

Article

Reducing Firewood Movement by the Public: Use of Survey Data to Assess and Improve Efficacy of a Regulatory and Educational Program, 2006–2015

Andrea Diss-Torrance ^{1,*}, Kim Peterson ² and Colleen Robinson ³

¹ Wisconsin Department of Natural Resources (WI DNR), P.O. Box 7291, Madison, WI 53707, USA

² Alpha Technology Group LLC, 23 South Owen Drive, Madison, WI 53705-5032, USA; ptrson@gmail.com

³ Forest Stewards Guild, 612 W. Main St., Suite 200, Madison, WI 53703, USA; colleen@forestguild.org

* Correspondence: andrea.disstorrance@wisconsin.gov; Tel.: +1-608-264-9247

Received: 20 December 2017; Accepted: 11 February 2018; Published: 14 February 2018

Abstract: This paper describes a program of policy management and research from 2006 through 2015. It focuses on regulator efforts to understand and address challenges presented by dispersal of forest diseases and invasive pests in firewood by the camping public. Five surveys conducted at two-year intervals informed these efforts. The first survey in 2006 benchmarked campers' awareness of forest threats by invasive species, their evaluations of firewood supplied at and near Wisconsin state parks, and their compliance with firewood movement rules which had been implemented that year. The 2008 survey tested for improvements in awareness and compliance and investigated campers' motivations. The motivation research showed that calculated, normative, and social motivations are all important to rule compliance in the camping context. Surveys in 2010, 2012, and 2014 confirmed these results and guided education and outreach efforts, adjustments to firewood movement rules for Wisconsin state parks and forests, and improvements to firewood supplies at state campgrounds. The survey sequence as a whole revealed that: (1) compliance improves dramatically in early program years and then levels off, suggesting that it may be unrealistic and cost ineffective to strive for 100% compliance in similar regulatory contexts; (2) persistence in messaging is important in building awareness and motivation; and (3) regulation and persuasion based on motivational principles can extend beyond specific situations where informing and regulating take place, suggesting that public properties can be useful venues for encouraging other types of environmentally responsible behavior.

Keywords: firewood; emerald ash borer; regulation; compliance; motivation; forest health

1. Introduction

Across North America, many invasive pests and diseases of trees are moved in firewood, including the emerald ash borer (*Agrilus planipennis* Fairmaire), Asian long horned beetle (*Anoplophora glabripennis* Motschulsky), gold spotted oak borer (*Agrilus auroguttatus* Schaeffer), and oak wilt (*Ceratocystis fagacearum* (Bretz) Hunt), as well as many others. These pests and diseases have caused millions of dollars of damage to communities and forests. Movement of firewood is an effective pathway for the accidental spread of invasive species for several reasons, the most basic of which are economic. Wood too riddled with tunnels or stained by fungi for use as lumber has some economic value as firewood, and homeowners may cut up trees that die on their properties for firewood instead of paying for disposal. Another feature of firewood that makes it an effective pathway is that it is often moved when it is moist and the organisms within it are alive. Firewood may not be used immediately at its destination, allowing the emergence of infesting organisms into new environments. Finally, quarantines on movement of firewood may not be as effective as those placed on well-organized

industries such as nurseries or wood mills because so much firewood is moved by the general public, and informing the public of the law and enforcement is difficult.

In 2006, in response to the rapid spread of the emerald ash borer (EAB) and other invasive forest pests, the Wisconsin Department of Natural Resources (Wisconsin DNR) began regulating firewood allowed by state campgrounds. This regulation was linked with an education campaign designed to dissuade the public from moving firewood for any purpose—to “Buy it where you burn it”. We recognized that reducing the rate of spread of wood borne invasive pests required a general change in public behavior, not just a temporary accommodation to rules encountered at state parks and forests. To determine if public awareness and behavior were improving, we surveyed campers at state parks and forests in that year, and then repeated the survey at two-year intervals through the 2014 camping season (five surveys in all). This ten-year study allowed us to observe the full development of public awareness and track motivations and behaviors of our target audience. We were able to observe responses to changes in our messaging and other external factors that influenced the decision to move firewood. We were also able to identify the point at which our messaging program appeared to reach saturation, which allowed us to economize by shifting from program development to maintenance.

