Received: 13 February 2022 | Accepted: 9 June 2022

DOI: 10.1002/pan3.10392

PEOPLE AND NATURE | BRITISH ECOLOGICAL SOCIETY

RESEARCH ARTICLE

Managers and shorebird biologists' perceptions of enforcement and voluntary compliance techniques to increase compliance with dog regulations on beaches

Ashley A. Dayer[1] | Jillian Everly[1] | Carolyn A. Comber[1] | Meredith L. Gore[2]

[1]Department of Fish & Wildlife Conservation, Virginia Tech, Blacksburg, Virginia, USA

[2]Department of Geographical Sciences, University of Maryland College Park, College Park, Maryland, USA

Correspondence
Ashley A. Dayer
Email: dayer@vt.edu

Funding information
National Audubon Society; National Fish and Wildlife Foundation, Grant/Award Number: ID:0111.19.063893 and CFDA#15.663

Handling Editor: Jennifer Atchison

Abstract

1. Disturbance to shorebirds by domestic dogs can cause direct and indirect bird mortality. Dog regulations to minimize disturbance are only effective if people comply with them.
2. Non-compliance is a universal problem in biodiversity conservation, with an associated body of applicable social science from the field of conservation criminology. We apply the lens of this literature to better understand non-compliance with dog regulations on beaches along the Atlantic Flyway of the U.S. and the role of law enforcement and voluntary compliance techniques (e.g. persuasive communications, behavioural alternatives) in fostering compliance.
3. Through in-depth interviews with 27 land managers and shorebird biologists experienced in creating and/or implementing regulations to reduce disturbance to shorebirds, we found that non-compliance is a challenge that law enforcement alone is inadequate to address.
4. Managers are working to overcome these challenges with law enforcement through training law enforcement officers, as well as voluntary compliance approaches, such as conducting on-site stewardship programs led largely by volunteers, placing educational signage at sites, and highlighting alternative areas to walk dogs.
5. The early stages of the COVID-19 pandemic in the U.S. increased dog walking on beaches and exacerbated the issue of non-compliance and lack of enforcement, while the capacity for educational and stewardship programs was also limited.
6. We conclude by recommending that managers and biologists tackle non-compliance with multiple and concurrent strategies along a spectrum from enforcement to voluntary compliance techniques, while also better studying the efficacy of these approaches. We also highlight the importance of continuing to track the ongoing challenges to compliance with biodiversity conservation regulations due to the COVID-19 pandemic.

KEYWORDS
compliance, conservation criminology, enforcement, human disturbance, shorebird conservation

1 | INTRODUCTION

Globally, many shorebird (order *Chadriiformes*) populations are in decline (Koleček et al., 2021). Among other challenges, human disturbance—when behaviour, activities, or physiology of a shorebird is disrupted (Weston, 2019)—can result in behaviour changes (Gibson et al., 2021), physiological modifications (Gibson et al., 2018) and even mortality to shorebirds (Maguire et al., 2019; Sabine III et al., 2008; Schulte & Simons, 2015). A variety of human activities can lead to such disturbance, with domestic dog walking as one of the most impactful (Mengak & Dayer, 2020). Dogs can adversely affect shorebirds by restricting foraging (Lafferty, 2001), crushing eggs (Weston et al., 2012), or even preying on chicks (Lafferty et al., 2006) and adults (Maguire et al., 2019). Further, domestic dogs use substantial space in their movements on beaches and greatly restrict shorebird habitat (Schneider et al., 2020). Regulations to restrict the ways in which dogs can use sites (e.g. leashing); partial or full closures; and zones for dogs and wildlife (or dogs off and on leash) are common solutions (Weston & Stankowich, 2014). These approaches aim to change temporal and spatial impacts of dogs on wildlife (Gore & Bennett, 2021; Maguire et al., 2019). Past research shows that regulations can be beneficial for the protection of shorebirds (Maguire et al., 2019; Schneider et al., 2020; Stigner et al., 2016; Weston et al., 2012). Yet, regulations are only effective if people comply with them (Arias, 2015), and there is ample evidence that compliance with regulations for dogs is lacking at sites worldwide (Weston & Stankowich, 2014).

Non-compliance with regulations and laws is a universal problem in biodiversity conservation (Gore, 2011; Solomon et al., 2015). Compliance is defined as 'adherence to rules related to natural resource use and conservation…the term compliance refers to whether a person or system adheres to rules or not' (Arias, 2015, p. 134). Managers in the U.S. and Canada portions of the Atlantic Flyway believe there are non-compliance issues with dog regulations, more so than other human activities that are regulated to restrict disturbance to shorebirds (Comber & Dayer, 2021b). Similarly in the Midcontinent Flyway of the U.S. and the East Asian-Australasian Flyway, researchers have documented non-compliance issues with regulations for dogs on beaches (Jorgensen & Brown, 2014, 2016; Maguire et al., 2019). Exacerbating concerns about non-compliance, the COVID-19 pandemic led to increased use of recreational areas (Hwang, 2020), as well as higher levels of dog ownership (Morgan et al., 2020) and closure of spaces typically set aside for dogs during lockdowns (Mayers, 2021). As Soga et al. (2021) articulate, these changes in recreation can result in improved human health and well-being but also increased pressures on wildlife.

Conservation social science researchers (Bennett et al., 2017), particularly within the field of conservation criminology, focus on studying illegal behaviour related to the environment (Gibbs et al., 2009; Gore, 2011). This literature provides a lens for understanding the challenge of non-compliance with dog regulations, particularly the decision-making of beach recreationists with dogs who pose risks to shorebirds, and potential strategies to address non-compliance with dog regulations (Gore & Bennett, 2021).

1.1 | Enforcement

Ecological research on disturbance to shorebirds from dogs often calls for more stringent enforcement (e.g. Baudains & Lloyd, 2007; Burger, 1986); yet, it is also acknowledged that enforcement alone may not be effective at achieving conservation outcomes (Bowes et al., 2017; Comber & Dayer, 2021b). Enforcement applies a regulatory approach, sometimes referred to as 'coerced compliance', whereby non-compliers are penalized (Arias, 2015). In this approach, offences must be detected and arrests or citations given with penalties implemented (Arias, 2015). In the case of shorebird disturbance, some managers along the Atlantic Flyway of the U.S. and Canada believe that law enforcement is less effective than other management strategies (Comber & Dayer, 2021b). This may be due in part to law enforcement authorities and programs tending to be strapped for time and resources (Eliason, 2011; Moreto, 2016; Rizzolo et al., 2021) and having to make tough decisions about where to focus enforcement activities (Dhanjal-Adams et al., 2016). Conservation enforcement is often reliant on local enforcement authorities (e.g. municipal police), who may have more pressing issues than wildlife-related enforcement (Dhanjal-Adams et al., 2016) or may not have adequate knowledge about wildlife conservation concerns (Rizzolo et al., 2021). Further, enforcement activities may backfire by leading to resentment from community members (Solomon et al., 2015). This conflict over shorebird management can even lead to people resenting shorebirds (Dayer et al., 2019).

1.2 | Voluntary compliance

Depending on the drivers of non-compliance, non-regulatory strategies can be developed, in lieu of or in addition to enforcement (Solomon et al., 2015; Williams et al., 2009). For example, communications can be effective when rules are not understood (Solomon et al., 2015) or social marketing may be effective when norms are important drivers of human behaviour (e.g. Comber & Dayer, 2021a; Veríssimo et al., 2020). These approaches are often referred to as voluntary compliance, which is 'performed purposefully as an act of approval with the rules or institutions, either when punishment is applicable or not' (Arias, 2015, p. 139).

Voluntary compliance tends to be accomplished through legitimacy (i.e. fostering perceptions that the authorities, regulations and procedures are legitimate), incentives (i.e. money, rewards, recognition, information given in return for complying), norms (i.e. fostering beliefs that a behaviour is morally appropriate and socially acceptable), alternatives (i.e. finding another behaviour to promote) and persuasive communication (Arias, 2015). With these voluntary approaches, some level of enforcement is often still needed in conjunction (Arias, 2015).

