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Motivations and barriers for the participation of family forest owners in conservation practices: an application of the transtheoretical model

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ABSTRACT

Understanding landowner motivations and barriers is critical to the success of conservation programs. In 2020, we conducted a survey of family forest owners in Vermont related to expert visits, patch cuts, and applying for cost-share funds. We analyzed the activities using the Transtheoretical Model of Behavioral Change (TTM) and ordinal logistic regression. The TTM stage of change varied by activity with 68% of the respondents being in the Action stage for expert visits, 29% being in the Action stage for patch cuts, and 14% being in the Action stage for cost-share. The significant variables in the regression models also varied, with positive aspects including expanding owners' knowledge, reassurance of existing management practices, following expert recommendations, and forest health benefits. Significant negative aspects included difficulty finding appropriate providers and information. These findings have important implications for effective program design and implementation.

KEYWORDS

Behavioral change model; cost-share; expert visit; nonindustrial private forest owners; patch cut; Vermont, USA; wildlife habitat

Introduction

Forests cover over thirty percent of terrestrial habitat across the globe (FAO, 2020) and provide crucial habitat functions for wildlife including clean water, food, shelter, and protection from predators. The northeastern United States is one of the most heavily forested areas of the country, but habitat quality and availability is declining in this region for many species that require heterogeneous forest age structures and composition (Olofsson et al., 2016). Changing land use patterns are a main source of this decline, as forestland that was cleared for agricultural purposes following European colonization regrew through passive or active management that typically promoted homogenous forest age and stand structure. Current threats to forest complexity include invasive pests, climate change, and forest fragmentation; the latter change results in shrinking interior forest habitats and reduced habitat conductivity (Dietzman et al., 2011). For species dependent on early-successional forest, such as the New England cottontail (*Sylvilagus transitionalis*) and golden-winged warbler (*Vermivora chrysoptera*), the overall maturation of forests in the

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northeastern United States is compounding these threats to habitat quality and causing some populations to decline (Askins, 2001). For species whose populations are in decline, the most effective mitigation measure is to maintain and enhance their habitat (Mir & Dick, 2012).

The state of Vermont is proportionally the fourth most-forested state in the United States and contains 1.8 million ha of forestland (Morin et al., 2020). Vermont's landscape includes the transition from maple/beech/birch forests, which are typical of the broader northeastern United States, to the spruce/fir forests of the northern part of the region and southeast Canada. This transition results in diverse forest composition, but the overall age structure is shifting toward larger, older trees as a result of the state's land use history (Morin et al., 2020). As of 2017, only 7% of Vermont's timberland area consisted of small-diameter stands, while medium and large-diameter stands comprised 24% and 69%, respectively (Morin et al., 2020). Stands of very large, old trees are rare across most of the eastern United States, including Vermont (Barton & Keeton, 2019).

Active and passive management strategies substantially influence the structure and composition of forests; the future of forest habitat depends substantially on the decisions of landowners and forest managers. In Vermont, family forest owners are collectively the largest group of landowners, controlling 60% of the forestland in the state (Butler et al., 2021). "Forests" are defined here as land with at least 10% forest cover that is at least 0.4 ha (1.0 ac) in size, at least 37 m (120 ft) wide, and not currently developed for non-forest use (Butler et al., 2021). "Family forests" are forests owned by individuals, families, estates, trusts, and family partnerships (Butler et al., 2021).

Due to the influence of family forest owners on Vermont's habitat quality, both governmental and non-governmental entities are working to support landowners whose goals align with habitat protection while promoting cultural, environmental, and economic benefits that extend beyond individual parcels. Originating at local, state, and national levels, policies, programs, and tools have been created including preferential property tax programs, conservation easements, cost-share assistance, and technical assistance. These efforts strive to help landowners meet their needs while simultaneously promoting forest stewardship practices that, among other benefits, enhance wildlife habitat.

Despite efforts to increase participation in conservation programs, most are used by only a small fraction of eligible participants. In Vermont, only 4% of family forest ownerships with 4+ ha have participated in a cost-share program, which is close to the national average (Butler et al., 2021). Participation by family forest owners in Vermont in other conservation practices, however, is relatively high; 31% of those with 4+ ha have received advice about their forest within the past five years and 38% are enrolled in the state's preferential property tax program (Butler et al., 2021). In contrast, only 18% of family forest owners nationwide have received advice in the past five years and 17% are enrolled in a preferential property tax program (Butler et al., 2021).

Due to the overall low levels of participation in conservation programs nationally, many studies have focused on ways to increase engagement and better understand the characteristics of family forest owners who choose to utilize these programs. Factors associated with enrollment have been found to include: size of holdings (Kilgore et al., 2008; Ma et al., 2012; Song et al., 2014), amount of financial compensation (Kilgore et al., 2008), program awareness (Kilgore et al., 2008), management intentions (Kilgore et al., 2008), and ownership objective (Song et al., 2014), with at least some factors varying geographically (Song

et al., 2014). Factors identified as barriers to participation in assistance programs include: distrust of the government (Rouleau et al., 2016), complicated application processes (Jacobson et al., 2009), and lack of effective, targeted outreach (McGrath et al., 2020).

