DISSERTATION

SOCIAL-PSYCHOLOGICAL FACTORS INFLUENCING COMMUNITY ENGAGEMENT IN URBAN BIODIVERSITY CONSERVATION

Submitted by

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ABSTRACT

SOCIAL-PSYCHOLOGICAL FACTORS INFLUENCING COMMUNITY ENGAGEMENT IN URBAN BIODIVERSITY CONSERVATION

As the human population grows and we continue to see rapid biodiversity loss, conserving natural resources in urbanized areas has become increasingly important. Motivating people to engage in pro-environmental behavior is one of the many strategies to address biodiversity loss. Strategic human action can help shape social norms and generate social movements that influence the social systems that intensify environmental degradation. This dissertation builds on the existing pro-environmental behavior literature and explores the motivators and barriers to different types of urban biodiversity conservation actions. These include personal-sphere behavior (i.e., participating in an action by oneself), social diffusion behavior (i.e., actions that disseminate information or behavior via social networks), and civic action behavior (i.e., citizenship actions to address a collective issue). In three articles, I use cross-sectional, experimental, and audience segmentation methods to compare the drivers of distinct behaviors, evaluate the impacts of theory-based outreach strategies, and identify target audiences for biodiversity conservation behaviors related to native plant gardening in the United States. Findings from this research can inform outreach strategies that promote greater community engagement in urban biodiversity conservation to support native wildlife and human wellbeing.

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Dissertation Overview

Biodiversity conservation and provisioning of "green space" in urban environments is increasingly a focus of conservation practitioners and researchers (Aronson et al., 2014; Ives et al., 2016; Nilon et al., 2017). Green space can be defined as public or private land within cities and peri-urban areas such as parks, individual yards, roadside verges, schoolgrounds, and more. Green spaces in cities provide unique opportunities to improve both conservation outcomes and human wellbeing (Aerts et al., 2018; Gardiner et al., 2013; Ives et al., 2016; Sandifer et al., 2015). There are three key arguments for the need to enhance biodiversity conservation in urban environments. The first is that urban areas play a key role in improving native species biodiversity. Ives et al. (2016) found that cities have disproportionally higher rates of endangered species than other areas, so management practices to conserve biodiversity are vital in these settings. For example, creating large habitat patches within urbanized areas, along with corridors that connect these patches, are key to supporting species richness (Beninde et al., 2015).

Additionally, urban conservation efforts are important for supporting ecosystem services and human wellbeing in cities. While many urban regions have gone through tremendous habitat destruction and change, urbanized areas still provide many ecosystem services, or direct and indirect benefits to humans (Millenium Ecosystem Assessment, 2005; Niemelä et al., 2010). For example, urban ecosystems provide climate regulation, rainwater drainage, habitat provision, and recreational value (Bolund & Hunhammar, 1999; de Groot et al., 2002; Niemelä et al., 2010). Urban green space is associated with more opportunities for physical activity, improved mental health, and even reduced crime rates (Keniger et al., 2013; Van Den Berg & Custers, 2011; Westphal, 2003). Increasingly, "green prescriptions," or orders from physicians to spend time in

nature, are being provided as a treatment for physical and mental disorders (Van den Berg, 2017).

Finally, improving biodiversity in urban areas is critical to address environmental justice issues posed by unequal access to green spaces and the impacts of climate change. Studies find that marginalized communities do not receive the same benefits from urban green spaces that wealthier, and whiter communities experience (Estabrooks et al., 2003; Taylor, 2011; Wen et al., 2013). Redlining, a policy that refused to insure mortgages in poorer areas, explicitly segregated neighborhoods by race. This policy has impacted the current ecological makeup of cities. For example, historically redlined neighborhoods have significantly less tree canopy than neighborhoods that were graded as "most desirable" (Grove et al., 2018; Schell et al., 2020). Furthermore, with increasing risk of extreme heat due to climate change, unequal patterns of vegetation across cities can create "heat riskscapes" for vulnerable populations (Jenerette et al., 2011). Increasing vegetation and biodiversity in cities can increase access to green space and mitigate negative effects of climate change, though it must be done in a way that takes into account the needs of the target communities to avoid negative consequences like green gentrification (Wolch et al., 2014). Green gentrification happens when green infrastructure projects increase property values and push out or displace the marginalized communities that the projects were aiming to support (Anguelovski, 2016; Rigolon & Németh, 2020).

Given these key benefits, many non-profits, municipal governments, and conservation agencies are starting to take actions to promote urban biodiversity conservation. These can include strategies like public zoning to create protected area for wildlife, financial incentives to promote private land management, and outreach campaigns to spread awareness and shape local norms around biodiversity conservation. For example, the City of Fort Collins, Colorado created

a sub-department, called Nature in the City (NIC), that focuses on habitat for people, plants, and wildlife throughout the city. For the past few years, in conjunction with the utilities department's Xeriscape Incentive Program (XIP), NIC provides homeowners additional financial resources to plant native plants in their low water landscapes (City of Fort Collins, n.d.). Bird City Wisconsin, an environmental conservation organization, certifies cities, towns, and communities that demonstrate a commitment to bird conservation, which includes activities like native habitat creation (Bird City Wisconsin, n.d.).

The actions of everyday residents are also needed to supplement public and nonprofit efforts and/or promote greater biodiversity conservation in urban environments in the absence of such programs and policies. Residential yards make up a significant portion of green space in cities. In fact, residential lawns can be considered the largest irrigated crop in the United States, taking up over 40 million acres of land (Milesi et al., 2005). Davies et al. (2009) argues that residential yards, and individual residents, should not be left out of urban conservation discussions. Motivating individuals to participate in pro-environmental behavior (PEB), especially in a collective or cooperative setting, can promote greater positive impacts on biodiversity loss (Amel et al. 2017). Overall, urban biodiversity actions at multiple levels are key to supporting wildlife and human wellbeing in cities.

Increasingly, researchers and practitioners have begun examining how to motivate resident action for urban biodiversity conservation (Alberti & Marzluff, 2004; Byrne & Grewal, 2008; Cook et al., 2012). This research has found that residents' decision-making and behaviors are influenced by multi-level social factors and socio-ecological feedback loops. Urban and residential landscapes are dynamic social-ecological systems made up of sociocultural and ecological processes, inputs, and feedback loops. There are multiple levels of social factors that

affect a person's management decisions on their property on the individual level (ex. attitudes, and values), the neighborhood scale (ex. local social norms and homeowners' association regulations) and the larger regional scale (ex. governmental policies, marketing by large corporations, and wider cultural systems). Social drivers of landscaping are influenced by both ecological inputs and legacy effects, such as the previous owner's landscaping decisions (Cook et al., 2012). See Figure 1 for Cook et al. (2012)'s framework of social-ecological relationships in residential landscapes.

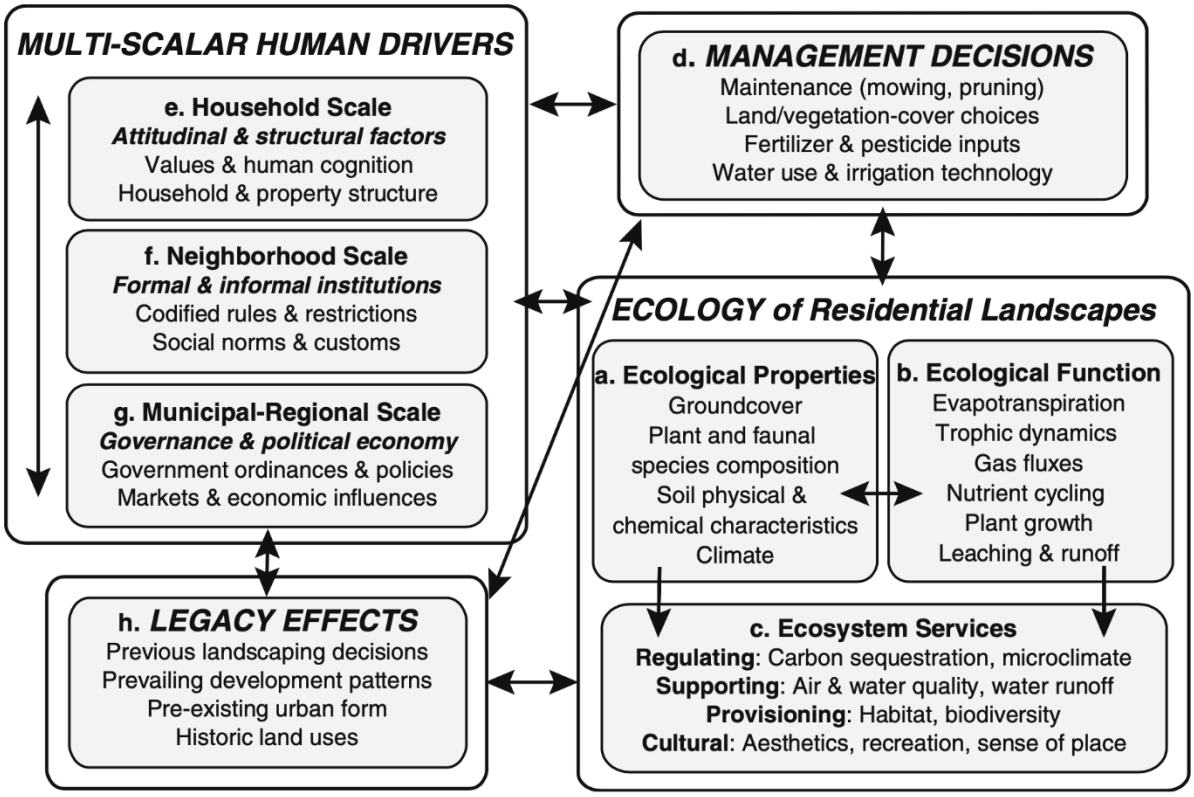

Figure 1. A conceptual framework of multi-scalar social-ecological interactions of residential landscapes (Cook et al., 2012)

Social aspects of Cook et al. (2012)'s theoretical model have been highly studied, including beliefs, attitudes, perceptions of norms, and decision-making surrounding individual urban conservation behaviors. For example, studies have explored attitudes and perceptions of

native plants and native plant gardening (see Gillis & Swim, 2020; Kurz & Baudains, 2012; Nassauer et al., 2009). These studies demonstrate that while attitudes towards native plants are relatively positive, social norms can affect decision making processes in residential native plant gardening. Strong social norms may even prevent native plant gardening actions, especially in the front yard where norms are more prevalent. The effects of decision-making on ecological outcomes have also been studied in the residential and urban context. Kinzig et al., (2005) found that socio-economic factors influence decision-making and biodiversity outcomes in parks in Phoenix, Arizona more than traditional drivers of biodiversity, such as human population density. Structural inequalities, especially policies built on racism and white supremacy, also contribute to management decisions that affect biodiversity in urban areas (Schell et al., 2020).

While this growing body of literature has examined the drivers and outcomes of people's individual management actions on their property, fewer studies have examined residents' collective actions related to urban biodiversity conservation. Collective actions refer to those in which individuals work together, or collaborate, to achieve a shared goal (Wright, 2009). Environmental collective action has been studied more broadly over the last 30 years (Gulliver et al., 2022), but there remains an opportunity to understand the social-psychological variables that influence individuals' involvement in collective action to address biodiversity loss. Amel et al. (2017) argues that collective actions are needed because they can more effectively influence broader systems. While individual, personal-sphere actions have been popularized, collective efforts can have a larger impact on infrastructure, and powerful systems that contribute greatly to biodiversity loss and environmental degradation (Maniates, 2001). Larson et al. (2015) argues that collective actions better influence decision-making, policy, and social norms so it is

important to study the motivators and barriers that influence social and civic actions beyond individual or personal-sphere behavior.

There are different types of collective action that individuals can participate in. Social diffusion behaviors (Jones & Niemiec, 2020; Rogers, 2003), or actions to spread behavior through a social network, may be particularly important to motivate. Diffusion behaviors can increase the impact that personal-sphere actions have on biodiversity conservation within cities by recruiting more people into the collective movement (Amel et al., 2017). Participating in social diffusion behavior creates an opportunity for individuals to move beyond the private sphere and take action that will have a larger impact on complex issues like biodiversity loss (See Figure 2: Amel et al., 2017). Individuals can also take civic action to influence urban landscapes. Civic actions are behaviors that seek to address collective or community concerns through activities like voting, volunteering, or signing a petition (Larsen et al., 2004). According to Amel et al. (2017) civic actions may have an even greater impact on social systems than diffusion behavior.

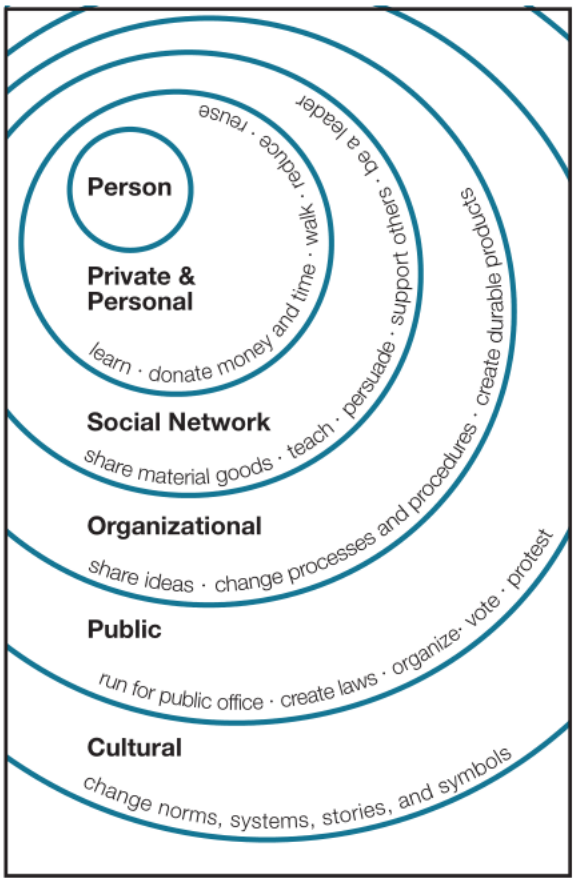

Figure 2. Spheres of Human Influence (adapted from Amel et al., 2017)

Issues of justice, equity, diversity, and inclusion (JEDI) also play a role in residential and urban social-ecological systems. Calls for JEDI in the environmental field seek to address underrepresentation of Black, Indigenous and/or People of Color (BIPOC) individuals at multiple levels (Bailey et al., 2020; Gould et al., 2018; Matulis & Moyer, 2017; Tallis & Lubchenco, 2014; Tulloch, 2020). The conservation field has a history rooted in colonialism and racist policies (Chaudhury & Colla, 2021; Rudd et al., 2021), and environmental organizations, especially those focusing on conservation, have been primarily run by white men (Taylor, 2014). According to the 2022 Green 2.0 transparency report, 34% of senior staff positions in large US environmental NGOs are held by people who identify as BIPOC, and an earlier study found that volunteers and members of environmental organizations are also primarily white (Green2.0,

2022; Taylor, 2014). In addition to environmental agencies, academic institutions play a role in making the conservation field more inclusive (Chaudhury & Colla, 2021)

JEDI issues are prevalent in urban biodiversity conservation. For example, while there are large benefits to urban green spaces, an often unintended consequence is "green gentrification," which refers to the increases in property values and displacement of marginalized groups that result from public greening projects (Haase et al., 2017; Rigolon & Németh, 2020). Encouraging broader, more diverse, engagement in urban conservation actions can lead to improved socio-ecological outcomes in urban landscapes. Community participation in the urban planning process not only reduces threats of gentrification, but also contributes to projects that are more likely to reflect the needs and preferences of the people who benefit from them (Turo & Gardiner, 2019). In addition, when people perceive landscapes as aesthetically pleasing, they are more likely to appreciate and protect them (Gobster et al., 2007).

Furthermore, while native plant gardening (i.e., the case study used in this dissertation), is a way to participate in urban biodiversity conservation, it is an inherently exclusive action to participate in individually. Gardening requires land and time, resources that may be more accessible to older, wealthier, and whiter audiences (Broady et al., 2022). Overall, this dissertation studies native plant gardening behavior at three levels, personal sphere, social diffusion, and civic action, in the United States. These three types of actions may have different barriers for participation, and a wider range of potential actions may help encourage participation from people with diverse backgrounds. Each chapter in this dissertation also addresses a gap in the literature to inform a larger, more inclusive native plant gardening movement. In the first chapter, I uncover potential motivators and barriers to participating in personal-sphere and social diffusion actions for native plant gardening. In the second chapter, I test outreach strategies to

encourage the social diffusion of native plant gardening. In chapter three, I explore how we can improve native plant gardening outreach, by developing messaging the targets the shared perceptions of specific segments of the population.

Theoretical Approach

In this dissertation, my three chapters apply the concepts of norms and efficacy which are central to many theoretical models of behavior and behavior change (i.e., Theory of Reasoned Action (TRA; Fishbein & Ajzen, 1975), Theory of Planned Behavior (TPB; Ajzen, 1985), Social Cognitive Theory (Bandura, 1986), The Focus Theory of Normative Conduct (Cialdini et al., 1990), Norm Activation Model (NAM; Schwartz, 1977), and Integrated Model of Behavioral Prediction (IMPB; Yzer, 2012)). Social norms are perceptions of what is considered acceptable in a given social environment and inform expectations of "normal" behavior. Different types of social norms have been studied, including descriptive norms (i.e., perceptions of how most people behave), injunctive norms (i.e., perceptions of how one ought to behave; Cialdini et al., 1990), and dynamic norms (i.e., perceptions of how other people's behavior is changing over time; Sparkman & Walton, 2017). Many studies applying behavior change models and examining the influence of norms on behavior have found social norms to correlate with behavioral intentions and measures of environmental behavior (see Culiberg & Elgaaied-Gambier, 2016; Niemiec et al., 2020; Nolan et al., 2008; Sparkman & Walton, 2017 as examples).

Because social norms have been found to predict behavioral intentions, for over 40 years social scientists have leveraged perceptions of social norms in social influence interventions to see if there is a causal relationship between social norms and pro-environmental behavior (PEB). In a meta-analysis, Abrahamse and Steg (2013) found that social influence approaches (i.e.,

strategies to change behavior by influencing perceptions of what is considered "normal" or acceptable in a social context) in PEB studies were more effective than control approaches, such as providing information about the benefits of pro-environmental action. In a larger review, Byerly et al. (2018) also found that contextual interventions, which included social influence approaches, were more effective than traditional education-based techniques. Social influence strategies have been studied in a variety of behaviors, especially recycling, energy consumption, and water conservation (Ferraro & Price, 2013; Schultz et al., 2007). It appears that social influence techniques work on a range of different types of behaviors but collective or social PEBs (such as voting or encouraging others to act in a pro-environmental way) and biodiversity conservation behaviors are less studied than the more popular household conservation behaviors mentioned above (Farrow et al., 2017; Niemiec et al., 2020). This dissertation seeks to address this gap by studying the influence of social norms on individual native plant gardening, the social diffusion of native plant gardening actions through social networks, and civic action to increase native plants (Jones & Niemiec, 2020).

Efficacy beliefs are another theorized driver of PEB. Self-efficacy refers to an individual's belief in their ability to achieve a goal or carry out an action (Bandura, 1977, 1997) and response efficacy can be defined as the belief that a performed action will achieve its overall goal (Roser-Renouf et al., 2014). A broad range of literature has correlated efficacy with behavior following Bandura's Social Cognitive Theory and Self-Efficacy theories (Bandura, 1977, 1986; see Breland et al., 2020; Chen, 2015; Choi & Hart, 2021; Hamann & Reese, 2020 as examples). Efficacy-based interventions have been particularly effective in health and educational research (Alsaleh et al., 2016; Bandura & Schunk, 1981; Boyle et al., 2011; Huang et al., 2020; Schunk, 2003; Seijts & Latham, 2001; Yehle & Plake, 2010). For example, self-

efficacy building strategies have been shown to help students reach academic goals and increase physical activity in patients with coronary heart disease (Alsaleh et al., 2016; Schunk, 2003)

Studies using efficacy-based interventions on PEBs have had mixed results. A series of studies by Jugert et al. (2016) demonstrated that collective response efficacy interventions can increase PEB intentions. Geiger et al. (2017) found that knowledge-based interventions, which strengthen efficacy beliefs, were effective in promoting engagement in climate change discussion. A recent field experiment tested the differences between normative messaging, appeals to self-efficacy and response efficacy, and information-only messaging on native plant gardening and outreach behaviors (Niemiec et al., 2021). They found preliminary evidence that efficacy messages increased participants' willingness to reach out to others about native plant gardening for biodiversity conservation (Niemiec et al., 2021). Alternatively, Hamann and Reese (2020) found that self-efficacy and collective efficacy manipulations did not have a significant effect on PEB intentions.

Perceptions of social norms and efficacy may be particularly relevant for urban biodiversity conservation. At the residential level, community and neighborhood norms can be highly influential in observable landscaping decisions, such as converting front yard lawn to native plants (Carrico et al., 2013; Larsen & Harlan, 2006). Residents who live in areas where they perceive their neighbors would not support their actions to conserve biodiversity in their yards, may not feel confident in their ability to encourage others to do the same. Furthermore, norms and efficacy may impact audiences differently and there may be unique barriers and motivators for different segments of the population. This dissertation, and Chapter 3 specifically, aims to further understand how norms and efficacy influence different audiences in urban biodiversity conservation actions.

Summary of dissertation chapters and contributions

This dissertation seeks to understand drivers of different types of native plant gardening behaviors and better understand how to engage a larger, more diverse audience in urban biodiversity conservation efforts. Combined, the three chapters study three types of actions that can be taken by individuals: personal-sphere, social diffusion, and civic action behavior. The study in Chapter 1 uses a cross-sectional survey design to understand the difference in social-psychological drivers between individual (i.e., personal-sphere) and diffusion native plant gardening behaviors, and if behavioral intentions predict indicators of actual behavior. Chapter 1 addresses the intention-behavior gap in the behavioral science literature by measuring the relationship between behavioral intentions and actual behavior, and variables that moderate this relationship, for native plant gardening and native plant diffusion. This study also applies an expanded Integrated Model of Behavioral Prediction (IMBP) to measure the influence of various types of norms and efficacy beliefs on native plant behaviors.

While correlational studies are key to finding new relationships, experimental studies are important to establish causal relationships between socio-psychological factors and behaviors. The second chapter study uses an online workshop-based field experiment to test if different types of outreach communication affect participants' behavioral intentions, measures of behavior and various social-psychological perceptions surrounding native plant gardening and native plant diffusion. Chapter 2 examines whether a workshop with normative and efficacy-based micro-interventions significantly changes perceptions or measures of real-world behavior compared to a "control" information-only workshop.

Drawing from findings in the first two studies and addressing calls for increased diversity in conservation, the third chapter uses audience segmentation research methods to further

understand the segments of the Unites States population that exist within the native plant gardening space and examine the motivations and barriers for participating in urban biodiversity conservation actions within those groups. This study engages groups underrepresented in the first two chapters and the urban conservation movement. These include younger adults (aged 18 to 39), those with a lower household income, BIPOC individuals, and people with less formal education. Chapter 3 aims to generate a more representative sample of voices to inform tailored outreach approaches for the urban biodiversity conservation movement.

Chapter 1: Understanding Individual and Diffusion Behaviors Related to Native Plant Gardening

Chapter Summary

While studies have examined factors influencing individual pro-environmental behavior, less research has examined the drivers of "diffusion behaviors" that disseminate new information via social networks. We conducted a survey of single-family households (n = 337) using an expanded Integrated Model of Behavioral Prediction to investigate the social-psychological drivers of individual and diffusion behavioral intentions for native plant gardening. We also examined how intentions related to actual behavior and potential moderators of the intention-behavior relationship. We found that while individual behavior-specific knowledge and attitude predict both individual and diffusion intentions, behavior-specific personal norms and self-efficacy predicted diffusion intention, and behavior-specific personal norm influenced individual intention. Contrary to theory, diffusion intentions were influenced by a combination of behavior-specific and non-specific predictors. These results suggest that to motivate diffusion intention, outreach interventions may need to enhance diffusion-specific personal norm and self-efficacy beliefs, rather than just individual behavioral perceptions. Intentions predicted indicators of actual diffusion behavior, as measured through native plant voucher use by individuals and their friends and family. However, these indicators of behavior were not predicted directly by social-psychological variables. Diffusion-specific self-efficacy and subjective knowledge appear to moderate the relationship between diffusion intentions and successful diffusion behavior.

Research has examined how social-psychological factors, such as attitudes, beliefs, and norms, drive individual pro-environmental behaviors such as household energy or water conservation (Bamberg & Möser, 2007; Byerly et al., 2018; Farrow et al., 2017). However, less is known about whether these same perceptual factors influence collective behaviors, such as sharing information, organizing efforts, and applying social pressure, which have the potential to enhance the scale and speed of environmental action (Amel et al., 2017). One understudied collective behavior that might facilitate widespread environmental action is "diffusion" behavior. Diffusion behaviors include sharing information with, reaching out to, and applying social pressure in one's social network to encourage a specific behavior (Jones & Niemiec, 2020; Niemiec et al., 2021).

Diffusion Behavior

Distinct from more commonly studied collective action behaviors, such as protesting, contacting politicians, and working together in a group for environmental outcomes (Fritsche et al., 2018; Lubell et al., 2007; Steel, 1996; Stern, 2000; van Zomeren et al., 2008), diffusion behaviors involve informal, persuasive, one-on-one engagement with others in one's social network (Jones & Niemiec, 2020). Diffusion behaviors range from more passive behaviors like putting a sign in one's yard to promote native plants, to more active behaviors like teaching someone how to plant a native plant (Jones & Niemiec, 2023). Attempts to persuade others (see Cialdini, 2001) as well as interpersonal discussion (see Frank et al., 2012) are examples of social diffusion behavior.

Diffusion behaviors may be especially important for conservation because they can facilitate the spread of information about pro-environmental behaviors (PEBs) to less-engaged audiences (Ma et al., 2012; McKiernan, 2017; Rogers, 2003; Snyder & Broderick, 1992) and

activate or reinforce norms encouraging PEBs. There is a growing body of literature on the effectiveness of diffusion behaviors on environmental and social issues (Abrahamse & Steg, 2013; Burn, 1991; Carrico & Riemer, 2011; Geiger et al., 2017; Green & McClellan, 2020; Groce et al., 2019). For example, Abrahamse and Steg (2013), conducted a meta-analysis of 29 papers using social influence approaches and found that the block leader approach (another term for relational organizing) was the most effective at influencing conservation behavior. Relational organizing, a type of diffusion behavior, involves mobilizing motivated individuals to encourage people in their social network to behave in a certain way (Niemiec et al., 2021). More recently, a get-out-the-vote field experiment found that municipal election turnout rates were significantly higher (13.2 percentage points) in a group that was exposed to peer organizing strategies (i.e., relational organizing) than a control group (Green & McClellan, 2020).

People may be more willing to act on information they receive through diffusion because they trust and listen to individuals perceived as similar to themselves (Burger et al., 2004; Goldberg et al., 2019). Thus, social diffusion may be more influential for changing behavior in addition to, or beyond, attitudes. Even without an existing norm for a behavior, diffusion behavior can create the perception that a new behavior is gaining popularity and inspire more rapid behavior change (Sparkman & Walton, 2017, 2019). Diffusion behaviors can also create social pressure to behave in a certain way because the actions in one's social circle encourage behavior change to achieve conformity (McKiernan, 2017). While research has examined the effectiveness of diffusion behaviors (Abrahamse & Steg, 2013; Geiger et al., 2017; Rogers, 1983), less is known about what motivates people to participate in such actions.

The few existing studies that have examined the drivers of participation in diffusion behaviors have pointed to the role of social norms and efficacy (Geiger et al., 2017; Lubell et al.,

2007; Niemiec et al., 2016, 2018; Swim et al., 2014; Swim & Fraser, 2014). For example, the potential to receive social sanctions from neighbors (i.e., injunctive norms) influenced participants' diffusion behaviors for invasive species control (Niemiec et al., 2018). An intervention that changed perceptions about how many others care about climate change (i.e., descriptive norms) increased willingness to engage in climate change discussions with others (Geiger & Swim, 2016). Diffusion self-efficacy (i.e., the belief that one can effectively reach out to others) and diffusion response efficacy are correlated with willingness to reach out to others about environmental topics (Hamann & Reese, 2020; Lubell et al., 2007; Niemiec et al., 2016; Swim et al., 2014; Swim & Fraser, 2014). An intervention that enhanced diffusion-specific self-efficacy (i.e., providing information on what to say to others) was shown to increase subsequent engagement in climate change discussions (Geiger et al., 2017). Based on this evidence, we posit that diffusion-specific social norms (i.e., injunctive and descriptive norms) and efficacy will influence diffusion behavioral intentions.

While this literature provides preliminary insight into the drivers of diffusion behavior, few studies have directly compared the relative influence of norms, efficacy, and other social-psychological perceptions on diffusion behavior (see Howell et al., 2015; Jones & Niemiec, 2020 as exceptions). Furthermore, little is known about the combination of individual and diffusion-specific perceptions that drive individual versus diffusion behavior. It is possible that some individual behavior-specific beliefs are critical for motivating diffusion; for example, people may need a sufficient amount of knowledge and self-efficacy for engaging in the individual behavior before reaching out to others (Jones & Niemiec, 2020) or may need to believe that enough others care about the individual behavior (Geiger & Swim, 2016). Social norms may be particularly

important for predicting diffusion behavior compared to individual behavior, because diffusion involves engaging with others and is thus a more "public" behavior (Lapinski & Rimal, 2005).

There may also be diffusion-specific beliefs that are important. For example, Jones and Niemiec (2020) found that people's perceived ability to reach out to others effectively (i.e., diffusion-specific self-efficacy) and perceived ability to influence others and the environment by reaching out to others (i.e., diffusion-specific response efficacy) impacted diffusion pro-environmental behavior in urban ecosystems. These authors, however, focused on a highly motivated, environmentally conscious sample, and did not examine the role of subjective knowledge, attitude, personal norm, and behavioral intention. A greater understanding of the diverse social-psychological factors influencing individual and diffusion behavior could inform whether unique outreach interventions are needed to motivate diffusion behavior.

Integrative Model of Behavioral Prediction

To understand the drivers of individual and diffusion behavior, we expanded the Integrative Model of Behavioral Prediction (IMBP), which focuses on social norms, attitudes, and efficacy as predictors of behavioral intentions (See Figure 3; Fishbein & Yzer, 2003; Yzer, 2012). We based our theoretical model on the IMBP because it incorporates both social norms and efficacy, constructs that have been found to influence both individual and diffusion PEB (Fishbein & Yzer, 2003). Similar to the Theory of Reasoned Action (TRA; Ajzen & Fishbein, 1980), the IMBP has been applied in public health studies and a variety of behavioral studies (Fishbein et al., 2003; Xu et al., 2020).

We expanded the IMPB by adding subjective knowledge and additional types of norms and efficacy. In addition to injunctive norms (i.e., how other people think one ought to behave), we added descriptive norms (i.e., observations of how others behave), dynamic norms (i.e.,

observations of how others have behaved over time), and personal norms (i.e., one's moral obligation to perform a behavior). Personal norms derive from the Norm Activation Model (NAM) which states that awareness of consequences (of performing or not performing the behavior) and ascription of responsibility to perform that behavior influence personal norms, which then influence PEB (Schwartz, 1977).

In a meta-analysis of studies measuring the influence of norms on conservation behavior, Niemiec et al. (2020) identified the need for more studies to include measures of injunctive, descriptive, and personal norms in behavioral intention models. Jones and Niemiec (2020) found dynamic norms to be a fourth type of norm that predicts diffusion behavior. We also measured diffusion-specific social response efficacy (i.e., the belief that one's actions will influence other people to behave in a certain way) and diffusion-specific environmental response efficacy (i.e., the belief that one's actions will make a positive impact on the environment) in addition to self-efficacy. We added these variables because they were significant predictors of individual and diffusion PEB in prior studies (Jones & Niemiec, 2020; Niemiec et al., 2020; Sparkman & Walton, 2017). We included individual behavior-specific and diffusion-specific measures of attitudes, efficacy, and norms.

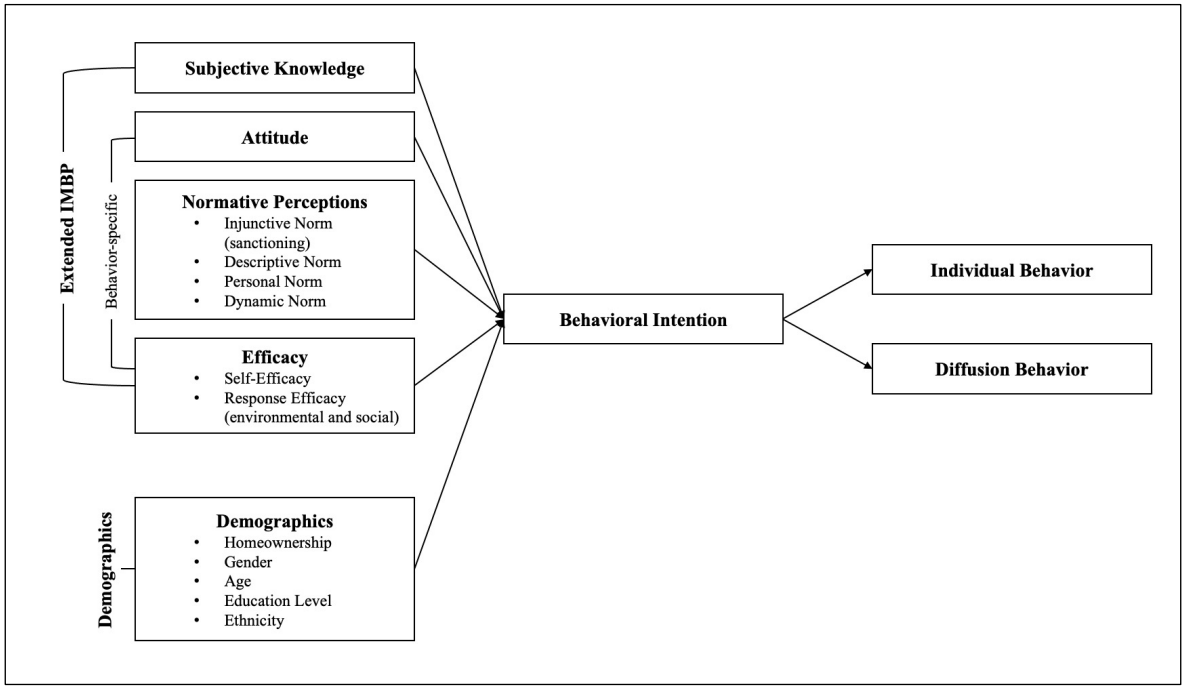

Figure 3. Full Model (Extended IMBP + Demographics)

This study also sought to understand the influence of demographic versus social-psychological variables from our expanded IMPB in predicting individual and diffusion behaviors. Earlier analysis of PEB focused on demographics as predictors, finding that women, highly educated people, and those living in urbanized areas had higher intentions to engage in PEB (Brécard et al., 2009; López-Mosquera et al., 2015; Saphores et al., 2012). While understanding the impact of demographics facilitates the targeting of certain audiences in pro-environmental outreach, research has repeatedly shown that social-psychological variables are stronger predictors of behavior (Botetzagias et al., 2015; Graham-Rowe et al., 2015; Li et al., 2019), so we included demographics here to test their relative predictive power against social-psychological variables.

Intention-Behavior Gap

In addition to examining unique drivers of individual and diffusion behavior, we also explored the link between behavioral intentions and actual behavior. A recent systematic review found that few correlational studies of pro-environmental behavior measured actual behavior; most simply measured behavioral intentions (Niemiec et al., 2020). Nilsson et al., (2020) argues that understanding attitudes has been the focus in conservation studies and that researchers need to shift their attention toward measurable behaviors because behavioral data provides the strongest evidence to guide conservation practices. When studies do measure behavior, often only self-reported behavior is considered (Lange, 2018; Steg & Vlek, 2009). This may introduce social desirability bias as participants respond in ways believed to be socially acceptable by perhaps over-estimating their engagement in PEBs (Ferraro & Price, 2013; Milfont, 2009). Other factors may also influence actual behavior beyond intention, in what is known as the "intention-behavior gap" (Bamberg & Möser, 2007; Carrington et al., 2010; Whitburn et al., 2020). Bamberg and Möser (2007), for example, found a pooled correlation of .52 between intention and behavior. Whether the intention-behavior gap is smaller or larger for diffusion versus individual behaviors remains unknown.

