Bird Friendly Beaches:
Evaluating dog and human interactions with Great Lakes piping plovers (*Charadrius melodus)* and other shorebirds

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Jordan E. Rutter

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Francesca J. Cuthbert, Advisor

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ABSTRACT

Shorebirds are declining at an alarming rate globally. The primary causes identified, and therefore focus of conservation efforts, are climate change and habitat loss. However, other anthropogenic influences are also important and need to be addressed. In doing so, cumulative impacts on shorebirds may not be eliminated but could be decreased. One of the most prevalent issues is dogs (*Canis familiaris*) on beaches. To date, no extensive research has been conducted on how to address this problem although many studies have focused on obtaining baseline data at specific focal beaches. Chapter 1 is a comprehensive literature review on dog impacts on shorebirds. Current science indicates that dogs on beaches are an issue for all shorebirds, at every age, at any time of year, around the world. However, the best practices for reducing the impacts or interacting with dogs and their owners were not included in the studies reviewed. Chapter 2 describes an in-person survey on beaches throughout Michigan, USA, to better understand the current knowledge and level of support for beach conservation as well as dog beaches by Michigan beach-goers. On the 30th anniversary of federal listing of the Great Lakes piping plover (*Charadrius melodus)* as an endangered population, the responses obtained provide important information about the current situation on these beaches. Results of the survey indicate: 1) the majority of participants are not aware of what a piping plover is (n=317, 58%), 2) participants are generally supportive of protecting beach wildlife (89% of participants responded “very important”) 3) participants

are relatively supportive of restrictions on human recreation if it helps protect beach wildlife (67% of participants responded “very important”). These data will improve current outreach and educational programs as incorporating the human dimensions aspect of conservation into the project will be crucial to the long-term success of the recovery effort.

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PREFACE

Partners of the Great Lakes Piping Plover Recovery Effort have observed and reported issues with dogs on beaches for many years. While there was always some management (e.g. roped off areas, monitors talking to dog owners in the immediate area, periodic law enforcement effort) conducted to address this issue, understanding the root cause and knowing how to better address this problem was not well known. The 30th anniversary of listing this species as a federally endangered population provides a prime opportunity to review current practices and knowledge. Reducing the impact of dogs in areas also occupied by nesting piping plovers was identified as a key challenge for me to pursue for my MS thesis research. Chapter 1 is a review of the literature on the impact of dogs on shorebirds globally. I used this effort to obtain knowledge of current research, study topics and research findings. Results indicated that dogs on beaches are a definite issue and cause numerous problems for shorebirds, however action items and strategies to address this issue were rarely presented in the literature. This review led to the topic of Chapter 2, which summarizes a survey I conducted with visitors to Michigan beaches along Great Lakes shorelines to obtain knowledge of public attitudes on the same beaches occupied by nesting plovers. Both chapters were prepared for publication in peer-reviewed journals and the intent is to inform land managers about workable strategies for addressing the dog-shorebird conflict which include: create more dog beaches, develop more specific outreach and education programs for beach visitors, and implement

modern methods (i.e. social media) to communicate with the public.

Chapter 1

“MAN’S BEST FRIEND”: A THREAT TO SHOREBIRDS?

INTRODUCTION

Dog disturbance and its impact on shorebirds is not a novel topic. Numerous studies have demonstrated that birds are affected at any age throughout their annual life cycle by dogs on beaches (Pfister et al. 1992, Lafferty 2001A, Lord et al. 2001, Burger et al. 2004, Foster et al. 2009) and this problem is global in its extent (Burger 1991, Lord et al. 2001, Ruhlen et al. 2003, Weston and Elgar 2007, Morse et al. 2006, Foster et al. 2009, Aarif et al. 2014). Burger et al. (2007) reported that where present, dogs are the largest anthropogenic disturbance to shorebirds on beaches. Although more information is still needed on the specific effects dogs have on shorebirds, little is known about how to educate dog owners to minimize their impact and there is no published literature describing initiatives with goals to change owner behaviors and the interactions between dog owners and beach wildlife. Furthermore, outcomes of education and outreach efforts with beach-goers, especially those focused on dogs and shorebird conservation, have not been reported.

Best practices for successfully reducing dog disturbance on a variety of beach situations are limited in the literature until recently. Beach closures to dogs and humans have been the traditional, but extreme strategy, to directly manage this issue. Separation of shorebirds and dogs on the beach has proven to be effective, with shorebird presence and abundance higher in non-dog areas (Stigner et. al 2016). However, such a policy is not always feasible due to space, human recreation, public demands/needs, or other pressures on the use of the

beach. Enforcing leash laws is a commonly advised and/or used alternative (Baruch-Mordo et al. 2011, Weston et al. 2012). However, the logistics and true effectiveness of this approach, as well as discussion of it as a compromise between pet owners and conservationists, have not been presented. Additionally, no study or guideline exists directing conservationists on how to reduce impacts given the parameters of their specific beach (Lafferty 2001A, Burger et al. 2007). While one study recommended that dog management on beaches be commensurate with wild mammalian predator management, the details of such a management plan, its realistic implementation, and continued maintenance were not described (Schlacher et al. 2015).

Coexistence of dog owners and beach wildlife, if possible, will require suitable changes in dog owner behavior. While literature exists regarding the impacts of dogs on beach wildlife, there is an overall deficiency in the literature about dog owners and their attitudes, shorebird knowledge, level of support for shorebird conservation, and corresponding owner behavior on beaches. Acquiring this information is an important first step in creating effective plans to better protect shorebirds worldwide. The purpose of this review is to: a) provide an overview of current knowledge about the impacts of domestic dogs on shorebirds, b) summarize strategies used to protect shorebirds from dog disturbance, and c) identify important aspects of dog owner behavior and attitudes as related to shorebird disturbance. Finally, I propose research to better understand how human behavior related to these impacts can be addressed.

METHODS

A diversity of databases (e.g. Google Scholar, JSTOR, PsychInfo) were searched using related keywords to generate articles related to dog impacts to shorebirds on beaches. The main database used was Web of Knowledge given that it is broad and multidisciplinary in scope. The key words used included a combination of: “dog,” “shorebird,” “human disturbance,” “anthropogenic,” “beach,” and “impact.” Articles were then narrowed down based on the extent to which birds were the focus and the information obtained was specific to human and dog disturbance.

DOG DISTURBANCE IMPACTS ON SHOREBIRDS

Shorebirds, and waterbirds in general, face significant threats today globally, primarily related to habitat loss and climate change (Wetlands International 2012, NABCI 2014). As of 2012, almost a quarter (24%) of all 812 waterbird species globally are identified as threatened, near threatened, or critically endangered (Wetlands International 2012). Almost 30% of all plover species worldwide are listed at some level of conservation concern (Wetlands International 2012) and North America and Europe have developed the strongest and most widespread conservation initiatives on both individual species and habitat issues (Wetlands International 2012). Because many birds are migratory, crossing political boundaries and encountering the global effects of climate change, it will take international cooperation to conserve waterbird populations and bring about positive environmental change.

The added pressure of human activities on beaches makes these challenges even more difficult to overcome. The impact of domestic dogs and their owners on both breeding and non-breeding shorebirds is a concern on many beaches worldwide. For example, dog and human impacts on shorebirds have been reported from New Zealand to New Jersey, Australia to Alaska, and beaches in between including India, California, and Texas (Burger 1991, Lord et al. 2001, Ruhlen et al. 2003, Morse et al. 2006, Weston and Elgar 2007, Foster et al. 2009, Aarif et al. 2014). Many studies have also recorded evidence that dogs on beaches affect all shorebirds, regardless of species. Several shorebird species have been studied to specifically evaluate the impacts of human and dog disturbance including New Zealand dotterels (*Charadrius obscurus*), various plover species (piping – *Charadrius melodus*, snowy – *Charadrius nivosus*, and hooded – *Thinornis rubricollis*), red knots (*Calidris canutus*), black oystercatchers (*Haematopus bachmani*), and others (Burger 1991, Lord et al. 2001, Morse et al. 2006, Burger et al. 2007, Weston and Elgar 2007, Foster et al. 2009, Webber et al. 2013). Several of these species also have special conservation status highlighting the impact and need for addressing the issue of disturbance.

Studies report that dog impacts are variable and impact the entire annual life cycle of some species of shorebirds. Stigner and colleagues (2016) found the presence of dogs on beaches decreases bird occupancy and abundance for all species. The literature also demonstrates that no one season or age of bird is

more affected by the presence of dogs (Pfister et al. 1992, Lafferty 2001B, Lord et al. 2001, Burger et al. 2004, Foster et al. 2009).

During the breeding season, dog disturbance may cause shorebirds to change nesting and foraging locations (Webber et al. 2013). When forced to choose a nest site to avoid dog disturbance, the new breeding and foraging location may not be as desirable, particularly in terms of safety from other predators and access to resources. Another study in New Jersey determined that disturbance to piping plovers (*Charadrius melodus*) decreased their foraging time (Burger 1991). Interruption of foraging directly impacts energy consumption by adult birds at a time when energetic demands are highest providing for their offspring. Finally, Lord and colleagues (2001) discovered that beach disturbance led to a direct decrease in New Zealand dotterel nesting success, while Ruhlen et al. (2003) reported that dogs in California contribute to and potentially increase overall chick loss.

The non-breeding season represents the greatest proportion of time spent annually in one location. Investigators in California reported that dog disturbance impacts are not season specific and can cause just as much stress to shorebirds during the non-breeding season as at any other time (Lafferty 2001A, 2001B). Although shorebirds are able to focus more on their own survival and have fewer energetic demands while not breeding, they are just as easily stressed (Lafferty 2001A, 2001B). This stress could potentially lead to decreased body condition with effects that carry-over into the breeding season to decrease survival or

reproductive success through reduced fecundity or other unidentified consequences (Lafferty 2001A, 2001B).

