Journal of Environmental Management 139 (2014) 135–145

Contents lists available at ScienceDirect

Journal of Environmental Management

journal homepage: www.elsevier.com/locate/jenvman

Motivations for rule compliance in support of forest health: Replication and extension

Kim Peterson*, Andrea Diss-Torrance [1]

Wisconsin Department of Natural Resources, 101 South Webster Street, P.O. Box 7921, Madison, WI 53707-7921, USA

ARTICLE INFO

Article history:
Received 22 May 2013
Received in revised form
12 January 2014
Accepted 24 February 2014
Available online 28 March 2014

Keywords:
Motivation
Compliance
Regulation
Forest health
Environmental behavior
Camping
Firewood
Emerald ash borer
EAB
Recursive partitioning
Random forest
Motivational postures
Social marketing
Affect
Social norms

ABSTRACT

This study replicates and extends research conducted in 2008. Based on a random sample of 800 campers who used Wisconsin state parks and forests in 2010, it confirms that calculated, normative, and social motivations are all important determinants of firewood movement rule compliance, a context where regulatees have primarily sporadic short-term interests, and where costs of compliance and non-compliance are both low. The study uses bi-variate statistical tests and recursive partitioning (standard and conditional permutation random forests) for analysis, and discusses findings from the perspective of a natural resources regulator of activities in multiple domains (e.g., business and recreational uses of forests in both rural and urban settings). It demonstrates how knowledge of motivations for compliance can inform two integrative research and analysis frameworks – motivational postures and social marketing, and discusses how affect and social norms may be utilized to improve regulator effectiveness.

1. Introduction

1.1. Overview

Understanding motivations for environmental behavior is essential to the design of regulations. Researchers have employed a variety of analytical frameworks to explain why consumers may be environmentally knowledgeable and aware, yet fail to adopt pro-environment behaviors or comply with environmental rules. Motivations have been investigated, but primarily in contexts where behaviors are ongoing or long-term in nature, and where costs of compliance and non-compliance may be high – for example, farming (Atari et al., 2009; Winter and May, 2001), building construction (Burby and Paterson, 1993), commercial fishing (Hatcher et al., 2000), and coastal resource management (Pomeroy et al., 1997).

This study extends research on these motivations to contexts where consumers have primarily short-term or sporadic interests, and where costs of compliance and non-compliance are both low. The behavior of interest is the movement of firewood for camping and consequent dispersal of an invasive insect, the emerald ash borer (*Agrilus planipennis* – EAB). This insect has killed tens of millions of ash trees in Michigan and neighboring states, and in Ontario and Quebec (USDA Forest Service, 2011). It has laid waste to forests, ruined neighborhood aesthetics in cities and towns, and imposed significant cost burdens for tree removal on state and local governments. Citizens are well aware of this, yet many continue to ignore quarantines and other regulations and bring firewood along on their camping trips.

This study replicates and improves upon a preceding study that produced encouraging but somewhat mixed results (Peterson and Diss-Torrance, 2012). It implements a survey instrument that

* Corresponding author. Tel.: +1 608 238 9104.
E-mail addresses: ptrson@gmail.com, kxp4@yahoo.com (K. Peterson), andrea.disstorrance@wisconsin.gov (A. Diss-Torrance).
[1] Tel.: +1 608 264 9247.

http://dx.doi.org/10.1016/j.jenvman.2014.02.036
0301-4797/

more accurately captures social motivation, refines criteria for compliance, examines stated reasons for non-compliance for the total population of respondents, not just a subset, and incorporates a direct comparison of proxies for three motivation types. It employs bi-variate statistical tests and two types of recursive partitioning for analysis (standard and conditional permutation random forests), thus avoiding the data distribution issues that complicated our previous study's analysis. It then demonstrates how findings can be incorporated in two integrative analysis frameworks (motivational postures and social marketing) and discusses how two extensions (affect and social norms) may improve regulator effectiveness.

1.2. Conceptual foundation

The basis for effective regulation depends on the willingness and ability of the regulated to comply. The literature on environmental regulation suggests three general motivations for compliance: calculated, normative, and social (Burby and Paterson, 1993; Levi, 1989; Tyler, 2006). This literature also addresses ability to comply – specifically, in terms of knowledge of rules and capacity to obey them (Winter and May, 2001). Regulatory context also influences compliance, as demonstrated in comparative analyses of agro-environmental regulations in Denmark, water quality rules in California, and building codes in Washington (May, 2005). Most of the studies conducted on environmental rule compliance have focused on contexts where behaviors are ongoing or long-term in nature, and where costs of compliance and non-compliance may both be high. The situation addressed in this research is radically different: outdoor recreation pursued sporadically on public lands, where costs of compliance and non-compliance are generally low. Questions therefore follow as to which motivation types are influential in this context.

Calculated motivations have been studied most, especially those related to cost of compliance, likelihood of detection, and likelihood of fine. For example, Becker (1968) maintained that regulatees comply with a regulation when they calculate that the benefits of compliance, including avoidance of fines or other sanctions, exceed the costs of compliance (see also Ehrlich, 1972; Stigler, 1970). These considerations are usually utility based, and presumably lead to the choice, for compliance or not, that has the higher net return. We demonstrated, in our previous study, that compliance with firewood movement rules decreases with increasing sensitivity to compliance costs, where cost dimensions include firewood price, quality, convenience, and reliability of supply (Peterson and Diss-Torrance, 2012).

A second general motivation for compliance derives from a combined sense of moral duty and agreement with regulation importance. Following Burby and Paterson (1993), this motivation is labeled normative commitment, although it has also been referred to as moral or ideological compliance (Levi, 1997, 1989; McGraw and Scholz, 1991), commitment based on civic duty (Scholz and Lubell, 1998; Scholz and Pinney, 1995), and perceived obligation to comply (Tyler, 2006). For firewood movement restrictions, this sense of duty and regulation importance derives from civic appeals made by state and local governments struggling with EAB infestations in both urban and rural contexts. Our previous study showed that these motivations have a demonstrable effect on decisions to comply with Wisconsin's Firewood Movement Rule.[2]

A third general motivation for compliance is the desire of regulatees to earn the approval and respect of significant "others" (Cochran et al., 1999; Grasmick and Bursik Jr., 1990) or, at least, to behave in ways that they advocate. This desire may have a socializing effect over time that leads to normative commitment, but its social component differs in the sense that the regulatee will comply to earn the approval of others, even though those values may not have been internalized to the extent of commitment. Significant others may include family and friends, but may also include coworkers, advocacy groups, and others. Our previous study failed to adequately measure this motivation construct, and results obtained were therefore ambiguous. We improved upon these measures for this research.

2. Material and methods

2.1. Data

Analysis relied on data obtained from a three-wave mail survey administered in December 2010 by the Wisconsin Department of Natural Resources (Wisconsin DNR). ReserveAmerica, the state's campground reservation agent, provided a comprehensive list of campers who had reserved one or more sites at a Wisconsin state park or forest during the calendar year. We randomly selected 800 names from this list, and received 524 usable returns by the cut-off date. This computes to a response rate of 69% of questionnaires successfully delivered.[3]

2.1.1. Motivations

Rather than ask campers questions about their motivations to comply with firewood movement rules, we focused on proxies for these motivations and their associations with compliance. This approach avoids the challenges of measuring intervening variables and psychological constructs, as well as inaccuracies due to temporal discrepancies; its downside is that it is ex post facto, not experimental by design. We also omitted questions about most respondent demographics due to ambiguities in decision processes and settings; that is, firewood movement decisions can be made at home in advance of a trip or en route, by one person or several, and may be influenced by previous decisions to obtain firewood in bulk, or to use supplies left over from previous trips. A respondent's role and influence in these decisions may also vary, so measuring these variables may not provide reliable insights, and may also increase the likelihood of survey non-response.[4]

Calculated motivation was measured through camper sensitivity to compliance costs. Importance ratings for five features associated with firewood and the places where campers get it were used as proxies for this sensitivity. Campers were asked "How important are the following factors related to *purchasing* firewood inside or near a state park or forest? Allocate 100 points among the following factors. Give more points to the factors that are more important. Give fewer points (or none) to factors you think are less important. Please be sure that the points total to 100." The factors were specified as follows (exact wording is shown; variables used

[2] This rule states that firewood cannot be moved more than 25 miles to a state park or forest, from a quarantine area (if the park is not in the quarantine), or from out of state.

