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# Cleaning Up East Potomac Park

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# Cleaning up East Potomac Park



## Abstract

East Potomac Park is suffering from a trash problem originating from river debris, fishermen, picnickers, and illegal dumping. In this project conducted with the National Park Service, we investigated the causes, impacts and approaches to the trash problem. We interviewed NPS staff, conducted a site assessment of the park, and reviewed literature on visitor behavior and waste management approaches to compare various infrastructural, informational, educational, and enforcement practices of parks in and around D.C. Based on this research, we created recommendations for the implementation of new approaches and created deliverables to supplement them: maps of proposed locations for more trash bins and fishing line containers; anti-littering signage created using the theory of planned behavior, and an education program local teachers can use to increase students' awareness of the impacts of trash.

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B term, December 13, 2018

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# WPI

According to a study conducted by the National Parks Conservation Association (NPCA) and Subaru, over 300 million people visit National Park Service (NPS) parks every year and they generate more than 100 million pounds of trash. The national parks should be preserved for the enjoyment of visitors; however, the growing trash problem has a negative impact, and not just on visitors. Trash in national parks endangers wildlife, impairs the visitor experience, and increases the cost of maintenance. The volume of trash in the national parks is closely related to the number of visitors, and visitation has been growing steadily at 20% per year over the last decade. Unfortunately, the ability of the NPS to address the trash problem has been hampered by stagnant or declining agency budgets resulting in decreases in staffing. As a result, the NPS is trying a variety of approaches in different parks to reduce the trash problem.

Hains Point and East Potomac Park are administered by the NPS as part of the National Mall and Memorial Parks (NAMA) and suffer similar problems with trash, as shown in Figure 1. NAMA has identified four types of trash problems in East Potomac Park:

- fishing line discarded by anglers
- visitor trash at picnic areas
- dumping of household items, such as car batteries and furniture
- debris that washes into the park from river flooding.

The overall goal of this project was to recommend improved strategies for NAMA to address these trash problems. In order to accom-

plish this goal, we:

- Evaluated trash problems and management practices at other parks.
- Characterized trash problems and management practices at East Potomac Park.
- Identify factors that affect littering behavior and visitor awareness.

Over a period of 14 weeks, we conducted literature reviews, site assessments, and semi-structured interviews. We began by completing extensive online research on this trash problem. We then evaluated the trash situation and current management practices in East Potomac Park through site assessments and interviews. We gathered information on other parks by conducting interviews with a range of NPS staff. We recorded this information for comparison purposes in order to identify the advantages and disadvantages of East Potomac Park's current practices and used this information to better inform our final recommendations.



*Figure 1. Overflowing trash can in East Potomac Park*

## Understanding the causes and consequences of trash

This section discusses the nature of the trash problem in the national parks. The three main causes of the trash problem within national parks are decreasing staff and budgets, increasing visitation, and visitor behavior. The trash problem has negative impacts on visitor experience, wildlife populations and park maintenance budgets. The NPS supports research on visitor awareness and behavior regarding trash problems to develop strategies to reduce the problem, and we review some of that research here. We have identified four approaches that the NPS uses to deal with the trash problem; infrastructural, informational, educational and enforcement. Following our summary of the research on trash problems and management in the parks in general, we focus more specifically on the trash problems in East Potomac Park.

### Trash in national parks

As previously noted, the amount of trash in national parks is significant and growing. Yellowstone National Park has one of the largest trash problems in the NPS system. With over 4 million annual visitors (Uhler, 1995), the amount of waste produced by Yellowstone in 2011 was more than 9.2 million pounds, accounting for 9.2% of the total amount of waste brought into national parks by visitors (Solid Waste Diversion, 2011). To address this problem, Yellowstone National Park employs a solid waste diversion project that splits the waste into landfill, recycling, and compost. This project has

diverted 73% of solid waste away from landfills. Figure 2 below shows the percentages of waste in each category for the year 2011.

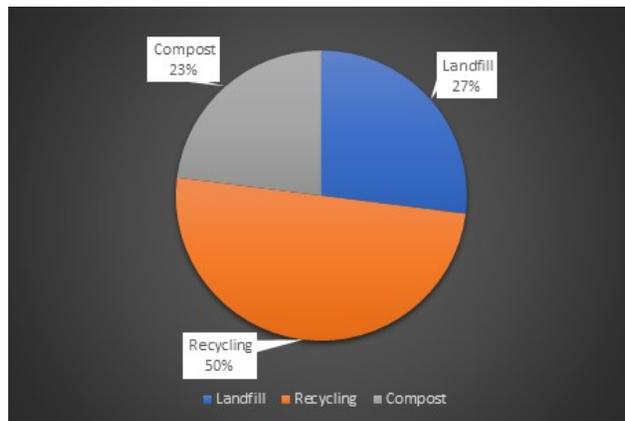


Figure 2. Proportion of Yellowstone National Park's waste sent to landfill or diverted via composting or recycling (adapted from Solid Waste Diversion, 2011)

## The cause of trash problems in national parks

Trash problems within national parks are becoming more severe due to an increase in visitation, a decrease in staffing and budgets, and visitor behavior and lack of awareness. The maintenance budget of the NPS decreased by almost 75% from 2009 to 2014 (Figure 3). Further exacerbating the problem, trash disposal costs have risen by \$70 per ton from 1998 to 2014 (Figure 3). Declining budgets and rising costs have forced the NPS to delay needed maintenance. Thus, de-

ferred maintenance estimates have increased from \$9 billion in 2006 to \$12 billion in 2014 (Figure 3). By 2017, the backlog of deferred maintenance had climbed to \$11.6 billion (Comay, 2018).

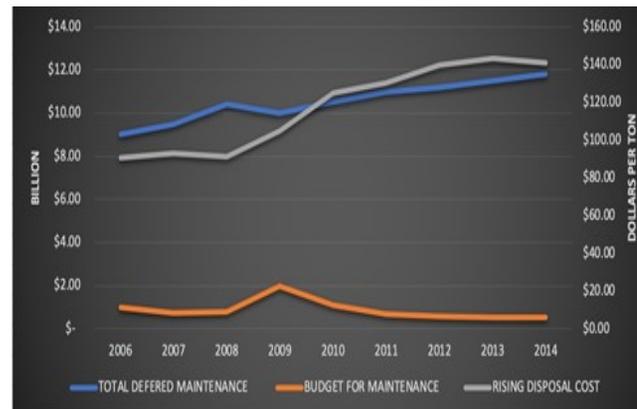


Figure 3. Budget for maintenance, total deferred maintenance and rising disposal cost (adapted from Regen 2018 and Rosengren 2016)

Visitation in the national parks has increased by 19% over the last 6 years from 279 million in 2011 to 331 million in 2017 (Bachmann 2018). Even though increasing visitation requires an increase in staffing to accommodate the increased park usage, full-time NPS staffing decreased by 11%, from 22,211 in 2011 to 19,539 in 2017 (Figure 4). Staffing was decreased due to the budget cuts mentioned above. One NPS superintendent was forced to cut his maintenance staff by half to adapt to the new budget (Taylor, E&E News, 2016).

Visitor behavior and a lack of awareness is another factor exacerbating the trash problem in parks. A study by Schultz, Bator, Large, Bruni and Tabanico (2013) found that both individual

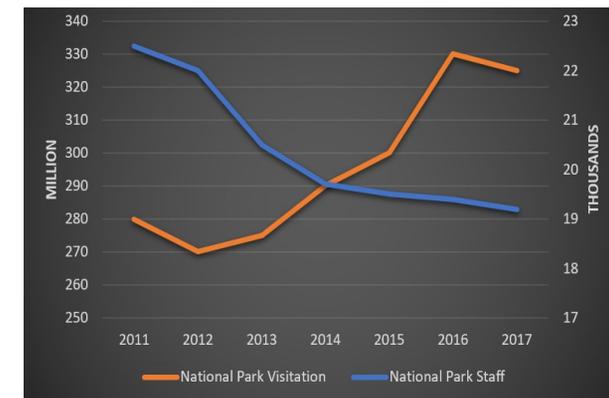


Figure 4. The budget crunch of America's national parks (adapted from Bachmann 2018)

and contextual factors may correlate with littering behavior. Individual factors include age, gender, and if the observed participant is in a group or alone. Observations of almost 9,000 people showed that age and gender were the only two significant predictors of littering, with males being more likely to litter than females and younger individuals being more likely to litter than older individuals. Two contextual factors, distance to a trash receptacle and the amount of existing litter, affected littering rates. The researchers found that littering rates were higher when there were no receptacles provided and that for every trash bin added, littering rates decreased by 1%. They also found that when trash receptacles were 0 to 20 feet apart, 12% of the observed people littered, which increased linearly as the distance increased from 21 to 60 feet. Once the trash receptacles were 61 feet or more apart, that number increased to 30%. Littering rates also increase when the amount of existing litter is high. The observers rated the amount of existing litter at the site on a

scale of 0-10. The results showed that for every number increase on the scale, the observed littering rate increased by 2% (Schultz, et al. 2013). This research suggests that to lower littering rates, parks should remove existing litter regularly and provide convenient and accessible means for proper disposal as a way to influence visitor behavior.