Migration presents numerous inherent challenges such as exhaustion, limited access to food and water, increased predation pressures, and severe weather. At stopover sites, migratory birds are primarily focused on refueling to continue their journey. Additional obstacles during this time are more taxing on individual birds. When present in foraging areas, humans and their pets disturb feeding birds, reducing a bird's ability to consume invertebrates and while simultaneously increasing their stress levels (Burger 1991, Lafferty 2001A).

Dog feces deposited on the beach influence the health of the beach ecosystem and are another negative impact on shorebirds. A study in Virginia Key, Florida, reported that of all types of excrement on the focal beach, dog feces had the highest microbial load concentrations (Wright et al. 2009). These feces impact the chemistry and generic composition of the shoreline substrate and increase both the abundance and diversity of the existing microbe community. This effect may increase the rate of disease in shorebirds and other local wildlife, as well as potentially expose them to uncommon infections. Ultimately, health issues related to dog waste could negatively impact birds thereby presenting another challenge for recovery efforts, especially for small populations. Additional research is needed, however, to better understand these specific effects.

The severity of multiple disturbance types to shorebirds has also been compared. People walking, people running, and people walking/running with a

dog were all treatment groups in a study in New Zealand (Lord et al. 2001). While all groups influenced shorebird behavior at the study site, individuals with dogs had the most substantial impact. Thus, any beach activity with a dog creates greater risk of disturbance to shorebirds. Another study, in Monterey Bay, California, determined that free running dogs had the most severe and negative impact on foraging sanderling (*Calidris alba*) behavior (Thomas et al. 2003). This finding may be because unleashed dogs have many similarities including size, appearance, and behavior with natural mammalian predators such as foxes (*Vulpes vulpes*), raccoons (*Procyon lotor*), skunks (*Mephitis mephitis*), as well as feral and/or free-ranging domestic cats (*Felis catus*) (Thomas et. al 2003, Banks & Bryant 2007). Dogs off-leash also often chase adult and juvenile birds, ultimately elevating the birds' stress levels and ultimately risking their survival. Chasing may also cause young birds to leave the territory of the adults and expose them to threats from predators and weather as well as failure to re-unite with their parents (F. Cuthbert, pers. obs.).

CURRENT STRATEGIES USED TO PROTECT SHOREBIRDS

Studies have examined a range of management methods, from full beach closure to completely open, public access to the beach (Burger and Niles 2013A, 2013B). Full beach closures, or even roped-off areas, are more beneficial to the birds both immediately and long-term compared to fully human and dog accessible beaches. Establishing a buffer between dogs and shorebirds provides

more protection and reduces stress for the birds in such areas (Burger and Niles 2013A).

Voluntary avoidance, or encouraging the public to willingly respect areas temporarily designated for shorebirds, is another tactic that has been studied. Dog walkers were the least compliant out of a variety of recreationists (i.e. anglers, birders, walkers) observed on beaches in New Jersey (Burger and Niles 2013B). Compliance by all people was higher when researchers and park police were regularly patrolling the beach (Burger and Niles 2013B). However, voluntary avoidance is not feasible for many areas given the expense of compensating people to monitor the beach as long and thoroughly as may be required to oversee this compliance.

Jorgenson & Brown (2014) investigated attitudes and compliance to a leash law, another strategy employed on beaches where dogs are allowed. This study was conducted in Nebraska at a site occupied by nesting piping plovers. The researchers determined that while most participants surveyed had positive opinions about this species and were generally aware of local leash laws, compliance was low (16% of all dogs observed were leashed). These results indicate that if the public has complete freedom regarding their behavior on the beach, then shorebirds will continue to be at risk.

Dog beaches have also been established at many sites where beach visitors and their dogs can go to designated portions of the shoreline that allow and even encourage dogs off leash. These areas are typically separated from

both the sites shorebirds tend to use as well as the primary human recreation areas. Benefits of dog beaches for shorebirds has had limited study (Williams et al. 2009). However, Stigner et al. (2016) demonstrated at various beaches in Queensland, Australia, that separate areas for dogs and wildlife does increase occupancy and abundance of shorebirds in the wildlife-oriented portion of the shoreline.

DOG OWNER BEHAVIOR AND ATTITUDES

Studies have found that attitudes, and subsequently the actions, of beach visitors directly impact wildlife on the beach (Jorgenson 2015). One study found that pet owners tend to like more wildlife species, and even feed them more frequently, than non-pet owners (Bjerke et al. 2003). Given that pet owners tend to be more favorable towards local wildlife than non-pet owners, one might hypothesize that pet owners would be supportive, both verbally and actively, of birds and related conservation efforts, especially when visiting a natural area (Bjerke et al. 2003). However, these opinions do not necessarily consider situations that include a pet(s). Many pet-owners view their dog(s) as another member of the family, even more so if they travel with them outside the home (Dotson et. al 2010). The variety of beliefs and motivations held by pet owners in general, and specifically about their pets, may influence owners to reduce support for conservation-oriented efforts.

Given sociality motivation (the desire to have relationships with others), the relationship an owner may have with his/her pet, and the anthropogenic

characteristics placed on that pet, it is easy to understand why an owner would want to bring a pet on a trip to the beach (Paul et. al 2015). Based on these behaviors, it can also be concluded that if a regulation prohibits access to the beach by a person's pet, the owner may disregard the rules because of the so-called best interests of the pet. For example, a leash law prohibits a pet from getting certain types of exercise and may restrict a dog's overall activity level. Thus, an owner may let his/her dog run free because the benefits to their dog are perceived to outweigh risks of not complying with the rule.

Numerous interactions must be considered when making decisions about the presence of dogs in public spaces. For example, maintaining a "certain ideal public order" is important for communities and for keeping the peace (Holmberg 2013). There are dog-human interactions as well as dog-dog, and in specific interest of this study, dog-wildlife. Logistics and other specifics to be addressed include: safety and risk assessments, level of disturbance to the area and other people, excrement and clean up protocol, and "dogginess" or the public's perception of the individual dog and its personality (Holmberg 2013).

Blouin (2013) identified three primary types of dog owners: dominionistic, humanistic, and protectionistic. Dominionistic owners believe that dogs are valuable for the services they provide and the work they can do for people, such as protection, hunting, or service. Humanistic owners value dogs and the bonds formed with them to the extent that these pets are essentially surrogate humans. Protectionistic owners believe that dogs have intrinsic value and are valuable

companions. These labels give insight to the psychology of dog owners and suggest how people may react in different situations with their dogs. These categories also indicate there are distinct sub-cultures and accompanying opinions for individual dog owners.

The effect of social norms on pet owners while at the beach has been shown to have a significant impact. For example, pet owners in Victoria, Australia, were more likely to keep their dogs leashed on a beach if they felt a high level of social pressure to do so (Williams et al. 2009). Therefore, other beach-goers and their assumed judgments can have a powerful influence on pet owners.

Finally, despite the strong interest in allowing dogs on beaches and for providing special areas for dogs, in one study on beaches along the Eastern Yucatán Peninsula in Mexico (Williams and Barugh 2014), 50% of those surveyed claimed they would prefer to visit dog-free beaches; they also supported a total ban on dogs in that area. However, those who hold similar opinions may do so for personal reasons (i.e. fear of dogs), which are not related to environmental, or conservation oriented motives (Chapter 2). It has also been found that individuals with negative opinions about dogs often extend those views toward dog-owners (Graham and Glover 2014). Dog parks may help reduce any animosity toward dogs and dog-owners by beach-goers who do not want to share recreation sites with dogs.

CONCLUSIONS

The issue of dogs on beaches and their interaction with shorebirds will continue to be a regularly encountered problem until more broadly acknowledged in recreational beach policies. With an increase in the number of households owning at least one dog, outdoor recreational activities will also see an increase in the presence of dogs joining their owners (AVMF 2012). People will especially continue to recreate on beaches with their dogs as long as they are permitted to do so (Jorgenson and Brown 2014). The density of dogs on beaches is highest where shoreline visitors are located, creating an even greater and more concentrated impact on local area and wildlife (Lafferty 2001A).

There is a correlation between an owner perceiving or experiencing a constraint on their pet, such as a leash law or closed beach, and that owner's behavior changing (Hung et al. 2016). The impact on owner behavior due to a pet constraint helps explain why pet owners may feel restricted when traveling even though they often consider traveling with a pet more convenient and enjoyable (Dotson et. al 2010). In the past, owners may have felt hindered from visiting a beach for a variety of reasons including the need to find arrangements for leaving their dogs at home. However, due to amenities such as dog friendly housing and beaches, they are now able to more easily travel to the beach with their pets. The current level of awareness among pet owners about increasing trends regarding dog-friendliness and hotels or other aspects of travel is low (Dotson et. al 2010). While increasing the knowledge of dog-friendly travel resources would most likely

increase both pet owner satisfaction and tourism, the resulting consequences to wildlife and the recreational experience for all visitors is a topic that needs more study. In summary, a balance must be achieved between ecotourism and the impacts such activities, such as recreating on the beach with dogs, have on local wildlife (Burger et al. 1995).

To reduce dog and shorebird interactions on beaches, pet owners who travel with dogs will need to be more involved in solutions to this dilemma. Land managers at state and national parks especially need to prioritize meeting the multiple needs of dog owners, shoreline biodiversity and the experience sought by non-dog owners. Involving pet owners as well as non-pet owners in conversations regarding dog policies, as well as creating additional surveys to increase knowledge about the needs and concerns of beach-goers at a diversity of locations will contribute positively to future solutions. Additionally, identifying strategies to encourage pet owner responsibility and compliance in coastal environments is necessary and needs more investigation.

Relationships between pet owners and biodiversity managers must also be fostered. Although labor intensive, the beliefs influencing owner behavior can only be identified through discussion with individual owners. This information is crucial in understanding the motives and causes of situations that occur on the beach. For example, a person who strongly values that their dog visits the beach with them and exercises during the outing can provide insight on why they let their dog run off-leash. This example can lead to further questioning into

alternative options for providing the dog exercise or other needs required or desired by the owner or pet. Beach managers could help foster the popularity and value of dog walking to people by establishing areas along the shoreline and through the park that allow and encourage dog walking.