2. Conceptual Basis

An important part of our research and management agenda was to address campers’ motivations to bring firewood with them on their trips. Understanding motivations for environmental behavior is essential to the design of effective regulations and in persuading the public to take desired voluntary actions. A comprehensive discussion of motivations is beyond the scope of this report and may be accessed in our previous work [1,2]. Briefly, our awareness-building and persuasion efforts sought to leverage three types of motivation, the first being normative motivation. People comply with regulations based on two related sets of normative considerations. One set comprises general moral principles, which include an individual’s sense of civic duty to obey laws and conform to general ideological values. A second set is more specific, and includes evaluation of rule appropriateness or value of a regulation. We measured these motivations using survey questions that captured campers’ feelings about the size of threat posed by invasive forest diseases and pests, the importance of stopping firewood movement, and whether limiting firewood movement makes sense and is the right thing to do. Knowing how campers perceived these issues could allow us to direct supplemental messaging to raise awareness of the threat and recruitment to address it. Messages such as “It’s not just EAB that moves in wood”, “Parks take this risk seriously, so should you when getting firewood for your property”, and “The wood industry takes quarantine precautions, do your part and not move firewood” were released to the public to bolster public perception of the value of not moving firewood. We also tailored education and outreach messaging to access social motivations for campers to follow firewood movement rules because: (1) people who are important to them think they should do so, (2) people who are important to them observe these rules themselves, and (3) they feel subjective pressure from people who are important to them to observe these rules. We addressed the third general motivation type, calculated motivation, by improving firewood supplies at state parks and forests in price, quality, convenience, and reliability (features that campers repeatedly told us were important to them) and by encouraging the provision of “certified-as-safe” firewood that campers could move freely throughout the state. A selective list of steps taken and their timing is provided in the appendix.

3. Materials and Methods

All five surveys conducted during the 2006 to 2015 timeframe utilized mail questionnaires administered in three waves over eight to ten-week periods. Although email questionnaires were considered, getting stable email addresses proved a challenge, and the length and format of our questionnaires further complicated effective use of this approach. ReserveAmerica, Wisconsin’s state campground reservation agent, provided comprehensive lists of campers who had reserved one or more sites at a Wisconsin state park or forest during the just-completed camping year. Random samples

of 800 names were selected from each of these lists; the surveys were conducted and data were collected, entered in a database, checked for accuracy and extreme values, and analyzed. Response rates are based on returns divided by questionnaires successfully delivered. The number of respondents and % response rate follow in parentheses for each survey year: 2006 (479, 62%), 2008 (495, 64%), 2010 (524, 69%), 2012 (450, 62%), and 2014 (468, 64%).

The surveys included a variety of yes/no response questions, semantic differentials, and constant sum scales to measure camper awareness, motivations, satisfaction with firewood supplies at and nearby campgrounds visited, and compliance with firewood movement rules. The questionnaire format was held mostly constant although some questions were added, removed, or modified, depending on information needs of the specific year. As a basis for the present analysis, we chose a subset of questions that were included in each survey (most appeared every year, although a few were absent in 2012), harmonized the data (e.g., adjusted for any differences in scale size or direction), merged the five data sets, and added an indicator variable to identify survey year. The merged file included 2416 records.

4. Results

4.1. Awareness

The first program goal undertaken in 2006 was to measure camper awareness of EAB and other forest diseases and pests. The Wisconsin DNR emphasized EAB because of its dramatic and highly publicized impact on both urban and rural forests in neighboring states. In subsequent surveys, we reduced the emphasis on EAB and instead included it in a list with six other invasive forest diseases and pests moved in firewood.

Results of policy and education program management during the time frame were encouraging. Data in Table 1 (row 1) show that the percentage of campers who were aware of EAB rose rapidly from 2006 to 2008 then leveled off as it approached saturation. The differences between the percentages are statistically significant.

Table 1. Camper awareness of firewood related issues ^{†,◇}.