It is possible that certain variables moderate the relationship between intention and behavior. Prior studies have suggested that people's level of control or beliefs about their self-efficacy to perform a behavior may influence both intention and behavior, and may also moderate this relationship (Ajzen, 2002; Kan & Fabrigar, 2017). According to Sheeran (2001), knowledge, may moderate the intention-behavior gap, because for someone to follow through on their intention, they must have enough knowledge on the subject to do so. Furthermore, there may be external factors that moderate the intention-behavior relationship (Hassan et al., 2016; Kollmuss & Agyeman, 2002). For example, a person may intend to plant a native plant in their

yard but are not able to realize this intention because, as a renter, their landlord does not allow it. To further analyze the intention-behavior gap, we explored whether self-efficacy, subjective knowledge, and homeownership moderate the relationship between intention and behavior.

Case Study: Native Plant Gardening

In this article, we examined the drivers of individual and diffusion behavior related to native plant gardening. In response to rapid losses in biodiversity, conservation practitioners and researchers have called for the creation of habitat in residential areas to support dwindling species (Garbuzov & Ratnieks, 2014; Gill et al., 2016; Klein et al., 2007; Widows & Drake, 2014). One approach to enhance native species habitat in urban areas is to encourage private landowners to plant native plants on their properties (i.e., "wildscaping"; Jones et al., 2021; Lerman & Warren, 2011; Widows & Drake, 2014). Gardens with native plants provide critical habitat for insects, amphibians and birds (Barnes et al., 2020; Goddard et al., 2010; Paker et al., 2014). Yards with native plants also require less water than yards with turf lawns (Vickers, 2006), and can positively impact human wellbeing by increasing people's wildlife encounters and time spent in biodiverse green spaces (Aerts et al., 2018; Bell et al., 2018; Goddard et al., 2013).

Despite the benefits of native plant gardening, lawns are still popular in U.S. residential areas. American turfgrass lawns take up three times more land than corn, making it the largest irrigated crop in the U.S. (Milesi et al., 2005). When making decisions about yards, people are influenced by social factors ranging from the individual scale (e.g., attitudes, beliefs), to the community (e.g., community associations) and institutional (e.g., rebates for replacing lawns) scale (Cook et al., 2012). Literature finds native plants are becoming more popular and are increasingly being perceived as aesthetically pleasing (Fischer et al., 2014; Hurd et al., 2006;

Kurz & Baudains, 2012; Larsen & Harlan, 2006; Peterson et al., 2012). Gillis and Swim (2020) explored U.S. resident's attitudes and perceived social norms towards sustainable landscaping and found both to be strong predictors of native plant gardening. Research has also found that landscaping decisions in more public spaces (i.e. front yards) are driven by social norms while decisions in the backyard are not (Carrico et al., 2013; Larsen & Harlan, 2006). Given the importance of social influence on sustainable gardening decisions, diffusion behavior related to native plant gardening has the potential to increase native biodiversity by building neighborhood and community norms that favor native plant gardening.

In this article, we studied the drivers of individual and diffusion behaviors and the link between behavioral intentions and indicators of actual behavior (i.e., tracking native plant vouchers that individuals use themselves and give to others via diffusion) using data from a field experiment (Niemiec et al., 2021). Through a mail-based survey and the tracking of voucher usage, we examined three key questions:

1. Which individual and diffusion-specific social-psychological factors in the extended IMBP and demographics model predict individual and diffusion behavioral intentions for native plant gardening? (RQ1) Previous studies find that attitudes, social norms, personal norms, self- and response efficacy predict individual intentions, but these relationships, and the relative importance of individual and diffusion-specific perceptions, have not been directly studied for diffusion intentions. We expect different social-psychological factors will predict individual versus diffusion behavioral intentions.
2. To what extent do intentions predict indicators of actual individual and successful diffusion behaviors? (RQ2) Addressing the intention-behavior gap, we seek to understand the strength of the relationship between intention and behavior in individual and diffusion

behavior-related settings. Based on previous studies, we expect there to be a moderate relationship between intentions and behavior.

3. Does self-efficacy, subjective knowledge, or homeownership moderate the gap between individual and diffusion intention and indicators of behavior? (RQ3) Drawing on theorized moderators of behavior, we expect control factors, like self-efficacy and subjective knowledge, and the external factor, homeownership, to moderate intention-behavior relationships in the context of native plant gardening and diffusion.

Methods

Sample and Data Collection

We examined our research questions through a survey and native plant outreach initiative in the suburban, greater Fort Collins area in northern Colorado (U.S.A). In April 2020, a cover letter, survey, and stamped return envelope was sent to 2,000 randomly selected single-family addresses within the city limits. We studied residents living in single-family homes because they are more likely to have space to plant native plants on their properties. The cover letter informed participants that we were interested in their beliefs about native plant gardening and included informed consent language. The survey was conducted under Colorado State University IRB #19-8879H. Participants were given the option to take the survey online via Qualtrics or send back a physical survey with the stamped return envelope. Providing the option to take the survey online or via mail is an increasingly popular survey technique to increase response rates (Stedman et al., 2019). After two weeks, participants received a reminder postcard which included the link to the online survey.

In total, 386 survey responses were returned (response rate = 19%). Seven incomplete surveys and 33 late responses were discarded. 211 of these responses were by mail while 126 of

the responses were completed online; mail respondents were slightly older, more female, and had weaker personal norms towards native plant gardening. As part of a larger field experiment (Niemiec et al., 2021), participants were exposed to differing messaging conditions one month after the survey was sent out. The one-month delay was intended to measure the link between perceptions and behavioral intentions without the influence of messaging; we discarded survey responses that were received after participants were exposed to messaging. We also removed participants that were missing four or more survey question responses (25% of predictor variables, $n = 9$) to impute missing values more accurately. The final sample included 337 useable surveys. Participants were older, more likely to identify as non-Hispanic and female, more highly educated, and more likely to own their home than the Fort Collins population (see Supplemental Material for detailed description of sample demographics).

Survey Measures and Procedure

The model drew directly from Jones and Niemiec (2020), who examined social-psychological factors influencing wildscaping behaviors in a highly motivated and environmentally active sample of Fort Collins residents (see Supplemental Material for survey questions). We adapted Jones and Niemiec's (2020) measures of efficacy and norms and added measures of subjective knowledge about native plant gardening, attitudes, and personal norms towards individual and diffusion native plant gardening behaviors to test our expanded IMBP (Figure 3; see Supplementary Materials for survey description). We measured previous behavior by asking participants if they had ever planted a plant specifically for wildlife, planted a native plant, and encouraged someone else to plant a native plant and they provided a yes or no response. Subjective knowledge about native plant gardening was measured with a 5-point unipolar scale from "extremely knowledgeable" to "not knowledgeable at all." Subjective

knowledge was the only predictor that did not include individual and diffusion-specific measures (see Supplementary Material).

We measured attitudes towards native plant gardening (i.e., individual behavior) and encouraging others to plant native plants (i.e., diffusion behavior). An attitude can be defined as an individual's degree of favorableness toward a specific behavior (Ajzen & Fishbein, 2000). The attitude measures were adapted from Bright and Manfredo (1996). We also measured self-efficacy, an individual's belief in their ability to perform a task or achieve a goal (Bandura, 1977, 1997), and two types of response efficacy, the belief that an action will achieve the expected outcome (Roser-Renouf et al., 2014). We divided response efficacy into environmental response efficacy, the belief that actions will make a positive impact on the environment (also referred to as "indirect goal collective efficacy; Hamann & Reese, 2020) and social response efficacy, the belief that actions will influence other people to behave similarly (following Jones & Niemiec, 2020). We adapted self-efficacy, environmental response efficacy, and social response efficacy measures from Jones and Niemiec (2020) who adapted them from Geiger et al. (2017) and Lubell et al. (2007). Each type of efficacy included individual and diffusion behavior-specific measures. For example, for individual behavior, environmental response efficacy was measured with the statement, "Planting native plants on my property has a positive influence on native pollinators, birds, and wildlife," and for diffusion, it was measured with the statement, "Convincing other people to plant native plants on their properties will make my own native plants better for wildlife."

We measured individual and diffusion-specific injunctive norms, or the belief that significant others will approve or disapprove of a behavior (Matthies et al., 2012; Niemiec et al., 2018), as well as individual and diffusion-specific descriptive norms (i.e., perceptions of other

people's behavior), adapted from Niemiec et al. (2019). We also measured dynamic norm items (i.e., perceptions of whether the prevalence of a behavior is changing over time), for both individual and diffusion behaviors, following Jones and Niemiec (2020) who adapted these items from Sparkman and Walton (2017). Measures of individual and diffusion-specific personal norms (i.e., a person's perception of their moral obligation to do something) were drawn from norm activation theory (Schwartz, 1977) with items adapted from Kim et al. (2012). Behavioral intentions were measured with a scale ranging from "not likely at all" to "extremely likely" for both the individual behavior of purchasing a native plant, and the diffusion behavior of encouraging someone else to plant a native plant. We measured demographics to assess sample representativeness of the Fort Collins population and to determine whether they influence individual and diffusion behaviors, given that demographics tend to correlate with pro-environmental behavior (Digby, 2013).

Measuring Indicators of Actual Behavior

We obtained indicators of actual behavior from a field experiment Niemiec et al., 2021). Participants were split into four messaging conditions and mailed informational packets about native plant gardening with vouchers to purchase native plants at local nurseries. Each participant received one individual $10 voucher to buy a native plant for their property and three $10 diffusion vouchers to share with friends, neighbors, or family. Diffusion vouchers measured successful diffusion behavior (i.e., someone successfully encouraged someone else to purchase a native plant using the voucher). Each voucher had a unique code, which enabled researchers to partner with local plant nurseries to track voucher use by each participant and their survey responses. The experimental study found few differences in either individual or diffusion voucher use between the different experimental messaging groups. For the present article, we

therefore did not separate voucher usage by message condition when examining voucher use by the survey participants. We used binary metrics of individual and diffusion voucher use as indicators for actual individual and diffusion behavior, respectively.

Data Analysis

To handle missing data, we conducted median and mode imputation using the "imputeMissings" package in R before running LASSO regressions (Meire et al., 2016). We ran a LASSO regression to select predictors to avoid overfitting our models, given we had a relatively large number of predictors (22 total) and medium-sized sample (n = 337; McNeish, 2015; Ranstam & Cook, 2018). We used the "glmnet" package in R to run a LASSO (Least Absolute Shrinkage and Selection Operator) regression and select predictors for both the individual and diffusion intention models (Friedman et al., 2010). To select the lambda value for our LASSO regression we performed a k-fold cross-validation, a widely used method to find the optimal lambda value (Chetverikov et al., 2021). We ran OLS regressions with LASSO-selected predictors to examine the variables that predict individual and diffusion behavior intentions (RQ1). We also ran a complete-case analysis as a sensitivity analysis to validate the imputed regression tables (i.e., determine consistency of regression outputs; see Supplementary Material).

We used the extended IMBP model (i.e., the diffusion-specific and individual-behavior-specific social-psychological variables) plus demographic variables to predict individual and diffusion intentions separately. We included the same variables in each model because we were interested in what individual-specific and diffusion-specific variables differentially predicted individual and diffusion intentions. Checks for multicollinearity indicated that the predictors for each model were not highly correlated ($r < .50$). To determine the relationship between behavioral intentions and indicators of actual behavior (RQ2), we conducted two binary logistic

regressions; the first between individual intention and individual voucher use and the second between diffusion intention and diffusion voucher use. We also ran two binary logistic regressions with LASSO-selected predictors to measure the relationship between behavioral predictors and indicators of behavior directly. In answering our third research question (RQ3) and testing for potential moderators, we ran binary logistic regressions predicting voucher use (binary 0/1) with an interaction between behavioral intention and the hypothesized moderator variable for both individual and diffusion behavior. To check the power of our analyses, we ran post-hoc power analyses for our moderation analyses and calculated minimum detectable effects (MDE) for the coefficients in our LASSO-selected regressions (see Additional Methods in Supplementary Material for further description).

Results

Individual Intention

The median response for intentions to purchase a native plant and encourage others to plant native plants was "moderately likely." LASSO-selected predictors from the extended IMBP and demographics explained 36% of the variance for the individual intention model (Table 1). In order of strength, positive associations with individual intention included homeownership (β = 0.33 p = .02), individual personal norm (β = 0.26, p < .001), individual attitude (β = 0.17, p = .02), and knowledge (β = 0.17, p = .03). Diffusion descriptive norm (β = -0.17, p = .01) and age (β = -0.01, p = .04) were negatively associated with intentions to garden with native plants. Four other variables were associated with individual intention, but not significant at the .05 level: individual self-efficacy (β = 0.15, p = .06), individual descriptive norm (β = 0.12, p = .07), individual social response efficacy (β = 0.11, p = .09), and diffusion injunctive norm (β = 0.10, p

= .10). The individual intention LASSO-selected model had minimum detectable effects (MDE) between 0.17 and 0.50.

Our complete-case OLS sensitivity analysis revealed slightly different results from the imputed analysis, though individual personal norm continued to be a strong predictor of individual intention. Most of the LASSO-selected variables in the imputed model were also found in the complete-case analysis. Individual descriptive norm appears to be a predictor of intention in the complete-case model, and none of the other variables were statistically significant at $p < .05$ (see Supplemental Material).

Table 1. LASSO Coefficients and OLS Regression for Individual Intention

	LASSO	OLS				
		β	*SE*	*p*	95% CI	
Knowledge	0.17	0.17	0.08	**.03**	0.01	0.32
Ind. Self-Efficacy	0.08	0.15	0.08	.06	-0.01	0.30
Diff. Self-Efficacy	0.05	0.09	0.07	.20	-0.05	0.23
Ind. Env. Response Efficacy	0.07	0.06	0.07	.37	-0.07	0.19
Diff. Env. Response Efficacy	0.05	0.05	0.06	.40	-0.07	0.18
Ind. Social Response Efficacy	0.08	0.11	0.06	.09	-0.02	0.24
Ind. Descriptive Norm	0.06	0.12	0.07	.07	-0.01	0.25
Diff. Descriptive Norm	-0.09	-0.17	0.06	**.01**	-0.30	-0.05
Ind. Dynamic Norm	0.02	0.03	0.06	.66	-0.10	0.15
Diff. Injunctive Norm	0.06	0.10	0.06	.10	-0.02	0.22
Ind. Personal Norm	0.17	0.26	0.07	**<.001**	-0.12	-0.40
Ind. Attitude	0.16	0.17	0.07	**.02**	0.03	0.32
Own Home	0.22	0.33	0.14	**.02**	0.05	0.60
Male	-0.11	-0.17	0.12	.15	-0.41	0.06
Age	-0.01	-0.12	0.06	**.04**	-0.24	0.01
Hispanic/Latinx	-0.02	-0.14	0.18	.44	-0.49	0.21
Adjusted R^2				.36		

Note. Ind. = individual, Diff. = diffusion, Env. = environmental, β = standardized coefficient; SE = standard error; CI = confidence interval.

Diffusion Intention

The diffusion intention model (LASSO-selected predictors from extended IMBP and demographics) had a strong goodness-of-fit for behavioral studies (adjusted $R^2 = .64$, see Table 2). The strongest predictors of diffusion intention were diffusion attitude ($\beta = 0.30$, $p < .001$), individual attitude ($\beta = 0.25$, $p < .001$), and diffusion personal norm ($\beta = 0.24$, $p < .001$), followed by knowledge ($\beta = 0.21$, $p < .001$) and diffusion self-efficacy ($\beta = 0.13$, $p = .01$). The diffusion complete-case LASSO sensitivity analysis selected ethnicity and gender and did not select individual personal norm. The complete-case sensitivity analysis resulted in the same predictors for diffusion intention as the imputed model but also included ethnicity ($\beta = -0.41$, $p = .01$) as a significant predictor at the .05 alpha level (see Supplemental Material), though ethnicity had the highest percentage of missingness in our sample (10%). The diffusion intention LASSO-selected regression had MDEs ranging from 0.11 to 0.17.

Table 2. LASSO Coefficients and OLS Regression for Diffusion Intention

	LASSO	OLS				
		β	*SE*	*p*	95% CI	
Knowledge	0.20	0.21	0.05	**<.001**	0.12	0.31
Diff. Self-Efficacy	0.05	0.13	0.05	**.01**	0.03	0.22
Ind. Env. Response Efficacy	0.01	0.05	0.05	.38	-0.05	0.14
Diff. Env. Response Efficacy	0.03	0.07	0.05	.16	-0.03	0.16
Ind. Social Response Efficacy	0.04	0.07	0.05	.12	-0.02	0.17
Diff. Social Response Efficacy	0.04	0.06	0.05	.24	-0.04	0.16
Diff. Dynamic Norm	0.00	0.04	0.04	.33	-0.04	0.13
Ind. Personal Norm	0.01	0.01	0.06	.88	-0.11	0.13
Diff. Personal Norm	0.17	0.24	0.06	**<.001**	0.12	0.37
Ind. Attitude	0.23	0.25	0.05	**<.001**	0.15	0.36
Diff. Attitude	0.24	0.30	0.06	**<.001**	0.19	0.41
Adjusted R^2				.64		

Note. Ind. = individual, Diff. = diffusion, Env. = environmental, β = standardized coefficient; SE = standard error; CI = confidence interval.

Linking Intentions and Predictors to Indicators of Behavior

Of the 337 survey respondents, 40 used an individual voucher to buy a native plant for themselves. There were 28 diffusion vouchers redeemed at participating nurseries. Individual intention significantly predicted use of an individual voucher (Odds Ratio = 1.55, *CI* = 1.16, 2.12, β = 0.44, *SE* = 0.15, p = .004) and diffusion intention significantly predicted diffusion voucher use (Odds Ratio = 1.56, *CI* =1.14, 2.17, β = 0.44, *SE* = 0.16, p = .007). For each increase in level of individual behavioral intention (ex. from "moderately likely" to "very likely), participants were 55% more likely to redeem an individual coupon. For each increase in level of diffusion behavioral intention, diffusion coupons were 56% more likely to be redeemed.

Despite the significant correlation between intentions and indicators of behavior, many people with strong intentions did not use vouchers. Of the 69 participants who said they were "very likely" to buy a native plant, only 15 (22%) redeemed a voucher for themselves. While 35 participants claimed they were "very likely" to share a diffusion voucher, only 8 (23%) of these vouchers were redeemed, though it is possible that more vouchers were shared than were redeemed by recipients (see Supplemental Material). Our logistic regressions with LASSO-selected variables predicting indicators of behavior found that only education predicted individual voucher use (β = 0.43, *SE* = 0.20, p = .03) and only age predicted diffusion voucher use (β = 0.03, *SE* = 0.01, p = .05). MDEs for the individual behavior LASSO-selected binary logistic regression fell between 0.56 and 1.15 and the diffusion behavior LASSO-selected binary logistic regression had MDEs ranging from 0.42 to 1.51.

Moderation Analyses

The moderation analyses revealed that there were no significant interaction effects between hypothesized moderators and individual intention on behavior (i.e., individual coupon use; see Table S6 in Supplemental Material). However, the relationship between diffusion

intention and diffusion coupon use was moderated by diffusion-specific self-efficacy ($\beta = 0.42$, $p = .02$) and subjective knowledge about native plants ($\beta = 0.44$, $p = .03$). Our post-hoc power analyses for the moderation analyses revealed that we had enough power ($1-\beta > .80$) for all the interaction effects except one. When measuring individual self-efficacy as a moderator of the relationship between individual intention and behavior we could detect an interaction effect of 0.13 with 73% power given the observed main effects of the interacting variables.

To enhance interpretability, we split the sample into participants with high levels of diffusion-specific self-efficacy (i.e., those who agreed or strongly agreed that they would be able to have a good discussion about native plant gardening with their community members; $n = 81$) and those with low levels (i.e., those who disagreed or strongly disagreed to the previous statement; $n = 143$). Diffusion intention only significantly predicted successful diffusion (i.e., diffusion voucher use) for the high self-efficacy group (Odds Ratio = 4.04, *CI* =1.57, 14.76, $\beta = 1.40$, $SE = 0.56$, $p = .01$). Similarly, when splitting the sample by high subjective knowledge (i.e., those who claimed to be moderately, very, or extremely knowledgeable; $n = 103$) and low knowledge (i.e., those who said they were only slightly knowledgeable or not knowledgeable at all; $n = 85$), only the high knowledge group had diffusion intention as a significant predictor of diffusion voucher use (Odds Ratio = 3.42, *CI* =1.48, 9.72, $\beta = 1.23$, $SE = 0.47$, $p = .01$). While homeownership predicts individual intention, it does not appear to moderate the relationship between intention and voucher use for either type of behavior.

Discussion

Motivating diffusion pro-environmental behaviors (PEBs) has the potential to enhance the speed and scale of conservation action adoption. Few studies, however, have examined the different drivers of diffusion behavior compared to individual behavior. We examined whether

demographics and social-psychological variables from an expanded version of the IMPB predicted individual and diffusion native plant gardening intentions. We also used indicators of actual behavior from a field experiment to examine the link between intentions and behavior. We found that some individual-level perceptions (i.e., subjective knowledge and attitude toward native plant gardening) predicted both individual and diffusion intentions. However, other predictors were specific to the type of behavior; in particular, diffusion intentions were predicted by diffusion-specific self-efficacy and personal norm beliefs, while individual intentions were predicted by individual-specific personal norm.

These findings suggest that individual behavior-specific perceptions alone are not sufficient for understanding diffusion behavior; rather, diffusion-specific perceptions are important to understand diffusion behaviors. For example, a person who feels confident in their ability to plant native plants does not necessarily feel confident in their ability to encourage others to do so. Unique outreach interventions may therefore be needed to target diffusion-specific personal norms and self-efficacy to promote diffusion intention. Approaches to increase levels of subjective knowledge about the topic may be helpful in motivating diffusion intentions alongside diffusion-specific interventions. Further, our findings regarding the role of personal norms and knowledge in predicting both types of behavior provide evidence for the need to expand the Integrative Model of Behavioral Prediction (IMBP) by adding these variables.

The observed effects in our individual intention LASSO-selected model fell within the effects found in a meta-analysis by Bamberg and Möser (2007). Analyzing studies that predicted pro-environmental behavioral intention, the authors found the overall effects of personal norm (β = 0.29), attitude (β = 0.29), social norm (β = 0.26), and perceived behavioral control (β = 0.31; a concept that grew out of Bandura's work on self-efficacy; Ajzen, 2002). Our diffusion model's

range of MDEs were smaller than the observed effects of these same variables in the literature, though it is important to note that this meta-analysis included studies on individual behavior rather than diffusion behavior. The range in MDEs for our behavior models were above the observed ranges (β = 0.13-0.16) found in Bamberg and Möser (2007) so it is likely we had enough power to detect the expected effect sizes when predicting indicators of behavior.

Our findings partially confirmed the results of a recent meta-analysis that found personal and descriptive norms to be stronger predictors of conservation behavior intentions than subjective/injunctive norms (Niemiec et al., 2020). In the present study, personal norms predicted both individual and diffusion intentions, but subjective/injunctive norms did not. We found that individual-specific descriptive norm was a marginally significant predictor of individual intention, and a significant predictor in the sensitivity analysis, but diffusion-specific descriptive norm negatively predicted individual intentions to purchase a native plant. This finding appears to be counter-normative because participants were more likely to purchase a native plant if they thought other people were not encouraging others to plant native plants.

These findings partially contradict previous literature that has shown a strong positive influence of descriptive norms on conservation behavior (Farrow et al., 2017; Jones & Niemiec, 2020; Kallgren et al., 2000). This result may have been a reflection of our highly engaged audience, with the majority of participants having previous experience with wildlife friendly and native plant gardening. It is possible that this highly motivated audience of people may be more likely to notice that other people are not talking about it as they are more aware of the topic and discussions around it. This trend in our sample may be due, in part, to an increased likelihood of survey participation when the survey's topic is of interest to the participant (Groves et al., 2004). Future research is needed to establish whether this trend holds up in studies with less engaged

audiences, and to understand the directionality of this finding (i.e., whether a reduced perception of diffusion-specific descriptive norm results from high individual engagement or if this perception motivates engagement in the individual behavior).

Diffusion-specific self-efficacy appears to be an important predictor of diffusion intention. In other words, people who feel more confident in their ability to encourage others to plant native plants are more likely to engage in this behavior. Outreach efforts trying to increase diffusion actions may focus on building diffusion-specific self-efficacy by introducing strategies like social modeling, or letting participants observe someone else doing the target behavior (Geiger et al., 2017), providing people with mastery experiences, where they can practice the target behavior (Bandura, 1977, 1997), having participants set proximal goals to reach the target behavior (Bandura & Schunk, 1981), and providing specific information about how to carry out the target behavior (Geiger et al., 2017). For example, if an organization was trying to promote native plant diffusion behavior, they might host a workshop where participants learn easy-to-follow steps of how to reach out to someone, watch someone else model successful native plant diffusion, give them time to practice opening lines and discussions about native plant gardening with someone else, and then set attainable goals to carry out the diffusion in their own lives. Future research could examine the impact of these interventions to enhance diffusion-specific self-efficacy (e.g., Niemiec et al., 2021).

Our results also contribute to theory about the behavioral specificity of social-psychological variables. According to the prior theory on behavioral prediction, such as TRA and TBP, predictors should be behavior-specific (i.e. predictor variables, such as attitudes, should be measured in a way that most relates to the behavior being predicted (Ajzen & Fishbein, 1980; Bamberg, 2003). In our study, this would mean that only individual-behavior

specific social-psychological variables should predict individual behavior, while only diffusion-specific social-psychological variables should predict diffusion behavior. However, we found that while some social-psychological variables appear to be behavior-specific, other variables predict both individual and diffusion behavior intentions. Specifically, we found attitude towards an individual behavior and knowledge about an individual behavior predict both individual and diffusion intentions. Personal norms and self-efficacy, on the other hand, appear to be behavior-specific predictors; that is, individual-specific personal norms (not significant at $p < .05$, but in the expected direction) and self-efficacy predicted individual intention, while diffusion-specific personal norms and self-efficacy predicted diffusion intention. Our results thus challenge the assumption that only behavior-specific predictors should be included in models of diffusion behavior and suggest that future studies on diffusion behavior should expand on traditional behavioral prediction models (TRA, TPB) by including both individual and diffusion-specific predictors.

There were also few demographic variables selected in our LASSO regression in our individual intention model and no demographics selected in our diffusion intention model. Our results align with trends in pro-environmental research demonstrating that demographic factors may not be as effective for predicting behavioral intentions as psychological variables (Li et al., 2019). Future research could continue to focus on social-psychological variables in predicting individual and diffusion behaviors related to native plant gardening, and outreach programs could focus on targeting social-psychological perceptions rather than demographics.

We found significant relationships between intentions and indicators of behavior for both individual and diffusion behaviors. Individual and diffusion intentions predicted behavior ($\beta =$ 0.44 for each) and beta coefficients were in line with the pooled correlation between intention

and behavior found in Bamberg and Möser's meta-analysis of PEB studies (2007). Though intentions predicted behavior, the majority of participants did not act on their intentions. Even when participants indicated strong intentions to engage in individual and diffusion behavior, less than a quarter of them redeemed vouchers or had their shared vouchers redeemed (see Supplemental Material).

In line with the intention-behavior gap, our logistic regressions with LASSO-selected variables predicting indicators of behavior found that none of the significant predictors of intention, significantly predicted the respective behavior. Education level predicted individual voucher use and age predicted diffusion voucher use. Only age predicted the indicator of diffusion behavior even though no demographic variables were selected in the diffusion intention model. That said, the coefficients in these models had relatively large standard errors and confidence intervals, so there is uncertainty in our estimates. Furthermore, demographics cannot be changed, and they are primarily useful for audience segmentation for outreach, so we caution against using demographics as a proxy for more research-supported predictors, such as beliefs and attitudes.

Even with moderate correlations between intention and behavior, our finding that social-psychological variables predict intentions but not behavior suggests that there could be contextual influences that affect the intention-behavior gap. For example, in the case of native plant gardening, context may play a larger role in acting on diffusion intentions because older individuals typically have more time and resources to focus on gardening behaviors. To encourage behavior, rather than just intention, outreach organizations might focus on specific contextual influences that hinder individuals from acting on their plans, such as specifically removing barriers for younger folks who may lack time and resources.

While social-psychological perceptions did not predict behavior, this could be, in part, due to the imperfect measurement of the behavior indicator. The current study design limited our ability to directly compare individual and diffusion behavior because the vouchers were an indicator of successful diffusion rather than diffusion attempt (i.e., sharing a coupon). It is possible that participants gave away vouchers, but their recipients did not choose to redeem them, or that recipients planted native plants without using a voucher. Future studies could more accurately compare these behaviors by measuring diffusion attempt directly. This could be done through self-report measures, participant observation, or tracking participant diffusion attempts through software that can send messages or coupons to select individuals.

According to our moderation analysis, diffusion self-efficacy and subjective knowledge about native plants moderated the relationship between diffusion intention and the indicator of diffusion behavior (i.e., diffusion coupon use). This finding reveals that participants with a higher sense of self-efficacy, or belief that they can reach out to others about native plants, and participants who feel they have more knowledge about native plants, were more likely to follow through on their diffusion intention and influence someone else to use the coupon they shared. Building on Geiger et al. (2017), diffusion-specific self-efficacy beliefs appear to be very important for engaging in diffusion behavior because it is both a predictor of diffusion intention and moderates the relationship between intention and behavior. Furthermore, this finding supports initial evidence that efficacy-based messages increased willingness to engage in native plant gardening diffusion behaviors (Niemiec et al., 2021). This provides further support for outreach efforts to increase diffusion behaviors to focus on building diffusion-specific self-efficacy, rather than building self-efficacy around the individual behavior they are trying to diffuse through social networks. Future studies could also use qualitative methods or social-

ecological systems approaches (see Jones et al., 2021; Lischka et al., 2018) to measure the barriers that affect people's actual individual and diffusion PEB.

It is important to consider that this sample was specifically designed to target Fort Collins residents living in single-family homes, so results may differ in other cultural and geographic contexts. Our results may be influenced by United States and Western cultural norms surrounding landscaping and residential land management decisions such as social pressures to maintain a well-manicured lawn (Larson et al., 2017; Robbins, 2007), as well as ideals of individualism and concerns about privacy and private property in the United States. The dry climate of Colorado, and drought conditions in surrounding states across the western US (National Drought Mitigation Center et al., 2021), may also motivate people in Fort Collins, Colorado to take more interest in native plant gardening for its water conservation benefits than people in the Eastern United States or in regions where drought is not as relevant.

Our results might also vary across different contexts due to yard size. United States lot sizes tend to be larger than in other countries (Hirt, 2015) so the property characteristics of our sample may not represent those in different regions of the world. In general, lot size may affect diffusion behaviors like planting native plants in the front yard and putting up informational signs because too large or small of a yard can affect visibility of such actions and therefore have less normative impact on other people. Furthermore, as lot size is correlated with socio-economic status, race, and ethnicity in the United States, individual and diffusion native plant gardening behaviors may be more attainable or socially acceptable in specific neighborhoods.

Future studies could explore whether these results differ in other regions, especially in more collectivistic societies, where individualistic ideals tend to be weaker. In the United States, due to deep-rooted individualistic values, personal norms and self-efficacy around diffusion may

provide a larger barrier to diffusion behavior. For example, a recent meta-analysis found that personal norms may more strongly influence behavioral intentions in individualistic countries (Morren & Grinstein, 2021). Furthermore, there may be other barriers to native plant gardening and diffusion in other regions that we did not measure in our survey.

Further research is needed on whether our results apply to different types of gardening. For example, it is possible that different characteristics of native plant gardening are more salient than characteristics of vegetable gardening. Self-efficacy may be more important for predicting native plant gardening behaviors than vegetable gardening because vegetable gardening is more common and socially accepted in the United States, so people may feel more confident in their ability to access resources to plant vegetables. Vegetable gardening also does not have the same ultimate goal of biodiversity or water conservation. People may be less focused on influencing others to grow vegetables because vegetable gardening often has a more individual goal of feeding the household, whereas native plant gardening tries to address a collective goal that requires people to work together.

While we sent our survey out to a random sample of homeowners, respondents were more highly educated and female than the general Fort Collins population. Our sample distribution may be affected by a general trend identified in prior studies that women and more highly-educated individuals are more likely to participate in pro-environmental behaviors and thus may be more likely to take a survey about these behaviors (Digby, 2013). Additionally, prior studies examining gardening behaviors often end up with samples biased towards female participants (Clayton, 2007; Kiesling & Manning, 2010), and there is some evidence that women are participating in sustainable gardening behaviors more than men (Zypchyn, 2012). A recent survey found that while Vermont residents reported increased gardening activities during the first

couple months of the COVID-19 pandemic, the odds of reporting gardening behaviors were higher for female participants (Morse et al., 2020). There is also a possibility that our sample is biased towards renters who have more control over their home, for example, those who are allowed to make changes to outdoor spaces may be more likely to respond to a survey on native plant gardening.

Conclusion

Being able to effectively influence adoption and dissemination of PEB is critical for addressing large-scale and urgent environmental issues such as biodiversity loss (Amel et al., 2017; Nilsson et al., 2020; White et al., 2019). Our study adds more evidence to the relatively new body of research showing that a range of social-psychological variables predict individual and diffusion intentions in the case of native plant gardening. Subjective knowledge about native plant gardening and individual-specific attitude predicted both individual and diffusion intentions. Behavior-specific self-efficacy and personal norm appear to be important predictors of diffusion intention. Despite previous evidence, most of the social norms we measured did not significantly predict native plant gardening or diffusion intentions. We also found that while individual and diffusion behavioral intentions significantly predicted indicators of individual and diffusion behaviors respectively, indicators of behavior were not predicted directly by the social-psychological variables that predicted behavioral intentions, demonstrating evidence of the intention-behavior gap. Additionally, diffusion self-efficacy and subjective knowledge moderate the diffusion intention-behavior relationship. Our results highlight the utility of applying an expanded IMBP to gain a more in depth understanding of diffusion behaviors. They suggest that in addition to enhancing the public's knowledge of and fostering positive attitudes towards conservation behavior, targeting diffusion-specific personal norms and self-efficacy may be

critical for practitioners promoting diffusion to achieve more widespread biodiversity conservation and environmental stewardship.

Chapter 2: Encouraging Social Diffusion of Pro-Environmental Behavior through Online Workshop-based Interventions

Chapter Summary

Motivating people to take environmentally friendly action, especially collective actions that promote greater social engagement, is important for addressing environmental issues like biodiversity loss. We conducted an online workshop-based field experiment to target social-psychological perceptions to motivate people to plant native plants and encourage others to do the same. To shift these perceptions, we added microinterventions to half the workshops, including normative messaging, public commitment-making, and providing feedback on the impact of reaching out to others. We used a voucher system to track real-world behavior by partnering with native plant nurseries. Compared to an information-only control workshop, our intervention workshops initially increased certain social-psychological perceptions related to encouraging others to plant native plants. However, they did not change behaviors, or many perceptions, compared to control workshops. Additional exploratory analyses revealed differing patterns of behavioral perceptions two months after the workshops. Further research is needed that implements experimental methods and real-world measures of conservation behavior to evaluate the impacts of theory-based outreach tactics on collective actions.

Promoting voluntary, pro-environmental behavior (PEB) change is critical for reducing environmental degradation and biodiversity loss (Byerly et al., 2018; Schultz, 2011). Most PEB change studies have focused on understanding and motivating individual, personal-sphere behaviors that can be done without interacting with other people (Farrow et al., 2017; Niemiec et al., 2020). However, recent literature highlights the importance of collective actions that facilitate changes in the broader networks, organizations, and societies in which people are embedded (Amel et al., 2017; Milfont et al., 2020). Such actions can strengthen conservation movements by facilitating the coordinated action necessary to address many environmental problems (Niemiec et al., 2020).

As discussed in Champine et al. (2022) and Jones and Niemiec (2020), one type of collective action that can facilitate more rapid social change for conservation causes is "diffusion behavior," or behavior that spreads information and applies social pressure through social networks. Diffusion behaviors may range from more passive forms, such as putting up a yard sign about a cause, to more active forms, such as sharing information and asking others to engage in a behavior (see Berl et al., 2022; Geiger et al., 2017; Jones & Niemiec, 2020; Niemiec et al., 2021; Niemiec et al., 2016; Sarrouf Willson et al., 2021; Segar et al., 2022 as examples). The term "diffusion behavior" derives from the theory of social diffusion, which suggests that people are more likely to change their behavior if influenced by a friend, family member, or others in their social network (Rogers, 2003).

