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Social-psychological correlates of personal-sphere and diffusion behavior for wildscape gardening

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ABSTRACT

Achieving conservation outcomes requires concerted engagement from many people across diverse societies. However, many conservation practitioners struggle to engage new audiences. Research suggests one effective strategy to reach nonengaged individuals is to encourage interested conservation actors to share information, provide resources and assistance, and organize local events to recruit others; we call these "diffusion behaviors." Previous studies suggest few conservation actors who engage in personal-sphere PEB also engage in diffusion PEB, potentially because these behaviors have unique barriers which have yet to be identified. We investigated if there are different psychosocial drivers of diffusion and personal-sphere PEB by surveying residents in Colorado, USA about their personal-sphere wildscape behaviors (e.g. planting native plants) and diffusion wildscape behaviors (e.g. helping a friend plant native plants). Including diffusion-specific psychosocial variables led to better predictions of both personal-sphere and diffusion PEB. Diffusion-specific self-efficacy, social and environmental response efficacy, and reputational concerns about perceived competence were significant predictors of diffusion behavior. Diffusion-specific environmental response efficacy and injunctive norms enforced through sanctioning significantly predicted personal-sphere behavior. Personal-sphere self-efficacy and dynamic norm beliefs predicted both behavior types. Our findings suggest that research should consider personal-sphere and diffusion PEB as distinct domains and should investigate the power of diffusion-specific perceptions. Conservation outreach programs seeking to encourage diffusion of PEB may benefit from designing programming to try to change these perceptions.

1. Introduction

Protecting biodiversity and addressing environmental threats such as climate change requires that many people across diverse societies engage in pro-environmental behavior (Byerly et al., 2018). A growing body of literature has examined the drivers of pro-environmental behavior (PEB) to inform the development of interventions that can motivate this behavior change. This literature has focused predominantly on understanding motivations and barriers to personal-sphere behavior, i.e. behavior people complete on their own and/or in private (Amel et al., 2017). For example, many studies have examined what factors motivate individuals to engage in energy and water conservation, recycling, eco-friendly purchasing, habitat restoration, invasive species management, and management of wildfire, flooding, and other natural hazards (Mumaw, 2017; Niemiec et al., 2020a; Stern, 2000; Truelove and Gillis, 2018). This research has identified many psychosocial drivers of personal-sphere PEB, including social norms, behavioral attitudes, efficacy and control beliefs, environmental beliefs, and underlying values and worldviews (De Groot and Steg, 2010; Klöckner, 2013; Kollmuss and Agyeman, 2002; Niemiec et al., 2020b).

Fewer studies have examined barriers and motivations influencing pro-environmental behaviors that involve recruiting others, coordinating efforts, and taking leadership actions to impact broader social networks, communities, organizations and governance systems (Amel et al., 2017). We refer to these behaviors as "diffusion behaviors," as they involve diffusing new information, behaviors and norms to broader levels of society beyond the individual (Rogers, 2003). Diffusion behavior can include sharing information, resources and assistance with others, organizing and hosting events, role modeling PEB, and encouraging action by other key stakeholders such as businesses and governments. Amel et al. (2017) suggest that motivating diffusion behavior is crucial for environmental sustainability because this behavior can achieve more rapid widespread change beyond what individuals achieve acting in isolation. Encouraging individuals to reach out to their social

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network, for example, can help spread information and behaviors to new audiences outside those who are already interested in and engaged with the cause (Mbaru and Barnes, 2017). This greater influence occurs because individuals within a social network are often seen as more trustworthy and credible than professionals working for agencies or nonprofit organizations (Abrahamse and Steg, 2013; Gootee et al., 2010). Motivating individuals to reach out to others is especially necessary in the environmental domain because many environmental challenges pose collective action problems and thus require coordinated action across properties and regions (Graham and Rogers, 2017; Ma et al., 2012; Niemiec et al., 2020a).