Another possible direction is to focus directly on the dogs. Research has shown that pet owners tend to be responsive to suggestions when communications are oriented toward the welfare of their dog and how the dog's role as part of a larger community (Rohlf et al. 2010). Reminding pet owners that their dog contributes to a place and situation with specific regards to public health, safety, and overall atmosphere may also be an effective strategy to employ. Alerting people to the risks loose dogs may encounter is also an option to use (Williams et al. 2009). For example, dogs off leash, regardless of location, are more prone to getting hurt via an accident or injured by wildlife, than those kept on leash. Dogs are also vulnerable to other environmental threats, and communicating this to dog owners and how valuable it is to keep dogs on-leash and nearby is important. For example, blue-green alga (*Cyanobacteria*) is one such threat and has recently become a concern in Minnesota and other Midwestern states. This problem resulted in dog deaths from unintentional poisoning after they swam or drank from bodies of water with blue-green algae blooms (Dunbar 2016).

In summary, pet owners, land managers and wildlife biologists need to collaborate on finding solutions to minimize dog activities on public beaches.

Encouragingly, a study in Queensland, Australia (Van Polanen Petel 2012) found that 90% of those surveyed believe that coexistence between dog owners and shorebirds is possible. Topics that need to be addressed include motivation and expectations for visitors to bring dogs to beaches, what features define a "good beach experience" for dogs and their owners, reception of dog owners to activity restrictions on dog beaches, and educational program development to bring awareness to owners of dog impacts on shorebirds and other beach wildlife. Improved understanding of these issues will help reduce dog impact on beach wildlife globally.

RECOMMENDATIONS

1. Create more dog beaches and dog-friendly areas.

Emphasizing dog specific beaches may be one of the most effective tactics (Williams et al. 2009) to reduce dog-shorebird conflict. If local beach managers designate areas that are dog friendly, this may be a satisfactory compromise. A dog-exclusive space, such as a dog beach, could help provide dogs and their owners a sense of place and belonging when visiting the beach. A dog beach could avoid the issues that result from all the various interactions (i.e. dog-human, dog-wildlife) on an open beach as well as offer other users their own safe space. The method of information delivery affects the acceptance rate of new management plans. Designation of a dog beach might be best conveyed to users as a tactic to meet the needs of each party rather than as forced separation or unfair treatment. Zoning or separated recreational areas on beaches has been

shown to be a cost-effective strategy as well one that benefits all parties (Stigner et. al 2016).

To ensure user satisfaction, these dog-exclusive areas should be large enough to allow even large dogs to run and/or give pet-owners the opportunity to walk their dogs a substantial distance. Dog beaches should also include basic amenities such as water and bowls for the dogs, bags and trash cans for dog feces, and benches for dog-owners. Depending on the location, partial fencing may also be advisable.

2. Education and Outreach

Education and outreach will continue to be vital aspects of any management plan addressing the issue of dogs on beaches. More specific messages and programs should be established to further these efforts. For example, being supportive of and even encouraging dogs to visit the beach with their owners is possible as long as the guidelines and expectations are presented clearly. One approach is to provide clear suggestions of dog friendly areas to visit or other dog activities that are permitted as well as the areas or activities to avoid. Helping pet owners realize the capacity they have to help or harm shorebirds could be a good framework with which to begin. Owners can be empowered and the public more involved by conveying that there are minimal actions that ensure a substantial, positive difference for wildlife conservation. For example, leashing dogs and providing shorebirds appropriate space can make a

substantial difference and achieving at least a compromise needs to be a priority (Thomas et al. 2003).

Research has demonstrated that campaigns directed toward pet owners are most likely to be effective when specific attitudes held by this group about their pets and related issues are targeted (Rohlf et al. 2010). This is one way to easily inform active campaigns based on the theory of planned behavior (Ajzen 1991) and survey work conducted.

3. Communication

Using new and modern methods may be another approach to addressing the shorebird-dog conflict issue. Social media is a free, low-maintenance, rapidly growing communication medium with huge potential for conservation campaigns. Access to a continually growing number of users with few obstacles is another benefit of using social media to spread information and messages. These platforms help establish connections between the public, land managers, conservationists, and the birds. Directed messages could easily be reiterated to the public. Such messages include facts about the shorebirds that are being affected, reminders and details on the beach policies (i.e. leash laws, fine amounts, etc.), positive local dog news or programs, or even lost dog information. Using social media to foster social norms regarding dogs on beaches (i.e. increase social pressure on reducing free-running dogs) may also be a more viable strategy (Williams et al. 2009).

Chapter 2

PLOVER LOVERS? KNOWLEDGE AND PUBLIC SUPPORT FOR PIPING PLOVER CONSERVATION BY VISITORS TO MICHIGAN BEACHES

INTRODUCTION

Although the Great Lakes piping plover (*Charadrius melodus*) population has been federally listed as endangered for 30 years, no formal research has examined beach-goer knowledge of piping plovers or level of public support for associated regional conservation and management efforts. Over these three decades, the focus has primarily been on understanding plover biology and developing strategies to support population recovery. The population has benefited from research and protection as evident by the increase from < 20 pairs at time of listing to 75 breeding pairs in 2016 (Rutter & Cuthbert 2016, unpubl.). However, improved understanding of the human dimensions aspect of the conservation effort is required to ultimately achieve population recovery goals.

Humans impact piping plovers in a variety of ways, but people are often unaware of those impacts or how their behavior causes them. There are direct consequences of human presence, as well as from their dogs, to plovers and other shorebirds. Studies reporting influence of disturbance type (e.g. human, dog, kites) on piping plover flushing behavior indicate both breeding and non-breeding birds are impacted even hundreds of meters from the disturbance (Cross 1990, Loegering 1992, Goldin 1993, Hoopes 1993). In New Jersey, Burger (1991) observed that human disturbance increased the amount of time piping plovers were vigilant while decreasing time spent foraging. Changes in site occupancy by snowy plovers (*Charadrius nivosus*) in Florida were

documented as a result of human disturbance to the birds (Webber et al. 2013). Decreased breeding success for New Zealand dotterels (*Charadrius obscurus aquilonius*) due to humans and dogs on beaches has also been recorded (Lord et al. 2001). Dogs decrease overall shorebird occupancy and abundance on beaches (Stigner et al. 2016) and dog feces increase exposure to microbes and diseases (Wright et al. 2009). Traditional protection of these birds is provided by predator exclosures, beach closures and psychological fencing (USFWS 2003) and at some sites, predator control (V. Cavalieri, pers. comm.) as well. Many Great Lakes piping plover nests are on public beaches or are otherwise shared with humans; therefore, addressing the public's impact on this rare species could benefit recovery efforts (Rutter & Cuthbert 2016, unpubl.).

Traditionally, management of human behavior in similar situations relies on law enforcement or restrictions on beach recreation, primarily due to its effectiveness (USFWS 2003, Baruch-Mordo et al. 2011, Weston et al. 2012). However, outreach and education is the more commonly chosen strategy addressing identified issues between the public and wildlife (Baruch-Mordo et al. 2011). Given the variation among beach policies regarding dogs (i.e. allowed, leash-law, not allowed) as well as the diversity in outreach and education across the Great Lakes region regarding this species, it is not unexpected that the public may have strong, polarizing views on piping plovers, as is the case on the Atlantic Coast.

Studies that adequately address how to minimize the impacts of human recreation on beach wildlife are still novel in the field of human/dog/shorebird interactions (Jorgensen & Brown 2015) although dogs have been identified as a threat to nesting piping plovers in the recovery plan for decades (USFWS 1985). Research also demonstrates that human/dog/shorebird interactions are a global issue, are not bird taxa specific, occur throughout the year, and are consistent at every stage of the birds' annual cycle (Chapter 1). Findings from these studies indicate that the human element of shorebird conservation can be better addressed by influencing changes in the public's behavior while on public recreation lands.

Few studies have directly addressed the human dimension issue of shorebird conservation, specifically how to manage it (Stigner et al. 2016). Relevant research has largely focused on observational rather than experimental data (Antos et al. 2006, Banks and Bryant 2007, Williams et al. 2009, Van Polanen Petel & Bunce 2012, Burger & Niles 2013, Maguire et al. 2013, Jorgensen & Brown 2014). In recent years, however, studies addressing human impacts on shorebirds have increased (e.g. Antos et al. 2006, Banks and Bryant 2007, Williams et al. 2009, Van Polanen Petel & Bunce 2012, Burger & Niles 2013, Maguire et al. 2013, Jorgensen & Brown 2014) and these indicate recognition of need for more attention to be directed toward this conservation issue. Professionals who work on recovery of shoreline-dependent species have observed the disparity between beach management and public opinion for

decades (V. Cavalieri, pers. comm.). Other documented cases exist where the conflict is not just between humans and wildlife but between humans and land managers as well. Furthermore, it is not surprising to learn that most issues and subsequent studies have focused on differences in opinion regarding human beach recreation restrictions (Jorgensen & Brown 2014).

The public holds a wide range of views regarding Great Lakes piping plovers. But, these views have been reported anecdotally to plover monitors researchers and law enforcement (Cuthbert, unpubl. data). However, throughout the duration of the recovery effort, these opinions have not been officially documented and have been based largely on personal experience and speculation. This study is the first to quantify the knowledge and attitudes held by the public who visit beaches used by piping plovers.

This survey provides a snapshot of public knowledge and opinion regarding Great Lakes piping plovers on the 30th anniversary of the listing of this population as federally endangered. These survey results are required to develop more targeted recovery efforts for the Great Lakes piping plover population. The overall purpose of this study was to obtain insight into Michigan beach-goer attitudes and knowledge regarding piping plovers and related conservation efforts. Data were also collected on dog ownership and public desire for dog beaches at shoreline recreation sites in Michigan.