Wildlife values are important to consider in the context of conservation assistance programs because landowners who hold positive attitudes and values toward wildlife have been found to be more likely to participate in conservation programs and forest management practices (Dayer et al., 2015; Sorice et al., 2014). The different ways in which wildlife is valued may impact forest management attitudes and behaviors and can be measured through "wildlife value orientations," which are general patterns of beliefs that provide meaning and direction to fundamental values in the context of wildlife (Fulton et al., 1996). Teel and Manfredo (2010) identified two primary wildlife value orientations: domination, in which wildlife is treated as a utilitarian commodity that humans have priority over; and mutualism, in which wildlife is seen as capable of relationships of trust with humans and is therefore deserving of rights and care. Wildlife value orientations have been used in a variety of contexts, including predicting wildlife-related behaviors and attitudes, such as explaining variation in public opinions regarding wildlife habitat management practices and predicting participation in wildlife-related recreation (Vaske & Needham, 2007). Wildlife value orientations were studied in the context of USDA Farm Bill grassland conservation programs, but were found to have no relation to program participation (Gigliotti & Sweikert, 2019). However, no such effort has been made to determine the orientations of family forest owners in the United States or to understand the influence of wildlife value orientation on forest conservation program participation.

Behavioral change models provide a framework for explaining human behavior and identifying potential mechanisms by which behaviors can be altered. The Transtheoretical Model of Behavior Change (TTM) was put forth by Prochaska and DiClemente (1983) based on studies of how smokers engaged in the process of stopping this addictive behavior. According to TTM, an individual progresses through different stages as they think about, plan for, make, and keep the change: Pre-contemplation, Contemplation, Preparation, Action, and Maintenance with the potential for Relapse at any stage from Contemplation through Maintenance (Prochaska & DiClemente, 1983). Those who are in the Pre-contemplation stage have either never thought about the activity or have thought about the activity but have chosen not to complete it. In Contemplation, individuals intend to do the activity but have not yet started to do so. Individuals in Preparation are actively planning to do the activity. In the Action stage, individuals do the target activity. In the Maintenance stage, individuals continue to perpetuate the desired behavior.

TTM has been used to analyze a multitude of behaviors beyond smoking cessation, although the vast majority of these studies have occurred within the physical and mental health fields, including substance abuse, eating disorders, medication compliance, and unplanned pregnancy prevention (Prochaska & DiClemente, 1983). The results have been used to identify the barriers at the various stages and develop approaches for mitigating these issues. The use of TTM is limited in the environmental field, but it has been used in studies regarding fossil fuel divestment (Abrash Walton, 2018), conservation estate planning (Markowski-Lindsay et al., 2017), perceptions of climate change (Semenza et al., 2008), and wildfire risk mitigation (Martin et al., 2007).

In Vermont, there are several programs that provide technical and financial assistance to aid private landowners in wildlife habitat creation and improvement, including the USDA

Natural Resources Conservation Service's Environmental Quality Incentives Program (EQIP) and the Woods, Wildlife, and Warblers program, a partnership between the American Forest Foundation, Vermont Woodlands Association, and Audubon Vermont. While the impetus of the research presented here was to study motivations and barriers for applying to cost-share programs, initial interviews indicated that two other factors were deeply entwined with a landowner's interest in and ability to apply for cost-share programs: specifically, whether the landowner had received program-related assistance from a natural resource professional and whether the landowner was interested in, or had suitable site conditions for, the forest management action toward which cost-share funds could be applied. To disentangle these dynamics, we used TTM to assess the motivations, barriers, and other factors, including wildlife value orientation, associated with family forest owners in Vermont related to three actions: 1) receiving technical assistance (e.g., walking the land with a natural resource professional); 2) conducting a patch cut to create wildlife habitat; and 3) receiving cost-share funds to conduct conservation activities. While there are some important differences between Vermont and other regions, such as the specifics of property tax programs (Frey, 2023), there are also many commonalities, such as the preponderance of family forest ownership (Butler et al., 2021). All of these differences need to be considered when determining the potential implications for other areas.

Methods

We designed a mail-based survey based on findings from prior research and semi-structured interviews to assess the efficacy of landowner technical assistance programs in Vermont aimed at increasing and improving wildlife habitat on family forestlands. All interview and survey procedures and materials were approved by the University of Massachusetts Amherst Institutional Review Board (Protocol ID: 2017–4379).

The survey instrument (see Supplemental Materials) contained questions related to the family forest owner's familiarity with specific conservation activities, TTM stage of change, motivations and barriers associated with taking action, wildlife value orientation, landowner attributes, and land attributes. While the survey asked about several conservation activities, this article focuses on three: expert visits, patch cuts, and cost-share programs. Expert visits were defined as a visit from a woodland expert to walk the land, and answer landowner's questions, and provide personalized advice. Patch cuts were defined as areas of woodland, typically 0.2 to 2 ha (0.5 to 5 ac) in size, in which all or most of the trees are cut to open the canopy and allow plants to grow back naturally. Cost-share programs were defined as programs run by federal, state, or non-governmental groups that provide financial assistance to qualified woodland owners to conduct specific conservation activities on their land, such as removing invasive plants, creating a forest management plan, or enhancing wildlife habitat.