In a study conducted in 2008 by OpinionWorks for the Alice Ferguson Foundation (Opinions about Trash Research in the Potomac River Watershed, 2008), many respondents agreed that the main reasons people littered were laziness and inconvenience. Holding onto small pieces of daily trash like gum wrappers, empty plastic bottles and cigarette butts until finding a trash bin can be inconvenient, and many just drop the trash on the ground. Respondents had a variety of excuses for their littering behavior, such as thinking their chances of getting caught were low, thinking they were justified to have others pick up their litter since they pay taxes, and thinking that their littering was acceptable because the trash they left behind was food waste that would decompose naturally. The respondents did not consider the consequences of their littering. One respondent commented that “when you litter you don’t ever think of it as having that big of an impact,” (Opinions about Trash, 2008), such as potentially injuring others or contaminating the watershed. This suggests that appealing to moral norms is an important factor when trying to change people’s littering behavior. The respondents also agreed that they do not litter in their own cars, houses, backyards and water they swim in. This shows people value their own self-interests and properties (Opinions about Trash, 2008).

According to Lawhon and Taff (2018), the writers of the executive summary of the study conducted by Subaru in partnership with the NPS, 74% of visitors properly dispose their waste into trash and recycling receptacles, with respondents strongly disagreeing with the statement that recycling bins are useless, inconvenient, or confusing. They also found two important factors when analyzing visitor behavior. First, visitors who knew about the waste management within the park prior to their visit were more likely to dispose of their trash properly. Second, visitors who looked at or saw signage were more likely to dispose of their trash properly. These paired results suggest that both signage on site and online information are important when it comes to improving visitor behavior. Their research suggested that better signage design would include: using messages that state how easy it is to dispose of trash, using messages that play on moral norms and give visitors a sense of responsibility, and using positive messages, e.g., “By properly recycling in Denali, you are helping to preserve this park,” (Lawhon and Taff, 2018). Some suggestions they made beyond signage included that national parks can use vendors/concessions to educate visitors about the proper trash and recycling and raise visitor awareness about the locations of recycling/trash infrastructure. In conclusion, this summary suggested that perceived difficulty, moral norms, and Zero Landfill Initiative awareness are the three main influences determining visitor littering behavior.

## *Impacts of trash in the national parks*

Whether it is because of a lack of visitor awareness, or the difficulty of proper waste management, trash has become a serious problem in parks. Proper waste management involves removing litter left behind by park users and regular pickup of trash from designated bins. Many parks struggle with waste management due to staffing and budgetary limitations. This increase in trash and the impediments to proper disposal have adverse effects on visitor experience, wildlife populations, and park budgets.

The quality of the visitor experience is based upon many factors, including the activities available (e.g., park programs) and the appearance and cleanliness of the park and its facilities (e.g., trails, buildings, bathrooms). In a study conducted by Lawal M. Marafa (2010), some of the biggest complaints among park users were about park resources and hygienic conditions of the park. A park's overall aesthetic can become very unappealing when it is filled with trash. When a park is aesthetically pleasing, individuals are motivated to be better stewards of the land by treating it with greater respect and having a sense of pride for the area (Blanchfield, Culjak, Ní Lochlainn, Gilleece, Zhao, Thomas, Lucey & Mansary, 2015).

Poor waste management affects wildlife populations. Trash can be mistaken for food by wildlife and is detrimental to the overall health of the ecosystem. Human-generated waste is a primary food source for many urban wildlife,

including foxes, skunks, and raccoons. Only 40% of an urban fox's diet is something other than scavenged food. However, the scavenged food is not always a food item. Sometimes the objects the animals eat are plastic or rubber bands, which can cause serious injury or death. The provision of human-generated waste only further attracts urban wildlife closer to humans and makes them become more comfortable around humans, as they associate human smells with food. This creates a threat to human health as they are carriers for diseases such as rabies (Bateman and Fleming, 2012).

Discarded fishing line can be a problem at many parks, including East Potomac Park. A study by Dau, Gilardi, Gulland, Higgins, Holcomb, Leger, and Ziccardi (2009) looked at the medical records at several wildlife rehabilitation facilities in California in order to determine how many animals sustained an injury due to fishing gear, specifically injuries relating to fishing line and hook entanglement and the digestion of lead fishing weights. They reviewed 9,668 individual cases from 2001 to 2006 of injuries to pelicans, gulls and pinnipeds in the California area and found that 1,090 of them (11.3%) were sustained from fishing gear related items. They described one cruel injury where there was "a hook embedded in the oral cavity of a gull with associated line entangling the wing, such that the wing was tightly bound to the head and neck, preventing the animal from flying or foraging for food" (Dau et al., 2009). Overall, 32.3% of pelican cases, 11.5% of gull cases and 2.8% of pinniped cases were the result of a fishing-gear related injury.

Park budgets are also affected by an increase in trash and littering. The litter left by park

visitors around the park grounds is costlier to clean up than trash placed in designated bins (Blanchfield et. al, 2015). Litter can block drainage sites after flooding occurs, and repair can be costly. In order to clean up trash and litter left behind by visitors, parks often must add more bins, empty the bins in the park more frequently, or hire contractors to pick up trash and litter from the ground, all of which use funds that could be better spent elsewhere in the park system (Blanchfield et. al, 2015).

### **Four types of trash management approaches used in national parks**

The NPS has taken four approaches – infrastructural, informational, educational and enforcement – to address the trash problem. Traditionally, a national park's waste management system involves the provision of trash and recycling receptacles (an example of an infrastructural approach) and signage (an informational approach) to encourage visitors to use them. However, these approaches do not always work, and park officials are forced to warn or fine offending visitors (an enforcement approach), especially with regard to dumping of waste items and hazardous materials. Below, we discuss common strategies within each of these approaches in more detail.

#### **Infrastructural-oriented approaches**

Traditionally, infrastructural-oriented approaches focus on providing trash (and sometimes recycling) bins throughout the national parks. These bins can take on many forms, including standard bins, wildlife-proof bins, and smart bins. Standard bins are designed to withstand damage from visitors and inclement weather.

er. However, standard bins are not well suited for keeping wildlife out and it is not easy for maintenance crews to know when the bin needs emptying unless it is visibly overflowing. Because of this, new types of trash bins have been developed (Buyer's Guide for Trash Receptacles, 2017)

Wildlife-proof bins serve the purpose of keeping wildlife out of the trash. This is beneficial to the health of animals, humans, and the environment. Not allowing animals to get into trash bins lowers both the amount of trash strewn about from the bins and the overall cost of maintenance. Often, wildlife-proof trash bins are made of stainless steel, have a heavy or self-latching lid, and are secured upright in some way. The material of construction helps to ensure that no animals can get through or create holes in the bins. The lid design keeps animals from getting in through the opening while still allowing a place for visitors to throw away their refuse. Securing the trash bins prevents them from being easily tipped over by wildlife attempting to eat the trash (Sinclair, 1995).

Bigbelly bins are smart trash bins invented by Big Belly Solar in Needham, MA. They have been adopted in many cities, parks, waterfronts and universities. The highest capacity bins can contain up to 150 gallons of trash, five times the capacity of regular trash bins of the same size. Bigbelly bins are entirely enclosed, making them animal proof and preventing leaking and odors. A sensor in each bin monitors the trash level and sends notifications to the maintenance crews, alerting them to collect the trash. This reduces the number of trips the maintenance crews need to take to monitor and empty the trash bins. The bins also prevent trash from overflowing; as noted above, overflowing trash tends to encourage

people to litter further. There are five different configurations of the bin for different waste streams: Trash, Single Stream Recycling, Bottles & Cans Recycling, Paper Recycling, and Compost/Organics (Smart Solutions for Cities, n.d.). Even with these advantages, one serious disadvantage is price: each bin costs \$4000, one reason that the Bigbelly bins have not been implemented in many areas (Culgin, 2013). Figure 5 shows the three types of trash bins.