METHODS

Study Species

The Great Lakes piping plover is a small, migratory shorebird; its population was listed as federally endangered in the United States in 1986 and a species at risk in Canada in 2002 (USFWS 1985, COSEWIC 2001). This population historically nested on the shoreline of all five Great Lakes but by the year of listing was only breeding in the state of Michigan (USFWS 1985). Over the past three decades, in response to protection and management, the population has increased to 75 breeding pairs that nested on four of the Great Lakes in four states and Ontario (Rutter & Cuthbert, 2016, unpubl. data). The Atlantic Coast and Great Plains populations are federally listed as threatened. These two populations continue to be substantially larger than the Great Lakes population and together encompass approximately 99% of the individuals in the species (Haig et. al 2005). Plovers typically arrive on the Great Lakes breeding grounds in mid-April, begin nesting in mid-May, and fledge chicks by early or mid-July. Fall migration usually begins with departure of the adult females in mid-July with the males following a few weeks later. Surviving fledglings depart days or weeks after the adults (Roche et. al 2010, Saunders et. al 2014). During the non-breeding season, Great Lakes plovers are reported as far north as North Carolina, as far south as the Bahamas and Cuba, and as far west as the Gulf coast of Texas and Mexico (Stucker et al. 2010).

This population of plovers nests exclusively on the beaches of the Great Lakes. They prefer wide, cobble beaches with sparse vegetation (Powell and Cuthbert 1992, Wemmer 2000, Haffner et al. 2009). Most nests are currently still found in Michigan and are located at sites managed under both public and private ownership in both the USA and Canada (Rutter & Cuthbert, 2016, unpubl.). Plovers typically lay a clutch of four eggs and will renest if there is a predation or other event that destroys eggs or causes desertion early enough in the season (Claassen et al. 2014).

Study Area

In person surveys to determine beach-goer attitudes and opinions were conducted at 11 plover nesting locations throughout the state of Michigan (Figure 1). Michigan has the largest proportion of nesting Great Lakes piping plover pairs (Rutter & Cuthbert, 2016, unpubl.). This state is also centrally located within the population's breeding range. Participants were intercepted on the beach during the 2016 plover-breeding season (May-July). Ten of these sites (Grand Marais - Agate Beach; Ludington State Park; Manistee - Fifth Avenue Beach; Muskegon State Park; Tawas State Park; Silver Lake State Park; Sleeping Bear Dunes National Lakeshore; Stearns Park Beach; Whitefish Point Unit of Seney National Wildlife Refuge; and Wilderness State Park) had active Great Lakes piping plover nests in 2015 and 2016. One site (Petoskey State Park) did not have an active nest in 2016, but plovers nested at this location in 2005. Management responsibility at these sites was varied and included National Park Service

(Sleeping Bear Dunes); U.S. Fish and Wildlife Service National Wildlife Refuge System (Whitefish Point); Michigan State Parks (5 parks listed above); city authority (Manistee; Stearns); and township board (Grand Marais).

Michigan Beach-Goer Survey

I verbally conducted and recorded all surveys (Appendix 1). No sampling bias for time existed as surveys were conducted in both morning and afternoon sessions (cumulative range 0900-1700).

Basic demographic information was collected from each participant including age, gender, and zip code. Following requirements under the University of Minnesota – Twin Cities Institutional Review Board permit (Study Number: 1505E70946); no one under the age of 18 was interviewed for the study.

A maximum of 14 questions (including the three demographic questions) were asked. All research questions were answered by the participant as “yes” or “no”, or on a zero to three scale. The scale was used for questions regarding level of importance or acceptability. Numerical responses were 0-3 with the following values indicating “not at all important/acceptable” (0), “slightly…” (1), “moderately…” (2), and “very…” (3).

Participants were first asked, “Do you know what a piping plover is?” If the person replied yes, then four additional and more taxa-specific questions were asked. These questions included: current endangered status, breeding location, human impact, and reception of information prior to the survey. Following these

questions, all participants, regardless of piping plover knowledge, were asked about their opinion on the importance of protecting beach wildlife as well as the acceptability of restricting human recreation if it helped protect beach wildlife. The final topic covered in the questionnaire regarded domestic dogs. Those surveyed were asked if they owned one or more dogs. If so, the participant was asked whether their dog accompanied them to the beach on that day, if they would use a dog beach (real or hypothetical depending on location), and the level of importance a dog beach is to them.

Program R was used to complete all statistical analyses (R Development Core Team 2008). Chi-square (X^2) tests and Cramer's V tests were used to determine whether statistical significance existed among or between groups. A paired t-test (comparison of means) was conducted to determine the difference between the levels of importance to protect beach wildlife with the acceptability of restrictions on human recreation. A multiple regression was also done using acceptability of restrictions on human recreation as the dependent variable with most other survey questions being independent variables (Table 2, Appendix 1). Statistical significance was determined if any p-value was less than 0.05.

RESULTS

A total of 551 surveys were completed during May-July 2016. Most participants were female (n=315, 57%) with males (n=236) comprising 43% of those surveyed. The majority of participants were Michigan residents (n=440, 80%; out of state or country; n=111, 20%). Age of participants ranged from 18 to

86. Mean age of those surveyed was 47 years old. Data and/or demographics of those asked to participate but who declined were not recorded. For this reason, no overall response rate is reported for this survey.

The majority of those surveyed did not know what a piping plover was (no: n=317, 58%; yes: n=234, 42%). Neither gender nor age were predictors of plover knowledge (gender: $X^2 = 0.049$, df=1, P=0.824, Cramer's V=0.009; age: X^2 =0.049, df=1, P=0.824, Cramer's V=0.455). However, home zip code was a significant predictor (X^2 =372.227, df=304, P=0.005, Figure 2). Michigan residents were proportionally more likely to know what a piping plover was compared to those from out of state. Of those who responded yes to prior knowledge of piping plovers, most were aware of the nesting status of piping plovers at that beach (yes: n=152, 65%; no: n=81, 35%). An overwhelming majority, 83%, was also knowledgeable regarding the current endangered status of piping plovers (yes: n=194; no: n=39, 17%). They also agreed that humans could negatively impact plovers (yes: n=224, 96%; no: n=9, 4%). Many people also claimed to have seen or received information about piping plovers prior to this survey (yes: n=144, 26%; no: n=89, 38%). However, only about a quarter of those who stated they obtained previous information could actually reference a source such as a park sign or pamphlet (participants that could reference an information source, n=47, 27%).

Protecting beach wildlife was of general importance to almost every participant, with a cumulative 99% of people reporting this was of some level of

importance to them (not at all important: n=4, 1%; slightly important: n=16, 3%; moderately important: n=38, 7%; very important: n=493, 89%, Figure 3). Gender and age were not significant contributors to this opinion (gender: $X^2 = 6.260$, df=3, *P*=0.099, Cramer's V=0.107; age: $X^2 = 0164.805$, df=204, *P*=0.979, Cramer's V=0.316). Home zip code also did not influence this opinion ($X^2 = 871.271$, df=912, *P*=0.829, Cramer's V=0.726). Knowing what a piping plover is or not was also not a predictor of these responses ($X^2 = 4.679$, df=3, *P*=0.197, Cramer's V=0.092).

In comparison, general acceptance levels for restrictions to human recreation were lower. While 97% of participants cumulatively responded that human recreation restrictions were of some level of acceptability, the distribution was different from that for the previous question regarding beach wildlife protection (not at all acceptable: n=18, 3%; slightly acceptable: n=30, 5%; moderately acceptable: n=134, 24%; very acceptable: n=369, 67%, Figure 4). Again, age was not an accurate predictor of the opinions collected ($X^2 = 197.506$, df=204, *P*=0.615, Cramer's V=0.346). Gender was a significant factor for this response as well ($X^2 = 11.615$, df=3, *P*=0.009, Cramer's V=0.145, Figure 5). Men were more likely to respond with a lower acceptance level than women. Knowing what a piping plover is or not was not a predictor of these responses ($X^2 = 1.401$, df=3, *P*=0.705, Cramer's V=0.050), but the participant's zip code was ($X^2 = 1006.562$, df=912, *P*=0.015, Cramer's V=0.780). Michigan residents were not as likely to be tolerant of restrictions in proportion to participants from out of state (participants

that chose a level 3 of acceptability, Michigan residents, n=290, 66%; out of state, n=79, 71%, Figure 6).

Half of all respondents owned at least 1 dog (n=282, 51%; did not own a dog: n=269, 49%). Of those with dogs, only 30% had their dogs on the beach accompanying them (yes: n=86; no: n=197, 70%). Most dog owners indicated that they either use the existing “dog beach” or would use one if it was available at the park (n=222, 79%).

Only dog owners were asked about the importance of dog beaches. However, five individuals independently indicated a dog beach was “very important” to them because of the future ownership of a dog or because the individual preferred dogs to be separated from the public beach area. Dog owners specifically had an 88% response-rating overall for the importance of dog beaches (not at all important: n= 33, 12%; slightly important: n=52, 18%; moderately important: n=56, 20%; very important: n=141, 50%, Figure 7). Out of the cumulative participant responses, 46% replied with some level of importance (not at all important: n=297, 54%; slightly important: n=52, 9%; moderately important: n=56, 10%; very important: n=146, 27%). Participant zip code was significantly related to the importance of dog beaches to them as well (X^2 =1040.964, df=912, *P* =0.002, Cramer’s V=0.74, Figure 8). Michigan residents indicated a much stronger value for dog beaches than those from out of state (participants that responded with very important, or a 3, Michigan resident, n = 121, 28%, out of state, n =21, 22%).

Difference in opinion between protecting beach wildlife and accepting restrictions was significant (X^2 =320.838, df=9, *P* <2.2e-16, Cramer's V=0.441; Paired t-test: t=11.556, df=550, *P* <2.2e-16, Table 1). A multiple regression indicated that gender and the opinion a person holds on protecting beach wildlife are the most significant variables when predicting the results for beach restriction acceptability (gender: *P*=0.033; protecting beach wildlife: *P*=<2e-16, Table 2). Age, knowledge of piping plovers, owning a dog or not, and the level of importance of a "dog beach" were not significant predictors (age: *P*=0.372; knowledge of piping plovers: *P*=0.082; owning a dog or not: *P*=0.5836; the level of importance of a "dog beach": *P*=0.349).