	2006	2008	2010	2012	2014	Test Results
Emerald ash borer	77.1% _a	91.9% _b	92.6% _b	94.9% _b	95.7% _b	$X^2(4, 2412) = 127.123, \rho = 0.000, V = 0.230$
Movement risks	67.9% _a	91.7% _b	97.7% _c	95.3% _{b,c}	96.6% _c	$X^2(4, 2387) = 324.342, \rho = 0.000, V = 0.369$
Prohibitions	66.5% _a	94.1% _{b,c}	93.5% _c	89.2% _c	97.6% _b	$X^2(4, 2399) = 286.952, \rho = 0.000, V = 0.346$

[†] All figures represent percentages of campers who completed the survey. Awareness was measured for multiple invasive species, although row 1 data reflect only the emerald ash borer. All three variables are based on Yes/No responses to the question regarding awareness. [◇] Each subscript letter denotes a subset of categories whose column percentages do not differ significantly from each other at the 0.05 level. Bonferroni corrections were applied to account for the fact that multiple comparisons were being made.

In addition to increasing camper awareness of threats posed by forest diseases and invasive pests, Wisconsin DNR managers worked to educate campers about risks associated with moving firewood and to ensure that campers believed these risks were legitimate. We realized that this type of awareness and recognition of risk would be somewhat slower to increase over time, as camper calculated motivations had to be overcome; for example, there is a widely held belief that firewood brought from home is cheaper and of higher quality than firewood obtained at or near campgrounds. Survey data over this period demonstrates that awareness of the link between invasive forest pests and firewood movement (risk) begins at a lower level than awareness of EAB, as expected, but then rises to levels that slightly surpass it (Table 1, row 2).

The third critical element of Wisconsin DNR's awareness building effort was for awareness of regulations related to firewood movement. Survey data show a sharp increase in the percentage of campers who were aware of the regulations from 2006 to 2008, then modest fluctuations in awareness

through 2014 (Table 1, row 3). Frequent refreshment of the message that firewood is regulated on state lands likely played a role in the rapid rise and maintained a high level of awareness of said regulation. Each time the distance was reduced for compliant firewood (2006, 2007, 2010, and 2014), extra effort was made by the agency to publicize the change in regulation; media coverage amplified this effort. In 2008, EAB was found for the first time in Wisconsin. Media coverage of this event and the efforts to prevent its spread, including firewood regulation, was intensive. In the period from 2011 to 2013, there were no strong new messages related to firewood regulation put forth by the Wisconsin DNR, which may have led to the small decline in awareness of regulation during 2012. Yearly refreshment and reminder of our message was beneficial in maintaining a high level of awareness, the first requirement for compliance. The frequency at which messaging must be renewed most likely differs in other situations, but program managers should plan to refresh messaging regularly to maintain public awareness.

4.2. Motivation

4.2.1. Normative Motivation

Although increasing camper awareness is important, it is not always sufficient by itself to achieve rule compliance. Campers must also be motivated specifically for compliance as well. Given 2006 benchmarks for camper awareness, education and outreach initiatives were refined. These initiatives attempted to leverage campers' normative motivations, and the perceived threat size of forest diseases and pests was chosen as an appropriate measure. Although perceived threat size does not reveal normative motivation directly (i.e., to fulfill a moral obligation or do the right thing), we are confident that camper recognition of threats provides prima facie evidence of it. To measure this construct, we asked campers to rate the size of the perceived threat on a seven-point scale where 1 = no threat; 4 = a moderate threat; and 7 = a huge threat. Average camper ratings of threat size increased from 2006 through 2010, then declined in 2012 before rebounding slightly in 2014 (Table 2 row 1). Differences between the means were statistically significant overall, although post hoc comparisons showed that some of these differences were not significantly different at the 0.05 level (Bonferroni correction was applied). This suggests that public education and outreach efforts effectively utilized this normative motive, but that possible reductions in publicity between 2011 and 2013 (as discussed above) may have contributed to the 2012 dip in perceived threat.

Table 2. Normal motivation ^{†,◇}.

	2006	2008	2010	2012	2014	Test Results [∇]
Threat Size—Invasive Species	5.00 _a	5.57 _b	5.81 _c	5.63 _{b, c}	5.73 _{b, c}	F (4, 2313) = 29.224, $\rho = 0.000$, $\eta^2 = 0.048$
Stop Movement Importance	5.53 _a	6.08 _b	6.16 _b	6.21 _b	6.29 _b	F (4, 2324) = 24.878, $\rho = 0.000$, $\eta^2 = 0.041$

[†] Measures are based on seven-point scales where values ranged from 1 = *not a threat* to 7 = *A huge threat*, and from 1 = *Not at all important* to 7 = *Extremely important*. [◇] Each subscript letter denotes a subset of categories whose column values do not differ significantly from each other at the 0.05 level. Bonferroni corrections were applied to account for the fact that multiple post hoc tests were made. [∇] Standard deviations ranged between 1.173 and 1.439 for Threat Size and from 1.134 to 1.618 for Stop Movement Importance. Levene statistics suggested unequal variances for both measures, but sample sizes for all groups were large and approximately equal, so we feel comfortable with these results.