Figure 5. The different types of trash bins available to the national parks (Keep Me Wild: Wildlife-proof Products, n.d.; Paris 34 Gal. Black Steel Outdoor Trash Can with Steel Lid and Plastic Liner-461-304-0006, n.d.; Smart Solutions for Cities, n.d.)

Some NPS parks are transitioning to new infrastructural removal practices. These practices mainly focus on the “Trash Free Park” or “Trash In, Trash Out” concepts that involve removing trash receptacles from an entire park or sections of a park, as shown in Figure 6 (Trash Free Park, George Washington Memorial Parkway, Frequently Asked Questions Fact Sheet, 2013). Visitors are expected to carry out the garbage they generate and dispose of it outside the

park. This concept aims to reduce the amount of litter in the park, encourages visitors to recycle at their homes, and allows the NPS to use the money spent on trash collection elsewhere more effectively (Trash Free Park, n.d.). Integral to this concept is encouraging all visitors to become partners in maintaining the parks. This concept has been implemented in ten areas in and around George Washington Memorial Parkway.



Figure 6. Trash free sign (Williamson 2013)

Another practice is implementing recycling and composting through programs like the Zero Landfill Initiative (ZLI). In 2004, Subaru of Indiana Automotive became the first company to achieve Zero Landfill Status in America and subsequently decided to help other organizations to do the same. They began partnering with the NPS for ZLI programs within national parks starting in 2015. Working with three test cases (Grand Teton, Denali, Yosemite), their objective was to use “Subaru's expertise to identify, test, and promote practices that reduce the amount of trash the NPS sends to landfills” (Zero Landfill Initiative, 2018). Through the ZLI, these three parks completed a waste characterization study,

developed a composting pilot program and adapted new recycling infrastructure throughout the parks. This infrastructure included 500 home recycling bins for NPS employees, public recycling bins for the NPS and concessionaires, universal Recycle Across America labeling on recycling bins and retrofitted recycling bins with safer openings to limit wildlife impacts (Zero Landfill Initiative, 2018). Figure 7 shows how the ZLI has increased the amount of waste diverted in each park.

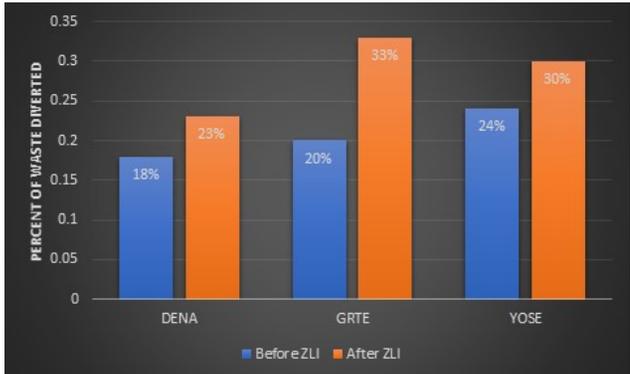


Figure 7. Waste diversion rate in the three ZLI national parks before and after the ZLI began (adapted from Lawhon and Taff, 2018)

**Informational-oriented approaches**

Informational-oriented approaches go hand-in-hand with infrastructural approaches and mainly focus on using visual reminders to encourage visitors to dispose of waste and recyclables properly and to protect national park environments. The NPS places signs on proper trash and recycling habits at key locations throughout the national parks. In 2018, the NPS adopted a new standardized labeling system

from Recycle Across America (n.d.) in Yosemite National Park, Grand Teton National Park and Denali National Park and Preserve to avoid confusion at recycling bins. It is supported from the donations by Subaru of America and Recycle Across America (RAA) which aim to use RAA's standardized recycling label system, as seen in Figure 8, to help visitors recycle easily and effectively.



Figure 8. RAA standard label system trash bins (Recycle Across America, Standardized Recycling Labels, n.d.)

Another informational approach involves trying to develop more effective signage to change visitor littering behavior in national parks. Brown, Ham, and Hughes (2010) have suggested that any strategy should be informed by an understanding of the target audience's perceptions about the target behavior. In a study in Mt. Field National Park, Tasmania, researchers used the theory of planned behavior (TPB) to design persuasive signage that was evaluated for its impact on visitor behavior. Research on the TPB has identified three primary types of cognitive beliefs that determine behavioral decisions. These are behavioral beliefs (i.e., a visitor's attitude towards

a behavior), normative beliefs (i.e., a visitor's normative pressure to perform or not perform a behavior), and control beliefs (i.e., a visitor's belief that he/she has the ability to perform a behavior). These principles were used to redesign more effective signage, as seen in Figure 9. The text highlighted in yellow corresponds to the control belief, the text in red corresponds to the normative belief, and the text in blue corresponds to the behavioral belief. This is contrasted by the standard park sign on the right, which is a simple command that visitors are likely to ignore. Visitors exposed to the sign on the left showed a 15% - 20% increase in litter pickup compared with a control group that did not observe the sign. These changes can reduce cost of litter collection, reduce detrimental impacts on wildlife and improve overall park aesthetic (Brown, Ham, Hughes, 2010).



Figure 9. Example of persuasive messaging to change park visitor behavior (Brown, Ham, Hughes 2010), and a standard park sign (Recycle Reminders, n.d.)

### Educational-oriented approaches

Educational-oriented approaches also

build on infrastructural approaches but go further and reinforce them. These educational efforts mainly focus on building partnerships with local schools and nonprofit nature protection organizations to create different educational programs and activities in national parks. The NPS is currently working with the Student Conservation Association and other youth organizations to offer opportunities for educating children in national parks to raise their awareness of trash problems. Other programs include Web-Rangers, an online cartoon game to help visitors familiarize themselves with national parks' regulations and policies, and Leave No Trace, which was developed to help educate and guide recreationists in sustainable minimum impact practices that mitigate or avoid recreation-related impacts (Leave No Trace in Every Park, n.d.). The Leave No Trace Center annually sends out surveys to land managers to get their opinions on the effectiveness of the program. One finding from the 2016 survey was that 72.8% of respondents thought the Leave No Trace program played an important role in reducing their trash problems.

According to the study by Schultz et al. (2013), younger people are more likely to litter than older people. This finding indicates the significance of educating youth on littering habits. Alice Ferguson Foundation (AFF) is an education-based foundation in the D.C. area, with a goal of connecting people to the natural spaces that they live around through education. AFF has partnered with many area schools and has provided students with curriculum opportunities to study nature. It has also partnered with the NPS to use national park land for field studies supported through their curricula. Talkin' Trash is one curriculum from the Bridging the Watershed program under AFF.

Teachers can sign up for this curriculum on their website, and go observe, collect, weigh and assess the trash and recyclables at various parks (Talkin' Trash, n.d.). Trash Free Schools is another program offered by the AFF where all the students in a school pledge to reduce school waste and recycle properly (Trash Free School, n.d.). Programs like Talkin' Trash and Trash Free Schools hope to prepare and inform students now, in order to shape and define their actions and awareness on littering in the future.

### Enforcement-oriented approaches

Enforcement-oriented approaches establish and enforce laws and policies. For instance, the NPS has its own law enforcement ranger team knowledgeable of the park system and regulations within the park at the local, state and federal levels. They are trained in basic law enforcement, and emergency operations. Most importantly, they patrol park grounds, enforcing rules and regulations and protecting park resources (How to Become a Park Ranger Law Enforcement Officer, n.d.). The United States Park Police also functions as a unit of the NPS with jurisdiction in all federal parks, but primarily located in the Washington, D.C., San Francisco, and New York City areas (United States Park Police, 2018). The U.S. Park Police are tasked with protecting the nation's parks and national monuments. They, unlike the park rangers, have the right to arrest and issue fines to park visitors according to federal and city regulations, such as giving a \$100 fine for littering.