DISCUSSION

In 2016, a snapshot of the public's opinions, knowledge, and general support for beach conservation issues was obtained, primarily at public recreation sites in Michigan. Results help provide a guide for actions to improve the recovery effort as it moves forward. Participant responses overall were much more positive than expected. Comparisons among the different responses are of greatest interest, however. While level of support for protecting beach wildlife was extremely high (very important: 89%), a 22% decrease in positive responses occurred when subsequently asked about acceptability of human beach recreation restrictions (very acceptable: 67%). This difference indicates participants strongly value conservation, provided impacts of conservation do not directly affect their existing lives and habits. While this opinion is not uncommon,

this attitude is not conducive for maximizing conservation efforts and achieving maximum recovery of piping plovers.

Public outreach and education is identified as one of the key aspects of the recovery effort in the U.S. Fish and Wildlife Service piping plover recovery plan for the Great Lakes population (USFWS 2003). The results from this survey indicate the potential value in developing more targeted messaging or campaign efforts to address the actions of Michigan beach visitors with potential to extend these efforts to other neighboring states. Data collected in Nebraska regarding Great Plains piping plovers also indicates there is potential for improvement in programs currently in place (Jorgenson & Brown 2014).

Differences observed between genders and zip code in regards to acceptability of beach restrictions are also of note. Recognizing that Michigan residents (compared to out of state) as well as men (compared to women) are less likely to be accepting of these restrictions better specifies the target audience for future work and initiatives. Not only does this difference between genders help direct future management tactics but it also highlights that there may be other factors (e.g. human characteristics, personal experiences, societal pressures) influencing human-wildlife conflict on Michigan beaches. Different outreach and messaging strategies may be used given the difference in opinions held by men compared to women, as well as current Michigan versus out-of-state residents.

Understanding differences between in-state and out-of-state beach visitors is vital information for future study and communication. Michigan residents were less likely to tolerate restrictions well and more likely to vocalize the importance of a dog beach. These data will inform establishment of a plan to better reach and communicate with those visiting coastal shorelines. Using forms of communication that connect with a broader or simply larger audience, such as social media or news outlets, could be important. While Michigan residents made up the majority of participants (n=440, 80%), out-of-state, or –country, beach-goers remain a key group to reach and include. Contrasts between coastal and inland Michigan residents are also vital to address due to the potential differences in experiences, values, and even frequency of thinking about issues such as beach wildlife and conservation.

The survey used in this study does not account for or measure the specific values held by participants. However, there are indications that characteristics such as personal identity may be important. For example, visiting a beach with a family or group; being an environmentally oriented person or owning a dog are all components of personal identity that may influence attitudes and behaviors. Few data on demographic information were collected and understanding the connections as well as influences of these variables on human behavior could be key to adjusting current or future conservation work. For example, results obtained indicating that zip code and gender are influential may offer initial insight, or act as surrogates, for all variables regarding beach-user values. More

research is needed to address this issue by incorporating the theory of planned behavior (Ajzen 1991) in the analysis of survey data. Fully understanding the values and beliefs that influence a person's, or in this case an entire group's, opinions and actions will allow for a more thorough work plan and insight into which stage or aspect of a person's behavior can be better targeted.

Half of all survey participants owned at least one dog, indicating this aspect of human disturbance requires more attention as well. This ratio was not surprising given the popularity of dogs as pets in the United States (Stallones et al. 1990). Dog beaches were recognized by almost all dog-owning respondents as an important element to improve beach enjoyment. This sentiment was expected given both personal experiences by recovery effort workers as well as the frequency with which people include their dogs when pursuing outdoor recreation (Ham & Epping 2006).

It is unlikely that the rate of people visiting the beach with their dogs will decrease in the future. According to the American Veterinary Medical Foundation, there has been an increase in the number of households with at least one dog between 2007 and 2012 (AVMF 2012). Thus, dogs on beaches is an important issue that needs to be addressed more seriously in the Great Lakes region, and even worldwide, than it has been to date (Chapter 1). Not only do dogs impact the beach environment and wildlife, but dog owners are influential as well. While beaches or even overall management plans may require dogs to be kept on leashes at all times, this requirement does not necessarily resolve the

problem for piping plovers or other beach wildlife (Melvin et al. 1991, USFWS 2003); dog owners do not always comply with leash policies. Non-compliance in areas where there are nesting piping plovers is commonly observed in the Great Lakes and is not unique to this area or species. Other areas with piping plovers as well as other species of shorebirds, such as Australia's hooded plover (*Thinornis rubricollis*), have also reported low rates of cooperation among dog owners (Hatch 1996, Dowling & Weston 1999, Lafferty 2001A, Jorgensen & Brown 2014).

Many dog owners responded that their priorities are more personal and dog oriented than wildlife directed. Such statements include the general belief that their dog's well-being is more important than that of beach wildlife, the need for their dog to get exercise or be otherwise unrestricted to better enjoy the time at the beach, and they also express that their dog is not having a negative impact (Cairns & McLaren 1980, Melvin et al. 1991, Burger 1994, Williams et al. 2009) on shoreline biodiversity. These perspectives provide evidence that shorebird and wildlife conservationists working globally need to include more effective messages to dog owners. For example, Jorgensen and Brown (2014) identified the need for more strongly and clearly conveying the reason for restrictions on dogs at a beach (i.e. leash laws) and the widespread nature of negative impacts caused by all dogs on nesting shorebirds.

Recognizing and including the dog-owning group of the public in discussions of public beach policies could have significant implications. Not only

will another aspect of the recovery effort be addressed, but it will also increase acknowledgement of this substantial group of shoreline visitors. This recognition could also benefit plover protection by providing beach-goers with a greater say and input in the recovery effort, and through discussion, avoid or resolve issues before they occur (Jorgensen & Brown 2015). For example, incorporating all groups in a collaborative way has been shown to be an effective strategy for finding solutions to economic related issues between piping plovers and Nebraska residents (Brown et al. 2011).

In conclusion, the Great Lakes piping plover population recovery effort has taken important steps towards delisting. However, maintaining this progress requires a stronger more targeted focus on human and plover interactions, which must be more broadly integrated into plover protection and recovery. Following are recommendations to target the issue of dogs on beaches at shoreline used by nesting plovers in Michigan; these suggestions are relevant to other nesting sites throughout the population's breeding range.

RECOMMENDATIONS TO DECREASE IMPACTS OF DOGS TO PIPING PLOVERS IN THE GREAT LAKES REGION:

1. Create dog beaches at all traditional plover nesting sites on public land in Michigan.

Although pets are allowed at all 103 state parks in Michigan, no sites that hosted nesting piping plovers in 2016 have a designated "pet-friendly shoreline" (Michigan DNR 2016). Tawas State Park had nesting plovers as recently as

2015 and is the only park regularly used by plovers with a formally designated dog beach. Sleeping Bear Dunes National Lakeshore, under federal ownership, has strict leash laws and no designated area where dogs can roam freely.

Creation of more “dog parks” on or adjacent to beaches separated from shorebird nesting habitat could be a potential compromise and increase Great Lakes piping plover conservation efforts and recovery in Michigan and elsewhere. Such a solution has been employed at Tawas State Park, a regular piping plover-nesting site. The dog beach at this location has several amenities including a fence to contain the dogs, a boardwalk for easy access to the beach from the main path, a bench for the owners, as well as waste receptacles. While the overall cost and upkeep of a dog beach will vary depending on size and location, the Tawas dog beach had an initial cost of approximately $1,550 (USD) with a regular annual maintenance cost of $250 (USD) (C. Allen, pers. comm.). The original budget for this project consisted of: snow fence - $200, boardwalk materials - $500, signage - $500, pet waste dispensers, bags and container - $350. Reoccurring annual costs of approximately $250 are required to restock the pet waste bags provided. Occasional additional costs may be accrued if other materials need to be replaced or additional amenities (e.g. water spigot, water bowls, picnic tables, etc.) are added to the beach. Daily checks for trash and refilling the pet waste bags make up the regular maintenance required. More annual upkeep includes installing the boardwalk and then removing it prior to winter to avoid wear or damage from ice.

While law enforcement is known to significantly aid in helping beach wildlife by increasing the dog on leash compliance level, this is not always an option for beaches for a variety of reasons (e.g. lack of personnel, funding, beach size) (Hatch 1996, Baruch-Mordo et al. 2011, Jorgensen & Brown 2014). Thus, designating a dog beach may not be feasible at all public Great Lakes beaches. By establishing a safe area for dogs and their owners to visit where there is the sense of fewer restrictions could at least aid in making a more amicable situation and interaction among the different groups (e.g. dog-owners, non-dog-owners, beach managers, conservationists). A designated area for each group will also potentially reduce the need for intensive enforcement. Offering such amenities could also be a source of income for the beaches/parks given that dog beaches are appealing to people and may increase visitation rates by dog-owners.

With support from non-dog owners for dog beaches, there is great potential to improve habitat for piping plovers and other shoreline biodiversity. By expressing the need to create well-defined areas, non-dog owners raised other issues with dogs on beaches, including the variation in opinion and human acceptance of dogs on the beach. The natural separation that would occur by establishing distinct and labeled areas for dogs and non-dog owners could help prevent future conflict for both groups. In turn, dog beaches will improve the recreational experience for dogs and their owners and reduce management time and expense for state and federal employees tasked with reporting dog/owner violations. Additionally, presenting approved beach areas with limited rules for

dog owners will translate as a positive experience through reduced need for enforcement or constant oversight by park employees. Predictable presence of formal dog beaches may also have strong public appeal because the guidelines and expectations should be clearer. Taking advantage of the social norms associated with using an obviously designated area for personal characteristics (in this case visiting a beach with a dog or not) could also be beneficial (Williams et al 2009).