Studies suggest that motivating individuals to engage in diffusion behavior can be a highly effective strategy for encouraging more widespread behavior change (Abrahamse & Steg, 2013; Burn, 1991; Hopper & Nielsen, 1991). As discussed in Niemiec et al. (2021) and Champine et al. (2022), a meta-analysis by Abrahamse and Steg (2013) found that diffusion

behavior (i.e., “the block leader approach”) was the most effective social influence technique at promoting large-scale behavior change. Motivating diffusion behavior may be particularly effective because it enables information to spread from an individual to others in their social network who might not otherwise seek out this information, reaching a wider audience than those who are already invested in the target PEB (Abrahamse & Steg, 2013; Burn, 1991; Mbaru & Barnes, 2017; Niemiec et al., 2016). Further, diffusion behaviors may help create new norms because as people are actively encouraged by friends to act in a certain way, they may begin to see this behavior as normal (Sparkman & Walton, 2019).

While a large body of research has focused on the impact of social diffusion, few studies have examined how to encourage people to engage in behaviors that facilitate this diffusion (see Geiger et al., 2017; Niemiec et al., 2021; Berl et al. 2022 for counterexamples). Examining barriers and motivations to diffusion behavior is particularly important because studies show that people who are engaging in a PEB in their own life can be reluctant to reach out to others about the behavior (Amel et al., 2017; Roser-Renouf et al., 2014). For example, Niemiec et al. (2019) found that residents who remove invasive species in their own yard often do not encourage their neighbors to do the same due to a fear of social sanctions. Furthermore, even with the importance of diffusion behavior for climate issues and relevant concerns, less than half of Americans (39%) regularly discuss global warming with others (Leiserowitz, et al., 2021a). This suggests that there may be unique barriers influencing diffusion behavior compared to personal-sphere behaviors.

There is preliminary evidence that diffusion-specific efficacy and normative beliefs are important for motivating diffusion behavior (Amel et al., 2017; Geiger & Swim, 2016; Jones & Niemiec, 2020; Niemiec et al., 2016). Self-efficacy refers to an individual’s belief in their ability to achieve a goal or behave in a certain way, while response efficacy is the belief that one’s

actions will create the intended response for the overall goal (Bandura, 1977, 1997; Hamann & Reese, 2020; Roser-Renouf et al., 2014). Educational interventions that described what to say to others effectively promoted engagement in public discussion about climate change by boosting participants' perceptions of self-efficacy (Geiger et al., 2017). Niemiec et al. (2021) found in a field experiment that efficacy messages were effective at motivating native plant diffusion behavior among a sub-sample of participants who were concerned about being perceived as competent. Choi and Hart (2021) also found that response efficacy (called personal outcome expectancy) was positively associated with climate change policy support, and Feldman and Hart (2016) found that efficacy messages increased climate change political participation because they generated hope. Perceptions of self-efficacy and response efficacy may therefore play a key role in encouraging diffusion behavior.

Social norms, the unwritten rules that determine what is considered acceptable in a social group or culture, have been widely studied in the behavior-change literature with studies demonstrating effective social norm interventions for behaviors like recycling, water conservation, and more (Abrahamse & Steg, 2013; Cialdini et al., 1990; Goldstein et al., 2008; Han & Hyun, 2018; Nolan et al., 2008). Injunctive norms are a person's perceptions of how they should behave and descriptive norms are perceptions of how other people are behaving (Cialdini et al., 1990). Recent studies have found that social norms may be particularly important for motivating more collective actions. For example, Howell et al. (2015) found a relationship between normative social pressure and intentions to engage in outreach about aquatic invasive species issues. Furthermore, Niemiec et al. (2019) found that interventions to enhance perceptions of descriptive and injunctive norms, such as facilitating communication between neighbors, collective goal setting, and public commitment-making increased neighbors'

recruitment and coordination behavior. Given this initial evidence, descriptive and injunctive norms may be particularly important for diffusion behavior.

When designing interventions to change behavior via enhanced perceptions of efficacy and social norms, research suggests that face-to-face communication and hands-on activities are most effective (Abrahamse & Steg, 2013; Bandura, 1977). Face-to-face interventions include strategies like public commitment-making and social modeling where participants interact with others instead of working individually. Hands-on activities, like creating mastery experiences, allow participants to practice an action rather than listening to a description of it. Less is known about the extent to which online interventions can effectively facilitate hands-on activities and peer-to-peer communication to achieve PEB change. In an education setting, it has been found that synchronous online learning environments (i.e., webinars or online workshops) increase participant knowledge more effectively than in-person or asynchronous online learning environments (Ebner & Gegenfurtner, 2019), though effects on behavior change remain unclear. Here, we seek to build on this literature by examining the effectiveness of a face-to-face normative and efficacy building intervention, delivered via online interactive workshops, at encouraging diffusion behavior.

In the present study, we conducted a field experiment to compare a traditional information-transfer online workshop with one that includes efficacy and norms-based interventions designed to motivate social diffusion for, as well as personal engagement in, conservation behavior. To build participants' efficacy regarding diffusion and personal behavior, intervention workshops applied research-based strategies, including *social modeling* (Bandura, 1971; Geiger et al., 2017*)*, *mastery experiences* (Bandura, 1977, 1997)*, social persuasion* (Bandura, 1988), and *proximal goal setting* (Bandura & Schunk, 1981; Bandura & Simon, 1977).

We also *provided feedback* on the positive ecological and social impacts of personal and diffusion behavior (Geiger et al., 2017). To build new social norms among a group of workshop participants, and change perceptions of broader regional social norms around native plant gardening and diffusion, intervention workshops *shared information* about regional and workshop-level social norms (Kidd et al., 2019; Sparkman & Walton, 2017), *prompted participants to compare themselves to the group* (Bartke et al., 2017; Festinger, 1954), had participants *make public commitments* (Jaeger & Schultz, 2017), and explicitly *addressed participants' reputational concerns* (Jones & Niemiec, 2020). See Table 1 for definitions and examples of interventions and see Supporting Information for full descriptions.

Our study is designed to address two critical gaps in the diffusion behavior existing literature: first, it integrates face-to-face efficacy and normative building components to evaluate beliefs that have been associated with diffusion behavior in correlational studies but have not been tested experimentally. As such, we address a recent call for more experimental studies testing theory-based interventions for behavior change for biodiversity conservation (Kidd et al., 2019). This experimental trial also tests a theory-based intervention for behavior change using real world measures. Self-report measures and behavioral intentions do not always correlate with real world behavior (Bamberg & Möser, 2007; Milfont, 2009), so this study explores the effects of an intervention on indicators of actual behavior.

Second, while previous studies on diffusion behavior have typically tested interventions designed to influence one or two perceptual variables at a time, our study tests whether a combination of different normative and efficacy-building microinterventions influence a broad range of diffusion-specific normative and efficacy beliefs, and whether these or other beliefs

alter diffusion behavior and behavioral intentions. This enables us to contribute to a more comprehensive understanding of the diverse perceptions that may influence diffusion behavior.

Case Study

We focus on the case study of diffusion behavior to promote native plant gardening. The growth of cities and urban sprawl has led to the expansion of "novel ecosystems" where actions like wildlife-friendly gardening are becoming available to a larger number of people (Klaus & Kiehl, 2021). Native plant gardening, a component of wildlife-friendly gardening, can support species biodiversity in urbanized spaces (Berthon et al., 2021; Burghardt et al., 2009; Fukase, 2016; Lerman & Warren, 2011). Many native insect species can only survive with plants that they co-evolved with and native plants host more diverse larval populations for native bird diets, so creating a network of habitat in urban areas can support native species survival (Burghardt et al., 2009). Yards that have replaced turfgrass with native plants help to conserve water use and tend to use fewer environmentally-harmful chemicals (Carrico et al., 2013; Milesi et al., 2005; Robbins, 2007; Vickers, 2006). Furthermore, native plant gardening can promote time spent in nature and increase wildlife encounters that are beneficial for physical and mental health (Aerts et al., 2018; Bell et al., 2018; Goddard et al., 2013). By studying diffusion behavior for native plant gardening we can deepen our understanding of how urban biodiversity conservation actions can spread through social networks and contribute to cities as hotspots for biodiversity stewardship and better human wellbeing (Mumaw & Raymond, 2021).

Hypotheses and Objectives

For our primary hypothesis, we posited that compared to the control, the treatment workshop that includes efficacy and norm building interventions would increase diffusion behavioral intentions in the days immediately after the workshop and two months later, and self-

reported diffusion behavior two months after the workshop. In our secondary hypothesis, we theorized that the efficacy and norms workshop intervention would enhance perceptions of diffusion-specific self and response efficacy, and injunctive, descriptive, and dynamic norms, compared to the control workshop. As an exploratory hypothesis, we posited that compared to the control, the treatment workshop would increase real-life diffusion behavior indicators, as measured by a voucher-sharing system. This hypothesis was considered exploratory because our indicator of diffusion behavior measured successful diffusion (i.e., having someone else redeem a participant's voucher) rather than diffusion attempt (i.e., sharing the voucher).

In addition, we examined the research question: Compared to the control, to what extent does the efficacy and norms intervention workshop increase personal-sphere behavioral intention and self-reported personal-sphere behavior (i.e., native plant gardening behavior)? This question built on previous studies that have used social influence and efficacy-based interventions to motivate personal-sphere PEB (see Goldstein et al., 2008; Hamann & Reese, 2020; Niemiec et al., 2019; Sparkman & Walton, 2017). Our hypotheses were pre-registered in an analysis plan posted to Open Science Framework (OSF) prior to the experiment (https://osf.io/zgaqf/).

Methods

Participant Recruitment

This field experiment was incorporated into a native plant outreach program that Colorado State University researchers launched in collaboration with Audubon Rockies. The study was conducted under Colorado State University IRB #19–8879H. We administered our experiment to 1,072 people in Colorado, U.S.A and surrounding states, via 12 online workshops. This took place March-May 2021, and each workshop had a maximum of up to 200 spots. Based on attendance rates from previous similar Audubon Rockies online workshops, we expected

~50% of registrants would attend. In total, 1,918 people registered, and 1,072 attended (a 56% attendance rate). Between 60 and 111 people attended each workshop with a total of 506 participants in control workshops and 566 in treatment workshops.

Audubon Rockies helped with workshop facilitation and marketing. To recruit participants, we also distributed information through Colorado-based organizations promoting native plant gardening and related groups on Facebook (e.g., Colorado Native Plant Gardening, Colorado Organic Gardening, Colorado Field Ornithologists). As such, participants were likely to be a "highly engaged" audience because they had demonstrated a previous interest in gardening, native plant gardening, xeriscaping, urban pollinators, bird conservation, or other related topics. We targeted a highly engaged audience because the aim of our study was to encourage those engaging in personal-sphere behavior to also participate in diffusion behavior. All workshops were advertised using the same language to ensure there was no bias in participants' selection of workshops (see Supplementary Materials for advertising flyer).

Measures

Participants were asked to complete a pre-survey and two post-surveys. Upon workshop registration, participants took the first half of the pre-survey, answering questions about pre-workshop behaviors, attitudes, behavioral intentions, and demographics. Participants filled out the second half of the pre-survey as the first activity in the beginning of the workshop, which included questions about personal-sphere and diffusion-specific efficacy and norms perceptions. The pre-survey was split into two halves to minimize the time spent to register for the workshop, thus removing a barrier to participate in the study. The first post-survey was sent out via email one day after the workshop and the second post-survey was sent to participants via email two months after the workshop. Post-surveys measured norm and efficacy perceptions specific to

personal-sphere and diffusion behavior, attitudes, behavioral intentions in the same way as the pre-survey, and the second post-survey measured self-reported personal-sphere and diffusion behavior (see Supplemental Materials for a description of measured variables).

Survey Measures

Besides subjective knowledge about native plants, we included distinct personal-sphere and diffusion-specific measures of each social-psychological variable. Personal sphere-specific variables focused on the individual action of native plant gardening, or using a native plant voucher for oneself, while diffusion-specific measures focused on the diffusion behavior of encouraging others to plant native plants, or sharing a native plant voucher with someone else. Behavior-specific intentions were measured with a 5-point scale asking participants their likelihood of engaging in the target behavior in the next year and self-reported behavior was measured by asking participants to share how many native plant vouchers they had used or shared.

We measured three types of social norms: injunctive norms, descriptive norms, and dynamic norms. Injunctive and descriptive norm measures were adapted from Niemiec et al. (2019) and dynamic norms were adapted from Sparkman and Walton (2017). We also measured self-efficacy and two types of response efficacy: social and environmental. Social response efficacy is a person's belief in their ability to make an intended social impact because of their behavior, such as successfully influencing someone to behave a certain way or inspiring others with one's action (similar to indirect goal efficacy; Hamann & Reese, 2020; Jones & Niemiec, 2020) Environmental response efficacy is the belief in one's ability to create the intended environmental impact, such as increasing biodiversity (similar to direct goal efficacy; Hamann & Reese, 2020). Efficacy measures followed Champine et al., (2022) and Jones and Niemiec

(2020) who adapted them from Geiger et al. (2017) and Lubell et al. (2007). We adapted attitude measures from Bright and Manfredo (1996) and personal norms measures from Kim et al. (2012). Subjective knowledge about native plants was measured with a 5-point scale and previous personal-sphere and diffusion behavior used binary (i.e., yes/no) responses.

Real-World Measures

After completing the post-survey, participants received one personal voucher code they could redeem at a partnering nursery to receive $10 off a native plant purchase, and three diffusion voucher codes to share with others to receive the same discount. Vouchers acted as an incentive to participate in surveys and workshop activities, but also served as indicators of personal-sphere and diffusion native plant gardening behaviors (i.e., secondary, exploratory outcomes in our analysis). Upon completion of the second post-survey, participants who completed the first post-survey received an additional $10 personal-sphere voucher. Those who participated at this stage but had not completed the first post-survey received their original personal-sphere and diffusion voucher codes. Vouchers were collected through our partnering nurseries, High Country Gardens (an online nursery that shipped plants within the contiguous United States) and High Plains Environmental Center (a nursery located in the "Front Range" of Colorado that provided plant pickup at no added cost).

Study Outcomes

Our initial a priori power analyses accounted for approximately 250 participants across five original workshops in each experimental condition and calculated power to detect a .35 scale point difference in continuous primary outcomes between workshops (i.e., diffusion intentions and self-reported behavior), assuming a standard deviation of 1 (which is the standard deviation of these behaviors in prior surveys; Jones & Niemiec, 2020). Once we ran the study, our analyses

were based on over 500 participants across six workshops in each experimental condition. While our study design likely enabled sufficient power to detect small differences in continuous outcomes such as behavioral intentions, we were underpowered to detect small differences in binary outcomes such as voucher usage. A priori power analyses for binary secondary outcomes (e.g., any diffusion voucher usage or not, any personal-sphere usage or not), revealed we could detect a 10% difference in usage rate between conditions (e.g., assuming a 10% voucher usage rate in the control, we could detect a 20% voucher usage rate in the intervention). Given this, our real-world indicators of behavior served as secondary, exploratory outcomes in this study.

Workshop Design

The twelve workshops were randomly assigned to two different conditions: control (information only) and intervention (efficacy and norms treatment). We matched workshops held on weekday lunchtimes and on weekend mornings into pairs; within each match, we randomly assigned the workshop to receive the control or intervention treatment. All workshops lasted 90 minutes and followed the same general outline: (1) welcome, introductions, study overview and workshop roadmap, (2) information about native plant gardening (3) information about native plant outreach, (4) breakout group discussions with focused prompts, and (5) wrapping up and next steps. The control workshops focused on a greater variety of possible actions people can take and gave greater detail about native plants, birds, and pollinators while the intervention workshops incorporated theoretically derived activities and messages designed to boost participants' efficacy and norms perceptions. For more information about matching and assignment of treatment and workshop design see Supporting Information. See Table 3 below for a definition and examples of each microintervention and Supporting Information for full descriptions of microinterventions in the intervention workshop.

Table 3. Definitions and examples of theoretically derived microinterventions being integrated into the intervention workshops

Construct	Intervention	Definition	Example
Self-efficacy	Social modeling (Geiger et al., 2017)	Individuals demonstrating or verbalizing how a behavior can be accomplished to other similar individuals.	Describe a case study of a particular Wildscape Ambassador and how they encouraged others in their community to plant native plants, as part of a bigger movement of many Wildscape Ambassadors engaging in this diffusion.
	Mastery experiences (Bandura, 1977, 1997)	Providing an individual the experience of successfully accomplishing a behavior.	Provide participants a chance to practice encouraging others to plant with native plants in a small group of workshop participants.
	Proximal goal setting (Bandura & Schunk, 1981)	Setting near-term goals to make behaviors seem more manageable and less overwhelming.	Prompt participants to set near-term goals surrounding native plant gardening and diffusion behaviors.
	Social persuasion (Bandura, 1988)	Expressing confidence in a person's ability to engage in a behavior successfully to build self-efficacy.	Use efficacy-building language and activities such as, "You already have a lot of the experience to do this" and, "This workshop will provide you all the additional training you need to be confident in reaching out to more people about native plant gardening and adding more native plants to your own yard."
	Knowledge-based interventions (Geiger et al., 2017)	Sharing specific information about exactly how to accomplish target behaviors.	Share step-by-step instructions on how to talk to others about native plant gardening and share diffusion vouchers.
Social response efficacy	Providing feedback on social impacts (Witte & Allen, 2000)	Providing feedback about the positive social impact of target behaviors.	Share stories of how others have succeeded in motivating others to garden with native plants, and how that in turn led to additional benefits to wildlife in other yards. Use language such as, "Simply by planting native plant gardens in your front yard, you can get other people excited about native plant gardening."
Environmental response efficacy	Providing feedback on ecological impacts (Geiger et al., 2017)	Providing feedback about the positive environmental impact of target behaviors.	Share stories of the tangible impacts to wildlife from gardening efforts of past Habitat Hero participants. Use language such as, "When you encourage your friends and neighbors, you are multiplying the benefit to birds, pollinators, and wildlife in your neighborhood."
Dynamic norms	Normative statistics and messaging (Kidd et al., 2019; Sparkman & Walton, 2017)	Sharing statistics and statements about the growing number of people participating in the target behaviors.	Share regional-level norms gathered from studies (Jones & Niemiec, 2020; Niemiec et al., 2021; Champine et al., 2022), and local, group-level norms gathered from workshop participants directly in the pre-survey and in live, interactive polls whose results were shared

			back with the group. Augment these statistics with messages such as, "You will be joining a growing movement in Colorado and more broadly of residents, businesses, and community leaders who are helping others create more native habitat in residential and urban areas."
Descriptive norms	Normative statistics and messaging (Kidd et al., 2019; Sparkman & Walton, 2017)	Sharing statistics and statements about the popularity of the target behaviors and how many others are participating.	Share regional-level norms gathered from studies (Jones & Niemiec, 2020; Niemiec et al., 2021; Champine et al., 2022), and local, group-level norms gathered from workshop participants directly in the pre-survey and in live, interactive polls whose results were shared back with the group. Augment these statistics with messages such as, "You are not alone – there is a whole movement of people across Colorado involved in native plant gardening."
	Public commitment-making (Niemiec et al., 2019)	Sharing a pledge to carry out an action in a public setting to create social pressure to follow through on that action.	Prompt participants to share one of their proximal goals in the form of a public commitment in the group chat for the rest of the group to see.
Injunctive norms	Addressing reputational concerns (Jones & Niemiec, 2020)	Assuring individuals that their behavior will be met with approval rather than disapproval.	Directly address reputation concerns in discussions by explaining that people are often more enthusiastic to engage in these discussions about native plant gardening than one might assume, as evidenced by the descriptive and dynamic normative statistics described above.
	Addressing pluralistic ignorance (Geiger & Swim, 2016)	Correcting the belief that one's private attitudes and judgements are different from those of others.	Explain to participants what pluralistic ignorance is and how it can lead people to "self-silence" even in situations when both they and their audience share an interest or belief.
	Facilitating group communication and expectation setting (Niemiec et al., 2019)	Creating a sense of community within a group by establishing shared interests and goals and providing opportunities to socialize.	Facilitate group communication and expectation setting to build participants' sense that there is a supportive community around them who will help them continue to gain necessary skills, and who will approve of the shared goal of expanding native plant gardening.

Analyses for Primary Outcomes

A pre-analysis plan for this study was pre-registered on OSF (https://osf.io/zgaqf/). To assess the impact of the intervention on our primary outcomes, we ran adjusted and unadjusted linear regressions with post-workshop diffusion intentions (measured in the days immediately

after the workshop and two months after the workshop) and self-reported diffusion behavior (measured two months after the workshop) as outcome variables. The intervention was entered in as a binary 0/1 variable, with the control condition as the baseline. We removed rows that had missing data for more than 15 measures, taking out participants who had not completed the second half of the pre-workshop survey (n = 478, i.e., 15 perceptual measures of norms and efficacy or 22% missingness) leaving 594 useable responses (see Figure 4). Of the remaining data there were only a few cases missing observations, so we used complete-case analysis to remove fewer than ten observations per regression analysis.

To avoid overfitting the models, we checked to make sure we had at least 20 observations per variable. We also pre-screened potential covariates with the washb package in R (Mertens & Arnold, 2018) using a bivariate likelihood ratio test with the outcome. If the p-value was less than 0.20, the covariate was included in the adjusted model. After pre-screening, adjusted regressions included a combination of pre-workshop perceptual variables, previous behavior, behavioral intention, and demographics, depending on the results of the likelihood ratio tests. Unadjusted analyses used pre-workshop diffusion intention and the binary intervention variable to predict post-workshop diffusion intention and self-reported behavior. See Supplemental Materials (Table S1) for a list of outcomes measured and covariates. We also conducted multiple-imputed ordinal logistic regressions as a sensitivity analysis, given that our primary outcomes were measured as 5-point scales. Multiple imputation is a technique to handle missing data that can preserve statistical power and maintain validity (McCleary, 2002). We used multiple-imputed data for our sensitivity analysis to compare to our complete-case results because we were unable to prescreen multiple-imputed data in the adjusted regressions.

Secondary and Exploratory Analyses

We conducted secondary analyses of the impact of the intervention on perceptions of social norms and efficacy, self-reported personal-sphere behavior, and intentions to engage in personal-sphere behavior using the same procedures described above for the primary outcomes. As an exploratory analysis, we examined the impact of the intervention on voucher usage. To assess the impact of the interventions on participants' personal-sphere and diffusion voucher usage, we conducted two binary logistic regressions with the binary outcome variable of voucher use versus no voucher use. For perceptual measures that were significantly predicted by treatment group directly after the workshop, or increased significantly regardless of workshop, we explored whether any changes remained two months after the workshop using mean comparison.

We had originally planned to run a Poisson regression with the outcome variable of number of diffusion vouchers used but few participants *(n* = 30) had more than one voucher used that they had shared. We also originally intended to explore whether perceptions (i.e., various norms and types of efficacy) mediated the relationship between workshop intervention and behavioral intentions and self-reported behavior or if personal norms moderated workshop effectiveness, but given that relationships between intervention and intentions and behavior were not significant (see below), mediation or moderation was not possible. Data are also available on OSF.

Results

Description of the Sample

Of the workshop registrants (*n* = 1,918) there were two groups: attendees, who participated in the online workshop, and non-attendees, who signed up but did not participate. We compared these two groups to explore bias in participants who were lost to follow up.

Attendees (n = 1,072) were older, more likely to own a home, identify as non-Hispanic/Latinx and female, and more likely to be more highly educated than non-attendees and Colorado residents in general (U.S. Census Bureau, 2020; see Supplemental Materials for additional findings from loss to follow up analysis). Demographics between attendees and participants who completed both pre- and post-workshop surveys were not significantly different (see Figure 4 for demographics of samples and loss to follow-up numbers).

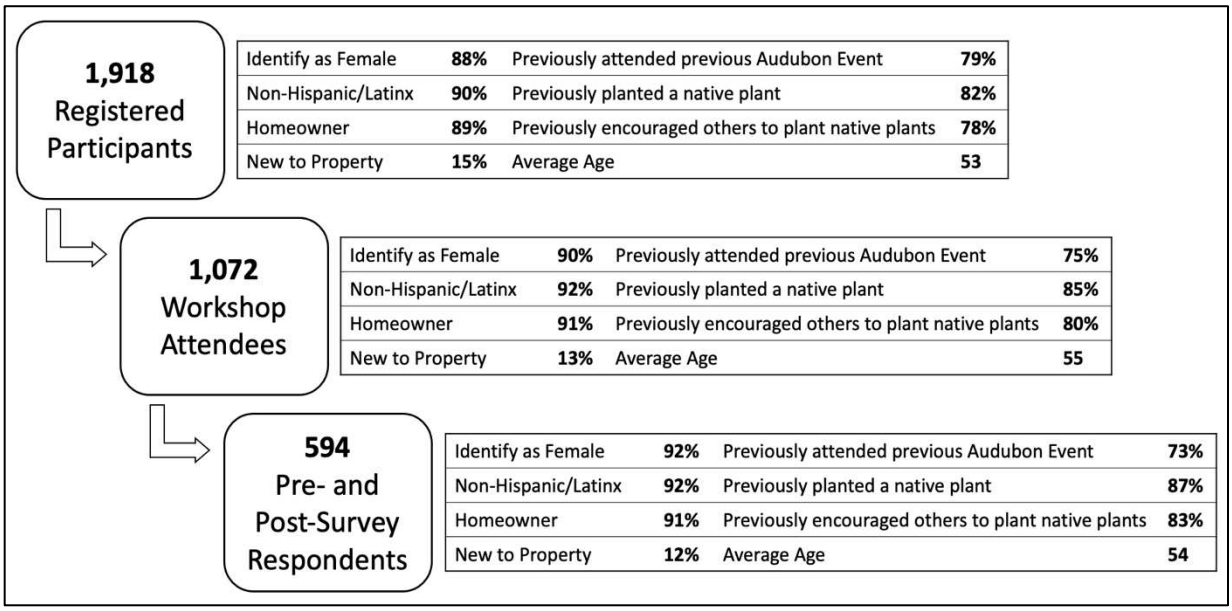

Figure 4. Loss to Follow Up

Note. This figure demonstrates the demographic characteristics of registrants, attendees, and survey respondents at each phase of the study.

Primary Outcomes

Overall, there were no significant differences in primary outcomes between the control and treatment groups. Both unadjusted and adjusted regressions demonstrated that treatment group was not a significant predictor of diffusion behavioral intention directly after the workshop (B = 0.03, SE = 0.07, p = .68, 95% CI [-0.11, 0.16]) or two months later (B = -0.01, SE 0.08, p =

.92, 95% CI [-0.17, 0.15]; see Figure 5). Treatment group was also not a significant predictor of self-reported voucher sharing two months after the workshop (*B* = -0.07, SE = 0.23, *p* = .74, 95% CI [-0.52, 0.37], see Supplemental Materials for full adjusted regression tables).

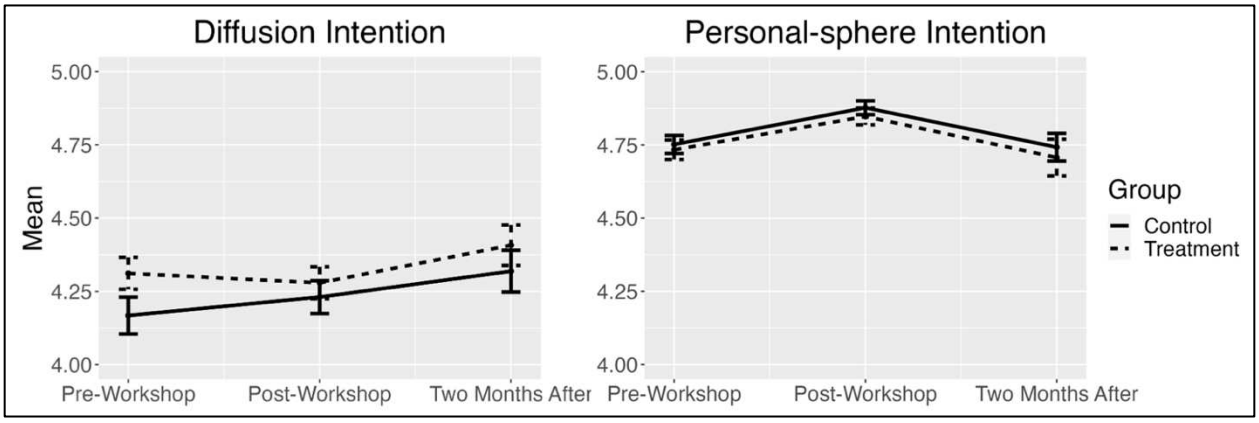

Figure 5. Means of Participants' Diffusion and Personal-sphere Behavioral Intentions Over Three Phases of the Study

Secondary Outcomes

Treatment group did not significantly predict personal-sphere behavioral intention (*B* = -0.04, SE = 0.04, *p* = .29, 95% CI [-0.11, 0.04], see Supporting Information for full adjusted regression table). Among the perceptual secondary outcomes, treatment group significantly affected initial diffusion-specific post-workshop descriptive norm (*B* = 0.21, *SE* = 0.10, *p* = .04, 95% CI [0.01, 0.42]) and social response efficacy (*B* = 0.13, *SE* = 0.07, *p* = .04, 95% CI [0.01, 0.26]) when controlling for respective pre-workshop perceptions. Specifically, participants who received the treatment group microinterventions were more likely than the control group to believe that most people in their community encouraged others to plant native plants (i.e., descriptive norm), and that their native plant diffusion actions would inspire others (i.e., social response efficacy).

Our sensitivity analyses (multiple-imputed regressions that controlled for pre-workshop perceptions), also revealed significant effects of treatment group for diffusion-specific sanctioning injunctive norm ($B = 0.23$, $p = .01$), environmental response efficacy ($B = 0.13$, $p = .06$), and supportive injunctive norm ($B = 0.14$, $p = .09$), but these findings were not replicated in the final models. Indicators of personal-sphere and diffusion real-world behavior (i.e., voucher usage) were not predicted by treatment group (personal-sphere: $B = -0.04$, $SE = 0.18$, $p = .83$, diffusion: $B = 0.28$, $SE = 0.25$, $p = .26$). Overall, 126 participants in the control group (25%) and 129 participants in the treatment group (23%) used an individual voucher. Additionally, 41 participants in the control group (8%) and 54 participants in the treatment group (10%) had at least one voucher used by someone they had shared it with. No other hypothesized secondary outcomes were significantly predicted by treatment group in adjusted analyses.

To examine our secondary hypotheses further, we explored the pattern of mean differences in post-workshop perceptions about native plant gardening (personal-sphere behavior) and native plant diffusion between the two workshop groups (Figure 6). While the regressions did not indicate a statistically significant impact of the intervention on all the different normative perceptions, there was a general trend of static normative perceptions among those in the intervention being higher than those in the control post workshop (see Figure 6).

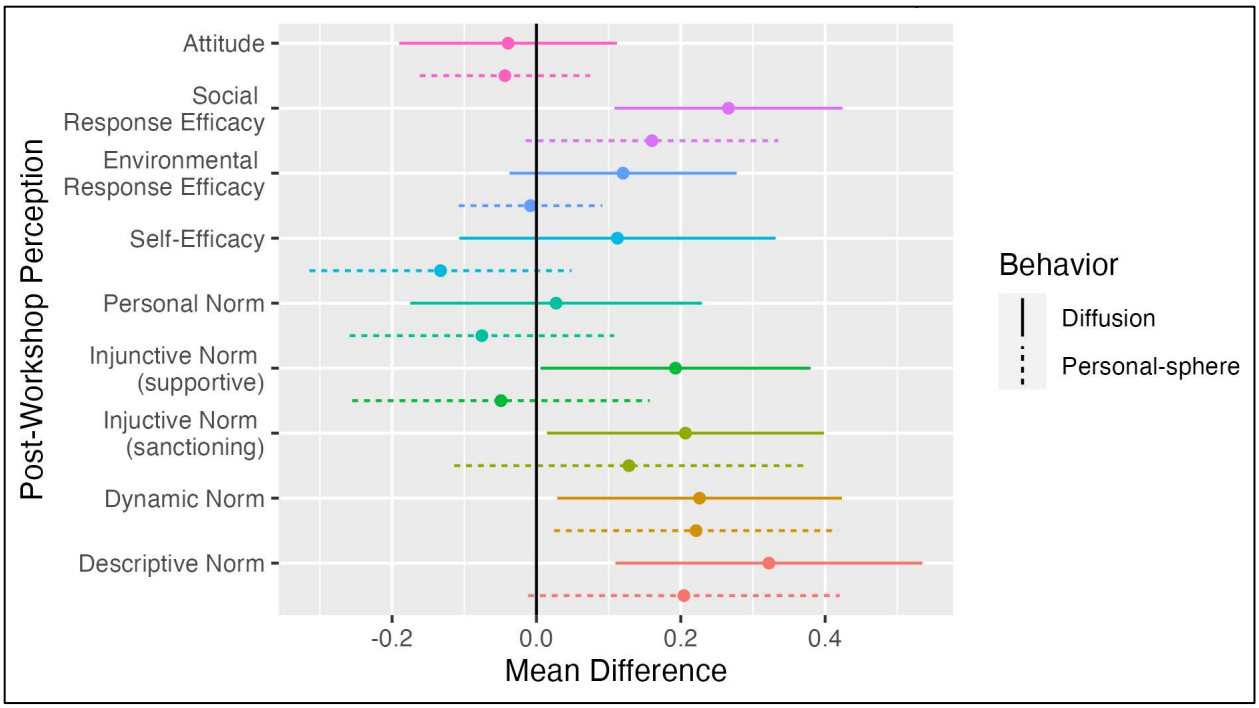

Figure 6. Mean Differences Between Treatment (n =308) and Control (n = 286) Workshops Immediately After the Experiment

Note. A positive mean difference represents stronger perceptions in the intervention and a negative mean difference represents stronger perceptions in the control. Mean differences were calculated from 7-point scales.

Discussion

Understanding strategies to motivate diffusion behavior can help increase the effectiveness of environmental movements (Amel et al., 2017). We developed outreach interventions to target social-psychological perceptions to motivate diffusion behavior and tested these interventions through a field experiment. We found that when compared to an information-only control, the added microinterventions did not influence participants' intentions to engage in diffusion behavior, self-reported diffusion behavior, or real-world indicators of diffusion behavior. However, in line with our secondary hypothesis, we did find that microinterventions

temporarily enhanced two social-psychological perceptions that have been associated with diffusion behavior in prior studies: diffusion-specific descriptive norm and diffusion-specific social response efficacy.

The treatment workshop increased perceptions of diffusion-specific descriptive norms immediately afterwards compared to the control. However, this effect did not persist at two months, we found that diffusion-specific descriptive norm perceptions were no longer significantly higher. In fact, perceptions of descriptive norms for both experimental groups decreased significantly after two months (see Supplemental Materials). This may be due to cognitive biases in which our brains focus on new information and pay more attention to relevant examples in our daily lives (i.e., recency and confirmation biases). Participants may have been initially persuaded that many others were talking about native plant gardening, but as they paid more attention to the topic after the workshop, these new norms were not reinforced. Participants may have also had increased interactions with others about native plant gardening after the workshop and these could have influenced perceptions of descriptive norms (Kashima et al., 2013).

Perceptions of diffusion-specific social response efficacy increased immediately after the intervention workshop compared to the control. In other words, treatment group participants were more likely to believe that if they were to encourage someone, they would receive a positive response from that person. At two months, treatment group social response efficacy perceptions did not continue to increase but remained higher than control group perceptions. Control group perceptions of diffusion-specific social response efficacy decreased after two months while the treatment group remained relatively stable. It could be that participants in the

control group did not have the same tools or information that the treatment group was given to maintain their belief that their actions would have a positive social impact over time.

Normative messaging and public commitment-making were the two microinterventions used to target descriptive norms, so our findings provide further evidence for the short-term effectiveness of these social influence interventions. Abrahamse and Steg (2013) found that public commitment-making was the second most effective intervention at encouraging behavior change and found smaller effect sizes for normative messaging (i.e., social norm information and feedback). More recently, a review on normative messaging interventions found that those highlighting descriptive norms had consistent positive effects on behavior change (Farrow et al., 2017). Our results suggest that these strategies may effectively influence short-term perceptions of descriptive norms, which are correlated with behavior change.