People's engagement in diffusion PEB is often assumed to follow naturally from their engagement in personal-sphere PEB. For instance, diffusion of innovation theory postulates that early adopters and opinion leaders will be intrinsically willing to try to influence others by virtue of having engaged in the original behavior (Rogers, 2003). Research testing this theory, however, has demonstrated that opinion leaders often need additional training to be willing to share a behavior change message (Valente and Pumpuang, 2006). Research also shows that individuals who engage in personal-sphere PEB rarely engage in diffusion PEB. For instance, a recent study of a private property stewardship intervention found that while over three-quarters of participating residents had adopted at least one personal-sphere PEB, only one-fifth had adopted one or more diffusion behaviors (Niemiec et al., 2019). Another study of stewardship behaviors among catch-and-release fishers found measures of previous participation in responsible catch-and-release fishing to be weak or insignificant predictors of engagement in peer pressure on others (Guckian et al., 2018). These findings suggest there may be unique barriers and motivations influencing engagement in diffusion PEB, above and beyond the factors influencing engagement in personal-sphere PEB, but few studies have examined these factors.

The research that does exist on the psychosocial factors influencing diffusion has provided preliminary evidence that efficacy and normative perceptions are two primary pathways affecting people's willingness to engage in diffusion behavior (Geiger et al., 2017; Geiger and Swim, 2016). *Efficacy* is an individual's perception of their own ability to achieve impact through their behavior (Bandura, 1977). *Self-efficacy* is an individual's perception that they have the ability to engage successfully in a particular behavior, while *response efficacy* (sometimes called 'expected reciprocity') is their perception that their behavior will have the desired outcomes, including on other people and the environment (Lubell et al., 2007; Swim et al., 2019). For example, Geiger et al. (2017) found that a key barrier to people discussing climate change with others is a lack of self-efficacy, or the perception that they do not know how to talk with others effectively on this topic.

Norms are socially enforced rules or expectations that govern communities and societies (Schultz et al., 2007). Individuals' normative perceptions have been strongly linked to their behavior (Niemiec et al., 2020b). *Descriptive norms* are perceptions of what other people are commonly doing, *injunctive norms* are perceptions of what other people believe is appropriate or good, and *dynamic norms* (also called 'trending norms') are norms that are changing over time (Cialdini, 2003; Mortensen et al., 2017; Schultz et al., 2007; Sparkman and Walton, 2017). Norms are reinforced by individuals' *reputational concerns* about how others will judge them positively or negatively when they engage in a behavior (Niemiec et al., 2019). Geiger and Swim (2016) identified that a barrier to discussing climate change was the inaccurate normative perception that others did not care about climate change, while Sparkman and Walton (2017) found that experimental exposure to dynamic norms increased study participants' engagement in climate action. Both negative and positive reputational feedback have been linked to PEB effort (Alpízar and Gsottbauer, 2015).

Because they entail perceptions about specific behaviors, efficacy and normative perceptions may vary considerably between similar diffusion and personal-sphere behaviors. One might be confident in one's ability to donate to a conservation nonprofit, for example, while still being unconfident in one's ability to persuade a friend to do the same. In other words, individuals may hold perceptions of self-efficacy, response efficacy, and a variety of norms about diffusion behavior that are conceptually distinct from their efficacy and normative perceptions about personal-sphere behavior. We call these perceptions that are specific to diffusion behavior (e.g., one's self-efficacy in reaching out to others) "diffusion-specific" norms and efficacy, compared to "personal-sphere" norms and efficacy (e.g. one's self-efficacy in engaging in the personal-sphere behavior). Few studies have directly tested whether and how personal-sphere and diffusion-specific normative and efficacy perceptions may differentially influence diffusion and personal-sphere behavior. Rather, studies often use the same social-psychological constructs to predict both types of behaviors (Lubell et al., 2007; Niemiec et al., 2018). Similarly, few studies have directly compared the relative influence of various types of normative and efficacy perceptions as barriers to diffusion behavior; instead, studies typically have examined the influence of only norms or only efficacy (Geiger and Swim, 2016; Geiger et al., 2017).

In this study, we seek to obtain a more precise understanding of whether and how different types of normative and efficacy perceptions influence engagement in personal-sphere and diffusion PEB. Revealing if there are the unique barriers to diffusion behavior is particularly important to conservation organizations that administer behavior change outreach programs, which are often faced with the challenge of 'preaching to choir' (i.e., only reaching audiences of already motivated individuals; Ma et al., 2012; Shaw and Miller, 2016). Recognizing this limitation, conservation organizations are increasingly seeking to encourage engaged individuals to diffuse behaviors throughout their social network (Mbaru and Barnes, 2017). However, outreach programs often employ the same tactics to encourage motivated individuals to diffuse behaviors as they use to encourage these individuals to adopt personal-sphere behaviors. If there are different psychosocial drivers of diffusion behaviors, then different outreach techniques may be needed to motivate these behaviors. We therefore address two research questions:

RQ1: Which efficacy and normative perceptions are the most important predictors of self-reported personal-sphere and diffusion behaviors?