2. Outreach and Education

To date, no study has developed and tested effective outreach and education programs to target dog owners on beaches (Chapter 1). Implemented programs must increase awareness but also educate regarding conservation. (Jorgensen & Brown 2014). Simple knowledge about piping plovers or any conservation message in general ultimately results in very little change because there is no guidance given to the public on how to use that information. Elements of these programs must be directed at helping people better understand the consequences of their actions and incorporating elements that have action items for the public. The most current USFWS recovery effort plan (2003) includes mention of conducting “educational presentations to citizen groups” however it does not specify any logistical or content details beyond “promote awareness of status and threat to piping plovers”. The plan also only references specific outreach to private landowners. While this group is necessary to include given that there are piping plovers that nest on private land (Chapter 1), there are other

key groups, such as dog owners that influence these birds and must receive communication.

Addressing beach-goer's opinions and the consequences of their actions is critical for eventual recovery of this endangered population. Collaborating with behavioral psychologists could be a potential partnership to improve these studies further. Behavioral psychologists specifically could assist at helping beach managers and/or conservationists better understand and address every stage of a person's behavior from belief formation to values to action. Embracing a multi-disciplinary approach for such a dynamic issue could allow for more comprehensive solutions to be identified and employed. Any such efforts though will complement existing management and conservation programs.

3. Increase communication

Not only does content and messaging improve effectiveness, but the medium of communication needs to be considered as well. Passive communication (i.e. brochures, signs) that has traditionally been used by this recovery effort (USFWS 2003) and others may not be the most effective mode. These methods require beach-users to find the material and take the time to read it. Such methods put the responsibility of learning and interpretation on the beach-goer. Even with "several press releases annually" limited traditional news stories are likely not enough to broadly inform the public (USFWS 2003). The use of press releases should continue since they do put piping plovers in the current news. However, the topics should not be restricted to only "piping plover special

status, biology, and management" (USFWS 2003). Special events, programs, and other exciting aspects of piping plovers and related conservation work should be considered for coverage.

More engaging and ongoing communication initiated by the conservation program may also help beach-goers better understand the messaging directed at them and receive it more regularly. Examples of these communications include in-person programs, social media and consistent personal interactions with onsite workers.

Table 1. Chi-square results of human survey questions based on the results of 551 Michigan beach-goers. See Appendix 1 for detailed information and key for each question (e.g. Q1, Q2, etc.).

Question Comparisons	Chi-squared	df	p-value	Cramer's V
gender versus plover knowledge	0.049	1	0.824	0.009
gender versus Q2	6.260	3	0.100	0.107
gender versus Q3	11.615	3	0.009	0.145
age versus plover knowledge	0.049	1	0.824	0.455
age versus Q2	164.805	204	0.980	0.316
age versus Q3	197.506	204	0.615	0.346
Q1 vs Q2	4.680	3	0.197	0.092
Q2 vs Q3	320.838	9	< 2.2e-16	0.441
Q3 vs Q4	2.988	3	0.394	0.074
Q1 vs Q3	1.401	3	0.705	0.050
Q2 vs Q4	3.378	3	0.337	0.078
Q4 vs Q8	383.790	3	< 2.2e-16	0.835
Zipcode vs Q1	372.227	304	0.005	0.822
Zipcode vs Q2	871.271	912	0.830	0.726
Zipcode vs Q3	1006.562	912	0.015	0.780
Zipcode vs Q8	1040.964	912	0.002	0.794

Table 2. Multiple regression results of six variables and their relationship with participant opinions on the acceptability of beach restrictions. See appendix 1 for detailed information and key for each question (e.g. Q1, Q2, etc.).

Multiple Regression with Q3 as Y (dependent variable)				
	Estimate	**Std. Error**	**t value**	**Pr(>|t|)**
(Intercept)	-0.038	0.185	-0.202	0.840
Sex	-0.113	0.053	-2.134	0.033 *
Age	0.001	0.002	0.894	0.372
Q1	0.096	0.055	1.743	0.082
Q2	0.889	0.055	16.27	<2e-16 ***
Q4	0.043	0.079	0.549	0.584
Q8	-0.028	0.030	-0.938	0.349
Residual standard error: 0.6073 on 544 degrees of freedom				
Multiple R-squared: 0.3409, Adjusted R-squared: 0.3336				
F-statistic: 46.9 on 6 and 544 DF, p-value: < 2.2e-16				

Figure 1. Map of sites used for 2016 Michigan beach-goer survey. Management responsibility at these sites was varied and included National Park Service (Sleeping Bear Dunes); U.S. Fish and Wildlife Service National Wildlife Refuge System (Whitefish Point); Michigan State Parks (5 parks listed above); city authority (Manistee; Stearns) and township board (Grand Marais).

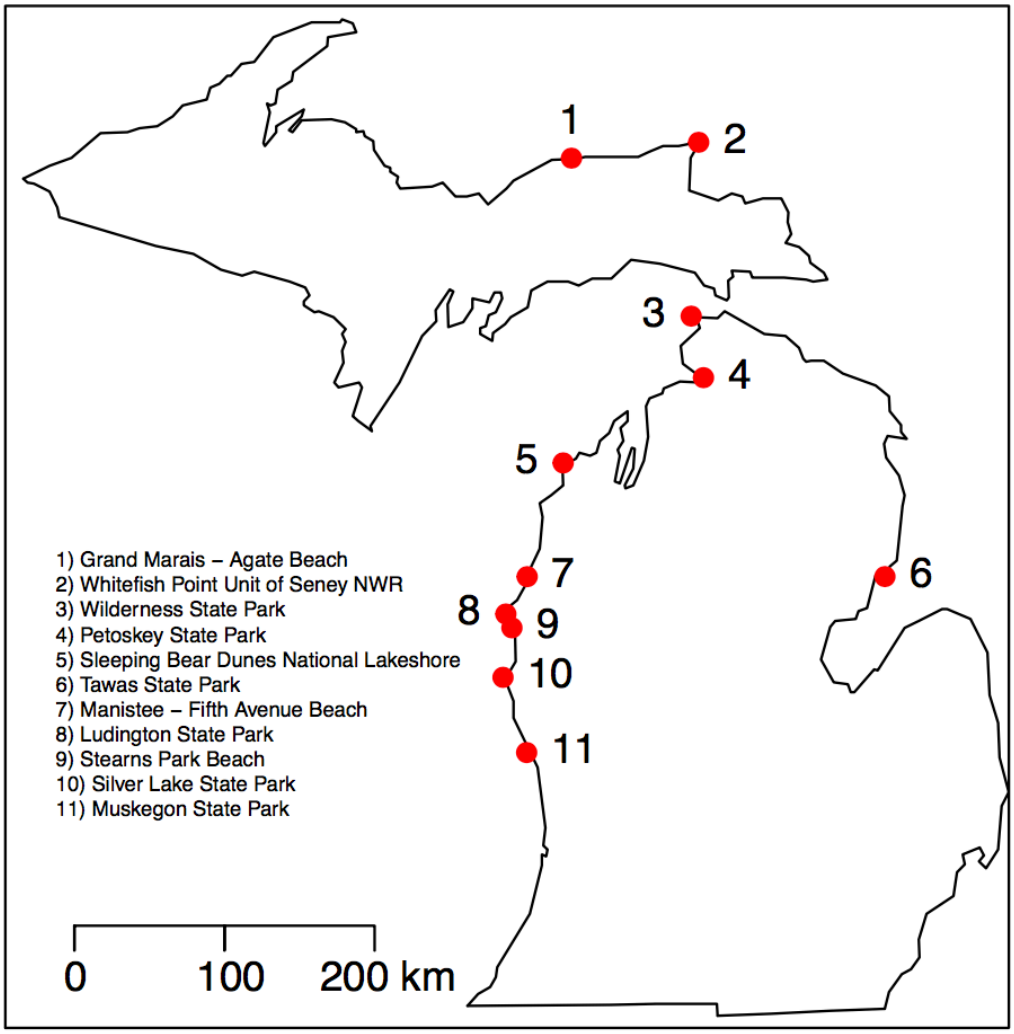


Figure 2. Comparison between resident and non-resident survey participants to the question, “Do you know what a piping plover is?”

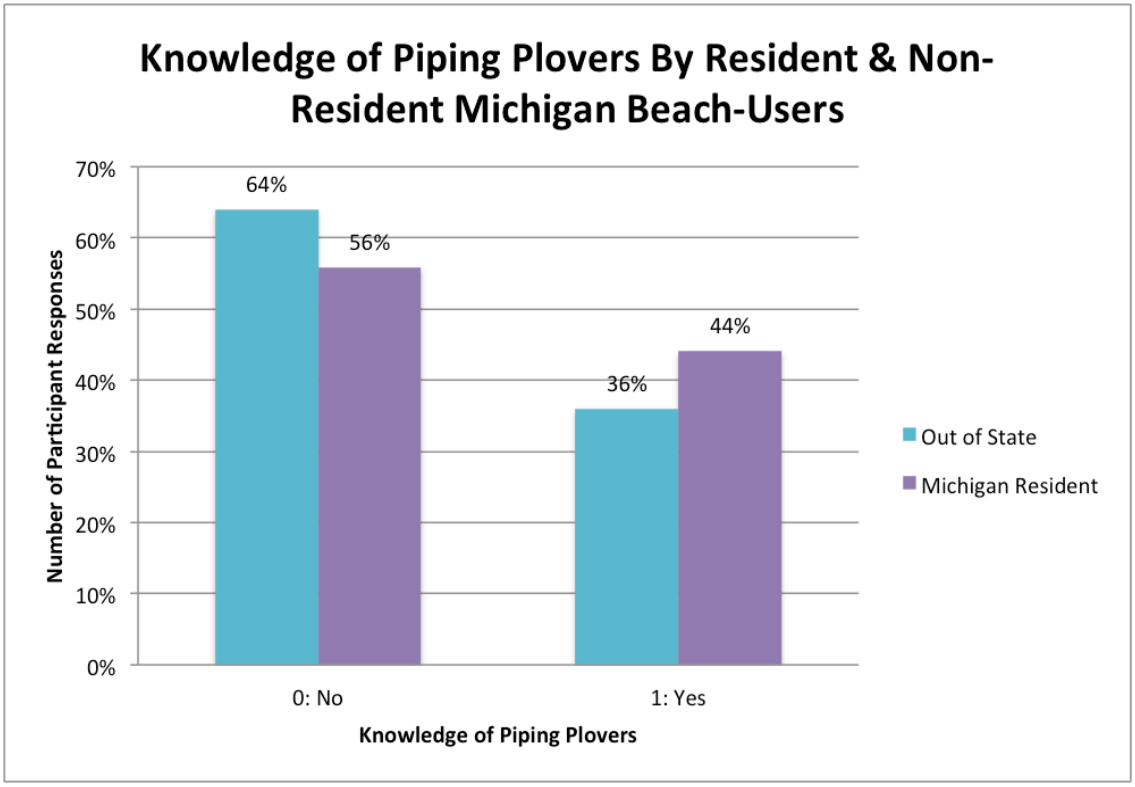


Figure 3. Percentages of survey participant responses to the question, “How important is it to protect beach wildlife?”