A more direct measure of normative motivation is the perceived importance of stopping firewood movement. Campers were asked to rate importance on a seven-point scale where 1 = *not at all important*, 4 = *neither unimportant nor important*, and 7 = *extremely important*. Overall results were statistically significant, but following a sharp increase from 2006 to 2008, ratings increased only gradually through 2014; differences from 2008 through 2014 were not statistically significant (Table 2, row 2).

4.2.2. Social Motivation

Social motivation was also investigated for its potential to influence compliance. We did not measure social motivation in 2006, and the approach used in 2008 utilized an indirect measure that

produced ambiguous results. We improved the measure significantly for the surveys of 2010 and 2012, and revamped it completely for 2014. Because of the differences in measurement, we discuss social motivation for only 2014. Our measure for this survey year utilized seven-point scales where values ranged from 1 = *strongly disagree* to 7 = *strongly agree*. The Family Influence statement was worded “My family wants me to limit my movement of firewood”. The Friends Influence statement substituted “friends” for “family” (“My friends want me to limit my movement of firewood”). Data showed that campers were motivated by these two important social groups, although to differing degrees. Nearly 61% of respondents agreed that their family wanted them to limit movement of firewood, but only 45.4% reported friend-based influence. This difference is not unexpected, and may follow from ambiguities in camper mindsets regarding family members and friends, as well as from differences in knowledge of their wishes regarding firewood movement. We hope to investigate this construct with more precision in future research.

4.2.3. Calculated Motivation

Firewood movement decisions are made only partly on the basis of perceived risk of spreading invasive pests and under varying degrees of social pressure. Previous research has shown that calculated motivations related to firewood availability at home, and to price, quality, convenience, and reliability differentials between at-home and at-campground firewood are also important, and have often worked counter to education and outreach efforts [1,3]. Specifically, some campers believe that firewood supplied at or near state parks and forests are lower in quality, higher priced, inconvenient, and/or unreliable when compared with wood from home, which is often free or already paid for, selected by the camper (so its quality is known), and readily at hand; therefore, they tend to bring firewood from home on camping trips. To investigate this issue, we asked campers questions such as: “People have told us that they bring firewood on camping trips for different firewood related reasons. Which of the following reasons apply to you?” In each study year, seven or eight reasons were listed plus an open-ended option, and respondents could select more than one reason. The most frequently cited reasons were that campers had firewood at home they wanted to use, and/or they had concerns with price, quality, or other characteristics of firewood obtained at or near campgrounds. These factors were highly correlated with compliance in all five surveys.

We hoped to see steadily declining percentages across survey years for all reasons campers brought firewood from home; Wisconsin state parks and forests worked diligently throughout the study period to persuade campers not to move firewood and to improve firewood supplies at campgrounds. However, only the reason “had wood at home” consistently declined (Table 3). In 2006, 33.2% of all respondents indicated that they brought wood because they had it at home and wanted to use it. This percentage declined in 2008, 2010, and 2012, then increased slightly to 10.5% in 2014. These changes were statistically significant overall ($\chi^2(4, 2384) = 120.496, p = 0.000, V = 0.225$), but proportions for 2010 through 2014 did not differ at the 0.05 level (see table cell subscripts). These results suggest that Wisconsin DNR has been successful in persuading campers not to bring firewood from home, not to stock firewood at home for use in camping, or both.

Table 3. Calculated motivation—brought wood because they had wood at home they wanted to use \diamond .

		2006	2008	2010	2012	2014	Total count and % across years
Yes	Count	159 _a	94 _b	77 _{b,c}	39 _c	49 _c	418
	% answering 'Yes'	33.2%	19.0%	14.7%	9.3%	10.5%	17.5%
No	Count	320 _a	401 _b	447 _{b,c}	379 _c	419 _c	1966
	% answering 'No'	66.8%	81.0%	85.3%	90.7%	89.5%	82.5%
Total	Count	479	495	524	418	468	2384

\diamond Each subscript letter denotes a subset of categories whose column values do not differ significantly from each other at the 0.05 level. Bonferroni corrections were applied to account for the fact that multiple comparisons were being made.

4.3. Compliance

Improvements in camper awareness and appeal to camper normative, social, and calculated motivations led to increases in compliance with firewood movement rules and to favorable shifts in other firewood-related behaviors. The analysis that follows distinguishes between compliance based on firewood source type, movement in bulk, and movement on camping trips.

4.3.1. Source Compliance

Our first measure of source compliance was based on primary source of firewood used by campers, which was derived from the following survey question: “Where do you TYPICALLY get the firewood you use for camping? (Circle numbers of all that apply)”. Campers then chose among the following options: (1) Nowhere—we seldom if ever build a campfire; (2) Buy inside park or forest; (3) Buy within (the allowable distance) miles of a park or forest (for example, at a roadside stand or convenience store); (4) Buy in hometown at a convenience store, grocery store, or other retail place; (5) Buy in hometown from a dealer (for example, a person with access to a woodlot); (6) Cut it ourselves (on our land or family/friend’s land, etc.); (7) Gather inside park or forest (from grounds or vacant campsites); (8) Gather in hometown from municipal sources (such as your city or town brush disposal site); (9) A friend or relative supplies it to us; (10) Get wood from pallets; (11) Get scrap lumber or wood left over from home projects, work, or business etc.; and (12) Other (Please describe).

The next survey question asked which was the respondent’s primary source of firewood; campers were considered compliant if they obtained firewood exclusively inside or near the places they camped (options 2, 3, and 7 above) or brought only scrap dimensional lumber left over from home or work projects, an allowable alternative (option 11). Data in Table 4 (row 1) demonstrate that camper compliance with firewood movement rules increased steadily over the study period, and proportions are statistically different for 2006, 2008, and 2010 (Bonferroni correction was applied).

A more rigorous definition of compliance included all firewood sources used, not just a primary source: if any source utilized was considered non-compliant then the camper was classified as non-compliant (row 2). As expected, percentages of compliant campers were lower across all camping seasons vis-à-vis the primary source measure but did increase similarly over time. The lower percentage of complying campers when the more rigorous definition was used shows that while most campers (77.8% in 2014) comply all of the time, some (92.2% – 77.8% = 14.4%) comply only most of the time. Comments supplied by some survey participants in the second group suggest that they may have used non-compliant sources of firewood to ensure that there was a minimal supply of dependable quality firewood on hand, to reduce the expense of camping, and/or because they wanted to use firewood acquired previously in bulk.

Table 4. Firewood movement rule compliance by campers \diamond .

	2006	2008	2010	2012	2014	Test Results
% of campers whose primary source of wood was compliant	57.9% _a	72.7% _b	88.5% _c	91.8% _c	92.2% _c	$\chi^2(4, 2296) = 259.698$, $\rho = 0.000$, $V = 0.336$
% of campers, <u>all</u> of whose sources of wood were compliant	44.5% _a	59.8% _b	77.6% _c	83.1% _c	77.8% _c	$\chi^2(4, 2324) = 219.151$, $\rho = 0.000$, $V = 0.307$
% of campers who did not move wood in bulk for use in camping	87.7% _a	91.9% _a	97.5% _b	97.1% _b	98.7% _b	$\chi^2(4, 2416) = 81.344$, $\rho = 0.000$, $V = 0.183$
% of campers who did not move wood in bulk for use in a home	82.5% _a	86.9% _a	87.8% _a	88.7% _a	85.7% _a	$\chi^2(4, 2416) = 9.360$, $\rho = 0.053$, $V = 0.062$
Average Distance Bulk Wood Was Moved for any purpose (Miles)	55.0	33.2	24.8	25.2	20.3	$F(4, 425) = 8.043$ $\rho = 0.000$, $\eta^2 = 0.071$
% of campers who complied on their last camping trip [†]	55.8% _a	73.2% _b	93.7% _c	-	93.6% _c	$\chi^2(3, 1940) = 291.578$, $\rho = 0.000$, $V = 0.388$

\diamond Each table subscript letter denotes a subset of categories whose column values do not differ significantly from each other at the 0.05 level. Bonferroni corrections were applied to account for the fact that multiple comparisons were being made. [†] In 2014, this question asked if campers complied on *all* trips for that year.

In addition to asking about firewood sources, we asked “Have you moved any large quantities of firewood (for example, a trailer or truckload) to or from your home in the last two years?” Response options included: for camping, for use at home, for use at a family member’s home, and for use at a cottage or second home. Data related to bulk movement of wood for camping and home use appear in rows 3 through 5 of Table 4. We asked about movement of large quantities because this may encourage trip non-compliance even after campers become aware of movement rules. This category of firewood is typically less expensive or free, of known quality and condition, and possibly more attractive than firewood acquired at or near campgrounds. Moreover, bulk supplies represent sunk costs that campers may be unwilling to write off after learning about firewood movement rules. Data in row 3 strongly suggest that bulk movement of wood for camping was not common at the start of regulation, and that its incidence decreased to nearly zero by 2014 (data show percentages of respondents who did *not* move firewood). Firewood regulations at campgrounds may have especially discouraged the movement of trailer loads of firewood as it is difficult to conceal such quantities, and surrender would be a significant, and thus deterring, loss. In addition, firewood regulation is not limited to state lands in Wisconsin. Federal and many county campgrounds also regulate firewood use. In a survey of private campground owners in 2011 [4], we found that 66% of respondents imposed limitations on firewood that was allowed onto their properties. In addition to camping, firewood is also moved in bulk for use in homes. Combining bulk movement for home use with cabin and second home use produced the fourth compliance measure shown in Table 4 (row 4). Our goal was to see if the reduced movement and stocking of wood for camping was generalized to firewood movement for use at residential properties. In 2006, when firewood regulation on state lands was first implemented, the proportion of campers who moved large amounts of wood for use at home was similar to the proportion that moved firewood for camping, but reductions in these percentages through 2012 were smaller than for camping-related movement, and were only borderline statistically significant. Movement of firewood in bulk for home use increased in 2014, but the change was not statistically significant and coincided with a shortage of propane fuel for heating in Wisconsin during the winter of 2013–2014, a factor that may have promoted bulk wood movement as a precautionary measure for the following winter.

The differences in reduction of bulk firewood movement for camping and home use suggest that additional approaches of reducing risk of spreading invasive pests in firewood are needed. One such approach is to educate homeowners to select wood sources that are less likely to carry pests. Wood from sources close to the home or cabin are less likely to harbor pests not already present in the area, and aging wood for two years near the place where it was cut also reduces risk. This message, which is at the heart of the distance limitation on wood entering state lands, appears to have been received

and acted upon by those who moved firewood in bulk. The average distance large amounts of wood were moved decreased from 55 miles in 2006 to approximately 20 miles in 2014 (Table 4, row 5).

4.3.2. Trip Compliance

During all survey years except 2012, when we did not investigate the respondent's most recent camping trip, we asked campers the following question (or a close variant) based on allowable mileage: "For your most recent camping trip to a Wisconsin state park or forest, did you bring any firewood from more than (the allowable distance) miles or from out of state?" Movement limits were set at 50 miles for the 2008 season, 25 miles for 2010, and 10 miles for 2014. Campers could then choose either No; Yes—we brought only logs; Yes—we brought only scrap lumber (2 × 4 s etc.); or Yes—we brought both logs and scrap lumber. The two options that excluded logs defined compliance. For the 2014 survey, we asked if campers had brought firewood on any camping trip to a state park or forest. Results show that compliance rose dramatically from 2006 to 2008, and then again in 2010; differences among these percentages were all statistically significant (Table 5, Row 6).

Table 5. Compliance with firewood regulations on trips in 2014 by three groups of campers separated based on their sources of wood: Highly Compliant, all their sources of wood are compliant with regulations; Moderately Compliant, their primary source of wood is compliant but their secondary sources are not; and Minimally Compliant, whose primary source of wood is not compliant [◇].

		Camper Group			Total [†]	
		Highly Compliant	Moderately Compliant	Minimally Compliant		
Compliance on any trip in 2014	Yes	Count % of the Group	325 _a 98.2%	56 _b 84.8%	19 _c 59.4%	400 93.2%
	No	Count % of the Group	6 _a 1.8%	10 _b 15.2%	13 _c 40.6%	29 6.8%
Total		Count	331	66	32	429

[◇] Each table subscript letter denotes a subset of categories whose column values do not differ significantly from each other at the 0.05 level. Bonferroni corrections were applied to account for the fact that multiple comparisons were being made. [†] The compliance percentage shown in this column differs slightly from that reported in Table 4 due to missing data based on source compliance.