### Trash problems at East Potomac Park

Created in 1933, National Mall and

Memorial Parks (NAMA) division of the NPS has control over 1000 acres of land in Washington D.C. including numerous memorials, monuments, and public spaces. NAMA attracts roughly 24 million visitors every year (Frequently Asked Questions, 2015), with visitation increasing during special events. Our project concerns East Potomac Park, with our main area of concern being the managed grass areas and lines of trees along the main road around the perimeter of the park, as outlined in red in Figure 10, and Hains Point, the picnic area near the southern tip of the park, as circled in blue. People can reserve the picnic areas there, and it is a common to see people fishing, running and biking. There are no areas of natural or wild vegetation in the park. See Supplemental Materials, B for more details about NAMA and East Potomac Park.

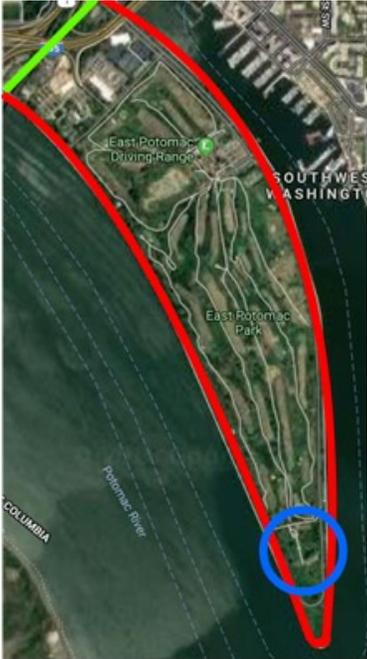


Figure 10. Study area of East Potomac Park

The NPS has a four-part problem when it comes to trash at East Potomac Park. Anglers fish along the perimeter seawall of the park and leave behind their supplies, including unused bait, empty containers, broken fishing rods, and leftover fishing line. Fishing line can have a significant negative impact on wildlife, causing injury or death to various animals (Blanchfield et al, 2015; Dau et al., 2009). NAMA has implemented monofilament containers for the fisherman to dispose of their fishing line properly, as seen in Figure 11, but they have not been very effective so far since many visitors use them for other trash, and discarded fishing line does not always make its way into the containers. During flooding, trash also floats in from the river and gets caught along the shoreline. This secondhand trash is outside of the park's control but negatively impacts the park aesthetic and puts further strain on the maintenance budget.



Figure 11. Fishing line container at East Potomac Park (Fishing , 2018)

The other types of trash at East Potomac Park include trash from picnickers and from illegal dumping, as seen in Figure 12. East Potomac Park has four picnic areas that visitors can reserve for \$90.00 (Hains Point Picnic Area, n.d.). Visitors are supposed to take all their trash home with them, but park staff were recently forced to put trash bins in when visitors did not follow that rule. Finally, East Potomac Park has a problem where people will come to the park to illegally dump their unwanted furniture, television sets, and other items rather than pay to get rid of it at the local dump.



Figure 12. Trash near the perimeter seawall of East Potomac Park

The NPS has problems with trash in parks across the United States. East Potomac Park, as part of the NPS, also suffers from these trash problems. However, there is little information on the scope of this problem, its causes, and the practices that might be used to combat it in this setting. In what follows, we outline the methods we used to investigate the trash problem at East Potomac Park and to learn what other parks are doing with their trash.

## Methods and Results

In order to complete our project objectives, we used a variety of methods, including literature reviews and interviews. The methods associated with each of our objectives are shown in Figure 13.

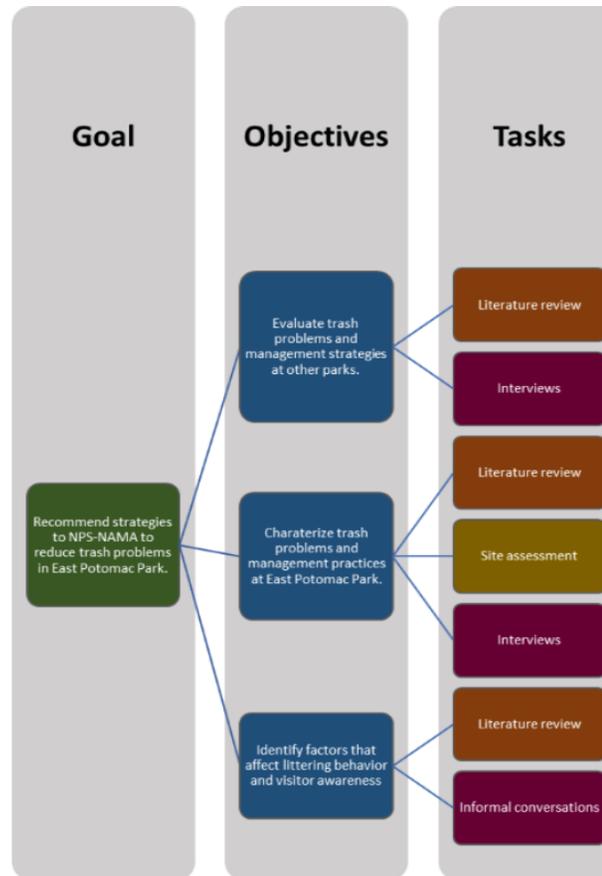


Figure 13. Methods used to address each objective.

## Objective 1: Evaluate trash problems and management practices at other parks

Our background research revealed that many parks suffer from trash problems and have implemented different policies and practices to alleviate these problems (with varying levels of success). To supplement our initial literature review, we conducted semi-structured interviews with key stakeholders of parks in and around the D.C. area that are managed by the NPS, including Rock Creek Park (ROCR), Anacostia Park, and C&O Canal National Historical Park. Our interviewees included Don Kirk (facilities manager, ROCR), Robert Mocko (environmental compliance/protection specialist, National Capital Parks – East), Arielle Conti (Stewardship Manager, Rock Creek Conservancy) and John Maleri (Program Manager, Rock Creek Conservancy), Kathryn Tyler (Volunteer Coordinator, ROCR) and Nick Solomon (Youth and Volunteer Program Coordinator, ROCR), Heather Zdobysz (Program Manager of Education, Alice Ferguson Foundation), and Rita Knox (Park Ranger, C&O Canal National Historical Park).

We developed a snowball sample by asking interviewees to recommend other potential interviewees. We gained consent for each interview and explained the purpose of our interview in a preamble at the beginning of the interview (Supplemental Materials, C). We asked for and gained consent to record every interview in addition to taking notes. Upon completion of our final report, we gave the interviewee the right to review before publication. Interview questions for

each interviewee can be found in Supplemental Materials, D.

### Insights on infrastructural approaches

From our interviews with Don Kirk and Robert Mocko, we learned about other NPS staff's management approaches. Robert Mocko told us that Anacostia Park, which is managed by NACE, provides trash bins that maintenance crews empty, but they rely on volunteers to complete a lot of the pickup from river debris (personal communication, October 31<sup>st</sup>, 2018). Don Kirk said ROCR is so large that they rely on NPS maintenance crews, outside contractors, and volunteers to manage waste in the park (personal communication, November 15<sup>th</sup>, 2018). The park is divided into different sites that are managed by one or more of these groups. For example, the contractors are in charge of removing trash from the bins and from the ground in Georgetown Waterfront Park every day. Another example of site management is Meridian Hill Park, where trash removal is conducted by in-house maintenance staff. However, during the busier months in the summer, there is a joint effort between maintenance staff and contractors. The trash bins are emptied twice a day by the contractors on weekends and once or twice during the week. He said the park staff still does the majority of the work even when volunteers are used. The maintenance staff usually goes out three times a week to empty bins, but it can vary. He says he is happy with the cur-

rent park maintenance by all groups. He also told us that ROCR uses wildlife-proof Rubbermaid™ trash bins in some of their locations and does not have recycling bins throughout the park. Unfortunately, the Rubbermaid bins can be difficult to use if trash becomes lodged in the chute mechanism or if they are full, the chute will not open easily. As a result, visitors often leave their trash on top of the bin rather than putting it inside.

We also gathered different perspectives from Don Kirk, Robert Mocko and Rita Knox on trash free park program and their opinions on the effectiveness of what they had implemented in their parks as well as others. Robert Mocko had never considered “trash in-trash out” for NACE parks since he heard that the policy did not work well in Great Falls Park, Virginia, but he thought it could have been more effective if the change in policy had been appropriately communicated to visitors. Mr. Mocko thinks education and outreach is very important in order to improve visitor's awareness about littering impacts and park practices, but Anacostia Park does not have any signage. Don Kirk told us that he also tried to remove trash bins in ROCR because emptying the trash bins is a significant effort for maintenance staff, but similar to Great Falls Park, it did not work well. ROCR did not implement any signage about the policy and the trash bins were replaced after a significant amount of trash was left around the picnic areas after weekends. However, the C&O Canal Park, a trash free park since 1999, successfully implemented the policy. The success was largely in part due to the installation of 130 trash bag dispensers and 60 to 75 signs informing visitors of

the policy. According to Rita Knox, C&O Canal National Historical Park reduced 75% trash in August of 1999, the same year they implemented their trash free park program. Although she was not able to provide us the statistics on the percentage after 1999, she said the amount of trash has remained at this reduced level throughout the years.