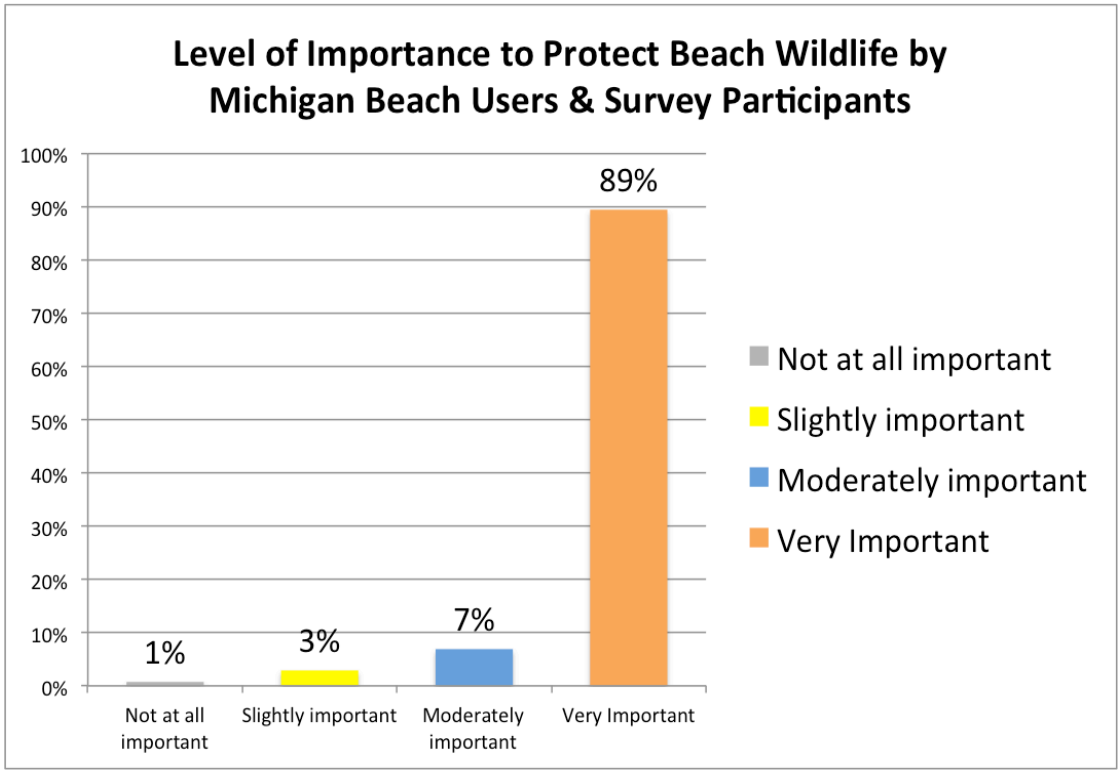


Figure 4. Percentages of survey participant responses to the question, “In general, would restrictions on some human recreation be acceptable to you if they help protect beach wildlife? (i.e. roped off areas, no dogs on beach, dogs allowed on beach but leash law enforced).”

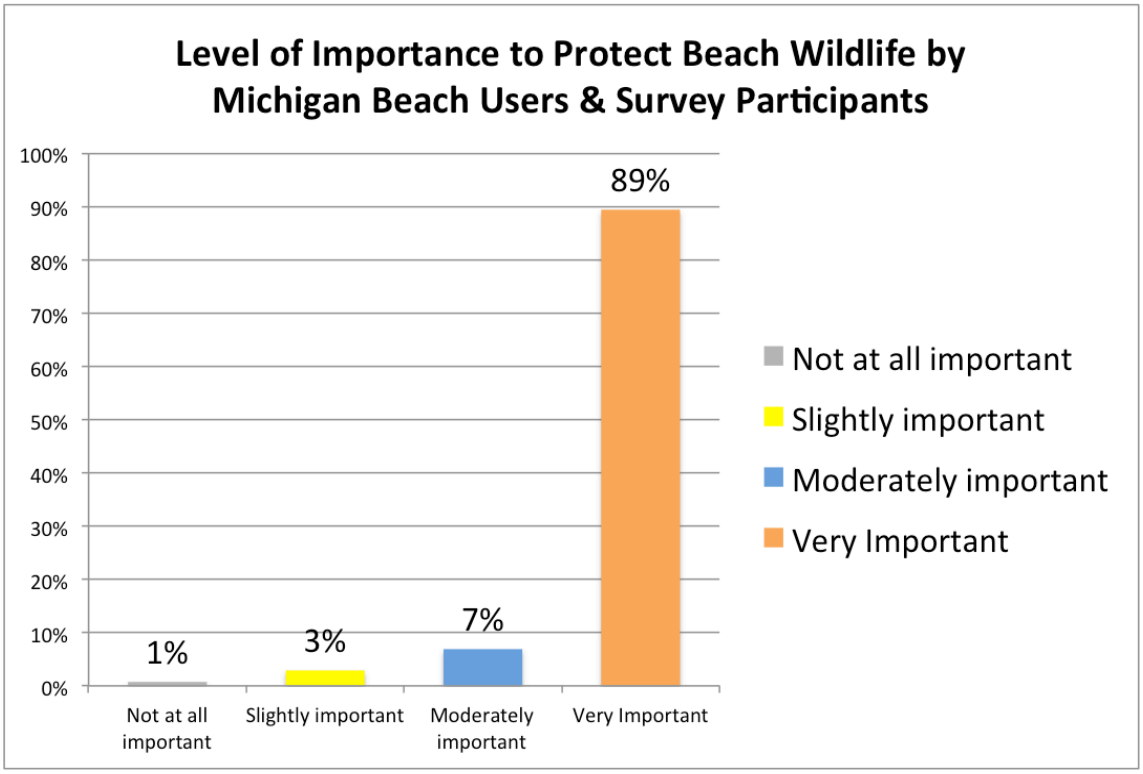


Figure 5. Differences in gender responses by survey participants to the question, “In general, would restrictions on some human recreation be acceptable to you if they help protect beach wildlife? (i.e. roped off areas, no dogs on beach, dogs allowed on beach but leash law enforced)”

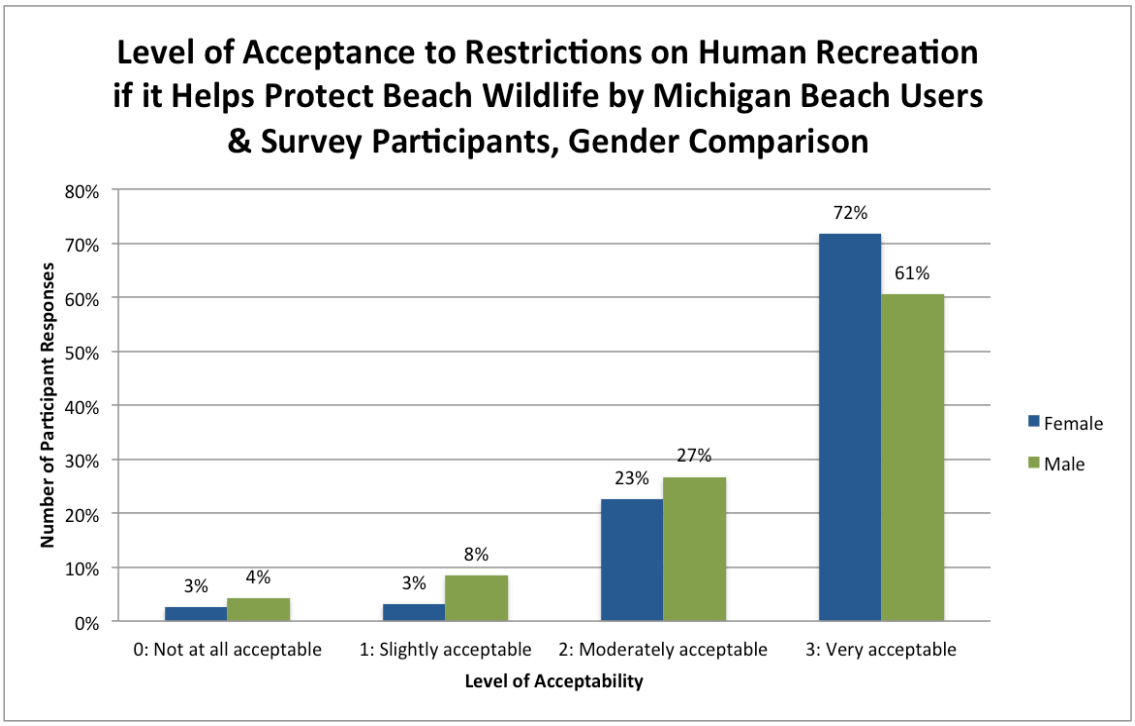


Figure 6. Comparison of resident and non-resident survey participant opinions to the question, “In general, would restrictions on some human recreation be acceptable to you if they help protect beach wildlife? (i.e. roped off areas, no dogs on beach, dogs allowed on beach but leash law enforced)”