Our microintervention to provide feedback on the social impact of diffusion behavior also appeared to initially increase social response efficacy compared to the control. We provided this feedback by telling participants that "people are twice as likely to retain scientific information when it comes from friends, family, and others they know, and ten times more likely to change their behavior" (Bollinger et al., 2020; Medley et al., 2009). This supports prior work on the impact of efficacy-based messages about the positive consequences of behavior change on individual and diffusion-related perceptions and behavior (Meijers et al., 2019, 2022). For example, Geiger et al. (2017) found that interventions that focus on the effectiveness of community-level action increased perceptions of both self-efficacy and response efficacy. To our knowledge, only one other study (Berl et al., 2022) has provided feedback on the social impacts of behavior to specifically target social response efficacy though they did not find it effective.

Our findings suggest that providing this information may be an effective short-term intervention strategy at increasing positive perceptions around diffusion behavior.

Our nonsignificant findings for treatment group on diffusion and personal-sphere behavioral intentions could be due to a variety of factors. First, a ceiling effect may have contributed to our null results of our primary outcomes. Norms and efficacy may be key barriers to diffusion but it could be that participants already had high perceptions of norms and efficacy before workshops so our interventions could not increase them further. Other than average perceptions of descriptive norms (mean = 3.9 on a 7-point scale), participants had relatively high positive pre-workshop perceptions of injunctive norms, dynamic norms, self-efficacy, and response efficacy (means ranging from 4.5 to 6.0 on a 7-point scale). Furthermore, on average, attendees had higher personal-sphere supportive injunctive norms ($p = .03$) and diffusion sanctioning injunctive norms ($p = .05$) than non-attendees. If attendees' perceptions of injunctive norms were stronger than an already highly engaged subset of Colorado residents, it is possible that our microinterventions could not increase perceptions of injunctive norms further.

A second explanation for our null findings related to our behavioral metrics is that our control workshop already had a high level of effectiveness. The control workshop was designed to align with previous Audubon Rockies workshops on native plant gardening and native plant diffusion behaviors, and we found that norms and efficacy perceptions increased between pre and post surveys in the control workshop as well as intervention workshop (see Figure S1). The information-transfer model of the control workshop could have served as an effective knowledge-based intervention to encourage diffusion behavioral intentions. Geiger et al. (2017) found a knowledge-based intervention significantly increased efficacy beliefs, which influenced climate change discussion. Preliminary results demonstrate that knowledge of planting native

plants predicts intentions to encourage others to plant native plants (Champine et al., 2022). Additionally, workshop characteristics could have created engaging learning environments in both workshops. For example, sharing a favorite plant in the meeting chat may have created a sufficient sense of community in the control workshop without additional treatment activities. Learner-centered, collaborative learning environments have been shown to be effective strategies for adult learning (Conole, 2014).

Alternately, it could be that norms and efficacy alone are not sufficient drivers of diffusion behavior, and that other perceptual factors that were not addressed by workshops (or that were addressed by both conditions) are more important for motivating diffusion behavior. Variables, such as moral exporting (i.e., a person's willingness to influence others to share their own moral values; Maki & Raimi, 2017) or a social identity as an activist in general (Kurz et al., 2020) may be more influential variables. Future studies to investigate social diffusion behavior may create interventions to specifically highlight additional potential predictors of diffusion behavior.

Lastly, workshops were facilitated in an online format due to social distancing measures during the COVID-19 pandemic. While this format likely allowed us to reach a larger audience, it is possible that our micro-interventions were less effective due to a lack of participant engagement in the online environment. Both students and instructors during COVID-19 reported an overall decrease in engagement in online versus in-person classes (Walker & Koralesky, 2021), and we noticed many attendees left the workshop when breakout activities began (the face-to-face component). The research team also observed participants running into technical difficulties, dealing with distractions outside of the webinar (e.g., work and childcare responsibilities), and time restrictions (e.g., joining late or leaving early). Any of these factors

could have created a less-than-ideal environment for learning and digesting the microinterventions presented in the treatment workshop. Furthermore, the phenomenon of "Zoom Fatigue," or a feeling of exhaustion after videoconferencing, may have effected participants' energy levels during workshops (Fauville et al., 2021).

Important to the context of our study, topics, tone, word-choice, and speaker characteristics can subconsciously convey appeals to specific norms in online workshop settings. The presenters of the workshops were white-appearing, educated women talking to a majority white educated woman-identifying audience. Even without overt social influence interventions, many participants may have been influenced by subconscious appeals to social norms. Different presenters might have led to differing results, and these kinds of field interventions should be tested across a wide range of audiences to enable better generalizability.

Conclusion

Complex social-ecological issues, such as biodiversity loss, require human action, especially diffusion actions which can help spread personal-sphere behaviors more efficiently through a social network (Amel et al., 2017). Our study demonstrates that it is challenging to change biodiversity-related behaviors in real-world settings, and our null findings reinforce the importance of experimental evaluation of conservation communication (Kidd et al., 2019). It also provides further evidence that normative messaging and public commitment-making are effective short-term strategies for increasing perceptions of descriptive norms for diffusion behavior. Additionally, providing feedback on the social impact of diffusion behavior may be an effective short-term strategy to target diffusion-specific social response efficacy in motivated individuals. Importantly, changing longer-term perceptions of norms and efficacy may require additional or repeated interventions beyond a single online workshop. Testing microinterventions

to change behavioral perceptions, and behaviors themselves, can inform the way outreach organizations engage audiences and create more effective campaigns to combat issues like climate change and biodiversity loss.

Chapter 3: Examining Native Plant Gardening Behaviors in the United States: An Audience Segmentation Study

Chapter Summary

Audience segmentation can be used to identify target audiences in environmental outreach and communication, but few studies have used segmentation to study biodiversity conservation behavior in the United States. This study used segmentation to better understand perceptions and behaviors around different types of actions related to native plant gardening. With a United States representative survey (*n*= 1,200), we measured social-psychological beliefs and intentions to engage in personal-sphere, social diffusion, and civic action behavior. A latent class analysis (LCA) revealed four distinct classes (i.e., groups) within the population: Disengaged, Personal Sphere-Ready, Social Diffusion-Ready, and Civic Action-Ready. Each class comprised approximately one-quarter of the United States population, and 74% of participants appear receptive to engaging in a native plant gardening action. We found that certain groups are more receptive to some types of behavior over others (i.e., personal-sphere behavior, social diffusion behavior or civic behavior). Findings revealed opportunities to create tailored outreach strategies, such as normative and efficacy-based interventions, to engage different groups in urban biodiversity conservation behavior.

A growing body of literature has found that people vary by their values, beliefs, and perceptions when it comes to environmental issues. According to Moral Foundations Theory (MFT), the variation in individuals' morals (i.e., a type of value about what is right and wrong) around environmental issues can be explained by five basic moral foundations: harm/care, fairness/reciprocity, ingroup/loyalty, authority/respect, and purity/sanctity (Feinberg & Willer, 2013; Haidt & Graham, 2007; Haidt & Joseph, 2004). The America's Wildlife Values project found that United States residents vary in how they view wildlife based on their value orientations of domination (i.e., the prioritization of human wellbeing and a utilitarian view of wildlife) and mutualism (i.e., the prioritization of social inclusion and belief in rights for wildlife; Teel & Manfredo, 2010). Normative perceptions about appropriate or common environmental actions can also vary depending on various sociocultural factors such as racial/ethnic group, socioeconomic status (i.e., education and income), and collectivism (i.e., the extent to which a person prioritizes collective goals rather than personal goals; Pearson et al., 2018; Sherman et al., 2022).

Audience segmentation is a technique used to group people based on their values, beliefs, perceptions, behaviors, and demographics to inform the design of outreach campaigns. Segmentation is a tool often used in the private sector to target specific groups within the market and it has been used in the academic fields of public health and communication. For example, an audience segmentation found that there were five groups that varied in their intentions to get a COVID-19 vaccine in Australia: vaccine enthusiasts, supporters, socials, hesitant, and sceptics (Thaker et al., 2023). Segmentation has also been used in the environmental field. The Global Warming's Six Americas project grouped people in the United States into six different segments based on their perceptions around the issue of climate change: the alarmed, concerned, cautious,

disengaged, doubtful, and dismissive groups (Leiserowitz et al., 2009, 2021a). Based on America's Wildlife Values, the population can also be classified into four different groups based on their beliefs about how wildlife should be managed (i.e., traditionalist, mutualist, pluralist, and distanced groups; Teel & Manfredo, 2010)

Audience segmentation can help design messages and outreach strategies for different groups based on their unique values, motivations, barriers, and behaviors. Australians in the "social" group of the COVID-19 vaccine segmentation had less favorable attitudes towards the vaccine than the "supporters" or "enthusiasts" but were more likely to get a vaccine to protect others than protect themselves. As such, an altruism-based message may be most effective to motivate this group to get vaccinated (Thaker et al., 2023). The Global Warming's Six Americas framework helped design outreach strategies to target high involvement individuals (i.e., those in the alarmed and concerned groups), low involvement individuals (i.e., the cautious and disengaged groups), and those who hold negative beliefs (i.e., the doubtful and dismissive). For example, according to the Elaboration Likelihood Model (Petty et al., 2009), the Six America's project suggests that outreach using complex messages with detailed information may be effective in motivating pro-environmental action for high involvement audiences, but outreach to low involvement groups should focus on more peripheral aspects of the messaging, such as the trustworthiness of the source or the use of humor (Roser-Renouf et al., 2015).

Messages have also been crafted according to findings from the American Wildlife Values project and Moral Foundations Theory to increase communication and behavior change effectiveness (Bright et al., 2000; Crawford et al., 2015; Feinberg & Willer, 2013; Freeman et al., 2021; Miller et al., 2018). Individuals in the "mutualist" group are most concerned with respect and care for wildlife. Messages on signage and outreach materials that highlight those ideals may

be most effective for audiences with mutualistic value orientations (Freeman et al., 2021; Miller et al., 2018). Additionally, Feinberg and Willer (2013) found that reframing environmental issues in terms of purity (i.e., one of the basic moral foundations) for people with more conservative political ideologies in the United States can increase positive environmental attitudes, a strong driver of environmental behavior.

Recent studies have used audience segmentation to study biodiversity conservation-related issues and behaviors specifically. Biodiversity conservation actions refer to practices that help maintain healthy ecosystems for non-human species. Amit and Jacobson (2017) grouped ranchers in Costa Rica by their perceptions and preventive practices to around human-wildlife conflict. In China, Tian et al. (2018) used segmentation to group landowners by their interest in forest certification and found the segments differed in their familiarity with the behavior and perceptions of potential benefits. Wells et al. (2022) segmented members and non-members of a European wildlife trust into groups based on environmental identity and found differences between the groups in personal-sphere behavior (i.e., "taking action in your own life to benefit wildlife") and social/civic behavior (e.g., "volunteering, signing a petition or attending a demonstration related to an environmental cause"). In Australia, Selinske et al. (2023) grouped Melbourne residents by demographics, behaviors, and their connection to nature to inform conservation programming, and MacDonald et al. (2019) segmented the Australian public based on their beliefs about conservation behavior.

An opportunity exists to identify the segments of the United States population most willing to engage in specific biodiversity conservation actions. By designing audience segmentation analysis not just around general environmental values, identity, or beliefs, but rather around the actions that might most directly benefit biodiversity, we argue that audience

segmentation can be made more useful for applied conservation campaigns. Studies examining communication strategies to promote biodiversity conservation behavior have had mixed results. This may be due to the use of a "one size fits all" approach rather than targeted messaging to different subsets of the audience who have discrete beliefs about or past experiences with the target behavior. For example, Berl et al. (2022) found that theory-based messages did not influence people to share information about Colorado's wolf reintroduction initiative.

Other experimental messaging studies find differing impacts between subsets in their samples. In a study that framed biodiversity loss as a public health risk, Joshi (2022) suggested that people with lower perceptions of self-efficacy and response efficacy (i.e., perceptions of whether they can carry out an action and that it will have the intended impact) may not respond as well to messaging that uses fear-based appeals compared to people with high perceptions of efficacy. Niemiec et al. (2021) found that efficacy-based messages to encourage others to plant with native plants were more effective for a subset of the sample that was highly engaged but with low beliefs of perceived competence. In addition, with a sample of Colorado residents, Niemiec et al., (2020) found preliminary evidence that a message highlighting a normative conflict between the Colorado Parks and Wildlife Commission and the public decreased the likelihood of voting for wolf reintroduction for participants with more positive attitudes towards wolves, but increased the intentions to vote for participants with neutral attitudes towards wolves.

To address this need for audience segmentation focused on biodiversity behavior, we conducted an audience segmentation study of wildlife-friendly gardening in the United States. Biodiversity conservation actions in individual gardens include minimizing pesticide use, planting native plants, and creating landscapes that support native wildlife (Clayton, 2007). In

this study we focus on behaviors related to native plant gardening (i.e., planting plants that are ecologically adapted to a specific region; Richards et al., 1998). Gardening behaviors often increase time spent in nature, which can build stronger positive attitudes towards the environment, motivate pro-environmental behavior (PEB), and provide opportunities to improve human health (Aerts et al., 2018; Bell et al., 2018; Haluza-Delay, 2001; Soga & Gaston, 2016). More specifically, wildlife-friendly gardening positively effects the local environment and provides benefits to humans, such as positive mental and physical health effects and increased social interactions (Aerts et al., 2018; Bell et al., 2018; Clayton, 2007; Kaplan, 2001; Soga et al., 2016; Stuart, 2005).

Wildlife-friendly gardening and landscaping appear to be gaining popularity in urban green spaces. An annual gardening survey by the National Gardening Association in 2022 found that 34% of U.S. adults purchase wildlife-friendly plants, and a quarter of Americans buy native plants specifically. Popularity for native gardening appears to be growing as 17% of American adults purchased native plants in 2020, compared to 13% in 2018 (Fallon, 2022; Whitinger & Cohen, 2022). A goal in urban ecology is to create an "ecological aesthetic," in which landscapes are both pleasing for human inhabitants and ecologically beneficial for non-human inhabitants (Gobster et al., 2007). A couple of studies have demonstrated that this ecological aesthetic is emerging in some European cities as many residents approve of infrequently mown meadows, a form of wildlife-friendly landscaping (Garbuzov et al., 2015; Southon et al., 2017). Furthermore, native plant gardening is becoming more popular, especially in neighborhoods with strong native plant gardening norms (Peterson et al., 2012).

Through our study, we expand on previous research by segmenting by behaviors not previously included in segmentation analyses. We used audience segmentation to better

understand if there are groups in the United States that vary in terms of their beliefs, perceptions, and actions around three types of behavior: personal-sphere behavior, social diffusion, and civic action related to native plant gardening. Our survey focused on planting a native plant around one's home (personal sphere), encouraging someone else to plant native plants (social diffusion), and taking a civic action (ex. voting, signing a petition, volunteering) to increase the number of native plants in one's community. Specifically, our study examined the research question: How can the United States population be segmented with regards to their beliefs, perceptions, and behaviors related to native plant gardening?

Methods

Our online survey used the website, Prolific, to generate a United States-representative sample (n =1,200). Prolific has been compared to similar platforms like MTurk and Crowdflower and shown to deliver high quality data with a more diverse sample population for online behavioral research (Palan & Schitter, 2018; Peer et al., 2022). Participants on the marketplace are pre-screened and have access to a short survey description, pay rate, and the estimated time for completion. For our study, Prolific used United States Census data to divide the sample into proportional subgroups by age, sex, and ethnic/racial group (consisting of five subcategories: Asian, Black, Mixed, Other and White; Office for National Statistics, 2015). We aimed to survey more than 1,000 participants to follow the Six Americas study protocols, generate accurate information criteria (IC) tests to identify our final model, and have sufficient statistical power to detect differences, if any, between groups within our sample (Aflaki et al., 2022; Nylund et al., 2007; Nylund-Gibson & Choi, 2018).

We piloted the survey with over 20 people who had varying levels of knowledge about native plant gardening and experience with behavioral research. Representatives from nonprofit

and governmental organizations working on urban biodiversity conservation initiatives, including native plant gardening outreach programs, piloted the survey. Researchers, undergraduates, and master's students in the field of human dimensions provided feedback. Additionally, several people with no background in social science or experience with native plant gardening piloted the survey. We paid study participants an average rate of $17.95 per hour and the survey took an average of 10 minutes to complete. The survey was conducted under Colorado State University IRB #19–8879H.

Measures

In line with Aflaki et al. (2022), we predefined the indicators measured in the survey to segment the sample into groups based on their beliefs, perceived motivators and barriers to action, and behaviors related to the three types of native plant gardening actions: personal-sphere, social diffusion, and civic action. We measured a variety of variables that could define distinct classes in our analysis (see Table S1). Following behavior prediction models such as the Theory of Planned Behavior (Ajzen, 1985) and the Integrative Model of Behavioral Prediction (Yzer, 2012), we added measures of behavior-specific beliefs and perceptions such as attitude, efficacy, and social norms (descriptive, injunctive, and dynamic).

We measured behavior-specific attitudes (i.e., a person's disposition towards a behavior) following Champine et al. (2022) who adapted them from Bright and Manfredo (1996). We adapted measures of self-efficacy (i.e., a person's belief in their ability to carry out an action; Ajzen, 1985, 2002) from Jones and Niemiec (2020) and adapted the Six Americas study's measures of response and collective efficacy. Response efficacy is the belief that one's actions will have the intended impact (Witte & Allen, 2000) and collective efficacy is the belief in a group's ability to achieve a common goal (Bandura, 2000). For example, personal-sphere

environmental response efficacy was measured with the following question: “If you planted native plants around your home, how much would it help the environment?” Similarly, collective environmental response efficacy was measured by asking, “If most people in the US took civic action to increase native plants, how much would it help the environment?”

We measured different types of social norms, including descriptive norms (i.e., perceptions of how others are behaving), injunctive norms (i.e., perceptions of whether important others support a target behavior), and dynamic norms (i.e., perceptions of others’ behavior over time; Cialdini et al., 1991; Sparkman & Walton, 2017). We adapted norms measures from Jones and Niemiec (2020) and Champine et al. (2022). For example, to measure social diffusion-specific descriptive norm we asked participants the extent to which they agreed with the statement: “Most people in my community have encouraged others to plant native plants.” In addition to social norms, we measured behavior-specific personal norms (i.e., a person’s moral obligation to behave in a certain way; Schwartz, 1977). We also added a measure of environmental moral exporting, or willingness to influence others to adapt one’s own environmental values, as it has been linked to environmental peer persuasion, a type of social diffusion behavior (adapted from Maki & Raimi, 2017).

The survey adapted several measures from the Six Americas project (Chryst et al., 2018; Leiserowitz et al., 2009). We changed their measures of worry about and importance of climate change to reflect issues related to native plant gardening including biodiversity loss, water scarcity, and pesticide/chemical exposure. To measure worry and importance of related issues we asked, “How worried are you about the following issues?” and “How important are the following issues to you?” We also asked participants about their perceptions of expected outcomes of urban biodiversity actions, their civic engagement, subjective knowledge, and topic relevance, all

adapted from the Six Americas' study. We asked participants about expected positive and negative outcomes of planting more native plants at the personal and population level. We measured general civic engagement by asking participants to select the civic behaviors that they had done in the past twelve months, such as voting or serving on a committee of a local organization.

The final audience segmentation survey was informed by a smaller, in-person survey (n = 137) that aimed to generate data from a real-world context. Participants for this initial survey were recruited in August 2022 at the Douglas County Fair in Castle Rock, Colorado, USA. Members of the research team administered the survey with an iPad and either audio recorded or inputted responses while participants followed along with a printed version of the survey. The majority (87%; n = 119) of these participants agreed to being audio-recorded throughout the entire survey and survey administrators prompted them to "think out loud" as they responded to questions. Qualitative coding of survey transcripts and open-ended responses helped us identify the motivators and barriers that influence beliefs and decision-making about our three behaviors of interest: personal-sphere, social diffusion, and civic action. From these results we added measures of extraversion (adapted from Woods & Hampson, 2005), environmental identity (adapted from van Zomeren et al., 2008), and amount of space for native plants around the home.

In addition to behavioral perceptions, we measured three types of self-reported behavior: previous behavior, habitual action, and behavioral intention. We measured previous behaviors as binary (i.e., yes/no) variables, and habitual actions and behavioral intentions on five-point scales (i.e., "never" to "very frequently" or "not likely at all" to "extremely likely"). Behavioral measures covered the three levels of behavior. For example, for civic action behavioral intention we asked, "In the next year, how likely are you to take a civic action to increase the number of

native plants in your community?" See Table S1 in Supplemental Material for measures in the segmentation survey.

Analysis

In line with the Six America's audience segmentation studies, we conducted a latent class analysis (LCA) to cluster participants into groups based on their beliefs, behaviors, and behavioral perceptions. LCA is an exploratory method that divides a sample into subgroups based on shared characteristics or scores measured in surveys or other types of assessments (Weller et al., 2020). We chose to use an LCA over a cluster analysis because it is based on a statistical model and can provide probabilities for specific cases (Aflaki et al., 2022). We followed the step-by-step guide to LCA from Aflaki et al. (2022) to ensure our method was sound. First, we checked for outliers in the data as LCA can be sensitive to extreme datapoints. Next, even though indicators in a model can be both continuous and categorical, we collapsed continuous indicators down to two or three, depending on the overall distribution, to make interpretation easier by examining high/positive, low/negative, or moderate/neutral levels of perceptions, beliefs, or behavior. There were 49 indicators without covariates entered into the LCA.

We used the poLCA package in R to run the LCA, returning models with one through eight classes (Linzer & Lewis, 2011, 2022). In choosing the best model, we calculated the Bayesian Information Criterion (BIC), Sample Size-Adjusted Bayesian Information Criterion (SABIC), Akaike Information Criterion (AIC), Consistent Akaike Information Criterion (cAIC), and Entropy. We also created Scree-Plots (aka elbow-plots) to visualize where the model fits changed. Considering the models with the lowest information criteria values, entropy values closest to one, the visual changes on the elbow plot, and theory, we chose the model with four

classes (i.e., four different segments or groups; see Table 5 for information criteria and Supplemental Material for Scree-Plots).

We reviewed the estimated class probabilities to examine the pattern of responses of each indicator item for each latent class (i.e., how did the different segments vary in their responses to survey variables). These included all the social-psychological concepts measured in the survey (e.g., attitudes, perceptions of social norms and efficacy, environmental identity, moral exporting, past behaviors, etc.). We focused on indicator levels that had a high probability (> 70%) of membership for each group to create descriptions and compared findings to theoretical frameworks. To better understand the demographic and geographic makeup of participants in each of the four classes, we separated the sample by predicted class membership and conducted descriptive statistics.

We also separated out key distinguishing characteristics (i.e., important indicator variables) by examining the pattern of probabilities for each indicator level and each class. We identified variables that had high consensus within each class (i.e., > 70% probability at a specific indicator level) and had distinct variability in probabilities between the classes (i.e., at least two groups had high consensus in different levels of the indicator). For example, a key distinguishing characteristic might have one class that has a high probability of having a positive perception towards a behavior and another class that has a high probability of having a neutral perception toward that behavior. In other words, key distinguishing characteristics were indicators in which two or more classes met the cut off for high probability, and at least two of those estimated class probabilities fell in distinct levels for that indicator.

Results

Sample Description

In this section we start with a description of how representative our sample was, we then discuss the key variables that distinguished the groups that emerged in our analysis, and we finish by discussing each group in more detail. We aimed to study a representative sample of adult United States residents based on age, sex, and simplified racial/ethnic group (i.e., five categories: Asian, Black, Mixed [two or more races], White, and other [some other race]) as these are the variables that Prolific has available for sampling. Our sample was representative in sex and ethnic group, and as expected, the sample was slightly older than the overall median U.S. age (i.e., average age of the total US population, including people under 18). In addition, more than half (60%) of respondents owned their home, 75% voted in an election in the last year, 82% identified as heterosexual, and 47% identified as Christian. The sample likely overrepresented voters (e.g., only 66% of voting-eligible people voted in the 2020 presidential election and 47% voted in the 2022 general election; McDonald, 2023) and underrepresented people who identify as Christian (e.g., adjusted estimates from a 2020 survey found that 65% of the US population identifies as Christian; Pew Research Center, 2021). See Table 1 for a comparison of our sample demographics to Census data. Slightly less than half (48%) of our respondents had previously participated in native plant gardening themselves (personal-sphere action). Roughly a third had participated in social diffusion (35%) and 14% participated in civic actions related to native plant gardening.

Table 4. United States Census Comparison

	Our Sample	U.S. Census
Adult Median Age	45	>38
% Male	49	50
% Asian	6	6
% Black	13	14
% Mixed Race	2	3
% Other Race	1	1
% White	78	76
% Homeowner	60	65
% Heterosexual	82	88

We also analyzed the geographic distribution of survey participants based on ecoregions (i.e., geographical areas with similar ecological conditions) because regional norms may affect beliefs, perceptions, and actions related to native plant gardening. The ecoregions represented in our total sample (n = 1,200) were as follows: Eastern Temperate Forests (n = 676; 56%), Great Plains (n = 142; 12%), Mediterranean California (n = 101; 8%), Taiga (n = 83; 7%), North American Deserts (n = 52; 4%), Temperate Sierras (n = 40, 3%), Northwestern Forested Mountains (n = 40; 3%), Marine West Coast Forest (n = 38, 3%), Southern Semi-Arid Highlands (n = 20; 2%), Hawaii (n = 4; < 1%), and there were four participants with missing data for their current ecoregion.

Classes

Table 5. LCA fit statistics for one- to eight-class solutions.

# of Classes	Log likelihood	BIC	SABIC	AIC	cAIC	Entropy
1	-51051.02	102775.60	102473.84	102292	102870.60	-
2	-45461.47	92277.14	91670.45	91304.93	92468.14	0.949
3	-43682.52	89399.90	88488.28	87939.05	89686.90	0.934
4	**-42763.99**	**88243.48**	**87026.93**	**86293.98**	**88626.48**	**0.924**
5	-42218.05	87832.25	86311.11	85394.1	88311.60	0.925
6	-41767.07	87607.93	85780.72	84684.14	88182.15	0.926
7	-41364.48	87486.40	85371.11	84070.96	88173.46	0.897
8	-41030.02	87470.37	85051.93	83566.28	88255.22	0.906

Note. The final model (four-class) had low information criteria values and an entropy value close to one.

BIC = Bayesian Information Criteria, SABIC = Sample Size-Adjusted Bayesian Information Criteria, AIC = Akaike Information Criteria, cAIC = Consistent Akaike Information Criterion

Our analyses revealed four latent classes, or segments, within the population. As in other audience segmentation studies, these groups vary in their beliefs, perceptions, and behaviors related to native plant gardening (see Table 6). Based on the variables that defined them, and theoretical drivers of behavior change, we named each class. Twenty-six percent of our sample fell into the Disengaged group, 26% were in the Personal Sphere-Ready group, 23% fell into the Social Diffusion-Ready group, and the remaining (25%) were placed into the Civic Action-Ready group. Of the beliefs, perceptions, and behaviors measured, certain variables were most likely to distinguish the classes from one another. These key distinguishing characteristics included personal-sphere previous behavior, personal-sphere-specific behavioral intention, social diffusion previous behavior, civic action-specific attitude, civic action-specific personal norm, and civic action-specific dynamic norm. See Table 6 for an overview of the six key distinguishing characteristics.

Table 6. Key distinguishing characteristics between the four latent classes

	Disengaged	Personal Sphere-Ready	Social Diffusion-Ready	Civic Action-Ready
PS Previous Behavior	No*	Yes	No	Yes*
PS-specific Behavioral Intention	Low*	Low	Low	High*
SD Previous Behavior	No*	No*	No	Yes*
CA-specific Attitude	Neutral*	Neutral	Positive	Positive*
CA-specific Personal Norm	Low*	Moderate*	Moderate*	Moderate
CA-specific Dynamic Norm	Low*	Moderate*	Moderate	Moderate*

Note. PS = Personal Sphere Behavior; SD = Social Diffusion Behavior, CA = Civic Action Behavior; *estimated class probability > 70%

In addition to the key distinguishing characteristics, other indicators defined each of the four classes because they had high consensus within the group. Table 7 provides the level of each indicator that had a greater than 70% probability for each segment of the population. For

example, people in the disengaged, personal sphere-ready, and social diffusion-ready groups were all highly likely to have low levels of subjective knowledge about native plants. There were also some indicators that did not vary much between groups, so we did not consider them distinguishing or defining variables. These included habitual behaviors, expected number of negative and positive outcomes of personal-sphere behavior and national-level efforts to plant more native plants, civic behavior, and injunctive norms for all three behaviors (injunctive norms were moderate to high for all four groups). We describe the distinguishing and defining variables for each class in the following section.

Table 7. Overview of high (>70%) estimated indicator level probabilities for each segment

	Disengaged	Personal Sphere-Ready	Social Diffusion-Ready	Civic Action-Ready
Subjective Native Plant Knowledge	Low	Low	Low	-
PS- specific Attitude	-	Positive	Positive	Positive
PS-specific Descriptive Norm	-	Moderate	-	-
PS-specific Dynamic Norm	-	Moderate	-	-
PS-specific Personal Norm	Low	Moderate	Moderate	-
SD-specific Attitude	-	-	Positive	Positive
SD Behavioral Intention	Low	Low	-	-
SD-specific Descriptive Norm	-	Moderate	-	-
SD-specific Dynamic Norm	-	Moderate	-	-
SD-specific Personal Norm	-	Moderate	Moderate	-
SD-specific Self-Efficacy	-	Moderate	-	-
CA Previous Behavior	No	No	No	-
CA Behavioral Intention	Low	Low	Low	-
CA-specific Descriptive Norm	Low	-	-	-
CA-specific Self-Efficacy	-	Moderate	-	-
Environmental Response Efficacy (all behaviors)	Low	-	-	-
Collective Response Efficacy (all behaviors)	-	-	High	High
Issue Worry – Biodiversity Loss	-	-	-	High
Issue Worry – Water Scarcity	-	-	High	High
Issue Worry – Chemical Exposure	-	-	High	High
Issue Importance (all related issues)	-	-	High	High
Moral Exporting	-	Moderate	-	-
Environmental Identity	-	Moderate	Moderate	-

Note. PS = Personal-Sphere Behavior; SD = Social Diffusion Behavior, CA = Civic Action Behavior,

- = probability < 70%

Class 1: Disengaged

We refer to Class 1 as the "Disengaged" group because they were defined by generally negative or weak (i.e., low) perceptions around native plant gardening behaviors (see Tables 6 and 7). There was a greater than 85% chance that participants in this group had little to no intention of participating in any of the three behaviors in the near future. Twenty-two percent of respondents classified as disengaged claimed they had planted a native plant before. Participants in this group did not have a lot of knowledge about native plants (74% of respondents had little to no subjective knowledge). There was only a 5% chance that participants in this group had engaged in social diffusion and a 1% likelihood that they have participated in civic action for native plant gardening. Participants in this group had a 4% chance of believing that personal-sphere native plant gardening would have a positive impact on the environment (i.e., they did not have strong environmental response efficacy), so they may not be inclined to engage in any actions that increase native plants in their community. Furthermore, this group had a 2% chance of believing that participating in civic actions to increase native plants was considered common behavior in their community, and they did not feel morally obligated (less than 1% likelihood) to participate in such behavior.

The Disengaged group had a median age of 47, the racial distribution of group members was 82% White, 8% Black, 6% Asian, 2% Mixed Race, 2% Other Race, and 55% had a bachelor's degree or higher. The Northwestern Forested Mountains and Mediterranean California ecoregions had the highest proportion of residents in this class (35% and 32% respectively). The North American Desert ecoregion had the lowest proportion of members in the Disengaged group (15%).

Class 2: Personal Sphere-Ready

We call Class 2 the "Personal Sphere-Ready" group because with strategic interventions or messaging, they may be ready to engage in personal-sphere behavior. While this group did not have much knowledge about native plant gardening (75% of group members claimed they had little to no knowledge on the subject), they did appear to have a strong positive attitude towards personal-sphere native plant gardening behavior (80% chance). Around half (56%) of respondents in this group claimed they had planted a native plant previously and 33% said they had participated in social diffusion for native plants. This group was defined by moderate or neutral perceptions for personal sphere and social diffusion behavior for native plant gardening and they did not have strong perceptions of whether these actions were considered common or uncommon behavior (see Tables 6 and 7). Participants were also 61% likely to have moderate confidence in their ability to plant native plants (i.e., personal sphere-specific self-efficacy). There was a less than 7% likelihood that Personal Sphere-Ready participants had positive perceptions of descriptive norms for any of the three behaviors. This group likely did not have any habitual civic action behavior (2% likelihood) and had no intention of participating in civic action themselves (0% chance).

The Personal Sphere-Ready group had a median age of 46, the racial distribution of group members was 77% White, 13% Black, 7% Asian, 2% Mixed Race, 1% Other Race, and 47% had a bachelor's degree or higher. The Taiga (30%) and Eastern Temperate Forest (30%) ecoregions had the highest proportions of Personal Sphere-Ready members. The Temperate Sierras ecoregion had the lowest proportion of members in this class (21%).

Class 3: Social Diffusion-Ready

Class 3, or the "Social Diffusion-Ready" group appeared willing to further engage in personal-sphere actions, and, with strategic outreach, may be ready to engage with social

diffusion behavior. While this group had little knowledge about native plants (92% of participants reported little to no knowledge on the topic), they had strong positive attitudes towards personal-sphere and social diffusion behaviors related to native plant gardening. There was a 91% likelihood that they had a positive attitude towards personal-sphere behavior and an 84% likelihood that they had a positive attitude towards social diffusion behavior. People in this group were highly likely to have a low (54% likelihood) or moderate (45% likelihood) perception of social diffusion-specific descriptive norm. In other words, they were unlikely to believe that native plant social diffusion is considered common in their community.

While many participants had not previously engaged in the three types of native plant gardening behaviors (past engagement was at 29% for personal action, 22% for social diffusion, and 3% for civic action), the Social Diffusion-Ready group was defined by a high sense of collective efficacy (i.e., belief in a group's ability to make a positive impact) for all three types of behaviors and believed the issues of biodiversity and water scarcity were highly important (over 81% likelihood). Fifteen percent of members had low social perceived diffusion-specific self-efficacy, 53% had moderate self-efficacy perceptions, and 32% had high self-efficacy perceptions. People in this group had a low likelihood of engaging in civic action for this cause in the foreseeable future (6% chance).

The Social Diffusion-Ready group had a median age of 44, the racial distribution of group members was 78% White, 14% Black, 4% Asian, 2% Mixed Race, 2% Other Race, and 63% had a bachelor's degree or higher. The North American Deserts (40%) and Northwestern Forested Mountains (35%) ecoregions had the highest percentage of membership. The Eastern Temperate Forest ecoregion had the lowest proportion of membership in the Social Diffusion-Ready group (21%).

Class 4: Civic Action-Ready

Class 4 is titled "Civic Action-Ready" because this group of respondents reported the most experience and positive perceptions towards personal-sphere action, was interested in continuing to engage in social diffusion, and with strategic intervention, may be ready to begin participating in civic action. This class was the most engaged in the three native plant actions (82% had planted native plants, 83% had engaged in social diffusion, and 41% had participated in civic action) and was defined by strong positive attitudes and collective efficacy towards all three types of behaviors (see Tables 6 and 7). Civic Action-Ready group members had a 61% chance of having moderate perceptions of civic action-specific self-efficacy. This group had over an 80% chance of having positive attitudes and a strong sense of collective efficacy for all three types of native plant gardening behaviors. They were also at least 87% likely to believe that issues related to native plant gardening (i.e., biodiversity loss, water scarcity, and chemical exposure) were highly important. This group had greater than a 61% likelihood of participating in personal-sphere and social diffusion behavior in the next year.

The Civic Action-Ready group had a median age of 44, the racial distribution of group members was 75% White, 15% Black, 8% Asian, 2% Mixed Race, and 54% had a bachelor's degree or higher. The Taiga (29%) and Temperate Sierras (28%) ecoregions had the highest proportion of Civic Action-Ready group members, and the Northwestern Forested Mountains had the lowest proportion of membership (5%).