### Insights on volunteer programs

We've learned that volunteer efforts are a big part of ROCR's trash management strategy and have been working effectively. We learned more about these volunteer groups, including the SOLVE program at ROCR, from our review of the literature and our interview with Kathryn Tyler and Nick Solomon, volunteer coordinators at ROCR (personal communication, November 7<sup>th</sup>, 2018). SOLVE stands for “Sustaining Our Lands with Volunteer Energy.” Each SOLVE site is partnered with ROCR and creates an agreement with the park with a list of tasks that the group agrees to do for their specific site. Every agreement specifies two tasks: picking up trash and reporting hazards. Each group of SOLVE volunteers focus on cleaning up at their site rather than focusing on trash throughout the park as a whole. These sites often include volunteers from the surrounding residential neighborhoods and communities. The proximity of the park to these neighborhoods gives the volunteers a sense of ownership in the park, which motivates them to give back and serve the park. Many of the SOLVE groups met at an event and

expressed interest to the park in forming a partnership, rather than the park trying to reach out to them. ROCR and the SOLVE program have such an abundance of volunteers that they do not have enough staff to supervise each site. Currently, there are 15 SOLVE groups, ranging in size, and only some have formal agreements. However, there is a quarterly site assessment and annual renewal/modification process for every site/agreement.

We spoke to Arielle Conti and John Maleri at the Rock Creek Conservancy, which is one of the partners in the SOLVE program. The Rock Creek Conservancy aims to protect the Rock Creek watershed. Protecting the watershed includes protecting the water quality, which is easily affected by trash in the water. So, as a part of their SOLVE program, Rock Creek Conservancy recruits volunteers to participate in their ‘Stream Team Initiative.’ This initiative organizes volunteers to clean up the entirety of ROCR at least twice a year. They have up to 5,000 volunteers for this program every year. Besides the semi-annual stream cleanups, the Rock Creek Conservancy organizes other events in the park once or twice a week. These are mainly cleanups led by their 75 Stream Team leaders.

From our interview with Heather Zdobysz, the program manager of education at the Alice Ferguson Foundation, we learned the Alice Ferguson Foundation is another resource for parks to use volunteers. Their trash free initia-

tive has partnered with Rock Creek Conservancy and C&O Canal Park to complete the Potomac Watershed Cleanup. The cleanup is conducted by volunteers annually in the month of April. In 2018, the volunteers cleaned up over 300 sites and over one million pounds of trash.

### Insights on educational approaches

From our interview with Heather Zdobysz and from our online literature review, we learned that the Alice Ferguson Foundation has an educational program in schools called “Talkin’ Trash.” The program is geared towards high school students but is also run with younger students once or twice a year. The Alice Ferguson Foundation partners with the NPS to use the parks and monuments to complete the program. Typically, it is run along the Potomac side of Ohio Drive in East Potomac Park. Heather said the students usually pick up 20-30 bags each time the program is run. The bags include trash and recycling which the students separate and weigh to determine the amounts of plastic and other recyclables. The stu-

dents also complete a “trash timeline” by sorting items in the order they think they will decompose. The activity gives students a perspective on how long the litter leaves an impact on the environment. Figure 14 shows a summary of our key findings for our first objective.

### Objective 2: Characterize the trash problems and management practices at East Potomac Park

Our goal with our second objective was to better identify the key problems with trash in East Potomac Park and the approaches currently in place to address them. We used direct observation and interviews with NPS staff to gather this information.

We conducted a site assessment during our first week in D.C. to gather more specific information about the trash problem at East Potomac Park. We recorded the general locations and types of trash observed and the number, condition and location of trash bins and fishing line con-

Key Findings from Other Parks
<ul style="list-style-type: none"> <li>• Most parks we observed use a combination of volunteers, in-house staff and contractors.</li> <li>• Wildlife-proof bins do their job effectively but visitors do not always use them correctly.</li> <li>• Trash in/trash out policies have had mixed results across NPS parks. Providing visitors with trash bags is potentially an important factor for their successful implementation.</li> <li>• Rock Creek Park has a unique way of organizing its volunteers: organizations partner in a SOLVE agreement with the park to pick up trash, report hazards, and perform various other tasks to keep a specific site/area of the park clean.</li> <li>• Few parks have informational signage about disposing of trash or recycling properly.</li> </ul>

Figure 14. Key findings for our first objective

tainers within the park. Our study area including the waterfront areas of East Potomac Park, as highlighted in red, and the picnic and parking areas at Hains Point, as circled in blue in Figure 15. The golf course that covers most of the area of the peninsula is leased from the NPS and was not part of our study area because the NPS is not responsible for trash management in this area. We recorded this information on a map of the park on our first day of observation. We wanted to conduct more of an observational study, and we went out into the park seven times in an eleven-day span from early morning to midafternoon, however we did not gather much more useful information past our first day.



Figure 15. Study area of East Potomac Park

We conducted semi-structured interviews with staff at NAMA to better understand how staff characterize the nature of the problem and the current trash management practices in East Potomac Park. Interviewees included James Pierce (Volunteer Coordinator) and Jacklyn Meyer (Community Volunteer Ambassador), Jeffrey Hitchcock (Environmental Compliance Program Manager), Jeffrey Gowen (Chief of Facilities Management), Jennifer Rudnick (Education Specialist), and Officer Conn (US Park Police Officer, District 1), as well as our sponsor liaisons, Leslie Frattaroli (Natural Resources Program Manager) and April Newman (Environmental Compliance Program Manager). We sought oral consent for the interviews and explained both the purpose of our research and the respondents right to review our final report before publication (Supplemental Materials, C). Interview questions for each interviewee can be found in Supplemental Materials, D.

From our site assessment of East Potomac Park during the first week, we found a couple of key facts about the park. Our sponsor liaisons provided a map of the locations of the trash bins and monofilament containers within the park because we wanted to confirm those locations. All six of the monofilament container locations that we observed were consistent with the locations provided to us by our sponsor, as shown in Figure 16. We noticed, however, that the containers were simple white PVC piping mounted directly on a white fence, which made them difficult to see, especially from the road and the parking bays.

The map indicated that there were 34 trash bins along the perimeter of the park. We observed only 31 bins around the perimeter, lo-

cated with an average of 380 feet apart from each other. We found that two bins were missing from the northern end of the park and one missing down near the southern end, as marked with red X's in Figure 17 below. We also found an additional six bins within the picnic area, although the sign at the entrance to the picnic area (Figure 18) indicated the park policy was "carry in, carry out" at that location. We also noticed that the trash bins throughout the park have both a wire outer frame and a plastic inner can, allowing trash to get trapped between the two containers and making removal more difficult, as confirmed by our interview with Jeffrey Hitchcock. As a cost cutting measure, the park does not use plastic trash bags, but this also inhibits easy removal. As a result of these issues, many of the trash bins were quite dirty, which could attract more wildlife and eventually necessitates their replacement. We found no recycling bins anywhere in the park.

Finally, the amount of trash we observed on the ground in the southern half of the park was not as much as we expected. This may be partly because of the season, as there are fewer visitors in the fall and winter months. However, there are not many trash bins in the northern part of the park, and that was where we saw the majority of the trash. In particular, we saw one 30-foot square that had 15 individual pieces of trash. We saw a variety of things, such as many illegal beer bottles, a great deal of plastic bags and wrappers, aluminum cans, and some strands of fishing line that did not make their way into a monofilament container. The trash bins were certainly being used, with most of them at least halfway full, but there were still plenty of small

pieces of trash in the grass both near and away from the bins. We also saw a couple of larger objects we think were dumped by visitors, such as large plastic parts north of the Hains Point entrance, some wooden planks near parking bays 4, 6 and 7, and a computer tower at parking bay 24. Our key finding however, was that further south, in the area of the park with more trash bins, we saw little trash other than small wrappers and bottle caps on the grass between the road and seawall.