We asked respondents similar, but not identical, questions about each of the conservation actions. For all three activities, respondents were asked about their experiences, motivations, and barriers. For cost-share programs and patch cuts, respondents were also asked about their familiarity with the activity. Familiarity was not asked regarding expert visits because pre-testing showed respondents to have a high degree of familiarity with the concept.

Motivations and barriers were assessed using 5-point Likert scales that ranged from strongly disagree to strongly agree, plus a "Do not know" option. The specific motivations and barriers varied by activity and were based on previous literature and pre-survey interviews. The questions related to wildlife value orientation came from Chase (2016) and included appropriate use, hunting, social affiliation, and caring dimensions.

Before implementation, cognitive interviews with Vermont family forest owners were conducted to assess the reliability of the survey instrument. Based on the results of these interviews, a few minor changes were made to the survey organization and instructions.

The population of interest was all family forest ownerships in Vermont with at least 4 ha of forestland. This 4-ha minimum is a common cutoff because parcels smaller than 4 ha are generally considered to be poorly suited for forest management or forestry-based programs (Butler et al., 2021). A random sample from this population was drawn using the 2017 Vermont Department of Taxes dataset, which includes the names, addresses, and parcel sizes for all private landowners in the state. The distribution of parcel sizes was very skewed with most owners owning relatively small parcels, but a substantial acreage in holdings of larger parcels. To ensure a good representation of landowners across the range of sizes of holdings, we drew a random sample with inclusion probabilities proportional to the size of holdings. The sample frame did not provide information on forested acreage, so all ownerships with 4+ ha were included; the survey asked owners about the acreage of forestland owned, and the population was over sampled to account for disqualification of those respondents without 4+ ha of forestland. Ownership type, e.g., family versus public or corporate ownership, was based on the name of the parcel owner listed in the dataset. Based on the desired confidence level of 95%, margins of error of ±3%, and anticipated response rates, the target sample size was 2,000. To account for over sampling due to the size of forest holdings, 2,122 unique ownerships were selected. Before the first mailing, all addresses were updated using the U.S. Postal Service's National Change of Address database.

To maximize response rate, the survey was implemented following the Tailored Design Method (Dillman et al., 2014). Implementation consisted of four waves of mailings, each one to four weeks apart: an introductory postcard; an initial survey with a cover letter and a postage-paid business-reply return envelope; a follow-up postcard; and a second survey with a cover letter and a postage-paid business-reply return envelope sent to those who had not yet responded. All mailings occurred between January 27, 2020, and March 17, 2020.

Between February 2, 2020, and June 4, 2020, 867 ownerships responded. Surveys that were less than 75% complete or that were returned by individuals outside the scope of the project were removed, resulting in 712 usable surveys and an overall cooperation rate of 38%.

A subset of the family forest owners who did not respond to the mail inquiries were contacted by phone to conduct a nonresponse assessment. Using Cohen's power analysis with a desired effect size of 0.6, a significance level of 0.05, and a power of 0.9, we determined that 31 nonresponders would need to be contacted. Thirty-three qualified nonresponders were successfully contacted, although three were later removed from the analysis because they returned completed surveys. Nonrespondents were asked six questions considered key variables or hypothesized to vary the most between responders and nonresponders. Differences were assessed using Pearson's X^2 test. Five variables (size of forest holding, trees had been cut for sale, expert visit, cost-share participation, and age) showed no significant differences between respondents and non-respondents (p-values ≥0.05). However, respondents were significantly more likely to identify as male (74%) than non-respondents (50% male).

The factors related to the TTM Stage of Change were tested using proportional odds logistic regression, a form of ordinal logistic regression (Agresti, 2010), with separate models created for each action. The odds ratios of the coefficients of the models, along with the 95% confidence intervals, are reported below. The ordinal logistic regression proportionality assumption was tested by comparing the coefficients from the ordinal logistic regression models to the coefficients from binomial logistic regression models where the stages were collapsed. The goodness-of-fit of the ordinal regression models was assessed using the Lipsitz likelihood-ratio test, an ordinal version of the Hosmer – Lemeshow test, the Pulkstenis – Robinson X^2 test, and the Pulkstenis – Robinson deviance test (Fagerland & Hosmer, 2017). Multicollinearity was assessed by examining variance inflation factors (VIF).

Based on the descriptions provided by Prochaska and Velicer (1997), the TTM Stage of Change for each respondent was classified for each action based on the experiential questions in the survey (see Supplemental Materials). Respondents were classified as being in the Action stage if they had done the specific action. Due to relatively few respondents in the Preparation and Contemplation stages, these two stages were combined. Respondents were classified as being in the Preparation/Contemplation stage if they were in the process of completing the action, planned to take the action within the next year, or planned to take the action sometime after the next year. They were classified as being in the Pre-contemplation stage if they had not thought about whether to do a specific activity, had thought about the activity but opted to not do it, or were unfamiliar with the activity. Respondents were classified as "familiar" if they reported being somewhat, very, or extremely familiar with an activity and were classified as "unfamiliar" if they reported having never heard of the activity or had heard of it but did not know much about it. Respondents classified as Pre-contemplation due to unfamiliarity were excluded from the analyses because they were not asked questions about motivations or barriers, as they would have no bases for answering these questions. No information about the Maintenance stage was collected.