RQ2: Do diffusion-specific efficacy and normative perceptions help better predict self-reported diffusion behaviors, compared to personal-sphere efficacy and normative perceptions alone?

2. Methods

2.1. Study context

Our research focused on a subset of pro-environmental behavior known as 'wildscaping,' a type of private lands stewardship through which engaged actors transform properties, usually residential, into more biodiverse habitat. This transformation occurs through removal of lawn, planting of native and xeric (i.e. drought-tolerant) plants, and creation of other habitat features (Mumaw, 2017). In addition to these personal-sphere behaviors, some gardeners act as advocates in their communities by engaging in diffusion behaviors to encourage others to wildscape their own properties (Jones, 2020). We conducted this study in the Fort Collins areas of Northern Colorado in the United States because of the increasing interest in wildscaping among a range of nonprofit and government actors concerned with declining pollinator numbers, climate threats to birds, potential water shortages from population growth, and health and well-being benefits of urban nature to residents (Audubon Rockies, 2016; Nature in the City, 2015).

2.2. Sample and procedure

We surveyed residents of the Fort Collins, Colorado area who had demonstrated an interest in nature conservation by signing up for a

municipal government email list-serv that shares natural areas news, volunteer opportunities, and other similar information. We selected this list-serv membership as our sample to reflect our study purpose of identifying whether distinct barriers might be preventing an interested audience from engaging in diffusion behavior in their community. We partnered with the City of Fort Collins Nature in the City (NIC) program, which provides grants and assistance to local residents, community groups and nonprofits to expand access to and create urban habitat. NIC collaborated on this research to help fulfill their mission to serve all sectors of the diverse Fort Collins community by better reaching community members who have historically been less actively engaged in municipal nature conservation events. The NIC program is nested within the Natural Areas department, which sent the survey out via email to 9222 list-serv members with working email addresses three times over three weeks in October 2019 (see Supplemental Material for recruitment documents). The survey was administered via Qualtrics and took an average of 11 min, in which respondents were asked to self-report previous engagement in a variety of behaviors, as well as their own efficacy and norms perceptions and relevant demographic details (see Supplemental Material for the full survey). As an incentive, respondents who completed the survey were entered into a raffle to win one native plant 'garden in a box,' worth approximately $150. Institutional ethics approval was received for this study.

2.3. Measures

The survey asked respondents about their personal-sphere and diffusion-specific efficacy and normative perceptions related to wildscaping using five- and seven-point Likert-style scales (Table 1). All our items were adapted from or duplicates of existing items in the literature. For both personal-sphere and diffusion behavior we separated response efficacy into two measures, one of perceived environmental impact

Table 1
Variables and constructs measured in survey of residents' gardening with native plants.

Domain	Construct	Survey question	Response scale
Personal-sphere behavior predictors	Self-efficacy	I have the skills and knowledge to plant native plants on my property.	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.	
	Response efficacy (social)	My personal actions to plant native plants on my property will motivate others in my community to do the same.	
	Injunctive norms (sanctioning)	People I know in my community would disapprove of me replacing lawn with native plants on my property.	
	Injunctive norms (praise)	People I know in my community support me replacing lawn with native plants on my property.	
	Dynamic norms	In recent years more people in my community have begun planting native plants on their properties.	
	Descriptive norms	Approximately what percentage of people in your community do you believe currently plant native plants on their properties?	Sliding scale from 0 to 100%
Diffusion behavior predictors	Self-efficacy	I wouldn't be able to have a good discussion about planting native plants with my neighbors. I know enough about planting native plants to be able to help my neighbors plant native plants on their properties.	7-point Likert scale ranging from "strongly disagree" to "strongly agree" with 4 being "neither disagree nor agree"
	Response efficacy (environmental)	Convincing other people to plant native plants on their properties will make my own native plants better for wildlife.	
	Response efficacy (social)	If I advocate for native plant gardening in my community, my efforts will inspire others to plant native plants.	
	Injunctive norms (sanctioning)	Most people would disapprove of me advocating for native plant gardening in my community.	
	Reputational concerns (competence and likeability)	If you encouraged others in your community to plant native plants, how likely is it that others would perceive you to be competent? If you encouraged others in your community to plant native plants, how likely is it that others would perceive you to be likable?	5-point Likert scale from "very unlikely" to "very likely"
Behavioral outcome	Personal-sphere	Which of the following native plant gardening actions have you engaged in? Planted native, pollinator-friendly, and/or bird-friendly plants Installed a birdfeeder(s) Removed lawn or sod Kept cats indoors Did community science monitoring of birds, pollinators, and/or plants Other native plant gardening actions (please describe)	"I have done this" or "I have NOT done this"
	Diffusion	Which of the following native plant gardening actions have you engaged in? Tried to convince someone else to plant native plants Shared information with someone else about planting native plants Helped someone else plant native plants Hosted a garden tour at your property to showcase your native plants Invited others to come over to look at your native plants Organized a native plant event in your community Participated in a native plant event in your community Contacted plant growers or sellers to encourage them to provide more native plants Other native plant advocacy actions (please describe)	"I have done this" or "I have NOT done this"