1.3 | COVID-19 impacts

At times of social upheaval, such as the COVID-19 pandemic, challenges for conservation can become even more pronounced as: (1) human behaviour patterns change; (2) there are more severe issues for enforcement to contend with; and (3) resources even for voluntary compliance support are limited. In the spirit of Schwartz et al. (2020), we aimed to learn from the COVID-19 pandemic, particularly associated higher levels of outdoor recreation, as an indication of what could happen with ongoing increased human use of coastal areas. The pandemic could impact wildlife conservation in a variety of ways, including decreased management and enforcement (Bates et al., 2020). In fact, Manenti et al. (2020) reported illegal killing of birds, likely due to less patrolling and monitoring as a result of the pandemic. Still, others reported anecdotally that patrols in protected areas and protection of vulnerable wildlife was maintained (Corlett et al., 2020). While the decrease in human pressures on wildlife was initially touted (Bates et al., 2020; Corlett et al., 2020), others described decreased human disturbance in locations with lockdowns (Manenti et al., 2020 in Italy); yet, most lockdowns in the US still allowed for outdoor recreation (Larson et al., 2021) and increased numbers of visitors at beaches (e.g. National Park Service, 2020).

Additionally, dog ownership increased due to the COVID-19 pandemic as people sought companionship (Ho et al., 2021; Morgan et al., 2020). While it is not clear if more dog ownership led to more dog walking (e.g. Owczarczak-Garstecka et al., 2021 found this was not the case in the UK), patterns of dog walking may have changed as dog parks were closed during lockdowns (Mayers, 2021), people took their dogs off leash more frequently (Owczarczak-Garstecka et al., 2021), or they sought places where they were less likely to interact with other people and their dogs (Holland et al., 2021). Overall, there is some indication that people visited green spaces to walk their dogs more frequently than those without dogs (Burnett et al., 2021). Yet, in Australia fewer domestic dogs were found on the beach during COVID-19 lockdown (Gilby et al., 2021). In contrast, likely due to differences in how lockdowns were treated in the U.S. (i.e. typically allowing and even encouraging outdoor recreation), shorebird biologists and managers associated with the American Oystercatcher Working Group reported more disturbance concerns for threatened shorebird species and restricted ability to manage these concerns (e.g. 2020 State Updates, 2021).

In this study, we aimed to better understand how compliance with dog-related policies is being addressed at sites along the Atlantic Flyway of the U.S., using a conservation criminology lens. To do so, we explored the local knowledge of on-the-ground practitioners (land managers and biologists) across the U.S. portion of the Atlantic Flyway who are experienced in developing and implementing regulations for dogs to minimize shorebird disturbance and also observed the results of these regulations. Such knowledge is often used in situations where there is inadequate empirical data (Cook et al., 2014). While such managerial or biologist knowledge is sometimes considered expert opinion (e.g. Comber & Dayer, 2021b), in line with Cook et al., we consider this local knowledge instead because these individuals often do not necessarily have relevant formal education or publication records, but they do have extensive relevant experience with shorebirds, coastal environments, management decisions, outcomes and recreationists' responses (Cook et al., 2014). Specifically, we explored managers' and biologists' (hereafter, managers) thoughts on to what extent enforcement (both detection and citation) effectively contributed to compliance, and what enforcement issues, if any, existed. We probed why managers believe enforcement issues exist and how they were working to overcome the issues. We were also interested in how managers of sites cultivate voluntary compliance (e.g. alternatives, communications, signage) with dog regulations (e.g. leash laws, area closures to dogs). Finally, we explored perceptions of how the COVID-19 pandemic, and associated increases in dog ownership and outdoor recreation, impacted dog regulation compliance and enforcement.

2 | METHODS

This study focused on the Atlantic Flyway, which is a well-established migratory route that shorebirds use to travel from the southern tip of South America to the Arctic tundra. According to Kirby et al. (2008, p. S51), a flyway is 'the total geographic area used by a population, species or group of species throughout its annual cycle'. Within the United States, the Atlantic Flyway extends from the offshore waters of the Atlantic Coast west to the Appalachian Mountains, and stretches from Maine to Florida. Of the shorebirds that use the Atlantic Flyway, some are federally threatened (e.g. piping plover *Charadrius melodus* and red knot *Calidris canutus*) or considered species of special concern (American oystercatchers *Haematopus palliates*). The Atlantic Coast of the United States is home to more than one-third of the population of people within the United States (Wilson & Fischetti, 2022), making the U.S. portion of the Atlantic Flyway a key place for management of human disturbance and also an ideal location for studying disturbance management. Human activities that are potentially disturbing are widely present at sites across the U.S. portion of the Atlantic Flyway (Comber & Dayer, 2021b). Managers use various techniques to reduce disturbance, but despite best efforts, non-compliance with restrictions for some activities, such as dog walking, continues to be problematic (Comber & Dayer, 2021b).

2.1 | Participant recruitment

Participants included land managers and biologists with previous experience developing and implementing dog zoning and closure policies and other dog regulations at shorebird sites along the US portion of the Atlantic Flyway. Individuals who lacked experience in the initial development process but had experience with continuing the implementation of successive regulations were also interviewed. We developed the sampling frame based on suggestions from participants at the 2020 Least Tern and Piping Plover Workshop and the list of US-based participants from a previous Atlantic Flyway-wide land manager survey (Comber & Dayer, 2021b) who responded that they had dog walking at their sites in the last 5 years. This multi-faceted process for determining who would be 'knowledgeable' about the topic followed best practices of local knowledge research (Joa et al., 2018).

2.2 | Interview construction

Interviews were semi-structured, generally following a script. The Atlantic Flyway Shorebird Initiative (AFSI) Human Activities Committee and other conservation social scientists reviewed the script before we finalized it. This research was approved by the Virginia Polytechnic Institute and State University Institutional Review Board (#19-1167).

2.3 | Interview implementation

We conducted interviews from May to July 2020. Recruitment emails contained a Qualtrics survey link (Qualtrics Version 1.0.0, 2009) that included consent information, screening to ensure candidate eligibility, and preferred dates and times for interviews. If participants met the requirements and consented to participate, we sent a confirmation email containing their personalized Zoom information for their desired date and time for the interview. We administered interviews and audio recorded using Zoom and a digital recorder as a backup. The Zoom audio recording feature saved and transcribed all interviews automatically. Researchers reviewed the recordings and manually corrected all interview transcription errors using InqScribe software (InqScribe Version 2.2.4, 2018). Participant names were replaced with numbers and dates in which the interview took place to ensure anonymity and to protect the identities of the participants.

2.4 | Interview analysis

All coding was conducted by J.E. who also conducted and transcribed the interviews. We used Dedoose Version 8.3.35 (2016), initially coding deductively based on our main research topics for the broader project (e.g. enforcement). Additional codes were created inductively as they emerged in the interviews. Co-authors reviewed and edited codes and the code book definitions to ensure clarity, consistency and replicability. J.E. then re-coded to adjust for revised code book definitions.

3 | RESULTS

3.1 | Interview respondents

We contacted 91 individuals to request an interview. Twenty-five individuals were ineligible because they lacked the necessary experience with the development of dog zoning and/or closure regulations at beaches to protect shorebirds or other wildlife. Twenty-eight individuals qualified and consented to participate. After interviewing, we determined that one interviewee did not have adequate experience with the development of dog regulations to fit with the study population criteria and they were unable to respond to most of our questions, making our final sample size 27. Our overall response rate of individuals who were eligible to participate due to their experience with regulation development and implementation (n = 25 ineligible) and agreed to participate was 40.9% of the 91 individuals originally contacted.

Individuals interviewed included land managers and biologists involved in beach management (hereafter, interviewees) from 11 states along the U.S. portion of the Atlantic Flyway. Interviewees worked for local, state (e.g. parks, natural resources, and wildlife agencies) and federal agencies (National Park Service, U.S. Fish and Wildlife Service), non-government conservation organizations (hereafter, NGOs) and universities. Some of the interviewees discussed sites where their employer is the site manager or owner, and others had expertise at sites where another agency or organization may own or manage the site but they were involved in monitoring or management. Many interviewees had experience with dog regulations at multiple sites (up to 25 sites), and regulations varied depending on the site (e.g. closures, zoning, leash or voice control laws), so it was not possible to distinguish insights of managers by type of dog management approach. Interviews lasted between 19.5 and 72.5 min with an average time of 44.1 min.