The independent variables used in the ordinal logistic regression models are described in Table 1. The motivation and barrier questions for each action were recoded as binary variables, with the two highest categories (Strongly Agree and Agree) coded as 1, and all other categories coded as 0. The size of forest holdings was log transformed to account for the skewed distribution of this variable. Wildlife Value Orientation was calculated through two value orientations: dominionism and mutualism (Chase, 2016). Each value orientation was calculated as the mean of the questions in that section, with the Likert scale coded 1 to 5 and consequently, value orientations ranged from 1 to 5.

All data manipulations and statistical tests were conducted in the R statistical environment (R Core Team, 2024). The proportional odds logistic regression models were run using the MASS package (Venables & Ripley, 2002) and the generalhoslem package (Jay, 2019) was used for running goodness-of-fit tests. The script used for analyses is available at: https://github.com/familyforestresearchcenter/TTM_FFO_VT.

Results

Expert Visits

Most (68%) of the respondents were classified as being in the Action stage for an expert visit (Figure 1a), implying that most respondents have already met with a natural resource expert

Table 1. Names and descriptions of independent variables included in models.

Model	Short description	Question text or description
Expert visit		
	Too costly	A visit from an expert is too costly OR Is it [sic] not worth the effort/time to request or schedule a visit with an expert
	Helps expand knowledge	A visit from an expert helps me learn something new about my land
	Provides personalized info	A visit from an expert is the best way to get personalized information about my woodland
	Provides reassurance	A visit from an expert gives me reassurance that I am taking good care of my woodland
	No experts/don't know how to find expert	There are no woodland experts that provide the information I want OR I do not know which woodland expert would be able to help me
	No need	I do not need expert advice to keep my woodland healthy
Patch cut		
	Helps establish young trees	Helps establish young trees on my woodland
	Improves wildlife habitat	Improves the habitat for some animals
	Improves hunting	Improves the hunting on my land
	Improves forest health	Is good for the overall health of my woodland
	Looks ugly	Looks ugly
	Was recommended by an expert	Was recommended to me by a woodland expert
	Will harm wildlife	Will harm the types of wildlife I care about
	Is too costly	Will cause me to lose income OR Is not worth the effort/time
	Will encourage unwanted plants	Will encourage the growth of unwanted plants/trees
Cost-share		
	Not interested	Are not of interest because I am already taking good care of my woodland
	Too complicated	Are too complicated to enroll in when administered by non-governmental groups OR Are too complicated to enroll in when administered by the government
	Funds wrong activities/ insufficient funding	Do not fund the improvements I am interested in doing OR Do not cover enough of the costs to make the application worth the effort
	Eases financial burden	Ease the financial burden of making an improvement that I was already planning to make
	Helps me improve my land	Help me improve an aspect of my woodland that I could not afford otherwise
	Provides reassurance	Help reassure me that I am taking good care of my woodland
	Provides valuable info	Provide me with valuable information
	Was recommended by an expert	Were recommended to me by a woodland expert
	Don't know enough	I do not know enough about cost share programs to apply
All		
	Size of forest holdings	Natural log of hectares of forestland owned
	Mutualistic wildlife value score	Score for mutualistic wildlife orientation values
	Dominionistic wildlife value score	Score for dominionistic wildlife orientation values

to walk or discuss their land. Relatively few respondents (4%) were classified as being in the Preparation/Contemplation stage, which implies they are, to varying degrees, in the process of arranging for an expert visit. The remaining respondents (28%) were classified as being in the Pre-contemplation (familiar) stage, which represents respondents who have not thought about whether they want a natural resource expert to visit their land and those who have opted against it. No respondents were classified as being in the Pre-contemplation (unfamiliar) stage as pre-testing found all owners to be familiar with expert visits and familiarity with this activity was therefore not measured on the survey.

The expert visit ordinal logistic regression model had acceptable (i.e., p-values ≥ 0.05) goodness-of-fit for three out of the four goodness-of-fit tests (Table 2). The

