

Creating Connections Between Environmental and Human Health and Messaging a Call to Pro-Environmental Action

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Section 1: Executive Summary

The Montgomery County Department of Parks, and other environmentally-oriented organizations, have historically had a difficult time communicating the importance of environmental issues to the general public. A major reason is that much of this communication has promoted environmental protection for the intrinsic sake of the environment, and not for human well-being. As a result, people who are not already environmentally inclined may not be interested in protecting it; they are unaware of how environmental crises may impact their own well-being. If they were made aware of such impacts, they might be more invested in environmental protection.

To address this issue, we investigated the connections between environmental and human health, and determined how those connections should be crafted and messaged, to initiate a call to pro-environmental action among diverse groups in the Montgomery County public. We carried these tasks out in the context of a park system and focused our work on how parks are beneficial to both human and environmental health, and how they can be used to message human-environment connections and pro-environmental behavior.

We researched the history of environmental communication in the U.S., current environmental-human health connections in water and air quality, and communication strategies that could encourage sustainability and support for parks in the County. This research culminated in a set of final recommendations for optimizing the pro-environmental messaging of the Department of Parks.

Research into the history of environmental communication revealed wide variety of message types to gain support for sustainable behavior. Since the 1950s, messages catering to human values—altruistic or egoistic—and messages in line with social and media norms, have been prevalent. We believe that such messages could be used by the Department of Parks to promote park visitation and support.

The investigation of environmental-human health connections revealed water and air quality deterioration as strong forces that are affecting both environmental and human health. Such forces, ranging from lead poisoning in water to carbon emissions in air, were found to be detrimental to both environments and humans, thus connecting the two—when environments are damaged, human health is damaged as well. However, parks can help mitigate these forces in a variety of ways.

Finally, the most effective forms of communication are those that are simple; messages that are straightforward and easy to understand by varied audiences. Furthermore, we found that messages that encourage environmental-human health protection were most effective when crafted as a social norm or human value, not by using information alone.

Based on of these findings, we devised a set of recommendations for Department of Parks messaging that include four steps that should be used in crafting Department messages:

- begin with an introductory hook
- describe environmental-human health connections
- craft environmental-human health connections
- conclude with a call to action.

We hope that these steps will help the Department garner optimal public support for its parks and natural environment.

Section 2: Description of the Problem

The Montgomery County Department of Parks seeks to promote a call to pro-environmental action among the County's citizens. It hopes to garner enhanced support for its environmental

protection initiatives and for public use of County parks. Historically, accomplishing this has been challenging. Messages have been geared toward encouraging sustainability to protect ecosystems for their own sake and without emphasizing how sustainability and environmental health benefit human health as well. Without this emphasis, members of the public not already environmentally inclined will not be motivated to change their behaviors to a more sustainable lifestyle, and will not value the support and visitation of parks.

To stimulate behavior change to value parks among a diverse population, the Department of Parks must make clear connections between environmental health and human health. Specifically, it must show how elements of the natural environment, including those found in parks, provide services and health benefits to people. And it must portray this idea in a strategic way to show that pro-environmental behavior, and the support and protection of county parks, is in fact a call to action to support and protect humans.

Section 3: Goals and Objectives

Given this challenge we have devised a plan help the Department achieve its environmental goals. The plan consists of two broad goals and three specific objectives. The two goals are:

1. Enhance the connections between environmental and human health in environmentally oriented messages the Department sends to the general public; make a further connection to ways County parks can benefit human health.
2. Help promote a call to pro-environmental action among diverse groups in the County, including and especially, those who are environmentally unaware or uninclined. Accomplish this by sharing effective methods for crafting and messaging environmental-human health connections the encourage the public to change their lifestyles to be more sustainable, and recognizes and promotes the natural and human benefits of visiting and supporting parks.

To accomplish these two goals, we have outlined and carried out three specific objectives:

1. Investigate **past** environmental messaging strategies used in different space and times contexts, to understand previously employed strategies. This includes investigating environmental-human health connections made in past messages.
2. Research **present** connections between environmental and human health, specifically within the context of water and air quality.
3. Devise **future** messaging strategies for the Department of Parks to craft environmental-human health connection messages in ways that gain public support for sustainability initiatives.

Several elements of these objectives are worth noting. First, each objective is designed to advocate for broad pro-environmentalism, and to also convince the public of the importance of parks—why they should be maintained and visited. Second, air and water quality in the second objective were specifically chosen, because the Department identified them as relevant to parks in particular; parks play a major role in mitigating threats to air and water quality, a fact that will be discussed in further

detail. Both air and water quality were examined for their anthropogenic sources, as well as associated environmental and public health impacts, to provide a holistic view, and the connectivity they reveal between the environment and the public. Both were also discussed in terms parks counteracting negative health impacts, to demonstrate their broad value. Finally, the objectives were organized into a past-present-future format, to provide a logical progression of ideas, and to show how environmental messaging can and should change as time goes on.

The goals and objectives culminate in recommendations for the Department of Parks, based in the findings made through research into the three objectives. The recommendations provide feedback on what we believe the Department should include in its messages to the public to gain support for parks and the environment.

Section 4: Benefits of Parks

By including park support as a goal, our project recognizes that the Department of Parks is a parks system. Therefore, a major element of project research focused on parks' role in providing benefits to both natural ecosystems and people. Summarizing various studies, Michael Tuffelmire of *The Rapidian* identified parks' four major benefits:

1. Parks help to improve the physical and mental health of people. For example, hospital patients with a view of parks through their window tend to recover much more quickly than those who do not.
2. Parks strengthen the levels of social interaction between people by bringing them together to central locations, instead of driving them apart through high-density development.
3. Parks burgeon local economies, by increasing the real estate values of houses that are adjacent to parks, in some cases by up to 20%.
4. Parks aid the environment by numerous means, including preserving natural biodiversity and regulating healthy urban climates (Tuffelmire, 2013).

From this starting point, we identified specific ways parks are beneficial to people's physical and mental health. These benefits include parks' role in forest bathing, allowing people to de-stress by immersion in natural environments. Park benefits also include improvements to cardiovascular health and reductions in diseases caused by airborne pollutants. In fact, some are considering the concept of "parks prescriptions," in which people facing health issues are told to visit parks as a treatment method.

Parks can support various societal needs and ecosystems, a fact central to the mission of the Department of Parks, which is to "...balance demand for recreation with the need for conservation; offer various enjoyable recreational activities that encourage healthy lifestyles" (Montgomery Parks, 2017). Both of these mission elements—recreation and conservation—are fulfilled by parks, based on their capacity to protect humans and natural environments.