(environmental response efficacy) and one of perceived social impact (social response efficacy), in order to distinguish between an action's capacity to motivate others and its capacity to achieve conservation impact. We adapted our self-efficacy and environmental response efficacy measures from Geiger et al. (2017) and our social response efficacy measures from Lubell et al. (2007)'s measure of expected reciprocity (studied elsewhere as 'indirect goal collective efficacy; Hamann and Reese, 2020). We measured personal-sphere injunctive norms enforced through both sanctioning and praise (Matthies et al., 2012; Niemiec et al., 2018), since those two forms of social normative feedback have been found to affect behavior differently, as well as diffusion injunctive norms enforced through sanctioning. We adapted the personal-sphere dynamic norms item from Sparkman and Walton (2017) and the personal-sphere descriptive norms item from Niemiec et al. (2019). Diffusion-specific reputational concerns comprise two measures, perceived competence and likeability, to assess participants' beliefs about how others' impressions of them might be affected by advocating for behavior change; both measures were adapted from Geiger and Swim (2016).

We used a series of yes-no questions to measure self-reported engagement in five personal-sphere wildscape behaviors and eight diffusion wildscape behaviors identified through a previous study of wildscape behavior, as well as an 'other" option for both categories (Table 1; Jones, 2020). We combined these responses into two categorical behavioral outcome variables measuring the number of different types of personal-sphere wildscape behavior and the number of different types of diffusion wildscape behavior that respondents reported having engaged in. We constructed our dependent variables as the number of different behaviors people had engaged in at least once for two reasons. First, our partner organization was interested in how to encourage people to engage in more different types of wildscaping behaviors, so this reflected the outcome of interest to conservation organizations. Second, some behaviors were habitual (e.g., planting native plants), while some were one-off (e.g., installing a birdfeeder), so a yes/no measure for each was the only consistent scale across behavioral outcomes. Our two categorical scales of behavioral outcomes were different lengths due to the total number of behaviors for each category: 0–3 for personal-sphere and 0–8 for diffusion.

2.4. Data analysis

We ran Pearson's correlation tests within our predictor variables to determine if each variable measured a distinct construct, and between our two outcome variables to determine if personal-sphere and diffusion behavior were associated. We excluded the second diffusion-specific self-efficacy measure from further analysis because it had a medium correlation (0.62) with personal-sphere self-efficacy. No other predictor variables had a correlation higher than 0.60. The correlation between the two outcome variables was 0.42, suggesting there was intermediate overlap between engagement in the two behaviors.

We tested our research questions by running a series of ordinal logistic regressions using the 'MASS' package in R. Model 1 tested the impact of personal-sphere predictor variables on personal-sphere behavior, and we added diffusion predictor variables in model 2. Model 3 tested the impact of personal-sphere predictor variables on diffusion behavior, and we added diffusion predictor variables in model 4. We used multiple imputation methods to account for missing data, excluding cases with more than 30% missingness for a sample size of 1038. We used the 'mice' package in R to impute the remaining data with 10 imputations and a seed of 81420 (Schomaker and Heumann, 2014). We calculated median and range Akaike information criterion (AIC) and conducted Wald tests to compare fit between imputed output for models 1 and 2 and models 3 and 4 (Meng and Rubin, 1992).