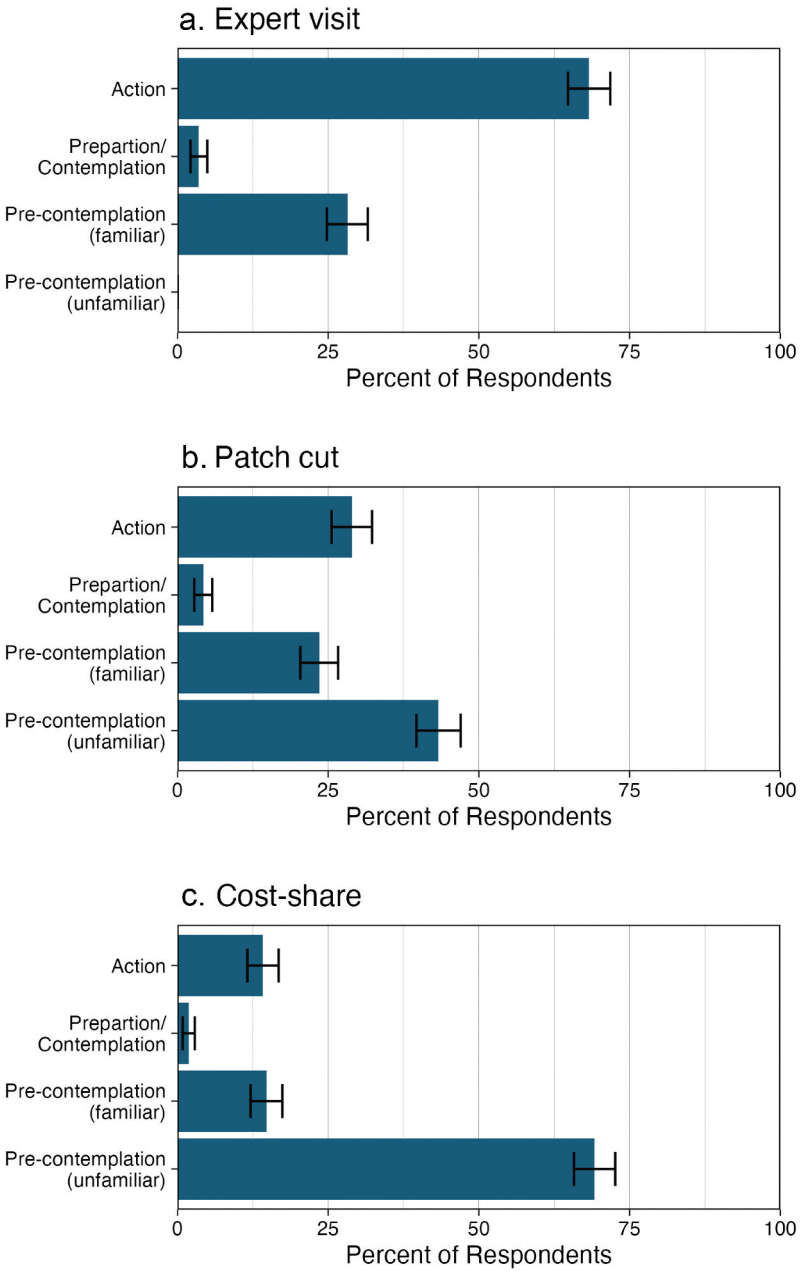

Figure 1. The percentage of family forest owner respondents by transtheoretical model stage of change for selected conservation activities, Vermont, 2018. Error bars represent 95% confidence intervals.

Pulkstenis – Robinson X^2 test was significant (p-value <.01) indicating a potential issue related to the covariate patterns of the categorical variables in the model. The problem was caused by the relatively few observations in the Preparation/ Contemplation stage. Testing of a binomial model of Action versus Pre-contemplation showed results consistent with the ordinal logistic regression model.

Table 2. Summary of an ordinal logistic regression model of the transtheoretical Model stages of changes for family forest owners receiving an expert visit, Vermont, 2018.

Variable	Odds Ratio[a]		Lower limit	Upper limit	*p*-value
Intercept 1|2[b]	4.17	*	0.77	22.43	0.10
Intercept 2|3[b]	5.36	**	0.99	28.88	0.05
Too costly	1.10		0.66	1.89	0.71
Helps expand knowledge	4.37	***	2.39	8.08	<0.01
Provides personalized info	1.35		0.70	2.57	0.37
Provides reassurance	1.83	**	1.00	3.33	0.05
No experts/don't know how to find expert	0.22	***	0.14	0.36	<0.01
No need	0.99		0.59	1.71	0.98
Size of forest holdings (log of ha)	1.87	***	1.52	2.32	<0.01
Mutualistic wildlife value score	0.84		0.66	1.08	0.18
Dominionistic wildlife value score	0.83		0.63[a]	1.09	0.18

[a]*p*-value: * ≤0.10; ** ≤0.05; *** ≤0.01.
[b]Level 1 = Pre-contemplation; level 2 = Preparation/Contemplation; level 3 = Action.
Lipsitz test: likelihood ratio statistic = 13.7, df = 9, p-value = .13.
Hosmer-Lemeshow test: X2 = 19.8, df = 17, p-value = .29.
Pulkstenis-Robinson X2 test: X2 = 238.43, df = 173, p-value <.01.
[c]Pulkstenis-Robinson deviance test: Deviance2 = 148.1, df = 173, p-value = .92.

The model met the proportional odds assumption and there were no multicollinearity issues detected (i.e., all VIF values ≤ 2.5).

