

A Behavior Change Campaign to Reduce Plastic Shotgun Wad Debris on the North- Central California Coast



**NOAA Office of National Marine Sanctuaries, and
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Cover photo: Plastic shotgun wad debris was found on Baker Beach in San Francisco, California. Photo: Kate Bimrose/Greater Farallones Association

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Executive Summary

Marine debris has become an increasingly important topic over recent years as ongoing research reveals rising impacts related to entanglement, ingestion, toxicity and chemical leaching, and habitat degradation. To address these impacts, government policies are targeting items of particular concern such as plastic bags, cigarettes, and straws. Monthly marine debris surveys conducted between 2012-2018 at six Greater Farallones National Marine Sanctuary beaches revealed similar trends with rope, straws, bottle caps, and shotgun wads as four of the most commonly found plastic items across all surveyed sites. Bottle caps, straws, and rope are considered non-point source items because they originate from different sources and cannot be traced back to a specific audience or location(s). Conversely, shotgun wads, a plastic component within shotgun shells, are a point-source item because they are tied to a specific demographic and likely originate from locations such as hunting reserves and shooting ranges along the San Francisco Bay shoreline or adjacent to river and slough tributaries that flow into the bay. This presents a unique opportunity for targeted initiatives within the hunting community to reduce their presence in the marine environment.

This pilot project implemented a behavior change campaign for reducing the abundance of shotgun wad debris on North-Central California outer coast beaches. Research identified two main behavior change pathways for reducing shotgun wad debris: 1) reduce plastic wad prevalence through wad retrieval, and 2) transition to biodegradable ammunition. Further investigation revealed several challenges associated with biodegradable ammunition including limited availability in stores, manufacturing and distribution scaling, and uncertainties over degradation rates and toxicity to the marine environment. To create lasting behavior change initiatives with a high likelihood of success and opportunities for evaluation, we identified the first pathway, wad retrieval, as our preferred behavior, and waterfowl hunters as our target audience. The resulting project goal was to reduce plastic shotgun wad debris from entering San Francisco Bay and depositing onto coastal beaches through behavior-changing strategies that encourage wad retrieval at two hunting reserves in San Francisco Bay; Don Edwards San Francisco National Wildlife Refuge (Don Edwards) and Eden Landing Ecological Reserve (Eden Landing).

Central to the campaign and critical for developing effective behavior-changing strategies, was understanding the factors that influence hunter beliefs and motivations, which drive their action or non-action toward the desired behavior. Understanding the factors that shape behavior is an effective, although not widely tested, method for achieving desired behavior change in order to address environmental issues such as marine debris. Examples of these factors, or determinants, include social norms (the behavior is accepted by one's social network), perceived action efficacy (the behavior will help solve the problem), and perceived severity (the problem is important or serious). To identify the factors that have the biggest impact on hunter behavior, we developed a determinants analysis survey and disseminated it both online and in-person at Don Edwards and Eden Landing.

Determinants Analysis Results

Survey results identified several determinants in support of the desired behavior including:

1) high willingness and belief in peer approval for picking up wads, and 2) high concern for litter and pollution. Survey responses placed hunters in either the “Doer” (they actively retrieve wads) or “Non-Doer” (they do not pick up wads) category. The determinants analysis also revealed misconceptions amongst hunters. For example, some hunters believed that other hunters did not pick up wads, while survey results indicated the opposite was true. Survey results also identified a lack of knowledge surrounding the issue, as many hunters did not know that wads are one of the most commonly found plastic items on local outer coast beaches. In addition to misconceptions and lack of awareness, lack of visibility and inaccessibility to discarded wads were identified as top reasons for not picking them up.

Information gained through the determinants analysis, alongside consultation with reserve managers, helped us develop strategies that addressed the barriers and emphasized the benefits of the desired behavior – retrieving plastic shotgun wads. Two strategies were designed to: 1) address hunters’ values surrounding litter and pollution, 2) raise awareness of the problem of shotgun wad debris, and 3) establish a social norm of picking up wads. These strategies included the use of signage and wad receptacles, such as single and voting-style options, which were installed at Don Edwards and Eden Landing for three weeks in January, 2020.

Strategy Results and Evaluation

To monitor and evaluate each strategy, we counted all wads and shells collected in the receptacles and provided them to TerraCycle to be upcycled into future products. The number of wads collected in each receptacle represented the only quantitative marker demonstrating a reduction of shotgun wads entering the marine environment. After installation, we also conducted in-person interviews and follow-up surveys. Survey comparison before and after strategy implementation appeared to indicate a net positive behavior change. This included:

- Increase in the percentage of Doers (from 60% to 85%)
- Increase in hunters who are “extremely willing” to pick up wads (from 47% to 68%)
- Enhanced awareness of the problem of plastic wads (from 29% to 47%)

Conversely, the strategies also revealed challenges associated with effectiveness and evaluation. For example, although the strategies suggested a favorable shift in behavior, the sample size was small and findings could have been influenced by many factors. We identified several factors that likely influenced strategy effectiveness, including:

- Location of signage and receptacles
- Time of day
- Length of time the signage and receptacles were available
- Existing hunter habits
- Signage and receptacle design
- Frequency of monitoring/emptying of receptacles

Interviews and surveys conducted after implementation demonstrated that hunters liked the general design of the receptacles, with more hunters using the voting-style rather than single-style receptacles. Feedback from hunters and reserve managers suggested the receptacles be bigger and more noticeable, with larger holes for depositing more wads at once. It was also important to consider how hunters moved through each particular hunting location and where they were most likely to find and pick up wads. Hunters recommended receptacles be placed in more convenient locations such as near the bathrooms, other garbage cans, and in parking lots where hunters pack out. To correct misconceptions that fellow hunters do not pick up wads and to establish a social norm that encourages wad retrieval, each receptacle was installed with some wads already deposited inside. Nevertheless, one hunter suggested filling the receptacles halfway with wads to further influence hunter use. This would require more frequent monitoring and counting or removal of wads in each receptacle to prevent overflow.

To increase awareness of the problem, signs educated hunters that wads are one of the four most commonly found items on local outer coast beaches. Although awareness alone is usually not enough to drive behavior change, during a follow-up survey one hunter remarked, “Public outreach seems to be the best answer. I had never thought about it before taking the previous survey and although it is easy to forget to pick them up, it is at least on my mind now.” Overall, hunters thought signage was a good idea and helped heighten awareness of the wad problem, but many indicated that they could get overlooked if additional signs were posted in the same area. Hunters also missed signage during early morning hours when hunting conditions may be preferable, but lack of sunlight prevented the signs from being seen. This highlights the importance of sign placement, effective messaging, and even printing on brightly colored paper in order to increase visibility and effectiveness. Because it is extremely difficult for a hunter to spot and retrieve their own wads, language encouraging a culture of cleanliness or duty to fellow hunters can increase the likelihood of hunters picking up wads discarded by others. Lastly, because it is easy for hunters to forget to pick up wads even if they are aware of the problem, it is worth installing and monitoring additional signs and receptacles to prompt them continuously and make it easier for them to engage in the desired behavior.

Biodegradable Ammunition

By focusing on wad retrieval through direct hunter engagement we also performed preliminary investigation into the second identified pathway for reducing shotgun wad debris; transition to biodegradable wads. Through surveys and interviews we were able to query hunter willingness and interest in purchasing biodegradable wads, should they become readily available. This lent insight into the barriers preventing biodegradable ammunition used by hunters, spread awareness about the existence of biodegradable ammunition, and helped bolster the demand needed in order to mass produce, and effectively price, biodegradable ammunition. Sections of this report (Lessons Learned and Future Directions and Planning) dive further into the topic of biodegradable ammunition and include suggestions for procurement of alternatives in retail stores, the role of policy and legislation, and bolstering manufacturing infrastructure.

Recommendations for Strategy Improvement

The Recommendations section provides several suggestions for: 1) implementing phase two of this pilot project, 2) scaling the selected strategies, and 3) options for hunting reserve managers to implement on their own. All recommendations build off of knowledge gained through project planning and implementation efforts as well as feedback from hunters and reserve managers.

Recommendations for phase two include:

- Promoting hunter engagement
- Improving existing strategies
- Enhancing data collection

Several recommendations for scaling up the selected strategies are also identified. These include:

- Increasing the size and number of receptacles
- Determining optimal placement
- Regularly changing voting-style options
- Considering new designs and messaging
- Testing combinations of different signage and receptacles

Additional recommendations are also developed for each reserve, with suggestions tailored to Don Edwards and Eden Landing based on their varying check-in and check-out procedures, and physical layout of each location. Recommendations to reserve managers are meant to be little to no cost or additional effort, on the part of reserve staff, but will still prove effective at reducing wad debris and encouraging shifts in hunter behavior. These include:

- Regularly recording and cleaning wad receptacles and nearby garbage cans
- Printing signage on neon paper
- Using hunter listservs to disseminate information
- Providing verbal reminders about retrieving wads
- Printing receptacle locations on hunter maps

This pilot project is an important first step for utilizing behavior change campaigns to address the issue of marine debris. Efforts to understand the beliefs and values of the waterfowl hunting community, and use those determinants to achieve a reduction in shotgun wad debris, proved to be an effective first phase for this campaign. This report can serve as a roadmap for addressing environmental issues through behavior change campaigns that design and implement strategies based on the beliefs and values that influence the behavior of the target audience. Lessons learned and recommendations stemming from this report can inform marine debris reduction campaigns in other locations facing similar impacts from point-source debris items. This report may also have broader applications for resolving other environmental issues through targeted behavioral campaigns.

Chapter 1: Introduction

In recent years the issue of marine debris has gained significant worldwide attention with increasing scientific research highlighting its pervasiveness and impacts to global marine habitat, species, navigation, and ecosystem health (Gregory, 2009 and Rochman et al., 2016). In response, governments, academia, and organizations have developed legislative, educational, and management strategies to address these impacts and reduce the amount of debris entering our coasts and oceans. State and national measures such as plastic bag bans (S.B. 270, 2013) and microbead bans (H.R. 1321, 2015) respectively, address debris types of particular concern. In northern California, plastic shotgun wad debris from waterfowl hunting was recently documented as one of the most commonly found items on several San Francisco Bay Area outer coast beaches (Bimrose, Lindquist, and Roletto, 2018). Like many debris items, shotgun wad debris is ubiquitous throughout the marine environment, yet the issue has received little to no attention (Benton, 1995; Montevicchi, 1991; Kanstrup and Thorsten, 2018). With the number of American waterfowl hunters reaching over two million people in 2016, the presence of shotgun wad debris compounds the already destructive impacts to coastal habitat (e.g., physical damage, shifts in chemical composition, decreased recreational value) and species (e.g., ingestion) resulting from marine debris (USDOJ, 2016). These impacts are of particular concern to Greater Farallones National Marine Sanctuary, a federally protected area of 3,200 square miles off the northern and central California coast.

From 2012-2018, the sanctuary, in partnership with NOAA's Marine Debris Program and Greater Farallones Association (GFA), monitored and recorded all man-made marine debris items at six coastal beaches along the sanctuary shoreline. The study compiled a first ever baseline of debris types and abundance on sanctuary shores. All data were uploaded to NOAA's Marine Debris Monitoring and Assessment Project (MDMAP) database, found at <https://mdmap.orr.noaa.gov>. The NOAA-managed database is a central resource for documenting debris deposition, and holds marine debris information from over 400 participating survey sites. Findings from sanctuary MDMAP surveys indicate plastic shotgun wad debris as one of the top 10 most commonly found items across all six surveyed beaches, with factors such as storm events and ocean currents contributing to wad deposition (Bimrose et al., 2018). Contrary to existing debris reduction efforts such as plastic bag and straw bans that address non-point source debris items, shotgun wads can be traced back to a particular demographic, in this case, waterfowl hunters.

As a result, in 2019 the sanctuary, GFA, and behavioral science non-profit Root Solutions, with funding from NOAA's Marine Debris Program, developed this pilot project to reduce shotgun wad debris on North-Central California coastal beaches. The project goal sought to reduce the amount of plastic shotgun wad debris entering San Francisco Bay and depositing on beaches through a behavior change campaign targeted at waterfowl hunters. The campaign identified the motivations and values of waterfowl hunters through a determinants analysis survey initiated by Root Solutions and analyzed how those factors influenced, or discouraged, hunter behavior regarding shotgun wad debris. Information stemming from the determinants analysis survey helped develop campaign strategies centered around increasing wad retrieval at two hunting

reserves within San Francisco Bay: 1) Don Edwards San Francisco Bay National Wildlife Refuge (Don Edwards), and 2) Eden Landing Ecological Reserve (Eden Landing). This report summarizes phase one of this pilot project including methods, strategy design and implementation, recommendations, and next steps.

Chapter 2: Methods

Effective campaigns, policies, and strategies that seek to motivate and sustain pro-environment culture depend on successful behavior change adoption. This is difficult to accomplish if you do not understand the values and perceptions of your target audience and how those factors drive, or inhibit, the desired behavior. Although many believe that the biggest barrier to behavior change is usually lack of awareness, this is often not the case (Lakoff, 2010). Generally, just because a person knows or wants to perform a behavior does not mean they will actually enact it: think about people who fail to exercise or eat healthy. Personal, social, and circumstantial factors determine behavior, which can form physical or mental barriers that, often unknowingly, prevent people from engaging in certain desired behaviors. All too often, many working on environmental issues use their own speculation to determine the “solution” that serves as the basis for campaigns, but this approach does not address the factors that truly influence behavior and perpetuate the issue.

A systematic way of determining barriers and benefits to behavior change is necessary for uncovering the root of the problem and developing lasting solutions. Campaigns are more successful when they include solutions that are co-created with the target audience whose behavior you are trying to change. To achieve this, we used a human-centered design approach with three phases, where each phase was interconnected and informed by the other two, resulting in a cyclical process. Together, these phases determined the project goal, target audience, desired behavior, and resulting suitable strategies for reducing the abundance of shotgun wad debris entering San Francisco Bay and depositing on outer coast beaches. Results from each of the three phases are described below.

Human-Centered Design Approach Phases:

1. **Initiation Phase:** Research the issue, learn from past initiatives, define the goal, and identify the target audience.
2. **Ideation Phase:** Brainstorm and evaluate potential desired outcome-producing behaviors that will help achieve the goal. Develop a determinants analysis survey to identify barriers to, and motivators of, the desired behavior.
3. **Design Phase:** Survey results inform strategy design, prototyping, and refinement in order to reduce barriers and amplify motivators needed to achieve lasting behavior change.

Strategies resulting from this process were implemented at two hunting reserves along San Francisco Bay, Don Edwards in Alviso, and Eden Landing in Union City (Figure 1). Strategies included signage and receptacles for collecting discarded shotgun wads. Collected wads were sent to [TerraCycle](#), a nation-wide recycling social enterprise, to be upcycled and re-used in future products. To evaluate strategy effectiveness, we compared hunter survey responses before and after strategy implementation, conducted in-person interviews, and solicited feedback from reserve managers. Evaluation results are described in Sections 6 and 7, alongside additional resources in Sections 8-10. Beginning in December 2019, we also conducted monthly MDMAP surveys at four sanctuary beach locations to observe depositional shifts in shotgun wad debris

resulting from strategies implementation through this project. Due to COVID-19 shelter-in-place requirements, MDMAP surveys were suspended on March 17, 2020.

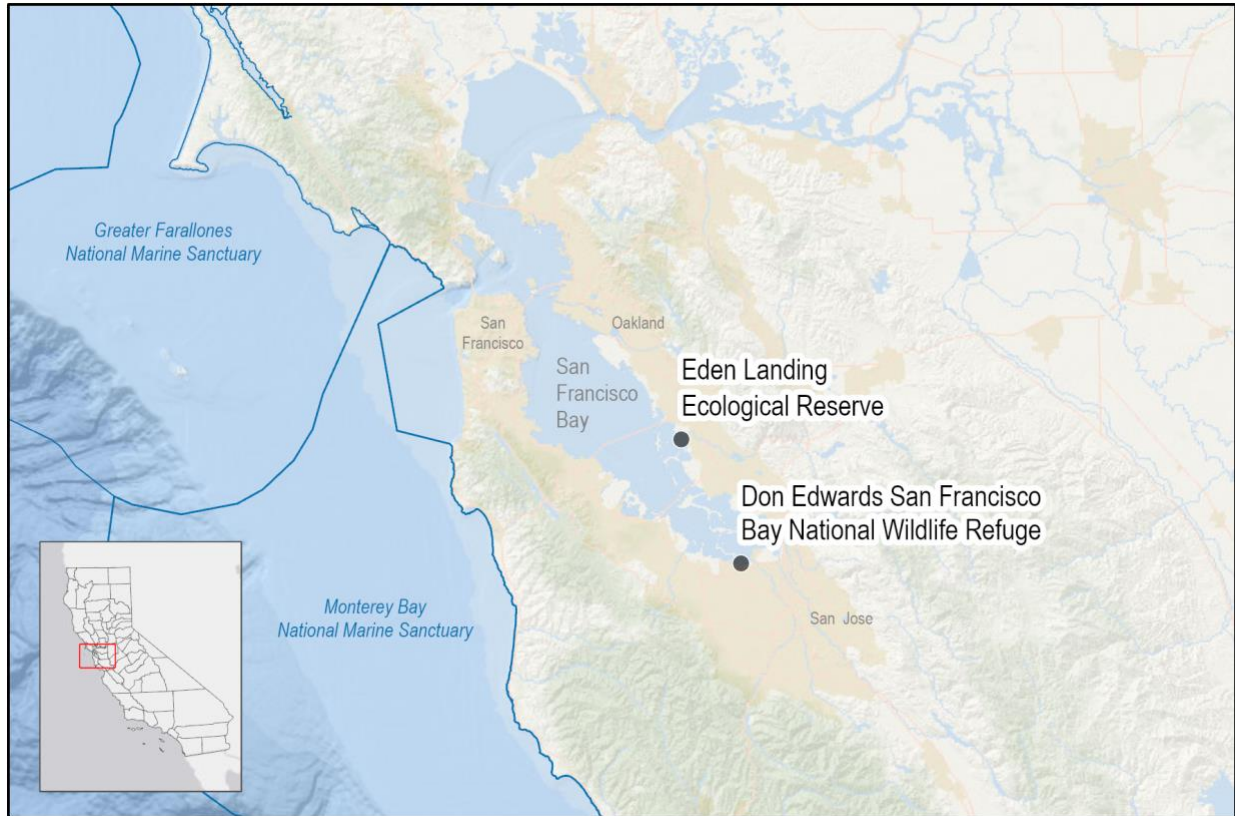


Figure 1: Location of Eden Landing Ecological Reserve in Alviso and Don Edwards San Francisco Bay National Wildlife Refuge in Union City, bordering San Francisco Bay. Credit: Sage Tezak/NOAA

Chapter 3: Initiation Phase

Information resulting from the initiation phase provided a clear understanding of the nature of the problem, the stakeholders involved, and the target audience. The initiation phase involved four interconnected steps: a) research the issue; b) learn from past initiatives; c) define the goal; and d) determine target audience. Knowledge gained here provided important guidance on the components of the problem, and associated audience groups, to prioritize in this behavior change campaign.

3.a. Research the Issue

Shotgun ammunition is composed of roughly five parts: the shell, shot pellets, wad, powder, and metal head with primer (Figure 2). Each wad sits inside the shell and separates the shot pellets from the gunpowder. Historically, wads were made of wool, felt, hair, cardboard, cork, or fiber. However, they did not protect the gun barrel from the steel shot, which made for inconsistencies in performance, and posed a fire danger as wads often smoldered after exiting the barrel of the gun. This, alongside affordability, quickly made plastic wads the preferred and ultimately ubiquitous alternative to natural wads. Other forms of ammunition such as biodegradable wads are used abroad, with several producers of non-plastic wads including Empire, Eley Hawk, Maxam (parent company of RIO) and Gamebore, serving European countries. Biodegradable ammunition, although available, is rarely used and difficult to access in the United States due to several factors including, but not limited to, high cost, variability in degradation rates, distribution challenges, and performance uncertainties (Biodegradable Shotgun Wads, 2020). Additional information regarding these factors, and suggestions for addressing them, is detailed in Section 10.