3. Results

3.1. Participants

Of the 9222 people who received the survey, 1130 completed it for a response rate of 12.3%. Most participants were women (73.5%), highly educated (84.6% bachelor's degree or higher), White (96.6%), Non-Hispanic/Latinx (96.2%) and owned their home (88.5%). These numbers are similar to the limited data that our partner organization has about who participates in their events, and are dissimilar from the larger Colorado population (Table 2). The vast majority (96.1%) of respondents had engaged in at least one personal-sphere behavior, at least one diffusion behavior, or at least one of both (Table 3).[1] Most respondents had planted native plants (84.6%), installed a birdfeeder (62.4%), tried to convince others to plant native plants (61.4%) or shared information with others about native plants (70.2%), while a minority of respondents had engaged in the remaining behaviors.

3.2. Psychosocial correlates of personal-sphere behavior

Three personal-sphere psychosocial variables predicted personal-sphere wildscaping behavior (Models 1 and 2, Table 4). These were personal-sphere self-efficacy, personal-sphere injunctive norms enforced through praise, and dynamic personal-sphere norms. Age and years living at the property were statistically significant ($p < 0.01$) demographic predictors. Diffusion environmental response efficacy and diffusion injunctive norms enforced through sanctioning ($p < 0.05$) were significantly associated with personal-sphere behavior, and diffusion self-efficacy was marginally significant (Model 2, Table 4). Personal-sphere self-efficacy had the largest association with behavior (odds ratios of 1.46 and 1.42 for models 1 and 2 respectively). Personal-sphere dynamic norms had the next largest effect size (1.17 for models 1 and 2).

The AIC range for the imputed model output for model 1 (i.e. personal-sphere predictors only) was 2321–2336, with a median of 2330, while the AIC range for the imputed model output for model 2 (i.e. personal-sphere and diffusion predictors) was 2312–2329, with a median of 2321. The Wald test comparing models 1 and 2 was significant ($p = 0.002$), indicating that model 2, with added diffusion variables, better predicted personal-sphere behaviors than the model with personal-sphere predictors only.

3.3. Psychosocial correlates of diffusion behavior

Three personal-sphere psychosocial variables predicted diffusion wildscaping behavior in the personal-sphere only model (Model 3, Table 4). These were personal-sphere self-efficacy, personal-sphere

Table 2
Survey demographics (n = 1130) compared to participants in City of Fort Collins Natural Areas Department events, from internal City data, and to the average Colorado population, from census data (U.S. Census Bureau, 2013–2017).

Demographic information	Survey	Natural Areas	Census
Median age	53	60–69	37
% Female	73.5	Unknown	49.6
% Bachelor's degree or higher	84.6	85.2	39.4
% White	96.6	91.7	84.2
% Non-Hispanic/Latinx	96.2	98.1	67.9
% Homeowning	88.5	Unknown	64.7

[1] Note: numbers on what percentage of respondents had engaged in at least one of each behavior type are derived from a sample size of 1088 due to 42 nonresponses for diffusion behaviors.

Table 3
Percentage of respondents engaged in personal sphere and diffusion behaviors (n = 1130).

Personal Sphere Behavior	Yes	No
Planted native plants	84.6%	15.4%
Installed a birdfeeder	62.4%	37.6%
Removed lawn or sod	48.8%	51.2%
Kept cats indoors	28.1%	71.9%
Did citizen science	19.6%	80.4%
Did other gardening behaviors (open-ended)	33.5%	66.5%
Diffusion Behavior	**Yes**	**No**
Tried to convince others to plant native plants	61.4%	38.6%
Shared information with others about planting native plants	70.2%	29.8%
Helped others plant native plants	31.1%	68.9%
Hosted a native plant garden tour	3.6%	96.4%
Invited others over to see garden	30.1%	69.9%
Organized native plant community event	3.2%	96.8%
Participated in native plant community event	32.4%	67.6%
Contact native plant growers and sellers	9.8%	90.2%
Did other advocacy behaviors (open-ended)	11.9%	88.1%
Combination of Personal Sphere and Diffusion	**Yes**	
Engaged in at least one personal sphere and at least one diffusion behavior	78.4%	
Engaged in only personal sphere behavior	14.2%	
Engaged in only diffusion behavior	3.5%	
Engaged in neither personal sphere nor diffusion behavior	3.9%	