Of the nine variables included in the model, four were significant, plus the intercepts (Table 2). Respondents who agreed with the statement that an expert visit helps them expand knowledge about their land were 4.37 times more likely to be in a later stage of behavioral change (OR = 4.37, 95% CI = [2.39, 8.08]). Respondents who agreed with the statement that an expert visit provides reassurance about their management practices were 1.83 times more likely to be in a later stage of behavioral change (OR = 1.83, 95% CI = [1.00, 3.33]). For respondents who agreed with the statements that there are no experts or they don't know how to find experts, the odds of being in a later stage of behavioral change were 78% (i.e., (1–0.22) × 100) lower; or put another way, respondents who disagreed with this statement were 4.55 (i.e., 1/0.22) times more likely to be in a later stage of behavioral change (OR = 0.22, 95% CI = [0.14, 0.36]). And for every unit increase in the log of hectares of forestland owned, respondents were 1.87 times more likely to be in a later stage of behavioral change (OR = 1.87, 95% CI = [1.52, 2.32]).

Patch Cuts

Twenty-nine percent of the respondents have had a patch cut on their land and were classified as being in the Action stage for this activity (Figure 1b). Relatively few respondents (4%) were classified as being in the Preparation/Contemplation stage for this activity. The remaining respondents were classified as being in the Pre-contemplation stage, either as familiar (24%) or unfamiliar (43%) with this activity.

The patch cut ordinal logistic regression model had acceptable (i.e., p-values ≥0.05) goodness-of-fit for all four of the goodness-of-fit tests, although the results for the Pulkstenis – Robinson X^2 test were marginal (p-value = .08) (Table 3). Again, the problem was caused by the relatively few observations in the Preparation/Contemplation stage. And again, testing of a binomial model of Action versus Pre-contemplation showed results

Table 3. Summary of an ordinal logistic regression model of the transtheoretical Model stages of changes for family forest owners conducting a patch cut, Vermont, 2018.

Variable	Odds ratio[a]		Lower limit	Upper limit	*p*-value
Intercept 1|2[b]	27.24	***	2.31	321.71	0.01
Intercept 2|3[b]	42.85	***	3.59	510.93	<0.01
Helps establish young trees	2.11	*	0.96	4.76	0.06
Improves wildlife habitat	1.34		0.40	4.74	0.64
Improves hunting	1.56		0.82	2.97	0.18
Improves forest health	2.73	***	1.41	5.35	<0.01
Looks ugly	0.82		0.45	1.52	0.53
Was recommended by an expert	6.84	***	3.91	12.34	<0.01
Will harm wildlife	0.64		0.19	2.10	0.47
Is too costly	1.00		0.43	2.39	0.99
Will encourage unwanted plants	1.29		0.73	2.32	0.38
Size of forest holdings (log of ha)	1.32	**	1.02	1.70	0.03
Mutualistic wildlife value score	0.80		0.59	1.08	0.14
Dominionistic wildlife value score	1.28		0.87	1.88	0.21

[a]*p*-value: * ≤0.10; ** ≤0.05; *** ≤0.01.
[b]Level 1 = Pre-contemplation; level 2 = Contemplation/Preparation; level 3 = Action $n = 320$.
Lipsitz test: likelihood ratio statistic = 5.1, df = 9, p-value = .83.
Hosmer-Lemeshow test: X2 = 20.6, df = 17, p-value = .25.
Pulkstenis-Robinson X2 test: X2 = 292.3, df = 260, p-value = .08.
Pulkstenis-Robinson deviance test: Deviance2 = 208.6, df = 260, p-value = .99.

consistent with the ordinal logistic regression model. The model met the proportional odds assumption and there were no multicollinearity issues detected (i.e., all VIF values ≤ 2.5).

Of the twelve variables included in the model, four were significant, plus the intercepts (Table 3). Respondents who agreed with the statement that patch cuts help establish young trees were 2.11 times more likely to be in a later stage of behavioral change (OR = 2.11, 95% CI = [0.96, 4.76]). Respondents who agreed with the statement that patch cuts improve forest health were 2.73 times more likely to be in a later stage of behavioral change (OR = 2.73, 95% CI = [1.41, 5.35]). Respondents who agreed with the statement that patch cuts were recommended by an expert were 6.84 times more likely to be in a later stage of behavioral change (OR = 6.84, 95% CI = [3.91, 12.34]). And for every unit increase in the log of hectares of forestland owned, respondents were 1.32 times more likely to be in a later stage of behavioral change (OR = 1.32, 95% CI = [1.02, 1.70]).

Cost-Share Programs

Most respondents were classified as being in the Pre-contemplation stage in terms of cost-share program participation, most of whom were unfamiliar with these programs (69%) and 15% were familiar but in this stage (Figure 1c). Only 2% of the respondents were classified as being in the Preparation/Contemplation stage. The remaining respondents (14%) were classified as being in the Action stage.

The cost-share ordinal logistic regression model had acceptable (i.e., p-values ≥0.05) goodness-of-fit for three out of the four goodness-of-fit tests (Table 4). The Pulkstenis – Robinson X^2 test was significant (p-value = .02). Again, the problem was caused by the relatively few observations in the Preparation/Contemplation stage. And again, testing of a binomial model of Action versus Pre-contemplation showed results consistent with the ordinal logistic regression model. The model met the proportional odds assumption and there were no multicollinearity issues detected (i.e., all VIF values ≤ 2.5).

Table 4. Summary of an ordinal logistic regression model of the transtheoretical Model stages of changes for family forest owners participating in a cost-share program, Vermont, 2018.