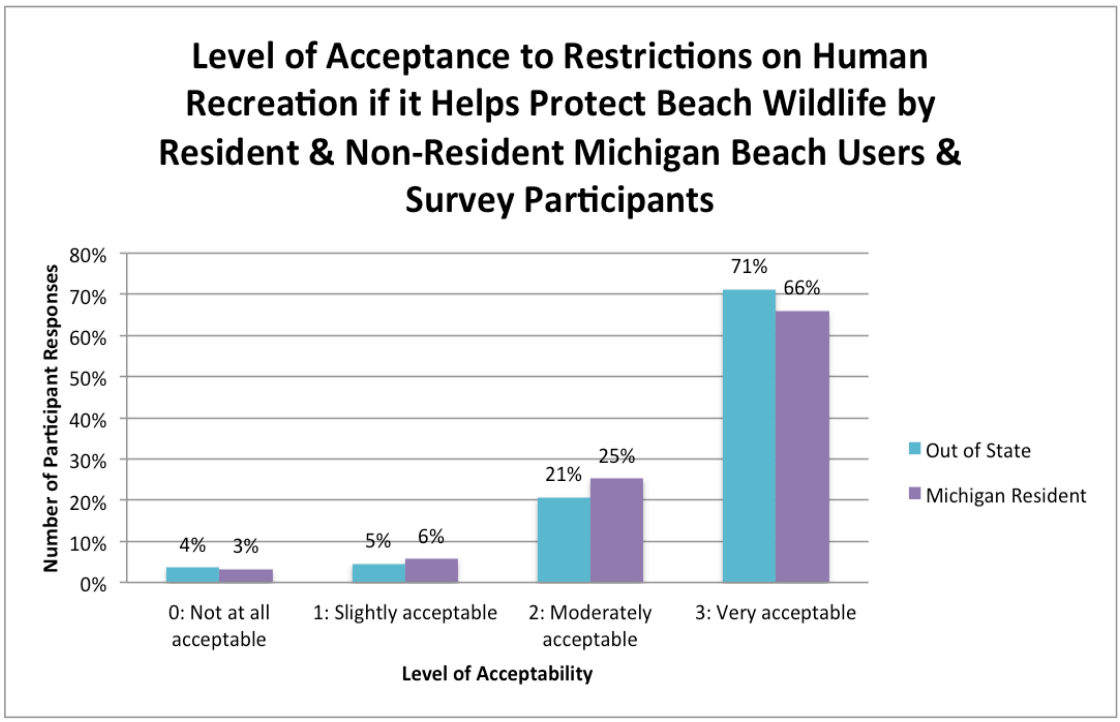


Figure 7. Percentages of survey participant responses to the question, “How important is a “dog beach” to you?”

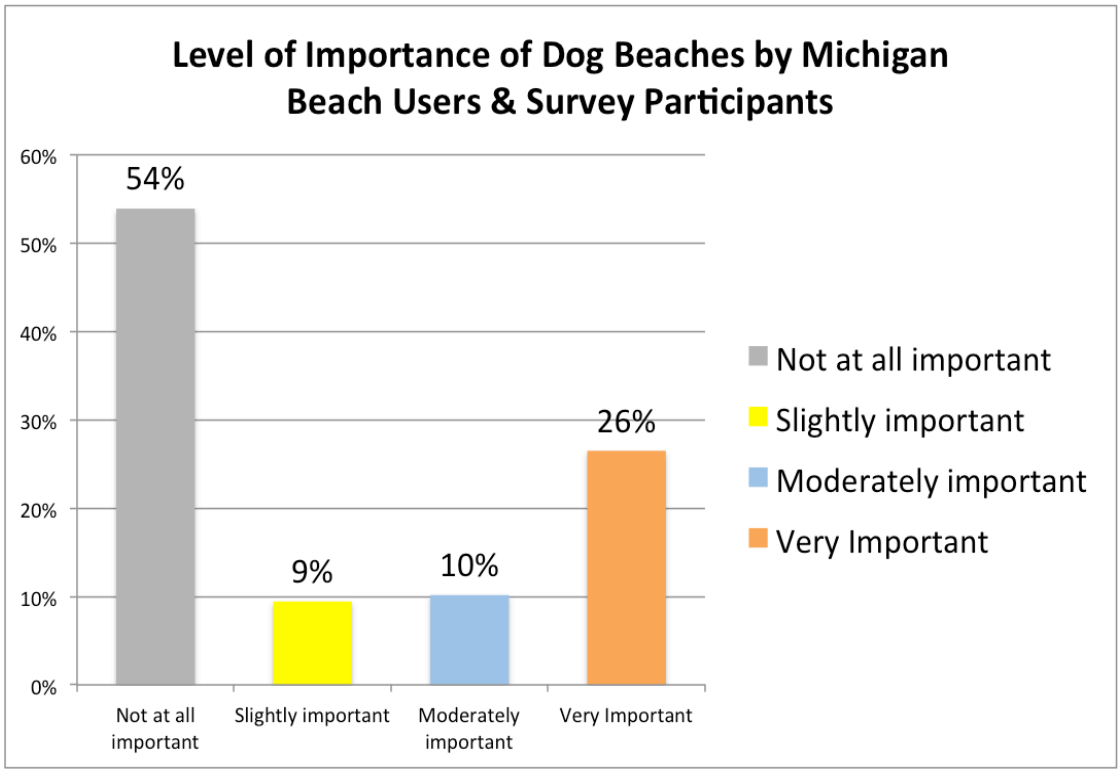
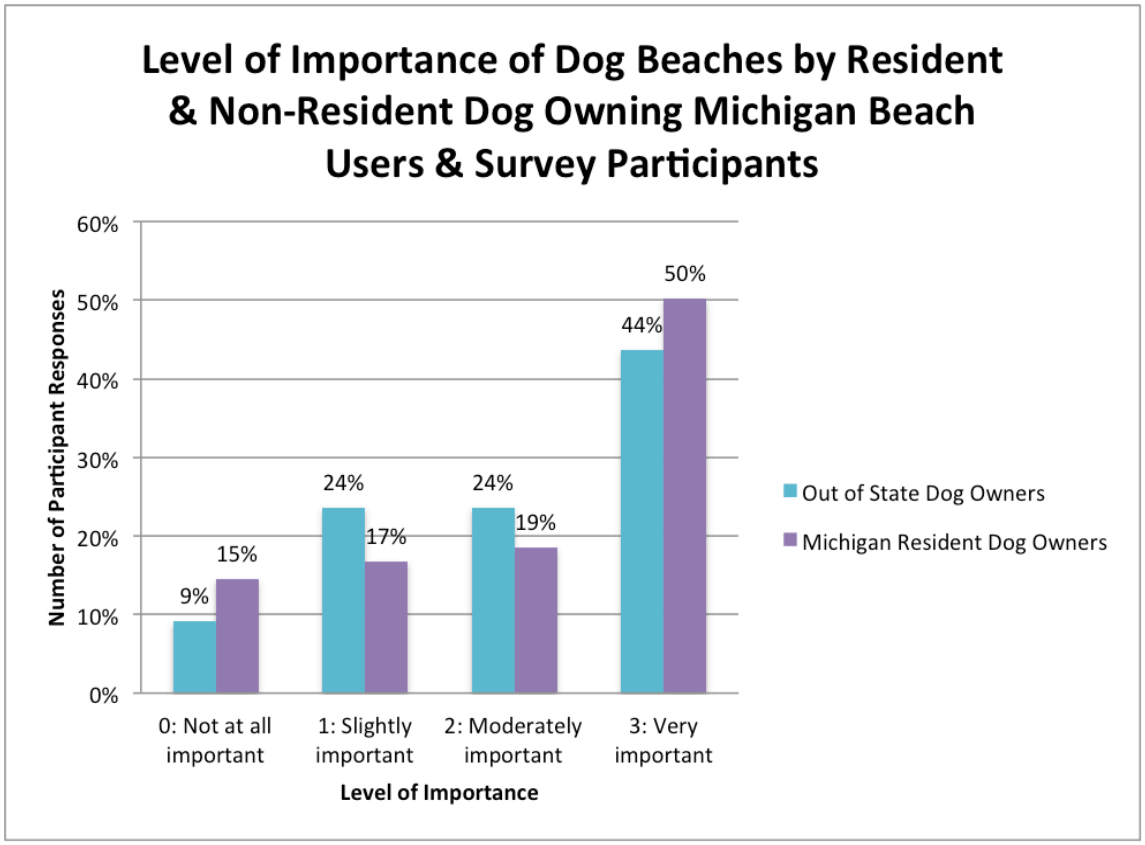


Figure 8. Differences between resident and non-resident dog-owner survey participant responses to the question, “How important is a “dog beach” to you?”



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Appendix 1. Survey given to visitors to Michigan beaches.

Survey ID #: _____ Beach: _____ Surveyor: _____ Date/Time: _____

UMN GREAT LAKES PIPING PLOVER PUBLIC SURVEY 2016

Zip: _____ Age: _____ Gender: MALE FEMALE

1) Do you know what a piping plover is?
If YES, ask all questions on sheet. If NO, stop at line.
YES NO

2) How important is it to protect beach wildlife?
Not at all important Slightly important Moderately important Very important

3) In general, would restrictions on some human recreation be acceptable to you if they help protect beach wildlife? (i.e. roped off areas, no dogs on beach, dogs allowed on beach but leash law enforced)
Not at all acceptable Slightly acceptable Moderately acceptable Very acceptable

4) Do you own one or more dogs?
YES NO

5) Did your dog(s) come to the beach with you today?
YES NO NA

Only ask if at a beach without a "dog beach"
6) If a "dog beach" were available here, would you use it?
YES NO

Only ask if at a beach with a "dog beach"
7) Are you aware of the "dog beach" here? Do you use it?
YES NO YES NO

8) How important is a "dog beach" to you?
Not at all important Slightly important Moderately important Very important

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Now we'd like to gather information about public knowledge in regards to piping plovers specifically.
9) Are you aware that piping plovers have nested on this beach?
YES NO

10) Are piping plovers protected by federal and state endangered species laws?
YES NO

11) Can the presence of people on beaches negatively impact piping plovers?
YES NO

12) Have you seen or received any information on piping plovers prior to this survey? If yes, where?
YES NO

Additional comments: