation, which is sufficiently lacking. There is evidence that many visitors ignore the presence of waste receptacles and deposit their waste wherever they stand. There is also evidence that visitors will leave waste in the general vicinity of receptacles without ensuring that the waste has been properly deposited (per. comm. Forest Service personnel, 2011). This is confounded by the fact that during peak visitorship, Forest Service personnel have difficulty emptying receptacles as quickly as they become full (pers. comm. Forest Service personnel, 2011). A feedback loop occurs in which personnel must spend time picking trash up from the ground and cannot spend as much time emptying the receptacles which, in turn, causes more trash to end up on the ground.

The Forest Service has tried several methods to increase visitor awareness and compliance regarding waste. The most basic attempt is posting signs; however, these are perpetually plagued with graffiti to the point of becoming illegible. A second tactic is a more in depth educational approach; Forest Service educators provide workshops for students and the public to learn about the damages from littering. These workshops are an important service, but the audience they reach is small when compared to the total number of visitors at the ANF each year – approximately 10,000 people compared to the approximately 3.1 million who visit the Forest (pers. comm. Forest Service personnel, 2011; NVUM, 2006). A more direct approach is the distribution of garbage bags to visitors on a per diem basis. Combined with the presence of Forest Service personnel, this effort has been moderately successful in encouraging visitors to pack out their waste, though encouraged reliance on bag handouts for proper disposal of waste.

The ANF has also recently become a pilot site for BigBelly Solar's automated compactors. These waste receptacles have a much larger capacity without significant added bulk and are designed to remotely send notification when they become full. If successful, BigBelly could save hours of unnecessary labor checking empty receptacles or emptying receptacles before they are full.

1.10 San Gabriel Canyon

As one of the most popular recreation areas in the Angeles National Forest, the East Fork of the San Gabriel River was chosen as a focal point for this project. In order to better understand the tension between human activity and natural resources in this area, this section will provide background information on the canyon, its surroundings, and its history.

1.10.1 The San Gabriel Mountains

The San Gabriel Canyon lies north of the City of Azusa and is part of the San Gabriel Mountains, which are characterized by steep, rugged terrain and have some of the highest mountains in the Transverse Ranges (National Park Service, 2011). John Muir once described these mountains as being "rigidly inaccessible" (Muir, 1918). The highest peak is Mt. San Antonio, which reaches a height of 10,064 feet (3068 meters). The San Gabriel Mountains span approximately 70 miles (113 km) and encompass 970 square miles (2510 sq km).

1.10.2 The San Gabriel River

The San Gabriel River flows through the canyon via two main forks: the East Fork and the West Fork. The River flows along 60 miles and drains a long, narrow watershed that includes the cities of Azusa, Covina, Norwalk, Cerritos, and Long Beach. There are 26 dams on the river and its tributaries, some of which are part of the San Gabriel River Water Conservation system. The Cogswell, San Gabriel, and Morris Dams collect and store stormwater runoff and snowmelt in reservoirs. This water can be released into spreading grounds where it recharges the San Gabriel Valley groundwater basin. There are a number of cities directly on the river that rely on the river and its recharge for fresh water. For example, the San Gabriel River provides 75% of the water to 108,000 people in the city of Azusa and the surrounding communities (San Gabriel Canyon Gateway Center, 2011).

1.10.3 The San Gabriel Valley

Starting at the mouth of the canyon, the San Gabriel Valley is highly urbanized. It includes 31 cities and is populated by more than 2 million people (San Gabriel Valley Economic Forecast and Regional Overview, 2011). These communities include a wide range

of peoples and incomes. All major ethnic groups within the Los Angeles area are represented in the San Gabriel Valley, and there are rather sizable Hispanic and Asian-American populations. While some communities in the Valley have median household incomes of over $100,000 per year, the average income for the valley as a whole is $43,000 (San Gabriel Valley Economic Forecast and Regional Overview, 2011). The valley is directly connected to the canyon via State Route 39, which runs through Azusa. Route 39 is also connected to Interstate 210, which provides access to and from the extensive freeway network of the greater Los Angeles area.

1.10.4 Human History in the San Gabriel Canyon

Humans have been active in the canyon since the days of the Tongva-Gabieleno tribe, the dominant Native American people throughout the Los Angeles basin (City of Azusa, 2011). Evidence of their activities includes a burial ground and rocks with distinctive markings, though these artifacts do not clarify exactly how native people used the canyon. The next historical use of the canyon was gold mining. Though there is some evidence for mining since the 1700s, the mining boom did not begin until 1854. Shortly thereafter, the town of El Doradoville was built at the fork of the canyon where some 2000 miners filed gold claims, mostly along the East Fork. Floods in 1861 and 1862 subsequently destroyed the town (City of Azusa, 2011). Gold mining, severely reduced since its boom days and now illegal according to the 1928 Watershed Withdrawal Act, has since become one of the river-based recreational activities in the canyon (Motherlode Outfitters, 2011). Now, the San Gabriel canyon is well known for recreational activities such as hiking, canyoneering, water play, and picnicking (City of Azusa, 2011).

1.10.5 National Park Service Resource Study

The National Park Service conducted a Special Resource Study in order to determine whether the San Gabriel River Watershed and Mountains are sufficiently significant and feasible for national park system unit designation. This study reviewed the area on the following criteria: resource quality, value to our nation's heritage, opportunities for public enjoyment or scientific study, and integrity as a true, accurate, and relatively unspoiled

example of a resource. According to the current draft of the study, the San Gabriel Mountains meet all these criteria (National Park Service, 2011).

The study notes that parts of the San Gabriel River, including the East Fork, are eligible for Wild and Scenic River designation in addition to providing "remarkable" recreational values and easy access to year-round water-based recreation. These sections of the river are exceptional illustrations of free-flowing southern California river systems and include scenic, recreation, fish wildlife, and historic resources value. More than 15 million people live within a 90 minute drive to the San Gabriel Mountains, and the year-round water access makes the San Gabriel Canyon a very popular recreation site (National Park Service, 2011). In short, the San Gabriel Canyon provides a combination of both exceptional natural and societal value.

The current draft of the study has determined that the environmentally preferred alternative is to designate a large National Recreation Area, managed by a voluntary partnership of agencies and organizations. The National Park Service would coordinate the formal partnership, lead a voluntary information network to provide interpretive and educational messages about significant resources, and provide a technical assistance program for conservation and recreation planning (National Park Service, 2011). Because this study is currently in process, we will not comment on how alterations in management of the San Gabriel Canyon will affect solid waste management.

1.11 The Problem

Because the ANF must regularly dispose of hundreds of tons of trash created by its millions of visitors, waste management is one of its major challenges. This section will explore the circumstances leading to the high volume of waste in the Angeles National Forest and the San Gabriel Canyon in particular.

1.11.1 Accessible by Millions

As mentioned above, more than 15 million people live within a 90 minute drive of the Angeles National Forest. Most of the eastern boundary of the Forest is bordered by the greater metropolitan area of Los Angeles (LA), and there are main entrances to the Forest

connected to the LA freeway network. Both the Angeles Crest Highway (State Route 2) and State Route 39 run directly from Interstate 210 into the Forest.

In addition to the main highway entrances, there are a number of entrances to the Forest through neighboring foothill communities. Most of the foothills are highly developed and have continuous housing almost until the Forest's borders. These smaller entrances also provide access to popular recreation areas such as Big Tujunga Canyon and Chantry Flats. Because of this, it is known as the "backyard wildland" of the area, and many residents see it as something more akin to a local park than a nationally protected resource (pers. comm. Forest Service personnel, 2011).

1.11.2 Concentrated Use

Because much of the terrain in the Angeles National Forest is rugged, most recreation is concentrated in easily accessible areas, such as the rivers along canyon bottoms and any sites directly off the Angeles Crest Highway. "Concentrated use areas" refers to areas that were not formally developed for recreation. Here, development refers to the provision of amenities such as picnic tables, trash receptacles, and rest rooms. Developed sites are designed for specific purposes and a certain number of people. Concentrated use areas, on the other hand, are where visitors simply tend to congregate.

Concentrated use areas are often engaged for multiple uses; picnicking, water play, fishing, and hiking are some of the most popular uses for any given concentrated use area in the Angeles National Forest. These uses occur simultaneously, attracting a variety of visitors to each area. The Forest is mandated to manage for multiple uses; however, this is usually managed through designed sites. Concentrated use areas are not subject to the same upkeep and provision of amenities, and consequently suffer if visitors do not take care to recreate in a responsible manner (pers. comm. Forest Service personnel, 2011).

In the case of San Gabriel Canyon, the East Fork is an exceptional example of a concentrated use area. Several thousand visitors engage in picnicking and water play over a holiday weekend along a small portion of the San Gabriel River, approximately 5 miles (8 km) in length on East Fork. These visitors park their vehicles along the side of the East Fork Road, in formal lots, and in pullouts. Any accessible stretch of riverbank will serve as a makeshift recreation area. Entire extended families will spend the day there celebrating

baptisms, birthdays, or simply seeking refuge from the heat or the city. Throughout the length of this dispersed area, rest rooms and dumpsters are located only by the roadside and not in the river terrace. The result is a high volume of trash found in the stream corridor, along the roadside, and surrounding the dumpsters (pers. comm. Forest Service personnel, 2011).

1.11.3 Visitor Characterization and Behavior

The majority of visitors to the San Gabriel Canyon are day users. They come mostly on weekends, and Sunday afternoon is usually a peak time (pers. comm. L'Tanga Watson, 2011). Most visitors come from the greater Los Angeles metropolitan area, and according to observations of Forest Service staff, many are from ethnic minorities, particularly of Hispanic descent. As mentioned above, many visitors treat the Forest as they would a local park. Visitors often do not behave as though the Forest is a protected resource. In some sense, these visitors have taken ownership of the Forest; they see it as their place to recreate, but they often ignore the responsibilities that come along with that ownership. Thus, they are prone to leave trash along the stream corridor and in other inappropriate places (pers. comm. Forest Service personnel, 2011).

Because the river is somewhat offset from the road and visitors hike down to recreate in the river terrace, trash is often left away from the road where it is difficult to collect. Due to the high volume of visitors, the Forest Service provides dumpsters at most large parking areas (paved or otherwise). No dumpsters are found in the river terrace because collection is done by dump trucks, which are confined to the road. Additionally, trashcans located in the stream corridor are at high risk of damage from winter storms and increased stream flows (pers. comm. Forest Service personnel, 2011).

In a 1985 study (Christensen and Davis), managers and users were asked to rate the importance of problems such as vandalism, theft, litter and rule breaking in natural settings; managers were much more likely to rate these problems as "serious" than were visitors. In addition, visitors were much less likely than managers to perceive education, incentives, site design and maintenance as effective solutions to problems (Hartley, 1986). This discrepancy in problem solving and communication between recreationists and managers leads to harsh solutions by managers to deal with the problems, such as law

enforcement. In the Christensen and Davis study, the use of law enforcement, although viewed as an effective strategy by both managers and visitors, does not force managers to convey to visitors the rationale behind the preventative strategies such as education, incentives, design and maintenance.

Hartley (1986) advises managers who are dealing with destructive behavior to view the visitors to the recreation areas in three categories: conformer, non-conformer, and inexperienced user. Within this context, a conformer is a visitor who makes an effort to follow established rules of the recreation area; a non-conformer is a visitor who blatantly disregards established rules when they conflict with user goals; and an inexperienced user is one who does not know the rules for a particular recreation setting. All three user types exit in the East Fork. Hartley calls for managers to recognize the visitors' intended use of the natural resources and their prior knowledge of established rules when designing strategies to overcome problems. This separation of users is intended to prevent harsh penalties from unintentionally falling on those whose prior experience precludes them from responsibly enjoying natural resources.

According to an unpublished 1983 paper by Donald Stikkers, the cultural background of visitors to the San Gabriel Canyon strongly influences how they use the natural resources of National Forests. An excerpt from Stikkers' 1983 paper was included in Marilyn Hartley's 1986 study on recreation management:

> Many Hispanic users in San Gabriel Canyon are recent immigrants to the United States. The notion that there are controls on use is foreign to their culture. The same seems to be true of far eastern immigrants showing up in growing numbers. [Within Mexico], a few facilities are built, garbage cans are unknown and litter is common. Users drive wherever they can, and help themselves to any available vegetation for firewood.

Although this characterization of recent Hispanic immigrants is from a single perspective and documented many years ago, Stikkers' primary message is still relevant to Forest managers. He identifies considerable cultural differences between recent immigrants to the United States, who may be used to far fewer controls on recreation, and those who have much more knowledge about the acceptable limits on public lands within the United States.

A 2001 compilation study by Deborah Chavez of the Pacific Southwest Research

Station, noted that certain studies have indicated how important family is for Hispanic visitors (Kelly, 1977; Valdes, 1991). This focus on family leads to Hispanics often recreating in large size groups. As managers become more aware of these group sizes, these visitors can be provided appropriate amenities to reduce impacts to natural resources (Chavez, 1998; Chavez, 2001). In addition, Chavez notes that a pattern of little or no planning before a recreation outing has been documented. This is evidenced by people arriving in street clothing or church clothing (on Sundays) with bags of groceries from the store, in contrast to planned visits where people arrive in swimsuits or hiking wear. Despite the apparent unplanned nature of the recreation, these visitors often spend the majority of the day at the recreation site, often in food preparation. These visitors are frequently seen cooling off in the river in street clothes, and using cooking utensils, paper plates and cups as toys in the river (Chavez, 2001).

1.11.4 Impacts from Gold Mining

The East Fork of the San Gabriel River was once the center of a gold mining boom, though gold mining has mostly become a recreational activity. There are still, however, a number of semi-permanent residents within the canyon who regularly pan for gold. It is acknowledged that these miners are essentially squatters in the canyon, and it is suggested that they have a significant impact on waste volumes (pers. comm. Forest Service personnel, 2011). Aside from the environmental impacts these squatters have on the canyon, their mining activities are illegal according to the Watershed Withdrawal Act, which prohibits the removal of mineral products from the watersheds within the Forest (Watershed Withdrawal Act, 1928).

1.11.5 Drinking Water Source

Because the San Gabriel River is a source of drinking water, the impact of human activities on water quality is a cause for increased concern. Various cities and companies spanning from Azusa to Long Beach have rights to surface water from the river. In order to bring that surface water up to drinking quality standards, the water must be treated. This includes processes to remove solids and pathogens, and both of these types of loads are increased by mining and improper waste disposal. Though these increased pollutant loads

make treatment more difficult, the water drawn from the San Gabriel River is a very important resource, as most water in the LA area is imported at a high cost. The San Gabriel River provides up to 40% of the freshwater used by specific communities within the LA area that have surface rights (pers. comm. San Gabriel River Water Committee, August 2011). Thus, the negative impacts on human activities on this local resource cause extra concern for downstream communities.

1.12 The 303(d) Listing

A 5.9 mile (9.5 km) stretch of the East Fork of the San Gabriel River is a 303(d) listing under the Clean Water Act. The East Fork is listed for trash, unlike other sections of the San Gabriel River, which are listed for lead, coliform bacteria, copper and pH. The trash comes from a nonpoint source, in this case, the users of the concentrated recreation area. The total maximum daily load (TMDL) for the East Fork was set at zero pieces of trash, approved by the EPA in 1999, and subsequently revised and accepted in 2000. This TMDL applies only to trash in the stream itself, and not in the surrounding areas. However, trash in the surrounding areas is a significant contributor to trash in the river (California Regional Water Quality Control Board, 2000).

Having been listed as an impaired water body, the East Fork of the San Gabriel River is subject to regulatory actions. In the TMDL document by the California Regional Water Quality Control Board, the problem was identified as stemming from large picnic groups in four locations along the East Fork, which was estimated to produce 400 32-gallon (121 liter) trash bags of waste each day -- only half of which was properly disposed of in trash receptacles. The responsibility of reducing the pollutant load to the approved TMDL was assigned to the U.S. Forest Service alone, and best management practices were recommended, though not required if the Forest Service was able to achieve the TMDL of zero trash in the river using other means (California Regional Water Quality Control Board, 2000).

The TMDL document identified the problem with reducing the load as primarily a lack of trash receptacles in the areas actually being used by the public. Given the relatively difficult terrain between the parking areas and the popular picnic areas, users tended not to carry trash back to the roadside receptacles. Additionally, the TMDL report noted that, as

of 2000, there were no signs reminding users not to litter or indicating that there are fines for littering. Citations for littering were not regularly issued, and there was little presence of Forest Service employees during peak use (California Regional Water Quality Control Board, 2000).

Recommended management practices to achieve the TMDL included seasonal installation of trash receptacles in the river terrace near commonly used undeveloped picnic areas. These were to be installed in May and removed in October, providing trash receptacles during peak use months (June through September), and removed before winter storms damaged the bins. Increased and better-designed signage, such as bilingual writing and international symbols for no littering were also recommended. Finally, increased Forest Service presence, including a full-time bilingual staff person in the area during peak use to both conduct more frequent trash cleanups, educate users about litter laws and proper trash disposal, and to enforce litter laws, was recommended. The cost of implementing these recommendations (as of 2000) was estimated at $75,000 a year, though these estimated costs were not broken down into individual elements (California Regional Water Quality Board, 2000).

2. Methods

2.1 Informational Interviews

Informational interviews were informally conducted with six employees of the Angeles National Forest who had no previous knowledge of the Bren Group project. The purpose of the interviews was to supplement the limited quantitative data that were available for this project, specifically concerning the amount of trash and the number of visitors to the East Fork of the San Gabriel River. Specific discussion topics included: characterization of waste, trash management, visitors, visitor education, labor, recycling, and wildlife. All of the interviews were conducted in person and questions were not standardized for any of the interviews. Persons selected for an interview were chosen based on their position within the ANF'S San Gabriel River Ranger District. Many of the interviews were conducted with employees that our contacts at the ANF had specifically recommended we meet. The first five interviews were unscheduled conversations with employees of the ANF on Friday, November 4, 2011. The sixth interview was pre-arranged and conducted in person on Monday, December 12, 2011.