3.2 | Issues of non-compliance

Some interviewees felt compliance was generally adequate at the sites where they worked. For example, one interviewee described high levels of compliance at their site due to controlled access with a gated entrance. Other interviewees reported that although non-compliance was an issue in the past, it had improved over time. An interviewee described how their policies were gradually accepted and understood in the community the longer they were in place:

> I think the first few years are difficult, especially when a place was open for so long. That switch definitely takes a little time, but word eventually gets out and at least the locals know to just keep moving on (Interviewee 25).

Still, many interviewees described residents as a user group that presented non-compliance challenges. An interviewee described locals' unwillingness to follow dog regulations, in addition to non-compliance with alcohol regulations: ‘a lot of locals feel like it's their God-given-right to go out there on the weekends with their kegs of beer and their dogs’ (Interviewee 16). Additionally, some local landowners living along the beach dismissed regulations, according to one interviewee:

> Each individual landowner may own a strip down to the low tide line. And that makes it more difficult because private landowners may say, ‘I don't care what the ordinance is, this is my private property and I have a dog and we'll do whatever we want to do’ (Interviewee 02).

The sheer number of new residents moving south along the Atlantic Coast was particularly challenging for one interviewee who said, ‘there's so many new people coming to [redacted state name]. Every day, we have the same conversations over and over with dog owners about the importance of the closures and why they can't have dogs there’ (Interviewee 11).

Additionally, interviewees often described non-compliant visitors as unaware, rather than being purposely dismissive of regulations. For example, an interviewee discussed the issue of uninformed visitors renting houses on closed portions of the beach:

> We do have problems with places where there's houses on the beach and the people rent the houses and the person who's renting does not tell them the beach is closed. No matter [if] we talk to the rental companies, they do not have to disclose it. (Interviewee 06).

Dog walkers as a group presented challenges through uncooperative behaviours and/or negative attitudes towards regulations. One interviewee described how dog owners assume that land managers dislike dogs: “I love dogs [but] people have told me, ‘Oh, you just hate dogs.’ I was like, no, ‘I have two dogs at home.’” (Interviewee 12).

Many interviewees discussed dog owners' emotional response to restrictions, often leading to hostile reactions towards authorities. An interviewee described a conflict they unintentionally had with a dog owner:

> I always try to explain to people. I never yell at people. I try never to threaten anybody with a ticket. I want to get them on the bird side. So, [I] was trying to appeal to the animal lover in her and she just listened and her face grew redder and redder and then she just exploded on me: ‘My dog has a God-given-right to run free wherever he wants’. (Interviewee 05).

Similarly, interviewees believed some dog owners were taking discussions about regulations personally, while the interviewees believed they were simply stating the rules and related science, as one interviewee recounted:

> The problem that really comes into play is it's such a personal issue for people. They get offended really easily, like you are saying that their dog is bad or misbehaved or they feel like something is being taken away from them. I always try to turn it to the birds' perspective. It's like, ‘it doesn't matter, your dog could be the best-behaved dog, it's the way these birds perceive dogs as predators. It's how they evolved. It's not saying that you're a bad dog owner or anything. It's not a personal issue’. But, unfortunately, it becomes very emotional, people screaming and crying at these meetings when they are allowed. They just get so upset about it. And so, as a biologist [I'm] trying to lay out these facts about how it affects birds, but they are coming at it from a very emotional standpoint [with] the feeling that their rights are basically being taken away (Interviewee 08).

Non-compliance led to safety issues for some shorebird conservation professionals. One interviewee described:

> I am a dog owner. I've owned dogs my whole life but the amount of vitriol and misinformation and lack of caring about other people and other resources… I was accosted on the beach. It just has really made me realize that I do not want to have anything to do with this work (Interviewee 03).

Not all of the interactions with non-compliant dog owners were hostile; in some cases, the dog owners simply tried to hide from authorities, as illustrated by one interviewee's recollection:

> We'll either drive away or walk up the beach a little bit and then go hide and then come back out [and] you'll see that they brought the dogs back out. (Interviewee 10).

Boaters caused particular non-compliance concerns because they and their dogs access sites where it is hard to enforce regulations because they are remote. One interviewee described boaters' disregard for regulations: “we get blatant people just completely ignor[ing] the signage and just go and pull up their boat and sit right out in the middle of a nesting beach and let their dogs run loose on the beach” (Interviewee 09).

3.3 | Role of law enforcement authorities in compliance

Many interviewees described challenges with inadequate or ineffective support from law enforcement authorities. Enforcement challenges included both (1) violations that were not detected by law enforcement officers (i.e. authorities are not present to witness a transgression) and (2) citations not being made, even if law enforcement officers witnessed violations.

Detection was a prevalent issue, often linked to lack of presence of law enforcement officers. As one interviewee reported, "on the islands, we may only have a ranger patrolling once every two hours on an ATV, so a lot can happen in two hours" (Interviewee 07). Multiple other interviewees described far less or even no enforcement presence at sites. Others described enforcement officers visiting a site but surveying it only from a vehicle in a parking lot, rather than patrolling by foot. This lack of enforcement presence spanned sites where local municipal law enforcement, state fish and wildlife agency, state parks, US Fish and Wildlife Service or National Park Service enforcement had jurisdiction. Notably, some sites relied on enforcement by just one law enforcement agency while others had access to multiple agencies. Interviewees often blurred the lines in their comments about law enforcement, or were not specific.

Where enforcement was present, passive enforcement through patrolling the beach was considered beneficial by some, while other interviewees were frustrated that law enforcement officers were not actively issuing fines and removing non-compliant users from the beach. A majority of the interviewees explained that law enforcement officers tended to give verbal warnings rather than tickets. As one interviewee described, 'I mean, if they see someone out in an area with a dog, they'll stop and talk to them and it's, you know, more in like an educational way, not, not too you know enforcement-like' (Interviewee 26). Similarly, other interviewees also described how the verbal warnings may be paired with education about the rationale for the regulations, 'But we do … issue tickets with fines, sometimes just depends on the situation and the individual, but the vast majority are warnings with education about why they shouldn't be there' (Interviewee 27).

Some interviewees questioned whether a ticket—the typical penalty for violating dog regulations–had ever been issued at their sites, while others explained that tickets were reserved for bigger issues. For instance, one interviewee described, 'when [law enforcement officers] see violations, you know, they'll give warnings. I don't think they've ever given a ticket, unless there was actual destruction of birds or a nest and they caught the person' (Interviewee 25). Another interviewee explained that the citation frequency varied by law enforcement authority:

> Rangers do go to law enforcement academy. They are not encouraged to write tickets. And if you are going to write a ticket it has to be something like a serious violation that can cause serious bodily injury. Now with that being said, we do have our local county sheriff's department patrol the beach in the summer and they are happy to write tickets as long as we keep the areas posted where the dogs are not supposed to be (Interviewee 05).

3.4 | Reasons for lack of law enforcement activity

Interviewees offered their perceptions of various explanations for the lack of law enforcement officers present and the lack of citations. Often, it was due to having other priorities as one interviewee stated:

> We really do not get law enforcement. If I were to call my lead law enforcement person because there's a dog on the beach, they are going to be like, 'I got [a] domestic battery over here or someone [is] illegally fishing, I'm not going to be able to get there'. It has to be pretty egregious for us to call law enforcement. (Interviewee 19).

A few interviewees described how law enforcement officers' lack of interest in shorebird disturbance, paired with other priorities or funding issues, led to lack of enforcement of regulations for shorebirds. A few interviewees reported that some high-ranking officers are not educated on the importance of disturbance-related issues and therefore considered infractions related to shorebird-related regulations trivial and not worth their time. Another interviewee unsatisfied with enforcement explained that an officer's beliefs about the efficacy of citations in enhancing compliance might influence whether they issue citations.