Figure 16. Monofilament container locations in East Potomac Park

Our first interview was with Jeffrey Hitchcock, an environmental compliance program manager at NAMA. Our sponsor liaisons had previously informed us about a proposal in place for East Potomac Park to replace their current trash bins with wildlife-proof bins. Mr. Hitchcock thinks those bins will create a vast difference in the park because there are so many animals (racoons, rats, birds, etc.) that dig into the bins for food and distribute the trash over the ground around the bins. He also explained the waste management process in East Potomac Park. They currently have only two trucks and two certified drivers to collect the trash in and around the trash bins. They complete this process three times per



Figure 17. Trash bin locations in East Potomac Park

day. However, they have some newly purchased trucks on the way. They also have approval to hire more staff but are waiting for Human Resources to begin the process. Specifically, they are hoping to hire a third driver in order to go back to three routes so the drivers can go back to trash removal areas more often, which could reduce the amount of trash pulled from the bins by animals or any overflow issues. Mr. Hitchcock also told us that the trash on the ground is supposed to be picked up by the landscaping company contracted by the park to mow, mulch, etc., but they have not been meeting the stipulations of the contract. The park service is withholding payment until these issues are addressed. Finally, he told us that while the signs encourage carry in/carry out, they need the trash bins in the picnic area or else the trash becomes unbearable. Like ROCR, they previously tried to remove the trash bins, but this resulted in large amounts of trash being left around the picnic area after every weekend.



Figure 18. Sign in Hains Point picnic area

We talked to James Pierce and Jacklyn Meyer, volunteer coordinators at NAMA, about

the volunteer groups in East Potomac Park. They clarified that members of the Youth Conservation Corp empty the six monofilament containers. They suggested that most volunteers are unwilling to walk the entire park perimeter to empty these containers, but the members of the YCC are paid and therefore required to take on this task. The entire area under NAMA’s jurisdiction (which includes the National Mall and monuments) attracted 4500 volunteers in 2017. Mr. Pierce and Ms. Meyer were very interested in starting a volunteer group to pick up trash/litter from East Potomac Park and thought they would be able to recruit numerous volunteers for such activities on a regular basis. We initially thought that volunteers were not allowed to pick up trash in East Potomac Park at all, but Ms. Meyer was able to get us specific information about volun-

teer projects run in the park over the past four years, as seen in Table 1, and we learned that three volunteer groups picked up trash this year. Jeffrey Gowen, the chief of facilities maintenance at NAMA was more skeptical about the prospect of using volunteers. He stated that while it would not breach the landscaping contract for volunteers to pick up trash in contracted areas, he did not think it was a good idea to place the role of litter removal solely on volunteers. He also explained they had removed so many trash bins from the park to reduce route times and man hours. He also strongly believed that fewer trash bins means less litter, however this position conflicts with many of our findings from the literature review and other interviews.

We spoke to Jennifer Epstein, the education specialist at NAMA to get a better understanding of the educational programs offered by NAMA. Most educational programs she runs focus on history, not park cleanliness or littering. She said she would be willing to distribute a new trash-based program for the schools if we created one for her because understaffing is a big challenge for her and she does not have time to create one on her own. She said because she receives a large number of requests to talk to students and she is only one person, she cannot do as much of a variety of programs as she’d like. She said it can be difficult to develop a program for many students that will keep them engaged and entertained, as well as follow the D.C. common core standards.

Project Year	Maintenance on the Golf Course	Picking up River Debris	Picking up Trash	Suckering Cherry Trees	Painting	Tree Removal	Picking up Fishing Line	TOTAL
2015	1	4	1	1				7 Projects 350 Volunteers
2016		2		3				5 Projects 80 Volunteers
2017					1	1		2 projects 106 Volunteers
2018		1	3				1 plus, the Youth Conservation Corps	5 projects 66 Volunteers
TOTAL	1	7	4	4	1	1	1	

Table 1. The types of volunteer projects in East Potomac Park in the past four years

Finally, we talked to Officer Conn with the U.S. Park Police to get an understanding of the enforcement practices at East Potomac Park. He explained that police officers open and close the gates at East Potomac Park and monitor the park for suspicious behavior. They have the authority to fine people for various infractions including littering (Figure 19), but rarely if ever issue citations since they have other priorities and are unlikely to catch anyone in the act. He noted that park rangers may give warnings and educate visitors or call the park police, but they do not have any authority to impose fines or other sanctions. However, there are no rangers in East Potomac Park. Figure 20 shows a summary of our key findings for our second objective.

		DC
Failure to use refuse receptacle (littering)	2.14(a)(1)	100
Failure to use refuse receptacle (dumping)	2.14(a)(1)	150
Using receptacles for private use	2.14(a)(2)	200
Depositing refuse in toilet facility	2.14(a)(3)	125
Draining refuse from trailer or vehicle	2.14(a)(4)	125
Bathing, washing food or clothing at public water outlet	2.14(a)(5)	75
Polluting water	2.14(a)(6)	500
Improper disposing of fish remains	2.14(a)(7)	50
Disposing of human body waste in developed area (UIP)	2.14(a)(8)	100
Disposing of human body waste in undeveloped area (UIP)	2.14(a)(9)	75
Violating conditions for disposal of body waste	2.14(b)	100

Figure 19. Violations that US Park Police officers will give fines for

### Objective 3: Identify factors that affect littering behavior and visitor awareness

Our third objective focused on identifying possible reasons why visitors are littering in parks. Originally, our plan was to conduct surveys and focus groups with park visitors to evaluate awareness, attitudes, and behaviors. However, we were unable to do so because Office of Management and Budget and NPS approval for such surveys and focus groups would take far longer than our appointed project timeline. We also

planned to observe visitors in the park but found there are very few at this time of year. Instead, this objective was accomplished through literature reviews about littering behavior in general and through informal ad hoc conversations with fishermen at East Potomac Park.

As noted in the background section of this report, our review of the literature revealed that visitors' littering behaviors are affected by individual and contextual factors. We also found that developing persuasive signage using the principles from the theory of planned behavior can influence visitor littering behavior in national parks.

Key Findings from East Potomac Park	
<ul style="list-style-type: none"> <li>Fishing line containers are difficult to see from the road because they are white on a white fence.</li> <li>The park is missing three trash bins from the map in figure 16 and has an additional six trash bins in the picnic area that were not on the map.</li> <li>The current trash bins have an inefficient design. They have both a wire outer frame and a plastic inner can, allowing trash to get trapped between the two containers.</li> <li>During our site assessment, we found the most trash is in the northern part of the park, where there are currently no trash bins.</li> <li>The sign in the picnic area has some elements from the theory of planned behavior referenced in our literature review, however they needed to put trash bins back into the area after they originally removed them.</li> <li>There is a conflict between providing more bins to reduce the trash in the park and having enough staff and money to manage the bins because they had previously removed 100 trash bins from the park and they currently only have two trash truck drivers.</li> <li>There were four trash pick-up projects run in East Potomac Park in 2018, contradicting our initial understanding that volunteers were not allowed to pick up trash in the park because of the landscaping contract.</li> <li>NAMA's education specialist would be willing to distribute an education program to teachers/schools about trash in the national parks.</li> <li>U.S. Park Police officers rarely issue fines for littering and dumping because it can be difficult to catch people in the act.</li> </ul>	

Figure 20. Key findings for our second objective

The monofilament containers are provided for the convenient disposal of used fishing line. We learned from Leslie Frattaroli and April Newman that visitors to the park will often dump their trash into these containers as well, even though the containers have a red label that clearly says “No Trash” in both English and Spanish. From our informal conversations with eight fishermen at East Potomac Park, we found that six of them did not know that there are fishing line containers provided in East Potomac Park. One reason they mentioned is the lack of information. Not only were they unaware that monofilament containers were provided, when they did see them in the park, they did not know what they were used for because of the lack of informational signage on the container. Another reason we found is the irregular locations of fishing line containers. We often saw fishermen congregating in the northern part of the park, as shown highlighted in red in Figure 21, where there are not any fishing line containers available. The fishermen we spoke to suggested that a map of fishing line container locations would be useful for their visits to the park, and the ones who had seen the containers said they did not notice or read the labels on them. One fisherman recommended a redesign of the opening of the container, making it a funnel shape rather than the current elbow shape, as people might not want to reach into the container. However, as long as the containers are being used properly and only have fishing line in them and not regular trash, we do not think this is a major concern.