[3] We used this same sampling frame and approach for our surveys in 2006 and 2008. Late returns allowed us to substitute for questionnaires that were deleted due to errors and outlier data; hence, the number of surveys available for analysis was also 524.

[4] There was also no way of ensuring that the person who completed the questionnaire would have participated in deciding the firewood purchase. In fact, respondents frequently offered comments and provided email addresses for follow-up, and in many cases these persons were *not* the individual to whom the questionnaire had been addressed. In cases such as these, the demographic data gathered could mislead and weaken analysis results.

in analyses are in bold italics): (a) Quality/condition of the firewood (***Quality***), (b) Price of the firewood (***Price***), (c) Convenience of the firewood's location (***Convenience_of_location***), (d) Convenience of the times at which I can get the firewood (***Convenience_of_time***), (e) Reliability of supply (e.g., I can depend on getting enough) (***Reliability_of_supply***), and (f) Other (Please describe).

A second set of variables addressed cost-related reasons for *bringing* firewood on camping trips. Campers were asked "People have told us that they *bring* firewood on camping trips for different firewood related reasons; which of the following reasons apply to you? (Circle numbers of all that apply)." Options included: 1 = Firewood quality is sometimes low inside state parks/forests (e.g., it's wet or burns too fast) (***Quality_problems***), 2 = Firewood prices are sometimes too high inside/near state parks/forests (***Price_problems***), 3 = The location of firewood inside state parks/forests is sometimes inconvenient (***Location_problems***), 4 = The firewood supply areas inside state parks/forests are sometimes messy or wet (***Supply_areas***), 5 = The hours at which firewood is available at state parks/forests are sometimes inconvenient (***Time_problems***), 6 = We're not sure firewood will be available inside/near a state park/forest (***Reliability_problems***), 7 = We get firewood in bulk at home and want to use it (***Bulk_firewood***), 8 = We sometimes have firewood left from previous camping experiences (***Leftovers***), and 9 = None of these reasons apply to me.

Normative motivation was measured using two variables. Campers were asked "How large a threat do you think forest diseases and pests are to Wisconsin state parks and forests?" (***Threat_size***), and "How important is it that campers stop bringing firewood from distant locations into Wisconsin state parks and forests?" (***Stop_movement***). These variables were measured using seven-point semantic differential 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.

Social motivation was more challenging to measure. We expect better compliance from campers who believe that their family and friends see the EAB as a threat and are committed to following the firewood movement rule, as there is a natural human tendency to conform with the opinions and expectations of significant others (Ajzen, 1991). We used five questions (variables) to capture these normative beliefs and motivation to comply; all were based on the Theory of Planned Behavior (Ajzen, 2011, 1991) and were designed to address the measurement problems encountered using the previous study's questionnaire.[5] The first three questions measured normative belief strength and asked about commitment toward compliance. The first introduced the norm as follows: "Some people are totally committed to following the Firewood Movement Rule. They follow this rule on every camping trip because they think it's the right thing to do – they're 100% committed. Others are less committed or not committed at all. How committed to following this rule are you?" (***Personal_commitment***). The next two questions captured this information related to family and friends: "How committed would you say your family is to following this Firewood Movement Rule?" (***Family_commitment***), and "How committed would you say your friends are to following this Firewood Movement Rule?" (***Friend_commitment***). The last two questions in this set captured motivation to comply by asking "How much are you influenced by what your family thinks about this Firewood Movement Rule?" (***Family_influence***), and "How much are you influenced by what your friends think about this Firewood Movement Rule?" (***Friend_influence***). Each of these questions provided a five-point scale for camper response, where 1 = 0%, 2 = 25%, 3 = 50%, 4 = 75%, and 5 = 100%. Because motivational influence is also seen as a product of norm strength and motivation to comply, two additional variables were created to test for social pressure by multiplying family commitment by its influence (***Fam_com_inf***) and friend commitment by its influence (***Friend_com_inf***). Values for each of these combined variables could range from 1 through 25.

2.1.2. Ability to comply

Ability to comply depends on awareness of the diseases and pests that threaten our trees and forests, awareness and understanding of the firewood movement rules designed to address these threats, and the capacity to follow these rules. Our 2008 survey revealed extremely high levels of awareness of the emerald ash borer and firewood movement rules, so for 2010 we measured awareness by asking about a wider range of pests as follows: "Please tell us which of the following forest diseases and pests you have heard of or read about." Seven options were provided, and level of awareness could therefore range from zero through seven[6] (***Totaware***). Compliance capacity was measured with respect to camping activity and associated firewood costs. We assumed that all campers can afford this activity on at least a modest scale (i.e., they have financial capacity for it), but that firewood movement compliance will vary depending on aggregate firewood costs (of all types): higher levels of camping activity imply higher costs and suggest greater likelihood of non-compliance. Capacity-related variables included nights spent on most recent camping trip (***Nights_spent***), amount of firewood used on this trip (***Firewood_used***), and number of camping trips taken in 2010 to Wisconsin state parks and forests (***Trips_taken***).

2.1.3. General level assessments

After asking campers to assess the threats posed by forest diseases and pests, and the importance of stopping firewood movement (the normative motivation questions described above), the questionnaire asked campers to rate the relative importance of different *types* of issues related to firewood and the places where they get it. A constant sum scale was used and the question was worded as follows: "How important are the following *types* of issues related to your decision to follow Wisconsin's Firewood Movement Rule (i.e., firewood cannot be moved more than 25 miles to a state park or forest, from a quarantine area, or from out of state)?" The options provided were: Firewood related – for example, the cost, quality, condition, convenience, and/or reliability of firewood brought from home versus that available at or near a park or forest (***Firewood_issues***); Do-the-right-thing – for example, protecting our natural resources and preserving them for future generations (***Normative_issues***); Family and friends – for example, obeying the firewood movement rule because your family and friends think it's important (***Social_issues***); and Getting caught – for example, having firewood confiscated for violating the

[5] According to the Theory of Planned Behavior, beliefs about the normative expectations of others and motivation to comply with them result in perceived social pressure or subjective norms. These norms are influential, but they are not identical with the broader construct of social norms. Some researchers have found this to be problematic. For example, Schwartz's norm activation model maintains that social norms become enacted only through personal norms, and that the expectations of important others are not fully absorbed by the individual (Schwartz and Howard, 1980; Schwartz, 1977). The value-belief-norm theory (Stern and Dietz, 1994) makes similar statements about the mediating influence of social context. These reservations notwithstanding, the Theory of Planned Behavior has been successful in explaining conservation related behaviors, even in comparison with the value-belief-norm theory (Kaiser et al., 2005). Accordingly, we used it to guide the construction of our measure.

[6] Options included: Sirex wood wasp, gypsy moth, Asian longhorn beetle, hemlock wooly adelgid, beech bark disease, oak wilt disease, emerald ash borer, and none of the above.

Firewood Movement Rule (in some cases there may be fines) (***Enforcement_issues***).

A second general level question asked campers for their thoughts about a total ban on firewood movement into state parks and forests: "Forest diseases and pests such as the emerald ash borer, gypsy moth, and oak wilt threaten to devastate our forests and parks. Wisconsin DNR has imposed firewood movement restrictions to combat these threats, but they persist. Do you think that a total ban on firewood movement into state parks and forests is justified?" Campers could answer No, Yes, or Unsure (***Total_ban***).

2.1.4. Compliance

Firewood movement rule compliance was measured with a survey question that identified where campers got firewood for their most recent trip. Two categories were derived: (1) non-compliance included campers who brought at least some of their firewood from home or some distant location (in the form of logs; dimensional lumber scraps were OK); (2) compliance included those who obtained all their firewood at or near the campground they visited (***Tripcom***). Our previous study included a third category for partial compliance – campers who got some of their firewood at or near the campground they visited *and also* brought some from home or a distant location, but we eliminated this category to more accurately reflect the choice for non-compliance, which is generally made before a trip starts (with acquisitions made at or near the campground resulting from a subsequent choice). Potentials for response bias due to fears about non-compliance were expected to be minimal to non-existent.[7]

2.2. Method

We analyzed the 30 predictor variables described above: 13 continuous and 17 categorical (the categorical variables comprised 64 levels). Elimination of cases with missing values for any of these variables left a data set of 372 complete cases. Given these data, we used recursive partitioning – specifically, random forests based on conditional permutation, to evaluate variable importance. We then used two procedures to confirm: one based on standard (non-conditional) random forests, and one based on bi-variate analysis (i.e., analysis of variance and chi-square tests).[8]

2.2.1. Recursive partitioning

Although a wide range of classical statistical methods were available for this research, including linear and logistic regression, and multiple discriminant analysis, these approaches are subject to certain data limitations. One of these is the so called "small n large p" situation, where the number of predictor variables p may approach or exceed the number of subjects or cases n. Even in studies with far fewer predictor variables than the number used here, the combination of all main and interaction effects of interest, especially in the case of categorical predictor variables, may lead to cell counts too sparse for parameter convergence. This proved to be true for our data set. Recursive partitioning overcomes this problem, as well as certain other challenging features of our data (e.g., heteroscedasticity and non-normality). Given our two-level response variable, we implemented classification tree analysis as our recursive approach.