social response efficacy, and personal-sphere dynamic norms ($p < 0.01$). Personal-sphere injunctive norms enforced through sanctioning was marginally significant at the level in the personal-sphere only model and significant in the combined model (Model 4, Table 4) and had a positive odds ratio, meaning that respondents who believed others would disapprove of them planting native plants were in fact more likely to advocate for native plant gardening in their communities. Personal-sphere social response efficacy was no longer a significant predictor of diffusion behavior at $p < 0.05$ when diffusion variables where added to the model, but personal-sphere self-efficacy and personal-sphere dynamic norms remained significant (Model 4, Table 4).

Four diffusion psychosocial variables predicted diffusion wildscaping behavior (Model 4, Table 4). Diffusion self-efficacy, diffusion environmental response efficacy, and perceived diffusion competence by others were statistically significant ($p < 0.01$) predictors, and diffusion social response efficacy was significant at the $p < 0.05$ level. Personal-sphere self-efficacy had the largest effect on diffusion behavior (odds ratios of 1.563 and 1.671 for models 3 and 4 respectively). Diffusion self-efficacy and reputational concerns related to perceived competence by others had the next largest effect sizes (1.228 and 1.248 respectively) for diffusion behavior.

The AIC range for the imputed model output for model 3 (personal-sphere predictors only) was 3635–3646, with a median of 3640, while the AIC range for the imputed model output for model 4 (personal-sphere and diffusion predictors) was 3579–3588, with a median of 3584. The Wald test comparing models 3 and 4 was significant ($p = 0.000$), showing that model 4 integrating diffusion predictor variables was meaningfully better at predicting diffusion wildscape behavior.

4. Discussion

Our findings indicate that incorporating diffusion-specific efficacy and normative perceptions can lead to better predictions of both personal and diffusion wildscape behavior. A greater number of diffusion-specific variables were significant predictors of diffusion behavior compared to personal behavior. Outreach programs seeking to facilitate the diffusion of pro-environmental behavior may therefore be more effective by specifically addressing these diffusion-specific perceptions.

Personal-sphere self-efficacy was a strong predictor of all behavioral outcomes, with the largest effect size compared to all other psychosocial and demographic variables for both personal and diffusion wildscape behavior (Bandura, 1977; Lauren et al., 2016). All three measures of diffusion efficacy – self-efficacy, environmental response efficacy, and social response efficacy – were significant predictors of engagement in wildscaping diffusion. Further, reputational concerns about being perceived as incompetent when reaching out to others was also a significant predictor of diffusion. Taken together, these results signal that residents need to feel comfortable and confident about their ability to both wildscape garden themselves and to approach neighbors and friends in order to promote wildscape gardening.

This suggests that there is a need for programs to not only train interested conservationists in wildscape gardening, but also train them in how to reach out to others within their social networks. Experimental studies, for instance, have shown that interventions that give people guidance on what to say when talking to others can increase diffusion-specific self-efficacy beliefs, which in turn can increase individuals' willingness to engage in climate change collective action (Geiger et al., 2017). A real-world example of a program that seeks to boost both personal-sphere and diffusion self-efficacy within our study site is

Table 4
Logistic regression models of personal-sphere and diffusion wildscape behavior (n = 1130).