3.5 | Role of COVID-19 in exacerbating non-compliance and enforcement challenges

All interviewees discussed the effects of COVID-19 on compliance and enforcement. A majority of interviewees reported an increase in people and/or dogs on beaches and a decrease in compliance. One interviewee recalled their experience during the COVID-19 pandemic with dog owners' purposeful disregard for regulations. Similarly, another interviewee explained that dog owners, many of them new dog owners, felt that in comparison to the concerns of COVID-19 that dog regulations should not be a focus:

> In March, when everybody had to start staying home, it was just bananas. I've never seen that many dogs and if we approach[ed] people, we got a lot of, 'it's a pandemic, I can't believe you're worried about birds right now'. That kind of attitude. So, it's definitely been worse through COVID…So many people have gotten new pets and our beaches are just loaded with them (Interviewee 18).

Another interviewee explained their strategy for controlling visitor numbers at their site through a gated entrance, while, as a result of their closure and increased outdoor recreation overall, visitation increased at surrounding beach sites.

The issue of more people and dogs on the beach for many sites were compounded by less staff and often no volunteers due to agencies' and organizations' safety protocols during the pandemic, as one interviewee explained:

> We would love to address it, but we're having a lot of problems because we had the stay-at-home orders [and] we also have fewer staff [than] we usually have. We don't have our interns. We don't have our volunteers. So there's less of us (Interviewee 18).

Other interviewees described ticketing as a solution to the pandemic spike in visitors. One interviewee reported low compliance and limited enforcement when beaches were closed, followed by an increase in tickets issued with the reopening of beaches:

> [Compliance] was pretty bad because of COVID. [When] closing the beaches, our deputies were told not to enforce a lot of stuff. But as soon as they opened the beaches up a few weeks ago that was it, they're writing tickets for people having dogs (Interviewee 13).

3.6 | Overcoming challenges of lack of enforcement

Interviewees also talked about how challenges of lack of enforcement have been overcome. In particular, some enforcement officers have taken renewed interest in shorebird disturbance-related training and have become devoted to protecting the resource. Enforcement was perceived to have increased in those areas.

One interviewee emphasized the importance of training and educating all types of law enforcement officers about the importance of enforcing shorebird regulations:

> We've also had a program with Audubon where they'll educate these guys [law enforcement officers] on what they are looking for and they really like it. It's not just our sheriff deputies, it is all local law enforcement … So, it's very helpful because we found that judges were just throwing this stuff out when issues would come up whether it was harassment or just completely destroying nests (Interviewee 13).

3.7 | Other approaches to crime prevention: Voluntary compliance to supporting enforcement

The approach on Atlantic Flyway beaches to facilitating dog walking compliance and minimizing shorebird disturbance included an array of other crime prevention techniques, which fell along a spectrum from truly voluntary compliance techniques to those more in support of enforcement (Figure 1). Many sites employed multiple strategies simultaneously, with signage being ubiquitous.

Signage to Facilitate Compliance and Enforcement: All interviewees used signage at their sites to increase compliance. A majority of interviewees used regulatory signs to communicate site restrictions, while some used educational or interpretive signage to convey messages. Others used both types. Most interviewees agreed that posting signage was an effective means of communication to facilitate compliance. Yet, the efficacy of educational versus regulatory signage was contested:

> ...at the time our [redacted] manager was very much into law enforcement and law code and so the first time we wound up with like 200 words. It was like a book that basically quoted all the law codes. Of course, nobody read it. One-hundred percent ineffective (Interviewee 05).

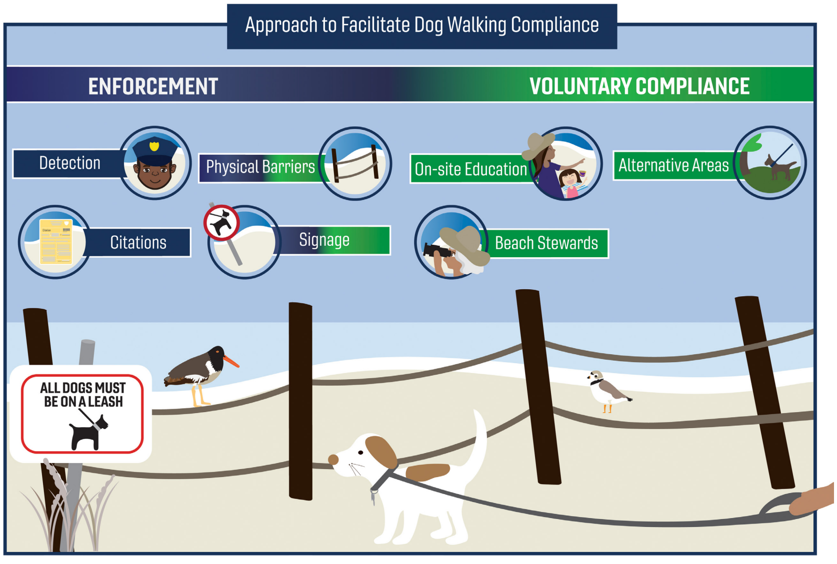

FIGURE 1 The approach on Atlantic Flyway beaches to facilitating dog walking compliance and minimizing shorebird disturbance, depicting strategies along a spectrum from enforcement to voluntary compliance techniques. Many sites employed multiple strategies simultaneously.

Another interviewee conveyed similar feelings towards regulatory signage and planned to transition to educational signage in the future, despite needing some of the code on the sign so tickets could be written:

> From my experience, putting regulations on a sign, nobody will read it. The public won't read it. Sometimes for law enforcement, they want the code on the sign so that they can write the ticket for what that violation is. Otherwise, they don't know how to write a ticket, apparently. But I think we'll probably have more public friendly signage (Interviewee 25).

Others felt regulatory signs were necessary to enforce legal codes and suggested regulatory signage with educational signage on beaches, such as this interviewee:

> I think they're useful working together. I think these days, people are curious and like to know why things are happening and so for a lot of people they really appreciate wildlife and they want to protect it. And if they understand that their pet is causing impacts, then for some people that helps them understand why they're being asked to change their behaviour. So, I think they're both effective, but you definitely need the regulatory signs. You couldn't just have the educational side (Interviewee 23).

Yet, other interviewees preferred simple, easy to understand regulatory signage that encompassed both symbols and pictures to portray messages. One interviewee advocated for signs with universal symbols such a dog with a slash through it or a dog on a leash. Despite attempts to deliver clear messages on signs, one interviewee explained inevitable ongoing non-compliance challenges:

> It never ceases to amaze me how many people do not see the big red beach closed sign and they still try to walk around the gate and start to make their way to the beach and they're like, 'I didn't even see the sign'. (Interviewee 18).

Physical Barriers: Barriers for protecting nesting shorebirds and other species, dune systems and sensitive habitat were described in a majority of interviews. Typically, physical barriers included symbolic fencing, roped off areas, and/or buoys as floating fences. One interviewee described symbolic fencing and its purpose: 'we do have symbolic fencing that we put up annually. It's posts with signs on them, twine and flagging between the signs. So, a dog could easily run under it, but it's more of a visual barrier' (Interviewee 15). Another interviewee reported creating barriers and fencing to reduce disturbance throughout multiple seasons, 'as we start seeing migratory flocks come through, we intentionally leave up areas of symbolic fencing that were used for breeding birds and even make them larger to give the resting shorebirds some space' (Interviewee 07).

Fencing was not used by sites a few interviewees discussed due to variable habitat conditions such as ephemeral nesting sites, changing and dynamic beach environments, or windy conditions that could demolish constructed fences.

On-site Education and Outreach: Staff and volunteers, who do not officially have an enforcement role, encouraged voluntary compliance—either through their presence alone discouraging violations or their education of people who may not otherwise be aware of regulations. As one interviewee explained, 'if we did not have staff out there, there would be almost no compliance' (Interviewee 20). Another offered, 'our staff is a great deterrent. A big part of our mission is, we expect our staff to engage with beachgoers, be a friendly presence, and really try to educate people' (Interviewee 20). Many sites relied on this interpretive and educational approach to build awareness and increase compliance, finding this more effective than enforcement as one interviewee indicated, 'face to face conversational protection that the volunteers [and] stewards provide is way more valuable than a guy with a gun' (Interviewee 11). Another interviewee explained how a positive educational approach is preferable to angering non-compliant users:

> I think the educational aspect works best, personally. Every time I have lost my cool and yelled at somebody, I have lived with regret because if you make them mad, they're going to take that dog off the leash the second you're off the beach (Interviewee 05).

Interviewees saw in-person adult and youth programs as a way to relate to the public and promote an awareness of regulations and understanding of shorebird health and their need for protection, while calling for specific pro-shorebird conservation behaviours. Outreach programs encouraged dog owners to respect beach regulations, hold each other accountable, be responsible with their pets, leash dogs when required, and keep dogs and beach users out of nesting areas. Youth programs were also commonly conducted to more broadly promote interest in wildlife and shorebirds, which interviewees believed might transfer to other family members as well. An approach shared among many interviewees was to first develop an interest in wildlife and shorebirds among the public, and then, to promote public support and acceptance of dog regulations for the benefit of shorebirds.

Volunteer Beach Stewards: Interns and stewards (volunteers who help protect the beach and shorebirds) aided staff in on-site interactions with the public. Typically, volunteer beach stewards notified people of regulations and also fostered an appreciation of wildlife and shorebirds among visitors. One interviewee described the stewards' positive approach to working with the public:

> I have the best stewards. And I gotta say some of the retired people, a lot of them have been biologists

> or they're really good birders and they just really seem to be able to handle some of the people. They don't get too wound up. They [can] stay pretty calm (Interviewee 06).

Alternative Recreational Areas: To accommodate dog walkers, interviewees provided information to locate alternative dog recreation areas. Alternative areas included dog parks and designated dog beaches. In some cases they created zones for wildlife and dogs, setting aside beach areas that were less sensitive as a way to compromise with dog walking desires of beach recreationists. One interviewee explained their rationale for zoning was driven by their need to meet the interests of the members of their organization, many of whom had dogs.

While zoned areas and dog beaches were typically viewed positively, interviewees reported that dog parks were less accepted among dog owners. Even if dog parks were near site locations, interviewees explained that most dog owners preferred beaches, possibly to fulfil their own exercise needs and enjoy the scenic beach environment. In the words of one interviewee:

> People do not equate being able to go into a small fenced area with grass as the same as being able to have your dog run wild on the beach. They just don't think of it as the same experience. And we'll offer it to people, but I have not heard feedback [from] people like, 'oh, that's really great to know thank you so much I'll go there instead'. It's more like, 'yeah I know I don't want to go to the stupid dog park, I want to run my dog on the beach' (Interviewee 18).

Information about alternative areas was shared via signs, maps and other outreach materials.

4 | DISCUSSION

Interviews with land managers and biologists revealed that they believe non-compliance with dog regulations on Atlantic Flyway beaches of the U.S. is a challenge that law enforcement alone is unlikely to adequately address, in part because there is not enough enforcement, especially in times of increased recreational use and dog ownership like the COVID-19 pandemic. We applied a conservation criminology lens to understand interviewees' reflections on enforcement (both detection and citation) and other crime prevention techniques to addressing non-compliance to minimize human disturbance of shorebirds. Here, we put our findings in the context of the shorebird disturbance and conservation criminology literature, while noting some unique aspects of this issue that diverge from other contexts. It should be noted that the findings we report are based on local knowledge. While local knowledge from practitioners has been shown to be comparable to scientific knowledge in some contexts (Cook et al., 2014) and it also has value beyond scientific ecological knowledge in the unique insights it can offer (Joa et al., 2018), there is still opportunity for more field-based research on this topic, which we outline as future directions.

4.1 | Law enforcement presence

Regulatory strategies for increasing compliance included enforcement presence, notifying visitors of regulations, issuing warnings, or, in rare situations, ticketing with fines. While Arias (2015) suggested that offences must be detected and citations given in order for law enforcement to be effective, our interviewees suggested that the mere presence of law enforcement officers was valuable. Most law enforcement officers simply explained regulations or gave warnings to non-compliant beach visitors. Beyond beach visitors being asked to leave the beach, particularly when they illegally had dogs with them, our interviewees did not discuss consequences beyond tickets given on occasion. Given that enforcement may have the ability to drastically reduce non-compliance of beach visitors (Hatch, 1996; Miller et al., 2014), consistently patrolling beaches during times of the day that have peak dog use (e.g. morning) may increase compliance, keeping in mind that timing and location are very relevant considerations (Kahler & Gore, 2017). Additionally, compliance may be improved by limiting the number of beach access points (Glover et al., 2011).

4.2 | Lack of enforcement challenges

Many challenges have prevented adequate enforcement of dog regulations in the U.S. at the sites, resulting in discontent among land managers and biologists, as described elsewhere (Comber & Dayer, 2021b; Maguire et al., 2019). Managers believed lack of enforcement may be due to budget constraints and the high costs associated with hiring officers (as in Eliason, 2011; Maguire et al., 2019), a lack of interest among law enforcement officers for shorebird disturbance-related issues, or their preoccupation with other responsibilities often considered more pressing (e.g. human safety). We suggest following up on this research by interviewing law enforcement officers tto better understand the constraints they face in addressing dog regulation non-compliance (as in Eliason, 2011). Currently, managers are working to overcome these perceived challenges through innovative ways of working with law enforcement authorities, such as training law enforcement officers about the importance of enforcing regulations to minimize disturbance to shorebirds and how to properly enforce regulations.

4.3 | Exacerbated challenges due to the COVID-19 pandemic

Managers believed there was a decrease in enforcement due to the Covid-19 pandemic (as suggested by Bates et al., 2020). Further, many of the managers reported higher use and human disturbance via dogs at the beach, unlike what was found by Manenti et al. (2020) in Italy. This difference could be because many states in the U.S. still allowed outdoor recreation during lockdowns and after lockdowns people still voluntarily avoided higher disease exposure in indoor settings (Larson et al., 2021). Notably our research only captured insights from the first few months of the COVID-19 pandemic, and it would be valuable to explore how increases in dog ownership and possible continued interest in outdoor recreation have played out for compliance with dog-walking regulations. While challenges to compliance with dog regulations during the COVID-19 pandemic may exist, there are also documented benefits of dog ownership and dog walking for people's physical health and well-being (Christian et al., 2018), especially in times of isolation such as the pandemic (Bussolari et al., 2021; Carr et al., 2021; Owczarczak-Garstecka et al., 2021). Managers of sites with multi-use objectives may need to consider new ways to balance the simultaneous needs of human health and biodiversity in the post-pandemic world and possibly consider more of a one health approach, which focuses on human well-being and conservation outcomes (Bates et al., 2021).

4.4 | Increasing compliance via voluntary techniques

According to Arias (2015), non-compliance can be improved by using voluntary compliance approaches such as education and outreach (Arias, 2015) and stewards (also known as guardians) and signage (Medeiros et al., 2007), in addition to enforcement. Unlike the typical binary presentation of these approaches (e.g. framing as the carrot or the stick, Baruch-Mordo et al., 2011), we found these strategies to present along more of a spectrum from enforcement of regulations to promoting voluntary compliance. For example, signage could be educational and fostering compliance or part of an enforcement strategy by stating the regulation. Following strategic communications approaches for shorebird conservation, as laid out in Kidd and Dayer (2020), can expand the utility of signage. The literature on situational crime prevention also echoes this call for strategies beyond enforcement (Flora & Fauna International, 2021). Techniques from that literature might be considered by the shorebird conservation community as some potentially useful techniques were not mentioned in interviews (e.g. cameras to make dog activities near nests more identifiable, dog walkers agree to certain behaviours when receiving a permit to enter a beach area with a dog).

