Private Landowners, Voluntary Conservation Programs, and Implementation of Conservation Friendly Land Management Practices

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Abstract
Private land conservation mechanisms are critical components employed by policy makers and conservation professionals to support the stewardship and protection of vital ecosystem services. While most research on voluntary conservation programs focuses on motives and barriers to participation, little is known about landowner activities and ecological status once property is enrolled in programs. Our mailed survey to landowners with property enrolled in the Indiana Classified Forest and Wildlands Program in U.S.A. revealed that (1) environmental motives, (2) residential motives like family life, and (3) having more land enrolled in the program were strong predictors of individuals who implemented conservation actions such as removal of invasive species and control of erosion. We also found that landowners witnessing environmental improvements on their land reported more conservation actions than those perceiving unchanged environmental conditions. A better understanding of landowner perceptions and conservation outcomes can help policy makers improve private land conservation programs.

Introduction
Undeveloped forests and other natural areas provide a range of vital ecosystem services (Constanza et al. 2006). A significant portion of these forests are privately owned and lay unprotected (Mayer & Tikka 2006). The conservation of forests is critically important as developing nations experience a higher demand for natural resources, which heightens the need for effective conservation approaches to support the sustainable use of private forests (Lambin & Meyfroidt 2011). Thus, evaluation and refinement of conservation mechanisms that engage private landowners is paramount (Drescher 2014).

Voluntary land conservation strategies consist of a variety of mechanisms, including private reserves and conservation easements. It is often assumed that if the benefits to landowners outweigh the costs, they will be more inclined to conserve, sustainably use, and/or manage the resources as stewards. Through an assessment of 39 conservation projects, Sala et al. (2001) found that such assumptions are only true under limited conditions. In a review of 60 U.S. incentive programs across 29 states, Noah & Zhang (2001) found that successful programs were those with diverse funding sources, significant landowner participation, and mechanisms for actively involving landowners in developing management plans.

The existing literature identifies several factors beyond financial incentives that affect forest landowner decision making to adopt conservation practices or to participate in conservation programs, including land tenure and entitlement, residency, values, past management experience, future plans, advice or information received,
as well as various sociodemographic factors (Nagubadi et al. 1996; Kittredge et al. 2003; Ma et al. 2012; Eggers et al. 2014). Research has also found that land use is an influential factor in predicting landowner interest in specific conservation programs and adoption of specific conservation actions (Koontz 2001; Farmer et al. 2015); however, mixed results make this a largely inconclusive arena (Koontz 2001; Cross et al. 2011; Ma et al. 2012).

In 2006, Mayer and Tikka conducted an analysis of voluntary incentive programs for private forestlands in Europe and North America with a focus on forestry programs that explicitly provide economic incentives and that have biodiversity conservation as a primary or secondary goal. They suggested that European programs tended to emphasize forest quality and diversity, while US programs tended to emphasize afforestation and forest quantity, such as Indiana’s Classified Forest and Wildland Program (ICFWP). As Mayer & Tikka (2006) pointed out, Indiana’s forest cover has increased by 12% since the start of the ICFWP, suggesting that the program is successful overall; however, despite having over 301,895 hectares enrolled in the program (3.2% of the total acreage in the state), the total forest cover in the state still remains extremely low in comparison with the state’s historical levels (INDNR 2014) and when compared to afforestation in the neighboring states of Illinois and Ohio. Additionally, there has been little discussion regarding whether or not such a seemingly successful program has contributed to improved ecological conditions and, in particular, biodiversity conservation in the forest ecosystems.

Our study’s contributions include the evaluation of: the connection between land use practices, conservation management strategies, perceived biodiversity conditions, and ecological functioning status data as self-reported by private forest landowners participating in the oldest voluntary statewide tax-incentivized forest and wildland conservation program in the United States. The following research questions guided our methods and analysis:

(1) Is there a relationship between ICFWP landowners’ land use types and their implementation of conservation management strategies?