Discussion

Audience segmentation can help us identify audiences and their shared perceptions to create more effective outreach strategies. While segmentation has been used in other sectors, varying academic fields, and for environmental issues, to our knowledge, it has not been applied

to native plant gardening behaviors in the United States. According to our latent class analysis there are four groups that vary in terms of their attitudes, behaviors, and normative perceptions. The segments appear to be uniquely primed for different types of native plant gardening actions, so a one-size-fits-all approach may not be effective in communication and outreach. The four groups we identified can help guide more efficient and effective outreach efforts needed to expand the native plant gardening movement.

Our results suggest that before beginning an outreach campaign about native plant gardening, an organization may want to start by determining which of the four groups they are targeting through their campaign. To uncover which of the segments that an audience falls into, organizations may want to observe participants, track engagement in different types of outreach events, and ask targeted questions to learn about participant perceptions and behavior. Recording participant feedback, comments, and questions may help uncover their attitudes, previous experience, normative perceptions, and behavioral intentions, the key variables that distinguished our observed groups. Tracking participation in events and including questions that measure attitudes, previous behavior, and perceptions of norms and collective efficacy (i.e., a defining indicator of the Social Diffusion-Ready group), on registration forms or surveys may help organizations identify their target audience(s) and use theoretically driven outreach strategies (see examples of how to measure these questions in the 'Survey Measures' table in Supplemental Materials).

Our results identified that 26% of the population fell into the Personal Sphere-Ready group, defined as people who may be ready to participate in native plant gardening themselves. A program aimed to engage Personal Sphere-Ready audience members might draw in participants using a title that signals it is for beginners such as "Native Plant Gardening 101," or

include in the description that it is for people who are new to native plant gardening or "native plant newbies." Low subjective knowledge defined this group so knowledge-building educational activities such as defining native plants, highlighting their benefits, and providing examples may be effective. With a moderate perception of self-efficacy, the Personal Sphere-Ready group may benefit from personal sphere-specific self-efficacy interventions like proximal goal setting, social modeling, mastery experiences, and social persuasion (Bandura, 1977, 1986; Bandura & Schunk, 1981) to boost the individual's sense of confidence in planting native plants themselves. This may involve asking participants to set SMART (Specific, Measurable, Achievable, Relevant, and Time-bound; Doran, 1981) goals for planting a native plant (i.e., proximal goal setting), bringing in a native plant gardener who can share their story of how they got started (i.e., social modeling), giving participants a hands-on experience planting a native plant (i.e., providing a mastery experience), and providing plenty of positive, encouraging feedback throughout (see Champine et al. in review for workshop-based micro-interventions to increase self-efficacy).

People in the Personal Sphere-Ready group had a lower sense of collective response efficacy than those in the Social Diffusion-Ready and Civic Action-Ready groups. To address the barrier of a low sense of response efficacy, it may be effective to use interventions that increase perceptions that their actions, and their actions combined with the actions of others, will have a positive impact on the issues they care about such as wildlife, saving water, or reducing pesticides. This may include sharing facts and statistics about the positive impacts of native plant gardening on multiple types of environmental issues. The use of peripheral-route messaging (i.e., a persuasion method that focuses on superificial cues rather than the content of the message) such as using humor, trusted sources, and personal narratives to evoke emotion, may also help

motivate this group as they are currently not very engaged in native plant gardening actions (Neumann et al., 2022; Petty et al., 1983; Roser-Renouf et al., 2015). According to the elaboration likelihood model of persuasion, peripheral-route messages are more effective for audiences that are not motivated to process a message deeply (Petty et al., 2009).

Our segmentation analysis found that 23% of participants fell in the Social-Diffusion-Ready class, or the group that may be ready to engage in social diffusion behavior for native plants. Individuals in the Social Diffusion-Ready group have strong positive attitudes towards personal-sphere and social diffusion behavior but could benefit from self-efficacy and knowledge building activities for both types of behavior (see Niemiec et al., 2021 for an example of efficacy-based interventions). To address the variation of self-efficacy perceptions in this group, outreach can use the same strategies mentioned above for the Personal Sphere-Ready group, though interventions should be behavior-specific. In other words, strategies to increase self-efficacy for social diffusion behavior should focus specifically on encouraging others to plant native plants, rather than planting a native plant individually. For example, to leverage social modeling for diffusion behavior, a program may bring in a person who has experience talking to others about native plant gardening or influencing people in their community to join the movement. This group has a low sense of subjective knowledge about native plant gardening so programs should still start with a basic introduction to native plants that includes definitions, benefits, and examples.

The Social Diffusion-Ready group might also benefit from interventions to strengthen their sense of descriptive norms towards the behaviors. For example, sharing relevant, positive, community-based statistics about how many people are participating in social diffusion may help boost perceptions of social norms around social diffusion behavior. This strategy, called

normative messaging (i.e., a type of peripheral-route messaging), is influential for different types of pro-environmental behaviors (see Abrams et al., 2021; Cialdini, 2003; Goldstein et al., 2008; Han & Hyun, 2018; Sparkman et al., 2020, 2021 as examples). Normative messaging may be effective for this group because they were likely to have no previous engagement in native plant gardening behaviors and less engaged audiences may be more influenced by peripheral-route messages (Petty et al., 2009). Furthermore, this group has a high sense of collective efficacy for the two behaviors, so appealing to their sense of community or involvement in a growing social movement may be effective in influencing behavior.

We found that 25% of participants were in the Civic Action-Ready group and may be ready to participate in civic action. The Civic Action-Ready group has likely planted native plants themselves and talked to others about it, but they may need additional motivation to take civic action. As this group is highly involved in native plant gardening, and thus might be expected to engage with more cognitively effortful messages, organizations can use central route messaging (i.e., the opposite of peripheral-route messaging), such as messages with more information and complexity (Petty et al., 2009; Petty & Cacioppo, 1986; Roser-Renouf et al., 2015). Preliminary evidence suggests that normative messaging may not be as effective for highly engaged populations in native plant gardening behaviors (Champine et al., in review; Niemiec et al., 2021). According to the Elaboration Likelihood Model, highly engaged individuals, like those in the Civic Action-ready group, may be motivated by their sense of moral obligation, ability, and passion for the issue rather than relying on outside influences to guide their behavior (Petty & Cacioppo, 1986)

Given their moderate sense of self-efficacy for civic action, strategies to target civic action-specific self-efficacy may be useful to engage the Civic Action-Ready group. For

example, to provide a mastery experience, an organization might give participants practice reaching out to a local legislator with a pre-made script that they can follow. Like the Social Diffusion-Ready group, this group has a strong sense of collective response efficacy, so appealing to a social movement may be effective. Furthermore, this group was highly worried about related issues (i.e., biodiversity loss, water scarcity, and chemical exposure) and believed these issues to be very important so using value-based messages that appeal to these issues may be effective.

The remaining 26% of participants were in the Disengaged group. The Disengaged group is likely to be unwilling to participate in any native plant gardening behavior as they have more neutral attitudes and weak perceptions of social norms and self-efficacy towards the three types of actions. While it may be more efficient to focus on the other three groups to grow the native plant gardening movement, there are still strategies to target the disengaged group such as peripheral route and normative messaging (Neumann et al., 2022; Petty et al., 1983; Roser-Renouf et al., 2015). See Table 8 for an overview of research-based strategies to target each of the four latent class segments most effectively.

Table 8. Research-based strategies to engage each group in native plant gardening actions.

	Peripheral-Route Messaging	Knowledge-Building	Self-Efficacy Intervention*	Response Efficacy Interventions*	Normative Messaging*	Appeals to Movement/ Issues	Central-Route Messaging
Disengaged	X				X		
Personal Sphere-Ready	X	X	X	X			
Social Diffusion-Ready		X	X	X	X	X	
Civic Action-Ready			X	X		X	X

Note. *Behavior-specific

Limitations

While we took steps to gather a representative sample of United States adults, it is likely that our sample varies slightly from the true population. Prolific, the survey distribution website, only uses three variables (age, sex, and simplified ethnic/racial group) to create a representative distribution, therefore our sample may have a distinct distribution of other demographic characteristics. For example, the sample was likely overrepresented by voters and underrepresented by people who identify as Christian. Furthermore, as our survey was on a study-marketplace, there may have been a selection bias of people with an interest in native plant gardening, because they could choose which study to participate in from several available studies.

Conclusion

After years of audience segmentation research around other environmental issues, this study used methods adapted from the Six Americas project to examine perceptions towards urban biodiversity conservation actions in the United States. We used the case study of native plant gardening to measure social-psychological beliefs and intentions to engage in personal-sphere, social diffusion, and civic action behavior. Our LCA revealed four groups that varied in terms of their attitudes, engagement in native plant actions, and concern for related issues. Our findings provide tailored opportunities for outreach for each of the four segments. Understanding the characteristics of each group and using research-based strategies to remove relevant social-psychological barriers can help environmental managers and organizations create effective outreach and communication strategies for distinct segments of the population. This strategic outreach can help grow the native plant gardening movement and further address biodiversity loss in the United States.

Dissertation Conclusion

With rapid biodiversity loss and population growth around the world, cities and urbanized areas have become important spaces to tackle biodiversity conservation issues (Rega-Brodsky et al., 2022). They provide habitat for many endangered species, ecosystem services, and opportunities for humans to connect with the natural world (Bell et al., 2018; Beninde et al., 2015; Goddard et al., 2010; Ives et al., 2016). Various social-environmental systems shape the urban and residential landscape and impact local biodiversity (Cook et al., 2012; Kinzig et al., 2005; Schell et al., 2020). While large issues like biodiversity loss have no "silver bullet" solution, their complexity creates opportunities for different points of intervention and strategies to address them. This dissertation specifically focuses on opportunities for individual action in addressing urban biodiversity conservation.

While top-down strategies, like governmental regulations and corporate environmental, social, and governance (ESG) initiatives, are important to combating biodiversity loss, I highlight the potential for individuals to help shape social norms and influence these larger institutions through participation in collective action. Aligning with Amel et al. (2017)'s spheres of human influence model, my research examines how individuals not only change their personal-sphere behavior but also the broader systems in which they are embedded. Promoting behavior beyond the personal-sphere, such as through social diffusion or civic action, can create more opportunities to spread awareness and social norms, build a social movement, and influence systems-level change.

The articles in this dissertation shed additional light on the motivators and barriers to personal-sphere, social diffusion, and civic action behaviors related to native plant gardening,

and demonstrate the need for research-based outreach interventions to influence greater community engagement in urban biodiversity conservation. In Chapter 1 I highlighted the importance of understanding the drivers of social diffusion behavior, or behaviors that disseminate new information and actions through social networks. While there is overlap between the drivers of personal-sphere and diffusion behavior, I found that enhancing diffusion-specific personal norms and self-efficacy in addition to personal-sphere specific behavioral perceptions may be particularly effective in motivating social diffusion.

Drawing from the results of the first chapter, in Chapter 2 I tested outreach interventions to target both personal-sphere and diffusion actions for urban biodiversity conservation. The research team developed research-based microinterventions to target specific social-psychological perceptions found to drive native plant diffusion behavior in Chapter 1 (i.e., knowledge, attitudes, and social diffusion-specific self-efficacy and personal norms), and microinterventions to target other types of perceptions that influence pro-environmental behavior (i.e., social norms and response efficacy). I tested the microinterventions in an online, workshop-based field experiment and found that while they did not significantly change indicators of real-world behavior, they did reveal initial increases in social-psychological perceptions related to social diffusion of urban biodiversity conservation behavior (i.e., encouraging others to plant native plants around their homes). This study highlighted the need for future research that uses experimental methods and real-world measures of behavior to inform outreach approaches in biodiversity conservation. Practitioners may draw on these findings to implement efficacy-based interventions in outreach to influence the social-psychological drivers of behavior in engaged audiences.

The focus of Chapter 3 aimed to address the limitations of sample size and representativeness in the first two chapters and examine an additional type of behavior beyond personal-sphere action and social diffusion: civic action. I found that participants in the first two studies were overrepresented by older, White, educated women, and decided to use an online sampling platform to survey a larger, more representative sample. I used audience segmentation to identify distinct target audiences in urban biodiversity conservation outreach, specifically for native plant gardening behaviors. My findings suggest that organizations can tailor their outreach approaches based on a groups' receptiveness and readiness for different types of behavior. A Latent Class Analysis (LCA) revealed four distinct groups within the United States. While 26% of the population is not ready to engage in any type of native plant gardening action (i.e., the Disengaged group), with targeted outreach strategies, 26% could be receptive to participation in personal-sphere behavior (i.e., planting native plants), 23% may be ready to engage in social diffusion behavior (i.e., encouraging others to plant native plants), and 25% could be motivated to engage in civic action to increase the prevalence of native plants. Together, the three studies in my dissertation contributed to a more nuanced understanding of native plant gardening behaviors and highlight the need for research-based, targeted outreach.

Across the three chapters of my dissertation there were a few social-psychological perceptions that emerged as drivers of native plant gardening behaviors. These included subjective knowledge about native plants, positive attitudes, strong personal norms, and efficacy-related constructs. My findings are partially consistent with theoretical models of behavior (e.g., Theory of Planned Behavior; Ajzen, 1985) though social norms did not appear to play as much of a role as initially hypothesized in the first two chapters. In Chapter 1, social norms were not significant positive drivers of either personal-sphere or diffusion behaviors even though past

studies have found norms, especially descriptive norms, to be strong drivers of conservation behavioral intentions (Farrow et al., 2017; Jones & Niemiec, 2020; Kallgren et al., 2000). In addition, the microinterventions in Chapter 2 appeared to initially influence perceptions of a diffusion-specific descriptive norm (i.e., beliefs that people encourage others to plant native plants), though this change did not last when remeasured two months after the workshop. These findings may provide evidence that social norms are not as effective drivers of behavior for more highly engaged audiences. However, with a more representative sample in Chapter 3, while strong positive social norms did not differentiate the two most engaged groups, the disengaged group was defined by negative perceptions of descriptive norms, and the personal sphere-ready group was most likely to have neutral perceptions of social norms around native plant gardening behaviors.

While normative constructs had varying results, efficacy-based measures appeared to be influential for the behaviors measured in the three chapters. In Chapter 1, diffusion-specific self-efficacy not only predicted diffusion intention, but also moderated the relationship between intention and an indicator of real-world behavior. Efficacy-based microinterventions in Chapter 2 increased perceptions of diffusion-specific social response efficacy (i.e., beliefs that diffusion actions would successfully influence others) immediately after the workshop, and though they did not continue to increase after the workshop, they remained significantly higher than the control group after two months. In my audience segmentation study, the disengaged group was defined by low perceptions of environmental response efficacy (i.e., belief that planting native plants would make a positive impact on the environment), and the two most engaged groups (i.e., Social Diffusion-Ready and Civic Action-Ready) were defined by strong perceptions of collective efficacy for all three types of behaviors (i.e., beliefs that collective efforts can achieve

the intended outcome). To continue developing effective strategies to motivate individual behavior outside of the personal sphere, future studies could test the influence of different types of efficacy-related constructs on urban biodiversity conservation behaviors.

I recognize that, as with all scientific research, there are limitations to my work. The studies in this dissertation use a primarily post-positivist epistemological approach (Trochim et al., 2016; Trochim & Donnelly, 2006). I used survey and experimental methods that draw on theory from social psychology and applied these to a new context. This involved breaking down complex phenomena into specific variables and constructs to understand how they can inform strategies to change behavior. Post-positivist approaches are beneficial because they recognize bias and acknowledge that knowledge is fallible, while uncovering reliable trends that can be generalized to other contexts (Mertens, 2019). However, my third chapter aimed to survey a larger, more representative sample of people to uncover voices that were underrepresented in the first two chapters, and I acknowledge that an online survey may not be an ideal method to legitimize different viewpoints, perspectives, and truths. Social psychological research, and its theories and methods, have been largely developed by WEIRD people (i.e., people in Western, Educated, Industrialized, Rich, and Democratic societies) studying WEIRD participants (Henrich et al., 2010). Thus, surveying the population with pre-determined measures may not accurately acknowledge the multiple worldviews and identities that shape the way people think about, perceive, and act in the world.

More constructivist methodologies, such as case studies and grounded theory, that use methods like interviews and focus groups, may be better equipped to understand the intricacies of a specific situation, or uncover multiple worldviews and perspectives. I took time before developing my third chapter to interview organizations that are working with underrepresented

audiences in conservation and recorded open-ended responses to perceptions about wildlife-friendly landscaping at a county fair in Douglas County, Colorado. These approaches deepened my knowledge of perceptions around wildlife-friendly gardening in Colorado and helped me uncover intricacies that I would not have thought to measure in my audience segmentation survey initially. Creating themes from my discussions with conservation practitioners and county-fair goers provided additional insights and ideas that a quantitative survey may not have been able to uncover.

Future studies could use more constructivist approaches to study the complexity of community engagement in urban biodiversity action in a specific context. For example, it could be useful to conduct a case study of an organization that uses novel, or research-based approaches to engage a wider audience in conservation actions. Lessons learned, and specific themes uncovered from a variety of qualitative data could then inform overarching strategies to improve urban biodiversity conservation outreach approaches. Strategies could then be experimentally tested to ensure feasibility and effectiveness in multiple contexts.

Overall, the chapters in this dissertation add to knowledge of influencing multiple levels of individual engagement in pro-environmental behavior and can guide the development of approaches to target personal-sphere, social diffusion, and civic action behaviors specifically. With the case study of native plant gardening, my research provides an analysis of key drivers of behavior, potential strategies to motivate behavior, and initial audiences to target in biodiversity conservation initiatives. After ensuring a receptive audience, the use of behavior-specific strategies to increase perceptions of efficacy may be most effective for promoting behavior beyond the personal-sphere. This research can inform outreach and education programming that

increases the resilience and wellbeing of the human and non-human residents in our urbanized landscapes.

References

Abrahamse, W., & Steg, L. (2013). Social influence approaches to encourage resource conservation: A meta-analysis. *Global Environmental Change*, *23*(6), 1773–1785. https://doi.org/10.1016/j.gloenvcha.2013.07.029

Abrams, D., Lalot, F., Hopthrow, T., Templeton, A., Steeden, B., Özkeçeci, H., Imada, H., Warbis, S., Sandiford, D., Meleady, R., Fell, E., Abrams, Z., Abrams, A., Ngan, X. Q., Celina, S., Tanyeri, A., Gammon, M., Abrams, B., Fischer, L., … Peckham, S. (2021). Cleaning up our acts: Psychological interventions to reduce engine idling and improve air quality. *Journal of Environmental Psychology*, *74*, 101587. https://doi.org/10.1016/j.jenvp.2021.101587

Aerts, R., Honnay, O., & Van Nieuwenhuyse, A. (2018). Biodiversity and human health: Mechanisms and evidence of the positive health effects of diversity in nature and green spaces. *British Medical Bulletin*, *127*(1), 5–22. https://doi.org/10.1093/bmb/ldy021

Aflaki, K., Vigod, S., & Ray, J. G. (2022). Part II: A step-by-step guide to latent class analysis. *Journal of Clinical Epidemiology*, *148*, 170–173. https://doi.org/10.1016/j.jclinepi.2022.05.009

Ajzen, I. (1985). From Intentions to Actions: A Theory of Planned Behavior. In J. Kuhl & J. Beckmann (Eds.), *Action Control: From Cognition to Behavior* (pp. 11–39). Springer. https://doi.org/10.1007/978-3-642-69746-3_2

Ajzen, I. (2002). Perceived Behavioral Control, Self-Efficacy, Locus of Control, and the Theory of Planned Behavior. *Journal of Applied Social Psychology*, *32*(4), 665–683. https://doi.org/10.1111/j.1559-1816.2002.tb00236.x

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behaviour.* Prentice Hall.

Ajzen, I., & Fishbein, M. (2000). Attitudes and the Attitude-Behavior Relation: Reasoned and Automatic Processes. *European Review of Social Psychology*, *11*(1), 1–33. https://doi.org/10.1080/14792779943000116

Alberti, M., & Marzluff, J. M. (2004). Ecological resilience in urban ecosystems: Linking urban patterns to human and ecological functions. *Urban Ecosystems*, *7*(3), 241–265. https://doi.org/10.1023/B:UECO.0000044038.90173.c6

Alsaleh, E., Windle, R., & Blake, H. (2016). Behavioural intervention to increase physical activity in adults with coronary heart disease in Jordan. *BMC Public Health*, *16*, 643. https://doi.org/10.1186/s12889-016-3313-5

Ro, E., Manning, C., Scott, B., & Koger, S. (2017). Beyond the roots of human inaction: Fostering collective effort toward ecosystem conservation. *Science*, *356*(6335), 275. https://doi.org/10.1126/science.aal1931

Amit, R., & Jacobson, S. K. (2017). Understanding rancher coexistence with jaguars and pumas: A typology for conservation practice. *Biodiversity & Conservation*, *26*(6), 1353–1374. https://doi.org/10.1007/s10531-017-1304-1

Anguelovski, I. (2016). From Toxic Sites to Parks as (Green) LULUs? New Challenges of Inequity, Privilege, Gentrification, and Exclusion for Urban Environmental Justice. *Journal of Planning Literature*, *31*(1), 23–36. https://doi.org/10.1177/0885412215610491

Aronson, M. F. J., La Sorte, F. A., Nilon, C. H., Katti, M., Goddard, M. A., Lepczyk, C. A., Warren, P. S., Williams, N. S. G., Cilliers, S., Clarkson, B., Dobbs, C., Dolan, R., Hedblom, M., Klotz, S., Kooijmans, J. L., Kühn, I., MacGregor-Fors, I., McDonnell, M.,

Mörtberg, U., … Winter, M. (2014). A global analysis of the impacts of urbanization on bird and plant diversity reveals key anthropogenic drivers. *Proceedings of the Royal Society B: Biological Sciences*, *281*(1780), 20133330. https://doi.org/10.1098/rspb.2013.3330

Bailey, K., Morales, N., & Newberry, M. (2020). Inclusive conservation requires amplifying experiences of diverse scientists. *Nature Ecology & Evolution*, 1–2. https://doi.org/10.1038/s41559-020-01313-y

Bamberg, S. (2003). How does environmental concern influence specific environmentally related behaviors? A new answer to an old question. *Journal of Environmental Psychology*, *23*(1), 21–32. https://doi.org/10.1016/S0272-4944(02)00078-6

Bamberg, S., & Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology*, *27*(1), 14–25. https://doi.org/10.1016/j.jenvp.2006.12.002

Bandura, A. (1971). Social Learning Theory. *General Learning Corporation*, 1–46.

Bandura, A. (1977). Self-efficacy: Toward a Unifying Theory of Behavioral Change. *Psychological Review*, *84*(2), 191–215.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory* (pp. xiii, 617). Prentice-Hall, Inc.

Bandura, A. (1988). Organisational Applications of Social Cognitive Theory. *Australian Journal of Management*, *13*(2), 275–302. https://doi.org/10.1177/031289628801300210

Bandura, A. (1997). *Self-efficacy: The exercise of control* (pp. ix, 604). W H Freeman/Times Books/ Henry Holt & Co.

Bandura, A. (2000). Exercise of Human Agency Through Collective Efficacy. *Current Directions in Psychological Science*, *9*(3), 75–109. https://doi.org/10.1111/1467-8721.00064

Bandura, A., & Schunk, D. H. (1981). Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. *Journal of Personality and Social Psychology*, *41*(3), 586–598. https://doi.org/10.1037/0022-3514.41.3.586

Bandura, A., & Simon, K. M. (1977). The role of proximal intentions in self-regulation of refractory behavior. *Cognitive Therapy and Research*, *1*(3), 177–193. https://doi.org/10.1007/BF01186792

Baranger, D. A. A., Goldstein, B. L., Vize, C., Lynam, D., & Olino, T. M. (2021). *InteractionPoweR: Power analyses for interaction effects in cross-sectional regressions.* https://github.com/dbaranger/InteractionPoweR

Barnes, M. R., Nelson, K. C., & Dahmus, M. E. (2020). What's in a yardscape? A case study of emergent ecosystem services and disservices within resident yardscape discourses in Minnesota. *Urban Ecosystems*, *23*(6), 1167–1179. https://doi.org/10.1007/s11252-020-01005-2

Bartke, S., Friedl, A., Gelhaar, F., & Reh, L. (2017). Social comparison nudges—Guessing the norm increases charitable giving. *Economics Letters*, *152*, 73–75. https://doi.org/10.1016/j.econlet.2016.12.023

Bell, S. L., Westley, M., Lovell, R., & Wheeler, B. W. (2018). Everyday green space and experienced well-being: The significance of wildlife encounters. *Landscape Research*, *43*(1), 8–19. https://doi.org/10.1080/01426397.2016.1267721

Beninde, J., Veith, M., & Hochkirch, A. (2015). Biodiversity in cities needs space: A meta-analysis of factors determining intra-urban biodiversity variation. *Ecology Letters*, *18*(6), 581–592. https://doi.org/10.1111/ele.12427

Berl, R. E. W., Sekar, S., Markevich, A., Camara, C., & Niemiec, R. M. (2022). Assessing the impacts of normative and efficacy-based messaging on the social diffusion of conservation science. *Conservation Science and Practice*, *4*(4), e12647. https://doi.org/10.1111/csp2.12647

Berthon, K., Thomas, F., & Bekessy, S. (2021). The role of 'nativeness' in urban greening to support animal biodiversity. *Landscape and Urban Planning*, *205*, 103959. https://doi.org/10.1016/j.landurbplan.2020.103959

Bird City Wisconsin. (n.d.). *Bird City Wisconsin—Communities Helping Birds*. Bird City Wisconsin. Retrieved October 9, 2021, from https://birdcitywisconsin.org/

Blake, K. R., & Gangestad, S. (2020). On Attenuated Interactions, Measurement Error, and Statistical Power: Guidelines for Social and Personality Psychologists. *Personality and Social Psychology Bulletin*, *46*(12), 1702–1711. https://doi.org/10.1177/0146167220913363

Blazheski, F. (2016). *Multifamily vs. Single-family housing trends*. 8.

Bollinger, B., Gillingham, K., & Gullo, K. (2020). *Making Pro-Social Social: The Effectiveness of Social Norm Appeals for Energy Conservation using Social Media*.

Bolund, P., & Hunhammar, S. (1999). Ecosystem services in urban areas. *Ecological Economics*, *29*(2), 293–301. https://doi.org/10.1016/S0921-8009(99)00013-0

Botetzagias, I., Dima, A.-F., & Malesios, C. (2015). Extending the Theory of Planned Behavior in the context of recycling: The role of moral norms and of demographic predictors.

Resources, Conservation and Recycling, *95*, 58–67. https://doi.org/10.1016/j.resconrec.2014.12.004

Boyle, J., Mattern, C. O., Lassiter, J. W., & Ritzler, J. A. (2011). Peer 2 Peer: Efficacy of a Course-Based Peer Education Intervention to Increase Physical Activity Among College Students. *Journal of American College Health*, *59*(6), 519–529. https://doi.org/10.1080/07448481.2010.523854

Brécard, D., Hlaimi, B., Lucas, S., Perraudeau, Y., & Salladarré, F. (2009). Determinants of demand for green products: An application to eco-label demand for fish in Europe. *Ecological Economics*, *69*(1), 115–125. https://doi.org/10.1016/j.ecolecon.2009.07.017

Breland, J. Y., Wong, J. J., & McAndrew, L. M. (2020). Are Common Sense Model constructs and self-efficacy simultaneously correlated with self-management behaviors and health outcomes: A systematic review. *Health Psychology Open*, *7*(1), 2055102919898846. https://doi.org/10.1177/2055102919898846

Bright, A. D., & Manfredo, M. J. (1996). A conceptual model of attitudes toward natural resource issues: A case study of wolf reintroduction. *Human Dimensions of Wildlife*, *1*(1), 1–21. https://doi.org/10.1080/10871209609359048

Bright, A. D., Manfredo, M. J., & Fulton, D. C. (2000). Segmenting the Public: An Application of Value Orientations to Wildlife Planning in Colorado. *Wildlife Society Bulletin (1973-2006)*, *28*(1), 218–226.

Broady, K., Booth-Bell, D., & Griffin, T. (2022). *Seven Economic Facts about the U.S. Racial Wealth Gap*. https://doi.org/10.21033/wp-2022-32

Burger, J. M., Messian, N., Patel, S., del Prado, A., & Anderson, C. (2004). What a coincidence! The effects of incidental similarity on compliance. *Personality and Social Psychology Bulletin*, *30*, 35–43.

Burghardt, K. T., Tallamy, D. W., & Gregory Shriver, W. (2009). Impact of Native Plants on Bird and Butterfly Biodiversity in Suburban Landscapes. *Conservation Biology*, *23*(1), 219–224. https://doi.org/10.1111/j.1523-1739.2008.01076.x

Burn, S. M. (1991). Social Psychology and the Stimulation of Recycling Behaviors: The Block Leader Approach. *Journal of Applied Social Psychology*, *21*(8), 611–629. https://doi.org/10.1111/j.1559-1816.1991.tb00539.x

Byerly, H., Balmford, A., Ferraro, P. J., Hammond Wagner, C., Palchak, E., Polasky, S., Ricketts, T. H., Schwartz, A. J., & Fisher, B. (2018). Nudging pro-environmental behavior: Evidence and opportunities. *Frontiers in Ecology and the Environment*, *16*(3), 159–168. https://doi.org/10.1002/fee.1777

Byrne, L. B., & Grewal, P. (2008). Introduction to Ecological Landscaping: A Holistic Description and Framework to Guide the Study and Management of Urban Landscape Parcels. *Cities and the Environment*, *1*(2), 1–20. https://doi.org/10.15365/cate.1232008

Carrico, A. R., Fraser, J., & Bazuin, J. T. (2013). Green With Envy: Psychological and Social Predictors of Lawn Fertilizer Application. *Environment and Behavior*, *45*(4), 427–454. https://doi.org/10.1177/0013916511434637

Carrico, A. R., & Riemer, M. (2011). Motivating energy conservation in the workplace: An evaluation of the use of group-level feedback and peer education | Elsevier Enhanced Reader. *Journal of Environmental Psychology*, *31*, 1–13. https://doi.org/10.1016/j.jenvp.2010.11.004

Carrington, M. J., Neville, B. A., & Whitwell, G. J. (2010). Why Ethical Consumers Don't Walk Their Talk: Towards a Framework for Understanding the Gap Between the Ethical Purchase Intentions and Actual Buying Behaviour of Ethically Minded Consumers. *Journal of Business Ethics*, *97*(1), 139–158. https://doi.org/10.1007/s10551-010-0501-6

Chabé-Ferret, S. (2021). *Statistical Tools for Causal Inference*. https://chabefer.github.io/STCI/

Champine, V., Jones, M., Lischka, S., Vaske, J., & Niemiec, R. (2022). Understanding Individual and Diffusion Behaviors Related to Native Plant Gardening. *Journal of Environmental Psychology*, *81*. https://doi. org/10.1016/j.jenvp.2022.101798

Champine, V. M., Jones, M. S., & Niemiec, R. M. (in review). *Encouraging Social Diffusion of Pro-Environmental Behavior through Webinar-based Efficacy and Norms Interventions*. osf.io/zgaqf

Chaudhury, A., & Colla, S. (2021). Next steps in dismantling discrimination: Lessons from ecology and conservation science. *Conservation Letters*, *14*(2), e12774. https://doi.org/10.1111/conl.12774

Chen, M.-F. (2015). Self-efficacy or collective efficacy within the cognitive theory of stress model: Which more effectively explains people's self-reported proenvironmental behavior? *Journal of Environmental Psychology*, *42*, 66–75. https://doi.org/10.1016/j.jenvp.2015.02.002

Chetverikov, D., Zhipeng Liao, & Victor Chernozhukov. (2021). On cross-validated Lasso in high dimensions. *The Annals of Statistics*, *49*(3), 1300–1317. https://doi.org/10.1214/20-AOS2000

Choi, S., & Hart, P. S. (2021). The influence of different efficacy constructs on energy conservation intentions and climate change policy support. *Journal of Environmental Psychology*, *75*, 101618. https://doi.org/10.1016/j.jenvp.2021.101618

Chryst, B., Marlon, J., van der Linden, S., Leiserowitz, A., Maibach, E., & Roser-Renouf, C. (2018). Global Warming's "Six Americas Short Survey": Audience Segmentation of Climate Change Views Using a Four Question Instrument. *Environmental Communication*, *12*(8), 1109–1122. https://doi.org/10.1080/17524032.2018.1508047

Cialdini, R. B. (2001). The Science of Persuasion. *Scientific American*, *284*(2), 76–81.

Cialdini, R. B. (2003). Crafting Normative Messages to Protect the Environment. *Current Directions in Psychological Science*, *12*(4), 105–109. https://doi.org/10.1111/1467-8721.01242

Cialdini, R. B., Kallgren, C. A., & Reno, R. R. (1991). A Focus Theory of Normative Conduct: A Theoretical Refinement and Reevaluation of the Role of Norms in Human Behavior. In *Advances in Experimental Social Psychology* (Vol. 24, pp. 201–234). Elsevier. https://doi.org/10.1016/S0065-2601(08)60330-5

Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology*, *58(6)*, 1015.

City of Fort Collins, U. (n.d.). *Xeriscape Incentive Program*. Retrieved October 5, 2021, from https://www.fcgov.com/utilities/residential/conserve/water-efficiency/xeriscape/incentive-program

Clayton, S. (2007). Domesticated nature: Motivations for gardening and perceptions of environmental impact. *Journal of Environmental Psychology*, *27*(3), 215–224. https://doi.org/10.1016/j.jenvp.2007.06.001

Conole, G. (2014). The Use of Technology in Distance Education. In *Online Distance Education* (pp. 217–236). AU Press, Athabasca University.

Cook, E. M., Hall, S. J., & Larson, K. L. (2012). Residential landscapes as social-ecological systems: A synthesis of multi-scalar interactions between people and their home environment. *Urban Ecosystems*, *15*(1), 19–52. https://doi.org/10.1007/s11252-011-0197-0

Crawford, B. A., Poudyal, N. C., & Maerz, J. C. (2015). When Drivers and Terrapins Collide: Assessing Stakeholder Attitudes Toward Wildlife Management on the Jekyll Island Causeway. *Human Dimensions of Wildlife*, *20*(1), 1–14. https://doi.org/10.1080/10871209.2014.948103

Culiberg, B., & Elgaaied-Gambier, L. (2016). Going green to fit in - understanding the impact of social norms on pro-environmental behaviour, a cross-cultural approach: Going green to fit in. *International Journal of Consumer Studies*, *40*(2), 179–185. https://doi.org/10.1111/ijcs.12241

Davies, Z. G., Fuller, R. A., Loram, A., Irvine, K. N., Sims, V., & Gaston, K. J. (2009). A national scale inventory of resource provision for biodiversity within domestic gardens. *Biological Conservation*, *142*(4), 761–771. https://doi.org/10.1016/j.biocon.2008.12.016

de Groot, R. S., Wilson, M. A., & Boumans, R. M. J. (2002). A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economics*, *41*(3), 393–408. https://doi.org/10.1016/S0921-8009(02)00089-7

Digby, C. L. B. (2013). The Influences of Socio-demographic Factors, and Non-formal and Informal Learning Participation on Adult Environmental Behaviors. *International Electronic Journal of Environmental Education*, *3*(1), 37–55.

Doran, G. T. (1981). There's a S.M.A.R.T. way to write managements's goals and objectives. *Management Review*, *70*(11), 35.

Ebner, C., & Gegenfurtner, A. (2019). Learning and Satisfaction in Webinar, Online, and Face-to-Face Instruction: A Meta-Analysis. *Frontiers in Education*, *4*. https://www.frontiersin.org/articles/10.3389/feduc.2019.00092

Estabrooks, P. A., Lee, R. E., & Gyurcsik, N. C. (2003). Resources for physical activity participation: Does availability and accessibility differ by neighborhood socioeconomic status? *Annals of Behavioral Medicine*, *25*(2), 100–104. https://doi.org/10.1207/S15324796ABM2502_05

Fallon, C. (2022). Consumer Gardening Report Finds One in Three People Turning to Native Plants, Gardening for Wildlife. *National Wildlife Federation*. https://www.nwf.org/Home/Latest-News/Press-Releases/2022/5-02-22-Consumer-Gardening-Report

Farrow, K., Grolleau, G., & Ibanez, L. (2017a). Social Norms and Pro-environmental Behavior: A Review of the Evidence. *Ecological Economics*, *140(C)*, 1–13. https://doi.org/10.1016/j.ecolecon.2017.04.017

https://doi.org/10.1016/j.ecolecon.2017.04.017

Fauville, G., Luo, M., Queiroz, A. C. M., Bailenson, J. N., & Hancock, J. (2021). Nonverbal Mechanisms Predict Zoom Fatigue and Explain Why Women Experience Higher Levels than Men. *Social Science Research Network*.