Variable	Odds Ratio[a]		Lower limit	Upper limit	*p*-value
Intercept 1|2[b]	67.69	***	2.77	1655.02	0.01
Intercept 2|3[b]	102.96	***	4.15	2553.25	0.00
Not interested	0.56		0.25	1.24	0.15
Too complicated	1.10		0.48	2.55	0.82
Funds wrong activities/insufficient funding	0.71		0.31	1.62	0.42
Eases financial burden	2.98	**	1.18	7.81	0.02
Helps me improve my land	0.79		0.29	2.02	0.63
Provides reassurance	0.51		0.16	1.53	0.23
Provides valuable info	2.90	**	1.08	8.04	0.04
Was recommended by an expert	6.24	***	2.82	14.49	0.00
Don't know enough	0.22	***	0.07	0.61	0.01
Size of forest holdings (log of ha)	1.33	*	0.95	1.88	0.10
Mutualistic wildlife value score	1.30		0.85	1.99	0.22
Dominionistic wildlife value score	1.63	*	0.97	2.84	0.07

[a]*p*-value: * ≤0.10; ** ≤0.05; *** ≤0.01.
[b]Level 1 = Pre-contemplation; level 2 = Contemplation/Preparation; level 3 = Action.
n = 175
Lipsitz test: likelihood ratio statistic = 9.6, df = 9, p-value = .39.
Hosmer-Lemeshow test: X2 = 18.0, df = 17, p-value = .39.
Pulkstenis-Robinson X2 test: X2 = 274.1, df = 226, p-value = .02.
Pulkstenis-Robinson deviance test: Deviance2 = 187.6, df = 226, p-value = .97.

Of the twelve variables included in the model, five were significant, plus the intercepts (Table 4). Respondents who agreed with the statement that participating in a cost-share program provides valuable information were 2.90 times more likely to be in a later stage of behavioral change (OR = 2.90, 95% CI = [1.08, 8.04]). Respondents who agreed with the statement that participation in a cost-share program was recommended by an expert were 6.24 times more likely to be in a later stage of behavioral change (OR = 6.24, 95% CI = [2.82, 14.49]). For respondents who agreed with the statement that they had insufficient information about cost-share programs, the odds of being in a later stage of behavioral change were 78% (i.e., (1–0.22) × 100) lower; or put another way, respondents who disagreed with this statement were 4.55 (i.e., 1/0.22) more likely to be in a later stage of behavioral change (OR = 0.22, 95% CI = [0.07, 0.61]). For every unit increase in the log of hectares of forestland owned, respondents were 1.33 times more likely to be in a later stage of behavioral change (OR = 1.33, 95% CI = [0.95, 1.88]). For every unit increase in their dominionistic wildlife value orientation, respondents were 1.63 times more likely to be in a later stage of behavioral change (OR = 1.63, 95% CI = [0.97, 2.84]).

Discussion

Using the TTM model, it is apparent that different motivations and barriers are associated with different stages, but the specific variables vary by conservation activity. The probability of having an expert visit their land increased for owners who agreed that visits help to expand their knowledge and provide reassurance of their management practices and for owners with large forest holdings and the probability decreased for owners who agreed that there are no experts in their area or they did not know how to find them. Based on these findings, getting more owners to receive expert advice can be increased by enhancing, and highlighting, the new information they can receive, along with receiving reassurance about

what they are already doing with their land. It is also very that owners know about these providers, the services available, how to contact the providers, and what, if anything, the services will cost. Although not explicitly tested here, trust is another factor that has been shown to influence forest management decisions (Harriman, 2020; Harrington, 2021).

Respondents have fairly low levels of familiarity with patch cuts, a finding supported by Peterson and Vaske (2017). Based on the ordinal logistic regression analysis, having this action recommended by an expert is the variable with the highest explanatory power. Other important variables include owners believing patch cuts improve the health of their forests and that this activity helps tree regeneration. These findings highlight the importance of receiving a clear, memorable recommendation from a trusted expert to take a specific management action, and that this recommendation emphasizes the benefits of the patch cut in the context of overall ecosystem health. Improving wildlife habitat is not a significant variable in the model, but it is highly rated by most owners and shows an upward trend across Stages of Change, so this angle should not be discounted when communicating with owners. Likewise, the potential negative aspects of patch cuts were not significant in the model, but the challenge of esthetics related to initial cutting efforts can be acknowledged, along with the fact that this is a transient state. But overall, the benefits to forest health and regeneration should be the strongest motivating factors and these elements can be highlighted in communications.

In the cost-share model, not knowing enough about the programs is one of the strongest predictors. While it appears that information will be helpful to advance people toward action, it should be noted that owners may need different types of information at different stages. And past research has shown that more information may actually encourage owners to stay in their current stages (Leahy et al., 2008). In terms of types of information, people in the Precontemplation stage likely need more general information, while people in the Contemplation and Preparation stages likely need more technical information and access to people who can help them. According to Rouleau et al. (2016), cost-share programs can generate confusion among landowners and natural resource experts alike because of the choices available and the applicable regulations. The provision of valuable information, as with expert visits, and the recommendation of an expert, as with patch cuts, are important factors. Targeted materials from trusted sources, including recommendations for different informational needs based on Stages of Change, may prove especially valuable.