Interviews were conducted with employee positions directly related to waste management within the San Gabriel River Ranger District, including Recreation Technicians, District Recreation Officers, and Forestry Technicians. The interviews were not recorded; written notes were taken by two of the group members during each interview. The notes were then compiled and compared for accuracy, before being reviewed by the rest of the group members. Each interview lasted approximately 10-15 minutes. The names of all interviewees in this report have been omitted to protect privacy.

2.2 NVUM Data Analysis

The Bren Group requested the raw National Visitor Use Monitoring (NVUM) data from the Natural Resource Manager website of the U.S. Department of Agriculture (USDA, 2011) and received it via email on March 3, 2011 (D. English, Visitor Use Monitoring Program Manager, 2011). The NVUM data were collected at multiple sites throughout the ANF, and the interview location was included in the raw data. Using this information, the Bren Group determined that 53 groups of people were interviewed at the East Fork of the

San Gabriel River, and all were interviewed at the same time of year. The Bren Group primarily focused on the stated ethnic and racial breakdown of the interviewed visitors.

Because this information was already collected and analyzed by the Forest Service, the Bren Group used this information source as a supplement to information gathered from additional sources. The data collected for the NVUM surveys were intended to illustrate trends in visitorship at the Forest level, and are not accurate when used at the district or site level (NVUM, 2006). This is due to the limited data and small sample sizes available for each site. Because these data were not intended for analysis at the individual site level, we will present our analysis of the demographics at the East Fork of the San Gabriel River concurrently with the results of the NVUM survey at the Forest level. The results of the Forest as a whole include visitors to the East Fork of the San Gabriel River.

2.3 Estimating Visitor Numbers

2.3.1 Estimating Car Counts

To estimate visitor numbers, car count data were obtained from the California Department of Transportation (CalTrans). These data were collected between June 2010 and August 2010, covering peak use of the East Fork recreation areas, excluding major holidays per standard CalTrans procedure (pers. comm. Steve Malkson, CalTrans Lead Transportation Engineer, 2011). Count stations were set up north and south of the East Fork turn off, for both northbound and southbound lanes, and counts were taken in 15-minute intervals. North of the East Fork turnoff, counts were continuous from June 16 through August 23, 2010, while south of the East Fork, there is a data gap from June 22 and July 6, 2010, for unknown reasons (CalTrans, 2010).

Visitor numbers were calculated first by determining the number of cars entering the East Fork turnoff. To do this, we subtracted the number of cars per 15-minute interval counted in the northbound lane at the station north of the turn-off from the number of cars counted in the northbound land at the station south of the turn-off. Because the majority of users of the East Fork recreation areas are from the population centers south of the Forest, it is reasonable to only count the cars turning onto East Fork that originated south of the turn-off. This also helps to account for people leaving the East Fork recreation areas and

heading south to the population centers, which would affect the car count if we included cars coming from north of the turnoff.

2.3.2 Estimation of Visitor Numbers

Once car counts were estimated, visitor numbers could be estimated by choosing an average number of visitors per car. Given that Forest Service estimates put visitor groups at eight people per group, and that the groups are described as mostly large family groups, it is reasonable to conservatively estimate that a single vehicle is carrying four people. However, it is also noted that, as of 2000, more than half of the vehicles in the recreation area were multi-passenger vehicles, each of which seat 5 to 10 passengers, so a higher estimate of visitor numbers could also be reasonable (California Regional Water Quality Control Board, 2000). We excluded data from the first and last days of the count, which were incomplete collection days, as well as data from days with only one data collection station or other days with incomplete collection.

2.4 TMDL Data Analysis

2.4.1 Description

TMDL data were collected by the Forest Service between 2004 and 2008, approximately once per month, for a total of 44 days of data collection. Teams of four, comprised of employees and volunteers, counted and recorded individual items within 42 standardized categories of trash items, and noted unusual items. At the end of the data collection period, a total of 187 categories of loose litter, along with four categories of semi-contained waste, were recorded (Table 2.4a).

Data were collected from four popular recreation sites along the East Fork of the San Gabriel River that were identified in the TMDL document. These core sites are Coyote Flats, Cattle Canyon Bridge, Oaks Picnic Area and Camp Follows. Starting February 17, 2006, two additional sites were included: Heaton Flats and Hampton Bay. Of the sites where litter data were collected, only one--Oaks Picnic Area--is a developed recreation site. The four core sites were visited on each data collection day, except for Cattle Canyon on May 26, 2006 and Camp Follows on both September 24, 2004 and March 17, 2006.

Additionally, the data for Oaks Picnic Area collected on November 11, 2005 is identical to the data collected at the same site on September 16, 2005. The Bren Group determined that this was likely a data entry error, and only included only the September data for analysis.

While some of these items were as small as a piece of broken glass, others were large items that had clearly been illegally dumped, such as a steel truck frame or a vending machine face. Items on the standard list were assigned weights based on the approximate size of the item (Table 2.4b), while non-standard items were grouped into one of three weight classes: 0 to 1.9 pounds (0-0.86 kg), 2.0 to 9.9 pounds (0.91-4.5 kg), and greater than 10.0 pounds (4.5 kg). Of the items in the over 10-pound weight category, items that would be difficult to remove from the river terrace were not included in the analysis. It was assumed that these items were not likely to be recovered, and therefore contributed to neither the dump cost nor the recycling benefit. Further, these items were assumed to be a result of illegal dumping activities, rather than recreational use.

After entering the TMDL data provided by the Forest Service into a digital format, data from each survey day were compiled into a comprehensive set containing daily totals of all items. This set of daily count totals was then translated into a set of daily weight totals.

Table 2.4a: TMDL Data Categories

Standard Categories		
Alum Cans	Aerosol Cans	Batteries
BBG Grills/Propane Bottles	Beach Toy	Blankets
Candy/Food Wrappers	Chairs/Tables	Charcoal/Char Bag
Clothing/Shoes	Construction Material	Diapers
Female Products	Foil	Food Containers
Forest Service-issued Yellow Trash Bags	Glass Bottles	Grocery/Veg Bags
Human Waste	Ice Chest/Styrofoam	Juice Boxes
Large Flattened Cardboard Boxes	Napkins	Packaged Food Container
Paper Plates, Cups, Bowls	Piece of Trash	Piles of Broken Glass
Pipes (Metal or PVC)	Plastic Bag w/ Food	Plastic Bottle - 32oz or more
Plastic Bottle - 8-28oz	Plastic Plates, Cups, Bowls	Plastic ware
Plywood	Pot/Pan kitchen ware	Rope
Rugs/Carpets	Soda or Beer Boxes	Steel Food Cans
Styrofoam Cups, Plates, Bowls	Tarps	Toilet Tissue

Non-Standard Categories		
1 Gallon Plastic jug	32 Gallon Trash Can	5 Gallon Bucket
5 Gallon Drum	55 Gallon Drum	Abandoned Car Engine
Air Gun	Air Mattress	Antenna
Auto Tire	Baby Car Seat	Baby Stroller
Balloons	Balls	Bar Soap
Barricade	Basket	Bath Soap (bars)
Bath Towels	Beach Umbrella	Bed Liner
Bed sheets	Bedspread	Bible
Bicycle	Boogie Board	Box
Bricks	Broken Glass	Broken Glass Bottle
Bubble Wrap	Bucket	Burlap bag
Burlap Sack	Camera Box	Candle
Candles (large)	Car Battery	Car Floor Mat
Car Jack	Cart	CD
CD Player	Cigarette Lighter	CO2 Canisters
Coat Hanger	Coleman Lantern	Come-along
Culvert	Dog Chain	Door
Dredging Hose	Easter Eggs	Easter Grass
Easy Up Frame	Empty Cigarette Pack	Film Container
Fire Prevention Sign	Fishing Net	Fishing Supplies
Flower Pot	Foam Cushion	Foam Mattress
Foam Mattress/Pad	Foam pad	Foam Pad 12x12x3 feet
Forest Service Info Sign	Garbage Can	Gas Cans
Gas Container	Gas Lamp	Generator
Generator set	Gloves	Grocery Cart
Hair brush	Hammock	Hatchet
Inner Tube	Inflatable Mattress	Jar of Fish Food
Ladder	Life Jacket	Lighter fluid bottles
Lighter Fluid Can	Martini Glasses	Mattress
Metal Fencing	Metal Piece	Metal Screen
Metal Vent	Miners Storage Box	Mining Hose 8x6 feet
Newspaper	Oil Container	Oil Jug
Oranges	Oyster Shell	Paint Cans
Paint Roller Pan	Paint Tray	Pallet
Panning Pan	Pillow	Pillow/Cushion
Piñata	Plastic Bin	Plastic Bucket
Plastic Chest	Plastic Drum (50 gallon)	Plastic Easter Baskets
Plastic Easter Egg	Plastic Pool Liner	Plastic Trash Can Lid

Plastic Tub	Porch Swing	Rake
Rear Bumper of Vehicle	Ribbon	Road Sign
Rubber Raft	Safety cone	Scissors
Seat Covers	Shampoo Bottle	Shovel
Shovel End	Silverware	Sleeping Bag
Sluice Boxes	Small Skip Loader	Soccer Ball
Spray Paint	Spray Paint Can	Squash
Steel Cable	Steel Truck Bumper	Steel Truck Frame
Stereo Speaker	Straw Mat	Sun Lotion Bottle
Sunglasses	Sunscreen Bottle	Suntan Lotion
Suntan Lotion Bottle	Swimming Goggles	Swimming Pool Liner
Table Leg	Tent	Tent Cover
Tent Sack	Tent Stake	Tire
Toilet Seat	Toothpaste Tube	Toothbrush
Towel	Traffic Barricade	Traffic Cone
Trash Can	Truck Frame w/Wheels	Twin Mattress
Umbrella	Vehicle Parts	Vending Machine Face
Ventilator	Volleyball	Wastebasket
Wheel Barrow	Wheel Barrow Frame	Wig

2.4.2 TMDL weight assumptions

The data collected in the TMDL categorizes the items found, but did not assign weights to each of these categories. As such, we found reasonable weights (in pounds) for each category based on manner of use by visitors in the recreation sites (Table 2.4b). Typically, the sites were used for day-use recreation, primarily family groups picnicking (California Regional Water Quality Board, 2000). With this in mind, it was assumed that the categories with a wide range of potential sizes and types of items would contain items typically seen in a day-use picnic setting. Further, observations of the East Fork of the San Gabriel River showed relatively steep, and occasionally long, paths from the parking areas down to the river terrace where recreation occurs (pers. obs. Bren Group, 2011). It was therefore assumed that items carried down to the recreation areas would tend to be lighter-weight versions of the given category,

or “camping” style, which is generally more portable. Finally, we assumed that items were empty, partially empty, dirty or otherwise used to the point of not being worth carrying back up to the parking area or attempting to remove from the forest.

When weights or item size were on a broad scale, we either calculated an average weight for a variety of styles for the item or based it on a range of likely weights. Categories that fall under this assumption include BBQ grills/propane bottles, beach toy, chairs/tables, ice chest/styrofoam, pipes, and toilet tissue. Items in the bottle, plates/cups/bowls, blankets, cans, and tarps categories were assumed to be a standard size based on likely item use. We recognize that in making these assumptions of standard size or weights, we forfeit some complexity of the collected data. However, in order to analyze the data in any meaningful way, assumptions were necessary. Additionally, we assumed that in choosing a given size for an item, we balanced the difference between larger and smaller items for that category.

For the 145 non-standard categories, we implemented an additional level of simplification to proceed with the analysis. Since these categories had comparatively few items, the broader assumptions should not significantly change the results. The additional simplification involved classifying these 145 categories based on their weight range. All items estimated to weigh less than 2 pounds were assigned an average weight of 1 pound (0.45 kg). All items weighing between 2 and 10 pounds were assigned an average weight of 6 pounds (2.7 kg). Items heavier than 10 pounds were assigned 15 pounds (6.8 kg).

After compiling the data, we found it necessary to remove some items that were strongly affecting the averages. The main categories removed were related to Easter, including confetti, of which every individual piece had been counted to the thousands. These highly detailed counts biased the average number of items as well as the average weight per item.

After assigning an average weight per item, the set of daily counts was then translated into a set of daily weights. For each day, there were total weights for each item category as well as the total weight of all items combined. These combined weights, referred to hereafter as daily litter totals, were then used to characterize the litter. All weights were rounded to the nearest pound.

Table 2.4b: Includes all standard categories of items, the assumptions made when determining weight, and per unit weight of each item in pounds.

Category	Assumptions	Weight (pounds/item)
Alum Cans	Standard 12-oz. soda/beer can	0.029
Aerosol Cans	17-oz steel can, empty	0.25
Batteries	Double-A batteries	0.05
BBQ Grills/Propane Bottles	Medium sized propane bottle	3
Beach Toy	Based on weight of beach ball, well within a likely range of beach toy weights	0.5
Blankets	Typical picnic blanket size of 4'x5', polyfleece material assumed to be average weight blanket material	1.6
Candy/Food Wrappers	Standard sized candy bar wrapper	0.009
Chairs/Tables	Standard, aluminum frame beach chair	6.5
Charcoal/Char Bag	Empty 4-kg bag	0.22
Clothing/Shoes	Item was a single shoe based on TMDL document, average weight between a woman's shoe and a child's shoe, based on shipping weight	2
Construction Material	One square-foot of Douglas fir two-by-four	1.28
Diapers	Used diaper	0.48
Female Products	Used tampon	0.022
Foil	Weight of box was negligible, one piece of foil was one square-foot	0.012

Food Containers	8”x8”x2.5” (160 cubic inches)	0.031
Forest Service Yellow Trash Bags	Empty bags	0.55
Glass Bottles	12 oz. bottle	0.53
Grocery/Veg Bags	1/6 of a barrel size	0.013
Human Waste	Occurrence	0.55
Ice Chest/Styrofoam	28-quart chest, which holds 36 cans	5
Juice Boxes	6.75-fluid ounce juice box	0.24
Large Flattened Cardboard Box	1’x1’x3” when flattened	2.5
Napkins	Paper napkin	0.009
Packaged Food Container	Cookie packaging	0.007
Paper Plates, Cups, Bowls	Average based on 9” and 10” CVS brand paper plates	0.017
Piece of Trash	One empty water balloon is equivalent to one piece of unidentified trash	0.001
Piles of Broken Glass	Equivalent of 6 glass bottles	3
Pipes (Metal or PVC)	2-foot pieces, average of likely range of weights	2
Plastic Bag w/ Food	Average food waste per capita per day	0.2
Plastic Bottle - 32oz or more	2-liter soda bottle	0.119
Plastic Bottle - 8-28oz	16.9-oz water bottle	0.028
Plastic Plates, Cups, Bowls	16-oz translucent plastic conex cup, Dart brand	0.039
Plastic ware	Dixie brand, medium weight, polypropolene plastic fork	0.007
Plywood	4’x3’ (12 square feet)	17
Pot/Pan kitchen ware	10” aluminum frying pan, Update International brand	2.3
Rope	¼” nylon rope, 6’ length	0.096
Rugs/Carpets	6-square yards, 5 pounds per square yard	30
Soda or Beer Boxes	Used FedEx medium weight box, 16”x5”x11”	0.44

Steel Food Cans	14 oz. can	0.09
Styrofoam Cups, Plates, Bowls	Cup	0.022
Tarps	10'x12' (120 square feet)	3
Toilet Tissue	2-ply, averaged from five manufacturers.	0.001
Box of Trash	Same amount as standard grocery bag	6
Bag of Trash (large)	Average, based on reported range of possibilities	45
Bag of Trash (small)	Standard grocery bag	6
Pile of Trash	Enough to fill 1 large trash bag	45

2.4.3 Litter Characterization

Because the data were not normally distributed, they were described by the median, minimum, maximum, and quartiles. The median was chosen as the primary descriptive statistic used to discern patterns within the data.

The composition of the litter was analyzed for the following types: California Redemption Value (CRV) recyclables, All recyclables, and items of concern. CRV recyclables refer to aluminum cans, glass bottles, and plastic beverage bottles. The CRV of larger bottles is $0.10, and the CRV is $0.05 for smaller bottles and cans; however, only the plastic bottles were further divided into bottles less than 24 ounces (oz.) (710 ml) and bottles greater than 24 oz during data collection. All recyclables included larger plastic items, glass items, and commonly recycled metal items. Litter described by at least one of the following criteria were included in Items of Concern: (1) appeared in large quantities, such as disposable dishware and flatware; (2) adversely affected designated habitat use in a clear manner, such as fishing nets; or (3) were specifically mentioned in the TMDL document as public health hazard, such as diapers (California Regional Water Control Board, 2000). Because CRV recyclables are easily recycled, more in depth analysis was performed in these categories.

First, for each survey day, the weight of each type of litter was found by summing the weights of all items that belonged in that type. To analyze the weight of litter types, the descriptive statistics previously mentioned were determined for each type. Next, these different types of litter were characterized as compositions, or percentages, of daily litter totals. The daily composition of each litter type was found, and the spread of these compositions was analyzed in the same manner as the weights.

Further analysis of these compositions was done based on different ranges of daily litter totals. Daily litter totals were divided into the following categories: less than 1000 pounds (45.4 kg), 1000-1500 pounds (45.4-680.4 kg), 1500-2000 pounds (680.4-907.2 kg), and greater than 2000 pounds (907.2 kg). The median compositions of each litter type were found for each daily litter total category. This was done to determine trends in composition as total litter increased. The analysis of medians based on daily litter total was repeated for each type of CRV recyclable.

Lastly, these different types of litter were analyzed based on season. Because high visitor numbers extend beyond the usual three-month summer season, summer was redefined for this analysis, and the other seasons were adjusted to accommodate this extension. Summer is defined as the May 25 – September 30, fall as October 1 – December 15, winter as December 16 – March 15, and spring as March 16 – May 24. Because visitor number varies by season, this analysis was done to observe how compositions changed throughout the year. The analysis of medians based on season was repeated for each type of CRV recyclable.