2.2.2. Random forests

Classification tree analysis offers clear advantages over classical statistical methods for our type of data, and has been used widely in natural resources research.[9] Nevertheless, there are disadvantages. In contrast with conventional regression modeling, (a) simple linear functions are highly approximated, (b) for some data sets, it is difficult to constrain the model by selecting the optimum pruning parameter through cross-validation, and (c) the output can be unstable – small changes in data can produce highly divergent trees. These disadvantages are overcome by random forests (Breiman, 2001), an approach that fits *many* classification trees to the data and then combines the predictions from all the trees.

2.2.3. Variable importance

Most statistical procedures for regression and classification measure the importance of variables indirectly using criteria such as statistical significance. In random forests, importance is typically determined by either the Gini impurity index or by mean decrease in permutation accuracy. The Gini index looks for the largest data set class and tries to isolate it from all other classes; it favors working on the largest class at the expense of the smaller. The permutation approach overcomes this weakness by randomly permuting[10] out-of-bag observations and then passing them down each tree to generate new predictions. The difference between misclassification rates for modified and original out-of-bag data, divided by the standard error, measures the importance of the variable. Unfortunately, this approach may overestimate the importance of correlated predictor variables. To overcome this weakness, Strobl et al. (2008) suggest a conditional permutation scheme, in which predictors are permuted only within groups of observations in order to preserve the correlation structure between them. Accordingly, we implemented random forests based on conditional permutation.

2.2.4. Implementation

Although this approach overcomes the data problems encountered in our previous study, several operational features must still be considered. One feature of random forests is that, for the same data set, results may differ between computational runs. The two sources of randomness responsible for these possible differences are the bootstrap samples that are randomly drawn, and the random preselection of predictor variables. Model stability is also affected by the nature and level of relationships among the predictors. For example, research has shown that when these variables are highly correlated, higher numbers must be preselected to adequately reflect conditional importance (Strobl et al., 2008), and this also helps to ensure that interactions of higher order are not missed in the tree building process. In addition, to assess a large

[7] First, we did not ask campers about compliance with the firewood movement rule, but about where they had obtained the firewood used on their most recent trip, where they typically get it, and whether they had moved any firewood in bulk during the preceding two years. We constructed the indicator of compliance from the trip-related questions. An additional safeguard was the positioning of questions about forest diseases and knowledge of the firewood movement rule in a section of the questionnaire to follow the trip related questions. Last, there were no fines for transporting firewood and almost no enforcement in 2010. Accordingly, we doubt that compliance related bias influenced this research.

[8] We implemented conditional permutation forests using package "party" in the programming language R (version 1.0-8; http://cran.r-project.org/web/packages/party/index.html). We implemented standard permutation and Gini-based random forests using package "randomForest" (version 4.6-7; http://cran.r-project.org/web/packages/randomForest/index.html).

[9] Random forests have been used to address issues ranging from ecohydrological and habitat modeling to prediction of species decline (Garzon et al., 2006; Jha and Vandermeer, 2010; Murray et al., 2010; Peters et al., 2007), as well as important forestry issues (Evans and Cushman, 2009; Falkowski et al., 2009; Iverson et al., 2008; Rehfeldt et al., 2009). They have also been evaluated with respect to various statistical approaches used in ecology (see Cutler et al., 2007; Kampichler et al., 2010; Olden et al., 2008; Prasad et al., 2006).

[10] Random values are substituted for observed values of the variable, thus breaking the association between the predictor and response variable.

number of predictor variables, a high number of trees or a high number of preselected variables, or ideally both, will help ensure that each variable has an adequate chance of occurring in different contexts with different covariates, and can thus better reflect potentially complex effects (Strobl et al., 2009).[11]

Given that some of our predictor variables were moderately correlated, we tested multiple levels of pre-selection (model parameter *mtry*) and chose the one that best separated importance estimates (i.e., that led to only minimal changes in order on repeated modeling (to be discussed)). Noting that $mtry = \sqrt{p}$ often produces the best results for classification forests (where p = number of predictors), but that larger numbers may be needed in situations where many weak or highly correlated variables are included (Breiman, 2001), we began with $mtry = 4$ and tested through $mtry = 18$. We constructed 1000 trees for each value and examined plots, then repeated the tests using forests of 5000 trees. The value that worked best for our data set was $mtry = 8$.

When variable importance is computed, a third source of model instability is the random permutation of the predictor vectors. Due to these processes, a random forest is exactly reproducible only when the random seed, a number that is set by the user, is fixed. Thus, the stability of variable importance for a forest can be tested through repeated executions with different random number seeds. If the order of predictor importance is maintained, the model is stable. If order differs, then the number of trees and/or number of preselected predictors should be increased and the paired test conducted again. We used this approach to test for stability, growing pairs of identically specified forests using different random number seeds.

We also recognized the disparity in class size for our response variable. For the 372 observations that remained after screening for missing data, this proportion was 354-to-18 (compliers-to-non-compliers). We would have preferred less class disparity, as standard permutation based importance measures may lose their ability to discriminate between associated and non-associated predictors for increasing class imbalance. This problem has been addressed through the use of sampling protocols (Evans and Cushman, 2009; Rehfeldt et al., 2009), and with the measurement of areas under ROC curves (Janitza et al., 2012), which we incorporated using feature AUC in R package 'party'. We also compared results for standard and AUC based models for forests of 5000 trees and $mtry = 8$ and found very little difference, which provided an additional measure of confidence in results.

3. Results

3.1. Variable importance based on conditional permutation

Variable importance estimates are generally considered as follows: those at or near zero have no influence on model performance, those with high positive values are influential, and those with high negative values degrade the efficiency of the model.[12] Considering this, we tested pairs of random forests using $mtry = 8$ where each forest was grown from a unique random number seed. We had hoped to find stability in order of importance for the full set of variables in a relatively small forest pair (e.g., 1000 trees), but were unable to do so. Although successively larger size forests identified the same 12 variables as important (of the 30 variables included in the models), their rankings across each pair varied slightly (i.e., for forests of 1000, 5000, 8000, and 10,000 trees). The top four variables *did* maintain their order of importance across all four forest pairs, but one or two of the next eight variables differed by one position (e.g., the variable at rank five in the first forest appeared at rank six in the second). Importance rankings stabilized for all 12 variables for pairs of forests of 12,000 trees, and this ranking is shown in Fig. 1. The dramatic change in slope beginning at the variable ranked fifth (i.e., ***Leftovers***) reflects a general reduction in differences among importance values for all lower-ranked variables, and is a feature that also characterized all preceding forest pairs (no doubt contributing to their order instability).

Important variables appear to the right of the dashed line in Fig. 1. These variables include, in descending order of importance (motivation type is shown in parens as C = calculated, N = normative, and S = social): ***Bulk_firewood*** (C), ***Family_commitment*** (S), ***Friend_commitment*** (S), ***Quality_problems*** (C), ***Leftovers*** (C), ***Firewood_issues*** (C), ***Threat_size*** (N), ***Location_problems*** (C), ***Fam_com_inf*** (S), ***Supply_areas*** (C), ***Reliability_problems*** (C), and ***Convenience_of_location*** (C). Clearly, calculated motivations dominate, although social and normative motivations are also reflected in these results. The classification error rate for out-of-bag observations was 4.84%, and is considered low.[13]

3.2. Variable importance based on standard permutation and Gini

To confirm these findings we evaluated variable importance using standard (non-conditional) permutation and the Gini impurity index. We used the same modeling approach as for conditional forests, varying *mtry* from 4 to 18 and growing forests of 1000 through 12,000 trees. Previous research has shown that variable selection in standard random forests is biased in favor of variables with certain characteristics, even if these variables are no more informative than their competitors. For example, categorical variables with many levels and numeric variables are artificially preferred, and this bias is particularly pronounced for the Gini index (Strobl et al., 2009). Although this proved to be true for our tests, a standard random forest comprising 12,000 trees confirmed seven of the 12 variables identified as important in the conditional forest, including the four identified as most important.

Results follow in Table 1; the 12 variables identified as most important by each measurement approach are shown in bold italics (important variables based on conditional importance are denoted with asterisks). Because the descendant nodes following any tree split are less impure, larger decreases in the Gini index suggest greater variable importance. Similarly, larger mean decreases in accuracy following random permuting suggest greater importance. Matches with important variables in the conditional permutation forest numbered six for Gini and five for mean decrease in permutation accuracy. There was also some divergence in order of importance; that is, of the four most important variables cited by conditional permutation forests, the rank order importance of three were confirmed based on mean decrease in permutation accuracy (i.e., ***Bulk_firewood***, ***Friend_commitment***, and ***Quality_problems***). The Gini approach also confirmed three but did *not* maintain their order. There were slight differences in order for conditionally

[11] Although this seems to argue for consistently specifying large numbers of preselected variables, model prediction error must also be addressed. This depends upon the strength of the trees in the forest and the correlation among them. Error rate decreases with increasing tree strength and increases with increasing correlation. Increasing the number of preselected variables increases both correlation and tree strength, so there's a trade-off to be considered relative to error.

[12] The rationale for this rule of thumb is that the importance of irrelevant variables varies randomly around zero (Strobl et al., 2009).

[13] Out-of-bag observations are those that are omitted from the bootstrap sample drawn to construct a tree. In a typical sample, approximately 63% of the original observations occur at least once; those that do not occur are called out-of-bag.

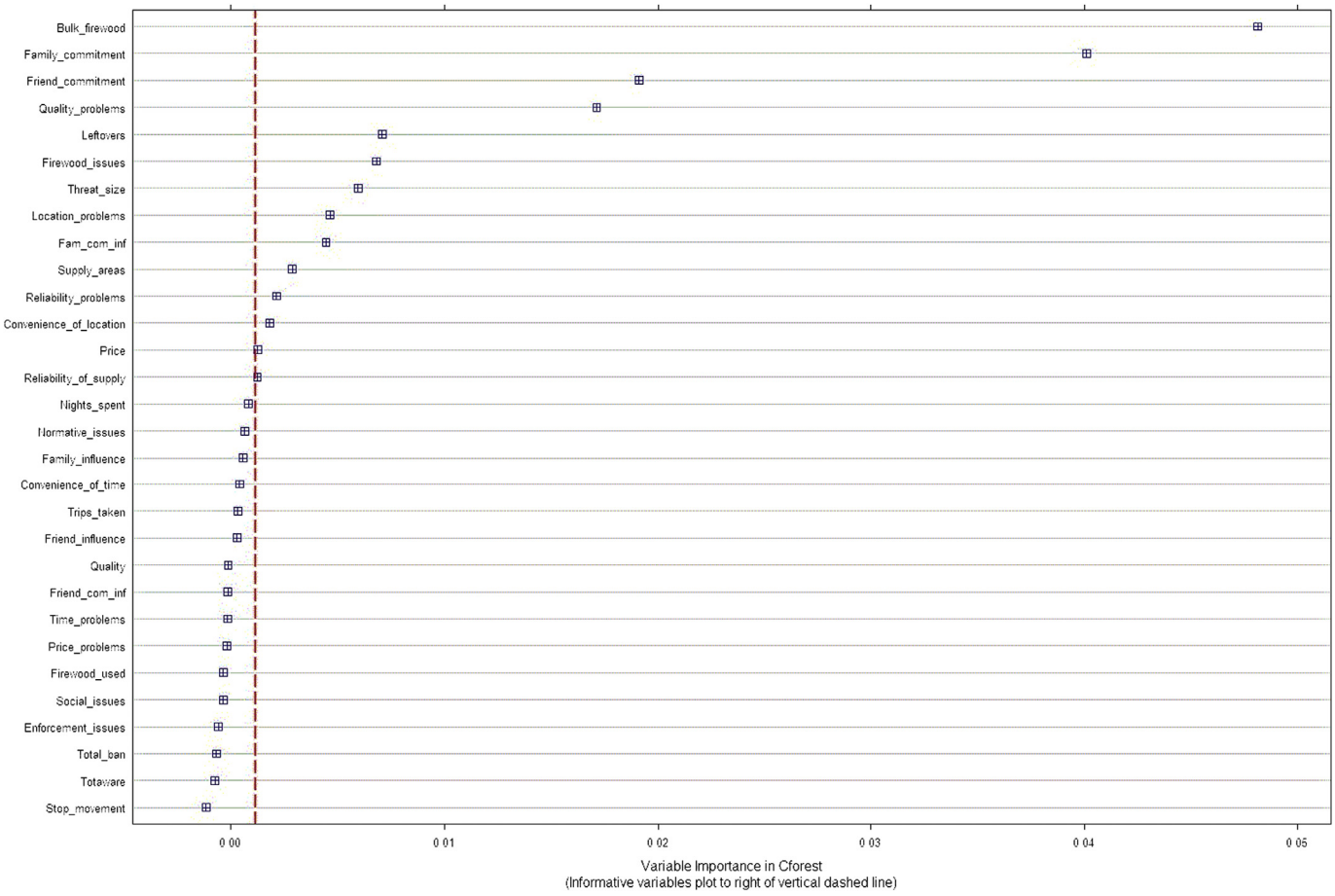

Fig. 1. Important variables based on conditional permutation.

important variables ranked five through 12 using either measure. These are the variables whose importance values differed only slightly (as shown by the steepened slope in Fig. 1), and this may have been due to random variation, or to the way in which standard random forests favor variables with many potential cut-points (i.e., continuous variables and categorical variables with many levels). In fact, nine of the important variables identified by the two measures shown in Table 1 fit this description (i.e., ***Nights_spent***, ***Quality***, ***Price***, ***Reliability_of_supply***, ***Firewood_issues***, ***Normative_issues***, ***Enforcement_issues***, ***Fam_com_inf***, and ***Friend_com_inf***), in contrast with only three of the 12 important variables identified by the conditional permutation approach, as shown in Fig. 1 (i.e., ***Firewood_issues***, ***Fam_com_inf***, and ***Convenience_of_location***). Nevertheless, these findings confirm the conditional permutation results, and the classification error rate for out-of-bag observations was only 5.11% (approximately the same as that achieved using the conditional approach).

3.3. Variable importance based on measures of association

A second general approach to confirmation examined levels of association between important predictor variables and firewood movement rule compliance. This type of evaluation proceeds one variable at a time, and therefore cannot capture importance due to variable interactions, but it does facilitate testing for direct strength and direction of effect. We compared means for the two compliance groups on each of the three continuous variables, and prepared contingency tables for the nine categorical variables. All 12 analyses (ANOVA and chi-square) showed the directions of association expected, and all were statistically significant, as shown in Table 2.[14] Effect sizes were also large for the four variables identified as most important in the conditional permutation approach (i.e., ***Bulk_firewood***, ***Quality_problems***, ***Family_commitment***, and ***Friend_commitment***), which are shown with asterisks. A detailed description of these confirmation tests appears as an appendix.

4. Discussion

These findings confirm the influence of calculated, normative, and social motivations in contexts where regulatees have sporadic short-term interests, and where costs of compliance and non-compliance are both low. Although the importance of ability to comply was not confirmed, this may be due to gains made in education and outreach since 2008, and to improvements made in the firewood supplied at Wisconsin state parks and forests. These findings are encouraging, but their implications for policy development and regulation are not necessarily clear. First, these are but three factors of many that can influence environmental behavior. Second, the interaction of these factors, along with many others, is complicated (see Gifford, 2011; Kollmuss and Agyeman, 2002; Lindenberg and Steg, 2007). Further, despite a wealth of research and published reports, regulation scholars still lack a consistent and comprehensive theory of compliance, and entertain a collection of

[14] ANOVA and chi-square test results include measures of significance (ρ) and effect size (η^2 for ANOVA and Cramer's V for chi-square). ***Supply_areas*** was only borderline significant (X^2 (1, 372) = 2.777, ρ = .096, V = .086).

Table 1
Important variables based on standard permutation and Gini[a].

Variable[b]	Mean decrease in permutation accuracy	Mean decrease in Gini index
Nights_spent	.04	***2.17***
Firewood_used	8.53	.47
Trips_taken	3.26	1.00
Quality_problems*	***13.81***	.74
Price_problems	***16.46***	.33
Location_problems*	3.12	.56
Supply_areas*	−2.60	.22
Time_problems	5.93	.14
Reliability_problems*	−3.74	.45
Bulk_firewood*	***17.79***	***1.50***
Leftovers*	.20	.54
Quality	***10.99***	***1.72***
Price	***17.36***	***1.55***
Convenience_of_location*	1.21	1.03
Convenience_of_time	−1.42	.79
Reliability_of_supply	***12.37***	***1.96***
Family_commitment*	2.54	***2.45***
Friend_commitment*	***16.43***	***1.77***
Family_influence	−4.66	.83
Friend_influence	4.52	.81
Threat_size*	***9.04***	***2.07***
Stop_movement	−3.15	.97
Firewood_issues*	.99	***1.91***
Normative_issues	***8.57***	***1.33***
Social_issues	−.97	.94
Enforcement_issues	***18.72***	.96
Totaware	4.42	1.02
Fam_com_inf*	***10.79***	***1.54***
Friend_com_inf	***16.44***	***2.01***
Total_ban	.68	.39

[a] For a forest of 12,000 trees with *mtry* = 8. Important variables determined by decrease in permutation accuracy and/or decrease in the Gini index are shown in bold italics. Larger numbers indicate greater importance.
[b] Asterisks following variable names indicate importance determined by the conditional permutation approach (Fig. 1).

partial and incompatible theories instead (Etienne, 2011). This has led to the development of integrative research and analysis frameworks, two of which are applied here.

4.1. Motivational postures

The first of these integrative frameworks addresses motivational postures, which are defined as "…conglomerates of beliefs, attitudes, preferences, interests, and feelings that together communicate the degree to which an individual accepts the agenda of the regulator, in principle, and endorses the way in which the regulator functions and carries out duties on a daily basis." (Braithwaite et al., 2007, p. 138). This framework recognizes that regulatees may adopt styles of engagement with authorities (termed postures) that may influence compliance behaviors and responses to regulation and enforcement. This theory emphasizes law's contingency and identifies how responses to regulation may include non-compliance as well as compliance. The challenge to regulators, according to this model, is to focus on reducing social distance, which includes two main components (Braithwaite, 1995): the rapport, social connectedness, and degree of trust and respect between the regulator and regulatee, and the degree of agreement they share regarding the ends and means of regulation. Regulators may exploit the deeper understandings facilitated by these postures to achieve more effective regulation (Braithwaite et al., 2007), as strategies suited to engendering compliance within each posture have been identified (Bartel and Barclay, 2011; Braithwaite, 2003a).

Table 2
Bi-variate test results for motivations to comply.

Predictor variables[a]	Test results: ANOVA and Chi-Square[b]
Calculated motivation	
Bulk_firewood*	X^2 (1, 372) = 30.619, ρ = .000, V = .287
Quality_problems*	X^2 (1, 372) = 16.494, ρ = .000, V = .211
Leftovers	X^2 (1, 372) = 5.416, ρ = .020, V = .121
Firewood_issues	F (1, 370) = 19.832, ρ = .000, η^2 = .051
Location_problems	X^2 (1, 372) = 13.379, ρ = .000, V = .190
Supply_areas	X^2 (1, 372) = 2.777, ρ = .096, V = .086
Reliability_problems	X^2 (1, 372) = 6.157, ρ = .013, V = .129
Convenience_of_location	F (1, 370) = 4.321, ρ = .038, η^2 = .012
Normative motivation	
Threat_size	X^2 (6372) = 17.492, ρ = .008, V = .217
Social motivation	
Family_commitment*	X^2 (4, 372) = 53.162, ρ = .000, V = .378
Friend_commitment*	X^2 (4, 372) = 43.704, ρ = .000, V = .343
Fam_com_inf	F (1, 370) = 5.957, ρ = .015, η^2 = .016

[a] Predictor variables are analyzed with respect to ***Tripcom*** (two groups: compliance, non-compliance). The four most important variables identified by the conditional permutation approach are shown with asterisks. Effect size for ***Threat_Size*** was also large (ranked seventh in Fig. 1).
[b] ANOVA and chi-square test results include measures for significance (ρ) and effect size (η2 for ANOVA and Cramer's V for chi-square).

We view this framework as particularly relevant to natural resources regulation. For example, Wisconsin DNR must balance competing demands for natural resources by both recreational and business users, and regulate activities that discharge waste to air, land, and water, threaten endangered species, spread diseases and invasive pests, and contribute to climate change. Citizen conceptions of Wisconsin DNR as a regulator in any one of these areas may be influenced by interactions with it in other areas as well. These conceptions, in turn, influence the formation of motivational postures and likelihood of rule compliance.

For this study, we obtained postures-related data from a subset of survey respondents who told us they were aware of the firewood movement rule but had *not* changed the way they got or moved firewood. The reasons they provided included the following (respondents could check all that applied): 1 = We're careful about the wood we move (e.g., we don't bring ash logs), 2 = We generally camp within 25 miles of home and are therefore legal, 3 = We don't think bringing (moving) firewood poses a real risk of spreading forest diseases and pests, 4 = Firewood movement rules don't make sense to us, 5 = We doubt that forest diseases and pests can be stopped, so why bother, 6 = We doubt that we'll be caught, 7 = We're tired of DNR's rules, 8 = Generally, we don't build fires or use firewood, 9 = Other (Please describe), and 10 = None of these reasons apply to me. We assigned these responses to Braithwaite's five motivational postures (2003b), as shown in Table 3, and note that counts reflect the number of times a response was selected, not the number of respondents.

These data show that the numbers of responses for defiant postures vary considerably, but that the campers making these statements mostly complied – especially the game players. This confirms conclusions drawn from previous research that even vocal critics of a regulator and/or its regulations may comply in percentages approximating those of groups that are not so critical (Braithwaite, 2003b). It remains for Wisconsin DNR to find ways to decrease social distance for defiant posture campers in general, and especially for those who do not comply. The information contained in the Reason statements offer valuable insights.[15]

4.2. Social marketing

A second integrative framework is social marketing. This approach is typically defined as a program-planning process that

[15] Defiant campers may be under-represented in these results, as only firewood rule-aware campers provided answers to this question.

Table 3
Motivational postures – reasons for not changing firewood movement behavior.

Orientation	Posture[a]	Reason	Responses[b]	%Comply[c]
Deference[d]	Commitment Capitulation	We already comply	32	96.9%
Defiance	Resistance	Firewood movement rules don't make sense to us	3	66.7%
		We're tired of DNR's rules	2	50.0%
	Disengagement	We don't think bringing (moving) firewood poses a real risk of spreading forest diseases and pests	3	66.7%
		We doubt that forest diseases and pests can be stopped, so why bother	6	83.3%
	Game playing	We're careful about the wood we move (e.g., we don't bring ash logs)[e]	29	72.4%
		We generally camp within 25 miles of home and are therefore legal	30	86.7%
		We doubt that we'll be caught	2	100.0%

[a] Posture descriptions are based on Braithwaite (2003b): *Commitment* – Belief in environmental regulations as a means of securing the common good; *Capitulation* – An acceptance of the regulator as a legitimate authority; *Resistance* – attributing negative and harmful intentions to the regulator – they're "out to get us; " *Disengagement* – A widespread disenchantment with the system whereby individuals have "given up" on the governments and regulatory system; *Game playing* – Perception of the regulator as a partner in playing and finding ways to use the law to one's own advantage.
[b] Eighty campers provided 107 responses to this survey question (which asked them to check all that apply).
[c] Percentages of campers citing each reason who complied with the firewood movement rule on their most recent camping trip.
[d] Both commitment and capitulation postures are represented in the reason cited.
[e] These campers may be deluding themselves, in which case they would be more appropriately classified in the Commitment posture. For example, some of the pests and diseases the regulation was designed to protect against are difficult to detect, and the rule applies to wood from all species of tree because a variety of pests and diseases attack many different species, not just ash.

applies commercial marketing concepts and techniques to promote voluntary behavior change (Kotler and Zaltman, 1971; Kotler et al., 2002). It has been used to promote conservation behaviors (Monroe, 2003), and has been extended for this purpose at the community level (McKenzie-Mohr, 2011, 2000). Social marketing has features in common with other behavior change disciplines, including an audience orientation, segmentation, behavioral focus, evaluation, and consideration of upstream and midstream target audiences. In addition, it has four core principles that are truly unique (Lee and Kotler, 2011).

The first of these core principles is *value exchange*. An offer is made based on an understanding of the target audience's perceived self-interest that will be rewarded for performing the desired behavior. With regard to restricting firewood movement to limit the spread of forest diseases and invasive pests, this implies communicating the need to protect and preserve healthy forests, both rural and urban, for present and future generations. This study's confirmation of normative motives as important suggests that this message has been well received. Value exchange also implies the need to make environmentally safe firewood available at or near campgrounds, and at a quality level and price that campers find attractive. This is confirmed by this study's finding that calculated motives are important.

A second unique feature of social marketing is *recognition of competition*. The firewood supplied at or near state campgrounds competes with firewood the camper can bring from home, which is invariably cheaper, of known and often higher quality, generally more convenient, and reliably supplied. This realization has led to the promotion of a firewood dealer certification program, which helps ensure the provision of invasives-safe, high quality firewood at or near each state park and forest.[16] Another feature of competition is private campgrounds, which may be located near state facilities and are not subject to the same firewood movement restrictions (apart from movement from quarantine areas). This situation may have influenced compliance rates at some state parks and forests, as some of our respondents questioned the effectiveness and fairness of restricting firewood movement to public but not private facilities. Wisconsin DNR has surveyed private campground operators and worked with their trade group to address this issue, and to help these operators inform their customers regarding the risks posed by forest diseases and invasive pests, and their relation to firewood movement.

Third, *the marketing mix*, also known as the four Ps, includes product, price, place, and promotion. The need to ensure that good quality firewood is available at campgrounds at a fair price, and is conveniently located and reliably supplied, was demonstrated by this study's confirmation of calculated motivations as important. Effective promotion would help ensure that all campers consider the firewood movement rule before they begin their trip, and feel confident of finding safe, high quality firewood at or near the campground(s) they plan to visit. Wisconsin DNR has partnered with its reservation agent to provide a rule reminder with every online reservation, and provides park and forest specific firewood information on its website. It has also improved the conditions under which firewood is provided at many state parks and forests (e.g., by building shelters for firewood and switching to bundled from loose).

The fourth unique feature of social marketing is *sustainability*, which results from continuous program monitoring and adjustment to changes occurring in the audience and environmental conditions. Wisconsin DNR has conducted broad scale camper surveys biennially since 2006. The goals have been to monitor firewood movement behavior, camper satisfaction with firewood supplied at or near the state campgrounds they visit, and reasons for not complying with the firewood movement rule, as discussed above. This information has led to the adjustment of firewood movement limits from 50 to 25 miles for all state parks and forests, and has been used to promote a firewood certification program to help ensure the supply of invasives-safe firewood. Confirmation of social motivation as important in this study suggests that attention also be paid to evolving social norms – especially those related to environmental issues, and to the social dimensions of firewood acquisition and use.

4.3. Social norms

An extension to these integrative analysis frameworks is based on social norms. Useful perspectives include deviance regulation

[16] This program is administered by the Wisconsin Department of Agriculture, Trade, and Consumer Protection.

theory, social identity and self-categorization theories, and the focus theory of normative conduct (Goldstein and Cialdini, 2007). Specific topics have been investigated in environmental contexts, including the efficacy of communications based on descriptive and injunctive norms (Cialdini et al., 2006), the use of descriptive norms in place of traditional normative appeals (Goldstein et al., 2008), and the design of belief-based messaging to increase compliance (Ham et al., 2008). Of particular interest are studies that demonstrate the effectiveness of offering peer comparisons (see Griskevicius et al., 2008), and that document how low cost persuasion strategies or "nudges" can change an individual's behavior by making him/her aware of the actions of others who have been in a similar situation (see Costa and Kahn, 2010; Goldstein et al., 2008; Schultz et al., 2007). Wisconsin DNR has designed and distributed banners, posters, and brochures that utilize injunctive norms to harness social and normative motives, and has distributed them to state campground properties, recreational equipment retailers, and state and county fairs (and other events). One of the messages communicated is the normative injunction to "Protect the trees where you live, play, or camp. Get firewood where you use it." More than 39,000 brochures with this message were sent to private campground operators in 2011 for distribution to their guests.

4.4. Affect

A second extension is found in the work of scholars studying consumer affect. Much of this work is based on Dittmar's theory on the meaning of material possessions (Dittmar, 2004, 1992), which proposes that the use of material goods fulfills three functions: instrumental, symbolic, and affective. This theory has been tested in transportation studies, where research has shown that auto use is most strongly related to symbolic and affective motives, and that instrumental motives are less important (Steg, 2005). In addition, five core motives have been identified for the drive to work, including affect related to the journey itself (Gardner and Abraham, 2007), and affective appraisals of the daily commute relate not only to journey time, but to travel modes, which are perceived as being variably stressful, depressing, boring, relaxing, interesting, exciting, or pleasant (Gatersleben and Uzzell, 2007).

These finding suggest that affect related to camping and the procurement of firewood may be managed to encourage pro-environmental behavior – specifically, to reduce the movement of firewood. For example, for many campers, cutting firewood can symbolize self-reliance, connectedness with family and friends (e.g., cutting from a family woodlot), and tradition. Our 2010 survey data reveal that roughly 8% of responding campers cut their firewood themselves, and another 2% got it from friends or relatives. Affect is likely to be involved in this, and may be managed through the use of normative and social appeals that encourage stewardship for forests and the trees that enhance campgrounds, residential neighborhoods, and personal properties, including woodlots.[17] For example, campers may be encouraged to use only certified or local (to their campground) firewood, and to verify that any firewood they buy in bulk or produce from their own property has been aged at least two years before it is moved. There's also a strong affective component in the use of firewood on camping trips. Our survey data show that 94% of all campers had a fire on their most recent trip, 87% said that having a campfire was *extremely* important, and 94% used their campfire for viewing pleasure and ambiance.[18] With creative messaging, this affect for campfires may be translated into pro-environmental regard for trees, and into firewood movement rule compliance. A third use of affect may be through icons such as Smokey Bear and Woodsy Owl. Smokey Bear is one of the most recognized icons in advertising history. According to an Ad Council tracking survey of U.S. adults, approximately 98% recognized Smokey Bear; 92% identified Smokey Bear on an unaided basis; and 3 out of 4 adults are able to recall Smokey's message of "Only You Can Prevent Wildfires" or a similar iteration, without prompting (The Ad Council, 2013). Woodsy Owl has not been around for as long, but is well known for his message "Give a hoot – Don't pollute!" Wisconsin DNR has sponsored both characters in their visits to numerous parades and public events, and in their efforts to educate regarding wildfires and natural resources.

5. Conclusions

This study confirms our previous study's findings that calculated and normative motivations influence firewood movement rule compliance (Peterson and Diss-Torrance, 2012), and shows that social motivations are influential as well. This resolves the ambiguous findings of our 2012 research, and environmental management options are implied. For example, with respect to calculated motivation, firewood supplied at or near campgrounds can be improved, which is generally a lower cost approach to discouraging firewood movement than increasing enforcement levels and imposing fines. Injunctive norms may also be used to harness social and normative motivations, and may be managed within the context of several integrative analysis frameworks. Motivational postures provide one such framework, and social marketing offers a second. Affect related to camping and firewood cutting may also be tapped and redirected. Although these results cannot be generalized beyond the present study's context, they have important implications, not only for controlling the spread of forest diseases and pests, but also for regulating behavior toward natural resources in general. They suggest that national, state, and local governments can more effectively manage natural resources to encourage user compliance with environmental rules, and develop comprehensive strategies that leverage affect and pro-environment norms.

Acknowledgments

The authors thank the Wisconsin Department of Natural Resources Division of Forestry, Public Lands and Conservation Services Section for funding this research, and three anonymous reviewers for their helpful comments.

Appendix. Description of bi-variate confirmation tests

Calculated motivation.

The variable identified as most important for differentiating compliance from non-compliance was ***Bulk_firewood*** ("We get firewood in bulk at home and want to use it"). Of the campers who cited this factor, 20.8% did not comply versus 4.8% overall; for those who did not cite this factor the percentage of non-compliers was only 2.5%. This association was statistically significant and the effect size was large (X^2 (1, 372) = 30.619, ρ = 000, V = .287). The fourth most important variable was ***Quality_problems***. Roughly 13% of campers who cited this problem did not comply, in contrast with only 2% of campers who did not cite this as a problem. This

[17] This appeal would resonate with campers who visit Wisconsin's Rocky Arbor State Park, which lost its entire canopy of 100-year-old white oaks to gypsy moth infestation in 2007. Although shrubs and some younger trees remain, the "old forest" ambiance is gone.

[18] Other uses cited (less frequently) included cooking, providing warmth, and recreation (e.g., roasting marshmallows).

relationship was statistically significant and the strength of association was moderate (X^2 (1, 372) = 16.494, ρ = .000, V = .211). ***Leftovers*** was the fifth most important variable. Approximately 12% of the campers who cited this factor did not comply on their most recent trip, while only 3.9% of those who did not cite this factor failed to comply (X^2 (1, 372) = 5.416, ρ = .020, V = .121). ***Firewood_issues*** emerged as the sixth most important variable. Campers had been asked to allocate 100 points among four general level issues, and the mean rating for non-compliers on this issue was 47.78 points, in contrast with 21.23 points for compliers (F (1, 370) = 19.832, ρ = .000, η^2 = .051). In addition to being more important to non-compliers than compliers, the 47.78 point rating means that firewood was almost as important to this group as all other issues combined. The variable rated as eighth most important was ***Location_problems***. Twenty percent of those who cited this problem did not comply; in contrast, only 3.7% of those who did not cite it failed to comply (X^2 (1, 372) = 13.379, ρ = .000, V = .190). ***Supply_areas*** appeared in tenth place. Of those who cited this as a problem, approximately 10% failed to comply; of those who did not cite it, only 4.2% failed to comply, although this relationship was only borderline significant and the effect size was weak (X^2 (1, 372) = 2.777, ρ = .096, V = .086). ***Reliability_problems*** appeared in eleventh place. Roughly 12% of campers who cited this problem failed to comply; in contrast, only 3.7% of campers who did not cite this problem failed to comply (X^2 (1, 372) = 6.157, ρ = .013, V = .129). The last variable identified as important in our classification analysis was ***Convenience_of_location***, one of the six factors evaluated with respect to firewood purchases at/near a state park or forest. Campers allocated 100 points among these factors, and the mean value of 6.50 assigned by non-compliers was lower than the 13.23 points allocated by compliers. This suggests that campers who complied valued the convenience of firewood obtained at or near the campground they visited above the valuations made by non-compliers, which confirms the conclusions drawn in our previous research (Peterson and Diss-Torrance, 2012). This relationship was statistically significant (F (1, 370) = 4.321, ρ = .038, η^2 = .012).

Normative motivation.

Only one normative variable was identified as important in the two random forest analyses. The seventh ranked variable, ***Threat_size*** showed higher cell counts for non-compliers in the middle range of the size-of-threat scale than in the high range (mostly 4s and 5s on the seven-point semantic differential scale), in contrast with compliers, who were distributed more toward the high end (mostly 6s and 7s). These differences were expected and were statistically significant (X^2 (6, 372) = 17.492, ρ = .008, V = .217), but seven of the contingency table's 14 cells had counts less than 5, which argues for a cautious reading of importance based on this measure.[19]

Social motivation.

The second most important variable identified by recursive partitioning was ***Family_commitment***. This variable was scaled from 1 to 5 where 1 stood for family members being 0% committed and 5 signaled 100% commitment. Fifty percent of the campers who cited 1 failed to comply, whereas less than 1% of campers who cited 5 did not comply. This relationship was statistically significant and the effect size was large (X^2 (4, 372) = 53.162, ρ = .000, V = .378). Similarly, ***Friend_commitment*** was confirmed as important. Roughly 67% of campers whose friends were 0% committed did not comply, whereas less than 1% of campers whose friends were 100% committed failed to comply. This relationship was also statistically significant and the effect size was large (X^2 (4, 372) = 43.704, ρ = .000, V = .343). The variable ranked ninth in importance was ***Fam_com_inf***. The average rating for those who did not comply was 9.22 points, in contrast with 14.40 points for those who complied (F (1, 370) = 5.957, ρ = .015, $\eta 2$ = .016) (values for this compound variable could range from 1 through 25 where larger numbers indicated greater social pressure).

[19] This should not be a cause for concern, as normative motives are also implied in the social motivation measures, which used the following wording: "Some people are totally committed to following the Firewood Movement Rule. They follow this rule on every camping trip because they think it's the right thing to do – they're 100% committed."

References

Ajzen, I., 1991. The theory of planned behavior. Organ. Behav. Hum. Decis. Process. 50, 179–211.

Ajzen, I., 2011. Constructing a Theory of Planned Behavior Questionnaire [WWW Document]. Unpublished manuscript. URL. http://people.umass.edu/~aizen/pdf/tpb.measurement.pdf (accessed 10.18.13).

Atari, D.O., Yiridoe, E.K., Smale, S., Duinker, P.N., 2009. What motivates farmers to participate in the Nova Scotia environmental farm plan program? Evidence and environmental policy implications. J. Environ. Manag. 90, 1269–1279.

Bartel, R., Barclay, E., 2011. Motivational postures and compliance with environmental law in Australian agriculture. J. Rural Stud. 27, 153–170.

Becker, G.S., 1968. Crime and punishment: an economic approach. J. Pol. Econ. 76, 169–217.

Braithwaite, V., 1995. Games of engagement: postures within the regulatory community. Law Pol. 17, 225–255.

Braithwaite, V., 2003a. A new approach to tax compliance. In: Braithwaite, V. (Ed.), Taxing Democracy: Understanding Tax Avoidance and Evasion. Ashgate Publishing Ltd., Aldershot UK, pp. 15–39.

Braithwaite, V., 2003b. Dancing with tax authorities: motivational postures and non-compliant actions. In: Braithwaite, V. (Ed.), Taxing Democracy: Understanding Tax Avoidance and Evasion. Ashgate Publishing Ltd., Aldershot UK, pp. 15–39.

Braithwaite, V., Murphy, K., Reinhart, M., 2007. Taxation threat, motivational postures, and responsive regulation. Law Pol. 29, 137–158.

Breiman, L., 2001. Random forests. Mach. Learn. 45, 5–32.

Burby, R.J., Paterson, R.G., 1993. Improving compliance with state environmental regulations. J. Pol. Anal. Manag. 12, 753–772.

Cialdini, R.B., Demaine, L.J., Sagarin, B.J., Barrett, D.W., Rhoads, K., Winter, P.L., 2006. Managing social norms for persuasive impact. Soc. Influ. 1, 3–15.

Cochran, J.K., Chamlin, M.B., Wood, P.B., Sellers, C.S., 1999. Shame, embarrassment, and formal sanction threats: extending the deterrence/rational choice model to academic dishonesty. Sociol. Inq. 69, 91–105.

Costa, D.L., Kahn, M.E., 2010. Energy conservation "nudges" and Environmentalist Ideology: Evidence from a Randomized Residential Electricity Field Experiment. National Bureau of Economic Research (Technical Report).

Cutler, D.R., Edwards Jr., T.C., Beard, K.H., Cutler, A., Hess, K.T., Gibson, J., Lawler, J.J., 2007. Random forests for classification in ecology. Ecology 88, 2783–2792.

Dittmar, H., 1992. The Social Psychology of Material Possessions: to have is to be. Harvester Wheatsheaf/St. Martin's Press, Hemel Hempstead, UK/New York.

Dittmar, H., 2004. Are you what you have? Psychologist 17, 206–210.

Ehrlich, I., 1972. The deterrent effect of criminal law enforcement. J. Legal Stud. 1, 259–276.

Etienne, J., 2011. Compliance theory: a goal framing approach. Law Pol. 33, 305–333.

Evans, J.S., Cushman, S.A., 2009. Gradient modeling of conifer species using random forests. Landsc. Ecol. 24, 673–683.

Falkowski, M.J., Evans, J.S., Martinuzzi, S., Gessler, P.E., Hudak, A.T., 2009. Characterizing forest succession with lidar data: an evaluation for the Inland Northwest, USA. Remote Sens. Environ. 113, 946–956.

Gardner, B., Abraham, C., 2007. What drives car use? A grounded theory analysis of commuters' reasons for driving. Transp. Res. Part Traffic Psychol. Behav. 10, 187–200.

Garzon, M.B., Blazek, R., Neteler, M., Dios, R.S., Ollero, H.S., Furlanello, C., 2006. Predicting habitat suitability with machine learning models: the potential area of *Pinus sylvestris* L. in the Iberian Peninsula. Ecol. Model. 197, 383–393.

Gatersleben, B., Uzzell, D., 2007. Affective appraisals of the daily commute: comparing perceptions of drivers, cyclists, walkers, and users of public transport. Environ. Behav. 39, 416–431.

Gifford, R., 2011. The dragons of inaction: psychological barriers that limit climate change mitigation and adaptation. Am. Psychol. 66, 290–302.

Goldstein, N.J., Cialdini, R.B., 2007. Using social norms as a lever of social influence. In: Pratkanis, Anthony R. (Ed.), The Science of Social Influence, Advances and Future Progress. Psychology Press, New York, pp. 167–192.

Goldstein, N.J., Cialdini, R.B., Griskevicius, V., 2008. A room with a viewpoint: using social norms to motivate environmental conservation in hotels. J. Consum. Res. 35, 472–482.

Grasmick, H.G., Bursik Jr., R.J., 1990. Conscience, significant others, and rational choice: extending the deterrence model. Law Soc. Rev. 24, 837–861.

Griskevicius, V., Cialdini, R.B., Goldstein, N.J., 2008. Social norms: an underestimated and underemployed lever for managing climate change. Int. J. Sustain. Commun. 3, 5–13.

Ham, S.H., Weiler, B., Hughes, M., Brown, T., Curtis, J., Poll, M., 2008. Asking Visitors to Help, Research to Guide Strategic Communication for Protected Area Management. CRC For Sustainable Tourism Pty Ltd, Gold Coast, Queensland, Australia (Technical).
Hatcher, A., Jaffry, S., Thebaud, O., Bennett, E., 2000. Normative and social influences affecting compliance with fishery regulations. Land Econ. 76, 448–461.
Iverson, L.R., Prasad, A.M., Matthews, S.N., Peters, M., 2008. Estimating potential habitat for 134 eastern US tree species under six climate scenarios. For. Ecol. Manag. 254, 390–406.
Janitza, S., Strobl, C., Boulesteix, A.L., 2012. An AUC-based Permutation Variable Importance Measure for Random Forests. University of Munich, Munich (Technical No. 130-2012).
Jha, S., Vandermeer, J.H., 2010. Impacts of coffee agroforestry management on tropical bee communities. Biol. Conserv. 143, 1423–1431.
Kaiser, F.G., Hubner, G., Bogner, F.X., 2005. Contrasting the theory of planned behavior with the value-belief-norm model in explaining conservation behavior. J. Appl. Soc. Psychol. 35, 2150–2170.
Kampichler, C., Wieland, R., Calmé, S., Weissenberger, H., Arriaga-Weiss, S., 2010. Classification in conservation biology: a comparison of five machine-learning methods. Ecol. Inform. 5, 441–450.
Kollmuss, A., Agyeman, J., 2002. Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? Environ. Educ. Res. 8, 239–260.
Kotler, P., Roberto, N., Lee, N., 2002. Social Marketing: Improving the Quality of Life. SAGE Publications Inc., Thousand Oaks, CA.
Kotler, P., Zaltman, G., 1971. Social marketing: an approach to planned social change. J. Mark. 85, 3–12.
Lee, N.R., Kotler, P., 2011. Social Marketing: Influencing Behaviors for Good. Sage.
Levi, M., 1989. Of Rule and Revenue. University of California Press, Berkeley, CA.
Levi, M., 1997. Consent, Dissent, and Patriotism. The Press Syndicate of the University of Cambridge, Cambridge, United Kingdom.
Lindenberg, S., Steg, L., 2007. Normative, gain and hedonic goal frames guiding environmental behavior. J. Soc. Issues 63, 117–137.
May, P.J., 2005. Compliance motivations: perspectives of farmers, homebuilders, and marine facilities. Law Policy 27, 317–347.
McGraw, K.M., Scholz, J.T., 1991. Appeals to civic virtue versus attention to self-interest: effects on tax compliance. Law Soc. Rev. 25, 471–498.
McKenzie-Mohr, D., 2000. Promoting sustainable behavior: an introduction to community-based social marketing. J. Soc. Issues 56, 543–554.
McKenzie-Mohr, D., 2011. Fostering Sustainable Behavior: an Introduction to Community-based Social Marketing, third ed. New Society Publishers, Gabriola Island, BC Canada.
Monroe, M.C., 2003. Two avenues for encouraging conservation behaviors. Hum. Ecol. Rev. 10, 113–125.
Murray, K.A., Rosauer, D., McCallum, H., Skerratt, L.F., 2010. Integrating species traits with extrinsic threats: closing the gap between predicting and preventing species declines. Proc. Royal Soc. B: Biol. Sci. 278, 1515–1523.
Olden, J.D., Lawler, J.J., Poff, N.L., 2008. Machine learning methods without tears: a primer for ecologists. Q. Rev. Biol. 83, 171–193.
Peters, J., Baets, B.D., Verhoest, N.E.C., Samson, R., Degroeve, S., Becker, P.D., Huybrechts, W., 2007. Random forests as a tool for ecohydrological distribution modelling. Ecol. Model. 207, 304–318.
Peterson, K., Diss-Torrance, A., 2012. Motivation for compliance with environmental regulations related to forest health. J. Environ. Manag. 112, 104–119.
Pomeroy, R.S., Pollnac, R.B., Katon, B.M., Predo, C.D., 1997. Evaluating factors contributing to the success of community-based coastal resource management: the Central Visayas Regional Project-1, Philippines. Ocean. Coast. Manag. 36, 97–120.
Prasad, A.M., Iverson, L.R., Liaw, A., 2006. Newer classification and regression tree techniques: bagging and random forests for ecological prediction. Ecosystems 9, 181–199.
Rehfeldt, G.E., Ferguson, D.E., Crookston, N.L., 2009. Aspen, climate, and sudden decline in western USA. For. Ecol. Manag. 258, 2353–2364.
Scholz, J.T., Lubell, M., 1998. Trust and taxpaying: testing the heuristic approach to collective action. Am. J. Pol. Sci. 42, 398–417.
Scholz, J.T., Pinney, N., 1995. Duty, fear, and tax compliance: the heuristic basis of citizenship behavior. Am. J. Pol. Sci. 39, 490–512.
Schultz, P.W., Nolan, J.M., Cialdini, R.B., Goldstein, N.J., Griskevicius, V., 2007. The constructive, destructive, and reconstructive power of social norms. Psychol. Sci. 18, 429–434.
Schwartz, S.H., 1977. Normative influences on altruism. In: Berkowitz, Leonard (Ed.), Advances in Experimental Social Psychology. Academic Press, New York, pp. 221–279.
Schwartz, S.H., Howard, J.A., 1980. Explanations of the moderating effect of responsibility denial on the personal norm-behavior relationship. Soc. Psychol. Q. 43, 441–446.
Steg, L., 2005. Car use: lust and must. Instrumental, symbolic and affective motives for car use. Transp. Res. Part Policy Pract. 39, 147–162.
Stern, P.C., Dietz, T., 1994. The value basis of environmental concern. J. Soc. Issues 50, 65–84.
Stigler, G.J., 1970. The optimum enforcement of laws. J. Pol. Econ. 78, 526–536.
Strobl, C., Boulesteix, A.-L., Kneib, T., Augustin, T., Zeileis, A., 2008. Conditional variable importance for random forests. BMC Bioinforma. 9, 307.
Strobl, C., Malley, J., Tutz, G., 2009. An introduction to recursive partitioning: rationale, application, and characteristics of classification and regression trees, bagging, and random forests. Psychol. Methods 14, 323–348.
The Ad Council, 2013. Smokey Bear – Only You Can Prevent Wildfires [WWW Document]. Smokey Bear – Only You Can Prevent Wildfires. URL. http://www.smokeybear.com/ (accessed 10.11.13).
Tyler, T.R., 2006. Why People Obey the Law. Princeton University Press, Princeton, New Jersey.
USDA Forest Service, 2011. Emerald ash borer [WWW Document]. Emerald ash borer. URL. http://www.emeraldashborer.info/ (accessed 12.16.11).
Winter, S.C., May, P.J., 2001. Motivation for compliance with environmental regulations. J. Pol. Anal. Manag. 20, 675–698.