Personal-sphere predictor variables	Model 1. Personal-sphere wildscape behavior			Model 2. Personal-sphere wildscape behavior			Model 3. Diffusion wildscape behavior			Model 4. Diffusion wildscape behavior		
	OR	*SE*	*p*	*OR*	*SE*	*p*	*OR*	*SE*	*p*	*OR*	*SE*	*p*
Self-efficacy	1.46	0.037	**0.000**	1.42	0.040	**0.000**	1.671	0.037	**0.000**	1.563	0.039	**0.000**
Response efficacy (environmental)	0.98	0.046	0.686	0.98	0.046	0.715	0.936	0.047	0.157	0.945	0.046	0.216
Response efficacy (social)	1.05	0.053	0.329	0.96	0.059	0.514	1.301	0.051	**0.000**	1.112	0.056	0.058
Injunctive norms (sanctioning)	0.97	0.037	0.366	0.95	0.039	0.233	1.066	0.035	0.071	1.094	0.037	**0.016**
Injunctive norms (praise)	1.14	0.05	**0.009**	1.13	0.052	**0.016**	1.05	0.048	0.302	0.997	0.049	0.956
Dynamic norms	1.17	0.053	**0.002**	1.17	0.054	**0.005**	1.169	0.051	**0.002**	1.13	0.052	**0.019**
Descriptive norms	1.00	0.004	0.549	1.00	0.004	0.566	1.003	0.003	0.384	1.004	0.003	0.307
Diffusion predictor variables												
Self-efficacy				1.08	0.041	0.059				1.228	0.04	**0.000**
Response efficacy (environmental)				1.13	0.055	**0.026**				1.171	0.052	**0.003**
Response efficacy (social)				1.06	0.071	0.382				1.16	0.067	**0.027**
Injunctive norms (sanctioning)				1.14	0.053	**0.011**				1.07	0.049	0.168
Reputational concerns (competence)				1.06	0.078	0.447				1.248	0.073	**0.003**
Reputational concerns (likeability)				1.13	0.084	0.158				0.998	0.078	0.977
Demographic variables												
Age	1.02	0.005	**0.000**	1.03	0.005	**0.000**	1.005	0.005	0.277	1.007	0.005	0.136
Gender	1.12	0.141	0.428	1.15	0.142	0.324	0.868	0.135	0.296	0.922	0.136	0.549
Educate	0.91	0.625	0.877	0.87	0.635	0.833	0.815	0.702	0.770	0.777	0.665	0.704
Years at property	1.03	0.008	**0.000**	1.03	0.008	**0.000**	1.002	0.007	0.786	1.004	0.007	0.525

p values in bold are significant at the 0.05 or 0.01 level.

Audubon Rockies' Wildscape Ambassadors program, which provides 2-3-h trainings on how to wildscape garden and how to reach out to neighbors and other community members (Jones, 2020). Such programs could also attempt to influence participants' perceptions of diffusion social and environmental response efficacy, for instance by sharing success stories from previous participants who were able to persuade their neighbors to begin wildscape gardening or by emphasizing the aggregate environmental benefits from collective action (Bandura, 1977; Camilleri and Larrick, 2019). There is currently a dearth of literature on whether and how these kinds of conservation ambassador and train-the-trainer interventions lead to more dispersed behavior change. Future research on these programs could build on the framework of diffusion predictors we have tested here.

Surprisingly, personal-sphere wildscaping behavior was also better predicted by the model that included diffusion-specific predictors. In particular, diffusion-specific environmental response efficacy and diffusion-specific injunctive norms enforced through sanctioning were significant predictors of personal behavior. This suggests that even behaviors assumed to be personal or private, such as gardeners' decisions to plant native plants or remove lawn, may be affected by diffusion beliefs. One potential explanation is that participants in this study may have been engaging in personal wildscaping behavior in their front yards, and that the greater public exposure in front yard spaces made perceptions of community expectations more salient (Visscher et al., 2016). Diffusion-specific beliefs may therefore be less associated with personal behaviors that are less observable by the public. Future research is needed to understand whether and why diffusion-specific variables may influence personal behavior.

We found that greater perceptions of personal-sphere dynamic norms, or a belief that wildscape gardening was becoming increasingly common in the local area, were associated with respondents engaging in more wildscape gardening and in more wildscape advocacy. These findings provide support for previous studies on plant-based eating and residential water conservation, which found that sharing evidence that a behavior is growing in popularity increases people's engagement in it – even when the behavior is counternormative (Mortensen et al., 2017; Sparkman and Walton, 2017). Our findings build on these studies by suggesting that dynamic norms are not only associated with personal PEB, but also with diffusion behaviors. Future research could expand on our findings by examining the extent to which interventions that share information about dynamic norms enhance engagement in diffusion PEB.