2.5 Successful efforts at trash reduction from other agencies

To inform our recommendations, and learn more about how other agencies address the problem of waste disposal in recreation areas, we identified agencies that either had similar goals as the Angeles National Forest or

similar types of visitors. Each agency was also chosen for their success or improvements in reducing waste or improving diversion. We identified the Los Padres National Forest, Yellowstone National Park, and CalTrans as potential sources of inspiration for addressing the trash problem at the East Fork. Phone calls were placed to these agencies to learn more about their efforts to reduce litter, reduce overall trash, and improve diversion rates.

Once we identified our purpose for calling, each agency or office transferred us to a person in charge of or familiar with managing either the recreation area (CalTrans and Los Padres), or the environmental program (Yellowstone). We then had open-ended conversations with each person to learn as much as we could about their efforts to reduce litter and improve diversion rates. We also asked for their impressions on how successful these efforts have been and what major obstacles to improving visitor use of recycling they tried to address. These observations and opinions do not necessarily reflect the views and opinions of the agency organization itself, and should be taken as personal opinion and experience. For this reason, we have chosen to keep our sources anonymous, and identify them only by the agency for which they work.

2.6 Decision Support Tool

Using the Recreation Sustainability Indicator Tool created by the South Lake Tahoe Basin Management Unit as an example (South Lake Tahoe Basin Management Unit, 2011), a decision support tool was created to compare the relative expected costs and potential beneficial impact areas of different recommended actions. The tool is divided into two sections: Forest Service Inputs (Inputs) and Areas of Beneficial Impact (Impacts). The Inputs section represents the anticipated costs in terms of money and labor, while the Impacts section represents areas where each action may positively affect visitor behavior or reduce litter.

Inputs were chosen to reflect the costs to the Forest Service that are of greatest concern to the Forest, based on conversations with ANF management staff. The inputs chosen were: (1) expected cost of implementation, (2) expected maintenance cost, (3) expected frequency of maintenance, (4) Forest Service labor for implementation or initial effort, (5) Forest Service labor for maintenance, and (6) whether the National Environmental Policy Act (NEPA) would be triggered by the action. Each input was given a range of options (High, Medium, or Low) and each option is associated with a value (0, 1, or 2). To avoid a user bias based on numbers, only the text options are possible inputs, with the numeric values encoded within the spreadsheet. The values for the chosen input action are then summed as the "Input Subtotal." The Input Subtotal represents which actions are expected to incur the least financial commitment and labor from the Forest Service. A higher number for the "Input Subtotal" would represent lower financial and labor inputs from the Forest Service, and hence, a possibly more desirable action.

In contrast to the Inputs section of the tool, the Impact section is strictly binary, with a simple yes/no option for each impact area. Without detailed studies on the effectiveness of each potential action, it was not possible to reasonably assume an anticipated level of impact of each action. A binary system was chosen to allow the tool to assess the method or area of impact. These areas of impact were chosen to reflect problems associated with visitor misbehavior related to improper trash disposal in East Fork. Impact areas chosen were: (1) action increased the visibility of authority, (2) reduced overall waste volume, (3) promoted education or outreach, (4) acted as an on-site trigger or reminder for good behavior, (5) increased diversion potential, and (6) positively affected visitor perception of the forest. A single value was associated with each "Yes" response, and no value (zero) was associated with "No" responses. These values were summed as the "Impact Subtotal," which represents the relative broadness of expected impact from an action. As with the Input Subtotal, a higher

calculated value for the Impact Subtotal is considered a more desirable option because it positively impacts many areas.

2.6.1 Using the Decision Support Tool

To use the tool, recommended actions to reduce trash and litter in the East Fork of the San Gabriel River were added to the tool and appropriate options selected for each category. For example, the recommended action of installing trashcans along the river terrace during a high use season would be expected to involve the following inputs (with value given in brackets, which are unseen in tool):

- Low implementation cost [0]
- Low maintenance cost [0]
- Frequent maintenance [1]
- Low implementation labor [1]
- High maintenance labor, [2]
- No NEPA [0]

This results in an Input Subtotal of 4.

On the beneficial impacts side, we would anticipate seasonal trashcans to result in:

- No change or small increase in visibility of authority [0]
- An on-site trigger for good behavior [1]
- If combined with recycling – would promote recycling [1]
- No reduction in the volume of waste [0]
- Not promote solid waste education [0]
- No improvement of visitor perception of forest [0]

This results in an Impact Subtotal of 2.

To compare with another action, increasing enforcement of litter laws is expected to have low implementation cost, low maintenance costs, frequent maintenance frequency, high implementation labor, high maintenance labor, but

would not require NEPA. This gives an Input Subtotal of 5, which could potentially mean that increasing enforcement of litter laws might be expected to cost the ANF less than installing trashcans along the river terrace for the high season. Increasing enforcement of litter laws also anticipates an increased visibility of authority, provides outreach opportunity from interacting with the public, acts as an on-site reminder for good behavior, increases diversion potential, and improves visitor perception of the forest. This would earn an Impact Subtotal of 5, implying that increased enforcement of litter laws would address more of the issues associated with the trash problem at the East Fork than installation of seasonal trash cans. Again, this does not necessarily mean that increasing litter law enforcement would prove more effective at reducing litter in the East Fork, only that it addresses more areas of concern, and would be expected to cost less to implement than installing trash cans seasonally.

While the tool is unable to incorporate effectiveness or depth of impact within each impact area, any category in the Input or Impact section may be weighted at the Forest's discretion to reflect areas of greater concern. For example, if the Forest would like to avoid invoking NEPA, they can change the values associated with the options for NEPA to reward a "No" response more heavily. Default associated values are shown in Table 2.6, while an example of the tool in use is seen in Figure 2.6.

Table 2.6: Default Input and Impact categories for the Decision Support Tool, showing default options for each category along with its associated value. Note: higher numbers indicate an option requires less of a given input or has broader impacts. These numbers are meant only for assessing options relative to one another and are not meant to reflect total or overall costs or values.

Category		Options	Weight
Inputs	Implementation Cost	High	0
		Medium	1
		Low	2
	Maintenance cost	High	0
		Medium	1
		Low	2
	Frequency of maintenance	None	2
		Once	2
		Occasional	1
		Regular	0
		Frequent	0
	Implementation labor	High	0
		Medium	1
		Low	2
	Maintenance labor	High	0
		Medium	1
		Low	2
	NEPA	Yes	0
		No	1
Impacts	Visibility of authority	Yes	1
		No	0
	Reduced volume of waste	Yes	1
		No	0
	Education and outreach	Yes	1
		No	0
	On-site diversion trigger	Yes	1
		No	0
	Increased diversion potential	Yes	1
		No	0

Figure 2.6: An example of the Decision Support Tool used to compare the relative inputs and impacts of two actions: increasing enforcement of litter laws versus installation of trash cans along the river terrace on a seasonal basis

		Forest Service Inputs						
Recommendation Action	**Parties involved**	**Expected Implemen-tation cost**	**Expected maintenance cost**	**Expected maintenance frequency**	**FS labor for implementation /initial effort**	**FS Labor for maintenance /continued efforts**	**NEPA required**	**Input Subtotal**
Increase enforcement of littering laws	Forest Service	Medium	Low	Occasional	High	High	No	5
Seasonal trash can installation along river terrace	Forest Service	Low	Low	Frequent	Low	High	No	7

	Areas of Beneficial Impact							
Recommendation Action	**Visibility of Authority**	**Reduced Volume of Trash**	**Education/Outreach**	**On-site trigger for desired behavior**	**Increases Diversion Potential**	**Improves Visitor Perception of Forest**	**Impact Subtotal**	**Total**
Increase enforcement of littering laws	Yes	No	No	Yes	Yes	Yes	4	9
Seasonal trash can installation along river terrace	Yes	No	No	Yes	Yes	No	3	10

2.6.2 Evaluating recommendations using the tool

To assess which of our recommendations would be most useful for the Forest Service to reduce waste in the dispersed use areas of the East Fork of the San Gabriel River, we utilized the decision support tool we created. Each recommendation action that was under Forest Service authority was entered in the tool. Appropriate responses were chosen for each input and impact category for each specific action. For each action, the tool produced an Input Subtotal, Impact Subtotal, and Total Score.

To assess which actions were likely to provide the broadest impacts for the least cost, recommendations were sorted by "Input Subtotal" then "Impact Subtotal." This produced a list of the actions that would cost the ANF the least in terms of money and labor, but would positively affect the greatest number of impact areas. We then sorted the recommendations to see which actions would have the fewest expected inputs, in order to see which recommendation would be cheapest for the ANF to implement. Finally, we looked at which actions would provide the broadest impact, regardless of the cost.

We also used the tool to assess which suite of actions would likely cost the least, but impact all six areas of concern. This was done by first sorting our recommendations by input, to get the cheapest options, then by choosing sets of actions that provided a "yes" in each impact category, for the smallest total input values. This suite of actions would provide the Forest with the most comprehensive set of actions to address the trash problem at the East Fork, for the least anticipated cost.

2.6.3 Creating Action Scenarios for Comparison

We created several different combinations of recommendations we believe would be effective in addressing the waste problem, and ran them through the tool. This allowed us to compare each combination against the others to evaluate the potential inputs and broadness of impact. The first

combination is made of actions that are expected to have immediate impacts upon implementation. The second combination is based on opportunities for public education on waste impacts. A third combination encourages peer-to-peer, volunteer-based approach to combat litter on-site. Another combination is focuses in increasing proper disposal, while the final combination addresses the waste problem from several different angles. Adjustments were made in evaluating scenarios with actions requiring outside authority. This involved omitting these actions when calculated scores and averages.

2.7 Forest Outreach on Solid Waste

In the development of the educational recommendations for the Forest Service, the Bren Group first evaluated why the East Fork of the San Gabriel River is popular with visitors, and described the demographic composition of the visitors. Demographic information included: ethnicity, income level, primary language, and purpose of visit. Most of the information gathered was from the informational interviews conducted with the Forest Service personnel, background research, National Visitor Use Monitoring Data (NVUM), and observations by the Bren Group. With this information, the Bren Group then assessed the Forest stewardship information presented to visitors of the Forest, including student education programs, signage, brochures, information at the visitor center, and Forest Service mascots (i.e. Woodsy Owl).

Evaluating the effectiveness of each of these methods was outside the scope of this project, so the Bren Group made the assumption that each of these educational methods is effective at reaching at least some sector of the visitor population. In other words, any outreach recommendations that the Bren Group proposes to the Forest Service would be in conjunction with the current outreach methods. The Bren Group then considered how these educational outreach methods address the most popular reasons for people to visit and recreate in the East Fork area. For example, if a family whose primary language

was Spanish visited the San Gabriel River for the first time on a Sunday afternoon, how many opportunities would the Forest Service have to educate them on Forest stewardship? The Bren Group evaluated the areas where the Forest Service can expand its educational outreach opportunities to those visitors who are currently unaware of their impacts on the Forest. Lastly, the Bren Group described incentives and disincentives for the visitors to the East Fork to properly dispose of solid waste. This background information was then used to develop a suite of recommendations to the ANF on possible ways to improve visitor response to outreach methods.

3. Results

3.1 Informational Interviews

We detail the information gathered from each interview and summarize the most relevant comments. All of the comments below reflect the opinions of individual employees and should not be considered the opinions of the Angeles National Forest or the Bren Group. All names have been omitted and comments grouped according to topic in order to protect the anonymity of the employees. For consistency and ease of reading, pronouns alternate between male and female to denote the change of an interviewee. This alternation is in no way correlated with the gender of the actual interviewee.

3.1.1 Characterization of trash issues

One employee described how ANF employees pick up trash from the roads and in the river. She said trash is so bad within the San Gabriel River that it has been listed as an impaired waterway (303[d]) under the Clean Water Act. In order to be taken off this list, she used to pick up and sort solid waste from river, which she then compiled for managers. She estimated that in the summer, 50% of the solid waste is composed of recyclables, such as aluminum and glass, and in the winter, 10% of the solid waste is recyclable. These data should still be

available from the Forest management. She estimates that she stopped compiling these data approximately two years prior to the date of the interview. Another employee also contributed to the collection of solid waste in the river to determine if the river was still in exceedance of the TMDL. He specifically looked at the East and West Forks of the San Gabriel River and counted how many pieces of trash he came across within the river. When describing the type of waste that he encounters within the West Fork of San Gabriel River, he said that he finds diapers, human waste, and couches.

One employee's prior experience was with a different National Forest, where there was not as much visitor solid waste as there is at the ANF. We then discussed the River and Mountains Conservancy's role in San Gabriel Canyon. She described how they have plans to install a flush toilet in the East Fork area, although they have not yet done a recreational use survey in the area nor initiated the NEPA process.

One employee firmly asserted that there was a trash problem in the San Gabriel River Ranger District, and two employees confirmed that it was not a seasonal problem, because although there might be more trash in the summer months, there was still too much in the winter. This is especially a problem in the popular snow play areas such as Mt. Baldy. One specifically noted seeing trashcan lids discarded after sledding.

One employee did not remember that solid waste was always such a serious problem in the San Gabriel River Ranger District. He theorized that prior to the opening of a freeway exit to Mount Baldy twelve years ago, there was much less graffiti and trash, but after opening up of the Mount Baldy exit from the main highway, he has noticed a difference in the amount of trash. He then mentioned, that Mount Baldy gets a lot of "serious hikers" who respect the Forest as a natural resource, and that Mount Baldy is fairly clean compared with San Gabriel River and Big Tujunga Canyon.

One employee likened the East Fork to any other large venue. “There’s a stadium effect,” she said, explaining how people tend to dispose of their trash in the most convenient manner: in their immediate vicinity, assuming that someone else will pick it up later. She did say that littering issues have gotten better since dumpsters were installed in most parking areas. As there is only one ANF employee who drives the dump truck, he is very familiar with the amount of waste coming from the San Gabriel Canyon. Each year, 130 tons (118 metric tonnes) of trash comes from about 5 miles of dispersed recreation along the East and North Forks.

3.1.2 Trash Management within the San Gabriel River

There are multiple dumpsters located on the East and West Forks of the San Gabriel River, along Hwy 39, and at Crystal Lake. Employees of the Forest are responsible for emptying the trash from the dumpsters into a large garbage truck owned by the ANF. When asked about solid waste management efforts within San Gabriel Canyon, one employee said that there are many trash dumpsters for public trash disposal, but because the crew is smaller than it has been in previous years, she feels that they have trouble keeping up with solid waste accumulation. All solid waste that is picked up within the San Gabriel Canyon goes to the Rincon work center to get separated, but trash that is deposited in dumpsters does not get sorted because of the volume (with the exception of the dumpster at the Rincon Fire Station). One employee noted that there had been suggestions to put trashcans nearer to the rivers, but because of the steep grades in the popular areas, it would be difficult to haul out trash, and in the winter, the water surges will carry the trashcans away.

One employee collects six bags from the trashcans in the Mount Baldy area every day Sunday through Friday. In each load, he sorts out all the recyclables, and he often has at least three bags of recyclables each day that he collects the trash. He also mentioned that Mount Baldy does not get as many

visitors as the East and West Forks of San Gabriel Canyon. He stated that there is a different demographic in Mount Baldy than in the San Gabriel Canyon; he noted that many of the visitors to Mount Baldy are hikers, who have travelled there to enjoy nature, and do not often leave much trash behind. In contrast, within the San Gabriel River Canyon there are gold miners and squatters who live in the river canyon and accumulate trash. In addition, Sundays are very busy in the East Fork of the San Gabriel River, and each Monday, it is not uncommon for Forest Service employees to pull 20 trash bags from the trashcans in the area. This is in addition to the dumpsters, which are picked up separately by a dumpster truck. One employee said that only two employees are responsible for removing the trash from the San Gabriel Canyon. Solid waste is picked up from the San Gabriel Canyon everyday Friday through Tuesday.

When asked about past maintenance practices, one employee explained that there used to be a community service program with volunteer cleanup crews. This program lasted for 15 years, but ended several years ago. There are still some volunteers who help clean out the canyon, but, according to the employee, some are, "starting to feel like they are doing the Forest Service's job. People want to do the fun stuff when they volunteer, not pick up trash all the time." Currently, there are 2 part-time Forest Service staff who clean out the canyon; there used to be 6 full-time staff members. Forest Service bag handouts do make a difference in containing the trash, but now they are handed out only when they are donated. The employee said that the problem with bag handouts, is that visitors begin expecting the Forest Service to provide bags. Another employee described the working staff for the San Gabriel Canyon as 5 employees, who generally work Thursdays, Fridays, Saturdays and Sundays, in addition to volunteers.

One employee described how often the dump truck is run and its operating costs. He said it should be run once a week, but is usually run every 2-3 weeks. There are only two people who drive the truck. He said that one run

takes an entire day (6-8 hours) and the average run hauls away 5-6 tons (4.5-5.4 metric tonnes) of trash. During peak times, the truck can haul away 10-20 tons (9.1-18 metric tonnes) per run and must be run 5 times per 3-day weekend. The dumpsters do not require much maintenance, though the bottoms need to be replaced every 10 years or so as they begin to rot. The truck itself requires $30,000-$40,000 per year for maintenance and gas. An employee guessed that having the ANF'S own trucks might still be the cheapest disposal option for them.

When asked about the Big Belly solar compactor trash can, one employee expressed an opinion about its use in high intensity recreation areas. She was concerned that it would be stolen, and believed the solar panels would be the first thing to go. If it were installed in a recreation area, it would definitely have to be bolted down. She recommended that it be installed somewhere like the Gateway Center or the Supervisor's Office. Two employees also mentioned that there is limited visibility of Forest Service personnel by the public in San Gabriel Canyon, and that increased visibility could positively influence some visitors' behavior.

3.1.3 Recycling

One employee described to the Bren Group how the ANF previously had a recycling program, but the recycling program was discontinued, likely because trash was put in the recycling bins too often. He said these containers were bear-proof, but were removed approximately 4-5 years ago. There is still one recycling container at the Mt. Baldy Visitor Center. The employee said that separating recyclables from the solid waste is now the responsibility of the employees who empty the trash containers (generally Recreation Technicians). Much of the separation of recyclables is performed at the Rincon Fire Station and recreation work center.

3.1.4 Wildlife within the San Gabriel River

One employee thought it was important to mention how the San Gabriel River, although polluted, is home to some endangered species including the Santa Ana suckerfish and the Southwestern willow flycatcher.

3.1.5 Visitors to the San Gabriel River

When asked about visitor use of the area, one employee recommended that we use the NVUM [National Visitor Use Monitoring Program] surveys to gauge user data in the area, even if the demographics are not entirely accurate. She also noted that Caltrans periodically records the number of cars that drive on Highway 39 through the San Gabriel Canyon and may also have useful data. The Forest Service estimates that in 2010, there were over 1 million visitors in the San Gabriel Canyon.

She also noted that many visitors do not understand that the Forest is a natural resource, and she has personally witnessed visitors improperly disposing of trash even in the presence of uniformed employees of the Forest Service. She felt that the San Gabriel River Ranger District is adequately staffed to handle the amount of waste produced by visitors, and because of volunteers, they have enough people to pick up the trash. The San Gabriel River Ranger District has a regular volunteer corps of about 30-40 people.

When asked about visitor use in the San Gabriel River Ranger District, one employee described the campgrounds as mellow, noting that the solid waste is concentrated in and around the San Gabriel River. Another employee mentioned that popular areas get significant amounts of trash, and in these areas there are many trashcans, and they are located where they are most needed. He has also seen people discard trash out of their car window. He postulated that some people may not know how to use bear-proof trashcans, or do not care to use it (i.e. sticking your hand in the "open-lid mechanism"). He often encounters overflowing trashcans, which he speculated could be solved by having more

employees to empty trashcans. He recalled that after a large summer holiday weekend, it can take two weeks to clean up the trash that was left behind. Another employee characterized the main problem as people not using dumpsters. He added that there might be a cultural influence to the problem where people believe that leaving trash on the ground will create a job for someone.

Regarding Forest management techniques in response to visitor behavior, one employee believed that most people do not read the signs. She cited the example of Adventure passes, which are required in many areas of the Forest, but visitors continue saying that they do not know about the program. She also mentioned that there are signs that warn visitors of $1,000 fine for littering, but this has not resulted in behavioral change on a large level. She described how the visitor center is a useful tool for educating the public on proper stewardship of the Forest. At the Mount Baldy Visitor Center, there is a receptacle to separate recyclables, but there are no such facilities at San Gabriel Canyon for general public to sort their own recyclables. For suggestions as to how the Forest Service could reduce the amount of trash in problem areas of the Forest, the employee thought that more uniform presence could diminish improper trash disposal by the public and reduce overall solid waste left behind in the Forest.

3.1.6 Visitor Education

One employee mentioned that there was an educational program that previously tried public outreach by giving visitors trash bags before they went into the San Gabriel Canyon. The program was meant to educate visitors about the importance of packing their trash out with them, instead of discarding it in the river. He said that the program did work, but was dismantled because people were relying on the Forest Service to supply them with trash bags instead of

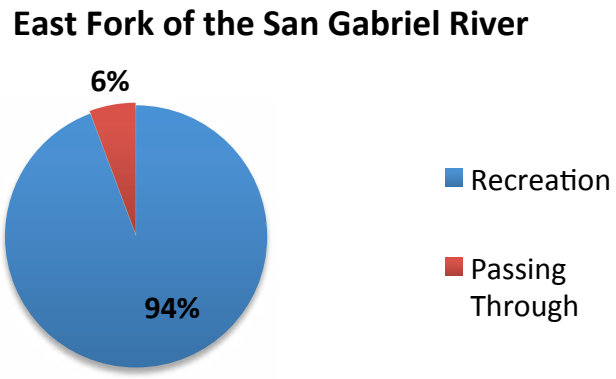
bringing their own. Sometimes people would just put wet clothes in the bags after playing in the river.

One employee was proud to mention that the Forest Service does have educational programs, and the first thing they teach students about is Forest stewardship, which includes packing out solid waste. She believed that there is a good mix of socioeconomic levels that are able to attend the program but would like to have more inner city students attend. Most of the program participants are 1st through 3rd grade students, though they have programs for students of all ages. Approximately 10,000 students per year attend a program in this district. Additionally, the ANF also conducts teacher-training workshops.

3.2 Demographic information of visitors and popularity of the East Fork of the San Gabriel River

Among the visitors to the East Fork of the San Gabriel River, 94.3% of the visitors said they came to the site to recreate Figure 3.2a. The other 5.7% said that they were just passing through. When compared to visitors to the Forest as a whole, 76.6% of those interviewed came for recreation. Other reasons for visiting the ANF included using the restroom (2.0%), work or commute (0.9%), passing through (11%), or some other reason (9.6%) (NVUM, 2006).

Most of the survey respondents who visited the East Fork of the San Gabriel River traveled an average of 39.8 miles (64.1 km) to reach the recreation area, with one visitor from out of state, and three who declined to give their distance traveled (NVUM 2006). This corresponds with information that visitors to the entire Forest gave; nearly three-quarters of visitors surveyed live within 50 miles (80.5 km) of the area they were recreating in. Within the East Fork, 39.6% of the respondents reported that their ethnicity was Hispanic and 52.8% reported that their ethnicity was white. This is compared to 20% Hispanic and 83.1% white in the ANF as a whole. The exact breakdown of the visitors reporting their ethnicity is detailed in the chart below (Figure 3.2b).



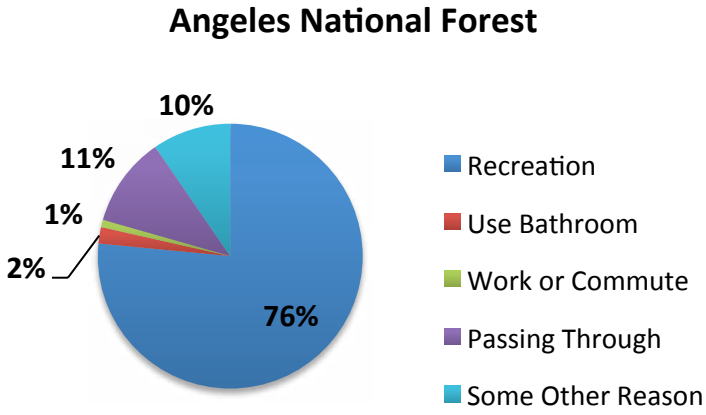


Figure 3.2a: Comparison of visitors stated reasons for visiting the Angeles National Forest with those visiting the East Fork of the San Gabriel River. (Source NVUM 2006)

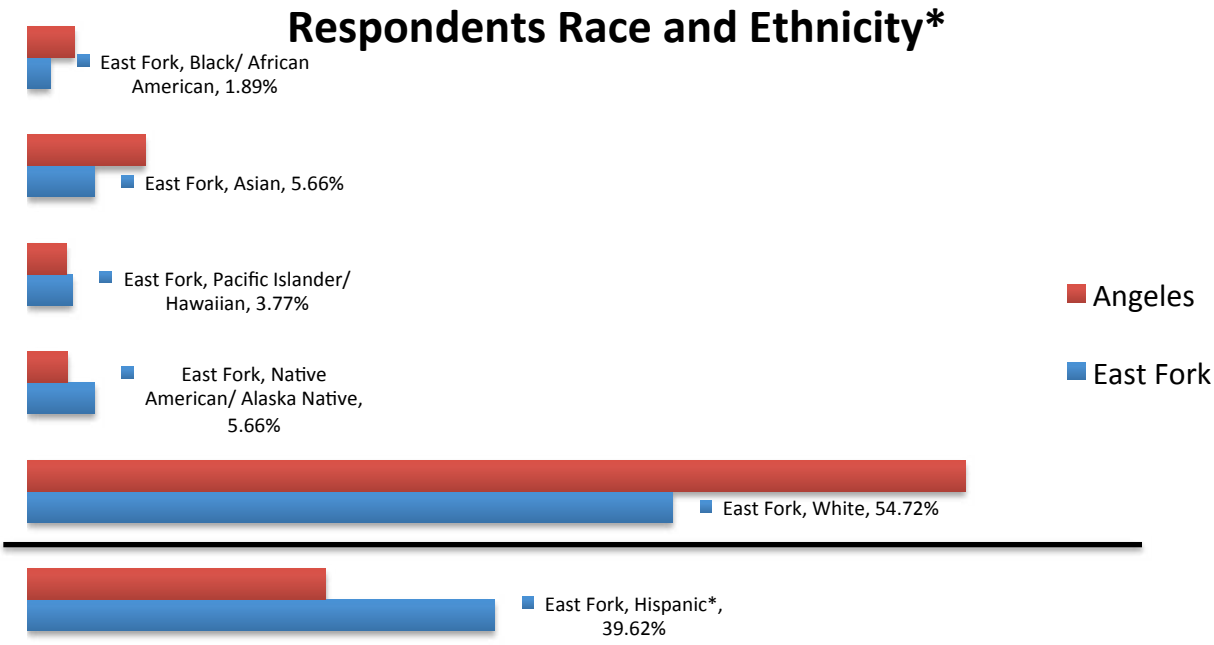


Figure 3.2b: Percentage of visitors to the Angeles and East Fork of the San Gabriel River who identified with each race category. *Ethnicity was asked a separate question, and the percentage of those who identified as Hispanic is indicated.

Information regarding the primary language of the visitors to the East Fork was not recorded in the NVUM survey. Anecdotal evidence from conversations with Forest Service employees and previous research on recreation areas in Southern California (Chavez, 2001), however, suggests that a large proportion of the visitors to the East Fork speak Spanish as a primary language. This is not meant to suggest that visitors with Spanish as a primary language do not also speak English, but when in family groups, such as when picnicking, there is a greater tendency to speak Spanish. In Chavez's 2001 survey data, she also notes that very few people reported a language other than English or Spanish as their primary language, but does mention that a few people indicated that they spoke Korean. She does not quantify the literacy level of the visitors in either language, but she does determine that there is a need for more multilingual signage and multilingual Forest Service informational packets. This study also includes detailed information about the differences in recreation patterns among ethnicities, income levels and social backgrounds, and advises managers to collect socio-demographic information about visitors to better serve the needs of those enjoying the Forest's resources.

Possible disincentives for improper waste disposal include full trashcans, distance to trashcans from riverbed, lack of knowledge of how to operate bear-proof trashcans, and visibility of solid waste in surrounding natural areas. The photos in Appendix I illustrate these examples.

3.3 Visitor numbers to the East Fork of the San Gabriel River

Table 3.3 shows the Mean number of cars turning onto East Fork Road per day over Summer 2010.

Table 3.3: Mean number of cars originating from the south turning on to East Fork Road per day between 16 June 2010 and 23 August 2010, excluding the time between 22 June 2010 and 6 July 2010.

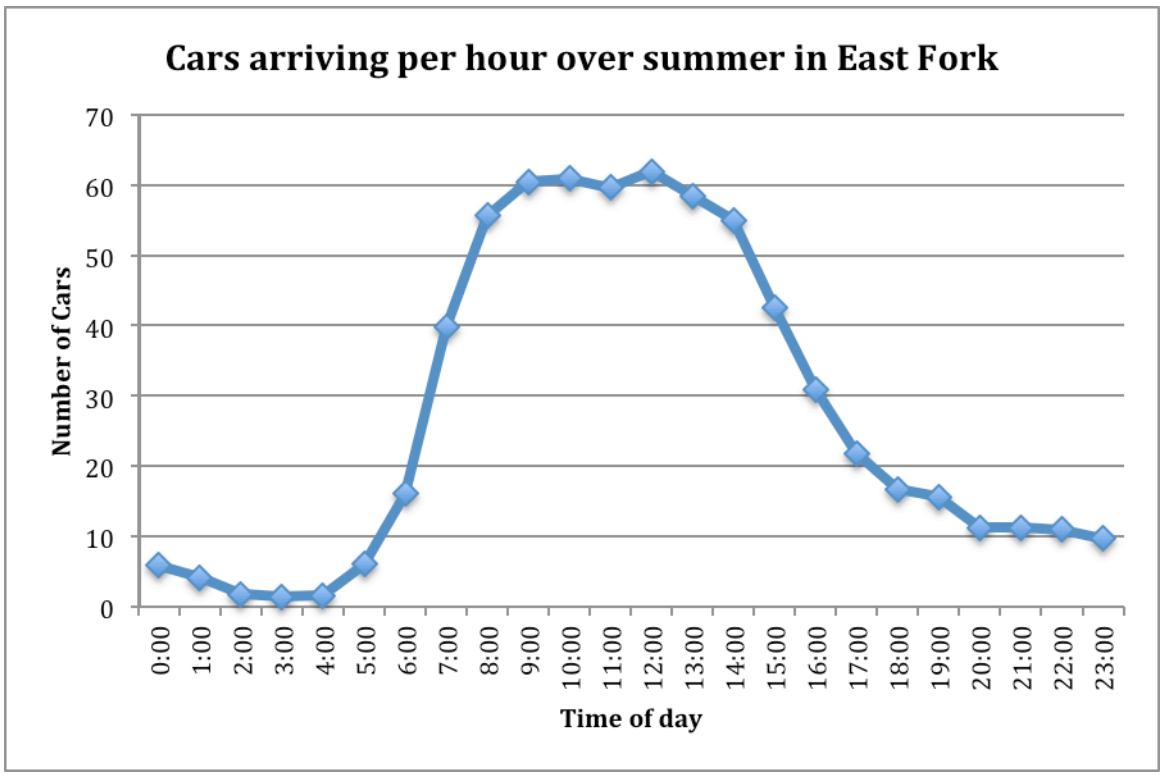
Day	Mean Number of Cars*	Mean Number of Visitors
Monday	358	1432
Tuesday	413	1652
Wednesday	399	1596
Thursday	435	1740
Friday	523	2092
Saturday	1060	4240
Sunday	1305	5220

*mean was rounded to the nearest whole unit

The most popular day of the week for visitors to use the East Fork was Sunday, with an average of 1,305 cars per day over summer, followed by Saturday, averaging 1,060 cars. Arrival time peaked between 8 am and 2 pm averaged across all days for the summer, with between 55 and 62 cars per hour turning onto East Fork Road during these times (Figure 3.3).

Summer weekends averaged 9,460 visitors, though weekend visitor numbers were estimated to peak at 12,640 visitors for the weekend of July 17 and 18, 2010. There was no car count over the Independence Day holiday, so it is likely that the true peak for visitor rates fell on Sunday, July 4, 2010. Sundays are the day of highest visitation to the East Fork.

Figure 3.3: Mean number of cars per hour originating from the south turning onto East Fork Road for all days between 16 June 2010 and 23 August 2010, excluding the time between 22 June and 6 July (data deficiency).



3.4 TMDL Data Analysis

3.4.1 Litter Composition

Figure 3.4a shows the distribution of daily litter totals, which is slightly skewed toward lower weights. The median of 3,733 lbs (1,693 kg) and other descriptive statistics of these data are enumerated in the table below (Table 3.4a).

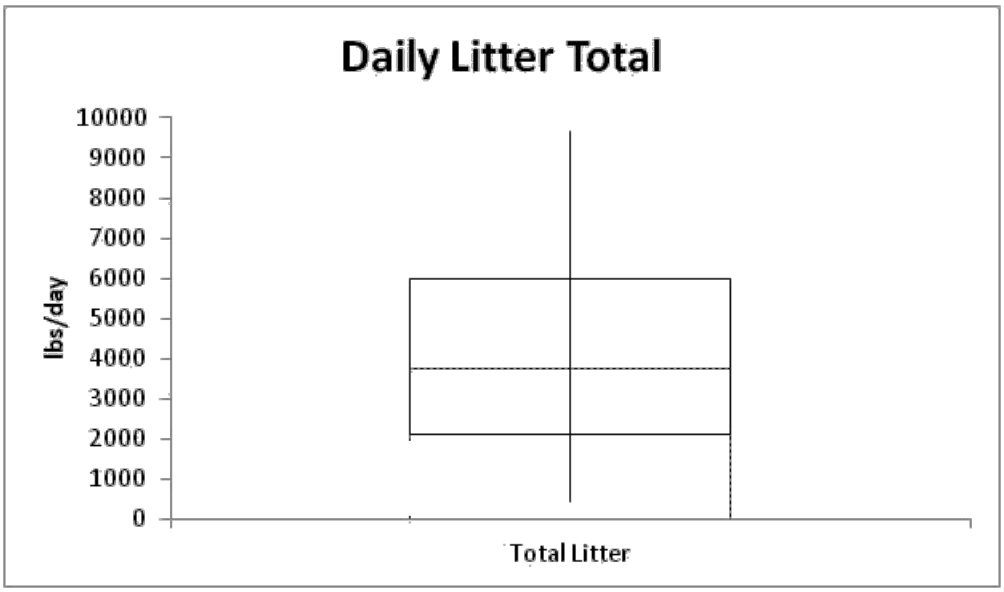


Figure 3.4a: Shows spread of litter weight, in pounds, surveyed each day. This includes minimum, maximum, and quartiles as well as the median weight (3,733 lbs or 1,693 kg).

Table 3.4a: Statistics characterizing the spread and range of all daily litter totals.

Statistic	Daily Litter Total (lbs)	Daily Litter Total (kg)
Median	3733	1693
Q1	2126	964
Min	424	192
Max	9657	4380
Q3	5991	2717

The weights of different litter types are characterized in the following figure and table (Figure 3.4b). CRV recyclables had a median weight of 57 lbs (26

kg), while All Recyclables had a median weight of 225 lbs (102 kg), and Items of Concern had a median of 44 lbs (20 kg).

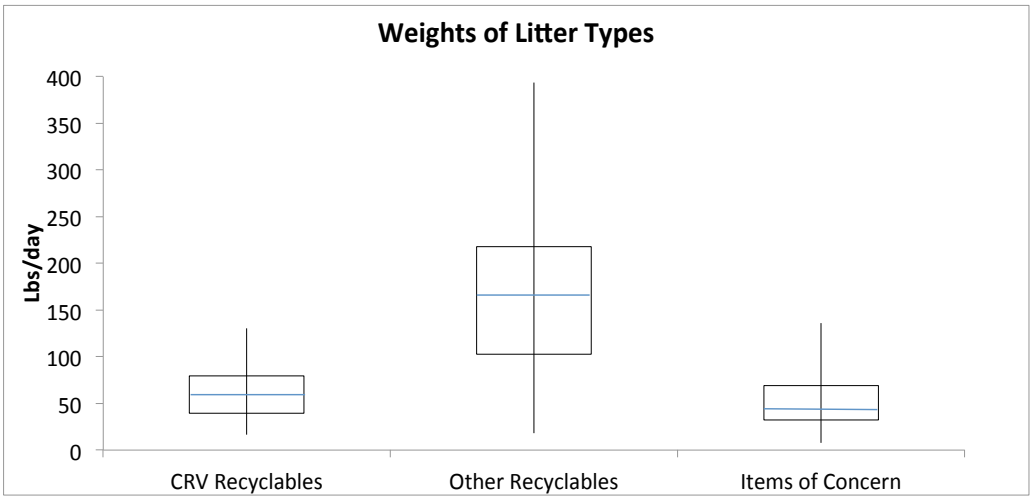


Figure 3.4b: Shows spread of daily weight, in pounds, of different types of litter. Minima, maxima, medians, and quartiles included for each type. CRV Recyclables had a median of 57 lbs (26 kg), All Recyclables: 225 lbs (102 kg), and Item of Concern: 44 lbs (20 kg).

Table 3.4b: Statistics describing the spread and range of CRV Recyclables, All Recyclables, and Items of Concern.

Statistic	CRV recyclables lbs (kg)	All Recyclables lbs (kg)	Items of Concern lbs (kg)
Median	57 (26)	225 (102)	44 (20)
Q1	38 (17)	152 (69)	33 (15)
Min	17 (8)	44 (20)	8 (4)
Max	130 (59)	492 (223)	135 (61)
Q3	80 (36)	290 (132)	70 (32)

The spreads of each type of litter are shown in the figure below (Figure 3.4c) and their descriptive statistics follow in a table (Table 3.4c). CRV recyclables had a median composition of 1.7%, All Recyclables had a median composition of 5.6%, and Items of Concern had a median composition of 1.3% of daily litter.

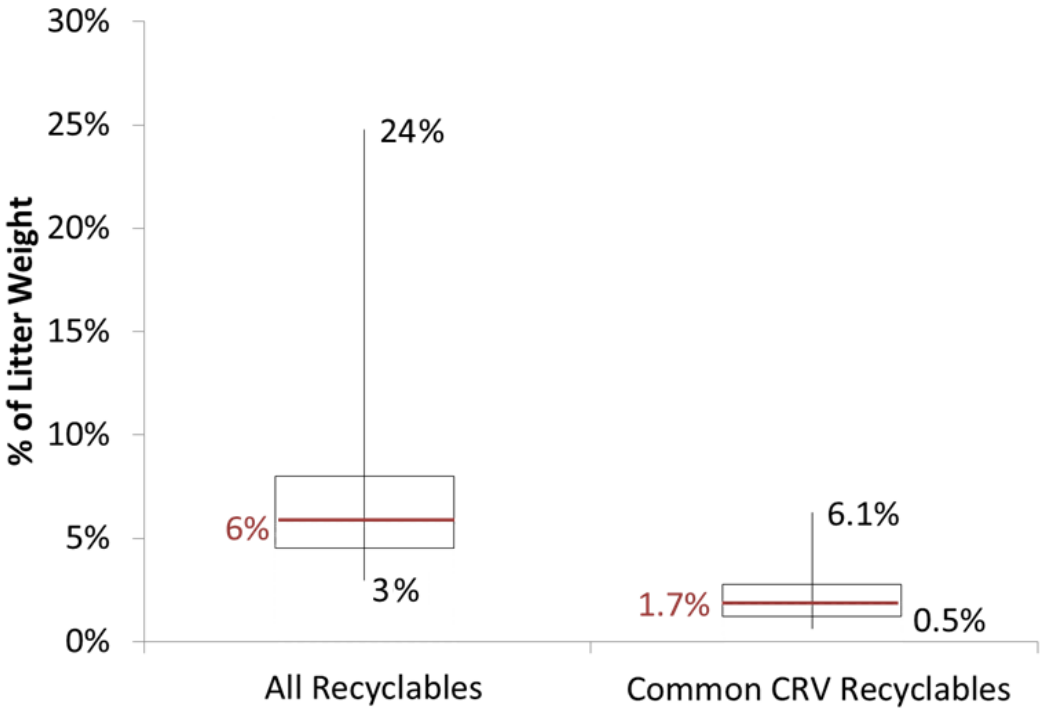


Figure 3.4c: Boxplots of compositions of CRV Recyclables and All Recyclables. Minima, maxima, medians, and quartiles included for each type. CRV Recyclables had a median composition of 1.7% of daily total litter and All Recyclables: 6%.

Table 3.4c: Descriptive statistics of compositions of each litter type for all daily litter totals.

Statistic (% of daily litter total)	CRV recyclables	All Recyclables	Items of Concern
Median	1.7%	5.6%	1.3%
Q1	1.1%	4.5%	1.0%
Min	0.5%	3.0%	0.4%
Max	6.1%	24.8%	6.9%
Q3	2.6%	8.0%	1.7%

All Recyclables and Items of Concern compositions tended to decrease with increasing litter totals (Figure 3.4d). CRV Recyclables comprised about 2.6% of litter when there was less than 1000 lbs (454 kg) of litter; this percentage dropped to 1.2% in the 1500-2000 lbs (680-907 kg) range for litter and increased with total litter thereafter (Table 3.4d).

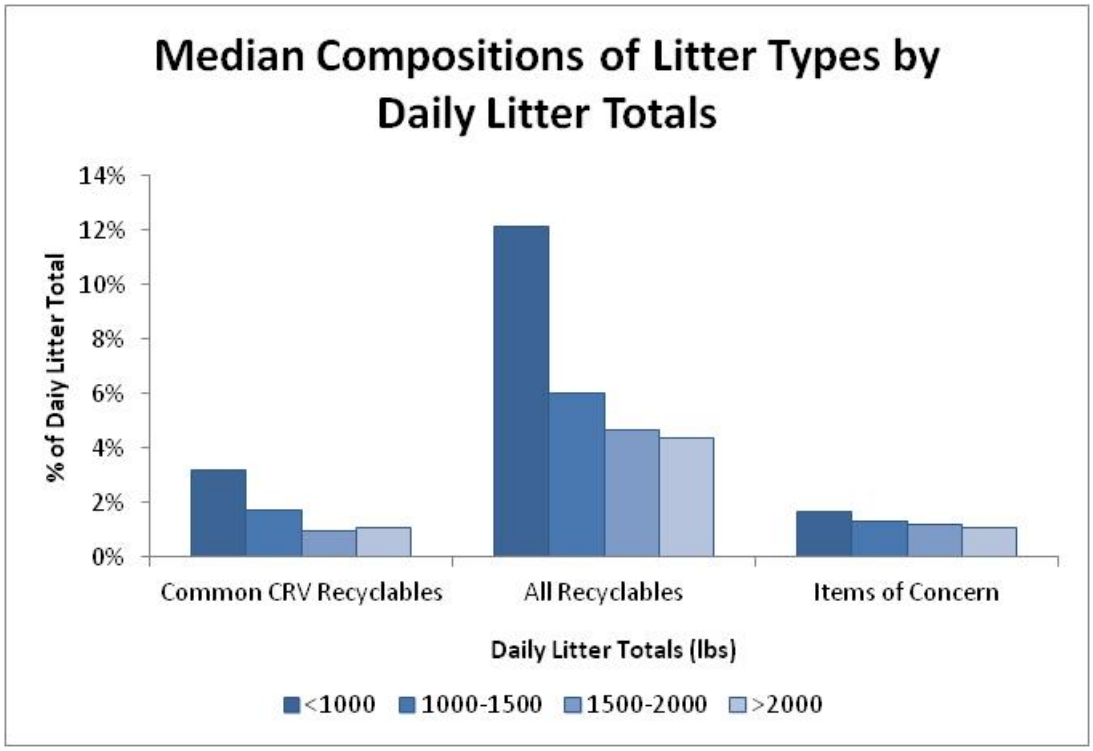


Figure 3.4d: Median compositions of CRV Recyclables, All Recyclables, and Items of concern for four ranges of daily total litter.

Table 3.4d: Median compositions of CRV Recyclables, All Recyclables, and Items of Concern for four ranges of daily litter total.

Daily Litter Total range lbs (kg)	CRV Recyclables	All Recyclables	Items of Concern
<1000 (454)	2.6%	12.1%	1.5%
1000-1500 (454-680)	1.7%	6.0%	1.2%
1500-2000 (680-907)	1.2%	4.7%	1.0%
>2000 (>907)	1.3%	4.4%	1.1%

Both CRV and All Recyclables were at their lowest composition in summer, increased as the year continued and peaked in winter (Figure 3.4e, Table 3.4e). Items of Concern were the lowest in spring and highest in fall.

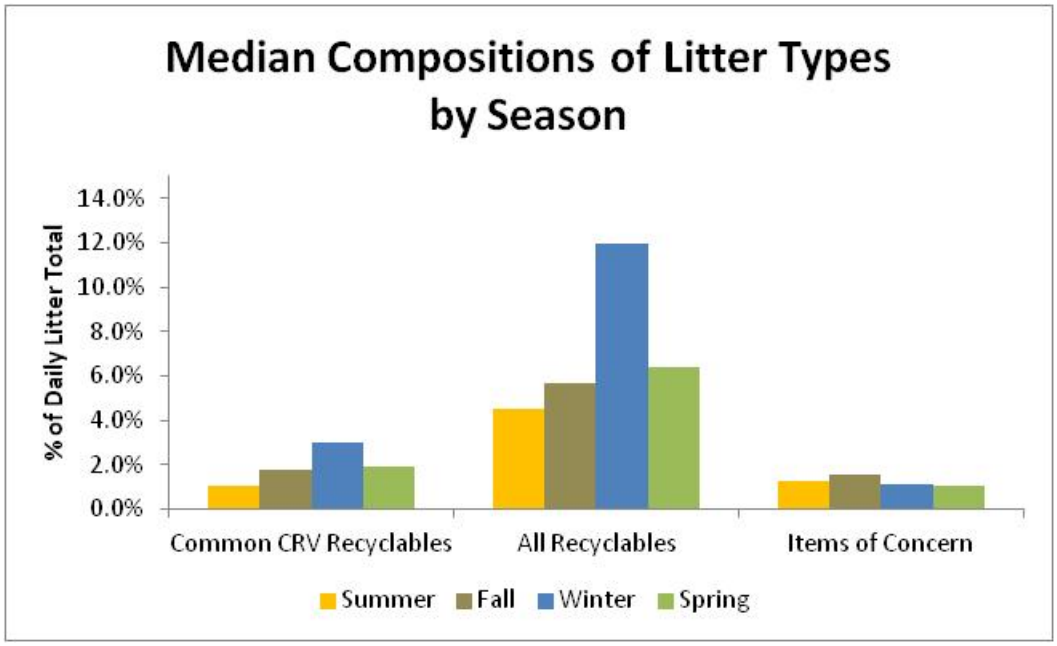


Figure 3.4e: Median compositions of CRV Recyclables, All Recyclables, and Items of Concern for each season.

Table 3.4e: Median compositions of CRV Recyclables, All Recyclables, and Items of Concern for each season.

Season	CRV Recyclables	All Recyclables	Items of Concern
Summer	1.1%	4.6%	1.3%
Fall	1.7%	5.7%	1.6%
Winter	3.0%	11.9%	1.1%
Spring	1.9%	6.4%	1.0%

3.4.2 CRV Recyclables

The percent composition of aluminum cans declined as daily litter total increases. Plastic and glass bottles tend to decrease as daily litter total increased, but the composition of these recyclables increased from the 1,500-2,000 lbs (680-907 kg) range to the greater than 2,000 lbs (907 kg) range (Figure 3.4f, Table 3.4f).

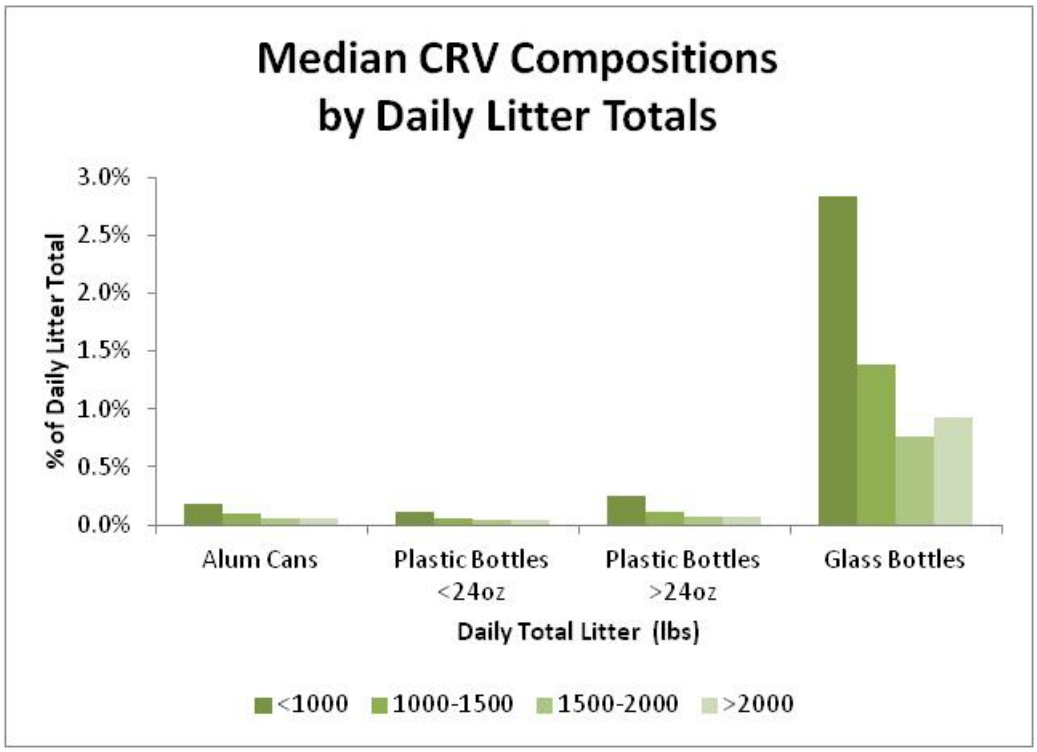


Figure 3.4f: Medians of aluminum cans, plastic bottles, and glass bottles for four ranges of daily litter total.

Table 3.4f: Median compositions of aluminum cans, plastic bottle, and glass bottles for four ranges of daily litter totals.

Daily litter total lbs (kg)	Alum Cans	Plastic Bottles <24oz	Plastic Bottles >24oz	Glass Bottles
<1000 (454)	0.13%	0.08%	0.25%	2.18%
1000-1500 (454-680)	0.09%	0.06%	0.11%	1.39%
1500-2000 (680-907)	0.07%	0.05%	0.08%	1.03%
>2000 (907)	0.07%	0.06%	0.10%	1.16%

All CRV recyclables peaked in composition during winter and were lowest during the summer. Spring tended to have higher compositions than fall (Figure 3.4g, Table 3.4g).

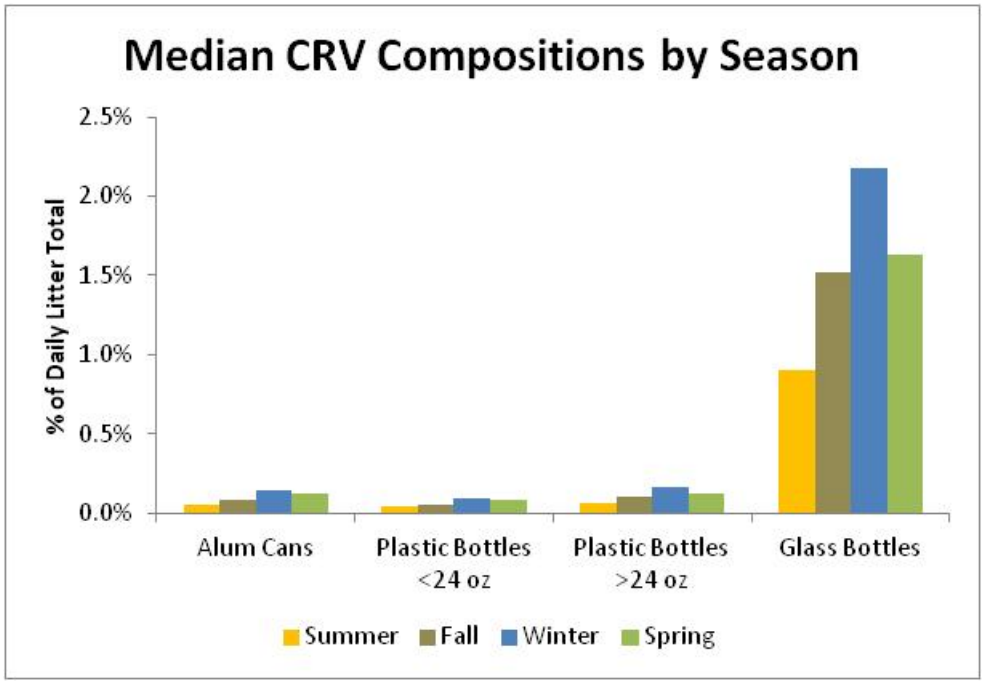


Figure 3.4g: Median compositions of Aluminum Cans, Plastic Bottles, and Glass Bottles for each season.