5. Discussion

Our results strongly suggest that efforts to increase public awareness of invasive forest diseases and pests and to reduce firewood movement have been effective, but several features of our approach warrant further comment. First, persistence in messaging may be instrumental in building awareness and motivation. We saw a slight dip in awareness of firewood prohibitions in 2012, during the period 2011–2013 when there was no new firewood movement information sent to the public. Managers and educators should refresh the core message periodically to maintain sensitivity and elicit appropriate responses. Second, compliance data for the study period show dramatic improvements from 2006 through 2010, and then a leveling off in 2012 and 2014. It is therefore appropriate to ask if we can do better or if there a small segment of the camping public that will not be persuaded and will never fully comply? Comparison of campers based on their typical sources of firewood provides useful insights in this matter, and three camper groups can be defined in terms of their presumed likelihood to comply as of 2014 (Table 5). The first group is considered potentially Highly Compliant because all of their sources facilitate compliance. Group two is considered only Moderately Compliant, as their primary source suggests compliance but their secondary sources indicate non-compliance. Group three is considered Minimally Compliant, as their primary source indicates non-compliance. All three groups are contrasted in terms of their association with trip compliance, which is the best indicator we have of actual firewood movement that conforms with stipulated limits.

These data are encouraging and show that only 1.8% of the Highly Compliant group moved firewood more than 10 miles on any trip taken to a state park or forest in 2014. This figure increases to 15.2% for Moderately Compliant campers as, and to 40.6% for Minimally Compliant campers. The differences are statistically significant, and the association between the variables is strong ($X^2(2, 429) = 78.452, \rho = 0.000, V = 0.428$). Although the proportion of Minimally Compliant campers who brought wood in violation of regulations is high, the overall percentage of such violators is relatively low (i.e., only 13 of 429 campers, or 3%), and including the ten Moderately Compliant campers did not increase this percentage much (i.e., to 23 of 429, or 5.4%). Accordingly, it may be unrealistic and cost ineffective to try to stop all non-compliant firewood movement. Instead, reduction of the risk of successful introduction is a reasonable goal.

6. Conclusions

Results of five camper surveys implemented from 2006 through 2015 demonstrate that all forms of awareness of firewood movement regulations and risks in Wisconsin campers have improved. Results also confirm that calculated, normative, and social motivations can be measured and managed to increase camper compliance with firewood movement rules (selected management actions taken follow as an appendix). We also found that compliance behavior transferred from camping activity to home firewood use. Therefore, it follows that regulation and persuasion based on motivational principles can lead to changes in behavior that extend beyond specific situations where regulation takes place, and that public properties can provide a venue for encouraging other types of environmentally responsible behavior.

Acknowledgments: The authors thank the Wisconsin Department of Natural Resources Division of Forestry, Public Lands and Conservation Services Section for funding this research.

Author Contributions: Andrea Diss-Torrance and Kim Peterson conceived and designed the study; Kim Peter developed and conducted the surveys and did the statistical analysis of the data. Colleen Robinson crafted and refined messaging based on survey results throughout the study and contributed input on each iteration of the questionnaire. Andrea Diss-Torrance and Kim Peterson wrote the paper.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Actions Taken to Combat Invasive Forest Diseases and Pests

Throughout the course of a ten-year study period (2006–2015), Wisconsin DNR took a variety of actions to combat invasive forest diseases and pests. The overarching goal of education and outreach efforts was to present a consistent message that limiting firewood movement was important, and that it was justified on moral grounds—it was the right thing to do. A selected listing of actions follows:

1. We improved firewood availability, quality, and reliability at state parks and forests in response to campers' complaints in our early surveys. We strove to keep costs competitive. All staffed campgrounds now provide firewood for sale, and firewood availability has been added to information provided for each campground on the Wisconsin DNR website. In addition, firewood for sale is now stored in shelters to keep it dry. Most state campgrounds provide firewood from state certified sources, many of which heat treat or age the wood thus ensuring higher quality.
2. We worked with the Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP) to encourage/sponsor development of a firewood certification program. Vendors are certified if they process wood by heating or aging to specification. Wisconsin DATCP inspects and certifies firewood processors at their request for an annual cost of \$50.
3. Wisconsin DNR supports development of the firewood industry by selling certified wood at state campgrounds, thus providing a predictable market and an opportunity for the public to try this value-added product. Since 2012, state campgrounds have limited firewood that is sold on premises to that which is either from a certified vendor or harvested from the property itself.

4. Wisconsin DNR law enforcement staff assist Wisconsin DATCP to enforce regulation of commercial and private transport of logs and firewood. Two federal quarantines of forest pests were in force in Wisconsin during the times of our surveys, for emerald ash borer and gypsy moth. The quarantines require mills, loggers, and those moving firewood to take specified precautions to prevent spread of these pests. Movement of regulated items across quarantine borders within Wisconsin is enforced by two state agencies. Wisconsin DATCP has lead authority for enforcement of these regulations and has extended its authority under agreement with Wisconsin DNR to allow wardens to enforce quarantine violations by private individuals, thereby filling a gap that had existed in enforcement.
5. Wisconsin DNR staff and researchers with the U.S. Forest Service developed a model of risk of introduction to state properties with increasing establishment of an invasive species [5]. Using this model, Wisconsin DNR adjusted firewood movement limits to state parks and forests to keep the level of risk stable as the EAB and other invasive forest pests and diseases established themselves in the state. Reductions in movement distance limits may have helped slow the spread of these species, and communication of these limits sent a strong message to campers that this threat was significant and imminent.
6. Created public service messages that utilized injunctive norms (e.g., “Don’t move firewood! Buy it where you burn it.”). Social science research has demonstrated that this improves regulation compliance.
7. Surveyed private campground operators (2011) to: (1) Determine their awareness of invasive pests and diseases of trees that could impact their properties and identify the steps they were taking or wanted taken by the state to protect their business (e.g., did they impose their own restrictions, how did they feel about a state-wide ban on transport, etc.). (2) Make them aware of free educational material available from Wisconsin DNR.
8. We distributed posters and 39,000+ brochures to campground operators for distribution to their camping customers. This established a consistent message for campers at both public and private campgrounds and greatly increased the dissemination of this information.
9. Suggested improvements in the listing of certified firewood vendors provided at DATCP’s website. State campgrounds provided opportunities for campers to try certified firewood.
10. We surveyed representative samples of campers to discover where they look for information about environmental matters, and which of these sources they consider most authoritative and valuable. This information helps target public service messaging efficiently.
11. We sponsored and/or participated in research to identify effective treatment options for firewood with the U.S. Forest Service’s Forest Products Laboratory.
12. We demonstrated the use of mechanized harvesting equipment in urban settings to increase efficiency in removing infested ash trees and make possible the utilization of these logs for the highest value products.
13. We developed precautions that people using or producing firewood can implement to prevent transmission of EAB and other invasive pests in firewood. We shared our survey results and managerial approaches with state and federal staff, working to reduce the spread of wood borne invasive pests.

References

1. Peterson, K.; Diss-Torrance, A. Motivations for rule compliance in support of forest health: Replication and extension. *J. Environ. Manag.* **2014**, *139*, 135–145. [[CrossRef](#)] [[PubMed](#)]
2. Peterson, K.; Diss-Torrance, A. Motivation for compliance with environmental regulations related to forest health. *J. Environ. Manag.* **2012**, *112*, 104–119. [[CrossRef](#)] [[PubMed](#)]
3. Peterson, K.; Diss-Torrance, A. *Wisconsin Certified Firewood Survey: Results and Analysis*; Wisconsin Department of Natural Resources: Madison, WI, USA, 2013.

4. Peterson, K.; Diss-Torrance, A. *A Survey of Private Campground Operators: Benchmark Results*; Wisconsin Department of Natural Resources: Madison, WI, USA, 2013.
5. Tobin, P.C.; Diss-Torrance, A.; Blackburn, L.M.; Brown, B.D. What Does “Local” Firewood Buy You? Managing the Risk of Invasive Species Introduction. *J. Econ. Entomol.* **2010**, *103*, 1569–1576. [[CrossRef](#)] [[PubMed](#)]



© 2018 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).