Interestingly, the effect of injunctive norms on behavior appears to be complex. While personal-sphere injunctive norms enforced through praise was a significant predictor of personal-sphere behavior, as might be expected, injunctive norms enforced through sanctioning were associated with behavior in unexpected ways. Not only were respondents who believed that others would disapprove of them advocating for wildscaping in their community more likely to plant native plants, respondents who believed that others would disapprove of them planting native plants were more likely to engage in diffusion behaviors. Community disapproval of one form of PEB may be therefore be encouraging residents to simply divert their energies into another closely related form of PEB – switching from personal-sphere behavior to diffusion behavior and vice versa. Future research is needed on whether perceived sanctioning for one action may motivate an already engaged audience towards greater engagement in a slightly different form of action for the same cause, and whether or how this holds true among unengaged audiences compared to more highly engaged audiences.

Finally, further research on normative and efficacy predictors of diffusion behavior could consider potential spillover between personal-sphere and diffusion behavior. This is particularly necessarily given that the relationship between diffusion and personal-sphere behavior has been overlooked in the PEB spillover literature (Maki et al., 2019; Nilsson et al., 2017). Such studies could explore if and under what circumstances engagement in personal-sphere PEB precedes engagement in diffusion PEB and vice versa. For instance, in our study over 78% of participants had engaged in at least one of both personal-sphere and diffusion behavior, 14% had done at least one personal-sphere behavior only, 3.5% had done at least one diffusion-specific behavior only, and 3.9% had done none. This indicates there may be some directionality in behavioral adoption whereby personal-sphere engagement precedes diffusion-specific engagement. Residents may not feel licensed to engage in diffusion behavior until they have engaged in the personal-sphere pro-environmental behavior themselves because of concerns about perceived hypocrisy (Gamma et al., 2020; Nilsson et al., 2017). This relationship may also vary based on the relative perceived difficulty of various personal-sphere and diffusion behaviors (Lauren et al., 2016). Investigating these questions was beyond this study given our cross-sectional design; longitudinal studies would be needed to elucidate if this directional relationship exists and for what reasons it occurs.

4.1. Study limitations

A limitation of our study is that our sample is representative of an already interested conservation community in the Fort Collins area, but is unrepresentative of the wider Colorado population. We deliberately sought to understand this already interested audience given that conservation organizations often already have access to interested audiences and are increasingly seeking to encourage them to diffuse behaviors (Mbaru and Barnes, 2017; Shaw and Miller, 2016). Further, diffusion of innovations theory suggests that it may be typical for early behavioral adopters to be unrepresentative of the larger community in this way (Rogers, 2003). Additional research would be useful to explore whether there are different predictors of diffusion among a nonengaged audience compared to a highly engaged audience, as well as to what extent diffusion behavior in wildscaping and other PEB domains allows program participants to reach diverse segments of a wider population, particularly those communities who are often marginalized in environmental outreach (Raymond et al., 2019).

An additional limitation is that we used a cross-sectional survey design at one time point, so we are unable to determine directionality between our psychosocial variables and behaviors. It is possible that engaging in PEB influenced our audience's psychosocial perceptions rather than the other way around; confirming the direction of the relationship requires longitudinal and experimental studies. Third, despite the strong significance of the relationship between many of the psychosocial predictors and our behavioral outcomes, the odds ratios for many of these predictors remain relatively low (between 1.08 and 1.671 for significant predictors) (Chen et al., 2010). This indicates a relatively small effect size, suggesting there are other important drivers of personal-sphere and diffusion wildscaping behaviors that are missing from our models. Finally, our behavioral outcome measure was self-reported engagement, which may differ from actual behavior (Maki et al., 2019).

5. Conclusions

Scaling up biodiversity conservation efforts will require motivating a broader audience to engage in pro-environmental behavior (Amel et al., 2017). To reach such a broader audience, conservation organizations are increasingly encouraging interested conservation actors to diffuse conservation behaviors to others in their social networks (Niemiec et al., 2019). Our study indicates that conservation organizations should consider diffusion as a specific subset of PEB that has unique efficacy and normative barriers. In particular, to diffuse conservation behaviors, our results suggest that conservation actors must have the confidence that such diffusion efforts are achievable and will be well-received. Deliberately integrating interventions to address these psychosocial barriers to diffusion into new and existing programming may increase the effectiveness of conservation outreach efforts, enhancing the movement's ability to protect biodiversity in a complex and changing world.

CRediT authorship contribution statement

Megan S. Jones: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing, Visualization, Funding acquisition. **Rebecca M. Niemiec:** Conceptualization, Methodology, Resources, Supervision, Writing - review & editing, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvman.2020.111271.

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