The Department also carries the responsibility to promoting parks; a heavy task considering that Montgomery County contains 419 parks covering nearly 37,000 acres (Montgomery Parks, 2017). That acreage includes nearly 2,800 acres of wetland (Figure 1) and 27,000 acres of forest. The park system

provides ecosystem services critical for human health, a concept that is the central theme of this project that is discussed in detail in following sections.



Figure 1: A characteristic wetland (EPA, 2016)

Section 5: Main Research Approach

The main research approach was to conduct literature reviews. Our sources consisted of primary literature articles and scientific papers, case studies, government reports, scholarly articles and documents, as well as information about Montgomery County parks provided by the Department. These sources varied over space and time to attain a wide array of relevant perspectives. Cumulatively, the sources allowed us to develop a product applicable to the general public. It was initially difficult to find sources directly pertaining to Montgomery County and its parks, and we extrapolated information from sources addressing national issues. However, through outreach with our client and subject specialists at McKeldin Library in College Park we were able to gather information directly applicable to Maryland, Montgomery County, and its parks. This specific and relevant information will allow the Department of Parks to create innovative solutions to messaging problems. The research findings are provided in detail in the following section.

Section 6: Key Findings

Past Environmental Messaging Strategies

Environmental Communication History

In investigating the connections between human and environmental health in United States public messages since the 1950s, we found that human behavior influences environmental problems such as biodiversity loss, habitat degradation, and water pollution. It is important to study these behaviors to help prevent further environmental loss. Pro-environmental behaviors are defined as “those behaviors that change the availability of materials or energy from the environment or alters the

structure and dynamics of ecosystems or biosphere positively” (De Groot & Steg, 2009). Pro-environmental behavior acts on what is right versus what is wrong and doesn't necessarily benefit individual interests.

In relation to people’s interests, there are three important values when it comes to human behavior and pro-environmentalism, which help environmental communication: egoistic, altruistic, and biospheric. It is presumed the values that affect behavioral beliefs also impact human intentions and behaviors. If the priority of values changes, that can effect “behavior-specific beliefs, intentions, and pro-environmental behaviors” (De Groot & Steg, 2009). People whose egoistic values are strong typically base their environmentally-related decisions on a cost-benefit analysis; if the benefits outweigh the costs, they will act in a more pro-environmental manner. People with highly altruistic values will consider cost-benefit analysis for other people, not only for themselves, unlike people with strong egoistic values. Finally, people with strong biospheric values will act pro-environmentally on the interpretation of cost-benefit analysis as a whole when considering ecosystems (De Groot & Steg, 2009).

In addition, the media has an effect on environmental communication especially regarding first and second order journalistic norms. With first order journalistic norms, “personalization, dramatization, and novelty are significant and baseline influences on both the selection of what is news and the content of the news story” (Boykoff & Boykoff, 2007). Personalization downplays economic, social, and political events because they lead to competition between different types of people—those who want power versus those acting to enhance socio-political leverage. Another key point is dramatization, in which the media dramatizes a crisis and de-emphasizes policy information.

Second-order journalistic norms informs authority-order and balance. This “informational bias leads to 'episodic framing' of news, rather than 'thematic framing' whereby stories are situated in a larger, thematic context, in which this has shown to lead to shallower understandings of political and social issues” (Boykoff & Boykoff, 2007). In other words, media often plays a role in giving incomplete representations of important issues.

When it comes to taking actions on environmental problems, humans are influenced by people inside and outside their communities—social norms—and we know that human activities have caused biodiversity loss, habitat degradation, and other environmental problems. Social norms are “shared understandings of how individual members should behave in a community under a given circumstance and members within the community reward or punish people for their behaviors” (Chen et al., 2009). Social norms apply if people decide to break rules or regulations. Humans interact differently when they know there might be consequences for their actions. Studies have shown that social and economic norms are important influences on individuals’ behavior, especially when it comes to resource management. For example, if an individual has to make a decision on land use that conflicts with community opinions, they may be open to social pressure.

Environmental messaging in different contexts has included all these ideas—altruistic, egoistic, and biospheric—as well as varying social and media norms, since the 1950s (Figure 2). These values and norms establish the types of messages that the Department of Parks may consider using to promote environmentalism and park use through environmental-human health connections, which are discussed below.

	Human Behavior	Human Behavior	Human Behavior	Media	Media	Social Norms	Social Norms
	Altruistic Values	Egoistic Values	Biospheric Values	1st Order Journalistic Norms	2nd Order Journalistic Norms	Social Norms	Economic Norms
Era 1 (1950-1960)							
Article 1 (Silent Spring)			X			X	
Article 2 (National Environmental Policy Act)		X					X
Article 3 (Santa Barbara Oil Spill)			X			X	X
Era 2 (1970-1980)							
Article 1 (Earth Day)			X			X	
Article 2 (The Love Canal)	X			X			X
Article 3 (Exxon Valdez Oil Spill)			X		X		X
Era 3 (1980-1990)							
Article 1 (Climate Change)		X	X	X		X	X
Article 2 (Public Comm.)	X					X	X
Article 3 (Factors Shaping Climate Change Coverage)		X	X	X	X	X	

Figure 2: This table illustrates how prevalent the characteristics of human behavior, media, and social norms are in scientific articles related to the environment in three different time periods since 1950. An X indicates that the characteristic is present in the article.

Pertinence to Parks

The prevalence of these human behavior values, as well as media and social norms, in historical environmental messaging are applicable today to communication for the Department of Parks to promote parks. For example, a message directed to an egoistic value may convince a person to visit a park if they are told it will decrease their chances of getting ill or will increase their rates of recovery from illness. This applies, for instance, to a message that could be sent to the 60% of adults in Kent County, Michigan, who are obese, informing them that park visitation could help them lose weight by promoting activities like walking and running (Tuffelmire, 2013). Such a message is an example of a connection between environmental health, in this case the preservation of parks, and human health, saving a person from illness. Messaging these connections may convince even the most egoistic people to support parks and environmental protection.

The Department of Parks can reach communities by attributing certain values to their communication. People are influenced by different values and norms. When it comes to social norms, people are likely to be influenced by the people in their community. If the Department can reach more individuals and change their behavior to be more pro-environmental, then even more people in those communities will become pro-environmental. This is because people tend to believe those who share their values more than information from reading about environmental issues in the media.