Table 3.4g: Seasonal median compositions of daily litter total for aluminum cans, plastic bottles, and glass bottles.

Season	Alum Cans	Plastic Bottles <24 oz.	Plastic Bottles >24 oz.	Glass Bottles
Summer	0.06%	0.05%	0.07%	0.90%
Fall	0.08%	0.05%	0.10%	1.52%
Winter	0.15%	0.10%	0.16%	2.18%
Spring	0.13%	0.08%	0.12%	1.63%

3.5 Efforts by other agencies to manage visitor waste

To protect the anonymity of our sources, we have chosen to identify them only by the agency or organization for which they work. These responses should not be considered the opinions of the agency and should be taken as opinions or impressions of individuals based on their personal experiences.

3.5.1 Los Padres National Forest

Concessionaires manage many of the high use recreation areas within the Los Padres National Forest. If the Forest notices a problem with trash in these areas, they direct the concessionaire to clean it up, and the concessionaire takes care of the problem within a few days. The Forest is able to use the threat of revoking the concession to impel concessionaires to maintain a clean recreation area. However, the Forest did note that they believed an area had to be developed before concessionaires could be brought in to manage a recreation area.

3.5.2 CalTrans

CalTrans estimates that a yearly total of 500,000 visitors use their northbound 101 Camp Roberts rest stop, and they assume that these are likely to be urban residents. These rest stops are not recreation areas similar to the ANF, but do represent urban users, large visitor numbers, and less investment by visitors in keeping the area clean.

CalTrans in Central California has numerous recycling bins at their rest stops along Highway 101. Signs in the kiosk at the rest stop educate visitors on which items can be recycled, and most recyclable items are accepted in the co-mingled bins. To help reduce incidents of visitors putting trash in the recycling bins, recycling bins are given distinct markings and grouped away from trashcans. Our CalTrans contact did note that the rest stop vending machines were stocked with a large number of items in recyclable containers, such as bottles or cans.

The recycling bins are emptied daily, and estimated to be full or nearly full each time they are emptied. Our contact believes that it is likely that some individuals sort through the recyclable to remove items with CRV value, and that this reduces the actual amount of recycling that occurs at the rest stop. She also believes that despite the odd user, most visitors try to use the recycling bins

appropriately, and that it is better for visitors to err on the side of putting trash in the recycling rather than recyclables in the trash. A partner group, the Plastics Division of the American Chemistry Council, installed the bins at the Camp Roberts rest stops in Central California.

3.5.3 Yellowstone National Park

Yellowstone National Park is a federal property whose mission is similar to the Angeles National Forest. It is a place where visitors go to interact with nature and use the park in large numbers. It differs from the ANF in its distance from major urban centers, and as a National Park, is perceived differently by visitors than a National Forest.

Yellowstone National Park has set a goal of 100% diversion by 2016. This means they hope to be able to recycle, compost, or reuse all of the waste produced in the park. Speaking with a member of Yellowstone's green team, we learned that the park has a separate contractor for all of the recycling in the park. This contractor has increased the number and location of recycling bins in the park, and has a strong environmental ethic. Campgrounds and visitor buildings almost all have recycling for typical items such as cans, bottles, and paper. Specialty items, such as bear spray canisters or construction material, may be brought to bins near central visitor centers. Recycling bins are distinguished from trash by color. Additionally, all concessionaires offer recycling and sell biodegradable picnic supplies. To further improve the diversion rate, all of the trash collected at Yellowstone is first sent to a composting facility. There, the trash is sorted for compostable material and recyclables. Only after all of these items are removed is anything sent to a landfill.

When asked about how the park encourages visitors to actively participate in achieving the park's diversion goals, our contact told us that it is likely easier than it would be in a National Forest, because Yellowstone's visitors

arrive with a certain consciousness. Visitors see a National Park as something special, whereas their impression of a National Forest is entirely different, and is accompanied by a different level of respect.

To further promote proper recycling in Yellowstone, the Park uses standardized signs and labels for recycling bins. These standard signs are also found throughout the surrounding communities, to provide a consistent message for residents and visitors as they are approaching and leaving the park. To aid in proper use of recycling bins, the park uses pictures in addition to words, to ensure international and non-English-speaking visitors understand what is and is not recyclable.

3.6 Using the tool to assess recommendations

3.6.1 Overall highest scoring action

The action that received the highest total score (combined Input and Impact scores) was the outreach and trash cleanup volunteer corps. This action received a total of 13 points. There was a three-way tie for second-highest scoring action. These actions were: (1) setting stringent diversion goals in bids for waste management contracts, (2) using fire personnel to help address problems of litter in the East Fork, and (3) creating a public photo contest for the ANF (Table 3.6a)

	Forest Service Inputs							Areas of Beneficial Impact							
Action	**Expected Implementation cost**	**Expected maintenance cost**	**Expected maintenance frequency**	**FS labor for implementation/initial effort**	**FS Labor for maintenance/continued efforts**	**NEPA required**	**Input Subtotal**	**Visibility of Authority**	**Reduced Volume of Trash**	**Education /Outreach**	**On-site trigger for desired behavior**	**Increases Diversion Potential**	**Improves Visitor Perception of Forest**	**Impact Subtotal**	**Total**
Outreach and trash volunteer corps	Low	Low	Infrequent	Low	None	No	9	Yes	No	Yes	Yes	No	Yes	4	13
Set stringent diversion goals in contractor bid request	Low	Low	None	Low	None	No	11	No	No	No	No	Yes	No	1	12
Enlist fire personnel in the fight against littering	Low	Low	Regular	Low	Medium	No	8	Yes	No	Yes	Yes	No	Yes	4	12
Angeles public photo contest for public information campaign	Low	Low	None	Medium	Low	No	10	No	No	Yes	No	No	Yes	2	12

Table 3.6a: Highest scoring actions when looking at combined Input and Impact score.

3.6.2 Least cost with greatest impact

The action scoring highest for Inputs was setting stringent diversion goals in bids for waste collection contracts. This action is associated with positive impacts in only one category: Increases Diversion Potential. The next highest-scored action for Inputs was a public photo contest campaign. This action was expected to impact two areas: outreach and visitor perception of the forest. The third-highest Input score was a tie between three actions: developing an outreach and trash volunteer corps, creating a graffiti task force, and appointing a dedicated volunteer coordinator. Of these actions, the volunteer corps is expected to impact four areas (visibility of authority, education/outreach, on-site trigger for desired behavior, and visitor perception of the forest), whereas the other two are only expected to impact two and none areas, respectively (Table 3.6b).

Table 3.6b: The highest scoring actions when considering lowest costs (inputs) followed by greatest impact.

	Forest Service Inputs							Areas of Beneficial Impact							
Recommendation Action	Expected Implementation cost	Expected maintenance cost	Expected maintenance frequency	FS labor for implementation /initial effort	FS Labor for maintenance /continued efforts	NEPA required	Input Subtotal	Visibility of Authority	Reduced Volume of Trash	Education /Outreach	On-site trigger for desired behavior	Increases Diversion Potential	Improves Visitor Perception of Forest	Impact Subtotal	Total
Set stringent diversion goals in contractor bid request	Low	Low	None	Low	None	No	11	No	No	No	No	Yes	No	1	12
Angeles public photo contest for public information campaign	Low	Low	None	Medium	Low	No	10	No	No	Yes	No	No	Yes	2	12
Volunteer coordinator for East Fork team	Low	Low	Infrequent	Low	Low	No	9	No	No	No	No	No	No	0	9
Graffiti task force	Low	Low	Infrequent	Low	Low	No	9	Yes	No	No	No	No	Yes	2	11
Outreach and trash volunteer corps	Low	Low	Infrequent	Low	None	No	9	Yes	No	Yes	Yes	No	Yes	4	13

3.6.3 Greatest impact with least cost

Five actions score 4 points in Impact Subtotal: (1) Increased enforcement of litter laws, (2) visitor center displays and exhibits (3) an outreach and trash cleanup volunteer corps, (4) public campaign to reduce waste, and (5) utilizing fire personnel in the off-season to address waste issues. Of these five actions, the outreach and trash cleanup volunteer corps had the highest score for Inputs, earning 9 points. Using fire personnel in the off-season received 8 points for inputs, while the visitor center displays earned 7. The other two actions each received 5 points for their Input totals (Table 3.6c).

Table 3.6c: The highest scoring actions when considering broadest impact (Impact Subtotal) followed by lowest cost (Input Subtotal).

		Forest Service Inputs							Areas of Beneficial Impact							
Recommendation Action	Parties involved	Expected Implementation cost	Expected maintenance cost	Expected maintenance frequency	FS labor for implementation/ initial effort	FS Labor for maintenance/ continued efforts	NEPA required	Input Subtotal	Visibility of Authority	Reduced Volume of Trash	Education/ Outreach	On-site trigger for desired behavior	Increases Diversion Potential	Improves Visitor Perception of Forest	Impact Subtotal	Total
Outreach and trash volunteer corps	Volunteer group, NFF, Friends of the Angeles	Low	Low	Infrequent	Low	None	No	9	Yes	No	Yes	Yes	No	Yes	4	13
Enlist fire personnel in the fight against littering	Forest Service	Low	Low	Regular	Low	Medium	No	8	Yes	No	Yes	Yes	No	Yes	4	12
Visitor center displays/ exhibits (large, eye-catching)	Forest Service	Medium	Low	Infrequent	Medium	Low	No	7	No	No	Yes	Yes	Yes	Yes	4	11
Public campaign to reduce waste	NFF, Friends of the Angeles, Forest Service	High	Medium	Regular	Medium	Low	No	5	No	Yes	Yes	No	Yes	Yes	4	9
Increase enforcement of littering laws	Forest Service	Medium	Low	Occasional	High	High	No	5	Yes	No	No	Yes	Yes	Yes	4	9

3.6.4 Comprehensive suite of actions with least costs

Sorting by Input Subtotal, then looking for suites of action with expected impact in each impact category provides suggestions for comprehensive approaches to addressing the problem of waste management in the East Fork, while keeping costs as low as possible. The set of actions that addresses each impact area, for the highest average input score, would be considered the most efficient way to produce a comprehensive solution. A variety of best options are detailed below in Table 3.6d.

Suite of Actions	**Input Total**	**Average input per action**	**Impact total**	**Average impact per action**
Stringent diversion goals in request for waste management contract bids + Public photo campaign + Outreach and trash volunteer corps + Public campaign to reduce waste	35	8.75	11	2.33
Public campaign to reduce waste + Outreach and trash cleanup volunteer corps + Stringent diversion goals	25	8.33	9	3
Visitor center displays + Fire dept. personnel + Public campaign to reduce waste	20	6.66	12	4
Stringent diversion goals + Fire dept. personnel + Public campaign to reduce waste	24	8	9	3
Seasonal trash cans + Public photo contest + Public campaign to reduce waste	22	7.33	9	3

Table 3.6d: Recommended actions that are expected to provide the most comprehensive way to address the waste problem in East Fork. Higher average input per action score is better than lower average input per action score, while higher average impact per action is better than a lower average impact per action. Each of these suites of action addresses each impact category identified by the Group.

3.6.5 Action Scenarios

When accounting for parking actions controlled by Los Angeles County, Combination A (immediate impacts) earned an average Input score of 8, with an average Impact 3.5, with two parking actions. Combination B (public education) averaged 6 point for Impact and 3.25 for Inputs. The peer-to-peer public education scenario (Combination C) earned 7.75 for Input, and 2.25 for Impact averages. Combination D, which is designed as a multiple-angle approach, averaged 6.5 and 2.5 for its Inputs and Impacts, respectively. The fifth combination, which is expected to increase proper disposal scored 8.33 for average Input, and 3 for average Impact, though contained one parking action (Table 3.6e).

Recommendation Suite	Input total	Average Input	Impact total	Average Impact
Combination A: Immediate Impacts Volunteer corps + decreased parking turnouts + decreased parking on street + seasonal trash cans	16*	8*	7*	3.5*
Combination B: Public Education Volunteer training + Spanish-language educational materials + public campaign to reduce waste + visitor center displays	24	6	13	3.25
Combination C: Peer-to-peer Outreach Volunteer corps + volunteer training + volunteer coordinator + Spanish-language educational material	31	7.75	9	2.25
Combination D: Multiple-angle Approach Volunteer corps + graffiti task force + decrease parking in turnouts + seasonal trash cans	25*	8.33*	9*	3*
Combination E: Increase Proper Disposal Loudspeakers + trash bag dispensers + recycling bins + seasonal trash cans	26	6.5	10	2.5

Table 3.6e: Input and Impact scores for recommendation combinations that are expected to be effective at reducing the waste and litter along the East Fork. *Combination includes at least one parking action. Because Los Angeles County controls the road, they were not assessed using the tool. Therefore, the Input and Impact scores do not include the parking actions, nor do the averages.

4. Discussion

4.1 Recycling Costs and Feasibility

As mentioned above, recycling and non-reusable waste may be viewed distinctly from a management perspective. The need to properly dispose or avoid accumulation of non-reusable waste gives the disposer an incentive to pay to get rid of said waste. However, the potential to resell recyclable materials gives the organization doing the disposing an incentive to acquire such waste. In other words, recyclables should not incur a cost for the disposer. This section explores some case studies of recycling costs for governments and large institutions as well as the market price of various recyclables.

4.1.1 New York City

In 1996, the City of New York spent an additional $200 for each ton of glass, plastic, and metal that was diverted from the landfill (Tierney, 1996). This was because the market price of recyclables was often significantly less than the cost of processing. In fact, the City typically had to pay $40 to dump each ton of these recyclables (Tierney, 1996). In 2002, it was reported that the $240 per ton spent by New York to recycle is almost twice the cost of disposal for non-recycled municipal waste. This is why Mayor Bloomberg proposed an 18-month moratorium on the City's glass, plastic, and aluminum recycling program with a claimed savings of $57 million (Sealey, 2002). However, by 2007 the Independent Budget Office (IBO) of the City of New York had a different opinion about the cost of recycling; the IBO recognized that the cost of shipping non-recyclable waste was steeply rising and would overcome any added costs for recycling (New York City Independent Budget Office, 2007). The additional costs come from the added labor required to sort recycling, something that would need to be accounted for in the ANF'S budget for recycling.

4.1.2 Loveland, Colorado

The City of Loveland, CO saved $40 per ton of waste that was diverted to recycling in 2004. Diversion will also save costs in the long run needed to establish and maintain additional landfills (City of Fort Collins, 2012). Though the ANF would not directly develop or administer new landfills; these costs would likely be passed on in the form of increased tipping fees (charges to dump waste at the landfill).

4.1.3 Three University Study

Cities are not perfect analogs to the ANF when considering waste problems, so it can be useful to consider universities, which also have highly concentrated populations and face problems with waste. Across three universities studied (University of Oregon, University of Colorado at Boulder, University of Nebraska-Lincoln), recycling cost a net $22-122 less per ton than waste disposal in 2009 (Jones, 2010). While none of these universities are in California and therefore do not allow a close comparison of the value of recyclables, the fact that all three spent less money by recycling is promising.

4.1.4 California

The average benefits for society as a whole are over $200 per ton more if the waste is diverted rather than disposed (Goldman and Ogishi, 2001). Beyond any benefits to the Forest itself, recycling in the ANF would positively impact the economy through job creation and pollution prevention. The net cost of recycling was less than landfill disposal when the landfill tipping fees were more than $35 per ton in large cities and $60 per ton in small ones (Goldman and Ogishi, 2001). The following table (Table 4.1a) includes the value of the recyclable items most common in the ANF'S waste stream according to the TMDL.

Table 4.1a: Market price for recyclable commodities in the Southwest U.S. as of 14 February 2012 (Source: Price Index Content Copyright 2012 by Recycling Data Management Corporation)

Commodity	$/ton ($/909 kg)
Amber glass	23.5
Flint glass	27.5
Green glass	5.5
Al Cans	62
Baled soft drink bottles	35.5

4.1.5 Price Volatility

There is variability in the market price of recyclables depending on the economy. For example, in early 2008, a West Coast market price for tin was $327/ton, but after the economic recession, that price fell to only $5. In many areas the market responded by demanding a fee to recycle certain categories of waste; managers generally accept such fees so long as they do not exceed the cost of trash disposal (Richtel and Galbraith, 2008). Prices of recyclables have been volatile and have not consistently followed a traceable pattern. When the economy fell in the 2008 recession, so did the values of various recyclables, but since then, the price of some recyclables have risen steadily, some have shot up and fallen back down, and some have oscillated (Fickes, 2010). Given the institutional nature of recycling, it is not always possible or reasonable to respond to the market by changing management practices. For this reason, consistent approaches with distant time horizons are advised; the more long-term investment, the less expensive it will be, regardless of volatility.

4.1.6 County of Santa Barbara

Jeff Simeon, Recycling Program Specialist for the County of Santa Barbara, provided insight on various ways to process recyclables and their relative costs. Mr. Simeon shared that the County of Santa Barbara employs a third party

company's Material Recovery Facility (MRF) to sort commingled recyclables for $70/ton and that company receives 10% of the sale price of the sorted material (pers. comm. Jeff Simeon, 2012). The County receives 90% of the value of the sorted and bailed material, though this is an unusual setup for many local governments. He also shared that many waste management companies collect and send recyclables directly to their own MRF.

Waste management companies that run collection trucks, landfills, and MRFs generally charge for municipal solid waste (MSW) but may collect recycling for free because they can sell it for a profit. There are also facilities known as dirty MRFs that receive mixed MSW and sort out the recyclables. Dirty MRFs tend to require a minimum percentage of recyclables, but if surpassed, they may allow disposal of the mixed waste for free; Jeff has never observed this with a dirty MRF, but it is possible if there is a large concentration of recyclable materials in the MSW (per. comm. Jeff Simeon, 2012).

4.1.7 ANF CRV potential

Through analysis of TMDL data, we were able to determine components of the ANF'S waste stream. Most notably, we established the potential weights of CRV recyclables from the San Gabriel Canyon based on the Forest's historical data. Applying the median percent compositions determined by analysis of the TMDL data, the ANF disposed of more than $4000 of CRV recyclables at the landfill. These weights and other results from the TMDL data discussed below may help the ANF make decisions about changing their current waste disposal methods.

Table 4.1b: Potential CRV from 2010. Weights of each recyclable were calculated as a proportion of the recorded dump tonnage. The proportions used were the median proportions of each type of recyclable as calculated from the TMDL data.

Recyclable Type	Aluminum Cans	Plastic Bottle <24oz	Plastic Bottle >24oz	Glass Bottles	Totals
Weight t (kg)	0.40 (363)	0.45 (408)	0.30 (272)	6.11 (5542)	9.04 (8201)
CRV ($)	1378	1049	719	1222	4368

4.1.8 ANF management

Currently, the ANF sends all of its collected waste to the LA County Landfill in Puente Hills at a cost of approximately $5,000-5,500 per year in tipping fees (pers. comm. Mike Hansen, 2012). As mentioned elsewhere in this report, the Forest is evaluating its practice of using Forest personnel and vehicles to haul waste. As this evaluation process progresses, Forest managers should consider all above options to inform their decision. For example, one price point could be where the potential revenue from CRV returns minus the associated labor equals the market value for a given commodity. If there is a dirty MRF in the area, and if the ANF'S waste stream meets their parameters, then money may be saved by avoiding MSW tipping fees and forfeiting recycling revenues.

4.3 TMDL Data

Prior to this project, understanding of the waste stream at the ANF was anecdotal, so the analysis of the TMDL data is a means of characterizing the composition of that waste stream and informing managers about potential waste diversion. We assumed that the composition of the TMDL data approximates that of the trash disposed in dumpsters and trashcans. This assumption allows managers to use these data to help them in their assessment of waste management options.

4.3.1 Litter Composition

The daily litter totals are not normally distributed; they lean slightly towards lower weights (Figure 3.4a). This indicates that though the amount of litter found in the East Fork TMDL survey sites tends to be less than 3733 lbs (1693 kg), there can occasionally be times when it is much greater. The spread of these totals is quite large, indicating that the amount of litter is rather variable (Table 3.4a). This variability is expected as the East Fork experiences periodic episodes of high use, such as summer or holiday weekends, which result in a number of high daily litter totals. Times with fewer visitors, such as winter, account for the lower end of the range.

CRV Recyclables and Items of Concern had similar spreads of weight (Figure 3.4b) while All Recyclables had a much wider range and higher median. This is most likely due to the fact that many items in All Recyclables, such as metal items and larger plastics, varied in size and could be much larger and heavier than CRV Recyclables and Items of Concern. These items appeared only occasionally and account for the high range of weights in this category. This wide range indicates that All Recyclables may not yield a consistently large amount of recyclable material, but some amount of material is usually found in the litter. The shorter range of CRV Recyclables and Items of Concern indicate that these types of litter are usually found in relatively consistent amounts.

This variability in All Recyclables was also reflected in its spread of percent compositions (Figure 3.4c). Both All Recyclables and Items of Concern had more variation in the top quarter of their compositions. This is most likely because these types of items were commonly found or very large, even when there was little litter, resulting in higher compositions of the daily litter total.

All three types of litter peaked at the lowest daily litter total range (Figure 3.4d). It seems that these types of litter are among the first to be produced. Even when there are few visitors, CRV Recyclables, All Recyclables, and Items of Concern are left in the river terrace. Their decline in composition indicates the

introduction of other types of waste as total litter increases. This finding is unsurprising as more visitors are more likely to produce a wider variety of litter types. This is especially true during peak visitation times as the supplies brought by visitors may begin to include toys, extra clothes, cooking utensils, and other items they deem necessary for a day of recreation.

The seasonal patterns also support the idea that both CRV and All Recyclables are among the first types of litter produced. Both of these types were at their highest composition in winter (Figure 3.4e), when there are the fewest visitors. As they are also present in the other seasons. Recyclables remain part of the litter composition year round.

4.3.2 CRV Recyclables

As total litter increased, the percent composition each type of CRV Recyclable decreased (Figure 3.4f). The seasonal flux of aluminum cans, plastic bottles, and glass bottles also followed the pattern of peaking in the winter and bottoming out in the summer (Figure 3.4g). Assuming that this is because these items are the first type of litter produced, these results are somewhat expected as other types of litter are likely heavier than these empty bottles and cans as the variety and total amount of litter increases. However, this decline in CRV recyclable composition is relatively small, meaning that the absolute weight of these items remains high. It is also important to note that the pronounced difference in percent composition between glass bottles and the other CRV compositions is due to the fact that glass bottles are simply heavier than the others, despite the fact that the counts of these items may be similar. These results show that there is a constant stream of CRV recyclables, which have the potential to generate revenue. Whether this is for the ANF or a disposal contractor depends on the how the ANF proceeds in their search for a possible waste contractor.

4.4 Using the Decision Support Tool to Assess Management Strategies

Recognizing that the decision support tool is only meant to help inform managers of how different recommendations are expected to compare to others, used alone, it should not dictate which actions or scenarios should be implemented. Additionally, as stated above, the tool does not incorporate a measure of effectiveness within each impact area. We did not use the tool to evaluate any recommendations that would require implementation by another authority.

4.4.1 Using the tool to create action scenarios

When looking solely at the tool's assessment of recommendation actions, a number of actions consistently ranked at the top of the list. The actions listed below did not always make the top 4 or 5 recommendations based on sorting, most likely due to their low input costs, but were consistently in the top 7.

(1) Setting stringent recycling criteria in any request for waste management contract bids is one of the cheapest activities to implement. This action, however, does not evaluate how this may increase bids submitted by potential contractors compared to less stringent recycling requirements.

(2) Establishing or strengthening a corps of volunteers who would act as outreach ambassadors while cleaning up trash in the East Fork is another low-cost measure that would address multiple areas of concern, and which scored high for all prioritizations we ran.

(3) Finally, utilizing Forest Service fire personnel to engage in outreach and maintenance of the recreation areas along the East Fork during the fire off-season also consistently ranked high among the actions when assessed by the tool. However, utilizing fire personnel is only feasible during the fire off-season, which coincides with visitor off-season. While they would still prove useful, they would be unavailable to assist in waste management or outreach efforts during peak visitor periods and therefore is expected to be less effective in addressing the waste problems in the area.

Using the tool to evaluate which actions would cost the least but have the greatest impacts, the Bren Group prioritized those actions with the fewest inputs required by the Forest. Interestingly, most of these actions had relatively low Impact scores, ranging from 0-2 with only one action scoring a 4. High Input scores indicate a relative low expected implementation cost. The Forest operates on a limited financial and labor budget, and must distribute resources wisely. Cost is a primary concern for any implementation action, but considering inputs alone does not necessarily result in a list of most effective recommendations to address the problem of waste. For example, none of the actions that received high Input scores was expected to reduce the overall volume of waste in the East Fork, a key goal in trash and litter management.

Examining actions by prioritizing the broadness of their impacts provides a different set of recommendations. None of our actions scored the maximum possible points of 5, but five actions scored 4 points each for Impact. The Input scores of these five actions ranged from a low of 5 to a high of 9. The actions that scored highest for Impacts reflect those actions that provide the broadest impact, though not necessarily the most effective impacts. Of the actions with the broadest impact, the outreach and trash cleanup volunteer corps scored highest for Inputs, and therefore is expected to cost less than the other high-impact actions to implement. We would then recommend that the Forest prioritize establishing or strengthening this type of volunteer corps, as it is anticipated to be relatively efficient (the volunteer corps scored within the top five actions when considering only the inputs). If the Forest is more concerned about the level of impact rather than the amount of inputs, it should also consider increasing and improving visitor displays and exhibits, increasing their enforcement of litter laws, and creating a public campaign to reduce waste.

Single actions will not be sufficient to address the waste and litter problems in the East Fork. Therefore, we used the decision support tool to assess the potential of various suites of actions. Using just the tool and the scores it produced for both Inputs and Impacts we provided a ranking of action

scenarios that would address all five of the Input categories. By ranking these suites of action by their average Input per action, we were able to determine which scenario would be expected to require the fewest inputs. This penalized those sets of actions containing more recommendations, which would result in higher total Input scores. The highest input score reflects the cheapest-per-action scenario, but does not necessarily reflect the scenario that provides the broadest impacts per action. Because of this, we also calculated the average impact per action, in order to assess whether the highest input scores truly reflected the best option, according to the tool, for the Forest.

This method provided us a way to prioritize sets of actions that would specify a comprehensive solution to addressing the factors we have identified as contributing to the problem of waste in the East Fork. The use of the tool provided an easy way to see how a set of actions would work together. Using the tool first resulted in some unexpected combinations of actions. Only one of the recommendations that the Forest Service has control over – as opposed to any suggestions related to road closures, which fall under the control of Los Angeles County – is expected to reduce overall waste from visitors. Therefore, this action is included in every action scenario when considering a comprehensive management option. Interestingly, the set of recommendations that scored the highest average Input score had the greatest number of actions, but the lowest average Impact score of all the comprehensive actions we considered. This suggests that this scenario, while requiring the least inputs, is not necessarily the optimal set of actions.

4.4.2 Applying the tool to potential action scenarios

In general only a limited number of actions will be considered at one time. These actions are likely to be presented in set combinations of action scenarios. Considering which of these scenarios will be the most effective for the least cost is important for decision-making. The tool can be used to help assess the value of each scenario in comparison to the others.

We compiled a set of five scenarios, each of which we believe would be effective in addressing the waste challenges in the East Fork. The scenarios are based on a variety of approaches, for example one considers immediate impacts, while another emphasizes outreach efforts. Running these scenarios through the tool provides a normalized comparison. That is, by utilizing the tool, the effects of biases are neutralized, and it becomes easier to compare scenarios. Though all scenarios were evaluated using the tool, adjustments were made for those with actions that require outside authority, as described in the methods.

Combination D has the highest average Input score (Table 3.6e), but also has a relatively high average Impact score, again indicating a good choice for Forest managers. However, one of the actions falls under the control of Los Angeles County, rather than the Forest. This means that the scenario may be difficult for the Forest to implement, because it would require coordination and cooperation with an outside authority. Additionally, reducing parking, as called for in the scenario, could reduce the revenue generated by the Forest Service Adventure Pass Program. This revenue directly funds amenities at the ANF, unlike other sources of revenue. Therefore, while reduced parking would result in fewer visitors and presumably less waste, it may not be in the best interest of the Forest for other reasons. At the moment the tool is unable to account for this.

Of the scenarios the Forest has complete control over, Combination B, focusing on public education is expected to cost the least.. . A similar, but more personal approach (Combination C), scores higher in average Impact, but is expected to cost more. Combination C focuses on volunteer-based, peer-to-peer outreach. This provides a personal connection to the Forest, and encourages stewardship by visitors

Depending on the available resources, preferred approach, and ability to coordinate efforts with outside parties, any of these combinations could be the best choice for Forest management. Once potential actions are identified, the tool can guide management towards a subset of actions appropriate the Forest's needs and abilities, as demonstrated above.

4.5 Recommendations for Management Strategies

There are two major aspects related to the problem of loose litter in the East Fork of the Angeles National Forest: improper disposal by the users of the recreation area, and the inability of the Forest staff to adequately maintain pace of trash management with visitor use. The management strategies we recommend are designed to address one or both of these issues, and ideally would be implemented in combinations that are both effective and feasible. The strategies are grouped into the several categories loosely based on the Impacts section of the tool.

4.5.1 Visibility of authority

Issue tickets to visitors who violate litter laws

Despite littering being illegal, the group did not encounter many references to litter-related ticketing. Forest Service personnel did note that unless they witness the visitor in the act of letting go of a piece of trash, a judge will throw out any ticket issued for littering (pers. comm. Mike Hansen, 2012). Additionally, the TMDL document identified a lack of anti-littering signage at the time the TMDL was established, so in the intervening ten years, the Bren Group concluded that enforcement of anti-littering laws has been challenging. Active ticketing of people who improperly dispose of trash could serve as a deterrent for visitors to litter. In addition to penalizing litterers directly through ticketing, it would serve to increase the visibility of Forest Service personnel in the area.

Increase visibility of Forest Service employees and volunteers through a structured program with distinct uniforms

While ideally the Forest would be able to have a full-time staff member present in the recreation area interacting with visitors, encouraging and educating them about the impact of improper waste disposal, we recognize the limited ability of the Forest to increase staff size or to provide full-time staff in the impacted areas. With this limitation in mind, we recommend strengthening

the volunteer program to allow volunteers to represent the Forest and fill in where the responsibilities of existing staff members pull them away from managing the waste situation in the East Fork.

To maximize the benefit of this program, we recommend appointing a single volunteer or intern as a Volunteer Coordinator who would be responsible for organizing shifts of volunteers on weekends and holidays to be present during prime recreation times, identified as between the hours of 8:30 am and 4:00 pm. These volunteers would have a uniform to identify them as representatives of the Forest. These uniforms could be the shirts already worn by volunteers at the interpretation centers, or more distinctive if necessary. In contrast to the volunteers that currently pick up litter in the East Fork recreation areas, these volunteers would also actively engage with visitors, acting as ambassadors for the Forest and educating them about the impacts of littering on the Forest and its recreation areas. These volunteers would be trained by the Forest in the issues related to waste, and must meet the following requirements: bilingual (primarily Spanish-English.), history of dedicated volunteer service to the Forest, completion of Forest training on waste problem in East Fork, and a set commitment to the program of specific hours per month.

4.5.2 Volume of Waste

Make better use of existing mascots to spread message of caring for the forest

Managing the amount of overall waste in the East Fork recreation areas comes down to two options: reduce the amount of potential waste brought into the canyon, or reduce the number of visitors using the recreation areas. Reducing the amount of waste produced is the most challenging goal, but can be achieved through education campaigns, public campaigns, and improved use of mascots. Partially through public education, Yellowstone was able to divert 75% of its 3,500 tons (3175 metric tonnes) of annual waste from the landfill in 2007 (Yellowstone Park Foundation, 2011).

These three approaches could be combined into a single public campaign to reduce waste. The Forest could set diversion goals and publicize these goals through the voice of Forest Service mascots, in both English and Spanish. The "Only You Can Prevent Forest Fires" campaign featuring Smokey Bear has been incredibly successful, and every schoolchild knows Smokey and how to prevent forest fires. Woodsy Owl is a pre-existing mascot that is less well known, but could be utilized if he was featured on more Forest Service materials and incorporated into educational campaigns in the same manner as Smokey. With the support of the National Forest Foundation, the Friends of the Angeles, and other partners, this educational campaign could be implemented, potentially with little cost to the Forest. To initially encourage participation, local schoolchildren can design a promotion logo that can be used to educate people about the Forest's diversion goals. With the incorporation of Forest Service mascots, Woodsy Owl and Smokey the Bear, a campaign that focuses on leaving less solid waste behind will be recognizable.

Issue tickets to visitors who violate parking laws

Another way to reduce overall volume of waste would be to reduce access to the recreation areas along the East Fork. The Forest has expressed their strong commitment to keeping the East Fork open to visitors because of the lack of opportunity to interact with nature in the surrounding communities, so closing the area entirely is not an option. However, the area is visited by anywhere between 8,000 and 12,000 visitors on a summer weekend, and the trash impact of these visitors is significant. Further limiting the ability of the Forest to reduce parking is the fact that East Fork road falls fully within the jurisdiction of Los Angeles County, which is responsible for managing parking, road closures, and anything that happens between the two shoulders.

To reduce, but not prevent, use of the area, we recommend the Forest coordinate with the County of Los Angeles to increase ticketing for parking violations. This would force visitors to remain in designated parking areas, and

allow the County and Forest to better manage where visitors park and how many people may use the area.

Reduce parking by installing more "No Parking" signs and reducing the size of vehicle turnouts

The Forest can also potentially partner with Los Angeles County and Caltrans to reduce parking options by designating more stretches of the road as "No Parking," and reducing the size of turnouts. Reducing the size of turnouts could be as simple as installing a barrier to prevent cars from using the entire area of the current turnout, preferably a barrier of boulders or some other natural-looking obstacle to maintain the look of the forest. Alternatively, the Forest could choose to increase developed recreation by placing picnic tables and trashcans in a section of the turnout, which would both reduce parking and help contain recreation to designated sections of the canyon.

Ban parking in the East Fork and establish a bus system for access to recreation areas

Additionally, the Forest, again in conjunction with Los Angeles County, has the option of closing all parking in the canyon and bussing visitors in to appropriate recreation sites. This would allow the Forest to have complete control over where people park and how many visitors may use the East Fork recreation sites. Further, it allows the Forest to direct visitors to preferred recreation areas. In this way, the Forest could bus visitors to one or two sites within the canyon per day, allowing staff adequate time to clean and prepare the other East Fork recreation areas between uses. This bussing service has the additional benefits of reducing the amount of items visitors are able to bring into the recreation areas to what they can carry rather than what fits in their car, limiting the amount of waste produced, and has potential as a revenue-generating venture, particularly if run by a concessionaire. A significant obstacle to this management action, however, is the method of recreation of visitors to

the East Fork. A bus would not allow them to bring their full-sized barbeque grill or recliners, as is currently the practice (pers. comm. Mike Hansen, 2012).

4.5.3 Combating improper disposal

The TMDL document contains recommended Best Management Practices that would help the Forest achieve the TMDL of zero trash in the river mentions a lack of proper signage in the area related to trash laws and anti-litter messages (California Regional Water Quality Board, 2000). The Forest has expressed to the Bren Group that their efforts to provide appropriate signage are often defeated by vandalism. The following story exemplifies the problem with signs in the area and was related to the Bren Group by a senior Forest manager. A new sign was installed at the beginning of a tour of the canyon for local authorities. A Forest staff member was tasked with checking on the sign every five minutes while the group continued along the tour. When the group returned to the sign, it was covered in graffiti, and the staff person who had been monitoring it reported the graffiti appeared within thirty minutes of the sign's installation (pers. comm. L'Tanga Watson, 2011). One of the Bren Group members was told that a sign in the Forest was intentionally knocked down by a visitor's truck (pers. comm. Forest Service personnel, 2011), and the entire Group saw a Forest Service sign covered in spray paint and lying in the bushes while on a site visit (pers. obs. Bren Group, 2011). Despite the potential value of forest signage, the frequent vandalism of signs in the East Fork makes installing more signs a questionable use of money and effort. Therefore, the Group has developed recommendations for providing sign information that would reduce the potential for vandalism.

Initially, the ANF should investigate alternate signage technologies. Winter et al. describe traditional signage in natural resource environments as primarily proscriptive signs, which tend to discourage negative conduct, although many interpretative staff believe that prescriptive signs, which encourage positive conduct can be more effective (Winter et al., 2000). Signs that are defined by Winter et al. as neither prescriptive nor proscriptive, but

descriptive in content, could possibly be less attractive to vandalize. Signage should be pictorial in nature, in order to reach visitors of various backgrounds. In addition, signs that are not stand alone, but incorporated into buildings, such as restroom facilities, would not necessarily stand out as a surface to be vandalized. Additionally, pathways leading to trashcans could be painted in parking lots or other surfaces. For example, at the far end of the East Fork, there is a large parking lot with few trashcans. If pathways were identified within the large parking lot that led to trashcans, visitors would not have to spend as much time searching for a trashcan and may leave less trash behind. Additional signage options can include:

- Suspending a sign between two trees along a cable;
- Using extremely tall poles to elevate signs, which can also be surrounded by native vegetation that discourages tampering (e.g. cacti);
- Posting the number for a graffiti hotline.

The Bren Group recommends three courses of action to deter vandalism along the East Fork recreation areas.:

Create graffiti task force to quickly address new incidents of vandalism

The first is the creation of a graffiti task force. This would be comprised of volunteers who live nearby and can respond quickly to reports of graffiti. This task force would be responsible for cleaning graffiti as soon as it is reported. The goal is to reduce the amount of time the graffiti is visible as much as possible. A small group of volunteers in Goleta, California has been doing this for 14 years, and claim to have reduced the attraction of the city for vandalism by removing the tags quickly and reducing the amount of time they remain visible (Santa Barbara Independent, 2011).

Install a speaker system in heavily used areas of the East Fork to play messages related to proper trash disposal

If a graffiti task force cannot be created or its efforts are not effective, we propose installing loud speakers in the areas. These speakers would be on top of sturdy poles and off the road to reduce the risk of being knocked down. The advantage of these speakers would be that even if they are covered in graffiti, they would still function, and broadcast the messages normally contained on signs. While there may be objections to this solution over the increased noise and disturbance of nature, we do not believe these speakers would create more of a noise impact than the large number of visitors in the area on high use days. These speakers could be set to a timer so they only play during peak visitation hours, further reducing their environmental impact.

Install video surveillance to discourage violations and allow for prosecution of serious offenders

Our final recommendation to deter vandalism is to install prominent video surveillance in the area. This could deter vandalism and other illegal behaviors, as well as potentially provide the Forest an opportunity to capture violations on film. Through video feeds, the Forest could potentially prosecute repeat offenders, as well as individuals who engage in illegal dumping. Illegal dumping results in large, difficult to remove, items being left in the river terrace, and create potential hazardous conditions. Examples of illegally dumped items recorded by the Forest include vehicle parts, machinery, and mattresses.

Install trashcans seasonally along the river terrace

Another impediment to proper waste disposal at the East Fork is the lack of ease in access to trashcans. While visitors are willing to haul their picnic and recreation supplies down to the river terrace, they are often unwilling to haul their waste along with their reusable supplies, back up the trail to their cars after a day of recreating. Without extensive educational outreach, this behavior is unlikely to change, so the Forest should instead focus on making it easier to use proper trash receptacles. In this effort, the Forest should install seasonal

trashcans in the river terrace where summer recreation occurs. Permanent installation is not feasible due to flooding and storm events, and wildlife considerations limit the options for the style of trash receptacles that are appropriate in the area. It is certainly more challenging to retrieve trash from bins that are away from roads, but if the Forest must already commit staff to going into these recreation areas to pick up litter, it would save them time and energy to provide appropriate trash bins in the most popular of these sites. These bins could be installed just prior to the Memorial Day holiday weekend in May, and removed following Labor Day in September. This would cover three major holidays (Memorial Day, Independence Day, and Labor Day), as well as the peak use months of June through August, and remove the bins well before they are threatened by storm events.

Re-install recycling bins

Further, re-installing recycling bins within the East Fork recreation area would increase the waste diversion potential of the ANF. Visible recycling bins in popular recreation areas also allow visitors to pre-sort the recyclables from the trash, which is currently done by Forest Service employees (when possible). Although recycling bins were removed from most areas of the Forest due to misuse (i.e. improper disposal of non-recyclable items), removal of the recycling bins can signal to the public that the Forest does not recycle. Visitors may also deposit waste into the recycling bin because the trashcan is full, though emptying the trashcans more frequently will alleviate the amount of trash deposited in the recycling bins.

In addition, the positioning of the recycling bin can also contribute to proper use of the recycling bins. In a discussion with Caltrans, the Bren Group was told that if the recycling bins are positioned near, but not directly next to the trashcans, the proportion of recyclables in the proper receptacle increases (pers. comm. CalTrans, 2012). For example, the recycling bin could be placed 3 feet (approx. 1 meter) away from the trashcan; this distance is not far to walk, but it

allows visitors the opportunity to decide which receptacle they will use. The ANF could incorporate alternate placement strategies and designs to increase the proportion of recyclables that are deposited into the recycling bin.

Install trash bag dispensers

To decrease the amount of litter left behind from visitors, trash bag dispensers could be installed in high use areas. In the past, visitors to the East Fork area were given trash bags upon entry into the recreation area. Now, the ANF can only hand out trash bags on busy weekends, and even then, only if the trash bags are donated. If the Forest installed trash bag dispensers, free trash bags would be available to the public, which they could then use to pack out their trash or bring it to a trashcan. Even if the bags are left near the trashcans on a busy weekend, less labor would be required of Forest Service employees to find, pick up, and then dispose of trash. Lastly, the Bren Group understands that there exists a high possibility that these bags will be used for purposes other than picking up trash; however, when the Forest has handed out bags in the past, at least some people have used them properly. If available trash bags reduce the amount of waste that is left behind by visitors, then that creates less work for the ANF and less litter left behind. These bags could potentially be donated to the ANF from local businesses.

Work with nearby fire stations to help with maintenance and outreach during the fire off-season

In general, partnerships could help the Forest achieve their management goal of reducing litter at the East Fork recreation areas. If the volunteer programs are deemed unfeasible due to a lack of participation, regulations that prohibit volunteers as representatives of the Forest, or inability to manage the program, the Forest should consider the option of utilizing the employees at the Rincon fire station. As Forest Service employees, they have the authority to represent the Forest in an official capacity. With the consolidation of the East

Fork, Crystal Lake, and Rincon stations (USDA, 2009), more employees will be in the area to supplement the Forest's efforts to maintain the East Fork recreation areas. When not busy with fire prevention or preparedness, Forest Service fire fighters often work on trail and recreation management (pers. comm. Forest Service firefighter, 2012). The efforts of ANF fire fighters in these areas could be used for visitor outreach, installation of trash bins, sign maintenance, and other management actions needed in the area. Particularly in regards to graffiti cleanup, these men and women can provide a quick response to reports of vandalism, being located just north of the East Fork turnoff. These activities would likely be most effective during the off-season, as fire season corresponds to the high season in East Fork, and should not be considered a complete or permanent solution.

Require recycling component in all bids for waste management contracts

The Forest is in the process of preparing to request bids from contractors for their waste management. Currently, the Forest collects all of the trash and transports it to the dump or recycling center itself. The cost effectiveness of this effort is being questioned in the face of having to purchase new trucks (pers. comm. L'Tanga Watson, 2011). To improve the diversion potential within the Forest, their bid request should have a recycling component for all easily recyclable materials. CalTrans rest stops have multiple recycling bins that accept paper, cans and most plastics (pers. comm. CalTrans landscape architect, 2012). The recycling program at Yellowstone National Park accepts all easily recycled items, but also maintains collection bins for unusual items and items unique to the park, such as bear spray cans. Further, Yellowstone increases its diversion rate by sending all trash collected to a composting center prior to arriving at a landfill. This diversion done entirely through contracts, and successfully reduced the amount of waste going to landfills from the park (pers comm. Yellowstone National Park Green Team, 2012).

Develop some or all of the East Fork to allow for concessionaire management of the area

The Forest should consider developing the East Fork recreation areas enough to bring in concessionaires. Once concessionaires are in place, they can be motivated to maintain sites through their contracts and the threat of their operations being shut down. A challenge with concessionaires is finding a way to attract them with potential business opportunities. These concessionaires could make money by selling supplies (dry clothes, towels, picnic supplies, snacks) or potentially charging for parking in these areas. This approach has proven successful in other National Forests, such as the Los Padres National Forest (pers. comm. Los Padres National Forest, 2012). In addition to handing responsibility for clean up to the concessionaires, this could reduce the amount of plastics in the area, as concessionaires could sell only biodegradable picnic supplies, as is done by concessionaires in Yellowstone National Park (pers. comm. Yellowstone National Park Green Team, 2012).

In summary, any of the following recommendations could reduce the waste problem at the East Fork of the Angeles National Forest, though combinations of these suggestions would likely be necessary to bring trash levels down to a more manageable level:

- Issue tickets to visitors who violate litter and parking laws
- Increase visibility of Forest Service employees and volunteers through a structured program with distinct uniforms
- Make better use of existing mascots to spread message of caring for the forest
- Partner with local groups to increase educational outreach
- Reduce parking by installing more “No Parking” signs and reducing the size of vehicle turnouts
- Ban parking in the East Fork and establish a bus system for access to recreation areas
- Create graffiti task force to quickly address new incidents of vandalism
- Install a speaker system in heavily used areas of the East Fork to play messages related to proper trash disposal

- Install video surveillance to discourage violations and allow for prosecution of serious offenders
- Install trash cans seasonally along the river terrace
- Re-install recycling bins
- Install trash bag dispensers
- Work with nearby fire stations to help with maintenance and outreach during the fire off-season
- Develop some or all of the East Fork to allow for concessionaire management of the area

4.6 Education

As discussed above, the educational opportunities available within the ANF can have a sizeable impact on visitor behavior. Currently, at any of the ANF'S visitor stations, Forest Service employees or volunteers provide information regarding the activities available in the area, directions, any safety warnings and maps or brochures of the region. Even though the visitor center staff has the opportunity to talk to the visitors about proper solid waste disposal, this may not happen. Because a conversation about trash may not occur, information about solid waste disposal should be prominently displayed throughout the visitor center complex. If the display is eye-catching and thought provoking, visitors may ask visitor center staff about the purpose of the display. Examples may include previously developed materials, such as photos of cars that have been damaged by bears trying to access food, or less well known campaigns such as California condors ingesting microtrash (small pieces of trash, usually smaller than a U.S. quarter). A detailed list of examples is included in Appendix II.

Displays can be set up in multiple ways to attract attention. They can be large, and placed in a prominent corner, in which case they must include sizeable, exciting photographs and tangible educational materials. For example, to educate the public on the hazards of microtrash to condors, place examples of microtrash that have been found in condors in a display box. Another example of an effective educational display could be placed on or near the counter within the visitor center. These displays could include more informational text because

many visitors intuitively go up to the counter to speak with visitor center employees. All displays should include information in Spanish and English.

To enhance educational outreach, the Forest should develop an educational tool in Spanish, which can be brought into the field. This tool should be comprised of a large flipchart similar in design to the EPA's agricultural worker's safety handbook (Appendix III). This tool should cover the following topics, in both English and Spanish: what happens to waste left behind, what to do with waste you produce during your visit, what trash cans/dumpsters look like and where to find them, how to use bear-proof cans, and should encourage recycling

A possible contributing reason that visitors leave trash behind when they leave the Forest is simply the land use designation as a National Forest, instead of a National Park. In a study by Linda Anderson in 1981, she asked visitors to rate scenic photographs based on their perceived beauty while including information about their land use designation (Anderson, 1981). Anderson noted that her results indicate that visitors compute both the landscape and land use designation into their rating of scenic beauty. Currently designated as a National Forest, the ANF could promote the scenic beauty of the Forest by initiating a public photo contest for visitors to participate in. The winning photos could be displayed on the Forest's website, within the visitor centers, or sent to the local media outlets for promotion of the Forest. The photos could also be promoted within the greater Los Angeles area in public gathering places.

In a 1980 study at Clemson University, the researchers found that trashcan design played a role in visitor litter disposal behavior (O'Neill et al., 1980). The study was conducted at college football games to determine if a festive trashcan designed for the occasion would receive more use than conventional trashcan in a similar high traffic area. Finding that the festive trashcan received over twice as much trash, the authors conclude that there is a stimulus involved in using the festive trashcan that is not afforded in the conventional trashcan. Similarly, the ANF may find that specially designed trashcans in the East Fork can influence people to deposit more trash in them

compared to traditional Forest trashcans. Again, getting the public involved increases general interest and gives surrounding communities a sense of ownership in the public lands. In this instance, the Forest could let high school art classes paint designs on prominent trashcans that reflect the students' views of the forest ecosystem, which could be updated and repainted annually.

Summary

The East Fork of the San Gabriel River is a highly visited area for many reasons and a popular attraction for visitors who are looking to escape the heat of urban Los Angeles and enjoy nature. In addition to the natural beauty of the canyon, the river is easily accessible from nearby highways. This ease of access encourages visitors to come to the ANF, even if the large numbers of visitors can easily overwhelm the recreation area on a typical summer Sunday afternoon. The biggest contributing factor to visitor behavior that results in high levels of litter is a poor public perception of the forest. Changing this perception will likely create the longest-lasting, greatest impact in reducing waste at the East Fork and throughout the Forest. Some employees of the ANF expressed concern that increased signage would not be effective at deterring improper solid waste disposal because it would be vandalized shortly after placement. Although this is a real concern, some direction for visitors in how to dispose of solid waste is necessary if visitors are expected to contribute to Forest cleanup. Just being aware of the rules is not enough to ensure compliance in a recreation area that frequently has thousands of users. In a complete educational program, the users should understand why there are certain rules in place regarding solid waste disposal. Forging the connections between the reason for regulations and consequences of not following established rules can yield to visitor compliance and a greater understanding and appreciation of the Forest from visitors.

Though the percent of litter that is easily recycled was low, when extrapolated out to the entire San Gabriel River Ranger District, we found an expected annual redemption value of $4400 (compared to $5165 in dump fees).

Expert opinion tells us this is conservative, as more CRV recyclables are likely found in the trash bins than left as litter.

We have provided the Angeles National Forest with a series of recommendations that can be implemented in the East Fork or other highly visited areas to combat excessive trash in natural areas. Recommended actions strive to target six different impact areas, such as visibility of authority and reduced volume of trash, that will address the waste problem in the East Fork. Using the decision support tool to compare the different recommendations against each other, Forest Service managers can prioritize these actions. The tool allows managers to visually and comprehensively assess how the different actions compare in terms of labor and cost inputs and benefits to the Forest.

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Appendix I

Figure Ia: Example of bear-proof trashcan lid in East Fork – San Gabriel River that some visitors to the Forest may not know how to operate. (Photo by Kirstina Barry)

Figure Ib: Decal on bear-proof trashcan lid near Icehouse Trailhead. Not all trashcans provide instructions on how to use the bear-proof lid. (Photo by Kirstina Barry)

Figure Ic: Example of disincentive to properly dispose of trash. Solid waste is clearly visible from the parking lot at the end of East Fork Canyon. (Photo by Kirstina Barry)

Appendix II

Suggestions for educational displays in visitor centers that can serve as an opportunity to engage visitors in a conversation about trash and litter.

- Statistics on the number of bears killed who are caught breaking into trash cans or cars to access food;
- The relationship between roadkill and leftover trash in popular recreation areas;
- The threat that microtrash poses to the endangered California condor, whose range is expanding to the ANF, in addition to other animals;
- Statistics on the amount of trash that the ANF hauls out every year. This information will most likely be presented in tons, but should be compared to an object with which most visitors would be familiar. An example could illustrate that the ANF hauls out an equivalent of (XX) number of school buses each year.
- The tons of trash disposed within the Forest each year in comparison to another recreation destination (e.g., a National Park);
- The Clean Water Act, and how the San Gabriel River is a listed waterway because of litter;
- The hazards that trash poses to visitors, employees of the Forest, and Forest Service firefighters, who may encounter hazardous materials, such as propane canisters that can explode under high heat conditions;
- Negative impacts of trash in the watershed as it relates to flooding and property damage;
- The life cycle of a recyclable item, such as an aluminum can, in comparison to a piece of plastic that is landfilled;
- How the rivers move trash to the ocean, which can then get caught up in the Great Pacific Gyre, or the Great Pacific Garbage Patch.

Appendix III

This Appendix will be part of the future Online Appendix of this report.

http://www.epa.gov/oppfead1/Publications/catalog/

Project website:

http://bren.ucsb.edu/~angeles

Direct link to online appendix:

https://sites.google.com/site/brenangeles/report-appendices