4.5 | Future directions

Challenges with and strategies to address non-compliance with regulations to minimize shorebird disturbance share much similarity with biodiversity conservation broadly; in both, voluntary compliance strategies, along with some level of enforcement, may be needed for conservation success (e.g. Bowes et al., 2017). Shorebird conservation-specific research has found that non-compliance may vary by type of dog regulation (e.g. complete dog closures compared to leashing areas; Maguire et al., 2019) and that sites with steward programs have positive impacts on shorebirds, especially in the summer (Michel et al., 2021). Still, there is a need for an evaluation of the efficacy (in terms of increased compliance with dog regulations) for enforcement vs. voluntary compliance vs. combined approaches to validate if the combined approach suggested in the conservation criminology literature and our interview findings is indeed most effective. Further, there is a need for research to determine if effectiveness of approaches varies over time since intervention (e.g. citation). Yet, similar to the broader conservation criminology literature (Gore, 2011; Solomon et al., 2015), research evaluating effectiveness of different interventions to promote dog leashing compliance is lacking and has been noted as a need for over a decade (e.g. Williams et al., 2009). This could be accomplished through a natural experiment if more sites were using a standardized monitoring technique, such as that developed for use across the Atlantic Flyway (Gibson et al., 2021), which tracks whether dogs are present and/or on leash. Such monitoring data could be paired with information about the approach the sites are using for management, including the frequency of enforcement patrols and citations, as well as the extent of use of voluntary compliance techniques, even in a rough fashion such as the presence or absence of various techniques. Or, a site-level evaluation could be conducted to study the efficacy of specific dog-walking compliance techniques, as in Marion et al.'s (2008) evaluation of the effectiveness of educational approaches to limit wildlife feeding along park trails.

Future non-compliance research related to dog walking could focus on conditions associated with non-compliance (e.g. what type of location and when is it most prevalent), because we know that disturbance challenges and management effort are seasonal (Comber & Dayer, 2021b). This information would provide strategic guidance on where to focus efforts to increase compliance and how that might be achieved. Further, understanding motivations of beach recreationists for non-compliance could help guide interventions, as suggested by Gore (2011). Comber and Dayer's (2021a) research on beach recreationists' motivations for leashing dogs in situations where not required is a starting point. Although this research did not focus on non-compliance, we expect some of the constraints (e.g. dogs needing exercise) and motivations to leashing (e.g. keeping dogs safe) might similarly impact compliance with dog regulations. Future research could also consider structural and contextual issues (e.g. what conditions cause rule followers to move into rule-breaking). Given the complexity of shorebird conservation, with a variety of threats simultaneously occurring, this future research could further help managers and conservation practitioners more holistically think about human behaviour vis a vis shorebird conservation needs.

Undoubtedly, there is a lot of potential for the shorebird conservation community to learn from the field of conservation criminology research, review insights from the literature in other settings, and collaborate with experts in this field. As Gore (2011, p. 659) explains, social scientists in conservation criminology have the expertise to 'describe, predictand explain effects of practices intended to influence human behavior and to reduce negative effects of environmental change on humans, other species, and ecological systems'. Such collaborations are part of a broader need to mainstream conservation social science into bird conservation (Dayer, Barnes, et al., 2020; Dayer, Silva-Rodríguez, et al., 2020). Likewise, the shorebird conservation context provides an opportunity to explore a conservation harm and crime prevention setting different than addressed in much of the conservation criminology literature, which often focuses on those with more severe punitive dimensions (e.g. poaching, illegal wildlife trade). Further, the impacts of non-acute disturbance events due to non-compliance (e.g. an off-leash dog disrupting a foraging bird that flies off without finishing feeding) may individually cause limited environmental harm, but cumulatively could cause mortality or even population-level impacts. Like many environmental issues today, the location where harm is generated (e.g. on wintering grounds) may not be the location where harm is realized (e.g. death on migrating grounds). For these reasons, there are a lot of opportunities for the many long-standing partnerships for shorebird conservation (e.g. Western Hemisphere Shorebird Group, Atlantic Flyway Shorebird Initiative) to be leveraged to deliver coordinated approaches to foster voluntary compliance among beach recreationists, instead of focusing on top-down approaches for compliance and enforcement.

AUTHORS' CONTRIBUTIONS

A.A.D. conceived the project; A.A.D., J.E., and C.A.C. designed the methodology; J.E. collected and analysed the data with supervision from A.A.D. and C.A.C.; A.A.D. led the writing of the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

ACKNOWLEDGEMENTS

We thank the participants of this study for their time and thoughtful insights. Tara Craig, of Virginia Tech, designed the figure. We thank the Atlantic Flyway Shorebird Initiative Human Activities Committee for their review of our interview script. We appreciate Walker Golder, previously of National Audubon Society, for his coordination of the broader project this study was part of and the Audubon field staff and the Virginia Tech Shorebird Program for their ongoing collaboration. We thank *People and Nature* Editor Robert Fish and reviewers Michael Weston and Grainne Maguire for their reviews of this manuscript, which substantially improved it. This project was supported by the National Audubon Society through a grant from the National Fish and Wildlife Foundation (ID:0111.19.063893, CFDA#15.663). The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the U.S. Government or the National Fish and Wildlife Foundation and its funding sources. Mention of trade names or commercial products does not constitute their endorsement by the U.S. Government, or the National Fish and Wildlife Foundation or its funding sources.

CONFLICT OF INTEREST

The lead author is a member of the Atlantic Flyway Shorebird Initiative Human Activities Working Group and the Road to Recovery for North America's Birds Organizing Committee. Funding for this research was provided as a sub-contract from the National Audubon Society through a grant from the National Fish and Wildlife Foundation.

DATA AVAILABILITY STATEMENT

The interview transcripts for this study will not be made available as they are confidential social science data that it is impossible to fully de-identify.

ORCID

Ashley A. Dayer https://orcid.org/0000-0002-8105-0776
Meredith L. Gore https://orcid.org/0000-0002-2613-4715

REFERENCES

2020 State Updates. (2021, February 2). American Oystercatcher Working Group 2020(ish) Meeting, Remote. http://amoywg.org/wp-content/uploads/2021/02/2020-Day-1-notes.pdf

Arias, A. (2015). Understanding and managing compliance in the nature conservation context. *Journal of Environmental Management*, *153*, 134–143.

Baruch-Mordo, S., Breck, S. W., Wilson, K. R., & Broderick, J. (2011). The carrot or the stick? Evaluation of education and enforcement as management tools for human-wildlife conflicts. *PLoS ONE*, *6*(1), e15681.

Bates, A. E., Mangubhai, S., Milanés, C. B., Rodgers, K., & Vergara, V. (2021). The Covid-19 pandemic as a pivot point for biological conservation. *Nature Communications*, *12*(1), 5176.

Bates, A. E., Primack, R. B., Moraga, P., & Duarte, C. M. (2020). Covid-19 pandemic and associated lockdown as a 'global human confinement experiment' to investigate biodiversity conservation. *Biological Conservation*, *248*, 108665.

Baudains, T. P., & Lloyd, P. (2007). Habituation and habitat changes can moderate the impacts of human disturbance on shorebird breeding performance. *Animal Conservation*, *10*(3), 400–407.

Bennett, N. J., Roth, R., Klain, S. C., Chan, K., Christie, P., Clark, D. A., Cullman, G., Curran, D., Durbin, T. J., Epstein, G., Greenberg, A., Nelson, M. P., Sandlos, J., Stedman, R., Teel, T. L., Thomas, R., Veríssimo, D., & Wyborn, C. (2017). Conservation social science: Understanding and integrating human dimensions to improve conservation. *Biological Conservation*, *205*, 93–108.

Bowes, M., Keller, P., Rollins, R., & Gifford, R. (2017). The effect of ambivalence on on-leash dog walking compliance behavior in parks and protected areas. *Journal of Park and Recreation Administration*, *35*(3), 81–93.

Burger, J. (1986). The effect of human activity on shorebirds in two coastal bays in northeastern United States. *Environmental Conservation*, *13*(2), 123–130.

Burnett, H., Olsen, J. R., Nicholls, N., & Mitchell, R. (2021). Change in time spent visiting and experiences of green space following restrictions on movement during the Covid-19 pandemic: A nationally representative cross-sectional study of UK adults. *BMJ Open*, *11*(3), e044067.

Bussolari, C., Currin-McCulloch, J., Packman, W., Kogan, L., & Erdman, P. (2021). 'I Couldn't have asked for a better quarantine partner!': Experiences with companion dogs during Covid-19. *Animals*, *11*(2), 330.

Carr, D., Friedmann, E., Gee, N. R., Gilchrist, C., Sachs-Ericsson, N., & Koodaly, L. (2021). Dog walking and the social impact of the Covid-19 pandemic on loneliness in older adults. *Animals: An Open Access Journal from MDPI*, *11*(7), 1852. https://doi.org/10.3390/ani11071852

Christian, H., Bauman, A., Epping, J. N., Levine, G. N., McCormack, G., Rhodes, R. E., Richards, E., Rock, M., & Westgarth, C. (2018). Encouraging dog walking for health promotion and disease prevention. *American Journal of Lifestyle Medicine*, *12*(3), 233–243.

Comber, C. A., & Dayer, A. A. (2021a). Understanding attitudes and norms of dog walkers to reduce disturbances to shorebirds. *Human Dimensions of Wildlife*, *27*, 1–15.

Comber, C. A., & Dayer, A. A. (2021b). Understanding the state of management of human disturbances to shorebirds across the Atlantic Flyway of the U.S. and Canada. *Wader Study*, *128*(3), 238–246. https://doi.org/10.18194/ws.00249

Cook, C. N., Wardell-Johnson, G., Carter, R. W., & Hockings, M. (2014). How accurate is the local ecological knowledge of protected area practitioners? *Ecology and Society*, *19*(2), 32. https://doi.org/10.5751/ES-06341-190232

Corlett, R. T., Primack, R. B., Devictor, V., Maas, B., Goswami, V. R., Bates, A. E., Koh, L. P., Regan, T. J., Loyola, R., Pakeman, R. J., Cumming, G. S., Pidgeon, A., Johns, D., & Roth, R. (2020). Impacts of the coronavirus pandemic on biodiversity conservation. *Biological Conservation*, *246*, 108571.

Dayer, A. A., Barnes, J. C., Dietsch, A. M., Keating, J. M., & Naves, L. C. (2020). Advancing scientific knowledge and conservation of birds through inclusion of conservation social sciences in the American Ornithological Society. *The Condor*, *122*(4), duaa047. https://doi.org/10.1093/condor/duaa047

Dayer, A. A., Silva-Rodríguez, E. A., Albert, S., Chapman, M., Zukowski, B., Ibarra, J. T., Gifford, G., Echeverri, A., Martínez-Salinas, A., & Sepúlveda-Luque, C. (2020). Applying conservation social science to study the human dimensions of Neotropical bird conservation. *The Condor*, *122*(3), duaa021. https://doi.org/10.1093/condor/duaa021

Dayer, A. A., Williams, A., Cosbar, E., & Racey, M. (2019). Blaming threatened species: Media portrayal of human–wildlife conflict. *Oryx: The Journal of the Fauna Preservation Society*, *53*(2), 265–272.

Dhanjal-Adams, K. L., Mustin, K., Possingham, H. P., & Fuller, R. A. (2016). Optimizing disturbance management for wildlife protection: The enforcement allocation problem. *The Journal of Applied Ecology*, *53*(4), 1215–1224.

Eliason, S. (2011). Policing natural resources: Issues in a conservation law enforcement agency. *Professional Issues in Criminal Justice*, *6*(3 & 4), 43–58.

Flora & Fauna International. (2021). Using situational crime prevention to address illegal wildlife trade: A toolkit. https://www.fauna-flora.org/app/uploads/2021/12/FFI-SCP-Toolkit.pdf

Gibbs, C., Gore, M. L., McGarrell, E. F., & Rivers, L. (2009). Introducing conservation criminology: Towards interdisciplinary scholarship on environmental crimes and risks. *The British Journal of Criminology*, *50*(1), 124–144.

Gibson, D., Chaplin, M. K., Hunt, K. L., Friedrich, M. J., Weithman, C. E., Addison, L. M., Cavalieri, V., Coleman, S., Cuthbert, F. J., Fraser, J. D., Golder, W., Hoffman, D., Karpanty, S. M., Van Zoeren, A., & Catlin, D. H. (2018). Impacts of anthropogenic disturbance on body condition, survival, and site fidelity of nonbreeding piping plovers. *The Condor*, *120*(3), 566–580.

Gibson, D., Hunt, K., & Catlin, D. H. (2021). Atlantic flyway disturbance project phase 2: Biological data collection report. https://vtechworks.lib.vt.edu/handle/10919/104947

Gilby, B. L., Henderson, C. J., Olds, A. D., Ballantyne, J. A., Bingham, E. L., Elliott, B. B., Jones, T. R., Kimber, O., Mosman, J. D., & Schlacher, T. A. (2021). Potentially negative ecological consequences of animal redistribution on beaches during Covid-19 lockdown. *Biological Conservation*, *253*, 108926.

Glover, H. K., Weston, M. A., Maguire, G. S., Miller, K. K., & Christie, B. A. (2011). Towards ecologically meaningful and socially acceptable buffers: Response distances of shorebirds in Victoria, Australia, to human disturbance. *Landscape and Urban Planning*, *103*(3), 326–334.

Gore, M. L. (2011). The science of conservation crime. *Conservation Biology: The Journal of the Society for Conservation Biology*, *25*(4), 659–661.

Gore, M. L., & Bennett, A. (2021). Importance of deepening integration of crime and conservation sciences. *Conservation biology: The journal of the society for Conservation Biology*, *36*, e13710. https://doi.org/10.1111/cobi.13710

Hatch, D. A. (1996). *Western snowy plover (a federally threatened species) wintering population and interaction with human activity on Ocean Beach, San Francisco, Golden Gate National Recreation Area, 1988 through 1996*. National Park Service.

Ho, J., Hussain, S., & Sparagano, O. (2021). Did the Covid-19 pandemic spark a public interest in pet adoption? *Frontiers in Veterinary Science*, *8*, 647308.

Holland, K. E., Owczarczak-Garstecka, S. C., Anderson, K. L., Casey, R. A., Christley, R. M., Harris, L., McMillan, K. M., Mead, R., Murray, J. K., Samet, L., & Upjohn, M. M. (2021). 'More attention than usual': A thematic analysis of dog ownership experiences in the UK during the first Covid-19 lockdown. *Animals*, *11*(1), 240.

Hwang, L. (2020). Parks and usage: When life went on hold America flocked to parks. In *Parks and the pandemic* (pp. 5–6). The Trust for Public Land.

Joa, B., Winkel, G., & Primmer, E. (2018). The unknown known – A review of local ecological knowledge in relation to forest biodiversity conservation. *Land Use Policy*, *79*, 520–530.

Jorgensen, J. G., & Brown, M. B. (2014). Piping Plovers *Charadrius melodus* and dogs: Compliance with and attitudes toward a leash law on public beaches at Lake McConaughy, Nebraska, USA. https://digitalcommons.unl.edu/natrespapers/644/

Jorgensen, J. G., & Brown, M. B. (2016). Impact perceptions and acceptance capacity toward Piping Plovers *Charadrius melodus* among visitors on a public beach in Nebraska, USA. *Wader Study*, *123*(1), 59–68. https://doi.org/10.18194/ws.00029

Kahler, J. S., & Gore, M. L. (2017). Conservation crime science. In M. L. Gore (Ed.), *Conservation criminology*. https://doi.org/10.1002/9781119376866.ch2

Kidd, L. R., & Dayer, A. A. (2020). Evidence-based recommendations for strategic communication efforts for shorebird conservation. *Wader Study*, *127*(3), 191–199. https://doi.org/10.18194/ws.00211

Kirby, J. S., Stattersfield, A. J., Butchart, S. H. M., Evans, M. I., Grimmett, R. F. A., Jones, V. R., O'Sullivan, J., Tucker, G. M., & Newton, I. (2008). Key conservation issues for migratory land- and waterbird species on the world's major flyways. *Bird Conservation International*, *18*(S1), S49–S73.

Koleček, J., Reif, J., Šálek, M., Hanzelka, J., Sottas, C., & Kubelka, V. (2021). Global population trends in shorebirds: Migratory behaviour makes species at risk. *Die Naturwissenschaften*, *108*(2), 9.

Lafferty, K. D. (2001). Disturbance to wintering western snowy plovers. *Biological Conservation*, *101*(3), 315–325.

Lafferty, K. D., Goodman, D., & Sandoval, C. P. (2006). Restoration of breeding by snowy plovers following protection from disturbance. *Biodiversity and Conservation*, *15*(7), 2217–2230.

Larson, L. R., Zhang, Z., Oh, J. I., Beam, W., Ogletree, S. S., Bocarro, J. N., Lee, K. J., Casper, J., Stevenson, K. T., Hipp, J. A., Mullenbach, L. E., Carusona, M., & Wells, M. (2021). Urban park use during the Covid-19 pandemic: Are socially vulnerable communities

disproportionately impacted? *Frontiers in Sustainable Cities*, *3*, 710243. https://doi.org/10.3389/frsc.2021.710243
Maguire, G. S., Miller, K. K., & Weston, M. A. (2019). Only the strictest rules apply: Investigating regulation compliance of beaches to minimize invasive dog impacts on threatened shorebird populations. In C. Makowski & C. W. Finkl (Eds.), *Impacts of invasive species on coastal environments: Coasts in crisis* (pp. 397–412). Springer International Publishing.
Manenti, R., Mori, E., Di Canio, V., Mercurio, S., Picone, M., Caffi, M., Brambilla, M., Ficetola, G. F., & Rubolini, D. (2020). The good, the bad and the ugly of Covid-19 lockdown effects on wildlife conservation: Insights from the first European locked down country. *Biological Conservation*, *249*, 108728.
Marion, J. L., Dvorak, R. G., & Manning, R. E. (2008). Wildlife feeding in parks: Methods for monitoring the effectiveness of educational interventions and wildlife food attraction behaviors. *Human Dimensions of Wildlife*, *13*(6), 429–442.
Mayers, R. (2021). Dogs unleashed: The positive role dogs play during Covid-19. *Leisure Sciences*, *43*(1–2), 252–259.
Medeiros, R., Ramos, J. A., Paiva, V. H., Almeida, A., Pedro, P., & Antunes, S. (2007). Signage reduces the impact of human disturbance on little tern nesting success in Portugal. *Biological Conservation*, *135*(1), 99–106.
Mengak, L., & Dayer, A. A. (2020). Defining human disturbance to shorebirds using manager and scientist input. *Environmental Management*, *65*(1), 62–73.
Michel, N. L., Saunders, S. P., Meehan, T. D., & Wilsey, C. B. (2021). Effects of stewardship on protected area effectiveness for coastal birds. *Conservation Biology*, *35*(5), 1484–1495.
Miller, K. K., Ritchie, E. G., & Weston, M. A. (2014). The human dimensions of dog-wildlife interactions. In M. E. Gompper (Ed.), *Free-ranging dogs and wildlife conservation* (pp. 286–301). Oxford University Press.
Moreto, W. D. (2016). Occupational stress among law enforcement rangers: Insights from Uganda. *Oryx: The Journal of the Fauna Preservation Society*, *50*(4), 646–654.
Morgan, L., Protopopova, A., Birkler, R. I. D., Itin-Shwartz, B., Sutton, G. A., Gamliel, A., Yakobson, B., & Raz, T. (2020). Human–dog relationships during the Covid-19 pandemic: Booming dog adoption during social isolation. *Humanities and Social Sciences Communications*, *7*(1), 1–11.
National Park Service. (2020, October 14). *Cape Hatteras National Seashore sees double-digit increase in September visitation*. National Park Service. https://www.nps.gov/caha/learn/news/cape-hatteras-national-seashore-sees-double-digit-increase-in-september-visitation.htm
Owczarczak-Garstecka, S. C., Graham, T. M., Archer, D. C., & Westgarth, C. (2021). Dog walking before and during the Covid-19 pandemic lockdown: Experiences of UK dog owners. *International Journal of Environmental Research and Public Health*, *18*(12), 6315. https://doi.org/10.3390/ijerph18126315
Rizzolo, J. B., Gore, M. L., Long, B., Trung, C. T., Kempinski, J., Rawson, B., Huyễn, H. T., & Viollaz, J. (2021). Protected area rangers as cultural brokers? Implications for wildlife crime prevention in Viet Nam. *Frontiers in Conservation Science*, *2*, 698731. https://doi.org/10.3389/fcosc.2021.698731
Sabine, J. B., III, Michael Meyers, J., Moore, C. T., & Schweitzer, S. H. (2008). Effects of human activity on behavior of breeding American oystercatchers, Cumberland Island National Seashore, Georgia, USA. *Waterbirds*, *31*(1), 70–82.
Schneider, T. J., Maguire, G. S., Whisson, D. A., & Weston, M. A. (2020). Regulations fail to constrain dog space use in threatened species beach habitats. *Journal of Environmental Planning and Management*, *63*(6), 1022–1036.
Schulte, S. A., & Simons, T. R. (2015). Factors affecting the reproductive success of American Oystercatchers *Haematopus palliatus* on the Outer Banks of North Carolina. *Marine Ornithology*, *43*, 37–47.
Schwartz, M. W., Glikman, J. A., & Cook, C. N. (2020). The COVID-19 pandemic: A learnable moment for conservation. *Conservation Science and Practice*, *2*(8), e255. https://doi.org/10.1111/csp2.255
Soga, M., Evans, M. J., Cox, D. T. C., & Gaston, K. J. (2021). Impacts of the Covid-19 pandemic on human–nature interactions: Pathways, evidence and implications. *People and Nature*, *3*(3), 518–527.
Solomon, J. N., Gavin, M. C., & Gore, M. L. (2015). Detecting and understanding non-compliance with conservation rules. *Biological Conservation*, *189*, 1–4.
Stigner, M. G., Beyer, H. L., Klein, C. J., & Fuller, R. A. (2016). Reconciling recreational use and conservation values in a coastal protected area. *The Journal of Applied Ecology*, *53*(4), 1206–1214.
Veríssimo, D., Vieira, S., Monteiro, D., Hancock, J., & Nuno, A. (2020). Audience research as a cornerstone of demand management interventions for illegal wildlife products: Demarketing Sea turtle meat and eggs. *Conservation Science and Practice*, *2*(3), e164. https://doi.org/10.1111/csp2.164
Weston, M. A. (2019). Human disturbance. In M. A. Colwell & S. M. Haig (Eds.), *The population ecology and conservation of Charadrius plovers* (pp. 277–308). CRC Press.
Weston, M. A., Dodge, F., Bunce, A., Nimmo, D. G., & Miller, K. K. (2012). Do temporary beach closures assist in the conservation of breeding shorebirds on recreational beaches? *Pacific Conservation Biology*, *18*(1), 47–55. https://doi.org/10.1071/PC120047
Weston, M. A., & Stankowich, T. (2014). Dogs as agents of disturbance. In M. E. Gompper (Ed.), *Free-ranging dogs and wildlife conservation*. Oxford University Press.
Williams, K. J., Weston, M. A., Henry, S., & Maguire, G. S. (2009). Birds and beaches, dogs and leashes: Dog owners' sense of obligation to leash dogs on beaches in Victoria, Australia. *Human Dimensions of Wildlife*, *14*(2), 89–101.
Wilson, S. G., & Fischetti, T. R. (2022). *Coastline population trends in the United States: 1960 to 2008* (No. P25-1139). US Census Bureau. https://www.census.gov/library/publications/2010/demo/p25-1139.html

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Dayer, A. A., Everly, J., Comber, C. A., & Gore, M. L. (2022). Managers and shorebird biologists' perceptions of enforcement and voluntary compliance techniques to increase compliance with dog regulations on beaches. *People and Nature*, *4*, 1279–1291. https://doi.org/10.1002/pan3.10392