Figure 2: Photo of shotgun ammunition with plastic shotwad and pellets (left) and shotgun shell and powder (right). Source: *Shelled Out* by gfpeck, available under a Creative Commons Attribution-NoDerivs 2.0 Generic License at <https://www.flickr.com/photos/wespeck/4434356844>. For more information see <https://creativecommons.org/licenses/by-nd/2.0/>.

When a shotgun is fired, the shell, or hull, exits the ejection chamber of the gun and drops in close proximity to the hunter, while the wad exits the barrel of the gun traveling at least 20 yards in front of the shooter (What You Should Know, 2018). This, along with their clear plastic coloring, make wads very difficult to retrieve while hunting waterfowl as they often land in waterways or densely vegetated sloughs and marshes. Once marine debris, wads are mistaken as squid by seabirds, used as materials for birds' nests, and even found in the stomachs of deep-diving cetaceans (Montevecchi, 1991 and Lusher et al., 2015). Wads, like all plastic debris, can also physically damage coastal habitats through abrasion or shearing, and their toxicity may be linked to changes in chemical composition of beach sediments and benthic habitat (NOAA, 2016). Over time, these items break down into microplastics, which can be ingested by smaller marine life such as fish, invertebrates, and microorganisms (NOAA, 2014). With millions of Americans hunting waterfowl each year on shoreline marshes, sloughs, and along tributary and riverine systems, the need to reduce shotgun wad debris from entering our waterways is ever increasing.

3.b. Learn from Past Initiatives

In addition to knowledge gained through researching the issue, learning from past examples of both successful and unsuccessful environmental campaigns can save time, effort, and resources. To gain information on previous shotgun wad debris initiatives we consulted with a series of academic, non-profit, and private organizations.

The Surfrider Foundation San Francisco chapter has taken up the issue of shotgun wad debris through discussions with stakeholders, public presentations, and wad tracking as part of their Wad Watch Program, available at <https://sf.surfrider.org/shotgun-wad-watcher/>. Since March 2019, data collected through this program has identified the date and beach location of thousands of wads across 12 different countries. An analysis by University of California at Berkeley students in partnership with Surfrider added further information about the challenges associated with the production and accessibility of biodegradable ammunition (Kearney and Wood, 2019). The analysis provided a high-level summary of hunter barriers to purchasing and using biodegradable shotgun wads, and identified cost, performance, and availability as the areas of highest concern for local hunters. From the students' perspective, "...policy options would be received negatively by the shotgun community. Thus, organizations invested in reducing pollution from shotgun wads should focus on educational efforts within the hunting and target shooting communities to raise awareness of biodegradable alternatives and encourage the adoption of biodegradable wads for conservation and performance reasons."

The project team also consulted with Jason McDevitt, director of the Technology Transfer Office at William and Mary's Virginia Institute of Marine Science, and CEO and founder of alternative ammunition company GreenOps Ammo. Jason detailed some of the manufacturing challenges associated with developing and scaling biodegradable ammunition. For example, manufacturers that produce plastic ammunition will need to develop new injection molds to accommodate biomaterials, each of which cost up to \$250,000. Because bio-wads are made and tested using various water soluble and degrading materials, the number of wads and the speed of production per mold can vary. Capital needed to produce biodegradable wad material is also expensive. Wads made of biopolymer material produced by GreenOps Ammo are significantly more

expensive than conventional polyethylene plastic wads, and can easily add 5¢ or more per shotshell. In order to reduce or regain these upfront costs, manufacturers must have capital to transfer equipment and ramp up production, combined with demand from the consumer which has yet to be seen in the United States.

3.c. Define the Goal

Background research and consultation with experts provided a strong foundation for evaluating wad reduction strategies with the highest leverage and likelihood of success. As a result we identified two main pathways for addressing the problem of shotgun wad debris in waterways: 1) reduce plastic wad prevalence through wad retrieval by hunters, and 2) transition to biodegradable wads.

As mentioned, hunter barriers associated with biodegradable ammunition include concerns over their cost, performance, and availability. Behavioral campaign strategies can be used to overcome cost concerns, but ultimately these are best achieved on the supply and manufacturing side through economies of scale. Overcoming performance concerns can also be enacted through behavior-changing strategies, such as demonstration events for hunters to test fire and compare different traditional and biodegradable ammunition. While some availability issues are on the supply side, strategies that encourage retailers to purchase and promote biodegradable ammunition, can be addressed through behavioral awareness and outreach. Although many of these strategies require funding and time beyond the scope of this pilot project, they are highlighted in Sections 8 and 10. In consideration of the limited resources available for this project, wad retrieval was selected as the priority pathway with the highest probability of achieving effective behavior change in order to reduce the abundance of shotgun wad debris entering waterways.

3.d. Determine the Target Audience

Identifying the appropriate target audience (e.g., people, organizations, policy institutions associated with the issue) helps achieve maximum effectiveness. When researching the issue, three potential target audiences were identified: 1) ammunition manufacturers and policymakers, 2) hunting range/reserve managers, and 3) hunters or shooters.

Ammunition Manufacturers and Policymakers

Shotgun ammunition manufacturers influence the issue because they produce and distribute the plastic shotgun wads that enter waterways and impact marine ecosystems. In the U.S., very few major ammunition manufacturers currently produce and stock biodegradable shotgun ammunition in stores. RIO's Royal Eco Blue Steel line, although available at their Marshall, Texas factory, are not available in stores and must be ordered and shipped directly to consumers. Others like GreenOps Ammo, are searching for opportunities to work directly with private manufacturers or partner with larger ammunition companies to produce and stock their product.

Policymakers influence this issue on several levels, such as the 2016 California Safety for All Act (S.B. 1235, 2016) that regulates the sale and transfer of ammunition, including eligibility checks

for possessing ammunition and required vendor licenses for selling ammunition. Phase two of California Prop 63 took effect in July 2019, making it illegal to buy shotgun ammunition online and to use any waterfowl hunting ammunition containing lead. California state law requires ammunition to be purchased face-to-face from a Federal Firearm Licensed Dealer or licensed ammunition vendor following an eligibility check. Although not impacting the use of plastic shotgun wads, the law limits purchasing to local suppliers, eliminates hunter's ability to purchase biodegradable alternatives online, or purchase them out of state and bring them back to California.

Ultimately, we did not select California policymakers and ammunition manufacturers as the target audience for this pilot project. However, in order to better understand the broader issues related to availability of biodegradable ammunition, we developed a secondary component of this project through a graduate-level course at the Middlebury Institute of International Studies (MIIS). Students in the Behavior Design for Sustainability class examined barriers associated with procurement of biodegradable wads at retail stores and developed potential strategies to address these obstacles. The students' findings and recommendations, as well as additional suggestions for addressing issues related to manufacturing and policy, are further discussed in Section 10.

Hunting Reserve Managers

Federal and state-run hunting reserves are managed through several agencies including the National Park Service, California Department of Fish & Wildlife, U.S. Fish and Wildlife Service, Bureau of Land Management, and Bureau of Land Reclamation. These entities are unable to stock or sell ammunition or promote ammunition name brands, and thus, have limited control over the ammunition used on their land. Similarly, reserve managers and enforcement staff have limited ability to monitor hunter retrieval of shotgun wads, nor the time available to look for and retrieve wads themselves. However, managers do have the authority to implement measures that influence the abundance of wads entering the marine environment, such as signage and disposal equipment.

Although we did not choose the managers themselves as the target audience, they were an important and "unofficial" audience that provided critical feedback for this project. Reserve managers from Don Edwards and Eden Landing supported shotgun wad debris reduction and partnered with us to implement strategies on their hunting grounds. As a result of this project, both managers kept and will continue to implement strategies developed through this campaign. As gatekeepers of their institutions, reserve managers provided insight into hunter behavior on their grounds and expressed a unique perspective on the beliefs and values that drive the broader hunting community. Ongoing consultation regarding the development and implementation of strategies also provided insight about the challenges managers face with respect to the issue of wad debris within their jurisdiction.

Hunters or Shooters

Given the above information about policymakers, manufacturers, and reserve managers, we determined that either waterfowl hunters or recreational shooters (or both) would be the most appropriate target audience for this project. Recreational shooters include those who visit

indoor or outdoor shooting range facilities and skeet or clay target ranges. These facilities are permitted to sell their own ammunition, although it must be fired at the facility and cannot leave the premises. Additionally, ammunition used for clay targets differ from waterfowl ammunition, and shooters who visit other range facilities use firearms, and corresponding ammunition, other than shotguns. It appears that overall, shooting ranges do not have a large impact on the local shotgun wad debris problem, as most facilities are indoor or inland from water bodies and tributaries. We identified only one public shooting range, the Richmond Rod and Gun Club, adjacent to the San Francisco Bay shoreline. On the other hand, many waterfowl hunting reserves are directly adjacent to the bay or along rivers and tributaries that empty into the bay, and subsequently the outer coast. Based on these facts, we identified the primary audience for this project to be waterfowl hunters.

Thanks to research gained through each step of the initiation phase, we identified the preferred outcome (reduced shotgun wad debris), desired behavior (wad retrieval), and target audience (waterfowl hunters) for this project. The resulting goal for this project was to reduce the amount of plastic shotgun wad debris entering San Francisco Bay waters and depositing on coastal beaches through the implementation of behavior changing strategies for hunters at two Bay Area hunting reserves, Don Edwards and Eden Landing. By focusing on wad retrieval through direct hunter engagement we also performed a preliminary investigation into the second identified pathway for reducing shotgun wad debris; a transition to biodegradable wads. Throughout this campaign hunters were queried on their willingness and interest in purchasing biodegradable wads, should they become readily available. This leant additional insight into the barriers preventing biodegradable ammunition use, spread awareness about the existence of biodegradable ammunition, and helped bolster the demand needed in order to mass produce and effectively price biodegradable ammunition.

Chapter 4: Ideation Phase

The ideation phase identified and evaluated different distinct outcome-producing behaviors and uncovered the determinants (i.e., motivators and barriers) of those behaviors through a determinants analysis survey. An outcome-producing behavior is the “end-state” behavior (McKenzie-Mohr, 2011), or behavior that comes last in a sequence of behaviors, that must be completed by the target audience in order to achieve the desired outcome — the reduction of shotgun wad debris. Outcome-producing behaviors are selected based on their ability to create lasting impact, likelihood of success, and opportunity for evaluation. From this phase, we identified retrieval of shotgun wad debris as the desired outcome-producing behavior and analyzed the primary barriers and motivators that influence this behavior in hunters.

4.a. Identify and Evaluate Outcome-Producing Behaviors

We identified three outcome-producing behaviors associated with a reduction in shotgun wad debris:

1. Hunters pick up their own wads during or after their hunting sessions
2. Hunters pick up any wads (theirs or others) during or after their hunting sessions
3. Hunters use biodegradable wads

To prioritize and select a final preferred outcome-producing behavior, we evaluated each of the three behaviors using this set of criteria: impact potential of behavior change, likelihood of success (probability of adoption and organizational effort required), and ability to evaluate (observe and measure) the target behavior.

Impact Potential

It was difficult to compare the beneficial impact to the environment generated by hunters picking up their own shotgun wads or others’ shotgun wads, compared to the use of biodegradable wads. Ultimately, picking up *all* wads before they enter the marine environment would be more beneficial to the ecosystem than allowing biodegradable wads to enter water bodies and impact marine resources prior to degradation. Variation in the properties and additives used in making biodegradable ammunition also create variation in the time needed to degrade these items, especially when exposed to different temperatures and landscapes. There is considerable debate as to the extent that biodegradable products actually do biodegrade (i.e. the original polymer is completely removed through microbial action) as well as uncertainty surrounding impacts to the environment concerning the leaching of chemicals and toxins as these products breakdown (UNEP, 2015). Further detail regarding this variation in biodegradable ammunition is described in Section 10.

Likelihood of Success

While picking up wads can be challenging, the lack of commercially available biodegradable wads and the current California law that prohibits online ammunition purchasing, made the use of biodegradable wads (outcome-producing behavior option 3) even more difficult to adopt. As

discussed earlier, the effort required to change current policies and adopt manufacturing processes that encourage biodegradable wads surpasses that of the more individual-focused effort to encourage hunter retrieval of their, or others', wads. Because wads travel at least 20 yards from the shooter, often over dense or watery terrain, the likelihood of finding one's own wad (outcome-producing behavior option 1) has a much lower likelihood of success than spotting spent wads that have washed ashore (outcome-producing behavior option 2).

Ability to Evaluate

Tracking the purchase of biodegradable shotgun wads is likely easier to monitor than tracking wad retrieval by hunters. Thus, *if* biodegradable wads had been readily available, option 3 may have been the chosen behavior, or part of multiple behaviors, to target for this project. However, we did identify several ways to evaluate hunter retrieval such as self-reported information (e.g., asking hunters if/when/how many wads they picked up), and monitoring the number of wads collected or removed through various implemented strategies.

After comparing the three potential outcome-producing behaviors, we selected option 2: Hunters pick up any wads (theirs or others) during or after hunting sessions, as the preferred behavior to best achieve the desired outcome.

4.b. Identify Determinants of Behavior

Research and consultation identified various components of the shotgun wad debris issue. We developed the overall project goal, which encompassed the project location (Don Edwards and Eden Landing hunting reserves), the audience (waterfowl hunters), and the desired behavior (picking up any wads), based on this information. The next task was to identify the determinants of behavior, which are factors that influence, or hinder, the behavioral choices or actions of waterfowl hunters.

Understanding the personal, social, and situational barriers that prevent waterfowl hunters from adopting the desired behavior informed the type and design of strategies implemented through this project. Taking the time to learn about waterfowl hunters' values, beliefs, and perceived motivators uncovers the influences that drive hesitation and opposition, as well as enthusiasm and support, towards the desired behavior. The focus can then shift toward designing strategies that are most likely to overcome the identified barriers and strategically communicate the benefits of the desired behavior change. A strategy that does not meet the needs of, or resonate with, the target audience is likely to fail.

The best way to identify factors that have the biggest impact on target audience behavior is through a determinants analysis, wherein Doers and Non-Doers of the desired behavior are identified through interviews, surveys, and observation. Examples of these factors, or determinants, include social acceptability and norms (i.e., whether the behavior is accepted by one's social network), perceived action efficacy (i.e., belief that the behavior will help solve the problem), perceived severity (i.e., whether the person thinks the problem is important or serious), and perceived self-efficacy (i.e., whether the person thinks they have the ability to perform the behavior).

4.c. Determinants Analysis

Our determinants analysis process included developing, disseminating, and analyzing a waterfowl hunter survey administered by Root Solutions to uncover motivations of behavior through a series of curated questions. Root Solutions first disseminated a pilot determinants analysis survey to each reserve manager, and both online and in one-on-one interviews to a group of hunters in our target audience and each of the reserves managers in order to gain an initial understanding of behavioral drivers. The pilot survey gathered important feedback on question content, topic, length, and ordering. Root Solutions then created and disseminated a final version of the determinants analysis survey to Bay Area residents with hunting interests through online forums including [Reddit.com](#) Waterfowl and Bay Area groups, [Rokslide Game Birds](#) forum, and [Hunting.net](#) forum. The survey was also advertised through video and still image ads on Facebook and Instagram. Although unable to determine how many people actually qualified to take the survey, these online videos and still image ads reached a total of 7,069 people. Surveys were also administered in-person at Eden Landing and Don Edwards (see Appendix B). In total 76 surveys were completed; 45 were completed through in-person surveys (22 at Don Edwards, 23 at Eden Landing), and 31 were completed through online surveys. Of the surveys administered in-person, all hunters were approached during each survey day. In total only two hunters who were approached did not take the survey.

It is important to note that a few survey-takers did not answer all of the questions due to factors such as limited time, low interest, or sensitivity to the topic. This is reflected in results below where total responses were less than 76. In order to encourage as much participation as possible, when administering surveys in-person we gave hunters the flexibility to answer a selected number of the most important questions, which we indicated on the survey with an asterisk. These included questions that qualified the survey-taker (do you hunt waterfowl?), determined if they were a Doer or Non Doer (do you pick up shotgun wads?) and open-ended questions that asked the barriers to, or benefits of, picking up shotgun wads. Understanding concern for hunters' time and sensitivity around the topic of hunting, management from Eden Landing requested that we disseminate a truncated survey, which consisted of those same asterisked questions (see Appendix B). When determining the fewest, most critical questions to include on a determinants analysis, survey administrators should always include two open-ended questions that ask about the benefits and barriers of performing the desired behavior. Written answers directly from the target audience can provide detailed insight into their beliefs, motivations, and inhibitions.

For this project, questions in the determinants analysis survey sought to understand factors such as perceived self-efficacy, perceived social acceptability and norms, perceived severity, and perceived action efficacy, all of which impact hunter behavior. To determine perceived social acceptability and norms, we asked hunters "How likely are your peers to approve of you spending a few minutes picking up shotgun wads?" Those that said their peers were somewhat or extremely likely to approve indicated that they perceive the action of picking up shotgun wads as socially acceptable. We also asked hunters "What percentage of waterfowl hunters do you think pick up at least one shotgun wad during or after hunting?" Responses to this question reflected whether people thought picking up wads was the social norm amongst hunters. In

order to determine perceived severity (i.e., perception that the problem is important), we asked hunters about their awareness of the problem and their level of concern.

In addition to determining influences on hunter behavior, responses to survey questions also placed hunters in either the Doer or Non-Doer category. Doers were hunters who picked up wads on one or more days they hunted during a typical season. Non-Doers were hunters who have not picked up wads on any day they hunted during a typical hunting season. To identify the Doers and Non-Doers, we asked hunters how frequently they picked up shotgun wads during a typical hunting season. Of the 76 total respondents, 43 were Doers (57%) and 33 were Non-Doers (43%).

Summary of Survey Results

Analysis of the survey results showed a high willingness to pick up wads (95% of hunters, including 88% of Non-Doers); strong beliefs in peer approval for picking up wads (85%); and many hunters perceive a positive impact from picking up wads (71%) (Figure 3). This indicated that the hunting community largely supports the target behavior, the act of retrieving wads. One hunter remarked, “If everyone did their part, it would have a big impact.” Concern for litter and pollution was also a high motivator amongst hunters (Figure 4). Not only did hunters report pollution reduction as the main benefit to picking up wads, it was also the top reason given for picking up shells (Figure 5). Out of 69 hunters, 80% were not aware that plastic shotgun wads are one of the most commonly found plastic items on Bay Area outer coast beaches, and 41 out of 51 (80%) expressed concern over the issue of wad debris. Most Doers (67%) reported no downsides to picking up wads, whereas 69% of Non-Doers reported downsides, citing “lack of access” (e.g. accessibility to wads in rough terrain or water bodies) (59%) and “visibility” (25%) as the top barriers to wad retrieval. 95% of Non-Doers also held the misconception that most other hunters do not pick up their wads, while in reality 57% reported otherwise. Additionally, Non-Doers (42%) were two times more likely than Doers (21%) to task manufacturers, distributors, and retailers with the responsibility of solving the plastic shotgun wad debris problem. Although we did not address this issue through strategy implementation, further investigation into manufacturer, distributor, and retailer responsibility is discussed in Section 10. Additional results from the determinants analysis survey provided further insight into the motivators and barriers associated with Doer and Non-Doer hunter behaviors (see Appendix C).

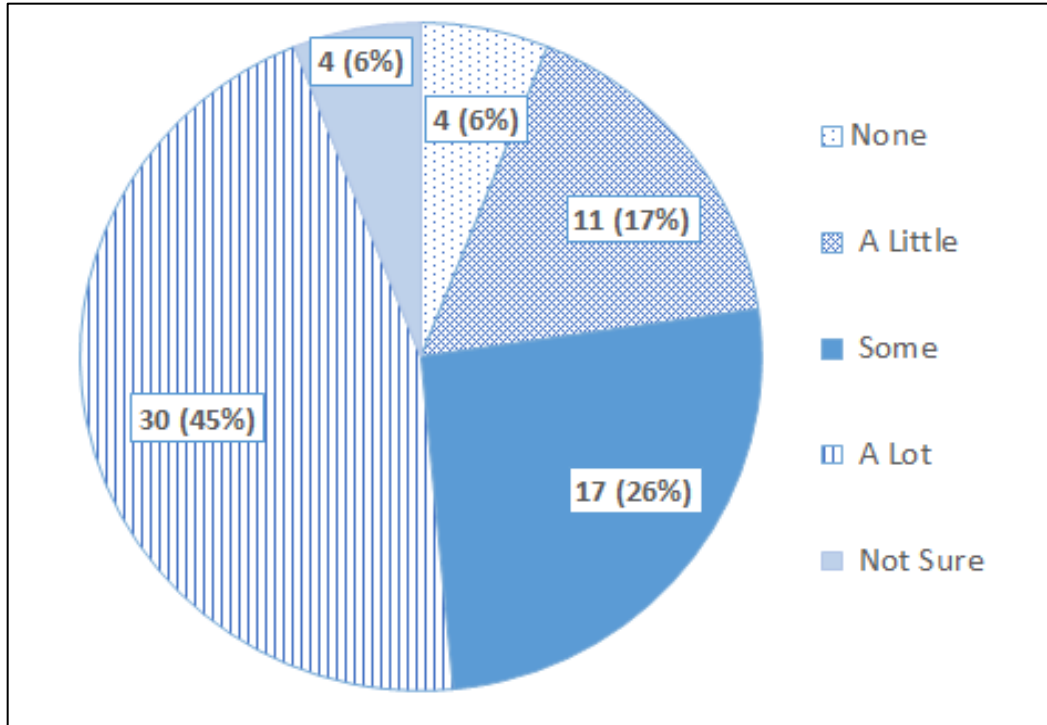


Figure 3: Determinants Analysis Survey Response: “How much positive impact do you think spending a few minutes picking up shotgun wads will have on our waters?” Pie chart demonstrates that 71.2% of hunters think picking up wads will have “some” (25.8%) or “a lot” (45.5%) of positive impact on our waters. Credit: Root Solutions

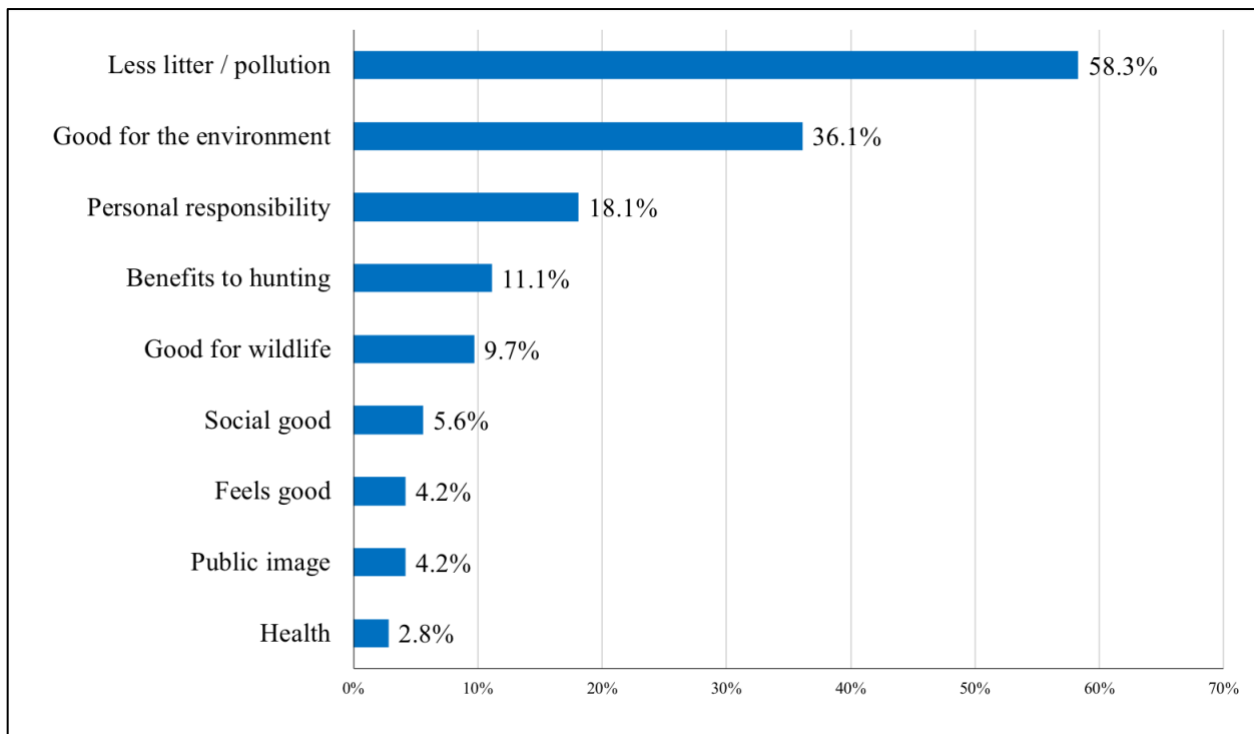


Figure 4: Determinants Analysis Survey Response: Benefits of spending a few minutes picking up shotgun wads during or after hunting. 58.3% reported “less litter/pollution” as a benefit to picking up wads. 36.1% reported picking up wads was “good for the environment.” Credit: Root Solutions

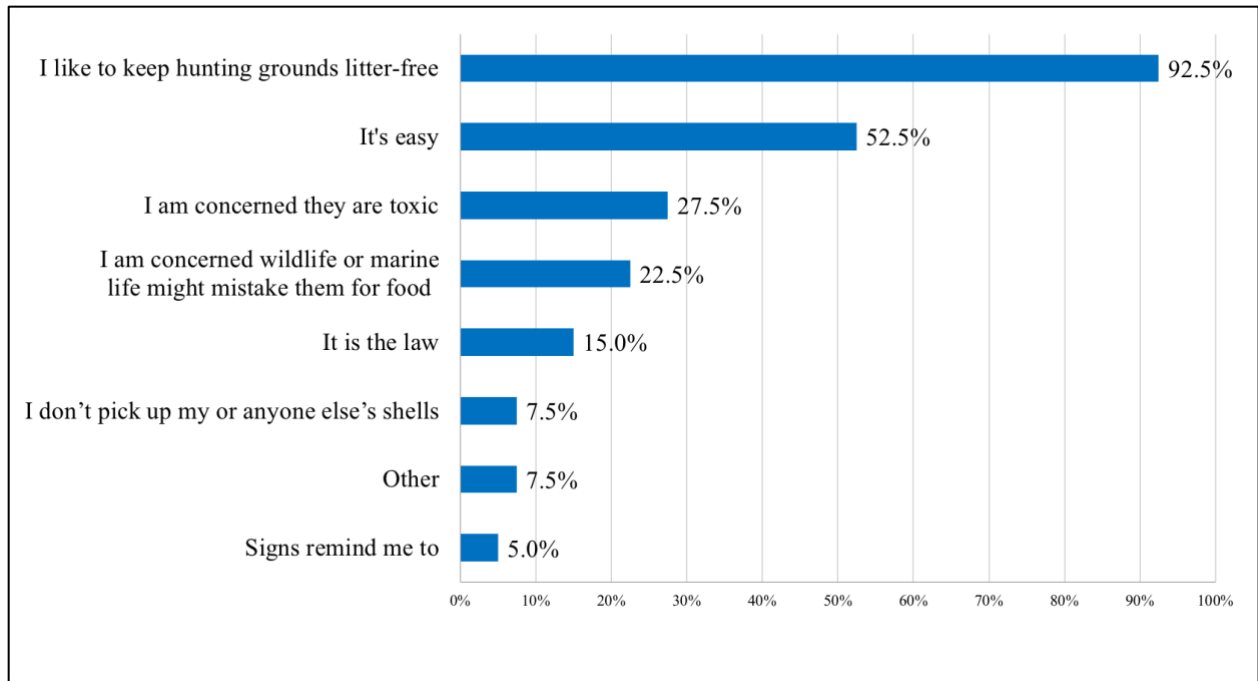


Figure 5: Determinants Analysis Response: Main motivations for picking up shotgun shells (not wads). 92.5% hunters said their main motivation for picking up shotgun shells was “to keep hunting grounds litter-free,” and 52.5% said they pick up shotgun shells because “it’s easy.” Credit: Root Solutions

Chapter 5: Behavior Change Strategies

Information gathered from the initiation and ideation phases culminated in the determinants analysis survey and identified a number of factors that contribute to Doer behavior, including: social acceptability, concern for litter and pollution, and unfamiliarity with wads as a common debris item found on local outer coast beaches. Of equal importance were barriers to the desired behavior reported in Non-Doer survey responses such as visibility and ease of access. Keeping these factors in mind we designed strategies to increase the desired behavior in Doers and establish the desired behavior in Non-Doers.

5.a. Strategy Design

Once we identified the barriers and motivators for the desired behavior, we developed a suite of strategies to overcome those barriers and/or amplify the motivators, including:

- Signage
- Wad receptacles
- Presentations and messaging at hunter orientation meetings and in online communications
- Commitment or pledge campaigns
- Hunter cleanup days and competition events at hunting reserves
- Messaging on printed maps and permits
- Retrieval tools to make it easier for hunters to pick up wads
- Recruiting hunters who are passionate about picking up wads and influential in the hunting community as ambassadors for the desired behavior

We discussed and reviewed all suggested strategies with reserve managers at Don Edwards and Eden Landing to confirm which options were preferred at each site. Due to timing restrictions (i.e., waterfowl hunting season is roughly four months from October through January), budget and feasibility, and availability of the reserve managers, implementation efforts focused on the following two strategies: signage and receptacles. Additional information on strategies not implemented by this project are detailed in Section 8.

Signage

Survey results revealed motivators, barriers, and hunter values, which we incorporated into effective messaging that would shift hunter behavior toward picking up wads. Non-Doers mistakenly assumed that most hunters do not pick up their wads, which we corrected by utilizing normative language highlighting how other hunters *do* pick up wads, such as “Hunters leave no trace” and “The majority of hunters pick up shotgun wads when they see them” (see Appendix D). These messages created a social norm, or accepted behavior, which can be a motivating factor of behavior change because it provides a standard by which people compare their own behavior. This makes decision-making quicker and easier while tapping into their desire to fit in with those around them (Schultz et al, 2007).

Non-Doers reported low visibility and inaccessibility as barriers to picking up wads. We developed signage to acknowledge the difficulty of finding wads and shifted focus from finding their own wads to picking up *any* wads. We exemplified this in signage asking hunters, “Spot a wad? Pick it up!” (Figure 8) and through visuals such as imagery of a magnifying glass (Figure 9).

Addressing hunters' high concern for litter and pollution, we developed messages such as the “leave no trace” slogan (Figure 8). Survey results also showed a lack of awareness of the plastic wad problem, although it is important to remember that awareness alone is usually not enough to drive behavior change. Nevertheless, hunters indicated support for raising awareness so we developed messaging and visuals stating “Did you know? Shotgun wads are one of the four most common plastic items found across outer coast beaches” (Figure 8). Examples of additional signage and the motivations and values associated with each message is further described in Appendix D.

Wad Receptacles

Survey results indicated that hunters have a sense of responsibility and desire to keep hunting areas clean. Transparent wad receptacles tapped into these values and served as a vivid reminder to pick up any wads in order to keep hunting grounds free of litter (Figures 8 and 10). Studies have found that people are more likely to litter when their environment is visibly scattered with garbage — depicting a pro-littering social norm — compared to when their surroundings are clean and well-maintained (Cialdini, Reno, and Kallgren, 1990). Visually seeing the wads inside the receptacles showed hunters how their efforts make a difference in reducing the occurrence of plastic wads entering nearby waters. This connects action to impact and provided immediate gratification for hunters who deposited wads in the receptacles. This also helped correct the Non-Doers' mistaken assumption that other hunters do not pick up wads, and created a social norm that promotes wad retrieval. The project team also felt that hunters would be more motivated to use the receptacles if they were fun. Usage of “ballot bins,” a combination of a disposal bin with a public opinion poll, to encourage proper disposal of cigarette butts in the UK has been shown to reduce cigarette litter by up to 46% (Reducing Cigarette Butt Litter, 2018). We developed receptacles that engaged hunters by allowing them to “vote” with their shotgun wads on something they care about, their favorite duck species. This allowed hunters to participate in an activity amongst their peers and motivated them to engage in the target behavior of picking up wads while associating that behavior with a fun activity (i.e., voting) (Figure 10).

Signage and Receptacle Placement

Placing receptacles in locations where hunters frequent such as check-in stations, prompted hunters to enact the desired behavior at the appropriate location and made it easier for them to dispose of wads when they found them. Since hunters at Don Edwards and Eden Landing must sign in when they arrive, signs displayed at the check-in stations served as a cue for action to prompt hunters at the appropriate time and space. Seeing signs at the point of decision reminded hunters to look for wads when they were in the field and helped them build the new habit of picking up wads as they were spotted.

5.b. Prototype and Installation

After identifying receptacle and signage locations, the next step in the process involved prototyping. To do this, we sketched various receptacle designs and developed signage messaging and layout options (See Appendix D). Prototypes served as a litmus test to assess hunter and reserve manager response to each design, and identified necessary changes to make both quickly and affordably, before constructing the final products. Coordination with reserve managers provided a clear understanding of where the receptacles and signs would be placed, how they would be installed, desired sizes and quantities, messaging and layout approval, and receptacle maintenance requests. With these parameters in mind, preferred designs were selected and the final signs and receptacles were developed.

Final Strategies

Receptacles and signs were installed at each hunter check-in station, including one receptacle and two signs at Eden Landing (Figure 6) and three receptacles and six signs at Don Edwards (Figure 7) for a total of four receptacles and eight signs. At Eden Landing, we provided a moveable floor standing ballot box-style receptacle near the check-in kiosk and left laminated signs for the reserve manager to post on the kiosk at his discretion (Figure 8). At Don Edwards Pond A5/A8, we nailed a sign inside the check-in station and installed a voting-style receptacle on the outside of the kiosk, facing the water (Figure 10). At Pond AB1/AB2, we nailed a sign inside the check-in station kiosk and installed a voting-style receptacle on the outside of the station kiosk facing the road (Figure 11). At Pond A3W, we nailed a sign to the bulletin board outside the check-in station and installed a non-voting receptacle inside the station kiosk (Figure 12).

All receptacles and signs at Don Edwards and Eden Landing were installed from January 6-7, 2020. We fastened receptacles inside check-in stations where available room existed so as not to interfere with hunters' signing in or filling out hunter cards. We installed other receptacles on the outside of kiosks, positioned in a direction so as to intercept the most hunters. To set a norm for hunters, we placed 10 shotgun wads into each receptacle compartment during installation to set an example of how the receptacles should be used (Figure 10). The wads also provided a vivid reminder to hunters to pick up wads as they saw them. The reserve manager at Eden Landing oversaw placement of the stand-up ballot-style wad receptacle and posting of signs during each hunt day. Signs and receptacles at Don Edwards were fixed to the walls at the check-in stations and required no management. We did not empty any of the receptacles prior to the end of the hunting season.



Figure 6: Strategy Implementation at Eden Landing. Map of Eden Landing with red star indicating location of sign and receptacle installation at check-in kiosk. Credit: Sage Tezak/NOAA and Esri ArcGIS Pro 2.7, Maxar. Greater Farallones National Marine Sanctuary. June 24, 2020.

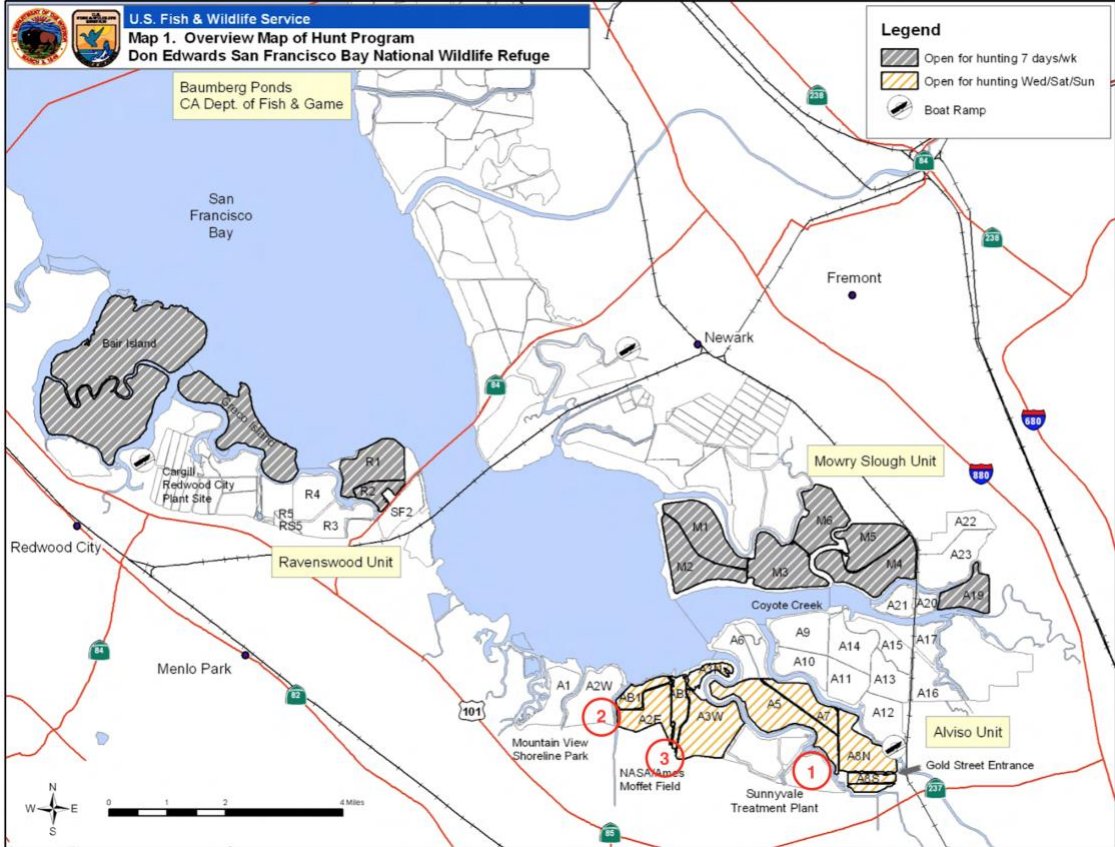


Figure 7: Strategy Implementation at Don Edwards. Map of Don Edwards indicating signage and receptacle locations. 1) Pond A5/A8, 2) Pond AB1/AB2, 3) Pond A3W. Source: U.S. Fish & Wildlife Service. Overview Map of Hunt Program at Don Edwards San Francisco Bay National Wildlife Refuge



Figure 8: Signs and Receptacles at Eden Landing. Photo of floor-standing ballot box receptacle with signs at check-in kiosk (left); signage to create awareness of plastic shotgun wads problem and encourage litter-free grounds (middle); signage to encourage retrieval of any wads (right). Credit: Christine Tsai/Root Solutions



Figure 9: Signage at Don Edwards. Signage to encourage retrieval of any wads and keep the hunting grounds litter-free (left); signage to create awareness of the shotgun wads problem (right). Credit: Root Solutions



Figure 10: Installation at Don Edwards Pond A5/A8. Photo of check-in station with signage posted inside and voting-style receptacle installed outside, facing the water (left); photo of voting-style receptacle to "Vote for your favorite duck" with "pintail" and "mallard" options. Credit: Christine Tsai/Root Solutions and Kate Bimrose/Greater Farallones Association



Figure 11: Installation at Don Edwards Pond AB1/AB2. Photo of check-in station with voting-style receptacle installed outside facing parking area (left); photo of signage posted inside check-in station (right). Credit: Christine Tsai/Root Solutions and Kate Bimrose/Greater Farallones Association.



Figure 12: Installation at Don Edwards Pond A3W. Photo of single-style receptacle installed inside check-in station (left); photo of signage posted on bulletin board outside check-in station near garbage can (right). Credit: Christine Tsai/Root Solutions

Signage and receptacles were available for only three weeks prior to the close of the hunting season on January 30th. During the 2019-2020 hunting season, Eden Landing held a total of 10 hunt days on scheduled Tuesdays, Thursdays, and Saturdays while Don Edwards was open every Wednesday, Saturday, and Sunday. As a result, strategies were available for three hunt days at Eden Landing and nine hunt days at Don Edwards. Due to the shortened time window, we did not refine or modify the signs or receptacles. However, based on feedback received from reserve managers and hunters, we made several recommendations for adjusting and improving the strategies, and detailed them in Section 8.

Chapter 6: Results

We counted all wads in the receptacles on the last hunt day at each reserve prior to the end of the hunting season. Wads were counted at Eden Landing on January 23rd and at Don Edwards on January 29th. Across all receptacles, we collected a total of 58 wads and 485 shells and prevented their entry into nearby waterways (Figure 13, Table 1). We sent all wads and shells to TerraCycle to be repurposed into usable raw material (pellets, flakes) to be molded into new products or packaging.



Figure 13: Wads and shells at Don Edwards, Pond A5/A8. Credit: Christine Tsai/Root Solutions

Table 1: Wad and shell count in each receptacle.

	Eden Landing (floor)	Don Edwards A5/A8 (voting)	Don Edwards A3W (single)	Don Edwards AB1/AB2 (voting)	TOTAL
Wads	17	23	0	18	58
Shells	269	209	1	6	485

6.a. Survey Comparisons Before and After Strategy Implementation

To assess changes in hunter response and measure potential behavior change resulting from the strategies, we administered a short follow-up survey to qualified hunters who completed the determinants analysis survey prior to strategy implementation. Of the 76 determinants analysis respondents, 55 provided their email address which was used to send the follow-up survey. Of those 55 hunters, we sent the follow-up survey to only those hunters who had the opportunity to actually see the signage and use the receptacles. This included hunters who had taken the determinants analysis survey in-person at Don Edwards or Eden Landing, or indicated online

that they hunted at either Don Edwards or Eden Landing. Of the 55 respondents who provided their email addresses, 38 qualified to take the follow-up survey. All qualified hunters received the first follow-up email on February 13th, which resulted in 14 survey responses the next day on February 14th. A second email with the follow-up survey was sent to the qualified hunters who had not yet responded, and six additional surveys resulted from this second outreach. In total 20 of the 38 (53%) qualified hunters completed the follow-up survey.

Of the 20 respondents, 14 people hunted at either reserve after January 7th when the signs and receptacles were installed, and thus had the opportunity to see and be influenced by the strategies. Nine out of the 14 hunters (64%) noticed at least one sign or receptacle, while six out of 14 (43%) noticed both signs and receptacles, and seven out of 14 (50%) saw and used the receptacles (Figure 14).

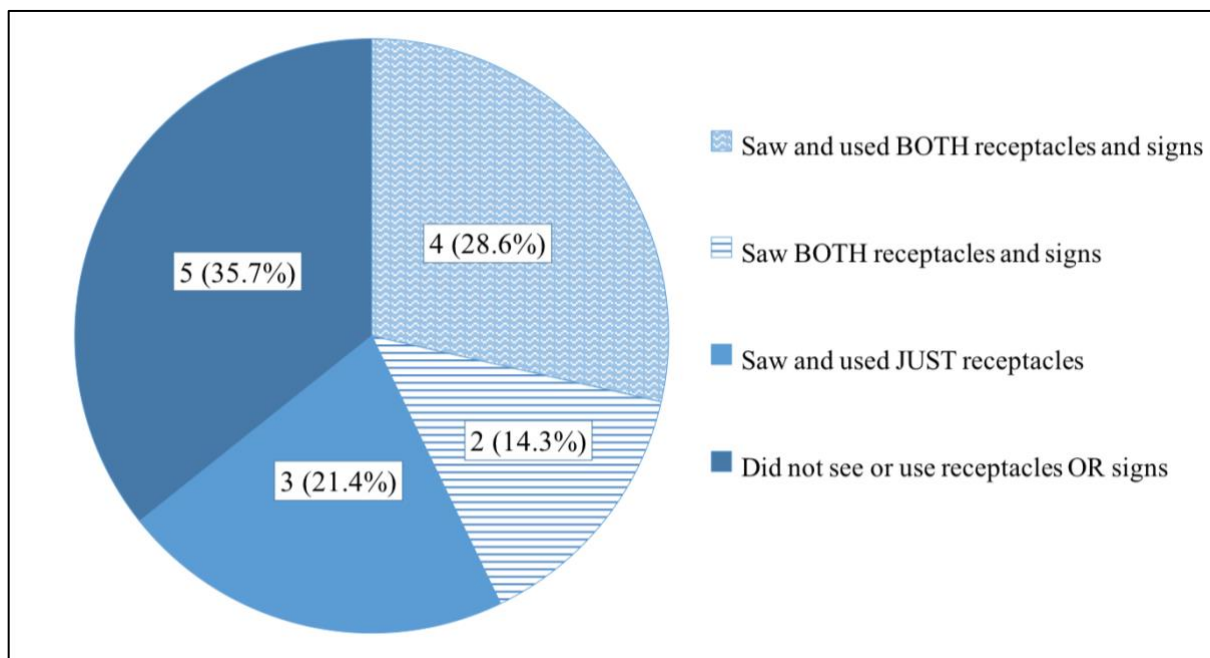


Figure 14: People who Hunted at Don Edwards or Eden Landing after January 7th. Percentage of 14 survey takers who saw and/or used receptacles and/or signs. Credit: Root Solutions

Questions included in the follow-up survey were nearly identical to those in the determinants analysis survey. For example, we asked hunters in both surveys how many hunt days they picked up wads and compared their responses from both surveys in order to determine any change. The number of Doers who reported picking up wads on some or every hunt day increased from 60% in the determinants analysis survey, to 85% in the follow-up survey (Figure 15). 55% gave the same response in both surveys, indicating no change. 35% gave an answer that indicated an increase in the frequency with which they picked up wads, while 10% gave an answer that indicated a decrease in frequency. Although about half of the respondents did not change answers and therefore did not demonstrate any change in behavior, it seems the signs and receptacles did lead to some behavior change for at least three hunters as the biggest increase in wad removal days were reported by those who saw the signs and used the receptacles.

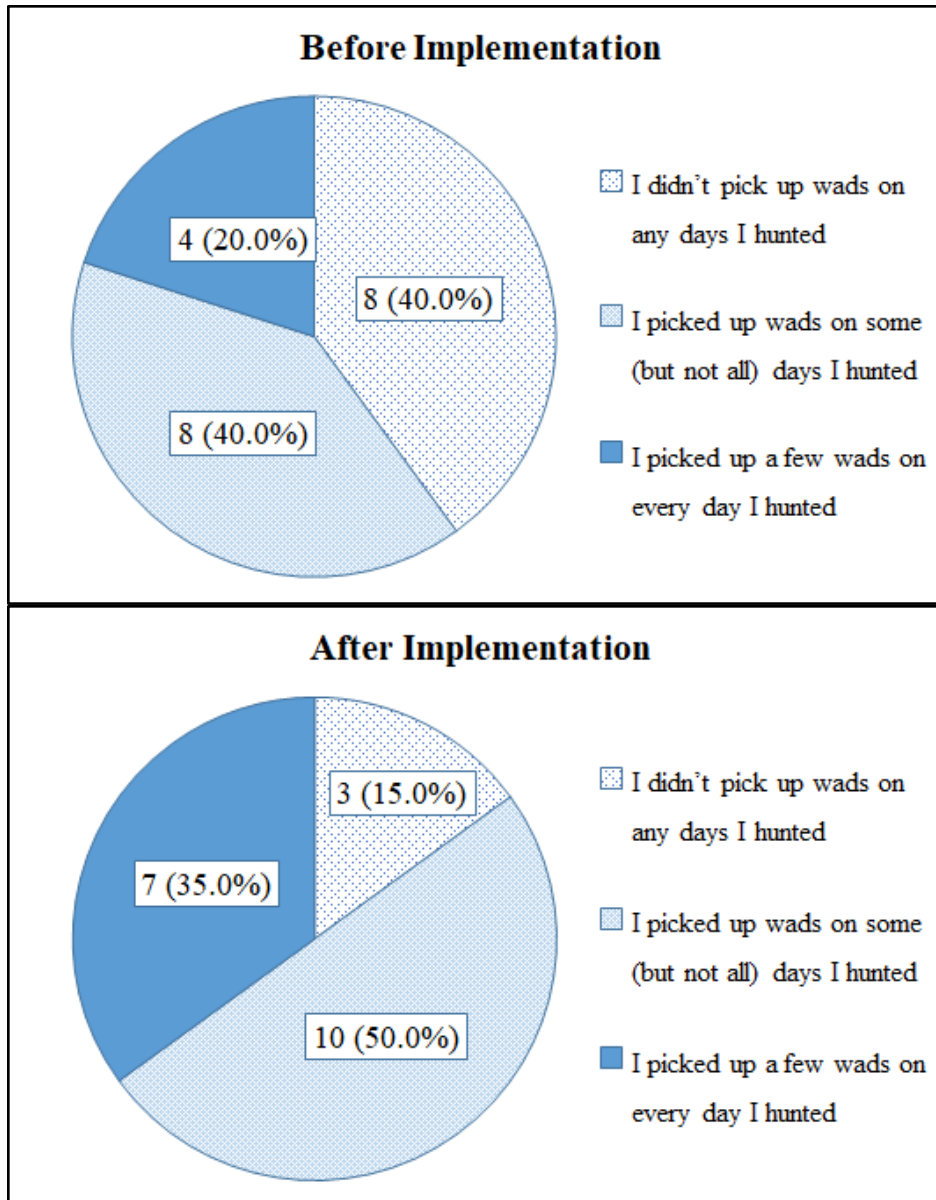


Figure 15: Comparison of Responses Before and After Implementation: "On how many hunt days did you pick up shotgun wads?" Comparison of pie-charts show the number of hunters who reported picking up wads on some or every hunt day (Doers) increased from 60% before strategy implementation to 85% after implementation. Credit: Root Solutions

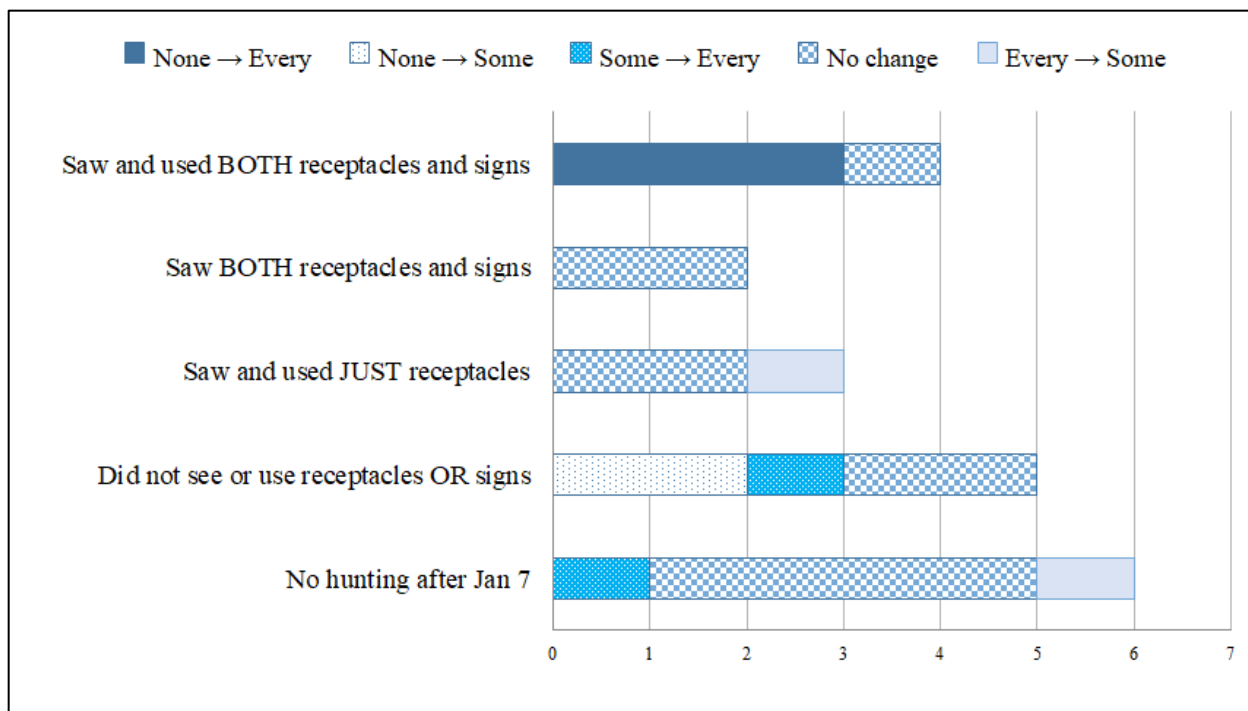


Figure 16: Comparison of Responses to Survey Question by Strategy Type: “On how many hunt days did you pick up shotgun wads?” Comparison of survey results before and after strategy implementation. Bar chart indicates that 55% of hunters reported no change in behavior picking up wads, 35% reported an increase in the number of days they picked up wads, and 10% reported a decrease. Three hunters who reported a change from “none” to “every day” all saw signs and used receptacles. Other hunters who reported an increase did not see either strategy. Credit: Root Solutions

When asked how willing they were to spend a few minutes picking up shotgun wads during or after hunting, 100% of the respondents reported being “somewhat” (53%) or “extremely” willing (47%), in the determinants analysis survey. One hunter did not respond to this question in the determinants survey so we could not compare his answers. In the follow-up survey, the percentage of hunters who reported being “extremely” willing increased to 68%, while the percentage of hunters who reported being “somewhat” willing decreased to 26%, and one hunter changed his answer from “somewhat” to “not at all” (Figure 17). 53% gave the same response in both surveys, indicating no change, while 32% gave an answer that indicated an increase in willingness to pick up wads, from “somewhat” to “extremely”, and 16% gave an answer that indicated a decrease in willingness to pick up wads.

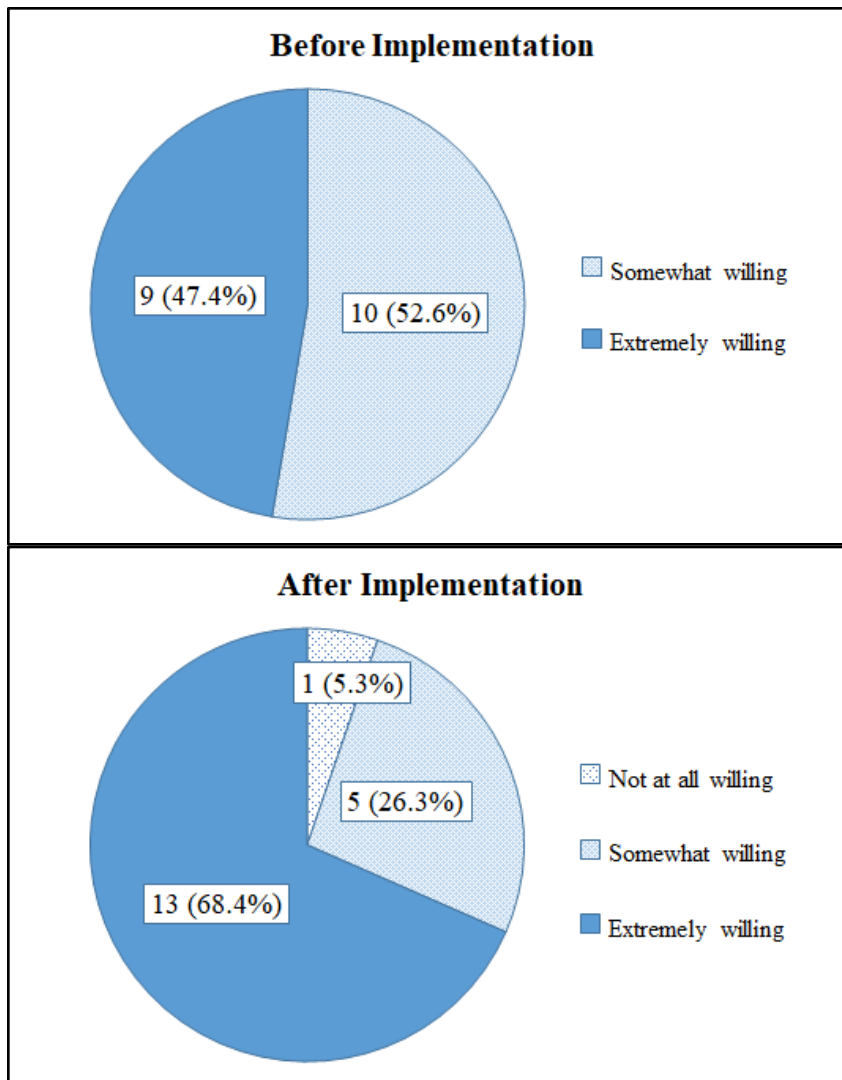


Figure 17: Comparison of Responses to Survey Question Before and After Implementation: "How willing are you to spend a few minutes picking up shotgun wads during or after hunting?" Comparison of pie-charts show the percentage of hunters who reported being "extremely willing" to spend a few minutes picking up shotgun wads increased from 47% to 68%. Credit: Root Solutions

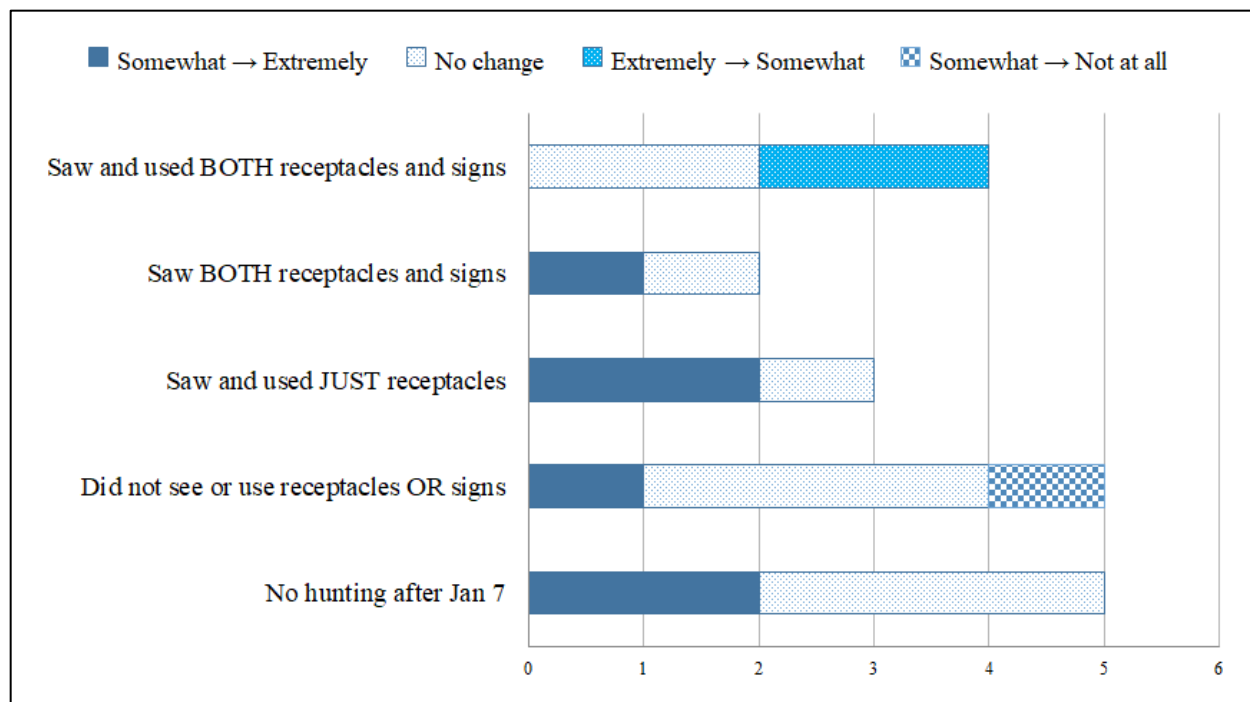


Figure 18: Comparison of Responses to Survey Question by Strategy Type: “How willing are you to spend a few minutes picking up shotgun wads during or after hunting?” Comparison of surveys results before and after strategy implementation. Bar chart demonstrates how seeing signs or using receptacles did not cause a significant variation in people’s willingness to pick up wads, as displayed by comparison of survey responses before and after implementation. 53% reported no change in willingness, 32% reported an increase in willingness, and 16% reported a decrease in willingness. Credit: Root Solutions

When asked if they were aware that plastic shotgun wads are one of the most common plastic items found on Bay Area coastal beaches, the determinants analysis survey indicated that 29% were aware of this issue while 71% were not aware. Three hunters did not respond to this question in the determinants analysis survey so we could not compare their answers. After implementation, the percentage of hunters who said they were aware of the issue increased to 47% while the percentage of hunters who said they were not aware of the issue decreased to 53% (Figure 19). 35% gave the same response in both surveys, indicating no change. Responses from 41% changed from “No” to “Yes,” while 24% changed from “Yes” to “No”. Although hunter awareness of the prevalence of shotgun wads on beaches increased from 29% to 47% after implementation, there was no significant correlation between this increase and the number of hunters who saw the signs and used the receptacles (Figure 20).

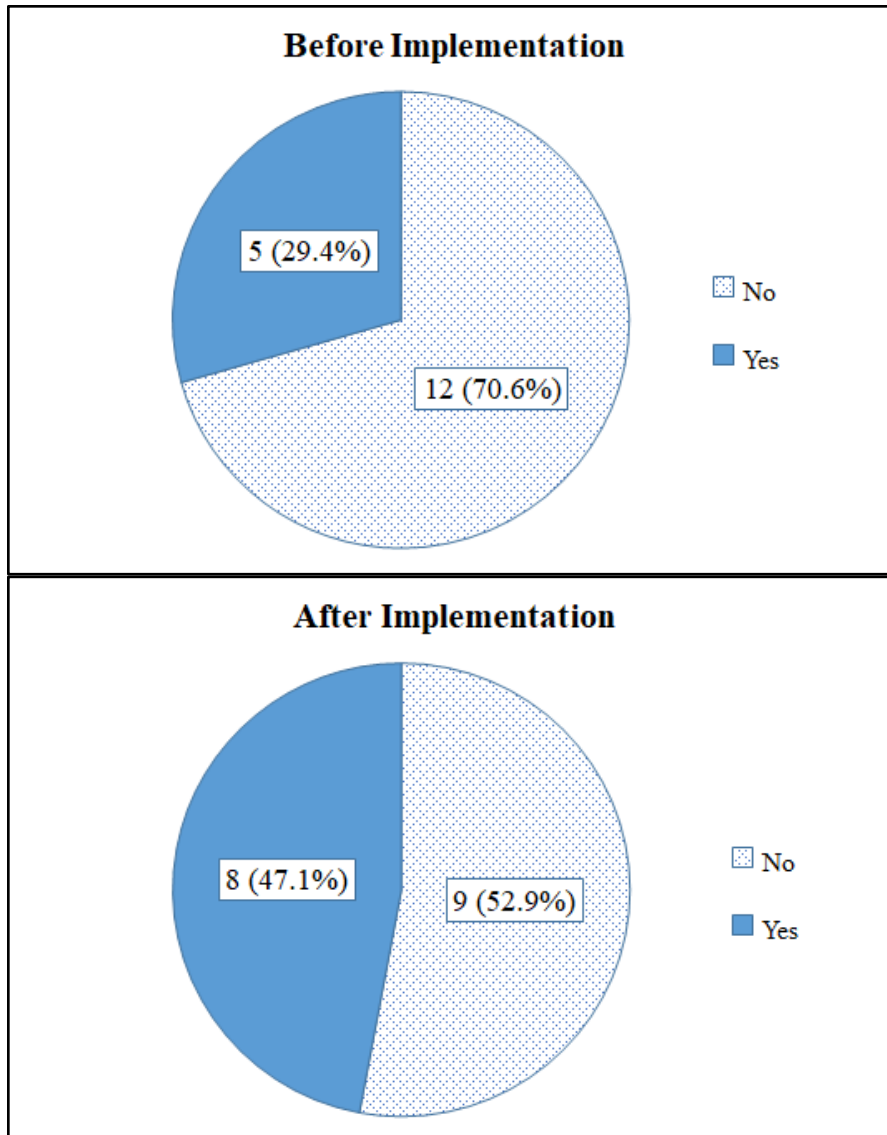


Figure 19: Comparison of Responses to Survey Question Before and After Implementation: “Are you aware that plastic shotgun wads are one of the most common plastic items found on Bay Area outer coast beaches?” Comparison of pie-charts show the percentage of hunters who reported being aware that plastic shotgun wads are one of the most common plastic items found on Bay Area beaches increased from 29% to 47%. Credit: Root Solutions

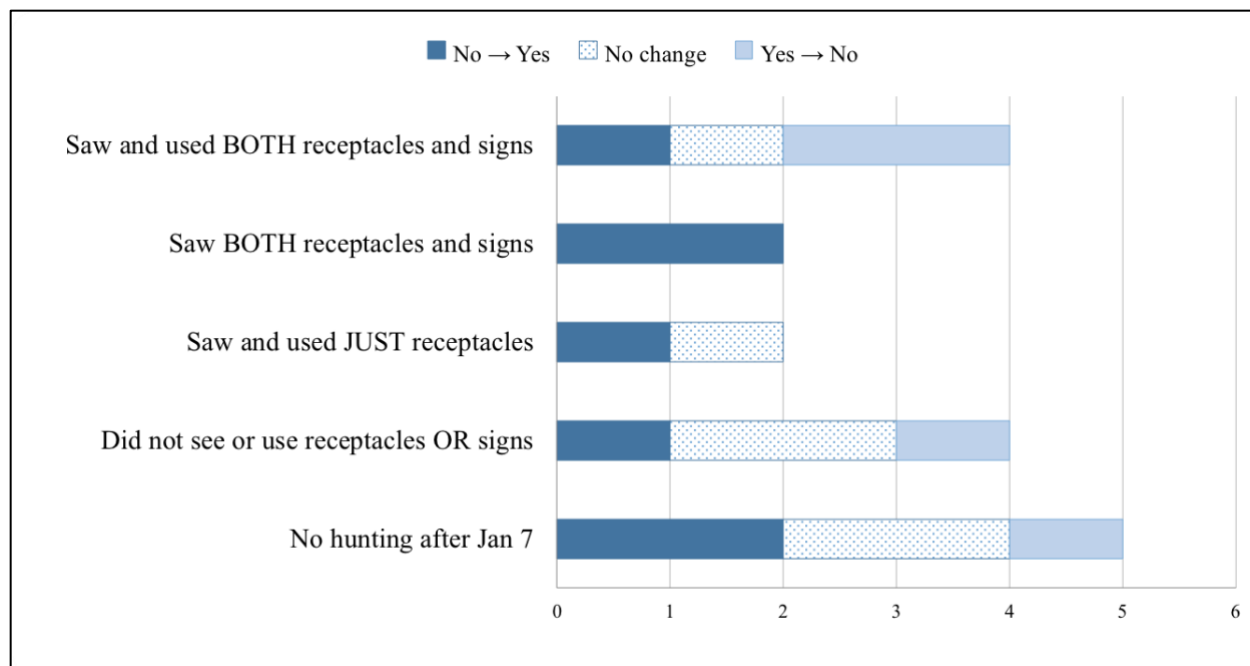


Figure 20: Comparison of Responses to Survey Question by Strategy Type: “Are you aware that plastic shotgun wads are one of the most common plastic items found on Bay Area beaches?” Comparison of surveys results before and after strategy implementation. Bar chart shows no significant variation based on whether or not hunters saw signs or used receptacles. 35% gave the same response, 41% changed answers from “No” to “Yes”, 24% changed answers from “Yes” to “No”. Credit: Root Solutions

6.b. Hunter Interviews

To also assess the usage and impact of the signage and receptacles, we conducted short in-person interviews with hunters before the hunting season concluded. The interviews included some questions from the follow-up survey such as whether they were aware that wads are one of the most common plastic items on Bay Area outer coast beaches, whether they had noticed or used the receptacles, whether they had noticed the signs, and any additional feedback. We also asked hunters if they picked up any wads this season and how that number of wads compared to the previous hunting season.

We interviewed a total of 16 hunters, 11 at Eden Landing and five at Don Edwards. 69% reported picking up wads this season. 50% self-reported that they picked up more wads this season than last season. One hunter interviewed at Eden Landing stated that the reason he picked up more wads this season than last season was because he had seen the sign that morning. Another 50% of interviewees said they had noticed the receptacles, 19% reported using the receptacles at Don Edwards, and 69% said they did not notice the signs. We learned that signs were especially difficult to see if hunters entered the reserve in the early morning hours before sunrise. Lastly, 75% reported they were not aware that plastic shotgun wads are one of the most common plastic items found on Bay Area outer coast beaches. One hunter reported he was now aware of the problem because he had taken our determinants analysis survey. Several hunters interviewed had never considered wads as debris and had mainly kept focus on removing their shells. Once educated about the presence and impacts of shotgun wad debris one interviewee said, “I’ve hunted for many years and I’ve never thought about the thousands of plastic wads I’ve shot into the environment.”

Chapter 7: Discussion

There are many factors to consider when evaluating the effectiveness of behavior change strategies implemented through this pilot project. Wads collected in the receptacles represented the only quantitative marker demonstrating a reduction in the number of shotgun wads entering the marine environment. Although survey comparisons before and after strategy implementation provided context to support a shift in behavior, the sample size was small and findings could have been influenced by a number of factors. In addition to surveys, information gained from in-person interviews and testimonials, although suggesting a positive shift in behavior, was anecdotal and also could not guarantee behavior change as a result of strategy implementation. This section takes a closer look at the varying influences and considerations for analyzing the effectiveness of strategies implemented through this project, and gives insight into the complexities associated with evaluating behavior change campaigns.

7.a. Shotgun Wad Presence at Hunting Reserves

We observed surrounding hunting grounds and trash cans at both Don Edwards and Eden Landing before and after strategy implementation in order to compare observable shifts in the presence of shotgun wad and other litter in the area. For the most part, hunting grounds at both reserves were clean, with little evidence of trash and few (less than 10) observed wads and shells on the ground during any one visit. We observed one trash can at Don Edwards adjacent to the check-in kiosk at ponds A5/A8 (Figure 21) to be full and overflowing with garbage, including some shells and wads, on multiple visits. One hunter commented that “it usually looks like that.” This may have influenced the use of the receptacles installed at this location, as the highest number of wads and shells collected at Don Edwards were at ponds A5/A8. The receptacle’s proximity to a boat launch and position near the full garbage may have also influenced hunters’ use of the receptacle. Additionally, we observed and interviewed the highest number of hunters at this location, and Don Edwards staff reported this kiosk as the most frequently attended, which can also explain the higher number of wads collected at this site.



Figure 21: Don Edwards Pond A5/A8 Check Station. Photo of overflowing trash can next to check-in station at Don Edwards Pond A5/A8 prior to strategy implementation. Credit: Christine Tsai/Root Solutions

The second highest wad count (18) was at Don Edwards Pond AB1/AB2. Reserve staff said this was the second most popular hunting location after Pond A5/A8. This location is also publicly accessible to bikers and runners/walkers, so it is possible that visitors other than hunters were using the receptacles. Garbage other than shells and wads were also disposed of at this location, which further suggests use of this receptacle by other recreationers such as bicyclists and runners. We counted only one wad at Don Edwards Pond A3W. This could be due to the fact that this is not a popular hunting spot at Don Edwards and because hunters drive to hunting locations after passing this particular check-in station. These hunters are more likely to pack their shells and wads out and not deposit wads in the receptacle located at the check-in station.

Eden Landing had only three hunt days after strategies were implemented. Upon exiting the reserve, Eden Landing staff approached hunters in their cars for check out. This greatly decreased the likelihood of hunters using the receptacle at the check-in kiosk and increased the likelihood of hunters packing out their wads for disposal elsewhere. Understanding this, the Eden Landing manager attempted to move the floor standing ballot receptacle to additional locations where it was more visible by hunters. Had there been more than three hunt days, additional exposure to the receptacle could have resulted in an increase or decrease in usage based on its position.

We collected both wads and shells in the receptacles at both hunting reserves. A significantly higher number of shells were present (485 shells vs. 58 wads), which is not surprising because hunters were already accustomed to picking up their shells, and because shells are generally easier to identify and retrieve compared to wads. Although 58 wads were collected in the receptacles, had the receptacles not been present, these same wads might still have been collected by hunters who have the habit of packing them out or disposing of them in garbage bins. The wad count in the receptacles provided data on the number of wads removed from the marine environment, but could not accurately determine actual behavior change. Instead,

combining data from the wad count along with a survey question to hunters such as “How has the availability of receptacles impacted you? I pick up more wads than usual; I pick up the same number of wads; I pick up less wads than usual,” could provide a more accurate picture of whether or not the receptacles help change hunter behavior.

7.b. Hunter Interviews After Implementation

It was not a guarantee that hunters surveyed after implementation actually encountered the signs and receptacles. For this reason, in-person interviews were conducted to gain insights into the impact of the strategies and feedback on improvements. Similarly, we cannot gauge whether behavior actually changed based on these interviews since self-reported behavior change is generally unreliable and is not a recommended method for evaluating strategy success. Observations of behaviors, wad counts in receptacles, as well as comparisons of survey responses before and after implementation, are preferred methods to understand if a behavior change has occurred. However, hunter feedback was extremely useful and should be incorporated into future iterations of this project, especially during the design phase.

The fact that a few hunters reported using the receptacles and one indicated that signage at Eden Landing had influenced the number of wads he picked up, demonstrates the strategies’ potential for positive impact on hunter behavior. Additionally, some of the hunters interviewed at Eden Landing reported noticing and using the receptacles at Don Edwards, which highlighted the importance of implementing strategies at several reserves. Since hunters are likely to hunt at multiple locations, establishing a norm of receptacles and signage at each reserve can help hunters develop a habit of keeping an eye out for receptacles and picking up wads.

7.c. Survey Results Before and After Implementation

Comparisons of survey results appear to indicate positive changes in behavior (increase of the percentage of Doers from 60% to 85%), willingness to pick up wads (increase in percentage of hunters who are “extremely willing” from 47% to 68%), and awareness of the problem of plastic wads (increase of hunters who are aware from 29% to 47%). The strategies seem to be a contributing factor in behavior change for some hunters, as the three hunters who reported the biggest change in behavior, from picking up wads on “no days” to “every day”, all saw the signs and used the receptacles. However, other hunters who reported an increase in the number of hunt days they picked up wads did not see either strategy after implementation on January 7th (Figure 16). Similarly, there were reported increases of willingness to pick up wads and awareness of the problem of plastic wads amongst both hunters who did, and did not, see the signs and receptacles.

These results show that there are many combinations of factors involved in changing hunter behavior, and while signs and receptacles may have contributed to changes in behavior, these changes cannot be solely attributed to their implementation nor can their permanence be guaranteed. For example, although awareness alone usually does not drive behavior change, some hunters may have also been influenced simply by increasing their awareness through the determinants analysis surveys. One hunter at Eden Landing told the reserve manager that after the determinants analysis survey, and before implementation, he couldn’t “unsee” the wads, and subsequently collected a bag of wads and shells and deposited it in the garbage. Another hunter

remarked on the follow-up survey, “Public outreach seems to be the best answer. I had never thought about it before taking the previous survey and although it is easy to forget to pick them up, it is at least on my mind now.” Because it is easy for hunters to forget to pick up wads even if they are aware of the problem, it is worth continuing to implement and monitor all strategies. This also makes a strong case for the theory that the more signs and receptacles there are, the better the results.

Another point to consider is that the signs and receptacles may have had an impact on the number of wads hunters picked up on any given day. We asked hunters about the number of hunt days they pick up wads, but did not ask them how many wads they typically pick up. It’s possible that the number of days they picked up wads remained the same, but the number of wads they picked up increased or decreased.

It is also important to be mindful that while conducting the in-person surveys, there is potential for social desirability bias, where hunters may give answers they think they should because they are socially acceptable. This could explain why some of the answers given in the follow-up survey were different from the determinants analysis survey, such as changes from being “extremely willing” to pick up wads prior to implementation, to “somewhat willing” after implementation. Similar response changes from “Yes” to “No” regarding awareness of plastic shotgun wads as one of the most common plastic items found on Bay Area beaches, could also be explained this way. If we could conduct outreach to hunters via anonymous online surveys, we could compare results to see if there are differences between how people answer questions privately versus in person. It would also be interesting to see how hunters would respond amongst their peers, such as during orientation meetings or hunt club meetings, compared to online survey responses.

7.d. Hunter Feedback

Information from interviews and surveys after implementation demonstrated that overall the hunters liked the general design of the receptacles (one hunter said he liked the “vote for a duck” design), but suggested they be bigger and more noticeable with larger holes to make it easier to drop more wads at once. Hunters said that receptacles should be placed in more convenient locations such as near the bathrooms, other garbage cans, and in parking lots where hunters pack out. One person suggested filling the receptacles halfway with wads to influence hunters to use them. Hunters also thought signage was a good idea and helped heighten awareness of the wad problem, but could get overlooked if additional signage was posted in the same area.

7.e. Factors Influencing Effectiveness

Location

The effectiveness of the wad receptacles was largely dependent on their location. We piloted the receptacles at the check-in stations which hunters must pass when they begin and finish their hunts, but are not necessarily the locations where hunters choose to dispose of wads. It is important to consider how hunters move through each particular hunting location and where they are most likely to find and pick up wads. For example, at Don Edwards Pond A5/A8, some hunters launched boats into the water while others walked along the levees. We placed one

receptacle on the check station kiosk facing the water, obscured from those walking the levees. Here, an additional receptacle installed on both sides of the kiosk could engage hunters coming from either direction. As hunters drive past the check-in kiosk to enter or exit Eden Landing, the receptacles should be placed near the driver side of the vehicle to catch the driver's eye and make it easier to dispose of wads. If the receptacles are placed in the proper locations, hunters may be more likely to use them rather than pack out their wads, which would allow for more accurate recording of removed wads.

Time of Day

Many hunters begin their hunt in the early morning before the sun rises. During these hours hunters had difficulty noticing the signs or receptacles when they entered the reserves. If the receptacles and signs were located throughout the hunting grounds, they would have a higher chance of encountering them later in the day when there is more light and higher visibility. Brightly colored signs or sensor-activated lights inside the check stations could also help capture attention and increase visibility.

Timeframe

Because the hunting season is relatively short (October - January) there is a small window of opportunity for engaging hunters and influencing behavior. Our strategies were only available to hunters for approximately three weeks. Because reserves like Eden Landing only host 10 hunting days per year, establishing visual (signs) and oral reminders (e.g., reserve managers, fellow hunters) to pick up and dispose of wads is increasingly important. Some hunters only hunt a few times a year, so unless strategies are implemented throughout the entire hunting season, not every hunter will have an opportunity to see them and shift their behavior. To increase behavior changing effectiveness and help hunters develop new habits, hunters should have multiple opportunities to engage with signs and receptacles.

Habits

Hunter habits are important to keep in mind. Hunters who are used to packing out trash are unlikely to separate wads and shells from other garbage collected while hunting. If hunters are reminded to pick up wads, and receptacles are easily accessible and pointed out upon entry, they are more likely to keep wad and shell garbage separate and deposit it when leaving the reserve. Some hunters also have a habit of picking up their own shells and garbage, often ignoring debris left by others. This highlights the importance of messaging on signs and receptacles that influence hunters to pick up all debris. Because it is extremely difficult for a hunter to spot and retrieve their own wads, language encouraging a culture of cleanliness or duty to fellow hunters can increase the likelihood of hunters picking up wads discarded by others.

Many hunters are also accustomed to ignoring the signage inside the check-in station, especially if they have been hunting at those locations for a long time. Thus, it is important to capitalize on periods of change, such as the beginning of the hunt season when new hunters visit reserves for the first time.

Design

One thing to keep in mind is that even if something might seem useful, (e.g., bigger receptacles) it doesn't necessarily translate into being used or effectively changing behavior. Incorporating ease of access (small receptacles inside kiosks) or fun elements (voting style receptacles) make strategies more enticing for hunters to use, which ultimately is the best indicator of behavior change. We designed the receptacles with a smaller hole to discourage hunters from using them as a trash can and encourage the deposit of wads and shells. However, hunters tend to collect wads and shells by the handful and want to deposit them all at once. The small hole may have discouraged hunters from using the receptacles, especially if they were short on time.

The final wad count at Don Edwards showed more usage of the voting-style receptacles than the single-style receptacle. It is possible that the voting-style box was more appealing to hunters, so it would be worth testing different styles at the same location to see if the box style has an impact on usage.

We made receptacles with clear acrylic so hunters could see how many wads had been collected, but it may not be the best material for withstanding outdoor elements such as the sun, weather, and rusting, as well as potential damage and vandalism. Receptacles with small holes or vents in the bottom may also help with emptying rain water during and after storms.

Receptacle Capacity

Most installed receptacles were not full by the end of the season, but the voting-style receptacle at A5/A8 was filled to capacity. If the receptacle was filled early in the pilot phase, this could have prevented other hunters from using the receptacles or discouraged them from picking up wads later in the hunting season. Like the other trash cans on the hunting grounds, the wad receptacles should be regularly emptied once they are full.

Chapter 8: Recommendations

Implementation of this pilot project, including challenges and lessons learned, resulted in a variety of recommendations for addressing: 1) next steps for phase two of this project, 2) options for scaling up, and 3) low cost suggestions for reserve managers. All recommendations build off of knowledge gained through project planning and implementation efforts, as well as feedback from hunters and reserve managers, and may apply to more than one category.

8.a. Recommendations for Phase Two

In-person engagement with hunters appeared to have a positive impact on awareness and behavior. In phase two, increased hunter outreach and communications in concert with refinements to receptacles and signage should occur. Hunters generally responded positively to the campaign, with one hunter saying, “Thank you for giving awareness to the wads.” Another told us, “This is awesome. Glad you guys are doing this work.”

Hunter Engagement and Outreach

- Increase communication with hunters through outreach to online interest groups, hunting organizations, and key leaders in the waterfowl hunting community.
- Develop partnerships with hunting clubs, sporting stores, nonprofit conservation groups, such as Duck Unlimited, and online organizations to disseminate outreach materials and follow-up surveys through electronic and print newsletters, blogs, mailings, and online postings.
- Investigate opportunities for outreach and education to waterfowl hunters through state and federal hunting licensing processes.
- Encourage or invite hunters to join an MDMAP survey and share shotgun wad debris data with hunters.
- Organize a reserve “cleanup day” event with waterfowl hunters and reserve managers to pick up and record data on discarded shotgun wads
- Capitalize on the transition period between waterfowl hunting seasons from March - September, and include messaging about picking up wads in communications with hunters as they prepare for the upcoming hunting season.

Although we executed strategy design iterations and prototyping through this project, refinement did not occur due to limited time and funds. After implementation, refinement is critical for increasing strategy effectiveness. Refinement based on feedback from project partners and suggestions from the target audience can inform improvements such as construction upgrades, location placement, and changes to outreach messaging or layout.

Improvements

- Consider installing timed or motion-activated lighting inside check-in kiosks so hunters can properly see signs and/or mounted receptacles during early morning hours.
- Install signage inside porta-potties for more visibility to hunters while they are a “captive audience.”

- Make signage permanent to educate recreational users and encourage them to retrieve and dispose of wads while walking, running, or biking along levees and trails near hunting reserves.
- Encourage reserves to actively contribute to reduction in plastics production by providing large TerraCycle boxes so wads and shells can be collected and proper disposal can be ensured. Incorporating a recycling component can also increase hunter retrieval of wads if they know the wads will be properly disposed of and upcycled into future plastic products.

Various methods for monitoring and collecting data are critical for evaluating the use and effectiveness of strategies, gauging behavior change in the target audience, and recording quantitative data on the number of wads removed from the marine environment.

Data Collection

- Conduct MDMAP surveys on coastal beaches during the storm season from December - May to capture shotgun wad debris data during high deposition months that also correlate with the waterfowl hunting season.
- Distribute surveys to hunters at the start and end of the hunting season to gather data that can inform whether behavior change has occurred. At the start of the season, ask hunters to estimate how many wads they picked up the previous season. At the end of the season, ask them to estimate how many wads they picked up during the current season, and compare the responses. Ask how the availability of receptacles impacted the number of wads they collected, and whether those receptacles impacted the number of days they retrieved wads as well.
- Engage as many hunters as possible to increase the sample size and design a way to conduct an anonymous online survey to reduce the occurrence of social desirability bias.
- Conduct a structured methodology for surveying wads and shells at the reserves at the beginning of the season by walking the pathways and levees used by hunters, monitoring the shoreline along hunting sloughs and marshes, going into hunt blinds, and using boats to observe waterways. This data can then be compared with data collected at the end of the hunting season and/or in subsequent seasons to determine changes in shotgun wad abundance in and around hunting reserves.

Phase Two Recommendations for Eden Landing

- **Increase accessibility** - Install at least four more plexiglass boxes next to porta-potties with adjacent garbage bins near hunter parking areas. Hunters will pack out at the parking lots after they finish hunting, and are less likely to use a receptacle at the check-in station (Figure 6).
- **Optimize engagement** - In the early morning hours when hunters enter the reserve, place the large ballot-style receptacle adjacent to the driver side door. Later in the day, when most hunters are leaving, move the receptacle so it again faces the driver side as the hunter exits.
- **Increase awareness** - At Eden Landing, hunters check in and report their harvest verbally to the reserve manager and/or volunteers. Managers and enforcement staff

should encourage retrieval of wads and point out receptacle locations to hunters upon entering the reserve.

Phase Two Recommendations for Don Edwards

Improvements

- Clean out receptacles more often. Smaller receptacles installed at Don Edwards may fill fast (e.g., Pond A5). If receptacles are not emptied regularly, they cannot be used effectively and can undermine efforts to establish a litter-free culture on hunting grounds.
- Additional receptacles should be installed on the outside of A5/A8 pond check-in stations as hunters approach these kiosks from various directions. If hunters arrive prior to sunrise or leave after sunset, it is difficult to see receptacles. Installation of more receptacles at these check-in stations can optimize exposure and increase the number of wads and shells collected.
- Consider installing signage in each of the 29 renovated hunting blinds. Hunters can stay in one blind for several hours, making these locations ideal for signage as hunters will likely have the time to read more content that encourages behavior change.
- Install receptacles inside blinds and provide additional tools such as garbage pickers or nets to help hunters retrieve wads in the water. Blinds would need to be accessed via boat and cleaned regularly.
- **Partnerships** - Work with Alviso Marina County Park, a Santa Clara County managed park adjacent to Don Edwards, where hunters launch boats and have seven-day access to the open bay during the hunting season. A partnership with Alviso Marina could include posting signage, installation of wad receptacles, and inclusion of information regarding shotgun wad debris during free interpretive boat tours conducted by park staff.
- **Orientations** - Attend hunter orientation meetings prior to the hunting season to conduct outreach such as presentations about general wad debris awareness, disseminating surveys, and soliciting feedback.
- **Pledges** - Orientations could be a good opportunity to test a pledge or commitment campaign. Have hunters sign their commitment to picking up and properly disposing of wads in available receptacles. People want to appear consistent with their peers, and pledges allow for this consistency (Cialdini, 2008). Ideally, the pledges are voluntary, specific, realistic, and written.

8.b. Recommendations for Scaling

Refine Signs and Receptacles

- Create larger plexi-glass boxes with the capacity to hold more wads and to allow hunters to dispose of multiple wads at once, rather than one at a time.
- Regularly change voting options on the voting-style wad receptacles to keep hunters' attention and interest in depositing wads in receptacles.
- Make signage posted on the outside of check-in kiosks bigger and more permanent.

- Determine optimal locations for hunter engagement with receptacles before installation (e.g., in parking lots, near porta-potties, near other trash cans, near hunting grounds).
- Install both types of receptacles (i.e., single box and voting style box) at the same location to monitor use and count wads deposited in each receptacle. This could provide information about which style of receptacle is most used, and therefore causes the greatest shift in behavior.
- Consider new designs and layout for receptacles to test against the single-style and voting-style designs. One design could include the creation of four side-by-side identical receptacles in different colors for compost (green), recycling (blue), garbage (black) and wads (red), accompanied by signs and visual icons instructing which items should be deposited in each bin. This could help hunters properly sort their garbage and increase the amount of recyclable and compostable materials diverted from landfills.

8.c. Recommendations for Reserve Managers

In the event that a second phase of this project is not feasible, and based on the reserve manager's interest in continuing to implement strategies, the following recommendations are available for managers to implement independently. These recommendations are meant to be little to no cost or additional effort on the part of reserve managers, but will still prove effective at reducing wad debris and encouraging shifts in hunter behavior.

Maintain Litter-Free Hunting Grounds

- Clean out garbage bins regularly to reinforce a litter-free culture within the reserve. Where personnel is limited, add more garbage bins.
- Consider counting wads deposited in garbage bins in order to get a more accurate count of wads removed.
- Regularly clean out, record data, and properly dispose of shotgun wads and shells within receptacles. Clean the receptacles when garbage cans are also cleaned.

Receptacle and Signage Improvements

- Continue to move wad receptacles throughout the hunting season to observe increases or decreases in hunter use. This should only be done if receptacles can be observed regularly and wads/shell counts can be made at each new location in order to note increase or decrease in receptacle use.
- Consider printing signage on neon paper to increase visibility when hunters enter reserves prior to sunrise.

Increase Awareness and Communications with Hunters

- Reserves have list serves of hunter contact info that are not available for public use or for mass distribution of information other than prescribed content from reserve personnel. Reserves can send newsletters, emails, or announcements encouraging the retrieval of wads through various messaging tactics that work best for their audiences (see Appendix D for examples of messages).

- Give feedback to hunters (e.g., newsletters, emails) that highlights the positive impact of their actions such as regular updates on the number of wads collected in receptacles.
- Recruit “key ambassadors” who are well known in the hunting community or regularly clean up reserves and spread awareness about shotgun wad debris.
- Include short messages about picking up wad debris on printed informational pamphlets and guidance materials that get distributed to hunters.
- Indicate the location of wad receptacles on hunting reserve maps.
- When exiting reserves hunters must indicate the number, species, and location of their harvest on written hunter cards at check stations or by dictating such information to the reserve manager and volunteers at kiosks. A simple question can be added to this process in order to reinforce the desired behavior and record additional supporting data (e.g., Did you pick up any shotgun wads today?)

Chapter 9: Lessons Learned

9.a. Sensitivity of Topic

In order to affect positive behavior change in hunters through strategies that reduce a source of marine debris it is important to adopt the following lessons learned.

- Adopt a beginner's mindset, with no preconceived notions or opinions, in order to engage hunters in open and honest dialogue.
- Understand the political and social nature of your target audience, including historical campaigns or events that shape their beliefs and actions. Learning from your audience is key for building partnerships and engaging spokespeople to perform the desired behavior.
- Speak with hunters in person to develop a rapport, address any concerns or answer questions, and correct any misconceptions they had about the project.

Throughout this project we learned that hunters are concerned about constraints on their ability to hunt and the potential for further restrictive legislation. Hunters also expressed having limited options for purchasing biodegradable ammunition. One hunter surveyed at Don Edwards said he had seen the survey team at Eden Landing during the previous weekend, but did not get out of his car because he thought his survey answers would be used to limit his hunting ability. Once he was assured that the survey only sought to learn about shotgun wads, he became much more relaxed and followed up with an email expressing interest in testing biodegradable ammunition.

9.b. Data Collection

In-Person Surveying

Hunters were very receptive to answering survey questions when approached in person, but timing was a challenge. Hunting schedules varied so it was difficult to know the optimal time to conduct surveys. Some hunters tend to hunt very early in the morning (before 5 a.m.), while others prefer to hunt before sunset. Many hunters stayed in the field for several hours, making it difficult to predict when they would return. Additionally, the best weather for duck hunting is generally cloudy, rainy, and windy, which is not optimal weather for conducting a survey.

Conducting surveys at Eden Landing was particularly challenging because the hunters generally did not get out of their cars at the check-in station, requiring additional effort by the survey team to engage with the hunters. Upon entry to the reserve, hunters were eager to reach their preferred hunting location and some only had a small window of time in the hours before or after work. When and how to approach hunters for surveys is extremely important. To address these issues, we conducted surveys during the morning hours, roughly between 8 and 11 a.m. We also brought along coffee and donuts to create an informal setting for discussion and encourage hunters to relax and stay longer to engage with the survey team.

Online Outreach

Reaching hunters through online platforms was also challenging. In order to protect the privacy of hunters, surveys could not be sent through reserve mailing lists so we disseminated them via online forums and targeted social media ads. Several of the online forums removed the survey post or blocked further posts after members reported the post as spam because they were skeptical of the survey's intentions. Posting ads on social media platforms was also difficult because images of hunters with their ducks were considered by the platforms to be “scary, gory, or sensational” and incorrectly associated with animal cruelty. The ads posted to Facebook were initially rejected and took several days for approval.

Even while conducting the survey in person, several hunters raised concerns that their answers would ultimately impact their ability to hunt. These concerns may be due to recent legislation banning lead ammunition and requiring in-person eligibility checks on ammunition purchases. We alleviated these concerns directly when speaking to hunters in person, but unfortunately could not address similar concerns by hunters who took the online survey. This underscores the importance of both in-person and online communication in order to reach a broad number of hunters and address the various challenges associated with survey dissemination.

Wad Collection

Determining exactly how many wads were prevented from entering San Francisco Bay as a result of our strategies was challenging. The number of wads counted in the receptacles was not necessarily an accurate measure of the number of wads hunters actually retrieved. As mentioned, many hunters have a habit of packing out and may dispose of collected wads and shells outside of the hunting reserves. Additionally, observation of garbage bins at each of the reserves indicated hunters' use of those bins to deposit wads and shells.

Chapter 10: Future Directions and Planning

In addition to strategies that focus on shotgun wad retrieval there are other avenues that can be pursued to reduce the amount of plastic shotgun wad debris entering the marine environment. These include procurement of biodegradable ammunition in retail stores, increased hunter awareness of biodegradable ammunition, policy or legislation, and financial investment.

10.a. Increasing Availability of Biodegradable Ammunition

This project revealed availability of biodegradable ammunition as a key factor influencing the reduction of plastic shotgun wads entering the marine environment. As mentioned, biodegradable ammunition is not widely advertised or adopted by waterfowl hunters in the United States, and many are uncertain of its performance and accuracy. Of the 72 hunters surveyed, only 6% said they had used biodegradable ammunition in the past. Some of these hunters created the ammunition themselves from paper and cardboard. In California, without biodegradable ammunition stocked in stores, hunters are unable to purchase it online. Hunter nervousness over procurement of biodegradable ammunition was further enforced during a conversation with one hunter at Eden Landing who stated that he had bought biodegradable ammunition, but was unwilling to share how or where it was purchased. Unwillingness to share this information may be due to concerns related to recent laws banning the sale of online ammunition.

Despite its scarcity, survey results reveal that hunters are very interested in using biodegradable ammunition. While the project goal did not focus on promoting biodegradable ammunition, we used in-person interviews and surveys to ask several questions related to the topic. Results from the determinants analysis revealed that 86% of hunters would be willing to use biodegradable shotgun wads and would purchase them if they were readily available. When asked an open-ended question about strategies other than retrieval to address the problem of wads entering waterways, 54% of hunters said “make them biodegradable.” Additional comments during one-on-one interviews supported this finding. One hunter mentioned that, although signs and receptacles are good and “they encourage awareness and action, we really need to come up with a bio-friendly wad.” Another hunter stated, “I think that hunters would be more willing to pick up wads or use biodegradable wads if they were given the information. I am definitely going to make sure I purchase biodegradable.” This feedback from the hunting community demonstrated the importance of making biodegradable ammunition available to hunters as part of a multi-pronged effort to address the issue of plastic shotgun wad debris.

As described earlier, GreenOps Ammo had attempted to bring their ammunition to market, but was not yet selling it due to financial shortcomings and lack of manufacturing infrastructure needed to mass produce their ammunition. Additionally, while there are other larger ammunition manufacturers that produce and sell biodegradable ammunition, these manufacturers appear to solely or primarily sell their product in the United Kingdom. Based on this research, it does not appear that biodegradable ammunition is readily available for sale in California.

Ultimately, determining whether and where hunters can purchase biodegradable ammunition in California was surprisingly difficult. Further investigation into this question was beyond the scope of this project, but because of its importance we worked with students from the Middlebury Institute of International Studies on this topic through a Behavior Design for Sustainability course. During the eight-week course students were tasked with completing a behavior change research project to better understand why biodegradable ammunition is not available in stores in California, and to propose strategies to overcome barriers to this issue. In the process of their own initiation phase, the students selected ammunition retailers as their target audience, and stocking and promoting biodegradable ammunition as their target behavior. Students were trained in the human-centered design process and developed a determinants analysis survey for distribution to ammunition retailers such as Dick's Sporting Goods, Big 5, Walmart, Bass Pro, and Cabela's, as well as shooting and hunting clubs that sell ammunition (see Appendix E). The students also developed high level recommendations for facilitating biodegradable ammunition procurement in stores, including:

- **Get feedback:** Prior to final strategy design and implementation it is important to speak with retail staff, store management, and gun club staff about the barriers to, and motivators of, stocking and promoting biodegradable ammunition.
- **Attend events:** Attend trade shows to talk with retailers about the plastic shotgun wad problem, answer questions about biodegradable wads, and promote the use of biodegradable ammunition.
- **Marketing:** Directly market the benefits of, and demand for, biodegradable ammunition to procurement staff at retailers and gun clubs through phone calls, emails, or in-person visits.
- **Procurement instructions:** Provide, or work with manufacturers to provide, step-by-step instructions to store managers and procurement staff on where and how to order biodegradable ammunition.
- **Signage:** Provide free signage with targeted visuals and messaging that explain the environmental benefits and performance capabilities of biodegradable ammunition. Provide suggestions for placement of biodegradable ammunition and accompanying signage in order to attract the highest numbers of patrons.
- **Social proof:** Share examples or testimonials from stores and clubs that already stock biodegradable ammunition. Share survey results that demonstrate hunter willingness to purchase biodegradable ammunition.

10.b. Increase Awareness

Awareness is insufficient, but necessary, to spur use or adoption of any product on a public scale. While surveys did not specifically ask if hunters knew of biodegradable wads as an alternative to plastic, conversations revealed that hunters tended to be unaware of their existence. However, hunters did demonstrate their interest, with 86% indicating a willingness to try biodegradable ammunition. If and when biodegradable ammunition becomes widely available, it will take time and effort to increase hunter awareness and investment in the product. Conversely, ammunition may not become widely available until hunters demand it. In each scenario, awareness sits at the focal point of both the demand and supply side of the issue.

Working to increase this awareness is an important next step. Hunter surveys should ask specifically about their knowledge of biodegradable ammunition, their willingness to try it, concerns about its cost or performance, and potential barriers and motivators to purchasing and using it. Following such research, evidence-based strategies could be deployed, including:

- **Requests** - Ask hunters to request that their retail store, shooting range, or hunting/gun club stock biodegradable ammunition.
- **Demonstrations** - Although demonstration events cannot take place at state or federally run public hunting reserves because they cannot promote or lobby for particular brands or companies, hunters can test biodegradable ammunition on private hunting grounds or shooting ranges. Test firing will help address concerns about range, ballistics, precision, and spray pattern related to the ammunition's performance. Biodegradable ammunition can also be used in marksmanship contests and events.
- **Hunter education:** Information about the use and performance of biodegradable ammunition can also be incorporated into online and in-person hunter education courses and taught to firearm instructors, especially those focused on youth engagement and people new to waterfowl hunting.
- **Samples:** Display samples of biodegradable ammunition can be made available for customers to look at and hold in stores and clubs.
- **In-store signage:** Provide in-store signage about biodegradable ammunition. This may include prominent signage near "regular" ammunition to redirect customers to the biodegradable ammunition, as well as signage near the cash register or near other hunting-related merchandise that says "Ask us about biodegradable ammunition."
- **Trade shows:** Aside from directly marketing the product at trade shows via exhibits or sponsorship, interested parties/partners can also sign up to be a speaker and give a short talk about the issue of plastic shotgun wads and solutions including biodegradable wads.
- **Product discovery sites:** Use online third-party platforms such as Rangeme.com that connect suppliers and retailers in order to stock new products in stores.
- **Testimonials:** Ask prominent hunting influencers to share testimonials of using biodegradable wads on their social media accounts.
- **Training and materials:** Provide materials to educate retail staff on how to communicate the benefits of, and concerns about, biodegradable ammunition.
- **Trade magazines and websites:** Advertise and/or get stories placed about biodegradable ammunition in trade magazines, ammunition catalogues, and websites such as Field & Stream and Outdoor Life.
- **Overall messaging:** Tie messages about biodegradable ammunition to hunters' identities as conservationists and their concern with pollution.

10.c. Policy and Legislation

Understanding the many sensitivities around ammunition and hunting regulations is critical for developing sound policies that encourage hunter compliance. Learning from recent policy changes, such as the 2019 California ban on lead ammunition, can inform which communication strategies were most effective, including which topics are potentially sensitive or controversial.

For example, many hunters feel hassled by tighter restrictions on ammunition availability and type, as well as increased costs for licenses and tags, limiting hunter options.

In order to reduce plastic shotgun wads as a source of marine debris, California lawmakers and policymakers could pursue legislation and policies that would incentivize, promote, or mandate the use of biodegradable ammunition. Including phased implementation and cost subsidies may help to alleviate concerns from hunters and their representatives regarding the cost, performance, or availability of biodegradable ammunition. Promoting awareness and garnering support for biodegradable ammunition from the public and local retailers will also be paramount to the success of any regulatory or policy change.

10.d. Capital Investment

Although eco-friendly technology is gaining traction in products such as compostable bags, utensils, and packaging, the materials used to create biodegradable shotgun wads vary. Several forms of biodegradable material are used, or being tested, for application in biodegradable ammunition. These materials have different degradation rates, especially when submerged in fresh compared to salt water, interacting with toxic or contaminated waterways, and/or buried in mud and sediment. Eco-friendly materials also range in cost, but are generally more expensive than plastic. Additionally, wads can be either one or two pieces, like the cup and base design developed by GreenOps Ammo. Wads with two parts have more exposed surface area, which can speed up the degradation process. GreenOps Ammo wads are made from a non-toxic biodegradable polymer formulation which tends to sink in water and can take months to degrade. Other companies such as RIO's hydro soluble Royal Eco Blue Steel line is of vegetal origin, degrading into carbon dioxide, mineral salts, and biomass in 24-48 hours when fully submerged or one week if on land. Others are producing or testing starch-based materials, bio-fibers, or using additives with polyvinyl alcohol which also dissolve in water. This creates wide variation in the cost and environmental considerations associated with different products, and makes the case for establishing a systematic use of one material in order to standardize the manufacturing process and establish a set price.

If a particular biodegradable material is standardized across all ammunition, financial investment whether through federal allocation, state support, or private capital can help offset manufacturing costs. This could also speed up production and distribution, which would help establish a culture of support, and negate the need for consumer demand as the mechanism for spurring production. Additional rebates or cost reductions for customers upon purchasing biodegradable ammunition could also increase demand for the product and bolster its usage among a wider net of hunters.

Chapter 11: Conclusion

Application of a human-centered design approach and resulting strategies can be an effective mechanism for establishing behavior change to benefit environmental issues. The initiation and ideation phases outlined in this pilot project were critical for: 1) gaining an understanding of the issue surrounding plastic shotgun wads in San Francisco Bay and on outer coast beaches, 2) identifying the target audience, and 3) determining a desired behavior. Though the use of biodegradable ammunition would help alleviate this problem, such ammunition is not readily available. Thus, in order to achieve the biggest potential impact on the problem, we identified shotgun wad retrieval as the target outcome-producing behavior, and we identified waterfowl hunters as the target audience.

In order to execute strategies that enhance the motivators and reduce the barriers to the desired behavior, it is critical to understand hunters' beliefs and values. Our determinants analysis survey revealed that most hunters have a willingness to pick up wads, even if they do not currently do so. The primary motivator for Doers who pick up wads was less litter and pollution in the environment, while the main barriers were lack of access and visibility. Non-Doers also tended to hold the misconception that hunters were not picking up their wads. Using these results, we designed signage and receptacle prototypes to: 1) prompt hunters to pick up and dispose of any wads they saw; 2) help keep hunting grounds litter-free; and 3) serve as vivid reminders that most hunters do pick up wads.

It was difficult to evaluate the strategies' ability to change behavior due to a number of factors, including the short timeframe for implementation, receptacle locations, and existing hunter habits such as packing out waste. Factors such as these are critical to consider in order to effectively scale and refine strategies. However, we did observe an overall increase in the number of hunters who reported picking up wads on some or every hunt day, and an increase in the number of hunters who reported being "extremely willing" to spend a few minutes picking up wads. Half of the hunters reported using the receptacles, and overall, hunters supported and appreciated the implemented strategies.

To better establish strategies that affect behavior change, they should be modified according to ongoing feedback and implemented for a longer period of time. Scaling strategies to additional reserves can also help establish behavior change as many people hunt at multiple reserves. Testing different strategies at different reserves can also provide additional data for evaluating effectiveness. Removal is one way to solve the problem of plastic shotgun wads found in Bay Area outer coast beaches, but because of the difficulty of finding and retrieving them, this approach is inherently limited. Additional strategies at other hunting reserves and private clubs should be installed if wad retrieval is to effectively reduce the abundance of shotgun wad debris. Given the hunters' high degree of support for biodegradable ammunition, finding a way to make biodegradable ammunition available to hunters is worth further exploration and research.

Overall, the application of behavior change campaigns can be an effective, although not widely used, method for addressing a variety of environmental issues beyond marine debris. Along with the recommendations, the project planning and implementation steps described throughout this

report can inform the development of other pilot initiatives that seek behavior change around environmental issues of concern. Such pilot projects should use many strategy designs and multiple monitoring and evaluation methods. Ongoing iterations of pilot projects similar to this initiative will strengthen the effectiveness of behavior change campaigns and help reduce human impact on the environment.

Acknowledgements

The project team would like to extend our gratitude to the many people and organizations that helped make this project possible, including our reserve partners Matthew Brown (Don Edwards San Francisco Bay National Wildlife Refuge), John Krause (Eden Landing Ecological Reserve), and Melisa Amato (San Pablo Bay National Wildlife Refuge) for their contributions in developing and installing our strategies on their hunting grounds. Many thanks to Jason McDevitt (Virginia Institute of Marine Science and CEO and Founder of GreenOps Ammo) for his ongoing expertise and guidance on the manufacturing and production of shotgun ammunition, and to Anna Kauffman (Surfrider San Francisco Chapter) for her consultation on local shotgun wad debris data.

This publication does not represent an endorsement of any product or company discussed within, but only represents the results, recommendations, and suggested as potential next steps for addressing the local problem of shotgun wad debris on the North-Central California coast. Several actions contained herein also reference potential or legislative options for addressing the issue of plastic shotgun wad debris. These actions are solely options, to be carried out by other organizations interested in addressing shotgun ammunition policy, and are not affiliated with NOAA, Office of National Marine Sanctuaries, or the Marine Debris Program.

In recognition of our funder, NOAA's Marine Debris Program and the Office of Response and Restoration, we acknowledge their continued support of Greater Farallones Association's Marine Debris Program with special thanks to Sherry Lippiatt for her tireless project management and contributions to campaign planning, implementation, and this final report. We also thank Greater Farallones Association staff for their review and contributions to this report, and to NOAA's Greater Farallones National Marine Sanctuary for reviewing this report and providing guidance throughout the project process. We cannot forget the over 150 volunteers who conducted 324 marine debris surveys from 2012-2018 who identified the issue of shotgun wad debris through their meticulous recording and reporting of debris items. Thank you to the Middlebury Institute of International Studies for their work in researching commercial availability of alternative shotgun ammunition. Lastly, we extend our greatest gratitude to the many hunters who took our surveys, generously shared their values and beliefs, and provided invaluable feedback that strengthened the effectiveness of this project and will inform future efforts at addressing the issue of shotgun wad debris.

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Appendix A: Root Solutions' Determinants Analysis Survey

Contact us with any questions or send us a photo of your survey answers:
info@therootsolutions.org

SURVEYOR NAME: _____ LOCATION: _____ TIME: _____

1.* Approximately how many days do you hunt waterfowl during a typical season?

- 1-5 days 6-10 days 11-20 days 20+ days

2.* During a typical season, on how many hunt days did you pick up shotgun wads?

- I didn't pick up wads on any days I hunted
 I picked up wads on some (but not all) days I hunted
 I picked up a few wads on every day I hunted

3.* How willing are you to spend a few minutes picking up shotgun wads during or after hunting?

- Extremely willing Somewhat willing Not at all willing

Did you pick up any shotgun wads today? Y / N

If so, how many did you pick up? _____

How do you usually pick up and / or carry the shotgun wads?

4.* On an average hunting day, how many shots do you fire? _____

5.* In your opinion, what are the downsides of spending a few minutes picking up shotgun wads during or after hunting?

6.* What do you see as personally beneficial about spending a few minutes picking up shotgun wads during or after hunting?

7.* What would make it easier for you to spend a few minutes picking up your, or someone else's, shotgun wads during or after hunting?

8. How often do you hunt waterfowl in the following ways:

	Never	Sometimes	Often	Always
By boat on a large body of water (e.g., lake, bay)				
By boat in sloughs, marshes, or creeks				
By foot over land				
By foot over a large body of water				
By foot near sloughs, marshes, or creeks				
In blinds over land				
In blinds over water				

9. If you hunt by boat, what location/pier do you launch from most often?

10. How easy or difficult is it to do the following?

	Relatively easy	Relatively difficult
Spot a shotgun wad floating in water		
Spot a shotgun wad on land		
Safely pick up a shotgun wad while in the water		
Safely pick up a shotgun wad on land		
Pick up a shotgun wad while in a boat		
Pick up a shotgun wad from a boat without disturbing wildlife		
Pick up a shotgun wad on land without disturbing wildlife		
Pick up a shotgun wad without walking a long distance		
Pick up a shotgun wad without interrupting your, or another hunter's, experience		

11. What percentage of waterfowl hunters do you think pick up at least 1 shotgun wad during or after hunting?

- 0-25% 26-50% 51-75% 76-100%

12. How likely are your peers to approve of you spending a few minutes picking up shotgun wads after hunting?

- Extremely likely
 Somewhat likely
 Not very likely
 Not at all likely

Why do you think this is?

13. Are you aware that:

	Yes	No
Plastic shotgun wads are one of the most common plastic items found on Bay Area beaches		
Wildlife, including waterfowl, mistake plastic shotgun wads for food		
Plastic shotgun wads do not biodegrade		
Plastic shotgun wads are toxic to our waters and marine life		

14.* How concerned are you that:

	Not at all	Somewhat	Extremely
Plastic shotgun wads are one of the most common plastic items on Bay Area beaches			
Wildlife, including waterfowl, mistake plastic shotgun wads for food			
Plastic shotgun wads do not biodegrade			
Plastic shotgun wads are toxic to our waters and marine life			

15. In your opinion, whose responsibility do you think it is to solve the plastic shotgun wad debris problem?

Select all that apply and please explain why.

- Hunters _____
- Range managers _____
- Government _____
- Manufacturers/distributors/retailers _____
- Hikers/bird watchers/nature enthusiasts _____
- Other _____

16. How much positive impact do you think spending a few minutes picking up shotgun wads will have on our waters?

- None A little Some A lot Not sure

17.* What would need to change (or what resources would you need) for you to be able to spend a few minutes picking up shotgun wads?**18.* Picking up shotgun wads is one way to help solve the problem of wads entering our waters. In your opinion, what are other ways to solve this problem?**

19.* Are you willing to use biodegradable shotgun wads to hunt waterfowl?

- Yes (I already use them)
- Yes (I'm willing to try them)
- No, I am not willing to try them

If no, why not?

20. Which of the following areas do you hunt at the most? Check all that apply.

- Don Edwards San Francisco Bay National Wildlife Refuge
- San Pablo Bay National Wildlife Refuge
- Eden Landing Ecological Reserve
- Napa-Sonoma Marshes Wildlife Area
- Grizzly Island Wildlife Area
- Private (such as Wing & Barrel Ranch)

Name of private hunting area:

- Others not in the list

Please Specify:

21. Bonus question: If you currently pick up your (or anyone else's) shotgun shells (not wads), what are your main motivations? (Select up to three)

- It is the law
- I am concerned they are toxic
- I like to keep hunting grounds litter-free
- I am concerned wildlife or marine life might mistake them for food
- It's easy
- Signs remind me to
- I don't pick up my or anyone else's shells
- Other: _____

22. Is there anything else you would like to share?

If you'd like to be entered to win a \$100 or \$50 gift card, please include your email address

Appendix B: Summary of Determinants Analysis Survey Results

PERCEIVED POSITIVE ATTRIBUTES/BENEFITS

What positive things the person perceives might or will happen as a result of performing the pro-environmental behavior.

What do you see as personally beneficial about spending a few minutes picking up shotgun wads during or after hunting?

- **Litter (42 out of 72 hunters, 58%)**
 - More than half of hunters gave a response related to less litter, cleaning the area, less pollution, and less contaminants.
- **Environment (26 out of 72 hunters, 36%)**
 - More than a third specifically mentioned the “environment” or the “planet” in their responses.
 - Ex: “Cleaning the environment, saving the environment, care for the environment, save the planet, etc.”
- **Personal responsibility (13 out of 72 hunters, 18%)**
 - 18% of hunters gave a response specifically referring to a code/ethic of personal responsibility.
 - Ex: “Leave no trace, doing our part, leave zero footprint, make it better than when you got there, it’s the right thing to do, clean up after yourself”
- **Benefits (8 out of 72 hunters, 11%)**
 - 11% of hunters referred to benefits to hunting itself.
 - Ex: “Keeping the hunting areas clean, lets us keep hunting here, keeps bay open to hunting”

PERCEIVED NEGATIVE ATTRIBUTES

What negative things the person perceives might or will happen as a result of performing the pro-environmental behavior.

In your opinion, what are the downsides of spending a few minutes picking up shotgun wads during or after hunting?

- **39 out of 75 (52%) hunters said there were no downsides.**
 - Doers are 3.9 times more likely to give the response of “none, N/A, no downsides” than NonDoers (29 out of 43 (67.4%) Doers, 10 out of 32 (31.3%) NonDoers).
- **27 out of 75 (36%) hunters said that lack of access** was a downside to picking up wads. This includes not being able to find the wad, not being able to get to them, the fact that the wads float or fly away, or that the wads sink in the water and are impossible to access.
 - Non-Doers are 5.4 times more likely to give this response than Doers (19 out of

32 (59.4%) Non-Doers, 8 out of 43 (18.6%) Doers). Amongst NonDoers, this was the #1 reported downside.

- **11 out of 75 (14.7%)** hunters reported **visibility** as a downside - not being able to “see” the wad or the poor visibility of the wad.
 - **Non-Doers are 4 times more likely to give this response than Doers (8 out of 32 (25%) Non-Doers, 3 out of 43 (7%) Doers).**
- **7 out of 75 (9.3%)** hunters mentioned **time** as a downside - less time hunting, budgeting time onshore, and how picking up wads is time-consuming.

PERCEIVED IMPORTANCE & SEVERITY

The degree to which the person perceives that the environmental problem is serious or important. (Note: Those that believe in techno salvation might believe something is important but that it will be fixed without requiring anything of them.)

Plastic shotgun wads are one of the most common plastic items found on Bay Area beaches

- **55 out of 69 (79.7%)** hunters said they were **not aware** of this issue, 14 out of 69 (20.3%) said they were aware
- **41 out of 51 (80.4%)** hunters said they were **somewhat or extremely concerned** about this

Wildlife, including waterfowl, mistake plastic shotgun wads for food

- **39 out of 68 (57.4%)** hunters said they were **not aware** of this issue, 29 out of 68 (42.6%) said they were aware
- **40 out of 49 (81.6%)** hunters said they were **somewhat or extremely concerned** about this

Plastic shotgun wads do not biodegrade

- **49 out of 69 (71%)** hunters said they were **aware** of this issue, 20 out of 69 (29%) said they were not aware
- **43 out of 51 (84.3%)** hunters said they were **somewhat or extremely concerned** about this

Plastic shotgun wads are toxic to our waters and marine life

- **40 out of 68 (58.8%)** hunters said they were **aware** of this issue, 28 out of 68 (41.2%) said they were not aware
- **44 out of 50 (88%)** hunters said they were **somewhat or extremely concerned** about this

PERCEIVED SELF-ABILITY / SELF-EFFICACY

Whether the person perceives that they are capable of succeeding at the action: do they have the know-how, do they have the skills, can they identify the appropriate course of action?

What would make it easier for you to spend a few minutes picking up your, or someone else's, shotgun wads during or after hunting?

- **28 out of 74 (37.8%)** hunters mentioned **color, visibility, or design.**
 - “It would be cool to shoot it if it were neon orange.”
- **9 out of 74 (12.2%)** hunters mentioned **tools** such as bags to carry the wads, grabbers, and magnets.
- **8 out of 74 (10.8%)** hunters mentioned **access to the wad**, such as knowing where the wads go and being able to locate / track the wads.
 - **Non-Doers are 10.9 times more likely to give this response than Doers (7 out of 31 (23%) Non-Doers, 1 out of 43 (2%) Doers).**
- **8 out of 74 (10.8%)** hunters mentioned **biodegradable wads.**
 - Making the wads biodegradable does not technically make them easier to pick up, but hunters still reported this (probably because they are thinking of the overall problem of the wads).
- **7 out of 74 (9.5%)** hunters mentioned **disposal bins.**
 - “Garbage cans are usually full”
 - “Place to put shells and wads other than trash”
 - “Trash near hunting ground.”

PERCEIVED ACTION-EFFICACY

Whether the person perceives that the pro-environmental behavior will solve the problem or at least mitigate it.

How much positive impact do you think spending a few minutes picking up shotgun wads will have on our waters?

- **47 out of 66 (71.2%)** hunters think it will have “**some / a lot**” of positive impact on the waters.
- **19 out of 66 (28.8%)** said “**a little/ none / not sure.**”

PERCEIVED SOCIAL NORMS & ACCEPTABILITY

Whether the person perceives that the pro-environmental action is performed by their social reference network (i.e., their community, family or others that are important to them) or is at least socially acceptable to this network.

What percentage of waterfowl hunters do you think pick up at least 1 shotgun wad during or after hunting?

Non-Doers tend to think that other hunters do not pick up their wads.

- **19 out of 20 (95%)** Non-Doers gave the response of “**0-25%**”. Non-Doers are 10.2 times more likely than Doers to give this response (19 out of 20 (95%) Non-Doers, 10 out of 21 (47.6%) Doers.)
- This perception is inaccurate and there is an opportunity to correct it! The survey shows that more than half of hunters (43 out of 76, 56.6%) do pick up wads.

How likely are your peers to approve of you spending a few minutes picking up shotgun wads during or after hunting? And why do you think this is?

- **35 out of 41 (85.4%)** hunters say peers are “**somewhat**” or “**extremely**” likely to **approve** of them picking up wads during or after hunting.
- **11 out of 25 (44%)** hunters referred to **hunter values/hunter responsibility** when explaining why peers would approve of them picking up wads.
 - “Hunters are conservationists. Hunters are environmentally friendly. Leave no trace. We always pick up after ourselves.”
- **5 out of 25 (20%)** referred to the **environment/sustainability**.
 - “They are for sustainability for the wildlife. They care about the environment.”

PERCEIVED RESPONSIBILITY

Whether the person perceives it is their responsibility to address the problem, regardless of whether this arises from a strong belief in fairness, a sense of altruism or biospherism, or similar factors.

In your opinion, whose responsibility do you think it is to solve the plastic shotgun wad debris problem, and why? (Select all that apply.)

- **30 out of 76 hunters (39.5%)** selected **hunters**
 - “They are the ones shooting. It would be nice to get biodegradable wads.”
 - “No one else has liability.”
 - “Take out what you take in.”
- **23 out of 76 (30.3%)** selected **manufacturers/distributors/retailers**
 - “[If] Ammunition manufacturers can be lobbied to make steel shot they can address the non-biodegradable plastic wad issue.”
 - “Color the wads!”
- **13 out of 76 (17.1%)** selected **government**
 - “Mandate biodegradable.”
- **10 out of 76 (13.2%)** selected **range managers**
- **9 out of 76 (11.8%)** selected **hikers/ bird watchers /nature enthusiasts**
 - “Everyone participating in nature should be leaving it as good or better than when they entered.”

PERCEIVED ACCESS & RESOURCES

Whether the audience perceives that they have the needed access and resources (services, products, time and money) required to adopt a given behavior.


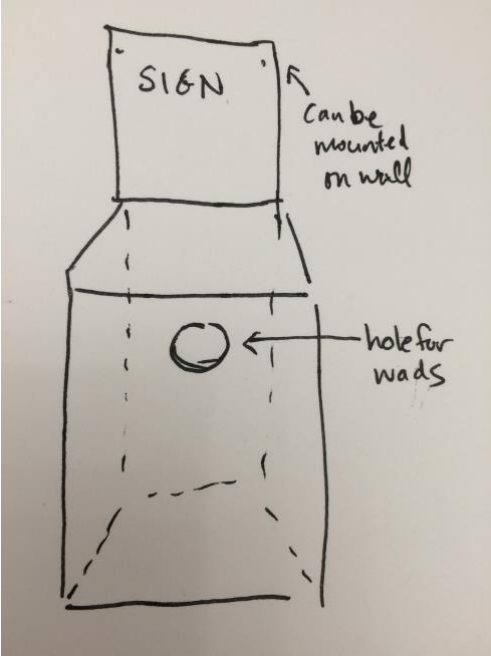
What would need to change (or what resources would you need) for you to be able to spend a few minutes picking up shotgun wads?

- **10 out of 46 (21.7%)** hunters reported **access to wad** - if wads were easier to locate and find.
- **9 out of 46 (19.6%)** hunters reported **visibility** - if wads were more visible or a different color.
- **6 out of 46 (13%)** hunters reported **education/awareness** - “education in right way,” “outreach in hunting community.”


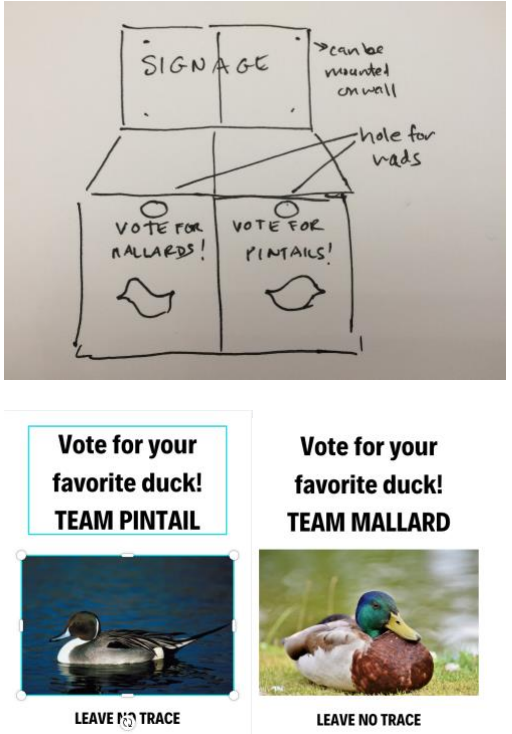
Appendix C: Receptacle and Signage Prototypes

Receptacle Prototypes


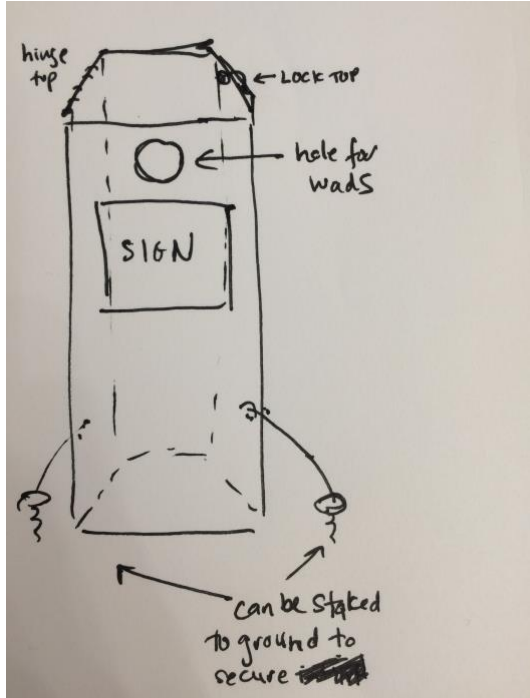
SMALL – Inside Check Station

Example	Sketch	Notes
		<ul style="list-style-type: none">• Placed on counter inside check station or attached to wall inside station• Can be mounted with screws on wall of check station, inside or outside• Includes area for signage (from above)• Round hole on side for depositing wads• Top can be easily opened to dispose wads <p>SIZE:</p> <ul style="list-style-type: none">• ~ 8" (w) x 6" (l) x 6" (h) + signage area

SMALL – Voting Style/Side by Side

Example	Sketch	Notes
	 <p>Vote for your favorite duck! TEAM PINTAIL</p> <p>Vote for your favorite duck! TEAM MALLARD</p> <p>LEAVE NO TRACE</p> <p>LEAVE NO TRACE</p> <p>EXAMPLE: Box can have images inside for hunters to vote on their favorite duck</p>	<ul style="list-style-type: none"> Placed on counter inside check station or attached to wall Can be mounted with screws on wall of check station, inside or outside Has two separate containers for “voting”, which will have images to encourage voting Includes area for signage (from above) Two round holes on sides for depositing wads / shells and “voting” Top can be easily opened to dispose wads <p>SIZE:</p> <ul style="list-style-type: none"> ~16” (l) x 8”(w) x 6”(h)

LARGE – Outside Check Station

Example	Sketch	Notes
		<ul style="list-style-type: none"> Placed outside of check station Round hole on side for depositing wad (we put hole on the side instead of top for less rain to get in) Hinge top to easily open box to dispose wads (want to have a top so rain doesn't get in) Can secure to the ground with a ground anchor <p>SUGGESTED SIZE</p> <ul style="list-style-type: none"> 16" (w) x 16" (l) x 30-36" (h) Could also be shorter and wider

Signage Prototypes

Option #1

**Spot a
Wad?**

Pick It Up!

This basic black and white option was suggested for outside of check-in kiosk at Eden Landing, to match the other signs.

MESSAGING TACTICS:

FOCUS ON WHAT IS EASY - It is difficult for hunters to find their own wads. Focus on what is easy for the hunter to actually do. Use messages that shift the hunters' mindset from their own wads, to any wads nearby - encourage them to stop and look around before they leave the hunting areas to check for wads/check the shoreline when they come back ashore/look around the boat to spot wads that have floated nearby.

MESSAGE: Spot a wad? Pick it up!

Option #2



MESSAGING TACTICS:

ACKNOWLEDGE DIFFICULTY - The imagery acknowledges that the wads are hard to see and are easily overlooked in the dirt and water.

FOCUS ON WHAT IS EASY - Use messages that shift the hunters’ mindset from their own wads, to any wads nearby.

RELATE TO WHAT HUNTERS CARE ABOUT - Using waterfowl in the images serves as a reminder of how the plastic wad problem can impact the hunting experience.

VISUAL: Water with flying waterfowl; magnifying glass with shotgun wad

MESSAGE: Spot a wad? Pick it up! Leave no trace

Option #3



MESSAGING TACTICS:

KEEP IT HOPEFUL - Emphasize the positive impact of the group’s efforts - ***“Every wad counts!”***

RELATE TO EXISTING CONCERNS - Use messaging that draws upon the hunters’ concern for keeping their hunting areas free of litter.

- Example: ***“Keep our hunting grounds litter-free. Spot a wad? Pick it up!”***

VISUAL: Misty water; magnifying glass with shotgun wad

MESSAGE: Every wad counts! Please keep our hunting grounds litter-free. Spot a wad? Pick it up!

Option #4



MESSAGING TACTICS:

EMPHASIZE HUNTERS’ EXISTING VALUES - Draw upon the hunters’ existing identity by connecting picking up wads to picking up shells - 93% (37 out of 40) say they pick up shells because they like to keep the hunting areas litter-free.

- Example: ***“Responsible hunters like you already pick up shells. Why not pick up wads when you see them too?”***

VISUAL: Hunter in field; magnifying glass with shotgun wad

MESSAGE: We know you already pick up your shells. If you spot a wad, please pick those up too! Hunters leave no trace

Option #5



MESSAGING TACTICS:

MAKE IT PERSONAL - Make the messaging personal (and help hunters remember that they can pick up other peoples’ wads).

- Example: ***“Pay it forward to keep hunting areas clean. Help your fellow hunters - pick up their wads, and they’ll pick up yours, too.”***

VISUAL: Hunter in field; magnifying glass with shotgun wad

MESSAGE: Help your fellow hunters. If you spot a wad, please pick it up! Watch for wads.

Option #6

DID YOU KNOW?

SHOTGUN WADS
are one of the four most common items found on the Bay Area outer coast beaches

LEAVE NO TRACE
Drop Wads and Shells Here

MESSAGING TACTICS:

MAKE THE PROBLEM VIVID - Make the problem stand out and show the supporting data

- Example: ***“Surprising, but true: Did you know that plastic shotgun wads are one of the most common plastic items found on Bay Area beaches?”***

VISUAL: Pie Chart of most common plastic items found

MESSAGE: Did you know? Shotgun wads are one of the four most common items found on the Bay Area outer coast beaches. Leave no trace. Drop wads and shells here.

Option #7

HUNTERS LEAVE NO TRACE

THE MAJORITY OF HUNTERS PICK UP SHOTGUN WADS WHEN THEY SEE THEM.

PLEASE WATCH FOR WADS

MESSAGING TACTICS:

HIGHLIGHT POSITIVE NORMS - Use messaging that corrects misconceptions - the majority of hunters are picking up wads.

- Example: ***“Hunters Leave No Trace. The majority of hunters pick up shotgun wads when they see them.”***

DEMONSTRATE GROUP NORMS - If possible, use images of a hunter picking up a wad from the ground / near the water to demonstrate what other hunters are doing. (Perhaps also show multiple hunters all picking up wads together in the image.)

VISUAL: Hunter in water; magnifying glass with shotgun wad

MESSAGE: Hunters leave no trace. The majority of hunters pick up shotgun wads when they see them. Please watch for wads.

Appendix D: MIIS Class Determinants Analysis Survey of Ammunition Retailers

Determinants Analysis Survey created by students of the MIIS course:

- Survey outreach email
- Survey questions

Determinants Analysis Survey Outreach Email

EMAIL SUBJECT: Please take our short survey about ammunition. [
\$50 Amazon Gift Card]!

Hello,

As part of a graduate research project, we are hoping you will take this [short survey](#) on behalf of your club or store about stocking ammunition. If you are not responsible for stocking ammunition, please forward to the responsible party. If you complete the survey by November 24th, you will be entered to win a fifty dollar amazon gift card.

We would like to learn more about hunting clubs and stores that stock hunting supplies and opinions regarding shotgun ammunition.

Your response is extremely valuable. It is important for us to hear from all suppliers. No matter your preferences or opinions, we value your perspective and want to hear from you.

This survey should only take 10 minutes or less to complete and includes 22 questions.

To be entered into the drawing: 1) You must answer all questions, and 2) You must provide your email address or phone number in the form at the end of the survey - this form is not linked to your responses.

Your responses are completely confidential and anonymized and your identity will not be used in any reports.

Thank you in advance for your time and insights.

Sincerely,

Graduate Team at Middlebury Institute of International Studies

Determinants Analysis Survey

1. Are you responsible for purchasing decisions for your store/club? (**Qualification**)
 - a. Yes
 - b. No
 - i. Skip logic - *(Thank you for your time, but only those that make purchasing decisions are eligible to take this survey.)

2. Have you stocked any biodegradable ammunition within the past year? (**Doer/Non-Doer**)
 - a. Yes
 - b. I used to but I don't anymore
 - i. Display LOGIC - Why did you stop stocking biodegradable ammunition?
 - c. No
 - i. Display LOGIC - Why not?

3. How willing are you to stock biodegradable shotgun ammunition? (**Doer/Non-Doer**)
 - a. Highly willing
 - b. Somewhat willing
 - c. Not at all willing

4. What city is your store/club located in? (**Demographics**)

5. Are you a store that carries hunting supplies?
 - a. If Yes → Proceed to next question
 - i. What is the name of your store?
 - ii. How many employees are currently employed at your store?
 1. 1-5
 2. 6-10
 3. 11-20
 4. 21-30
 5. 31-40
 6. 41-50
 7. 51+
 - b. If no → next question

6. Are you a hunting club?
 - a. If yes → Proceed to next question
 - i. What is the name of your club?
 - ii. How many members are a part of your club?
 - b. If no → Skip logic-- Tell us where you work

7. Which manufacturers do you have established relationships with? Please select all that apply. (Demographics/Other)
 - a. Alliant Techsystems
 - b. BAE Systems Land and Armaments
 - c. CCI (Ammunition)
 - d. Federal Premium Ammunition
 - e. Green Ops Ammunition
 - f. Remington Arms
 - g. Sierra Bullets
 - h. Western Cartridge Company
 - i. Other (Please Specify)

8. What benefits - if any - would your store/club experience if it were to stock biodegradable ammunition? OPEN (Perceived Benefits)

9. What are the downsides - if any - of stocking biodegradable ammunition? OPEN (Perceived Negative Attributes)


10. What would make it easier - if anything - for you to stock biodegradable ammunition? OPEN (Perceived Ability)

11. Whose responsibility is it to ensure the availability of biodegradable shotgun ammunition to hunters? (Perceived Responsibility)
 - a. The manager's
 - b. The owner's
 - c. My responsibility (person stocking)
 - d. Government
 - e. Other

12. Please answer yes or no to the following series of statements. Are you aware that: (Perceived Severity)
 - a. Wildlife, including waterfowl, mistake plastic shotgun shells and wads for food
 - b. Plastic shotgun shells and wads do not biodegrade
 - c. Plastic shotgun shells and wads are toxic to our waters and marine life

13. Thinking about the relationship between hunting and the environment, how concerned are you about the following statements? (Perceived Severity)
 - a. Wildlife, including waterfowl, mistake plastic shotgun shells and wads for food
 - i. Not at all
 - ii. Somewhat
 - iii. Extremely
 - b. Plastic shotgun shells and wads do not biodegrade
 - i. Not at all
 - ii. Somewhat
 - iii. Extremely

- c. Plastic shotgun shells and wads are toxic to our waters and marine life
 - i. Not at all
 - ii. Somewhat
 - iii. Extremely
14. How does supplying biodegradable ammunition compare to other environmental problems regarding hunting? (**Perceived Severity**)
- a. Much more important
 - b. Somewhat more important
 - c. Equally important
 - d. Somewhat less important
 - e. Much less important
15. If your store were to stock biodegradable shotgun ammunition, how likely do you think it would influence hunters to use them? (**Perceived Action Efficacy**)
- a. Extremely likely
 - b. Somewhat likely
 - c. Neither likely nor unlikely
 - d. Not very likely
 - e. Not at all likely
16. How likely do you think stocking biodegradable ammunition would influence your competitors to also stock biodegradable ammunition? (**Perceived Action Efficacy**)
- a. Extremely likely
 - b. Somewhat likely
 - c. Neither likely nor unlikely
 - d. Not very likely
 - e. Not at all likely
17. How much of a positive impact do you think stocking biodegradable ammunition would have on plastic pollution? (**Perceived Action Efficacy**)
- a. None
 - b. A little
 - c. Some
 - d. A lot
18. How likely are your customers/consumers to approve of your store/club stocking biodegradable ammunition? (**Social Acceptability**)
- a. Extremely likely
 - b. Somewhat likely
 - c. Neither likely nor unlikely
 - d. Not very likely
 - e. Not at all likely

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19. How likely would your competitors approve of your store/club stocking biodegradable ammunition? (Social Acceptability)
- Extremely likely
 - Somewhat likely
 - Neither likely nor unlikely
 - Not very likely
 - Not at all likely
20. What things need to change in order for you to stock biodegradable ammunition? OPEN (Perceived Access)



AMERICA'S UNDERWATER TREASURES