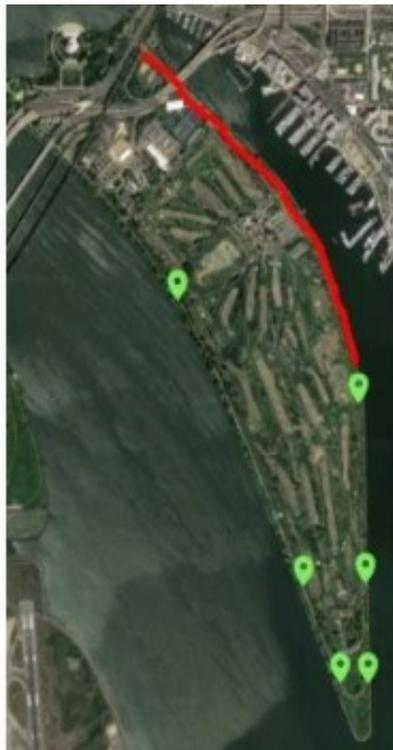


Figure 21. Observed fishermen locations compared to fishing line container locations

## Deliverables and Recommendations

We came into this project with the goal of recommending strategies to NPS-NAMA to help reduce the trash problems in East Potomac Park. Through our literature reviews, site assessment, and interviews, we developed recommendations with accompanying deliverables to help NPS-NAMA get started on their implementation.

From our literature review, we found that providing trash bins closer together reduced littering rates. There is currently a proposal to replace all the current bins with wildlife-proof bins. This will definitely be of help to the park but does not address the problem of distance between the bins. Therefore, in addition to the replacement of bins, we recommend they add additional wildlife-proof bins to lessen the distance between them. While the research suggests that bins placed closer than 60 feet reduce littering, this would amount to almost 300 trash bins for the 3-mile perimeter of the park. This creates concerns regarding budget and operating costs. Not only would it be costly to acquire the additional bins, it would raise the cost for the emptying of the bins, as the maintenance crews would have to spend more time on their routes. Keeping these limitations in mind, **we recommend they provide additional bins in the key areas where the trash accumulates.** These areas are marked on the map below (Figure 22) and **include the northern part of the park where there are currently no trash bins, and the parking bays where there is currently an average of one bin per bay.** We suggest the park monitors the results of the additional bins and adjusts their spacing, locations, and frequency of pickup as needed.

Following this same idea, we created a map of proposed fishing line container locations. We found from our informal conversations with fishermen that the places they often fish are well dispersed from the current locations of the fishing line containers. Therefore, **we propose that East Potomac Park provides 12 additional**

**fishing line containers to supplement the six they currently have**, with more fishing line containers along the perimeter of the park before the start of the one-way road, which is the area we identified that fishermen often congregate. However, we recognize that we have visited in the slower months for visitation and that more fisher-



Figure 22. Map of recommended locations to add trash bins

men may be located along the perimeter around Hains Point, so **we recommend a more uniform distribution of the additional fishing line containers along this area** as well, and that the park monitors the results of these additional containers and adjusts their spacing, locations, and frequency of pickup as needed. The proposed fishing line container map is located below in Figure 23.

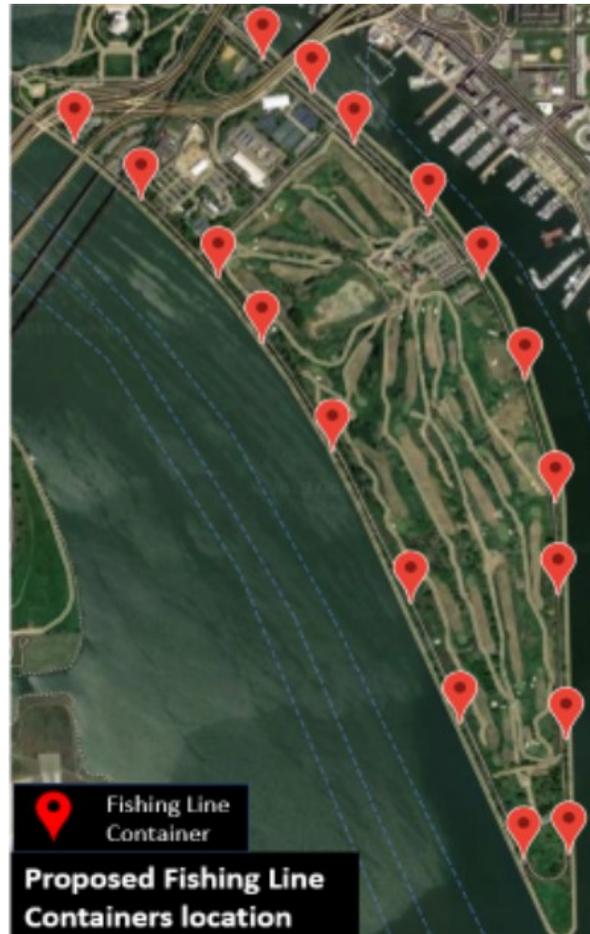


Figure 23. Map of proposed fishing line containers

In addition to providing more fishing line containers in the park, the NPS should also consider a new design for all of them. Our conversations with fishermen alerted us that many of them were unaware of what the containers were for and where they were located. **The new design could be as simple as recoloring them, putting a new label on them with a picture of monofilament fishing line and much larger text**, and potentially making them smaller, as they are white containers on a white fence and hard to notice. While making them smaller would make them harder to notice, they would be a brighter color and a smaller container attracts less trash. If the containers stay attached to the fence, then informational signs could go on the fence next to them. **Another route would be to change their location, moving them to the other side of the walkway on a pole.** We understand that this is less likely because of the increase in cost and potentially lengthy approval process it would require, however this would significantly improve their visibility.

Independent of the chosen solution, **we have developed an example of informational signage that can be provided with the containers.** We suggest this signage is provided in both English and Spanish. This signage focuses on educating fishermen on the use of the containers and their locations around the park. It was created based on our literature review findings on the theory of planned behavior. Using a similar strategy to the study conducted in Russell Falls Park, the signage (Figure 24) targets the three belief systems identified by the study. The text boxed in blue targets the normative belief by appealing to

an individual's pressure to perform a behavior. By emphasizing that the task can save animals, the text implies that doing nothing will harm animals, putting pressure on people reading the sign to dispose of their fishing line properly. The text boxed in orange targets the control belief by addressing the individual's ability to perform an action. By stating that the containers are located around the park, the text points out the accessibility of the containers and that it is a simple action to perform. An unmarked example of the sign can be found in Supplemental Materials, E.

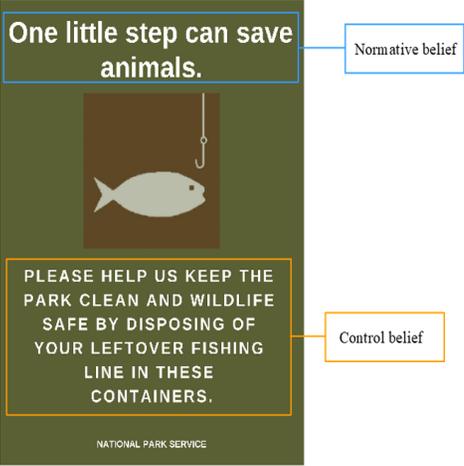


Figure 24. Proposed signage to be provided with the monofilament containers

Although signage can be somewhat obtrusive in a natural environment, and many signs can be ineffective, we identified a study in our literature review that tested signs using the theory of planned behavior, and the signs effectively reduced littering by 15-20%. Following similar steps as this study, **we developed signage for**

**East Potomac Park that can be placed periodically around the park in areas in or around trash bins and picnic tables to influence visitor littering behavior**, as seen in Figure 25.