Previously mentioned connections between environmental and human health are discussed in below in relation to deteriorating water and air quality, including how parks manifest those connections by supporting environmental and human well-being.

Present Environmental-Human Health Connections

Water Quality

Anthropogenic Sources

In November 1994, the Montgomery County Council enacted an ordinance regarding water quality. Its goals were to “restore high quality chemical, physical, and biological conditions in the waters of the state in the County” and that the County may order a “correction of any degradation of riparian habitat and aquatic life caused by a failure to maintain agricultural best management practices” (County Council for Montgomery County, Maryland, 1994). More 20 years ago the County made water quality a priority, but findings show that runoff from agricultural and urban areas are the major cause of deteriorating water quality in Maryland. Additionally, findings demonstrate that the major implications of this are biodiversity loss and the persistence of toxic chemicals in aquatic environments.

Research shows that Maryland’s agricultural industry has played a large role in deteriorating water quality. While outside Montgomery County, the Delmarva Peninsula offers some insight. Research has shown that “the concentrations of nitrogen, phosphorus, and pesticides in streams and rivers of the Delmarva Peninsula reflect the predominance of agriculture and the soil and aquifer conditions that promote transport of agricultural chemicals to streams” (Denver, 2004). In Montgomery County, the agricultural industry covers nearly 64,000 acres dedicated to farmland as of 2012 (Montgomery County Government, 2017). These numbers indicate a strong likelihood that the agriculture in Montgomery County is compromising water quality.

Urbanization also has a detrimental effect on water quality. As a study conducted in the Maryland’s Piedmont showed, “stream quality impairment is first evidenced when watershed imperviousness reaches 12%, but does not become severe until imperviousness reaches 30%” (Klein, 1979). However, in 2005, the Montgomery County Council established that the “maximum percentage of net lot area that may be covered by an impervious surface” is 20% (County Council for Montgomery County, Maryland, 2005). The discrepancy in these two values points to the fact that water quality could still be compromised by urban runoff even with the standards set in 2005.

Environmental Impacts

Findings also indicate deteriorating water quality is leading to a loss of biodiversity in aquatic ecosystems and the persistence of toxic contaminants. Research has shown that deteriorated water quality can interfere with the life cycle of certain fish species, leading to a reduction in their numbers (Maes & Breine, 2008). These outcomes could be particularly troubling in parks, as it could reduce quality of the visitors' experience, which is surrounding oneself with nature, and if park areas continue to lose species due to deteriorating water quality, then the appeal of parks could be drastically reduced.

This information answers the research question about the major anthropogenic sources of deteriorating water quality in Maryland and the resulting environmental implications. Through research it is evident that the County has a problem with runoff, which it is directly causing deterioration in water quality. Despite previous Council decisions, the standards for runoff have not been enough to mitigate concerns.

Given the size of the agricultural industry in Maryland it is the foremost concern regarding water quality. Agricultural runoff can deposit many pollutants in water bodies, including nitrogen, phosphorus, and pesticides. Research sources state that, "Commercial fertilizer is the primary agricultural nonpoint source of nitrogen and phosphorus" (Puckett, 1995). These chemicals can have significant impacts on water quality; nitrogen and phosphorus can lead to eutrophication, which drains the water body of dissolved oxygen, resulting in a dead zone. Urbanization also has a detrimental effect on water, as it can "increase stormwater runoff which in turn causes an increase in the frequency and severity of flooding, accelerated channel erosion, and alteration of the stream bed composition" (Klein, 1979).

It is not realistic to scale back the agricultural industry or urbanization in Montgomery County. They provide jobs and food. However, there are measures to mitigate the effects on water quality. The 1994 County Council decision on water quality also stated that, "If illegal pollutant discharges from properties engaged in agriculture impair aquatic life or public health, cause stream habitat degradation, or result in water quality standards or criteria violations, the Department must pursue correction of these violations in conjunction with the Soil Conservation District and, if necessary, the state Department of the Environment" (County Council for Montgomery County, Maryland, 1994). Modern day pesticides, herbicides, and insecticides contain an overwhelming amount of pollutants that impair water quality. It is therefore the County's responsibility to mitigate these effects. Possible solutions include investing in research for cleaner pesticides, building buffers between agricultural lands and surrounding ecosystems, and minimizing impervious surfaces. Surface waters in the County flow within 27 watersheds into 1,500 miles of streams, with 66% of surface water draining directly into the Potomac River (Montgomery County Government, 2012). If runoff is not properly addressed by Montgomery County, these water bodies will continue to be flooded by contaminants that will further compromise water quality.

If these issues aren't addressed in a timely manner, aquatic ecosystems will continue to deteriorate. Organisms have adapted to live in certain environments, with some adapting to live in extreme conditions where harmful chemicals are present. However, water bodies in Maryland traditionally do not contain toxic chemicals, and their presence harms the ecosystem. It has been shown that, "trace metals, including copper, zinc, manganese, molybdenum, and cobalt, are added to fertilizers as micronutrients" (Hamilton et al., 1993). In conjunction with urban runoff, this agricultural runoff can

have an extremely detrimental outcome. It has been shown that chloride from urban runoff can be toxic to aquatic species. Furthermore, chloride toxicity can be amplified when other indications are present, such as potassium and magnesium which could potentially be found in agricultural runoff (New Hampshire Department of Environmental Services, 2017). Urban discharge can also contain bacteria and viruses that can severely harm aquatic species (Chapman, 1996).

If these issues aren't addressed, the life cycles of aquatic species could be damaged, leading to widespread biodiversity loss throughout the state. The best way to address this issue is to rethink the chemicals that people use in both agricultural and urban settings. It's merely hopeful to think that runoff can be entirely eliminated, but one way to reduce this problem is to reduce the toxicity of the runoff itself. If people can minimize the amount of chloride used in urban areas while also reducing the trace metals used in agricultural fertilizers, biodiversity losses in aquatic environments can be mitigated.

Additionally, the presence of toxic chemicals in aquatic environments can have a long-lasting effect. Many toxic chemicals are environmentally persistent and can remain in environments for decades. Agricultural runoff can contain trace amounts of radon, which can be an extreme hazard. These chemicals can remain for long periods and present a serious human health concern, particularly in public drinking water. Historical cases have shown that deteriorated drinking water has a direct public health connection; poor drinking water quality in Washington County, Maryland led to an increase in occurrence of pancreatic cancer (Ijsselmuiden, 1992). These cases portray a harsh reality; if this issue is not addressed, both environmental and human health can be compromised. Montgomery County must address toxicity levels of agricultural and urban runoff to preserve water quality to avoid serious public health impacts addressed in more detail below.

Public Health Implications

"Urban sprawl," the rapid expansion of metropolitan areas due to transportation advancements and socioeconomic developments, has led to the creation of suburbs (Frumkin, 2002). The creation of suburbs has negative and positive implications for humans in general, but has had overall negative impacts on human health. *Poisoned Waters* explains that the expansion of metropolitan areas threatens both the quantity and quality of our water supply (Smith, 2009). The creation of cities and suburban communities has caused major sanitation and safety concerns, mostly on the east coast that can be traced back to the 19th and 20th centuries when cities first began rapidly expanding.

The Washington Suburban Sanitary Commission (WSSC) provides most of the public water and sewage services in Montgomery County. WSSC is the eighth largest wastewater utility in the United States (WSSC, 2016). Although WSSC has had treatment problems in the past, most drinking water problems occur after the water has been treated, making them much more difficult to catch because the water can only be tested when it comes out of the tap. Outdated infrastructure that allowed lead leakage into drinking water in Flint, Michigan and Chicago, Illinois endangered those residents, particularly in communities of color.

The Montgomery County Public Schools (MCPS) has found high lead levels in water in some of its schools, and has attempted to mitigate it from 2004-2007 in collaboration with WSSC, Montgomery County Department of Health and Human Services (DHHS), and the Montgomery County Department of

Environmental Protection (DEP). They conducted a systemwide lead testing program of the drinking water from plumbing fixtures (NBC4 Washington, 2016).

Laytonsville Elementary in Montgomery County has been on bottled water since the 1990s, so students don't drink water that has exceeded lead standards in nine of ten sampling periods since 1993 (NBC4 Washington, 2016). Montgomery County public schools spokesman Derek Turner said that as of April 2016, the school system continues to provide bottled water, at a cost of \$1,500 a year. Laytonsville is a diverse community (Figure 3) and it is unfortunate that this would be the only school that still has high lead levels in water in 2017.

The World Health Organization's Ottawa Charter for Health prostates a central tenet, "Health is created and lived by people within the settings of their everyday life: where they learn, work, play, and love," (World Health Organization, 2017). This established a healthy-settings approach to health promotion, where people actively use and shape their environment and thus create or solve problems relating to health. The 36,891 acres of park space in Montgomery County provide spaces for recreation, but also places to learn about environmental concerns (Montgomery Parks, 2017). Montgomery County Code Section 19-47 on water quality control reads, "The County must work in conjunction with municipalities, counties, agencies of the state, and the federal government to establish interagency agreements and to take other steps necessary to accomplish the purposes of this Chapter" (Montgomery County Code, 1994). Park systems are essential in teaching citizens the intrinsic value of the environment, but to better communicate that, it's necessary to establish a more tangible connection with human health and safety. It should be noted that a primary source for counteracting subpar water quality is parks, including the numerous parks present in Montgomery County.

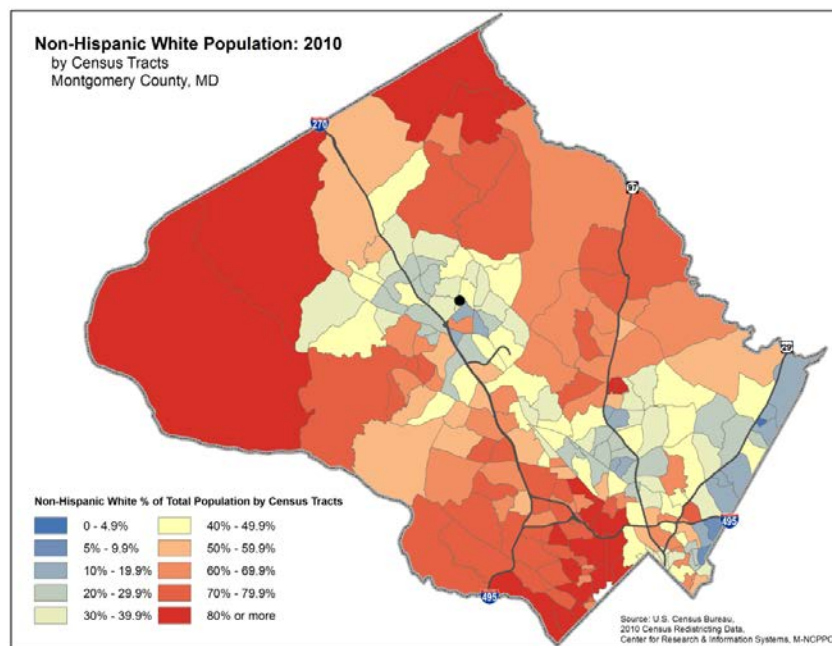


Figure 3: The non-hispanic white population of Montgomery County from the census. The black dot indicates where Laytonsville Elementary is located. The school is in one of the County's most diverse communities (Montgomery County Planning Department, 2011).

Pertinence to Parks

There is a clear connection between environmental water quality and park health and function. In this dynamic relationship, water quality affects park health and, more notably, parks are mitigate with water quality issues. Parks can be home to many organisms and ecosystems that filter water, which can help remove of harmful contaminants. For example, wetlands filter pollutants from inflowing water, in some cases filtering close to 100% of metal pollutants (Dunbabin & Bowmer, 1992). Park wetlands could play a major role in removing contaminants like radon and lead from ecosystems and drinking water supplies, preventing damage to both. In this way, parks improve their health, and also protect surrounding ecosystems and human societies from harmful pollutants. They prevent threats such as the toxicity of chloride from urban runoff, and developmental delays in children with lead poisoning. Parks provide an essential ecosystem service.

Additionally, the streams and riverbanks in parks are often lined with trees and other vegetation, which stabilizes the banks and act as a natural buffer from runoff. Tree canopies reduce rain erosion, roots promote water and contaminant uptake, and leaves provide surface area for contaminant evaporation (EPA, 2017). One study even showed that three cubic centimeters of tree sapwood can filter several liters of water per day, enough water for one person (Boutilier et al., 2014). Preventing runoff from reaching water bodies is an indispensable ecosystem service that parks, and their vegetation offer, again protecting nearby ecosystems and human societies from contaminants.

For the public to understand parks' critical importance, it may be necessary to convey the variety of ecosystem services they provide. By establishing the connection between environmental water quality and public health, and showing the ways parks maintain water quality, we can demonstrate how parks are an integral component of maintaining human health.

Air Quality

Anthropogenic Sources

According to the U.S. National Park Service, there are four main types of air pollution sources: mobile, stationary, area, and natural sources (National Park Service, 2017). This research focused on mobile sources and their impacts. Currently, Maryland's experiences a high number of days when ozone levels exceed NAAQS. In 2002, the County Council made a decision to protect air quality and create goals to enforce air quality (Subin et al., n.d.). Since then, air quality has been a priority for the County, due to the environmental and health implications. Findings show that the County has made an effort to reduce air pollutants, however there is still room for improvement. Furthermore, the County was able to reduce the number of days exceeding NAAQS, but it still has roughly 10 days annually in which these standards are exceeded.

HOV lanes have been implemented on most freeway systems in the United States as a measure to improve mobility, trip time reliability, and air quality (National Cooperative Highway Research Program, 1998). They can be effective if people do not create additional trips (EPA, 1998). Researchers Johnston and Ceerla studied the effects of new high-occupancy vehicle lanes on travel and emissions in California, a highway system comparable to Maryland. They found that HOV lanes increased travel

distance and emissions compared to other forms of transportation like buses and trains. They also found that HOV lanes would increase vehicle miles travelled by about 4% (Johnston & Ceerla, 1996). This may not seem high, but a 4% increase in travel distance adds up when considering daily commutes and people traveling along the east coast. In addition, a study by researchers Boriboonsomsin and Barth found that HOV lanes contribute to higher emissions due to “more frequent and aggressive acceleration/deceleration maneuvers.” This is because HOV lane vehicles tend to travel at higher speeds compared to those in normal lanes (Boriboonsomsin & Barth, 2008). Increased emissions led to increased air pollutants. This emissions increase led to a significant number of days exceeding NAAQS (Figure 4), causing significant health and environmental impacts.

Number of days 8-hour Ozone Concentrations Exceeding NAAQS 2003-2016

Year	Number of days 8-hour Ozone Concentrations exceeded NAAQS
2016	8
2015	5
2014	4
2013	4
2012	21
2011	20
2010	33
2009	4
2008	20
2007	43
2006	35
2005	42
2004	23
2003	23

Figure 4: Number of Days Exceeding 8-hour Ozone NAAQS, 2003-2016 (Maryland Department of Environment, 2016)

Environmental Impacts

Findings indicated that air pollutants can have a serious effect on the environment. Acid rain, eutrophication, ozone depletion, crop and forest damage, and global climate change are all more prevalent with an increase in air pollutants (Department of Environmental Protection, n.d.).

Acid rain is formed when sulfur dioxide and nitrogen oxide reach the air and are transformed into sulfate or nitrate particles. Both are at high levels in the County (Figure 5). According to the Maryland Department of the Environment, dealing with acid rain is extremely important in Maryland for restoring and preserving the Chesapeake Bay. DEP has found that all aquatic life can be harmed by acid rain. High water acidity interferes with oxygen circulation and causes heart problems in fish (Maryland Department of the Environment, n.d.).

Furthermore, excessive nitrogen and phosphorus fall into water bodies every day, through air pollutants caused by mobile transportation sources. Fossil fuels are burned as people drive their vehicles and release nitrogen oxides into the atmosphere, which is then absorbed into water bodies. Excess nutrients create harmful algal blooms and deprive aquatic zones of oxygen (EPA, 2017). The Chesapeake Bay is the largest estuary in the United States and its watershed encompasses all of Montgomery County. An increase in vehicle miles traveled increases emissions and air pollutants (Figure 5). When there is too much nitrogen and phosphorus in the environment, algae grow faster than an ecosystem can handle. Algal blooms result and severely reduce or completely eliminate oxygen in the water, leading to the death of large numbers of fish (EPA, 2017).

On a different note, when cars release nitrogen oxide, it contributes to ground level ozone. According to Clean Air Partners, each year, cars travel more than 38 billion miles, accounting for 30-40% of the ozone-causing pollutants (Clean Air Partners, n.d.). Montgomery County’s parks are filled with beautiful and functional ecosystems. However, air pollutants that thin the ozone layer create harmful effects for these ecosystems (Figure 6). UVB radiation affects the physiological and developmental processes of plants, contributing to problems with the timing of plants’ developmental phases and metabolisms. In addition, the Environmental Protection Agency finds that ozone impacts marine ecosystems. Radiation causes damage during early development stages of fish, shrimp, crab, amphibians, and other marine animals. The level of NOx in Maryland is still high from vehicle emissions; in 2014 it was just under 80,000 (Figure 7).

Air pollution damages crops and trees in County parks through ground-level ozone. Ground-level ozone can lead to reductions in crops, reduced growth and survivability of tree seedlings, and increased plant susceptibility to disease, pests and weather (Department of Environmental Protection, n.d.). These impacts indicate how damaging poor air quality can be to the environment. This poor air quality can impact people as well.

Air Quality Concentration of Air Pollutants in Montgomery County

Pollutant	Average Time	Air Quality Concentration	Monitoring Station and Year
Carbon Monoxide	8-hour	1.0 ppm	Beltsville, MD 2010
Lead	Rolling 3-month average	N/A	N/A
Nitrogen Dioxide	Annual	26.7 ppb	Essex, MD
Particulate Matter (PM10)	24-Hour	24 $\mu\text{g}/\text{m}^3$	Glenburnie, MD 2009
Particulate Matter (PM2.5)	24-Hour	25 $\mu\text{g}/\text{m}^3$	Rockville, MD 2009-2011
Ozone	8-Hour	0.077 ppm	Rockville, MD 2010
Sulfur Dioxide	1-hour	10 ppb	Beltsville, MD 2010

Figure 5: Montgomery County Ambient Air Quality Monitoring Data (Montgomery County Department of Transportation, 2013). NAAQS lists carbon monoxide, lead, nitrogen dioxide, particulate matter (PM10 and PM2.5), ozone, and sulfur dioxide as the most harmful and concentrated pollutants.

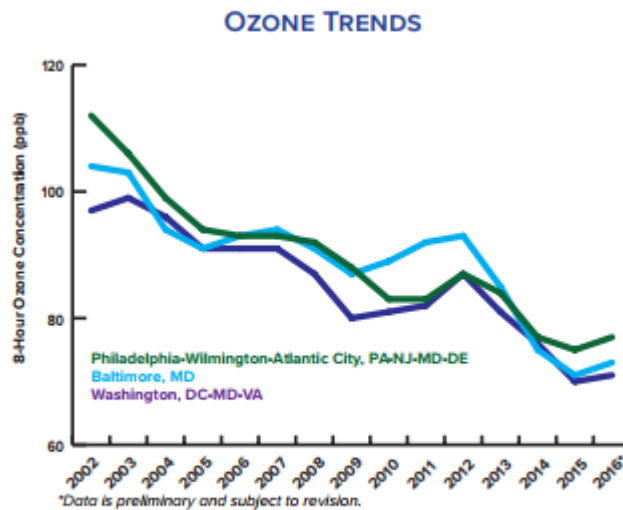


Figure 6: Ozone Trends from 2002-2016 (Maryland Department of the Environment, 2017).

NO_x Emissions from Highway Vehicles in Maryland from 2005, 2008, 2011, and 2014

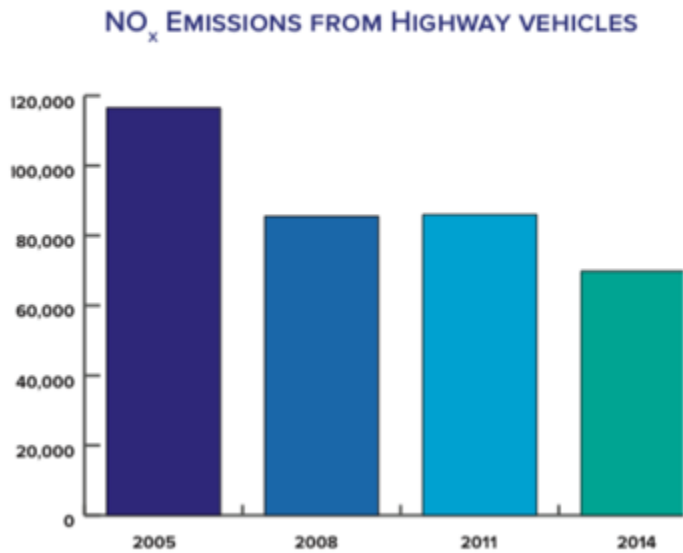


Figure 7: NO_x Emissions from Highway Vehicles 2005-2014 (Maryland Department of the Environment, 2017)

Public Health Implications

Local government documents indicate that the primary air pollution problems in Maryland are tropospheric ozone and high particulate matter levels. These air quality problems are common in urban areas and can have negative health impacts on the people who live in areas where these pollutants are found.

Particulate matter pollution is a common air quality concern in urban areas, where it is generated by vehicle exhaust and construction and presents potential health risks from exposure. Exposure to fine particulate matter causes health problems including cardiovascular and respiratory problems. Chronic exposure has been known to cause obstructions in pulmonary pathways and exacerbates the process of them forming (Pope & Dockery, 2006). Blocked pulmonary pathways can cause death in people who have been subjected to particulate matter pollution. Additionally, particulate matter can cause respiratory tract infections and lung cancer (Rai, 2015). Exposure can stress the respiratory system and eventually lead to more chronic problems such as lung cancer. Short-term exposure to particulate matter pollution can lead to lung discomfort and mild lung infections.

Additionally, tropospheric ozone pollution is caused partly by the emission of greenhouse gases from automotive emissions and power plants. Urban heat islands increase the temperature of an urban area as compared to surrounding rural areas. This temperature increase can exacerbate the rate at which tropospheric ozone occurs (Doherty et al., 2009) and health effects of exposure to ozone begin to emerge. Repeated exposure to ozone can cause health problems such as chronic respiratory disease and pulmonary attenuated function response (Hazucha & Folinsbee, 1992). The risk of exposure to ozone pollution can age the lungs and inflame pathways in the respiratory tract. In urban areas this a problem during the spring and summer as the temperature rises and increases the risk of being exposed to ozone pollution. Despite the severity of these health issues, it should be noted, similar to water quality, that parks play a key role in mitigation, making them a critical avenue for good human health.

Pertinence to Parks

Similar to the previous discussion of water quality, findings show a strong connection between park presence and use with better air quality, thus benefiting environments and people. The County's park system includes 419 parks across 36,891 acres, 500+ lakes, 457 miles of streams, 284 playgrounds, 238 miles of paved and natural trails, and 134 picnic areas. The park system is "an enjoyable, accessible, safe, and green park system that promotes community through shared spaces and treasured experiences" (Montgomery County Parks, 2017). If we continue emitting the same amount of harmful pollutants into the air each year, we will not be able to use the park system.

But more importantly, these systems help prevent air quality threats in the first place. For example, trees in parks can reduce air pollution by removing pollutants directly from the air and by other means, culminating in an annual pollution removal of 75,000 tons in the U.S.. As an added benefit, park trees absorb 95% of incoming ultraviolet radiation (Nowak & Heisler, 2010). This relates directly to the discussion of UVB's impact on the plant development; while trees may be impacted by incoming UV radiation, they will prevent impacts on park visitors by diverting the UV threat, lowering the risk of developmental disorders.

Parks can be a critical ecosystem service for air and water quality, by protecting both natural environments and human societies from harm in a variety of ways. The Department of Parks should communicate the importance of parks to the public, particularly how they embody the connectivity between environmental and human health. Parks help demonstrate how environmental damages and benefits are not a distant phenomenon, but one that can directly affect humans and their ability to live

healthy lives. There are numerous ways to effectively message this idea and boost pro-environmental action and park support, discussed below.

Future Messaging Strategies

Effective Messaging Techniques

Scientists believe their jobs are important, yet have a hard time explaining their findings to the public, a concept we have encountered throughout our research. Overwhelmingly, research shows that environmental health professionals believe their field is not well understood by the public, the media, or policymakers (Morrone et al., 2005). This is alarming because these they also believe that serious environmental health threats are facing citizens. Yet, research shows that scientists are somewhat divided on whether they can effectively communicate messages about environmental health to various audiences.

When scientists address the public, they seem unable to motivate serious change in the audience's habits. Public understanding of health issues is a function of past experiences, culture, demographics, and psychology. These are internal factors that include an individual's knowledge and health literacy. Health literacy is the personal, cognitive and social skills that determine an person's ability to gain access to, understand, and use information to promote and maintain good health. These internal factors cannot be addressed by public education campaigns that focus solely on information delivery. Even with evidence of environmental health risks, if the information contradicts the community's feelings about the issue, the information may not be accepted.

Public understanding is also influenced by external agents, information sources such as the media, friends and neighbors, government agencies, and special interest groups. The critical aspect in the effectiveness of these information sources is whether they are perceived as trustworthy by the individual or community. Both mass media and interpersonal ideas and feelings appear to support public understanding of health issues, as well as perpetuating misconceptions (Stamm et al., 2000).

Effective public messaging can be improved by reviewing past health campaigns. When telling vulnerable communities about the risk of pandemic influenza, researchers discovered certain themes that best develop the message (Vaughan & Tinker, 2009), including plans should be made from the perspective of the targeted population, messages must be sensitive to and relevant for the audience, and communication must be integrated with the audience's daily lives such as through billboards and commercials. Health campaign messages should be simple, straightforward, and framed to redefine the issue for the target audience. For example, the slogan of President Reagan's war on drugs campaign, 'Just Say No to Drugs' was simple, straightforward, and applied to children. Messages that relate to the audience have a higher chance of motivating public action. Given this, how can a message effectively relate to an audience? What should be emphasized in these messages to make them appealing to diverse groups?

Effective Messaging Emphases

In determining how connections between environmental and human health should be crafted in public communication to garner optimal levels of pro-environmental support, we devised and reviewed three different messaging emphases: information-based, social norm, and human value. In other words, the importance of protecting environmental, and by extension human, health can be portrayed in public messages by providing relevant facts and information, by convincing people that such protection is what their community does, or by encouraging them to view protection as the right thing to do.

With information-based emphasis, the message should target particular audiences (Kennedy, 2010), raising awareness of environmental health hazards (Whitmarsh, Lorenzoni, & O'Neill, 2012), and personalizing public engagement in preventing such hazards (Liu, Eleta, Kobernus, & Cole-Hunter, 2016). However, this emphasis can be ineffective if simply providing the public with information doesn't motivate rational pro-environmental action, especially considering that different people interpret information in different ways (Whitmarsh, Lorenzoni, & O'Neill, 2012). Additionally, an information-based message may only be appreciated by people who are already environmentally inclined, and thus not be effective for gaining the support of a diverse public (Liu, Eleta, Kobernus, & Cole-Hunter, 2016).

By contrast, social-norms emphasis can be more effective. By promoting pro-environmental behavior by showing that such behavior is a norm, it can galvanize people to change their actions through social approval or disapproval of those actions (Tracey, 2005). A noted disadvantage of this emphasis is that merely describing a behavior as a social norm is not always sufficient for pro-environmental support. Rather, social approval or disapproval messages must be included to more effectively gain support (Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007).

The human values emphasis is sometimes viewed as less effective than the social norms emphasis, but it can be a powerful way to attain pro-environmental support. Several studies highlighted that if positive values, like selflessness, are ingrained, portraying pro-environmental action as emulating these values could be a powerful way to promote behavior change toward a more sustainable lifestyle (Schultz & Zelezny, 2003). However, it should be noted that based on past environmental communication strategies, emphasizing egoistic, self-centered values may also be a way of promoting pro-environmental behavior. If the benefits of such a behavior outweigh its costs, a selfish person will act in favor of sustainability (De Groot & Steg, 2009). For example, walking to work every day will save money, so they may choose to walk to work, thus engaging in sustainable action.

These emphases share parallels to past environmental messaging strategies. For instance, social norms are "shared understandings of how individual members should behave in a community under a given circumstance and members within the community reward or punish people for their behaviors" (Chen et al., 2009). These norms thus influence people's behavior; social reward and punishment, approval or disapproval, can encourage or discourage a person from acting a certain way (Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007). Because these findings parallel those from our analysis of past environmental messaging strategies, it is evident that certain messaging emphases like those of social norms or human values, are powerful ways to promote pro-environmental action. As such, they are appropriate emphases for messages about parks.

Pertinence to Parks

Parks can disseminate powerful pro-environmental messages, by highlighting the connections between human and environmental health, and by using the messaging strategies and emphases mentioned above. Consider, for example, the contrast between two park signs. The first sign is from Singapore’s City Square Mall (Figure 8). This billboard follows a comparatively weak information-based emphasis by including facts like “...the 49,000 square feet [sic] park.” It is wordy and includes the term “ecology” without explaining what it means. It is counter to the simple and straightforward message used in Reagan’s war on drugs, and to the need for increased scientific literacy among members of the public. As such, this billboard is flawed in its ability to promote a call to action for sustainability.



Figure 8: Singapore City Square Mall billboard (Keith, 2010).

By contrast, the second sign is much stronger in motivating a call to action. It was made by Sustainable Highland Park, in New Jersey (Figure 9). The message is simple and straightforward with minimal words, consistent with the Reagan program’s messaging strategies. It also uses the comparatively strong messaging emphasis of social norms, by using a catchy acronym “BYOB,” and with using the word “fantastic” to show that choosing reusables is approved of, including socially.



www.sustainablehighlandpark.org

Figure 9: Sustainable Highland Park sign (Sustainable Highland Park, 2017).

By using these strategies on park billboards and signs, as well as on other forms of park communication, the Montgomery County Department of Parks could move closer to achieving a pro-environmental call to action. Of course, these signs are not the ultimate strategy for success; they could be improved by making connections between human and environmental health. Such connections, and recommendations for a powerful strategy for the department, are addressed in the concluding section.

Section 7: Messaging Recommendations

These recommendations are ways to address the Montgomery County Department of Parks' sustainability agenda. They suggest content for their pro-environmental messages to the public, make influential connections between environmental and human health, and promote a public environmental call to action. Furthermore, because the department is a parks system, the recommendations are written in the context of promoting the human and environmental benefits of parks. The recommendations suggest crafting pro-environmental messages with four parts, described below.

1. **Part 1: begin with an introductory hook** → an interesting informational fact can show the reader how parks benefit human health.

The goal of this step is to grab the reader's attention, whether or not they are environmentally inclined. An interesting fact provides a hook that convinces readers to keep reading. And by making the fact specifically about how parks can be a benefit to readers themselves, the hook is strengthened, as the readers are interested in reading more about what is beneficial for them.

Beginning the message with a fact is consistent with starting off with an information-based messaging emphasis. This emphasis is a rational choice to initiate a message, because it acts as a prerequisite for pro-environmental action by raising awareness of environmental and human health topics (Whitmarsh, Lorenzoni, & O'Neill, 2012). For this emphasis to be effective in this context, the fact should be simple and easy to understand by diverse audiences, like the slogan, "Just say no to drugs" (Vaughan & Tinker, 2009).

There are various options for interesting facts to use. If the writer wants to focus on water quality, then the fact could be that three cubic centimeters of tree sapwood can filter several liters of water per day, which is enough water for one person per day (Boutilier et al., 2014). This would in turn ensure that the reader's drinking water would be devoid of contaminants like radon that could lead to health hazards like pancreatic cancer, as was the case in Washington County, Maryland (Ijsselmuiden, 1992). If the writer wants to focus on air quality, the fact could be that park tree leaves absorb 95% of incoming ultraviolet radiation, shielding the reader from the harm of that radiation (Nowak & Heisler, 2010).

A specific example of an introductory hook would be to state on a park billboard: "Did you know that the trees in this park clean enough water for you to drink safely every day?" This statement is information-based, simple and straightforward, and relates to a human health benefit that parks provide, making it a good way to catch the reader's attention from the beginning.

2. **Part 2: describe environmental-human health connections** → expand on Part 1 by providing information that parks are part of a broad environmental system, and how the system's health strongly connects to the health of people, including the reader.

Once the reader's attention is caught, the goal of this step is to show how parks, and the environment in general, play a significant role in the reader's good health. This part of the message relates directly to the environmental and human health implications of water and air quality (see Section 6).

Findings outline numerous environmental and human health impacts of poor water quality, demonstrating the potential connections between environmental and human health, which the message writer could highlight. For example, how urbanization can "increase storm water runoff which in turn causes an increase in the frequency and severity of flooding, accelerated channel erosion, and alteration of the stream bed composition" (Klein, 1979). This impact of urbanization can be environmentally harmful, as flooding can alter the dynamics of natural ecosystems in stream beds and related areas. But, it can also be harmful to humans; flooding can expose people to toxic chemicals found in water, including, as previously discussed, lead (NBC4 Washington, 2016). The same environmental event, stormwater flooding affects both the environment and people, connecting the two. This connection can be highlighted by the message writer.

Similar types of connections could be made for air quality, and the message writer could emphasize these as well. For example, HOV lanes contribute to higher emissions due to "more frequent and aggressive acceleration/deceleration maneuvers" (Boriboonsomsin & Barth, 2008). Such emissions harm the environment by bolstering the impacts of climate change, and affect human health by raising urban temperatures. This temperature rise can exacerbate the rate at which tropospheric ozone occurs

(Doherty et al., 2009), which in turn can cause chronic respiratory diseases and other health issues (Hazucha & Folinsbee, 1992). Emissions demonstrate that here too, in the context of air quality, environmental and human health are connected. When the environment is healthy, so are humans.

The major point of this idea is how parks mitigate environmental impacts, thus improving both environmental and human health. This strengthens their connection, and furthers the reader's appreciation of parks. For instance, a message writer could mention that while particulate matter harms environments, and causes obstructions in pulmonary pathways (Pope & Dockery, 2006), park trees can remove this and other pollutants at a rate of 75,000 tons per year in the U.S. (Nowak & Heisler, 2010). This is yet another connection of how parks enhance both environmental and human health.

A specific example of how the message writer could continue the message would be to state the following: "These trees, and this park, are part of a broader natural environment. And believe it or not, this environment is protecting you from harm and keeping you in good health. Its streams filter the water you drink to keep it clean, and its trees take harmful particles out of the air you breathe. In this way, parks and natural environments keep you safe from dangerous diseases, and ensure that you remain healthy every day." Like the Part 1 statement, this conforms to an information-based emphasis, and is simple and straightforward, despite being slightly longer.

3. **Part 3: craft environmental-human health connections** → emphasize the environmental-human health connections in simple, straightforward phrases that show how human-environmental protection is socially normal and carries admirable human values; encouraged the reader's support .

With a newfound understanding that human and environmental health are connected, and that natural environments protect people's health, the reader should be encouraged to support environmental-human health protection. The writer's objective should be to convince the reader to protect environmental, and by extension, human health. As well, the message writer should indicate that a good way to achieve this protection is to support parks. This entails two major components: first, the reader must understand how his/her past experiences, culture, demographics, and psychology, which are elements of public health understanding (Stamm et al., 2000), play into this protection. For instance, pointing out that a reader's experience of riding a bicycle through a park is a form of environmental protection, by using an alternative to an emissions-releasing car as a means of transportation.

Also, the reader must realize how the protection of human-environmental health and the support of parks are social norms (Tracey, 2005) and human values (Schultz & Zelezny, 2003), both of which have been shown to galvanize people into pro-environmental action. Encouraging a reader to believe that their choice to ride a bicycle, instead of driving a car, is a behavior that their friends will approve of and will think of as emulating good values, is a strong avenue to encourage such action.

To implement these two components, and enhance the strength of the specific message example from Parts 1 and 2, the message writer could proceed by explaining: *"So if you want to remain healthy, you should do what you can to protect the environment and support parks like this one. In fact, you being in this park today shows your support for parks, and your contribution to protecting the environment and your health. Thinking about this park visit, and all of the visits you've made in the past, and how they all would be approved of by your friends, and would make them see you as a person of*

high values, if they knew, or perhaps already know, that all along you've been contributing to a noble cause." This statement, while also long, does not use complex scientific or health terms, and is simple and easy to understand.

4. **Part 4: conclude with a call to action** → End the message with a convincing and powerful statement that calls the reader to action for human-environmental protection and support, including regular visitation, of parks.

At this point, the reader should understand how their contributions to environmental-human health are not only important, but personally beneficial. Once the reader has this mindset, the final step is to motivate pro-environmental and pro-park action. This could include the use of catchy phrases, as used by Sustainable Highland Park in "Bring your own bag," as a spinoff of the more commonly known phrase "BYOB" (Sustainable Highland Park, 2017). It could also include telling the reader that acting in a pro-environmental manner is often as simple as coming back to visit a park again. Any relevant phrase that is compelling and passionate fits into this step.

Continuing the example statement in the first three parts above, the writer could conclude by declaring: *"So get out there and make a difference! Protect the environment, protect yourself, and support parks like this one. Oh, and the best part about this is that being an environmental difference-maker can sometimes be as simple as just coming back to visit this park again. We hope to see you again soon!"* This message is simple, while effectively portraying a call to action among members of the public to boost human-environmental well-being.

Of course, the examples here are just one approach. The Montgomery County Department of Parks should use other examples as necessary. Nonetheless, we hope that these recommendations, and this project, will help the Department achieve its pro-environmental and pro-park objectives. Overall, we hope that implementing these recommendations will bring the Montgomery County public, and its environments, toward a more sustainable future.

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