Feinberg, M., & Willer, R. (2013). The Moral Roots of Environmental Attitudes. *Psychological Science*, *24*(1), 56–62. https://doi.org/10.1177/0956797612449177

Feldman, L., & Hart, P. S. (2016). Using Political Efficacy Messages to Increase Climate Activism: The Mediating Role of Emotions. *Science Communication*, *38*(1), 99–127.

Ferraro, P. J., & Price, M. K. (2013). Using Nonpecuniary Strategies to Influence Behavior: Evidence from a Large-Scale Field Experiment. *The Review of Economics and Statistics*, *95*(1), 64–73. http://dx.doi.org/10.1162/REST_a_00344

Festinger, L. (1954). A theory of social comparison processes. *Human Relations*, *7*, 117–140. https://doi.org/10.1177/001872675400700202

Fischer, A., Selge, S., van der Wal, R., & Larson, B. M. H. (2014). The Public and Professionals Reason Similarly about the Management of Non-Native Invasive Species: A Quantitative Investigation of the Relationship between Beliefs and Attitudes. *PLoS ONE*, *9*(8), e105495. https://doi.org/10.1371/journal.pone.0105495

Fishbein, M., & Ajzen, I. (1975). *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research*. Addison-Wesley.

Fishbein, M., Hennessy, M., Yzer, M., & Douglas, J. (2003). Can we explain why some people do and some people do not act on their intentions? *Psychology, Health & Medicine*, *8*(1), 3–18. https://doi.org/10.1080/1354850021000059223

Fishbein, M., & Yzer, M. C. (2003). Using Theory to Design Effective Health Behavior Interventions. *Communication Theory*, *13*(2), 164–183. https://doi.org/10.1111/j.1468-2885.2003.tb00287.x

Frank, L. B., Chatterjee, J. S., Chaudhuri, S. T., Lapsansky, C., Bhanot, A., & Murphy, S. T. (2012). Conversation and Compliance: Role of Interpersonal Discussion and Social

Norms in Public Communication Campaigns. *Journal of Health Communication*, *17*(9), 1050–1067. https://doi.org/10.1080/10810730.2012.665426

Freeman, S., Taff, B. D., Miller, Z. D., Benfield, J. A., & Newman, P. (2021). Mutualism Wildlife Value Orientations Predict Support for Messages About Distance-Related Wildlife Conflict. *Environmental Management*, *67*(5), 920–929. https://doi.org/10.1007/s00267-020-01414-1

Friedman, J., Hastie, T., & Tibshirani, R. (2010). Regularization Paths for Generalized Linear Models via Coordinate Descent. *Journal of Statistical Software*, *33*(1), 1–22.

Fritsche, I., Barth, M., Jugert, P., Masson, T., & Reese, G. (2018). A Social Identity Model of Pro-Environmental Action (SIMPEA). *Psychological Review*, *125*(2), 245–269. https://doi.org/10.1037/rev0000090

Fukase, J. (2016). Increased Pollinator Activity in Urban Gardens with More Native Flora. *Applied Ecology and Environmental Research*, *14*(1), 297–310. https://doi.org/10.15666/aeer/1401_297310

Garbuzov, M., Fensome, K. A., & Ratnieks, F. L. W. (2015). Public approval plus more wildlife: Twin benefits of reduced mowing of amenity grass in a suburban public park in Saltdean, UK. *Insect Conservation and Diversity*, *8*(2), 107–119. https://doi.org/10.1111/icad.12085

Garbuzov, M., & Ratnieks, F. L. W. (2014). Quantifying variation among garden plants in attractiveness to bees and other flower-visiting insects. *Functional Ecology*, *28*(2), 364–374. https://doi.org/10.1111/1365-2435.12178

Gardiner, M. M., Burkman, C. E., & Prajzner, S. P. (2013). The Value of Urban Vacant Land to Support Arthropod Biodiversity and Ecosystem Services. *Environmental Entomology*, *42*(6), 1123–1136. https://doi.org/10.1603/EN12275

Geiger, N., & Swim, J. K. (2016). Climate of silence: Pluralistic ignorance as a barrier to climate change discussion. *Journal of Environmental Psychology*, *47*, 79–90. https://doi.org/10.1016/j.jenvp.2016.05.002

Geiger, N., Swim, J. K., & Fraser, J. (2017). Creating a climate for change: Interventions, efficacy and public discussion about climate change. *Journal of Environmental Psychology*, *51*, 104–116. https://doi.org/10.1016/j.jenvp.2017.03.010

Gelman, A. (2019). Don't Calculate Post-hoc Power Using Observed Estimate of Effect Size. *Annals of Surgery*, *269*(1), e9–e10. https://doi.org/10.1097/SLA.0000000000002908

Gelman, A. (2018). You need 16 times the sample size to estimate an interaction than to estimate a main effect | Statistical Modeling, Causal Inference, and Social Science. *Statistical Modeling, Causal Inference, and Social Science*. https://statmodeling.stat.columbia.edu/2018/03/15/need-16-times-sample-size-estimate-interaction-estimate-main-effect/

Gill, R. J., Baldock, K. C. R., Brown, M. J. F., Cresswell, J. E., Dicks, L. V., Fountain, M. T., Garratt, M. P. D., Gough, L. A., Heard, M. S., Holland, J. M., Ollerton, J., Stone, G. N., Tang, C. Q., Vanbergen, A. J., Vogler, A. P., Woodward, G., Arce, A. N., Boatman, N. D., Brand-Hardy, R., … Potts, S. G. (2016). Protecting an Ecosystem Service. In *Advances in Ecological Research* (Vol. 54, pp. 135–206). Elsevier. https://doi.org/10.1016/bs.aecr.2015.10.007

Gillis, A. J., & Swim, J. K. (2020). Adding native plants to home landscapes: The roles of attitudes, social norms, and situational strength. *Journal of Environmental Psychology*, *72*, 101519. https://doi.org/10.1016/j.jenvp.2020.101519

Gobster, P. H., Nassauer, J. I., Daniel, T. C., & Fry, G. (2007). The shared landscape: What does aesthetics have to do with ecology? *Landscape Ecology*, *22*(7), 959–972. https://doi.org/10.1007/s10980-007-9110-x

Goddard, M. A., Dougill, A. J., & Benton, T. G. (2010). Scaling up from gardens: Biodiversity conservation in urban environments. *Trends in Ecology & Evolution*, *25*(2), 90–98. https://doi.org/10.1016/j.tree.2009.07.016

Goddard, M. A., Dougill, A. J., & Benton, T. G. (2013). Why garden for wildlife? Social and ecological drivers, motivations and barriers for biodiversity management in residential landscapes. *Ecological Economics*, *86*, 258–273. https://doi.org/10.1016/j.ecolecon.2012.07.016

Goldberg, M. H., van der Linden, S., Maibach, E., & Leiserowitz, A. (2019). Discussing global warming leads to greater acceptance of climate science. *Proceedings of the National Academy of Sciences*, *116*(30), 14804–14805. https://doi.org/10.1073/pnas.1906589116

Goldstein, N. J., Cialdini, R. B., & Griskevicius, V. (2008). A Room with a Viewpoint: Using Social Norms to Motivate Environmental Conservation in Hotels. *Journal of Consumer Research*, *35*(3), 472–482. https://doi.org/10.1086/586910

Gould, R. K., Phukan, I., Mendoza, M. E., Ardoin, N. M., & Panikkar, B. (2018). Seizing opportunities to diversify conservation. *Conservation Letters*, *11*(4), e12431. https://doi.org/10.1111/conl.12431

Graham-Rowe, E., Jessop, D. C., & Sparks, P. (2015). Predicting household food waste reduction using an extended theory of planned behaviour. *Resources, Conservation and Recycling*, *101*, 194–202. https://doi.org/10.1016/j.resconrec.2015.05.020

Green, D. P., & McClellan, O. A. (2020). *Turnout Nation: A Pilot Experiment Evaluating a Get-Out-The-Vote "Supertreatment."* Turnout Nation. https://www.turnoutnation.org/thereport

Green2.0. (2022). *2022 NGO and Foundation Transparency Report Card* (p. 179).

Groce, J. E., Farrelly, M. A., Jorgensen, B. S., & Cook, C. N. (2019). Using social-network research to improve outcomes in natural resource management. *Conservation Biology*, *33*(1), 53–65. https://doi.org/10.1111/cobi.13127

Grove, M., Ogden, L., Pickett, S., Boone, C., Buckley, G., Locke, D. H., Lord, C., & Hall, B. (2018). The Legacy Effect: Understanding How Segregation and Environmental Injustice Unfold over Time in Baltimore. *Annals of the American Association of Geographers*, *108*(2), 524–537. https://doi.org/10.1080/24694452.2017.1365585

Groves, R. M., Presser, S., & Dipko, S. (2004). The Role of Topic Interest in Survey Participation Decisions. *Public Opinion Quarterly*, *68*(1), 2–31. https://doi.org/10.1093/poq/nfh002

Gulliver, R. E., Star, C., Fielding, K. S., & Louis, W. R. (2022). A systematic review of the outcomes of sustained environmental collective action. *Environmental Science & Policy*, *133*, 180–192. https://doi.org/10.1016/j.envsci.2022.03.020

Haase, D., Kabisch, S., Haase, A., Andersson, E., Banzhaf, E., Baró, F., Brenck, M., Fischer, L. K., Frantzeskaki, N., Kabisch, N., Krellenberg, K., Kremer, P., Kronenberg, J., Larondelle, N., Mathey, J., Pauleit, S., Ring, I., Rink, D., Schwarz, N., & Wolff, M.

(2017). Greening cities – To be socially inclusive? About the alleged paradox of society and ecology in cities. *Habitat International*, *64*, 41–48. https://doi.org/10.1016/j.habitatint.2017.04.005

Haidt, J., & Graham, J. (2007). When Morality Opposes Justice: Conservatives Have Moral Intuitions that Liberals may not Recognize. *Social Justice Research*, *20*(1), 98–116. https://doi.org/10.1007/s11211-007-0034-z

Haidt, J., & Joseph, C. (2004). Intuitive ethics: How innately prepared intuitions generate culturally variable virtues. *Daedalus*, *133*(4), 55–66. https://doi.org/10.1162/0011526042365555

Haluza-Delay, R. (2001). Nothing Here to Care About: Participant Constructions of Nature Following a 12-Day Wilderness Program. *The Journal of Environmental Education*, *32*(4), 43–48. https://doi.org/10.1080/00958960109598662

Hamann, K. R. S., & Reese, G. (2020). My Influence on the World (of Others): Goal Efficacy Beliefs and Efficacy Affect Predict Private, Public, and Activist Pro-environmental Behavior. *Journal of Social Issues*, *76*(1), 35–53. https://doi.org/10.1111/josi.12369

Han, H., & Hyun, S. S. (2018). What influences water conservation and towel reuse practices of hotel guests? *Tourism Management*, *64*, 87–97. https://doi.org/10.1016/j.tourman.2017.08.005

Hassan, L. M., Shiu, E., & Shaw, D. (2016). Who Says There is an Intention–Behaviour Gap? Assessing the Empirical Evidence of an Intention–Behaviour Gap in Ethical Consumption. *Journal of Business Ethics*, *136*(2), 219–236. https://doi.org/10.1007/s10551-014-2440-0

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The weirdest people in the world? *Behavioral and Brain Sciences*, *33*(2–3), 61–83. https://doi.org/10.1017/S0140525X0999152X

Hirt, S. A. (2015). Zoned in the USA. In *Zoned in the USA*. Cornell University Press. https://www.degruyter.com/document/doi/10.7591/9780801454714/html

Hopper, J. R., & Nielsen, J. M. (1991). Recycling as altruistic behavior: Normative and behavioral strategies to expand participation in a community recycling program. *Environment and Behavior*, *23*(2), 195–220. https://doi.org/10.1177/0013916591232004

Howell, A. P., Shaw, B. R., & Alvarez, G. (2015). Bait Shop Owners as Opinion Leaders: A Test of the Theory of Planned Behavior to Predict Pro-Environmental Outreach Behaviors and Intentions. *Environment and Behavior*, *47*(10), 1107–1126. https://doi.org/10.1177/0013916514539684

Huang, X., Mayer, R. E., & Usher, E. L. (2020). Better together: Effects of four self-efficacy-building strategies on online statistical learning. *Contemporary Educational Psychology*, *63*, 101924. https://doi.org/10.1016/j.cedpsych.2020.101924

Hurd, B. H., St. Hilaire, R., & White, J. M. (2006). Residential Landscapes, Homeowner Attitudes, and Water-wise Choices in New Mexico. *HortTechnology*, *16*(2), 241–246. https://doi.org/10.21273/HORTTECH.16.2.0241

Ives, C. D., Lentini, P. E., Threlfall, C. G., Ikin, K., Shanahan, D. F., Garrard, G. E., Bekessy, S. A., Fuller, R. A., Mumaw, L., Rayner, L., Rowe, R., Valentine, L. E., & Kendal, D. (2016). Cities are hotspots for threatened species: The importance of cities for threatened species. *Global Ecology and Biogeography*, *25*(1), 117–126. https://doi.org/10.1111/geb.12404

Jaeger, C. M., & Schultz, P. W. (2017). Coupling social norms and commitments: Testing the underdetected nature of social influence. *Journal of Environmental Psychology*, *51*, 199–208. https://doi.org/10.1016/j.jenvp.2017.03.015

Jenerette, G. D., Harlan, S. L., Stefanov, W. L., & Martin, C. A. (2011). Ecosystem services and urban heat riskscape moderation: Water, green spaces, and social inequality in Phoenix, USA. *Ecological Applications*, *21*(7), 2637–2651. https://doi.org/10.1890/10-1493.1

Jones, M. S., & Niemiec, R. M. (2020). Social-psychological correlates of personal-sphere and diffusion behavior for wildscape gardening. *Journal of Environmental Management*, *276*, 111271. https://doi.org/10.1016/j.jenvman.2020.111271

Jones, M. S., & Niemiec, R. M. (2023). Motivating relational organizing behavior for biodiversity conservation. *Conservation Science and Practice*. https://doi.org/10.1111/csp2.12880

Jones, M. S., Sekar, S., Dillard, C., Mertens, A., & Sparkman, G. (in prep). *Who Will Advocate for a Sustainable Diet? Understanding the Psychological Predictors of Relational Organizing*.

Jones, M. S., Teel, T. L., Solomon, J., & Weiss, J. (2021). Evolving systems of pro-environmental behavior among wildscape gardeners. *Landscape and Urban Planning*, *207*, 104018. https://doi.org/10.1016/j.landurbplan.2020.104018

Joshi, A. (2022). Motivating sustainable behaviors by framing biodiversity loss as a public health risk. *Journal of Risk Research*, *25*(2), 156–175. https://doi.org/10.1080/13669877.2021.1913634

Jugert, P., Greenaway, K. H., Barth, M., Büchner, R., Eisentraut, S., & Fritsche, I. (2016). Collective efficacy increases pro-environmental intentions through increasing self-

efficacy. *Journal of Environmental Psychology*, *48*, 12–23. https://doi.org/10.1016/j.jenvp.2016.08.003

Kallgren, C. A., Reno, R. R., & Cialdini, R. B. (2000). A Focus Theory of Normative Conduct: When Norms Do and Do not Affect Behavior. *Personality and Social Psychology Bulletin*, *26*(8), 1002–1012. https://doi.org/10.1177/01461672002610009

Kan, M. P. H., & Fabrigar, L. R. (2017). Theory of Planned Behavior. In V. Zeigler-Hill & T. K. Shackelford (Eds.), *Encyclopedia of Personality and Individual Differences* (pp. 1–8). Springer International Publishing. https://doi.org/10.1007/978-3-319-28099-8_1191-1

Kaplan, R. (2001). The Nature of the View from Home: Psychological Benefits. *Environment and Behavior*, *33*(4), 507–542. https://doi.org/10.1177/00139160121973115

Kashima, Y., Wilson, S., Lusher, D., Pearson, L. J., & Pearson, C. (2013). The acquisition of perceived descriptive norms as social category learning in social networks. *Social Networks*, *35*(4), 711–719. https://doi.org/10.1016/j.socnet.2013.06.002

Keniger, L., Gaston, K., Irvine, K., & Fuller, R. (2013). What are the Benefits of Interacting with Nature? *International Journal of Environmental Research and Public Health*, *10*(3), 913–935. https://doi.org/10.3390/ijerph10030913

Kidd, L. R., Garrard, G. E., Bekessy, S. A., Mills, M., Camilleri, A. R., Fidler, F., Fielding, K. S., Gordon, A., Gregg, E. A., Kusmanoff, A. M., Louis, W., Moon, K., Robinson, J. A., Selinske, M. J., Shanahan, D., & Adams, V. M. (2019). Messaging matters: A systematic review of the conservation messaging literature. *Biological Conservation*, 92–99.

Kiesling, F. M., & Manning, C. M. (2010). How green is your thumb? Environmental gardening identity and ecological gardening practices. *Journal of Environmental Psychology*, *30*(3), 315–327. https://doi.org/10.1016/j.jenvp.2010.02.004

Kim, H., Lee, E.-J., & Hur, W.-M. (2012). The Mediating Role of Norms in the Relationship between Green Identity and Purchase Intention of Eco-friendly Products. *Human Ecology Review*, *19*(2), 125–135.

Kinzig, A. P., Warren, P., Martin, C., Hope, D., & Katti, M. (2005). The Effects of Human Socioeconomic Status and Cultural Characteristics on Urban Patterns of Biodiversity. *Ecology and Society*, *10*(1), art23. https://doi.org/10.5751/ES-01264-100123

Klaus, V. H., & Kiehl, K. (2021). A conceptual framework for urban ecological restoration and rehabilitation. *Basic and Applied Ecology*, *52*, 82–94. https://doi.org/10.1016/j.baae.2021.02.010

Klein, A.-M., Vaissière, B. E., Cane, J. H., Steffan-Dewenter, I., Cunningham, S. A., Kremen, C., & Tscharntke, T. (2007). Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society B: Biological Sciences*, *274*(1608), 303–313. https://doi.org/10.1098/rspb.2006.3721

Kollmuss, A., & Agyeman, J. (2002). Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research*, *8*(3), 239–260. https://doi.org/10.1080/13504620220145401

Kurz, T., & Baudains, C. (2012). Biodiversity in the Front Yard: An Investigation of Landscape Preference in a Domestic Urban Context. *Environment and Behavior*, *44*(2), 166–196. https://doi.org/10.1177/0013916510385542

Kurz, T., Prosser, A. M. B., Rabinovich, A., & O'Neill, S. (2020). Could Vegans and Lycra Cyclists be Bad for the Planet? Theorizing the Role of Moralized Minority Practice Identities in Processes of Societal-Level Change. *Journal of Social Issues*, *76*(1), 86–100. https://doi.org/10.1111/josi.12366

Lange, F. (2018). The Pro-Environmental Behavior Task: A laboratory measure of actual pro-environmental behavior. *Journal of Environmental Psychology*, 9.

Lapinski, M. K., & Rimal, R. N. (2005). An Explication of Social Norms. *Communication Theory*, *15*(2), 127–147. https://doi.org/10.1111/j.1468-2885.2005.tb00329.x

Larsen, L., & Harlan, S. (2006). Desert dreamscapes: Residential landscape preference and behavior. *Landscape and Urban Planning*, *78*(1–2), 85–100. https://doi.org/10.1016/j.landurbplan.2005.06.002

Larsen, L., Harlan, S. L., Bolin, B., Hackett, E. J., Hope, D., Kirby, A., Nelson, A., Rex, T. R., & Wolf, S. (2004). Bonding and Bridging: Understanding the Relationship between Social Capital and Civic Action. *Journal of Planning Education and Research*, *24*(1), 5–115. https://doi.org/10.1177/0739456X04267181

Larson, K. L., Hoffman, J., & Ripplinger, J. (2017). Legacy effects and landscape choices in a desert city. *Landscape and Urban Planning*, *165*, 22–29. https://doi.org/10.1016/j.landurbplan.2017.04.014

Larson, L. R., Stedman, R. C., Cooper, C. B., & Decker, D. J. (2015). Understanding the multi-dimensional structure of pro-environmental behavior. *Journal of Environmental Psychology*, *43*, 112–124. https://doi.org/10.1016/j.jenvp.2015.06.004

Leiserowitz, A., Maibach, E., Rosenthal, S., Kotcher, J., Carman, J., Neyens, L., Marlon, J., Lacroix, K., & Goldberg, M. (2021a). *Climate Change in the American Mind*. Yale University and George Mason University.

Leiserowitz, A., Maibach, E., & Roser-Renouf, C. (2009). *Global Warming's Six Americas: An Audience Segmentation Analysis* (pp. 1–139). George Mason University.

Leiserowitz, A., Roser-Renouf, C., Marlon, J., & Maibach, E. (2021b). Global Warming's Six Americas: A review and recommendations for climate change communication. *Current Opinion in Behavioral Sciences*. https://doi.org/10.1016/j.cobeha.2021.04.007

Lerman, S. B., & Warren, P. S. (2011). The conservation value of residential yards: Linking birds and people. *Ecological Applications*, *21*(4), 1327–1339. https://doi.org/10.1890/10-0423.1

Li, D., Zhao, L., Ma, S., Shao, S., & Zhang, L. (2019). What influences an individual's pro-environmental behavior? A literature review. *Resources, Conservation and Recycling*, *146*, 28–34. https://doi.org/10.1016/j.resconrec.2019.03.024

Linzer, D. A., & Lewis, J. (2011). PoLCA: an R Package for Polytomous Variable Latent Class Analysis. *Journal of Statistical Software*, *42*(10), 1–29.

Linzer, D. A., & Lewis, J. (2022). *PoLCA; Polytomous Variable Latent Class Analysis* (1.6.01). http://dlinzer.github.com/poLCA

Lischka, S. A., Teel, T. L., Johnson, H. E., Reed, S. E., Breck, S., Don Carlos, A., & Crooks, K. R. (2018). A conceptual model for the integration of social and ecological information to understand human-wildlife interactions. *Biological Conservation*, *225*, 80–87. https://doi.org/10.1016/j.biocon.2018.06.020

López-Mosquera, N., Lera-López, F., & Sánchez, M. (2015). Key factors to explain recycling, car use and environmentally responsible purchase behaviors: A comparative perspective. *Resources, Conservation and Recycling*, *99*, 29–39. https://doi.org/10.1016/j.resconrec.2015.03.007

Lubell, M., Zahran, S., & Vedlitz, A. (2007). Collective Action and Citizen Responses to Global Warming. *Political Behavior*, *29*(3), 391–413. https://doi.org/10.1007/s11109-006-9025-2

Ma, Z., Kittredge, D. B., & Catanzaro, P. (2012). Insights into Individual and Cooperative Invasive Plant Management on Family Forestlands. *Small-Scale Forestry*, *11*, 87–100.

MacDonald, E., Harbrow, M., Jack, S., Kidd, J., Wright, A., Tuinder, P., Balanovic, J., Medvecky, F., & Poutasi, M. (2019). Segmenting urban populations for greater conservation gains: A new approach targeting cobenefits is required. *Conservation Science and Practice*, *1*(10), e101. https://doi.org/10.1111/csp2.101

Maki, A., & Raimi, K. T. (2017). Environmental peer persuasion: How moral exporting and belief superiority relate to efforts to influence others. *Journal of Environmental Psychology*, *49*, 18–29. https://doi.org/10.1016/j.jenvp.2016.11.005

Maniates, M. F. (2001). Individualization: Plant a Tree, Buy a Bike, Save the World? *Global Environmental Politics*, *1*(3), 31–52. https://doi.org/10.1162/152638001316881395

Matthies, E., Selge, S., & Klöckner, C. A. (2012). The role of parental behaviour for the development of behaviour specific environmental norms – the example of recycling and re-use behaviour. *Journal of Environmental Psychology*, *32*(3), 277–284. https://doi.org/10.1016/j.jenvp.2012.04.003. Mbaru, E.K., Barnes, M.L., 2017.

Matulis, B. S., & Moyer, J. R. (2017). Beyond Inclusive Conservation: The Value of Pluralism, the Need for Agonism, and the Case for Social Instrumentalism: Beyond inclusive conservation. *Conservation Letters*, *10*(3), 279–287. https://doi.org/10.1111/conl.12281

Maxwell, S. E., Delaney, H. D., & Kelley, K. (2018). *Designing Experiments and Analyzing Data: A Model Comparison Perspective* (3rd ed.). Routledge.

Mbaru, E. K., & Barnes, M. L. (2017). Key players in conservation diffusion: Using social network analysis to identify critical injection points. *Biological Conservation*, *210*, 222–232. https://doi.org/10.1016/j.biocon.2017.03.031

McCleary, L. (2002). Using multiple imputation for analysis of incomplete data in clinical research. *Nursing Research*, *51*(5), 339–343. https://doi.org/10.1097/00006199-200209000-00012

McDonald, M. P. (2023). *US Elections Project*. US Elections Project. https://www.electproject.org/home

Mckenzie, D., & Ozier, O. (2019). Why ex-post power using estimated effect sizes is bad, but an ex-post MDE is not. *Why Ex-Post Power Using Estimated Effect Sizes Is Bad, but an Ex-Post MDE Is Not*. https://blogs.worldbank.org/impactevaluations/why-ex-post-power-using-estimated-effect-sizes-bad-ex-post-mde-not

McKiernan, S. (2017). Managing Invasive Plants in a Rural-amenity Landscape: The Role of Social Capital and Landcare. *Journal of Environmental Planning and Management*, *61*, 1419–1437.

McNeish, D. M. (2015). Using Lasso for Predictor Selection and to Assuage Overfitting: A Method Long Overlooked in Behavioral Sciences. *Multivariate Behavioral Research*, *50*(5), 471–484. https://doi.org/10.1080/00273171.2015.1036965

Measuring Religion in Pew Research Center's American Trends Panel. (2021). *Pew Research Center*. https://www.pewresearch.org/religion/2021/01/14/measuring-religion-in-pew-research-centers-american-trends-panel/

Medley, A., Kennedy, C., O'Reilly, K., & Sweat, M. (2009). Effectiveness of Peer Education Interventions for HIV Prevention in Developing Countries: A Systematic Review and

Meta-Analysis. *AIDS Education and Prevention : Official Publication of the International Society for AIDS Education*, *21*(3), 181–206. https://doi.org/10.1521/aeap.2009.21.3.181

Meijers, M. H. C., Remmelswaal, P., & Wonneberger, A. (2019). Using Visual Impact Metaphors to Stimulate Environmentally Friendly Behavior: The Roles of Response Efficacy and Evaluative Persuasion Knowledge. *Environmental Communication*, *13*(8), 995–1008. https://doi.org/10.1080/17524032.2018.1544160

Meijers, M. H. C., Smit, E. S., de Wildt, K., Karvonen, S.-G., van der Plas, D., & van der Laan, L. N. (2022). Stimulating Sustainable Food Choices Using Virtual Reality: Taking an Environmental vs Health Communication Perspective on Enhancing Response Efficacy Beliefs. *Environmental Communication*, *16*(1), 1–22. https://doi.org/10.1080/17524032.2021.1943700

Meire, M., Ballings, M., & Van den Poel, D. (2016). *Impute Missing Values in a Predictive Context* (0.0.3). https://cran.r-project.org/web/packages/imputeMissings/imputeMissings.pdf

Mertens, A., & Arnold, B. (2018). *washb: An internal R software package to facilitate and standardize intention-to-treat analyses in the WASH Benefits trials* (0.2.2).

Mertens, D. M. (2019). *Research and Evaluation in Education and Psychology* (5th ed.). SAGE Publications, Inc. https://us.sagepub.com/en-us/nam/research-and-evaluation-in-education-and-psychology/book259357

Milesi, C., Elvidge, C. D., Dietz, J. B., Tuttle, B. T., Nemani, R. R., & Running, S. W. (2005). *A Strategy for Mapping and Modeling the Ecological Effects of US Lawns*. 6.

Milfont, T. L. (2009). The effects of social desirability on self-reported environmental attitudes and ecological behaviour. *The Environmentalist*, *29*(3), 263–269. https://doi.org/10.1007/s10669-008-9192-2

Milfont, T. L., Osborne, D., Yogeeswaran, K., & Sibley, C. G. (2020). The role of national identity in collective pro-environmental action. *Journal of Environmental Psychology*, *72*, 101522. https://doi.org/10.1016/j.jenvp.2020.101522

Millenium Ecosystem Assessment. (2005). *Ecosystems and Human Well-being: Synthesis.* Island Press.

Miller, Z. D., Freimund, W., Metcalf, E. C., & Nickerson, N. (2018). Targeting your audience: Wildlife value orientations and the relevance of messages about bear safety. *Human Dimensions of Wildlife*, *23*(3), 213–226. https://doi.org/10.1080/10871209.2017.1409371

Morren, M., & Grinstein, A. (2021). The cross-cultural challenges of integrating personal norms into the Theory of Planned Behavior: A meta-analytic structural equation modeling (MASEM) approach. *Journal of Environmental Psychology*, *75*, 101593. https://doi.org/10.1016/j.jenvp.2021.101593

Morse, J. W., Gladkikh, T. M., Hackenburg, D. M., & Gould, R. K. (2020). COVID-19 and human-nature relationships: Vermonters' activities in nature and associated nonmaterial values during the pandemic. *PLOS ONE*, *15*(12), e0243697. https://doi.org/10.1371/journal.pone.0243697

Mumaw, L. M., & Raymond, C. M. (2021). A framework for catalysing the rapid scaling of urban biodiversity stewardship programs. *Journal of Environmental Management*, *292*, 112745. https://doi.org/10.1016/j.jenvman.2021.112745

Nassauer, J. I., Wang, Z., & Dayrell, E. (2009). What will the neighbors think? Cultural norms and ecological design. *Landscape and Urban Planning*, *92*(3–4), 282–292. https://doi.org/10.1016/j.landurbplan.2009.05.010

National Drought Mitigation Center (NDMC), U.S. Department of Agriculture (USDA), & National Oceanic and Atmospheric Administration (NOAA)., (2021). *U.S. Drought Monitor*. https://droughtmonitor.unl.edu/

Neumann, C., Stanley, S. K., Leviston, Z., & Walker, I. (2022). The Six Australias: Concern About Climate Change (and Global Warming) is Rising. *Environmental Communication*, *16*(4), 433–444. https://doi.org/10.1080/17524032.2022.2048407

Niemelä, J., Saarela, S.-R., Söderman, T., Kopperoinen, L., Yli-Pelkonen, V., Väre, S., & Kotze, D. J. (2010). Using the ecosystem services approach for better planning and conservation of urban green spaces: A Finland case study. *Biodiversity and Conservation*, *19*(11), 3225–3243. https://doi.org/10.1007/s10531-010-9888-8

Niemiec, R., Jones, M. S., Lischka, S., & Champine, V. (2021). Efficacy-based and normative interventions for facilitating the diffusion of conservation behavior through social networks. *Conservation Biology*, *35*(4), 1073–1085. https://doi.org/10.1111/cobi.13717

Niemiec, R. M., Ardoin, N. M., Brewer, F. K., Kung, S., & Lopez, K. (2018). Increased Neighbor Interaction and Fear of Social Sanctions: Associations with Resident Action to Control the Invasive Little Fire Ant. *Society & Natural Resources*, *31*(10), 1149–1168. https://doi.org/10.1080/08941920.2018.1456594

Niemiec, R. M., Ardoin, N. M., Wharton, C. B., & Asner, G. P. (2016). Motivating residents to combat invasive species on private lands: Social norms and community reciprocity. *Ecology and Society*, *21*(2). https://doi.org/10.5751/ES-08362-210230

Niemiec, R. M., Champine, V., Vaske, J. J., & Mertens, A. (2020). Does the Impact of Norms Vary by Type of Norm and Type of Conservation Behavior? A Meta-Analysis. *Society & Natural Resources*, 1–17. https://doi.org/10.1080/08941920.2020.1729912

Niemiec, R. M., Sekar, S., Gonzalez, M., & Mertens, A. (2020). The influence of message framing on public beliefs and behaviors related to species reintroduction. *Biological Conservation*, *248*, 108522. https://doi.org/10.1016/j.biocon.2020.108522

Niemiec, R. M., Willer, R., Ardoin, N. M., & Brewer, F. K. (2019). Motivating landowners to recruit neighbors for private land conservation. *Conservation Biology*, *33*(4), 930–941. https://onlinelibrary.wiley.com/doi/full/10.1111/cobi.13294

Nilon, C. H., Aronson, M. F. J., Cilliers, S. S., Dobbs, C., Frazee, L. J., Goddard, M. A., O'Neill, K. M., Roberts, D., Stander, E. K., Werner, P., Winter, M., & Yocom, K. P. (2017). Planning for the Future of Urban Biodiversity: A Global Review of City-Scale Initiatives. *BioScience*, *67*(4), 332–342. https://doi.org/10.1093/biosci/bix012

Nilsson, D., Fielding, K., & Dean, A. J. (2020). Achieving conservation impact by shifting focus from human attitudes to behaviors. *Conservation Biology*, *34*(1), 93–102. https://doi.org/10.1111/cobi.13363

Nolan, J. M., Schultz, P. W., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2008). Normative Social Influence is Underdetected. *Personality and Social Psychology Bulletin*, *34*(7), 913–923. https://doi.org/10.1177/0146167208316691

Nylund, K. L., Asparouhov, T., & Muthén, B. O. (2007). Deciding on the Number of Classes in Latent Class Analysis and Growth Mixture Modeling: A Monte Carlo Simulation Study. *Structural Equation Modeling*, *14*(4), 535–569.

Nylund-Gibson, K., & Choi, A. Y. (2018). Ten frequently asked questions about latent class analysis. *Translational Issues in Psychological Science*, *4*(4), 440–461. https://doi.org/10.1037/tps0000176

Office for National Statistics. (2015). *Harmonised Concepts and Questions for Social Data Sources: Ethnic Group*.

Paker, Y., Yom-Tov, Y., Alon-Mozes, T., & Barnea, A. (2014). The effect of plant richness and urban garden structure on bird species richness, diversity and community structure. *Landscape and Urban Planning*, *122*, 186–195. https://doi.org/10.1016/j.landurbplan.2013.10.005

Palan, S., & Schitter, C. (2018). Prolific.ac—A subject pool for online experiments. *Journal of Behavioral and Experimental Finance*, *17*, 22–27. https://doi.org/10.1016/j.jbef.2017.12.004

Pearson, A. R., Schuldt, J. P., Romero-Canyas, R., Ballew, M. T., & Larson-Konar, D. (2018). Diverse segments of the US public underestimate the environmental concerns of minority and low-income Americans. *Proceedings of the National Academy of Sciences of the United States of America*, *115*(49), 12429–12434. https://doi.org/10.1073/pnas.1804698115

Peer, E., Rothschild, D., Gordon, A., Evernden, Z., & Damer, E. (2022). Data quality of platforms and panels for online behavioral research. *Behavior Research Methods*, *54*(4), 1643–1662. https://doi.org/10.3758/s13428-021-01694-3

Peterson, M. N., Thurmond, B., Mchale, M., Rodriguez, S., Bondell, H. D., & Cook, M. (2012). Predicting native plant landscaping preferences in urban areas. *Sustainable Cities and Society*, *5*, 70–76. https://doi.org/10.1016/j.scs.2012.05.007

Petty, R. E., Brinol, P., & Priester, J. R. (2009). Mass media attitude change: Implications of the Elaboration Likelohood Model of persuasion. In *Media effects: Advances in theory and research* (3rd ed., pp. 125–164). Routledge.

Petty, R. E., & Cacioppo, J. T. (1986). The Elaboration Likelihood Model of Persuasion. In *Advances in Experimental Social Psychology* (Vol. 19, pp. 123–205). Elsevier. https://doi.org/10.1016/S0065-2601(08)60214-2

Petty, R. E., Cacioppo, J. T., & Schumann, D. (1983). Central and Peripheral Routes to Advertising Effectiveness: The Moderating Role of Involvement. *Journal of Consumer Research*, *10*(2), 135–146.