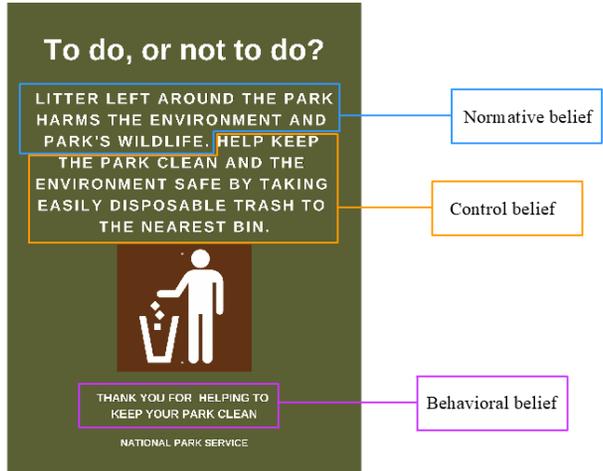


Figure 25. Proposed signage to affect littering behavior

This sign was also developed to target the three belief systems mentioned above. The text boxed in blue targets the normative belief by appealing to an individual's pressure to perform in a similar way as mentioned previously. The sign directly addresses the fact that litter harms wildlife, and that failure to act will contribute to this. The text boxed in orange targets the control belief by again addressing an individual's ability to perform an action. By stating that the individual should take any easily disposable trash, the sign addresses that while some trash may be out of reach or too filthy to be picked up, any help they can give is appreciated. The text boxed in purple targets the behavioral belief by appealing to an individual's attitude

towards the behavior. By thanking the visitor for helping, the sign reinforces the behavior by acknowledging the good nature of the action and sends a positive message to the reader, hopefully influencing their behavior on trash pickup in the future positively. An unmarked example of the sign can be found in Supplemental Materials, E.

We identified another way to influence visitor littering behavior: through educational programs regarding trash. Therefore, **we recommend that East Potomac Park and NPS-NAMA distribute an educational program that we created for middle school students that includes a visit to the park to increase awareness of the problem and create a sense of pride in keeping East Potomac Park clean.**

This lesson plan was created using a similar structure to a program that the Alice Ferguson Foundation runs in other parks in the D.C. area and is geared towards middle school aged children following the D.C. common core standard "MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment." The standard defines method designing as "examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact," so we developed the lesson plan to include a pre-visit discussion of the impacts of trash and ways to reduce these impacts, an observational visit to the park to identify and assess what they've previously discussed, and a post-visit summarization to analyze their findings. Along with the lesson plan, we have also compiled a small list of references for the teach-

ers to use to further develop the lesson plans. The lesson plan provides sample questions that the teacher/program instructor can ask the students, as well as instructions for what the students will do while they are visiting the park. Figure 24 is an example of the tasks that students will complete during their visit to East Potomac Park. The hands-on learning provided by the visit to the park will allow the students to think more critically about the impacts trash has and what parks and visitors can do to reduce them. This will help them write the summary we recommend they complete in the post-visit on their experience in the park and what they plan to do to reduce their impact. The summary will be sent back to the park to give students a chance to provide feedback based on their findings. The full lesson plan can be found on the next two pages, with sample answer keys within Supplemental Materials, F.

Based on our interviews with Jennifer Epstein and Jeffrey Hitchcock, we have learned that some areas of management are understaffed. Jennifer Epstein said it is difficult for her to keep up with the requests she receives to run educational programs. She said if she had more staffing, she would be able to accommodate more schools/classes and run a different variety of programs. Jeffrey Hitchcock also mentioned understaffing as a problem in the maintenance department. Currently, they only have two licensed truck drivers to complete the trash route every day. This makes it difficult to keep up with the volume of trash in the entirety of NAMA, especially in the busier months in the spring and summer. **We recom-**

**mend further study into this problem to determine how much extra staff would help address some of these problems, and they hire appropriately based on their findings.**

The understaffing in the maintenance department can also be supplemented by volunteer groups in the parks. While the litter pickup around the park is designated to the contractors, we believe it would be beneficial to have volunteer groups complete litter pick up as well. Currently, the contractors are being withheld pay because their quality of work does not meet the requirements specified in their contract. We received concerns about volunteers not being committed enough to do a daily clean up job, however we also received clarification that having volunteers pick up litter is not a breach of the contractor agreement. Based on this information, **we recommend that the volunteer coordinators develop a weekly volunteer group to complete trash pickup.** The volunteer groups would supplement the work the contractors and maintenance workers do to keep the park clean and could be done on Mondays after weekends, because that is when we have learned the most trash is left behind, especially in the busier months. This

program could be adapted to be run more often in the busier months if necessary. A weekly volunteer group would also help to create a sense of pride and ownership in the park and would help by picking up trash and river debris.



# A Detailed Lesson Plan in Environmental Science (Middle School, Grades 6-8)

## “Trash Rangers”

### Objectives

At the end of the lesson, students will be able to:

1. Recognize the impacts that litter has on wildlife and the environment
2. Identify ways to reduce littering and its impacts
3. State whether the observed park employs any of the strategies they identified to be useful

### Subject Matter

Cause and Effect Relationship

### Reference/s:

**Materials:** Visual aids

**Value Focus:** Develop a knowledge of the impacts they have on their environment

### Procedure A. Pre-visit

Teacher's Tasks	Students' Tasks
<p><i>Introduce that trash is a problem for wildlife and the environment.</i></p> <p><i>Create a cause and effect board to fill out as the students answer the following questions:</i></p> <ul style="list-style-type: none"> <li>• What are the impacts of trash on wildlife? Are they good or bad? Why?</li> <li>• What are the impacts of trash on the environment (soil, water, air, plants)? Are they good or bad? Why?</li> <li>• What are the impacts of trash on humans? Are they good or bad? Why?</li> <li>• What types of trash do you think are common in the park? What kind of impacts could they have on the park?</li> <li>• What could happen if these problems continue?</li> </ul> <p><i>Create a board to fill out as the students answer the following question:</i></p> <ul style="list-style-type: none"> <li>• What do the students think can be done to reduce littering and its impacts? Why do they think that will help?</li> </ul> <p><i>Create an observation table using the topics identified in the discussion. (sample provided below)</i></p>	<p><i>Give thoughtful responses with explanations into why they chose those impacts</i></p> <p><i>Give thoughtful responses with explanations into why they think it will be helpful</i></p>

### B. Visit

Teacher's Tasks	Student's Tasks
<p><i>Split the park into sections (shown in the example below) and divide the students into teams to complete data collection in those sections</i></p> <p><i>Encourage students to think about the impacts the trash has while they are collecting it</i> Especially regarding the impacts different types of trash can have</p>	<p><i>Observe the type, amount, and location of trash in their section by completing the observation table (provided below)</i></p> <p><i>Observe any immediate impacts of trash in their section (i.e. Wildlife in/around the cans, soil degradation)</i></p> <p><i>Observe any strategies the park employs in attempt to reduce littering (i.e. signs, trash bins, etc.)</i></p>

### C. Post Visit

Teacher's Tasks	Student's Tasks
<p><i>Discuss each team's observations as a class and document the findings from each section. Compare each section's findings to find similarities/differences in trash problems for the park. Have the students verbally answer the following questions:</i></p> <p>Based on our observations, what do you think is the worst problem for the park? Why? What kind of impacts does this specific problem have on the park?</p> <p>What do you think causes the difference in trash problems? Why? Is it a difference in management in certain areas?</p> <p>How much trash was there? How much of it was recyclable? What does this mean for the park (in terms of what they can do to reduce trash impacts)?</p> <p><i>Pose the following questions for the students to complete a summary of the visit:</i></p> <p>What observations did they make into the impacts of trash (regarding soil/water)?</p> <p>Was the park using any strategies we identified before we visited that could be useful in reducing trash? Were they using any that we didn't identify? Were these strategies effective?</p> <p>What do you think this park could do to improve the effectiveness of their strategies?</p> <p><i>Inform the students that these summaries will be shared with the park.</i></p>	<p><i>Give thoughtful responses using evidence from their observations.</i></p> <p><i>Write a summary of their visit to the park using information from the class discussion and by answering the questions posed by the teacher. Explain what they are going to do to reduce trash impacts in their own lives.</i></p>

## Conclusion

The overall goal of this project was to recommend strategies to the National Mall and Memorial Parks division of the National Park Service to address trash problems at East Potomac Park. In order to accomplish this goal, we started with investigations on the causes, impacts and approaches to the trash problem by reviewing literature. Approaches in the NPS range from providing no trash bins to providing improved trash bins (i.e. wildlife-proof bins) with varying levels of success. We then conducted interviews with park staff in various parks in and around the D.C. area about the trash problems they have and the practices they employ to address the problem. We also completed a site assessment of East Potomac Park, supplemented by some informal conversations with anglers in the park. On site, we reviewed additional literature on visitor behavior and waste management in combination with interviews of NAMA staff. We found that one constant throughout our research and interviews is the need to adopt more effective informational and educational approaches to achieve behavioral change. Based on this research, we recommended various strategies the park could add or improve on.

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