Wildlife value orientation is generally not a significant (p-value >.05) influence on the conservation actions. However, one dimension – Dominionistic- is marginally significant (p value = 0.07) solely in the cost-share model. Our finding that wildlife value orientation does not have a significant influence on conservation actions is supported by Gigliotti and Sweikert (2019), who found that wildlife value orientation for landowners in the upper Midwest was not related to participation in USDA Farm Bill conservation programs for grassland conservation. Part of the issue may relate to how the programs and actions are presented; they might benefit from a stronger focus on wildlife benefits.

While informative, the TTM model had some limitations. Analyzing motivations and barriers across the stages meant that some items had to be combined and one stage, Maintenance, was not captured in the data collection. Even with combining the Preparation and Contemplation stages, the sample size for this group is small, but this reflects these being relatively transient, although critical, stages. Maintenance, e.g., continued consultation with experts, is an important stage that should be included in future

research (Dayer et al., 2017; Lutter et al., 2019) by adding questions that can identify this group.

The three activities examined are interrelated for many owners. For example, many participants learned about the potential benefits of patch cuts during a visit from an expert and contemplated applying for cost-share funds if both the patch cut and the cost-share program were recommended by this professional. Some studies have concluded that cost-sharing assistance was an important motivation for accomplishing forest management activities (Buffum et al., 2011; Drummond & Loveland, 2010; Kilgore & Blinn, 2004), while others have found that landowners would have, to at least some extent, completed the management practices regardless of participation in the program (Andrejczyk et al., 2016; Kilgore et al., 2015; Sun, 2007). We find some support for the latter idea in that landowners in the Action stage for cost-share programs are more likely to agree that the cost-share program eases the financial burden of an improvement activity they were already planning.

While there are many barriers to participation in conservation activities, family forest owners are also motivated by factors to keep their woodland intact and healthy including environmental stewardship, recreation, income from woodland resources, esthetics, family legacy, privacy, religion/spirituality, and the woodland being part of their home (Bengston et al., 2011). Within the environmental stewardship value, one specific motivator for maintaining and improving forest health is for wildlife habitat (Bengston et al., 2011) with 77% of family forest ownerships across the USA with 4+ ha, and 84% in Vermont, indicating that wildlife habitat is a "very important" or "important" reason for owning their land (Butler et al., 2021). So, although this study focused on wildlife habitat, these activities could be considered initial forays into other forest management activities.

Tailoring the content and types of communications for landowners based on their Stage of Change for an activity can provide more relevant and impactful resources and connections; an individual's stage should be apparent from one-on-one communications. For uninformed communications (e.g., mass mailings) it is better to target specific types of people, such as through social marketing approaches (Hollins et al., 2022). For example, providing information about why a landowner should consider taking a conservation action will be most influential in moving landowners out of the Precontemplation stage, and that providing landowners with information about how to take the action will be most useful for moving people beyond the Contemplation and Preparation stages. This information needs to come from trusted sources that ideally share the same values and focus as the landowner (Vainio et al., 2018). By identifying a landowner's Stage of Change for the adoption of a new behavior, service providers can provide information that is the most relevant while ensuring that the landowner is not overwhelmed by too much information.

To increase the rate at which landowners meet with natural resource experts, messaging can promote the idea that experts can help landowners learn something new about their land, and information can be provided about which experts would be able to help them. Information about whether there is a financial cost associated with these visits would also be helpful. Many landowners identified conducting patch cuts or participating in cost-share programs due to an expert's recommendation. When increasing engagement with these two activities is a goal, it may be helpful to increase outreach by natural resource experts who are able to provide clear, memorable recommendations and who are able to help landowners learn about the programs and, if appropriate, help in applying for the programs.

Conclusions

Overall, the family forest owners in Vermont who responded to our survey are engaged with wildlife-related conservation activities on their forestland, with most having had an expert visit, and while there is lower familiarity for patch cuts and cost-share programs, over half of the respondents who are familiar with these activities had conducted them. The TTM Stages of Change model provides important insights into family forest owner behaviors by disentangling motivations and barriers that vary across stages and activities. Progression through the Stages of Change is typically linear, although linear progress is not an underlying assumption of the model and someone may circle through several stages more than once (Prochaska et al., 1992). While our analysis cannot establish causality, the results are consistent with the theoretical framework and, where available, are supported by previous literature and could be applied to the design and implementation of conservation programs such as those examined here. If forestry professionals or outreach organizations can establish a landowner's Stage of Change, perhaps through a pre-visit screener questionnaire or as part of an automated online tool, they may be able to provide more targeted information with a higher conservation impact. While this study focused on three activities in Vermont, there are potential applications for similar regions and similar activities.

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Author Roles

Harrington: Conceptualization, Formal Analysis, Investigation, Methodology, Writing – original draft. Butler: Conceptualization, Formal Analysis, Funding acquisition, Methodology, Writing – review & editing. Sass: Formal Analysis, Writing – review & editing.

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