Ranstam, J., & Cook, J. A. (2018). LASSO regression. *British Journal of Surgery*, *105*(10), 1348–1348. https://doi.org/10.1002/bjs.10895

Rega-Brodsky, C. C., Aronson, M. F. J., Piana, M. R., Carpenter, E.-S., Hahs, A. K., Herrera-Montes, A., Knapp, S., Kotze, D. J., Lepczyk, C. A., Moretti, M., Salisbury, A. B., Williams, N. S. G., Jung, K., Katti, M., MacGregor-Fors, I., MacIvor, J. S., La Sorte, F. A., Sheel, V., Threfall, C. G., & Nilon, C. H. (2022). Urban biodiversity: State of the science and future directions. *Urban Ecosystems*, *25*(4), 1083–1096. https://doi.org/10.1007/s11252-022-01207-w

Richards, R. T., Chambers, J. C., & Ross, C. (1998). Use of Native Plants on Federal Lands: Policy and Practice. *Journal of Range Management*, *51*(6), 625. https://doi.org/10.2307/4003603

Rigolon, A., & Németh, J. (2020). Green gentrification or 'just green enough': Do park location, size and function affect whether a place gentrifies or not? *Urban Studies*, *57*(2), 402–420. https://doi.org/10.1177/0042098019849380

Robbins, P. (2007). *Lawn People: How grasses, weeds, and chemicals make us who we are*. Temple University Press.

Rogers, E. M. (1983). *Diffusion of innovations* (3rd ed). Free Press; Collier Macmillan.

Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). Simon and Schuster.

Roser-Renouf, C., Maibach, E. W., Leiserowitz, A., & Zhao, X. (2014). The genesis of climate change activism: From key beliefs to political action. *Climatic Change*, *125*(2), 163–178. https://doi.org/10.1007/s10584-014-1173-5

Roser-Renouf, C., Stenhouse, N., Rolfe-Redding, J., Maibach, E., & Leiserowitz, A. (2015). Handbook of Environment and Communication. In *Engaging Diverse Audiences with Climate Change: Message Strategies for Global Warming's Six Americas* (1st ed., p. 434). Routledge. https://doi.org/10.2139/ssrn.2410650

Rudd, L. F., Allred, S., Bright Ross, J. G., Hare, D., Nkomo, M. N., Shanker, K., Allen, T., Biggs, D., Dickman, A., Dunaway, M., Ghosh, R., González, N. T., Kepe, T., Mbizah, M. M., Middleton, S. L., Oommen, M. A., Paudel, K., Sillero-Zubiri, C., & Dávalos, A. (2021). Overcoming racism in the twin spheres of conservation science and practice. *Proceedings of the Royal Society B: Biological Sciences*, *288*(1962), 20211871. https://doi.org/10.1098/rspb.2021.1871

Sandifer, P. A., Sutton-Grier, A. E., & Ward, B. P. (2015). Exploring connections among nature, biodiversity, ecosystem services, and human health and well-being: Opportunities to enhance health and biodiversity conservation. *Ecosystem Services*, *12*, 1–15. https://doi.org/10.1016/j.ecoser.2014.12.007

Saphores, J.-D. M., Ogunseitan, O. A., & Shapiro, A. A. (2012). Willingness to engage in a pro-environmental behavior: An analysis of e-waste recycling based on a national survey of

U.S. households. *Resources, Conservation and Recycling*, *60*, 49–63. https://doi.org/10.1016/j.resconrec.2011.12.003

Sarrouf Willson, M., Turley, C., Daar, L. A., Al Masroori, H., Al Muscati, H., Al Aufi, M., Al Bulushi, A., Al Harthi, S., & Willson, A. (2021). Addressing Marine Wildlife Entanglement in Derelict Fishing Nets Using Community-Based Social Marketing: Case Study and Lessons Learnt. *Social Marketing Quarterly*, *27*(4), 284–301. https://doi.org/10.1177/15245004211053841

Schell, C. J., Dyson, K., Fuentes, T. L., Des Roches, S., Harris, N. C., Miller, D. S., Woelfle-Erskine, C. A., & Lambert, M. R. (2020). The ecological and evolutionary consequences of systemic racism in urban environments. *Science*, *369*(6510), eaay4497. https://doi.org/10.1126/science.aay4497

Schultz, P. W. (2011). Conservation Means Behavior. *Conservation Biology*, *25*(6), 1080–1083. https://doi.org/10.1111/j.1523-1739.2011.01766.x

Schultz, P. W., Nolan, J. M., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2007). The Constructive, Destructive, and Reconstructive Power of Social Norms. *Psychological Science*, *18*(5), 429–434. https://doi.org/10.1111/j.1467-9280.2007.01917.x

Schunk, D. H. (2003). Self-Efficacy for Reading and Writing: Influence of Modeling, Goal Setting, and Self Evaluation. *Reading & Writing Quarterly*, *19*(2), 159–172. https://doi.org/10.1080/10573560308219

Schwartz, S. H. (1977). Normative Influences on Altruism. In *Advances in Experimental Psychology* (Vol. 10, pp. 221–275). Academic Press.

Segar, J., Callaghan, C. T., Ladouceur, E., Meya, J. N., Pereira, H. M., Perino, A., & Staude, I. R. (2022). Urban conservation gardening in the decade of restoration. *Nature Sustainability*, 1–8. https://doi.org/10.1038/s41893-022-00882-z

Seijts, G. H., & Latham, G. P. (2001). The effect of distal learning, outcome, and proximal goals on a moderately complex task. *Journal of Organizational Behavior*, *22*(3), 291–307. https://doi.org/10.1002/job.70

Selinske, M. J., Harrison, L., & Simmons, B. A. (2023). Examining connection to nature at multiple scales provides insights for urban conservation. *Biological Conservation*, *280*, 109984. https://doi.org/10.1016/j.biocon.2023.109984

Sheeran, P. (2001). Intention–Behavior Relations: A Conceptual and Empirical Review. In *European Review of Social Psychology* (pp. 1–36). John Wiley & Sons, Ltd. https://doi.org/10.1002/0470013478.ch1

Sherman, D. K., Updegraff, J. A., Handy, M. S., Eom, K., & Kim, H. S. (2022). Beliefs and Social Norms as Precursors of Environmental Support: The Joint Influence of Collectivism and Socioeconomic Status. *Personality and Social Psychology Bulletin*, *48*(3), 463–477. https://doi.org/10.1177/01461672211007252

Snyder, L. B., & Broderick, S. H. (1992). Communicating with Woodland Owners: Lessons from Connecticut. *Journal of Forestry*, *90*, 33–37.

Soga, M., & Gaston, K. J. (2016). Extinction of experience: The loss of human–nature interactions. *Frontiers in Ecology and the Environment*, *14*(2), 94–101. https://doi.org/10.1002/fee.1225

Soga, M., Gaston, K. J., & Yamaura, Y. (2016). Gardening is beneficial for health: A meta-analysis. *Preventive Medicine Reports*, *5*, 92–99. https://doi.org/10.1016/j.pmedr.2016.11.007

Southon, G. E., Jorgensen, A., Dunnett, N., Hoyle, H., & Evans, K. L. (2017). Biodiverse perennial meadows have aesthetic value and increase residents' perceptions of site quality in urban green-space. *Landscape and Urban Planning*, *158*, 105–118. https://doi.org/10.1016/j.landurbplan.2016.08.003

Sparkman, G., Macdonald, B. N. J., Caldwell, K. D., Kateman, B., & Boese, G. D. (2021). Cut back or give it up? The effectiveness of reduce and eliminate appeals and dynamic norm messaging to curb meat consumption. *Journal of Environmental Psychology*, *75*, 101592. https://doi.org/10.1016/j.jenvp.2021.101592

Sparkman, G., & Walton, G. M. (2017). Dynamic norms promote sustainable behavior, even if it is counternormative. *Psychological Science*, *28*(11), 1663–1674.

Sparkman, G., & Walton, G. M. (2019). Witnessing change: Dynamic norms help resolve diverse barriers to personal change. *Journal of Experimental Social Psychology*, 15.

Sparkman, G., Weitz, E., Robinson, T. N., Malhotra, N., & Walton, G. M. (2020). Developing a Scalable Dynamic Norm Menu-Based Intervention to Reduce Meat Consumption. *Sustainability*, *12*(6), 2453. https://doi.org/10.3390/su12062453

Stedman, R. C., Connelly, N. A., Heberlein, T. A., Decker, D. J., & Allred, S. B. (2019). The End of the (Research) World As We Know It? Understanding and Coping With Declining Response Rates to Mail Surveys. *Society & Natural Resources*, *32*(10), 1139–1154. https://doi.org/10.1080/08941920.2019.1587127

Steel, B. S. (1996). Thinking Globally and Acting Locally?: Environmental Attitudes, Behavior and Activism. *Journal of Environmental Management*, *47*, 27–36. https://doi.org/10.1006/jema.1996.0033

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology*, *29*(3), 309–317. https://doi.org/10.1016/j.jenvp.2008.10.004

Stern, P. C. (2000). New Environmental Theories: Toward a Coherent Theory of Environmentally Significant Behavior. *Journal of Social Issues*, *56*(3), 407–424. https://doi.org/10.1111/0022-4537.00175

Stuart, S. M. (2005). Lifting Spirits: Creating Gardens in California Domestic Violence Shelters. In *Urban place: Reconnecting with the natural world* (pp. 61–88). Boston Review.

Suldovsky, B. (2017). The Information Deficit Model and Climate Change Communication. In B. Suldovsky, *Oxford Research Encyclopedia of Climate Science*. Oxford University Press. https://doi.org/10.1093/acrefore/9780190228620.013.301

Swim, J. K., & Fraser, J. (2014). Zoo and aquarium professionals' concerns and confidence about climate change education. *Journal of Geoscience Education*, *62*(3), 495–501. https://doi.org/10.5408/13-048.1

Swim, J. K., Fraser, J., & Geiger, N. (2014). Teaching the Choir to Sing: Use of Social Science Information to Promote Public Discourse on Climate Change. *Journal of Land Use and Environmental Law*, *30*, 91.

Tallis, H., & Lubchenco, J. (2014). A call for inclusive conservation. *Nature*, *515*, 27–28.

Taylor, D. E. (2011). The Evolution of Environmental Justice Activism, Research, and Scholarship. *Environmental Practice*, *13*(4), 280–301.

Taylor, D. E. (2014). *The State of Diversity in Environmental Organizations Mainstream NGOs Foundations Government Agencies*. https://doi.org/10.13140/RG.2.2.34512.40962

Teel, T. L., & Manfredo, M. J. (2010). Understanding the Diversity of Public Interests in Wildlife Conservation. *Conservation Biology*, *24*(1), 128–139. https://doi.org/10.1111/j.1523-1739.2009.01374.x

Thaker, J., Richardson, L. M., & Holmes, D. C. (2023). Audience segmentation analysis of public intentions to get a COVID-19 vaccine in Australia. *Public Understanding of Science*, *32*(4), 470–488. https://doi.org/10.1177/09636625221138494

Tian, N., Lu, F., Joshi, O., & Poudyal, N. (2018). Segmenting Landowners of Shandong, China Based on Their Attitudes towards Forest Certification. *Forests*, *9*(6), 361. https://doi.org/10.3390/f9060361

Trochim, W., Donnelly, J., & Arora, K. (2016). *Research Methods: The Essential Knowledge Base*.

Trochim, W. M. K., & Donnelly, J. P. (2006). Positivism & Post-Positivism. In *The Research Methods Knowledge Base* (3rd ed.). Atomic Dog. https://conjointly.com/kb/positivism-and-post-positivism/

Tulloch, A. I. T. (2020). Improving sex and gender identity equity and inclusion at conservation and ecology conferences. *Nature Ecology & Evolution*, *4*(10), 1311–1320. https://doi.org/10.1038/s41559-020-1255-x

Turo, K. J., & Gardiner, M. M. (2019). From potential to practical: Conserving bees in urban public green spaces. *Frontiers in Ecology and the Environment*, *17*(3), 167–175. https://doi.org/10.1002/fee.2015

U.S. Census Bureau. (2019). American Community Survey 1-year estimates. *Census Reporter Profile Page for Fort Collins, CO*. http://censusreporter.org/profiles/16000US0827425-fort-collins-co

U.S. Census Bureau. (2020). 202 Census Demographic Data Map Viewer. https://mtgis-portal.geo.census.gov/arcgis/apps/MapSeries/index.html?appid=2566121a73de463995ed2b2fd7ff6eb7

Van den Berg, A. E. (2017). From Green Space to Green Prescriptions: Challenges and Opportunities for Research and Practice. *Frontiers in Psychology*, *8*. https://doi.org/10.3389/fpsyg.2017.00268

Van Den Berg, A. E., & Custers, M. H. G. (2011). Gardening Promotes Neuroendocrine and Affective Restoration from Stress. *Journal of Health Psychology*, *16*(1), 3–11. https://doi.org/10.1177/1359105310365577

van Zomeren, M., Postmes, T., & Spears, R. (2008). Toward an integrative social identity model of collective action: A quantitative research synthesis of three socio-psychological perspectives. *Psychological Bulletin*, *134*(4), 504–535. https://doi.org/10.1037/0033-2909.134.4.504

Vickers, A. (2006). New Directions in Lawn and Landscape Water Conservation. *American Water Works Association*, *98*(2), 56–156. https://doi.org/10.1002/j.1551-8833.2006.tb07586.x

Walker, K. A., & Koralesky, K. E. (2021). Student and instructor perceptions of engagement after the rapid online transition of teaching due to COVID-19. *Natural Sciences Education*, *50*(1), e20038. https://doi.org/10.1002/nse2.20038

Weller, B. E., Bowen, N. K., & Faubert, S. J. (2020). Latent Class Analysis: A Guide to Best Practice. *Journal of Black Psychology*, *46*(4), 287–311. https://doi.org/10.1177/0095798420930932

Wells, V. K., Forbes, S., Powell, M., & O'Reilly, D. (2022). Segmentation, environmental identity and stages of change: An application to a wildlife trust. *Business Strategy and the Environment*, *31*(3), 934–949. https://doi.org/10.1002/bse.2927

Wen, M., Zhang, X., Harris, C. D., Holt, J. B., & Croft, J. B. (2013). Spatial Disparities in the Distribution of Parks and Green Spaces in the USA. *Annals of Behavioral Medicine : A Publication of the Society of Behavioral Medicine*, *45*(Suppl 1), 18–27. https://doi.org/10.1007/s12160-012-9426-x

Westphal, L. M. (2003). Urban greening and social benefits: A study of empowerment outcomes. *Journal of Arboriculture*, *29*(3), 137.

Whitburn, J., Linklater, W., & Abrahamse, W. (2020). Meta-analysis of human connection to nature and proenvironmental behavior. *Conservation Biology*, *34*(1), 180–193. https://doi.org/10.1111/cobi.13381

White, K., Habib, R., & Hardisty, D. J. (2019). How to SHIFT Consumer Behaviors to be More Sustainable: A Literature Review and Guiding Framework. *Journal of Marketing*, *83*(3), 22–49. https://doi.org/10.1177/0022242919825649

Whitinger, D., & Cohen, P. (2022). *National Gardening Sruvey: 2022 Edition*. National Gardening Association.

Widows, S. A., & Drake, D. (2014). Evaluating the National Wildlife Federation's Certified Wildlife Habitat™ program. *Landscape and Urban Planning*, *129*, 32–43. https://doi.org/10.1016/j.landurbplan.2014.05.005

Witte, K., & Allen, M. (2000). A Meta-Analysis of Fear Appeals: Implications for Effective Public Health Campaigns. *Health Education & Behavior*, *27*(5), 591–615. https://doi.org/10.1177/109019810002700506

Wolch, J. R., Byrne, J., & Newell, J. P. (2014). Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough.' *Landscape and Urban Planning*, *125*, 234–244. https://doi.org/10.1016/j.landurbplan.2014.01.017

Woods, S. A., & Hampson, S. E. (2005). Measuring the Big Five with single items using a bipolar response scale. *European Journal of Personality*, *19*(5), 373–390. https://doi.org/10.1002/per.542

Wright, S. C. (2009). The Next Generation of Collective Action Research. *Journal of Social Issues*, *65*(4), 859–879. https://doi.org/10.1111/j.1540-4560.2009.01628.x

Xu, Y., Chan, L. S., & McLaughlin, M. L. (2020). Familism and the intent to practice safe sex among Chinese women living in the United States: An integrative model of behavioral prediction approach. *Journal of Communication in Healthcare*, *13*(3), 158–168. https://doi.org/10.1080/17538068.2020.1800370

Yehle, K. S., & Plake, K. S. (2010). Self-efficacy and Educational Interventions in Heart Failure: A Review of the Literature. *The Journal of Cardiovascular Nursing*, *25*(3), 175–188. https://doi.org/10.1097/JCN.0b013e3181c71e8e

Yzer, M. C. (2012). The integrated model of behavioral prediction as a tool for designing health messages: Theory and Practice. *Designing Messages for Health Communication Campaigns: Theory and Practice*, 21–40.

Zypchyn, K. (2012). Getting Back to the Garden: Reflections on Gendered Behaviours in Home Gardening. *Earth Common Journal*, *2*(1). https://doi.org/10.31542/j.ecj.60

Supplemental Materials

Chapter 1

Sample and Data Collection

Participants' ages ranged from 18 to 90 years old with a median age of 51. The median age in Fort Collins is 31 years, but our sample reflects residents in single-family homes, who are more likely to be in the Baby Boomer generation (56-74 years old; Blazheski, 2016). According to the U.S. Census Bureau (2019), Fort Collins residents are predominantly White (88% White, 80% non-Hispanic/Latino), and well-educated (56% have a bachelor's degree or higher). Half (50%) of Fort Collins residents identify as male, 64% of Fort Collins households are single-family units, and 45% of households are renter occupied. Most of the sample identified as non-Hispanic/Latinx (88%), were highly educated (85% bachelor's degree or higher), identified as female (65%), and owned their home (81%). Most participants held positive attitudes toward native plant gardening (86%), and more than half of participants held positive attitudes toward native plant diffusion behavior (65%). Two thirds reported that they had planted a plant specifically for wildlife on their property (68%) and half of participants claimed they had encouraged someone else to plant native plants (i.e., engaged in diffusion behavior; 50%).

Survey Measures and Procedure

Our survey began with definitions of terms that were used throughout, such as property, native plant, and native plant gardening. The survey was divided into four sections and had a total of 34 questions. The first section asked questions about the participants' previous behavior, subjective knowledge, and approximate estimations of how many people are participating or interested in native plant gardening. The second and third sections of the survey measured individual and diffusion behavior-specific attitude, intention, efficacy, and additional social

norms variables. At the end of the survey, we included a demographics section including age, gender, ethnicity, level of education, and homeownership.

Data Analysis

We ran post-hoc power analyses with the InteractionPoweR package in R (Baranger et al., 2021) to determine the power of our observed effect sizes in our moderation analyses due to evidence that interactions are often underpowered (Blake & Gangestad, 2020; Gelman, 2018; Maxwell et al., 2018). Given that estimates of effect sizes found in studies are noisy and can overestimate power (Gelman, 2019), we also calculated minimum detectable effects (MDE) for the coefficients in our LASSO-selected regressions by multiplying the standard error by 2.8 (Chabé-Ferret, 2021). MDEs are the minimum effect size that a study can estimate at a level of significance. They rely on the estimated standard error, lead to less variation than calculating ex-post power, and do not depend on the statistical significance of results (Mckenzie & Ozier, 2019).

Table S1. Social-Psychological Constructs in Survey

Construct	Survey Item(s)	Response Scale
Subjective Knowledge	How knowledgeable do you feel about gardening with native plants in Northern Colorado?	5-point Likert scale from "not knowledgeable at all" to "extremely knowledgeable"
Attitude	Would you say your general attitude towards native plant gardening is positive, negative, or neutral? Would you say your general attitude towards encouraging others to plant with native plants is positive, negative, or neutral?	7-point Likert scale from "extremely negative" to "extremely positive"
Self-Efficacy	I have the skills and knowledge to plant native plants on my property. I wouldn't be able to have a good discussion about planting native plants with my community members.	7-point Likert scale ranging from "strongly disagree" to "strongly agree" with 4 being "neither disagree nor agree"

Response Efficacy (Environmental)	Planting native plants on my property has a positive influence on native pollinators, birds, and wildlife. Convincing other people to plant native plants on their properties will make my own native plants better for wildlife.	7-point Likert scale ranging from "strongly disagree" to "strongly agree" with 4 being "neither disagree nor agree"
Response Efficacy (Social)	My personal actions to plant native plants on my property will motivate others in my community to do the same. If I advocate for native plant gardening in my community, my efforts will inspire others to plant native plants.	7-point Likert scale ranging from "strongly disagree" to "strongly agree" with 4 being "neither disagree nor agree"
Injunctive Norm (sanctioning)	People I know in my community disapprove of me replacing lawn with native plants on my property. Most people would disapprove of me advocating for native plant gardening in my community.	7-point Likert scale ranging from "strongly disagree" to "strongly agree" with 4 being "neither disagree nor agree"
Personal Norm	I feel a moral obligation to plant native plants on my property. I feel a moral obligation to encourage others to plant with native plants	7-point Likert scale ranging from "strongly disagree" to "strongly agree" with 4 being "neither disagree nor agree"
Descriptive Norm	Most people in my community have planted native plants on their properties. Most people in my community have encouraged others to plant native plants	7-point Likert scale ranging from "strongly disagree" to "strongly agree" with 4 being "neither disagree nor agree"
Dynamic Norm	In recent years, more people in my community have begun planting native plants on their properties. In recent years, more people in my community have begun encouraging others to garden with native plants.	7-point Likert scale ranging from "strongly disagree" to "strongly agree" with 4 being "neither disagree nor agree"
Behavioral Intention	How likely are you to purchase a native plant for your property in the next year? How likely are you to encourage others to plant native plants in the next year?	5-point Likert scale from "not likely at all" to "extremely likely"

Table S2. Sensitivity Analysis (complete-case analysis) for Individual Intention

	LASSO	OLS				
		β	*SE*	*p*	95% CI	
Knowledge	0.14	0.14	0.09	.10	-0.03	0.31
Ind. Self-Efficacy	0.08	0.15	0.09	.09	-0.02	0.32
Diff. Self-Efficacy	0.02	0.07	0.08	.87	-0.09	0.23
Ind. Env. Response Efficacy	0.15	0.14	0.08	.07	-0.01	0.29
Diff. Env. Response Efficacy	0.08	0.11	0.08	.17	-0.04	0.26
Ind. Social Response Efficacy	0.10	0.12	0.07	.09	-0.02	0.27
Ind. Descriptive Norm	0.09	0.20	0.07	**.01**	0.06	0.34
Diff. Descriptive Norm	-0.01	-0.14	0.07	.06	-0.28	0.01
Diff. Injunctive Norm	0.00	0.11	0.07	.12	-0.03	0.25
Ind. Personal Norm	0.14	0.24	0.09	**.01**	0.07	0.40
Ind. Attitude	0.09	0.11	0.09	.22	-0.07	0.28
Own Home	0.11	0.27	0.15	.07	-0.02	0.56
Male	-0.07	-0.20	0.14	.15	-0.47	0.07
Hispanic/Latinx	-0.06	-0.28	0.21	.17	-0.69	0.12
Adjusted R^2				.36		

Ind. = individual, Diff. = diffusion, Env. = environmental, *β* = standardized coefficient; SE = standard error; CI = confidence interval.

Table S3. Sensitivity Analysis (complete-case analysis) for Diffusion Intention

	LASSO	OLS				
		β	*SE*	*p*	95% CI	
Knowledge	0.16	0.17	0.06	**.003**	0.06	0.28
Diff. Self-Efficacy	0.02	0.14	0.06	**.02**	0.02	0.25
Ind. Env. Response Efficacy	0.02	0.04	0.06	.50	-0.07	0.15
Diff. Env. Response Efficacy	0.06	0.09	0.06	.11	-0.02	0.15
Ind. Social Response Efficacy	0.01	0.07	0.05	.12	-0.09	0.13
Diff. Social Response Efficacy	0.05	0.02	0.06	.38	-0.07	0.18
Diff. Dynamic Norm	0.02	0.04	0.05	.44	-0.06	0.15
Diff. Personal Norm	0.19	0.27	0.07	**<.001**	0.14	0.40
Ind. Attitude	0.27	0.29	0.07	**<.001**	0.16	0.42
Diff. Attitude	0.23	0.29	0.07	**<.001**	0.15	0.43
Male	-0.04	-0.13	0.16	.20	-0.34	0.07
Hispanic/Latinx	-0.22	-0.41	0.16	**.01**	-0.72	-0.11
Adjusted R^2				.65		

Ind. = individual, Diff. = diffusion, Env. = environmental, *β* = standardized coefficient; SE = standard error; CI = confidence interval.

Table S4. Binary Logistic Regression for Individual Behavior

	LASSO	LR				
		β	*SE*	*p*	95% CI	
Knowledge	0.03	0.20	0.23	.27	-0.16	0.55
Ind. Social Response Efficacy	0.05	0.14	0.20	.49	-0.24	0.55
Ind. Personal Norm	0.16	0.39	0.24	.11	-0.07	0.88
Ind. Attitude	0.03	0.12	0.24	.62	-0.33	0.63
Male	-0.01	-0.50	0.41	.23	-1.36	0.28
Education	0.19	0.43	0.20	**.03**	0.05	0.85

LR = logistic regression; Ind. = individual, β = standardized coefficient;
SE = standard error; CI = confidence interval.

Table S5. Binary Logistic Regression for Diffusion Behavior

	LASSO	LR				
		β	*SE*	*p*	95% CI	
Ind. Social Response Efficacy	0.16	0.31	0.26	.24	-0.18	0.85
Ind. Dynamic Norm	0.25	0.41	0.28	.14	-0.14	0.96
Diff. Dynamic Norm	0.27	0.45	0.26	.08	-0.03	1.00
Ind. Personal Norm	0.10	0.34	0.27	.20	-0.16	0.89
Male	-0.25	-0.83	0.54	.12	-1.99	0.16
Age	0.01	0.03	0.15	**.05**	0.00	0.06
Education	0.17	0.43	0.24	.07	-0.01	0.94

LR = logistic regression; Ind. = individual, Diff. = diffusion, β = standardized coefficient;
SE = standard error; CI = confidence interval.

Table S6. Moderation Analyses: Binary Logistic Regressions predicting Indicators of Behavior (voucher use)

Individual Behavior	*β*	*SE*	*p*	95% CI		Diffusion Behavior	*β*	*SE*	*p*	95% CI	
Self-Efficacy						*Self-Efficacy*					
Ind. Intention	0.58	0.21	**.006**	0.18	1.01	Diff. Intention	0.68	0.25	**.006**	0.20	1.19
Ind. Self-efficacy	-0.07	0.20	.73	-0.46	0.33	Diff. Self-efficacy	-0.34	0.27	.20	-0.88	0.17
Ind. Intention * Ind. Self-efficacy	0.10	0.19	0.54	-0.29	0.47	Diff. Intention * Diff. Self-efficacy	0.43	0.19	**.02**	0.06	0.79
Knowledge						*Knowledge*					
Ind. Intention	0.51	0.21	**0.01**	0.11	0.94	Diff. Intention	0.72	0.47	**.003**	0.26	1.22
Knowledge	0.06	0.21	0.79	-0.37	0.45	Knowledge	-0.41	0.28	.14	-1.00	0.12
Ind. Intention * Knowledge	0.20	0.19	0.29	-0.17	0.58	Diff. Intention * Knowledge	0.44	0.20	**.03**	0.05	0.84
Homeownership						*Homeownership*					
Ind. Intention	0.05	0.42	0.90	-0.78	0.91	Diff. Intention	-0.01	0.48	.98	-0.99	0.95
Homeownership	0.15	0.48	0.75	-0.73	1.18	Homeownership	-0.03	0.53	.95	-1.02	1.13
Ind. Intention * Homeownership	0.64	0.47	0.18	-0.32	1.57	Diff. Intention * Homeownership	0.77	0.53	0.15	-0.29	1.84

Ind. = individual, Diff. = diffusion, β = standardized coefficient; SE = standard error; CI = confidence interval

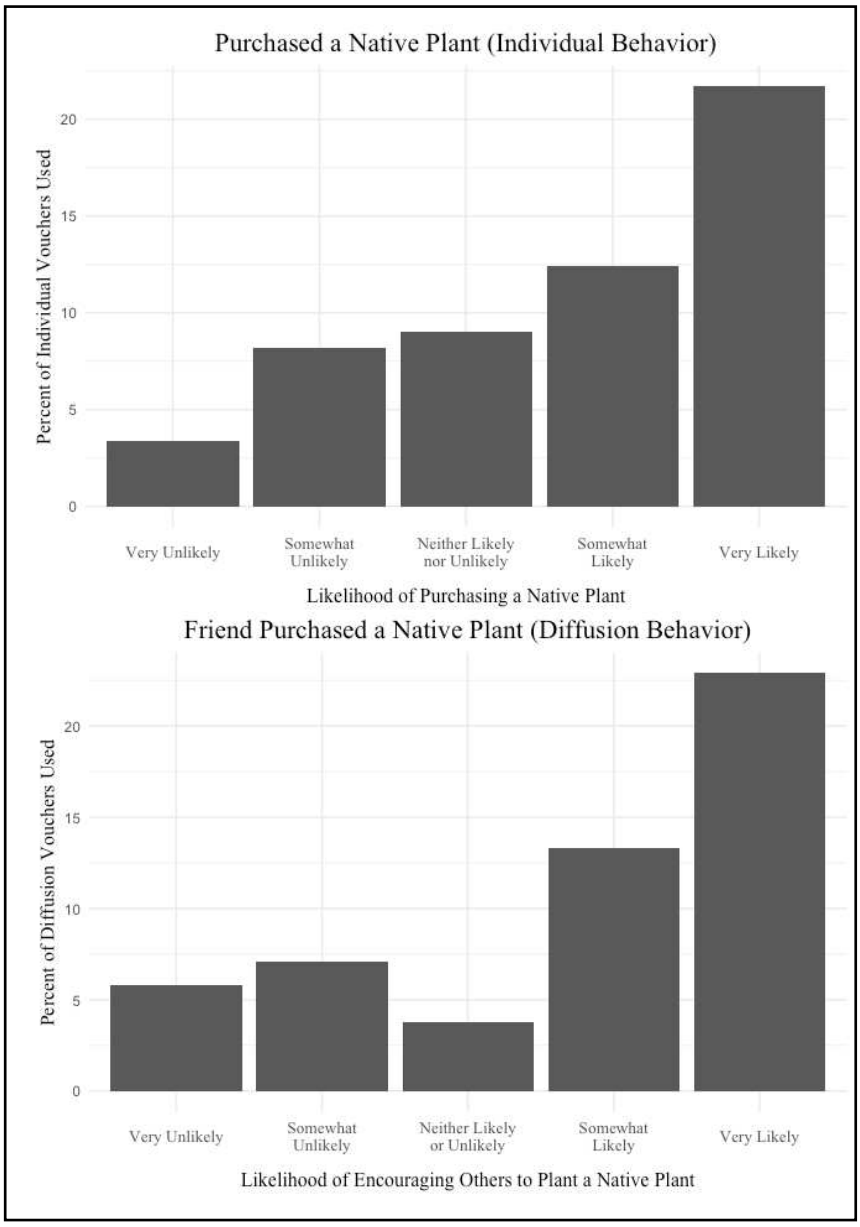

Figure S1. Voucher Use by Intention

Chapter 2

Table S1. Overview of Measured Variables

Type	Construct	Measurement*
Primary Outcomes	**Behavioral Intention** (general – diffusion)	How likely are you to *encourage a friend or neighbor to purchase a native plant* for their property in the next year? (5-point Likert scale)
	Self-reported Behavior (diffusion - # of coupons)	In the last two months, how many times have you given away a "Friend and Neighbor" Native Plant Coupon to encourage someone else to buy a native plant for their property? (0-3)
Secondary Outcomes	**Behavioral Intention** (specific – diffusion)	By taking part in this study, you will receive three $10 native plant coupons to share with other people, how likely are you to share these coupons? (5-point Likert scale)
	Behavioral Intention (specific – individual)	By taking part in this study, you will receive up to two $10 coupons to buy native plants for yourself, how likely are you to redeem these coupons? (5-point Likert scale)
	Behavioral Intention (general – individual)	How likely are you to *purchase a native plant* for your property in the next year? (5-point Likert scale)
	Self-Reported Behavior (individual)	In the last two months, have you used a "Self" Native Plant Coupon to buy a native plant for yourself? (yes/no)
	Self-Reported Behavior (diffusion without coupon)	In the last two months, how many times have you encouraged others to plant native plants ***without*** using a "Neighbor" Native Plant Coupon?
	Actual Behavior (diffusion)	"Neighbor" Coupons used (0-3)
	Actual Behavior (individual)	"Self" Coupons used (0-2)
	Descriptive Norm (individual – interest estimate)	Approximately what percentage of people in your community do you think are interested in planting native plants on their properties? (0% to 100% scale)
	Self-Efficacy (individual)	I have the skills and knowledge to plant native plants on my property.
	Descriptive Norm (individual)	Many people in my community have planted native plants on their properties.
	Environmental Response Efficacy (individual)	Planting native plants on my property has a positive influence on native pollinators, birds, and wildlife.
	Social Response Efficacy (individual)	My personal actions to plant native plants on my property will motivate others in my community to do the same.
	Injunctive Norm (individual – sanctioning)	People in my community would disapprove of me replacing lawn with native plants on my property.
	Dynamic Norm (individual)	In recent years, more people in my community have begun planting native plants on their properties.
	Injunctive Norm (individual – supportive)	People I know support me replacing lawn with native plants on my property.
	Self-Efficacy (diffusion)	I wouldn't be able to have a good discussion about planting native plants with my community members.

	Descriptive Norm (diffusion)	Most people in my community have encouraged others to plant native plants.
	Environmental Response Efficacy (diffusion)	Encouraging other people to plant native plants on their properties will make my own native plants better for wildlife.
	Social Response Efficacy (diffusion)	If I encourage others to plant native plants in my community, my efforts will inspire others to plant native plants.
	Injunctive Norm (diffusion – sanctioning)	Most people would disapprove of me advocating for native plant gardening in my community.
	Dynamic Norm (diffusion)	In recent years, more people in my community have begun encouraging others to garden with native plants.
	Injunctive Norm (diffusion – supportive)	People I know support me encouraging others to plant native plants.
	Personal Norm (individual)	I feel a moral obligation to plant native plants on my property.
	Personal Norm (diffusion)	I feel a moral obligation to encourage others to plant with native plants.
	Attitude (individual)	Would you say your general attitude towards *native plant gardening* is positive, negative, or neutral? (7-point Likert scale, "extremely positive" to "extremely negative")
	Attitude (diffusion)	Would you say your general attitude towards *encouraging others to plant native plants* is positive, negative, or neutral? (7-point Likert scale, "extremely positive" to "extremely negative")
Other Covariates	**Subjective Knowledge**	How knowledgeable do you feel about gardening with native plants in Colorado? (5-point Likert scale, "not knowledgeable at all" to "extremely knowledgeable")
	Previous Behavior (planting for wildlife)	Have you ever planted a plant specifically for wildlife (such as birds, bees, butterflies, or other pollinators) on your property? (yes/no)
	Previous Behavior (planting native plants)	Have you ever planted a native plant on your property? (yes/no)
	Previous Behavior (diffusion)	Have you ever encouraged someone else to plant native plants on their property? (yes/no)
	Household Income	What is your household income?
	Gender	What is your gender?
	Age	What is your age (in years)?
	Education Level	What is your highest level of education?
	Race	What is your race?
	Ethnicity	What is your ethnicity?
	HOA Membership	Are you part of a Homeowners' Association?
Other Variables	**Information Source**	How did you hear about this online workshop?
	Workshop Helpfulness	We would like your feedback on the Habitat Hero Native Plant Outreach workshop. How helpful did you find the workshop?
	Workshop Improvement	What can we do to improve this workshop in the future?

	Workshop Recommendation	How likely are you to recommend this native plant outreach workshop to a friend?
	Type of Plants Bought	What type of native plant did you buy?
	Coupon Recipients	Who did you give your (first, second, third) "Neighbor" Native Plant Coupon to?
	Participation in Prior Study	Last spring, CSU Researchers and the City of Fort Collins Nature in the City program mailed $10 Native Plant Vouchers to residents in the greater Fort Collins area, did you participate in this initiative?

* Perceptual survey items measured on a 7-point Likert scale ranging from "strongly disagree" to "strongly agree" unless otherwise noted.

Additional Methods

Workshops were advertised as a special series on "Native Plant Outreach" as part of the larger ongoing series of in-person and online workshops Audubon Rockies has delivered within their Habitat Heroes program (https://rockies.audubon.org/habitat-hero; Jones et al., 2021). The Habitat Heroes program trains individuals and organizations on how to create habitat for birds and wildlife through wildlife-friendly gardening strategies (e.g., planting native plants) and certifies bird-friendly gardens.

Workshop Design

Workshops were held on weekdays at 12:00pm and on Saturday mornings at 9:00am to increase our accessibility to a diversity of interested target audiences. Both intervention and control workshops emphasized the call for participants to engage in diffusion behavior (i.e., encouraging others to plant native plants) as well as personal-sphere native plant gardening behavior. Keeping all workshops to 90 minutes ensured differences in outcomes between the two types of workshops were due to differences in content rather than length. In the control workshops, sections (2) and (3) focused on providing a lot of information. Information about the benefits of native plant gardening in Colorado, how to garden with native plants, the benefits of native plant outreach, and how to engage in outreach about native plants built on content from

previous workshops delivered by Audubon Rockies (Jones et al., 2021) and publicly available materials created by other local organizations, such as the Colorado Native Plant Society. Control workshops were based on the information-deficit model, a popular communication approach that assumes a lack of public engagement in a behavior is due to a lack information or knowledge about the topic (Suldovsky, 2017). Information-transfer strategies, like those highlighted in our control workshops, represent the status quo for pro-environmental behavior change communication and public engagement. In the intervention workshops, sections (2) and (3) focused on activities to increase positive perceptions of efficacy and norms.

Table S2. Descriptions of individual and diffusion-specific microinterventions in intervention workshops

Constructs	**Interventions**	**Individual Workshop Microinterventions**	**Diffusion Workshop Microinterventions**
Self-efficacy	Social modeling (Geiger et al., 2017)	A five-minute story about a real-life role model, told by an Audubon Rockies staff member who has worked in this area for years. Specifically, the staff member will share about how this role model attended a previous Habitat Hero training because her friend invited her, when she had no previous experience with native plant gardening. She then got inspired to add natives to her own garden and noticed how her garden provides habitat for birds and pollinators. She started with a small patch of her yard and added 15 different types of native plants, let volunteer sunflowers grow, switched to drip irrigation to save water and hassle, and started seeing all kinds of birds and insects come to that patch of yard. Now she gives formal Habitat Hero trainings herself and tells people in her community about Habitat Hero certification and native plants whenever the topic comes up.	
	Mastery experiences (Bandura, 1977, 1997)	Not feasible within the online workshop structure.	Allow participants to practice sharing coupons with each other in breakout groups using provided scripts as templates, such as: “Planting native plants was new to me, too, but it was simple! The nursery makes it easy to find and order plants online, and it feels good to help provide a home for wildlife. Plus, it saves me water, I use fewer chemicals, and it’s beautiful.”

	Proximal goal setting (Bandura & Schunk, 1981)	Set proximal goals in small breakout groups about what native plants participants will buy (e.g., where, when), supported by proximal goal messages such as "We've talked about a lot of factors to consider about what plants to buy and where to plant them. Remember to keep this manageable for yourself – we're not talking about going away and redesigning your whole yard tomorrow! Just thinking about how you could add a couple more plants to existing beds or pulling out a little piece of lawn."	Set proximal goals in small breakout groups about who to share diffusion coupons with (e.g., how, when), supported by proximal goal messages such as "We've talked about the different people you could share coupons with, and the other different ways you can do outreach about native plants. But the most important thing is that you start somewhere – you don't have to be an expert in all forms of outreach yet, you can start small."
	Social persuasion (Bandura, 1988)	Regularly remind participants that the organizers believe in their ability to act through messages such as: "By the time you leave this workshop, our aim is that you feel confident in your ability to add a few native plants to your yard and to encourage a couple friends or neighbors to do the same," "You already have a lot of the experience you need" (and saying what that is), and "You don't have to be an expert to reach out to others. You can inspire them no matter if you have planted, 1 native plant or 100."	
	Knowledge-based interventions (Geiger et al., 2017)	Share specific information about exactly how to buy native plants, using the individual voucher, and planting native plants.	Share specific information about exactly how to talk to others about native plant gardening and share diffusion vouchers.
Social response efficacy	Providing feedback on social impacts (Witte & Allen, 2000)	Share stories of how other individuals' native plant gardens have encouraged their friends and neighbors to also plant native plants simply by seeing the garden's beauty, the wildlife it attracts, and the water savings. Integrate messages such as: "Native plant gardens get other people interested in native plants just by looking at them."	Share research that demonstrates that people are twice as likely to retain scientific information when it comes from friends, family, and others they know, and they are 10 times more likely to change their behavior.
Environmental response efficacy	Providing feedback on ecological impacts (Geiger et al., 2017)	Explain in detail the benefits of native plant gardening to birds, pollinators, and water conservation, and adding messages such as, "Plant it and they will come," and	Explain how native plant outreach multiples the benefits of native plant gardening to birds, pollinators, and water conservation, and supporting this with messages such as

		"People who've been gardening with native plants talk about having hummingbirds and bumblebees coming to their flowers before the plants are even in the ground."	"When you encourage your friends and neighbors, you are multiplying the benefit to birds, pollinators, and wildlife in your neighborhood."
Dynamic norms	Normative statistics and messaging (Kidd et al., 2019; Sparkman & Walton, 2017)	Share normative data from an engaged Fort Collins audience, a random Fort Collins audience, and the people who registered for these workshops about how likely people are to plant a native plant in the next year. Share specific numbers and percentages with participants, and the studies the data came from, to boost credibility. Augment these facts with messages such as: "Native plant gardening is becoming more and more common," and "Water conservation is becoming more and more important in Colorado, especially on the Front Range, and people are taking action to reduce use in residential areas."	Share normative data from an engaged Fort Collins audience, a random Fort Collins audience, and the people who registered for these workshops about how likely people are to encourage a friend or neighbor to purchase a native plant in the next year. Share specific numbers and percentages with participants, and the studies the data came from, to boost credibility. Augment these facts with messages such as: "You will be joining a growing movement in Colorado and more broadly of residents, businesses, and community leaders who are helping others create more native habitat in residential and urban areas."
Descriptive norms	Normative statistics and messaging (Kidd et al., 2019; Sparkman & Walton, 2017)	Share normative data from an engaged Fort Collins audience, a random Fort Collins audience, and the people who registered for these workshops on: 1. What percentage of people have ever planted a plant specifically for wildlife 2. What percentage of people have ever planted a native plant Create a sense of supportive local norms among the people in this specific workshop through interactive polls with results visible to the group:	Share normative data from an engaged Fort Collins audience, a random Fort Collins audience, and the people who registered for these workshops on what percentage of people have ever encouraged someone else to plant native plants. Create a sense of supportive local norms among the people in this specific workshop through interactive polls with results visible to the group: 1. "Where are you joining this call from?" 2. "How would you describe your experience level with native plant

		1. "Where are you joining this call from?" 2. "How would you describe your experience level with native plant gardening?" Participants respond between 1 (Novice) and 5 (Expert) for native plant gardening, after receiving a working definition of this term. 3. "Which of the following proven benefits from native plant gardening makes you the most interested in native plant gardening?" Participants select all that apply from a list of eight options.	outreach?" Participants respond between 1 (Novice) and 5 (Expert) for native plant outreach, after receiving a working definition of this term. 3. "Which of the following proven benefits from native plant outreach makes you the most interested in native plant outreach?" Participants select all that apply from a list of eight options. Integrate messages such as: "This was the most popular Habitat Hero workshop series maybe ever. We have hundreds of people registered, so people are excited about doing more of this!"
	Public commitment-making (Niemiec et al., 2019)	After setting proximal goals in small groups, participants will be invited to share one goal publicly with the rest of the workshop attendees in the Zoom chat. An edited and condensed chat transcript will then be sent out to participants after the workshop to help the group track what others committed to.	
Injunctive norms	Addressing reputational concerns (Jones & Niemiec, 2020)	Integrate messages such as: "Some of us live in places where you're expected to maintain a lawn in the front yard. If that's the case, no worries! You can have native plants alongside lawns, like in a garden bed at the front of the house or the sides. And lots of people who are worried about what their neighbors might think get really creative in their backyards, where it's their own private space."	Invite participants to engage in outreach to audiences they already know are likely to be curious or receptive, augmented by messages such as: "People are actually much more receptive to this than you might think – remember, it's becoming increasingly common, so people are likely to be more used to seeing these kinds of gardens around, even if they haven't done it themselves."
	Addressing pluralistic ignorance (Geiger & Swim 2016)	NA.	Explain to participants what pluralistic ignorance is, and how it can lead people to "self-silence" even in situations when both they and

			their audience share an interest or belief.
	Facilitating group communication and expectation setting (Niemiec et al., 2019)	Provide time in breakout groups for participants to share their past experiences with native plant gardening and outreach, discuss their proximal goals with one another, and build a sense of how confident the group is about sharing vouchers and designing native plant gardens. Supplement this with messages throughout such as: "If you have questions over the coming weeks, you can reach out to us, we're here to help" and "Part of feeling confident in yourself comes from knowing that there's a supportive community of like-minded people who are also planting native plants and talking about native plants – you are not alone!"	

Additional Results

Description of the Sample

On average, attendees had been living on their properties (rented or owned) for longer (mean = 13 years vs. 11 years) than non-attendees, and a smaller percentage of attendees had recently moved to their property (i.e., lived there for less than a year) than non-attendees. Slightly more workshop attendees had previously engaged in planting for wildlife (86%), planting native plants (85%), and encouraging others to plant native plants (80%) compared to non-attendees (80%, 79%, and 75% respectively). In comparison to non-attendees, a higher percentage of attendees had also attended previous events hosted by Audubon Rockies.

Table S3 Adjusted Regression with Clustered Standard Errors for Post-Workshop Diffusion Intention

	B	*SE*	*p*	95% CI	
Treatment	0.03	0.07	.68	-0.11	0.16
Pre-Diff. Intention	0.20	0.05	**.00**	0.11	0.29
Diff. Descriptive Norm	0.02	0.04	.54	-0.05	0.10
Ind. Descriptive Norm	-0.03	0.03	.33	-0.08	0.03
Diff. Self-Efficacy	0.00	0.03	.93	-0.07	0.06
Ind. Self-Efficacy	0.10	0.03	**.00**	0.04	0.16
Diff. Env. Response Efficacy	0.00	0.05	.93	-0.10	0.09
Ind. Env. Response Efficacy	0.06	0.06	.31	-0.06	0.19
Diff. Soc. Response Efficacy	-0.03	0.04	.56	-0.11	0.06

Ind. Soc. Response Efficacy	0.11	0.04	**.01**	0.02	0.19
Diff. Injunctive Norm (sanctioning)	0.04	0.03	.25	-0.02	0.09
Diff. Dynamic Norm	-0.02	0.05	.69	-0.11	0.07
Ind. Dynamic Norm	0.00	0.05	.97	-0.09	0.10
Diff. Injunctive Norm (supportive)	0.07	0.04	.12	-0.02	0.15
Ind. Injunctive Norm (supportive)	0.03	0.03	.33	-0.03	0.08
Diff. Personal Norm	0.11	0.05	**.04**	0.00	0.22
Ind. Personal Norm	-0.06	0.06	.35	-0.17	0.06
Diff. Attitude	0.43	0.06	**.00**	0.32	0.55
Ind. Attitude	-0.24	0.09	**.01**	-0.42	-0.07
Knowledge	0.03	0.06	.58	-0.09	0.15
Diff. Previous Behavior	0.12	0.18	.49	-0.23	0.48
Ind. Previous Behavior	-0.05	0.09	.57	-0.22	0.12
Gender	0.01	0.07	.91	-0.13	0.15

Ind. = individual/personal-sphere, Diff. = diffusion, Env. = environmental,
Soc. = Social, *B* = unstandardized coefficient; *SE* = standard error; *CI* = confidence interval.

Table S4. Adjusted Regression with Clustered Standard Errors for Two-month Follow-up Diffusion Intention

	B	*SE*	*p*	*95% CI*	
Treatment	-0.01	0.08	.92	-0.17	0.15
Pre-Diff. Intention	0.21	0.10	**.04**	0.01	0.40
Diff. Self-Efficacy	-0.01	0.04	.86	-0.09	0.07
Ind. Self-Efficacy	-0.01	0.05	.85	-0.11	0.09
Diff. Env. Response Efficacy	0.04	0.09	.61	-0.13	0.22
Diff. Soc. Response Efficacy	-0.09	0.07	.19	-0.23	0.05
Ind. Soc. Response Efficacy	0.10	0.06	.08	-0.01	0.21
Diff. Injunctive Norm (sanctioning)	0.02	0.04	.65	-0.06	0.10
Diff. Injunctive Norm (supportive)	0.05	0.09	.57	-0.13	0.23
Ind. Injunctive Norm (supportive)	0.01	0.06	.85	-0.10	0.12
Diff. Personal Norm	0.00	0.10	.96	-0.19	0.18
Ind. Personal Norm	0.08	0.07	.29	-0.07	0.22
Diff. Attitude	0.39	0.13	**.00**	0.13	0.64
Knowledge	-0.06	0.06	.26	-0.18	0.05
Diff. Prev. Behavior	0.02	0.16	.91	-0.29	0.33
Ind. Prev. Behavior	0.28	0.20	.15	-0.10	0.66
Ethnicity	-0.13	0.24	.58	-0.61	0.34
Gender	-0.04	0.15	.79	-0.34	0.26

Table S4. Adjusted Regression with Clustered Standard Errors for Self-Reported Voucher Sharing (Indicator of Diffusion Behavior)

	B	*SE*	*p*	*95% CI*	
Treatment	-0.07	0.23	.74	-0.52	0.37
Ind. Self-Efficacy	-0.03	0.09	.71	-0.20	0.14

Diff. Env. Response Efficacy	-0.04	0.13	.76	-0.30	0.22
Diff. Injunctive Norm (sanctioning)	0.06	0.09	.48	-0.11	0.24
Ind. Dynamic Norm	0.09	0.08	.29	-0.08	0.25
Diff. Injunctive Norm (supportive)	0.02	0.09	.85	-0.16	0.19
Ind. Injunctive Norm (supportive)	0.11	0.08	.16	-0.04	0.27
Diff. Attitude	0.31	0.09	**.00**	0.12	0.49
Knowledge	0.09	0.14	.51	-0.18	0.37

Ind. = individual/personal-sphere, Diff. = diffusion, Env. = environmental,
B = unstandardized coefficient; *SE* = standard error; *CI* = confidence interval.

Table S4. Adjusted Regression with Clustered Standard Errors for Post-Workshop Individual Intention

	B	*SE*	*p*	*95% CI*	
Treatment	-0.04	0.04	.33	-0.11	0.04
Pre-Ind. Intention	0.25	0.05	**.00**	0.15	0.35
Ind. Descriptive Norm	0.00	0.02	.80	-0.03	0.04
Diff. Self-Efficacy	0.02	0.01	.25	-0.01	0.05
Ind. Self-Efficacy	0.04	0.02	**.0**4	0.00	0.09
Diff. Env. Response Efficacy	0.02	0.03	.52	-0.04	0.07
Ind. Env. Response Efficacy	0.05	0.05	.37	-0.06	0.15
Diff. Social Response Efficacy	0.03	0.02	.24	-0.02	0.07
Diff. Injunctive Norm (sanctioning)	0.02	0.03	.37	-0.03	0.07
Ind. Injunctive Norm (sanctioning)	0.00	0.01	.91	-0.02	0.02
Ind. Dynamic Norm	-0.01	0.02	.74	-0.05	0.03
Diff. Injunctive Norm (supportive)	0.00	0.03	.95	-0.06	0.05
Ind. Injunctive Norm (supportive)	0.03	0.01	.09	0.00	0.05
Diff. Personal Norm	-0.04	0.01	**.00**	-0.07	-0.02
Ind. Personal Norm	0.05	0.02	.02	0.01	0.09
Diff. Attitude	0.03	0.02	.23	-0.02	0.07
Ind. Attitude	0.03	0.05	.59	-0.07	0.12
Knowledge	0.01	0.02	.72	-0.04	0.05
Diff. Prev. Behavior	-0.03	0.06	.65	-0.15	0.09
Ind. Prev. Behavior	0.05	0.06	.35	-0.06	0.16
Ethnicity	-0.32	0.22	.15	-0.75	0.12

Ind. = individual/personal-sphere, Diff. = diffusion, Env. = environmental, Soc. = Social,
B = unstandardized coefficient; *SE* = standard error; *CI* = confidence interval.

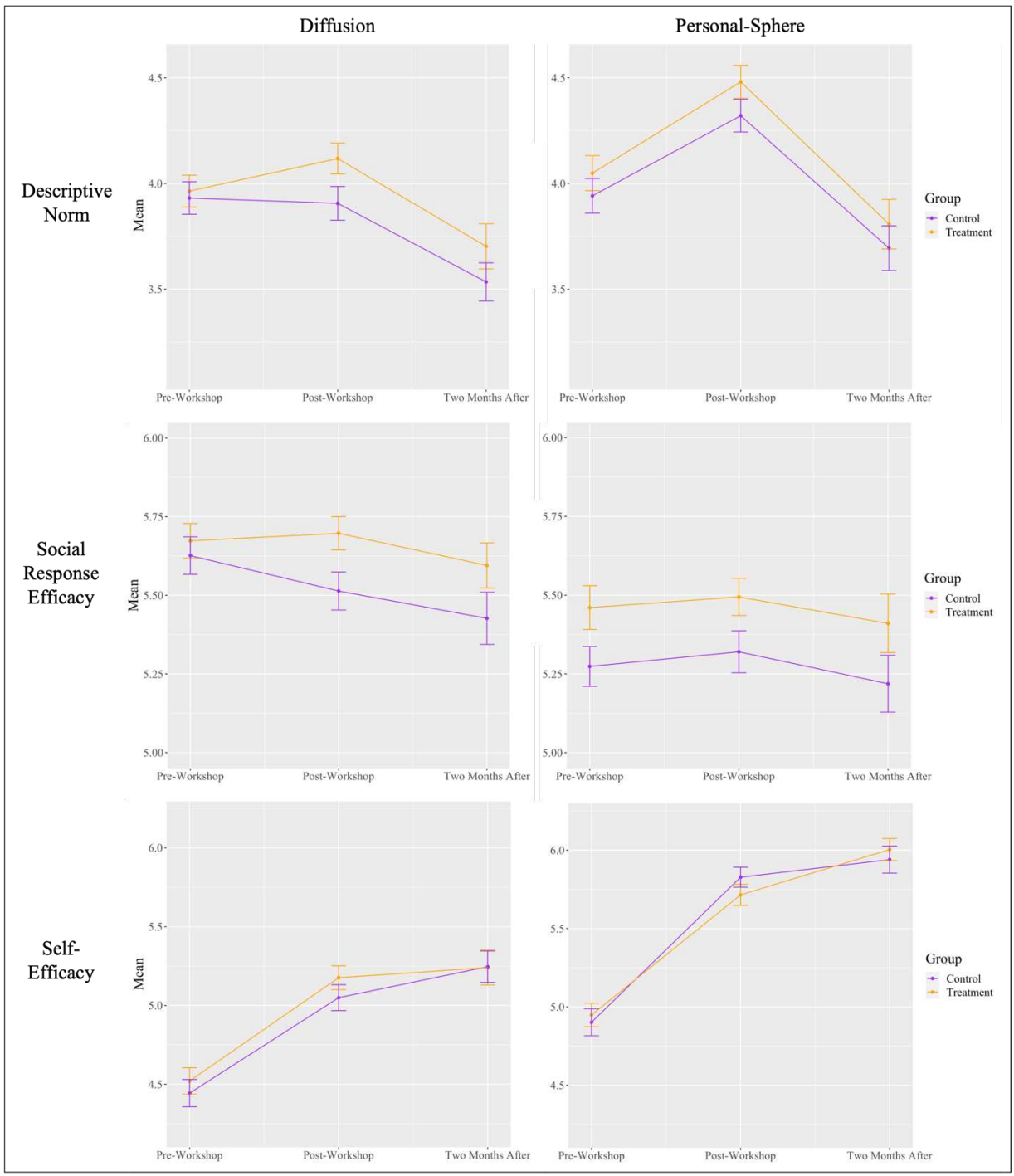

Figure S1. Means of Behavior-specific Self-Efficacy and Descriptive Norms over time

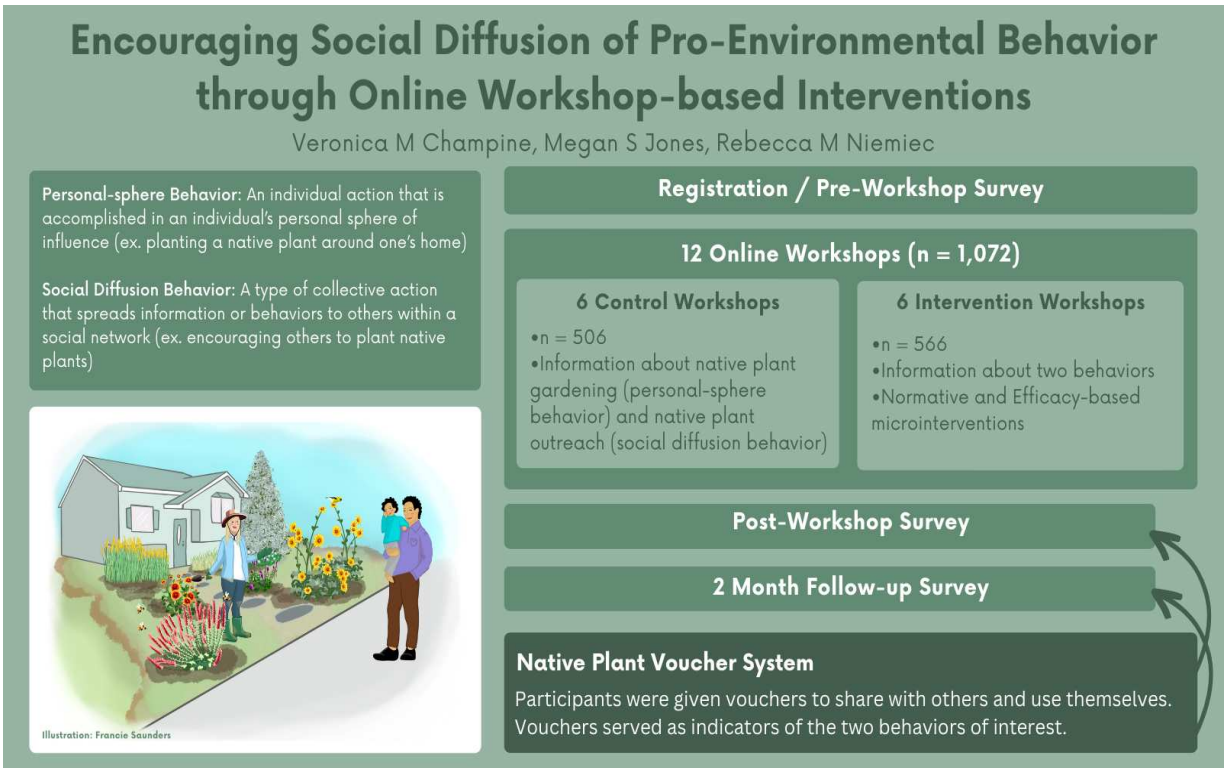

Figure S2. Study Infographic

Chapter 3

Table S1. Survey Measures

Variable	Measurement
Relevance	How much have you thought about *native plant gardening* in general?
Subjective Knowledge	How knowledgeable do you feel about *planting native plants*?
Attitude - Personal-sphere	Would you say your general attitude towards *planting native plants* is positive, negative, or neutral?
Attitude - Social diffusion	Would you say your general attitude towards *planting native plants* is positive, negative, or neutral?
Attitude - Civic action	Would you say your general attitude towards *taking a civic action (ex. voting, signing a petition, volunteering) to increase native plants* is positive, negative, or neutral?
Positive outcomes - Personal-sphere	Please check all of the answers below that you believe are true. *If I take steps to plant more native plants around my home*, it will… (answers in survey)
Negative outcomes - personal-sphere	Please check all of the answers below that you believe are true. *If I take steps to plant more native plants around my home*, it will… (answers in survey)
Positive outcomes - country /population level	Please check all of the answers below that you believe are true. *If people in the United States take steps to plant more native plants*, it will…(answers in survey)
Previous behavior - personal-sphere	Have you ever *intentionally planted a native plant* around your home?
Previous behavior - social diffusion	Have you ever *encouraged someone else to plant native plants* around their home?
Previous behavior - civic action	Have you ever *taken a civic action (ex. voting, signing a petition, volunteering) to increase native plants* in your community?
Self-efficacy - social diffusion	I wouldn't be able to have a good discussion about planting native plants with my community members. (REVERSED)
Descriptive norm - social diffusion	Most people in my community have encouraged others to plant native plants.
Injunctive (sanctioning) norm - social diffusion	Most people would disapprove of me advocating for native plant gardening in my community.
Personal norm - social diffusion	I feel a moral obligation to encourage others to garden with native plants.

Dynamic norm - social diffusion	In recent years, more people in my community have begun encouraging others to garden with native plants.
Moral exporting	I am willing to try to influence the behavior of my family and friends to more closely align with my own views on issues I care about.
Self-efficacy - civic action	I have the skills and knowledge to take a civic action to increase native plants in my community.
Descriptive norm - civic action	Most people in my community have taken civic actions to increase native plants.
Injunctive (sanctioning) norm - civic action	Most people would disapprove of me participating in civic actions to increase native plants.
Personal norm - civic action	I feel a moral obligation to take civic actions to increase native plants.
Dynamic norm - civic action	In recent years, more people in my community have begun taking civic actions to increase native plants.
Self-efficacy - personal sphere	I have the skills and knowledge to plant native plants around my home.
Descriptive norm - personal sphere	Most people in my community have planted native plants around their homes.
Injunctive (sanctioning) norm - personal sphere	People I know in my community disapprove of me replacing lawn with native plants around my home.
Personal norm (moral norm) - personal sphere	I feel a moral obligation to plant native plants around my home.
Dynamic norm - personal sphere	In recent years, more people in my community have begun planting native plants around their homes.
Space for native plants	How much space do you have to *plant native plants* around your home?
Importance of native plants	If you had the chance to plant a plant around your home, *how important to you would it be that it is a native plant*?
Habitual action - personal-sphere	*How often* do you participate in the following actions? - Choose native plants to plant around your home
Habitual action - social diffusion	*How often* do you participate in the following actions? - Encourage others to plant native plants
Habitual action - civic action	*How often* do you participate in the following actions? - Partake in civic action (ex. voting, signing a petition, volunteering) to increase native plants in your community

Behavioral intention - personal-sphere	In the next year, how likely are you to *plant native plants around your home*?
Behavioral intention - social diffusion	In the next year, how likely are you to *encourage someone else to plant native plants*?
Behavioral intention - civic action	In the next year, how likely are you to *take a civic action to increase native plants in your community*?
Environmental Response Efficacy – personal sphere	If *you planted native plants around your home*, how much would you help the environment?
Environmental response efficacy - social diffusion	If *you encouraged others to plant native plants*, how much would you help the environment?
Environmental response efficacy - civic action	If *you took civic action to increase native plants*, how much would you help the environment?
Collective environmental response efficacy - personal-sphere	If *most people in the US planted native plants around their home*, how much would it help the environment?
Collective environmental response efficacy - social diffusion	If *most people in the US encouraged others to plant native plants*, how much would it help the environment?
Collective environmental response efficacy - civic action	If *most people in the US took civic action to increase native plants*, how much would it help the environment?
Issue Concern - biodiversity loss	How *worried are you* about the following issues? - Biodiversity loss (ex. decline/extinction of species on Earth)
Issue Concern - water scarcity	How *worried are you* about the following issues? - Water scarcity (ex. lack of access to safe water supplies)
Issue Concern - Pesticide/chemical exposure	How *worried are you* about the following issues? - Pesticide/chemical exposure (ex. humans interacting with substances that can cause health problems)
Issue importance - biodiversity loss	How *important* are the following issues to you personally? - Biodiversity loss (ex. decline/extinction of species on Earth)
Issue importance - water scarcity	How *important* are the following issues to you personally? - Water scarcity (ex. lack of access to safe water supplies)
Issue importance - pesticide/chemical exposure	How *important* are the following issues to you personally? - Pesticide/chemical exposure (ex. humans interacting with substances that can cause health problems)
Previous civic behavior	Which, if any, of the following have you done in the past 12 months? (Select all that apply)
Behavioral Intention w/ Information - social diffusion	If given information about the benefits of native plant gardening to share, *how likely would you be to reach out to others* with this information?

Environmental/Climate Identity	I feel connected to the climate movement.
Environmental/Climate Identity	I see myself as an environmentalist.
Environmental/Climate Identity	I consider myself a climate activist.
Introversion	How much do the following descriptions sounds like you? - Someone who is a reserved, private person, doesn't like to draw attention to themselves and can be shy around strangers.
Extroversion	How much do the following descriptions sounds like you? - Someone who is talkative, outgoing, is comfortable around people, but could be noisy and attention seeking.
Education	What is your highest level of education?
Political identity	Generally speaking, do you think of yourself as a… (Political Party)
Rent/Own	Do you rent or own your home?
Income	What is your annual household income?
Race / Ethnicity	What is your race and ethnicity? (Select all that apply.)
Sexual orientation	What is your sexual orientation?
Religion	What is your religion?
Current state	Which state do you currently live in?
Previous States	In the past 10 years, which state(s) have you lived in?
Childhood State	In which state did you spend the majority of your childhood?
Current Ecoregion	Which *ecoregion* do you currently live in? (with map)
Previous Ecoregions	In the past 10 years, which ecoregion(s) have you lived in? (with map)

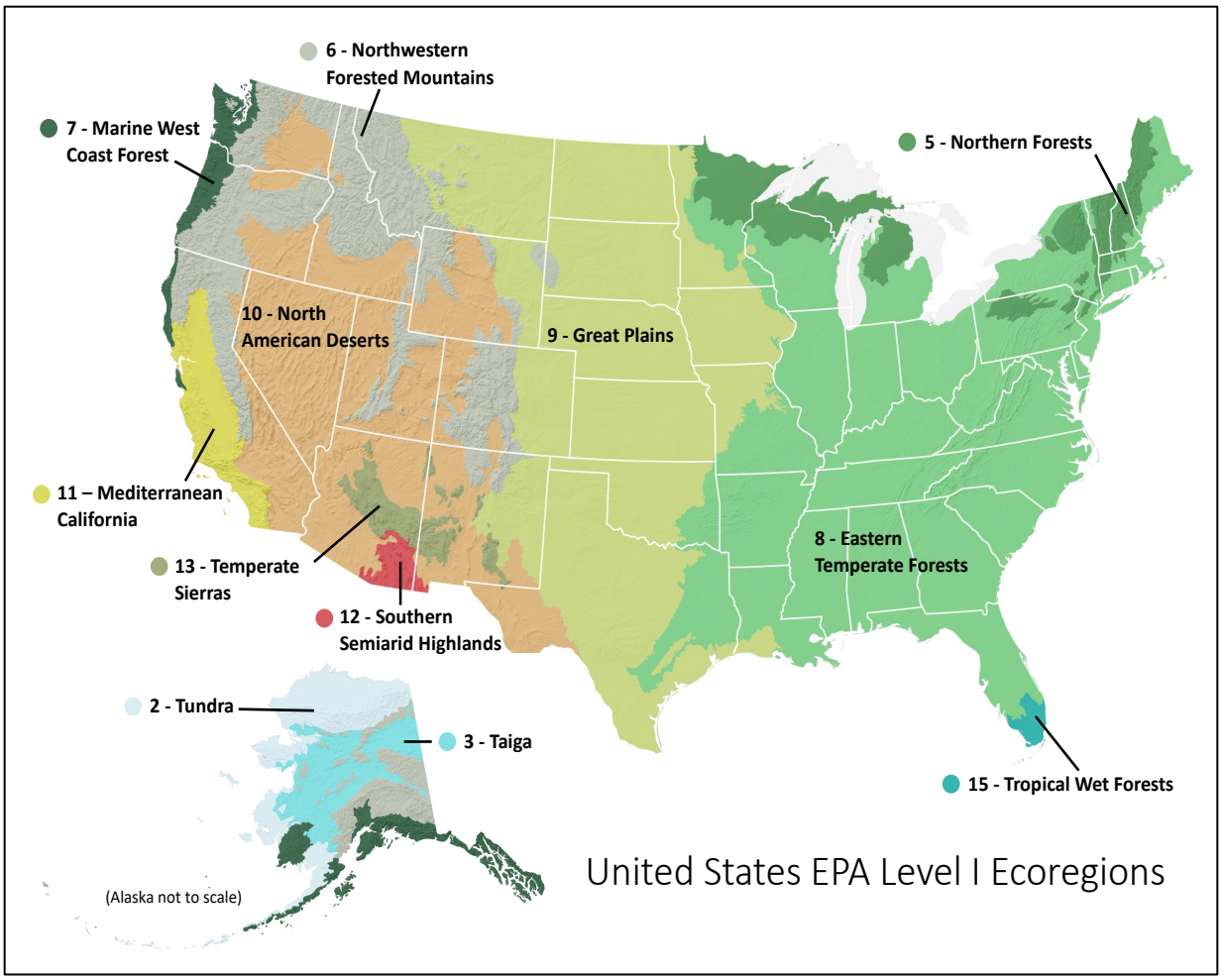

Figure S1. United EPA Level I Ecoregions*
*Generated with data from EPA.gov

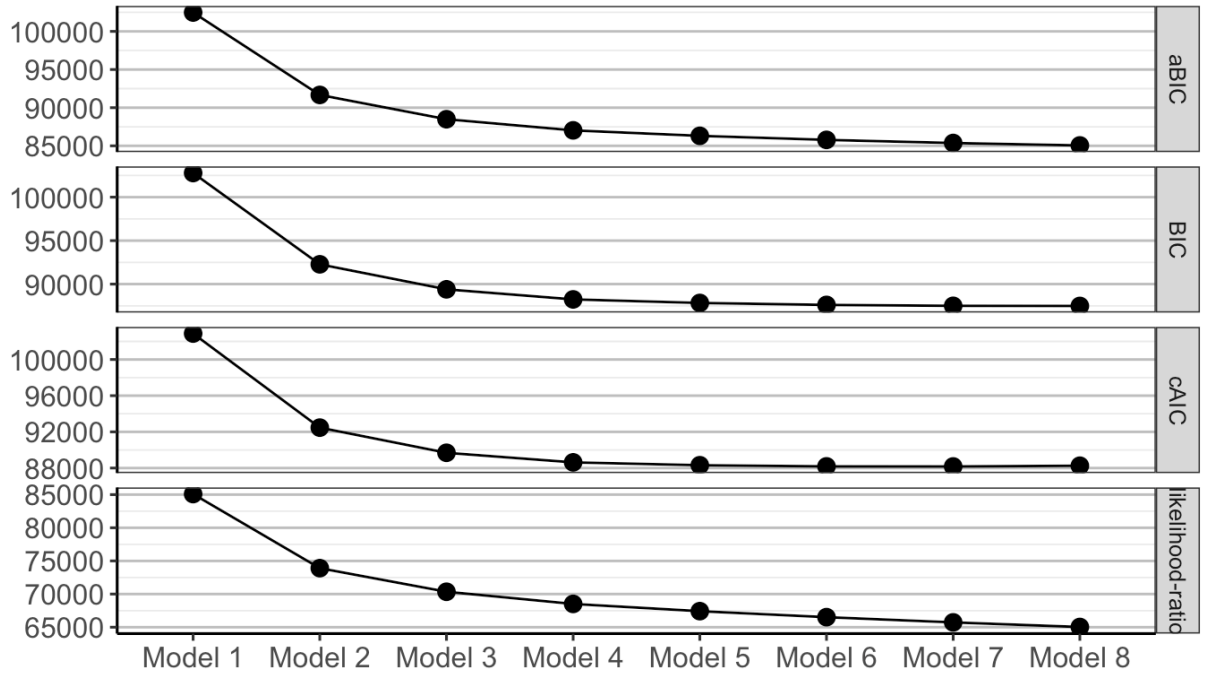

Figure S2. Scree plots to choose final model