(2) What is the relationship between landowners’ perceived biodiversity and ecological functioning of their land and their implementation of conservation management strategies?

Methods

Today, Indiana’s land cover is dominated by herbaceous species and nonwoody vegetation such as lawns, crop-land, and pasture (Figure 1). Forests cover 19% of the state. Indiana was 85%–93% forested pre European settlement (early 19th Century), falling to 6% by 1920 (Nelson 1998). The ICFWP (1921) sought to encourage proper timber management by incentivizing participation...
through property tax reductions that assessed land values at $1/acre (State of Indiana n.d.). Lands qualified for the program are those that total at least 4.04 hectares of forest, wetland, shrubland, and/or grassland, and must be left in a “natural” state. Landowners must develop a written land management plan with a state district forester (or a wildlife biologist or professional forester), file annual reports, and allow monitoring of the property by a district forester at least once every seven years. The management plan must include a description of the land, landowner goals, and a prescription for how goals will be achieved over a 10 year period (INDNR 2014).

A sample of 500 (out of 9,000 + ) names and addresses of ICFWP participants was acquired from the Indiana Division of Forestry. Participants were stratified based on year of enrollment, including two specific time blocks, 1/1/1980-12/31/1999 (N = 150) and 1/1/2000-11/20/2013 (N = 350) in order to focus the study on recent enrollees while not negating those who enrolled in previous decades. The survey was administered on the basis of a 3-step modified Dillman’s Total Design Method (Dillman et al. 2009), which included the provisioning of a $2 bill incentive. The survey was sent to 500 potential participants in 2014, with 68 returned for insufficient addresses.

Section 1 of the instrument solicited data on participation in the ICFWP and property attributes, such as year of enrollment, property classification, and land owned and enrolled. Section 2 focused on land stewardship, landscape features, and conservation management practices adopted. The final section solicited demographic details.

The survey data were analyzed in multiple phases. First, descriptive statistics were used to calculate means and proportions for demographic variables, land characteristics, the implementation of conservation management strategies, biodiversity level, and ecosystem functioning status (Table 1). The implementation of conservation management was measured based on a Likert-type scale including ten different conservation management strategies and their level of implementation (completed = 4, underway = 3, planned = 2, not planned = 1, or not applicable = 1; Supporting Information Appendix A—Part B, question 3). Varimax rotation was used and factor loadings greater than 0.300 are listed in Table 2. Composite scores were created by taking the mean of the items with the strongest factor loadings on each factor which emerged (for example, “for privacy” is included in the third component (0.556) but not the first (0.431)). The first component describes the importance landowners attach to the environment and enjoyment; the second component includes investments, farming, and hunting; and the third component describes a personal residence and family life. Cronbach’s alpha values were calculated to assess the reliability of each of the three scales. Subsequently, scatterplots were performed and Pearson correlations were calculated to assess landowner management practices based on the importance attached to each land use type. To further identify factors influencing landowner implementation of conservation management strategies, we used multiple linear regression model to explain variation in the level of implementation by the importance of each land use type, the hectares of

| Table 1 Participant responses to the implementation of conservation management strategies, biodiversity status, and ecological functioning |
|---------------------------------------------------------------|
| Cons. mgmt. strategies | Completed | Underway | Planned | Planned |
| Invasive species work | 13.6% | 55.0% | 17.1% | 14.3% |
| Planting of native species | 22.9% | 20.7% | 13.2% | 43.2% |
| Prescribed burns | 6.8% | 6.1% | 5.0% | 82.1% |
| Removal of unhealthy trees | 11.4% | 38.6% | 20.4% | 29.6% |
| Removal of unsafe trees | 8.6% | 33.6% | 15.7% | 42.1% |
| Habitat improvement | 12.1% | 49.3% | 18.2% | 20.4% |
| Groundwater protection | 11.8% | 18.2% | 11.1% | 58.9% |
| Erosion control | 13.9% | 26.8% | 10.7% | 48.6% |
| Environmental monitoring | 3.9% | 29.6% | 15.0% | 51.4% |
| Allowing succession | 10.4% | 47.1% | 17.9% | 24.6% |
| Mean | 12.1% | 33.9% | 15.4% | 38.6% |

Biodiversity status

| Factor | Poor | Fair | Good | Outstanding |
|--------|------|-----|------|-------------|
| %      | 0    | 13.7% | 65.2% | 21.2% |

Ecological functioning

| Factor | Improving | Remaining the same | Declining |
|--------|-----------|--------------------|----------|
| %      | 47.8%     | 51.4%              | <1%      |
Table 2 Factor loadings from exploratory factor analysis of the importance of each reason for owning the land enrolled in the ICFWP

| Reason for owning the land enrolled in the ICFWP | Environmental (alpha = 0.769) | Financial (alpha = 0.671) | Residential (alpha = 0.665) |
|-------------------------------------------------|-----------------------------|--------------------------|---------------------------|
| To enjoy beauty or scenery                       | 0.738                       |                          |                           |
| To protect nature or biological diversity       | 0.805                       |                          |                           |
| To protect water resources                      | 0.649                       |                          |                           |
| To protect or improve wildlife habitat          | 0.840                       |                          |                           |
| For land investment                              |                            | 0.570                    |                           |
| It is part of my primary residence land         | −0.320                      | 0.767                    |                           |
| Is part of my cabin or vacation home site       | 0.375                       |                          |                           |
| Is part of my working farm or ranch             |                            | 0.478                    | 0.323                     |
| For privacy                                     | 0.431                       |                          | 0.556                     |
| To raise my family                              |                            |                          | 0.701                     |
| To pass land on to my heirs                     |                            | 0.550                    |                           |
| For firewood                                     | 0.309                       |                          | 0.539                     |
| For timber products, such as logs/pulpwood      |                            | 0.752                    |                           |
| For nontimber products, such as nuts/syrup     | 0.345                       |                          | 0.455                     |
| For hunting                                      |                            | 0.679                    |                           |
| For recreation, other than hunting              |                            | 0.562                    | 0.382                     |

Land enrolled in the program, total hectares owned, as well as several demographic variables (sex, age, education, and employment) that were previously identified as potential factors influencing landowner decision making.

To address research question 2 about the relationship between landowners’ perceived biodiversity level (Part B question 1 - biodiversity quality: poor, fair, good, or outstanding) and ecological functioning (Part B question 2 - biodiversity status: declining, remain the same, or improving) of their property and their implementation of conservation management strategies, we used an analysis of variance (ANOVA) to describe the variation in conservation management based on landowners’ three groups of perceived biodiversity quality and three groups of perceived ecological functioning status.

**Results**

A total of 308 out of 432 potential participants responded to the survey, of which 280 questionnaires were deemed usable (65% response rate). Of the 280 respondents, 82% were male, the average age was 63 years, 100% were white, and 43% were employed full time. Fifty percent of our respondents had at least a bachelor’s degree, and the majority (76%) of respondents indicated a household income level above $50,000 in 2013 (28% had a household income above $100,000). The median total land area owned was 34.80 hectares and median land area enrolled in the program was 17.40 hectares. Eighty-nine percent of respondents themselves enrolled their land in the ICFWP. Few landowners had fully completed the various conservation management activities that we collected data on (only 12.1%); however, 49.3% reported that activities were currently “under way” or that they had plans to start the activities. Table 1 provides a detailed description of the conservation management strategies, the implementation status based on the proportion of survey respondents, and descriptive statistics for the perception of biodiversity status and ecological functioning level.

Our first research question focuses on the relationship between ICFWP landowners’ land use types and their implementation of conservation management strategies. We hypothesized that individuals using their enrolled land to protect the environment and support ecosystem services would be more likely to be engaged in or have completed conservation management strategies than those using their land predominantly for financial gain or residential life. This hypothesis was confirmed by our results.

The Cronbach’s alpha reliability scores of these scales was 0.780 for the conservation management scale, and 0.769, 0.671, and 0.665 for the environmental, recreational, and residential land use scales, respectively, meaning the items in each scale were highly related to each other. Figure 2 shows a positive relationship between the importance of each land use type and the implementation of conservation management strategies. The Pearson correlation coefficients attributed to environmental, financial, and residential land uses and the level of implementation were 0.29 ($P < 0.001$), 0.20 ($P = 0.001$) and 0.26 ($P < 0.001$), respectively.
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Multiple linear regressions were performed on the implementation level of conservation management strategies based on the importance of the three types of land use, with covariates for land size, land size in the ICFWP, sex, age, employment, income, and education. However, income was removed from the model due to large amounts of missing data (15%). Results (Table 3) show that landowners who highly rate the importance of environmental land use had higher levels of implementation of conservation management strategies on their property ($P = 0.007$), while residential land use was also positively related ($P = 0.036$). Land owners who highly rated financial motivations were not as correlated with the implementation of management strategies after accounting for environmental and residential motivations in the model. Landowners who had more land enrolled in the program had completed more conservation management strategies as well ($P = 0.003$), but this was not

Table 3 Results of linear regression on implementation of conservation management strategies ($n = 257$)

| Variable                                      | Coefficient | Std. Err. | P-value |
|-----------------------------------------------|-------------|-----------|---------|
| Intercept                                     | 1.40        | 0.37      | <0.001  |
| Environmental land use                        | 0.15        | 0.06      | 0.007   |
| Financial land use                            | 0.04        | 0.04      | 0.373   |
| Residential land use                          | 0.09        | 0.04      | 0.036   |
| Hectares enrolled in ICFWP (log)              | 0.37        | 0.12      | 0.003   |
| Total hectares (log)                          | −0.12       | 0.11      | 0.270   |
| Female (vs. male)                             | −0.15       | 0.10      | 0.147   |
| Age                                           | −0.01       | 0.01      | 0.015   |
| Education: less than HS (vs. Grad Degr)       | −0.15       | 0.24      | 0.545   |
| Education: HS or GED (vs. Grad Degr)          | 0.11        | 0.11      | 0.314   |
| Education: some college (vs. Grad Degr)       | −0.01       | 0.09      | 0.936   |
| Education: bachelor’s (vs. Grad Degr)         | 0.01        | 0.10      | 0.941   |
| Employment: full-time (vs. other)             | −0.14       | 0.14      | 0.300   |
| Employment: retirement (vs. other)            | 0.07        | 0.14      | 0.628   |
necessarily true of those who owned more land overall. In terms of demographic characteristics of landowners, older landowners were less likely to have implemented conservation management strategies than younger landowners ($P = 0.015$). Education, employment, and sex did not appear to have any significant effect on landowner implementation of conservation management strategies.

Finally, our second research question focuses on the relationship between landowners’ perceived biodiversity and ecological functioning of their land and their implementation of conservation management strategies. We hypothesized that those ranking the biodiversity status of their land higher would be more likely to engage in conservation management strategies. Our results support this assumption as Figure 3 suggests differences in (1) landowners’ engagement in conservation management strategies across the different levels of perceived biodiversity on their property (left), and (2) landowners’ engagement in conservation management strategies across the different levels of perceived ecological functioning of their property. The ANOVA confirmed such observations with significant differences between the levels of perceived biodiversity (Fair, Good, Outstanding) ($F_{2,275} = 14.74$, $P < 0.001$), as well as between the three levels of perceived ecological functioning of their land ($F_{2,269} = 12.56$, $P < 0.001$). Landowners who reported “Outstanding” biodiversity had implemented significantly more conservation management strategies (on average $M = 2.49$), than those who reported “Good” ($M = 2.06$, post-hoc Sidak $P < 0.001$) or “Fair” biodiversity ($M = 1.98$, post-hoc Sidak $P < 0.001$). None of the participants reported “Poor” biodiversity. Additionally, landowners who perceived “improving” ecological functioning over time reported significantly more implementation of conservation management strategies ($M = 2.33$) than those who perceived the ecological functioning of their land as “remaining about the same” ($M = 1.99$, Sidak $P < 0.001$). There were only two participants who reported ecological functioning as “declining” ($M = 2.15$) and therefore did not show significant differences from the other two groups.

**Discussion**

As stated by Selinske *et al.* (2015), most private land conservation studies focus on either recruitment or, to a lesser extent, retention. An important subject, and one which is absent from the literature, is what happens on private-conserved lands after enrollment. Our quantitative analysis showed that while the various land use motives (environmental, financial, and residential) were significantly correlated with the implementation of conservation management strategies, the amount of land enrolled in the program was linked to a greater quantity of strategy implementation. Strong correlations also exist between perceptions of biodiversity and ecological functioning with the implementation strategies.

The first finding is not surprising, having been consistently documented throughout the literature (Zorondo-Rodríguez *et al.* 2014). What is more interesting to consider and has policy implications is that as landowners’ motives for the land were stronger, they were more likely to care for the land as adopters of conservation management strategies (Drescher 2014). A second point of importance concerns the result that when respondents’ land use was dominated by “financial” motives, their likelihood of implementing conservation management strategies was lower. Policy considerations that alter such behavior and support action are thus warranted. One innovative approach would be to use performance payments as a portion of the financial incentive for program enrollees as opposed to offering all the financial incentives upon enrollment (Iles & Marsh 2012). Performance payments as a concept is not new; however, it is absent from the discussion on private forest conservation. According to Cox (2007), performance payments are an effective means for encouraging “management-intensive, knowledge-based conservation systems” (133–136). Given the time lapse necessary to see change in forests, some performance payments could focus on short-term outcomes (eradication of certain invasive species or successful establishment of native systems for example), while some might be reserved for the performance of long-term strategies (implementation of specific strategies- soil runoff).

Second, having more land enrolled in the ICFWP was found to be a significant predictor for the implementation of conservation management strategies. This result converges with those of Eggers *et al.* (2014) and Hatcher *et al.* (2013), who found forest management activities to be more relevant to owners of larger forests with size of land holdings determining the implementation of greater forest management activities. Since large, continuous plots of forest tend to be more economically viable, provide more ecosystem services, and support more wildlife habitat than smaller, fragmented plots, it is valuable to find that landowners who enrolled more land in the ICFWP demonstrated a higher level of commitment to implementing conservation management strategies. Additionally, this presents policy and extension-education opportunities to develop better strategies for engaging landholders with smaller acreage, an often-overlooked need (Greene *et al.* 2004). Greene *et al.* highlight this issue, finding that South Carolinian nonindustrial forest owners’ knowledge about existing programs ranged from
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Figure 3 Box-plots for the relationship between landowner perceived biodiversity (left) and ecological functioning (right) of their property and their engagement in conservation management strategies (mean across 10 activities: 1 = not planned, 2 = planned, 3 = underway, 4 = completed.) The top and bottom of each box indicate the data values at the 25th and 75th percentile, with a horizontal line at the 50th percentile (median), and whiskers extending from the box show the data within 1.5 times the interquartile range (Tukey 1977) with individual data points beyond the whiskers indicating potential outliers in the tail of the distribution.

50% to 80%, depending on the program. Peer to peer education has also emerged in recent years as a critical communication strategy for improving program participation (Schubert & Mayer 2012). Specifically considering educational approaches that capitalize on existing community networks (Hofferth & Iceland 1998; Schubert & Mayer 2012) while considering social norms of an area’s culture (Pretty & Smith 2004) can be vital for achieving desired conservation outcomes and for reaching rural populations.

Finally, landowners’ perceptions of biodiversity and ecological functioning of their property were found to relate to the reported implementation of conservation management strategies. In other words, in the eyes of the landowners, their conservation management strategies are paying off and the implementation of management strategies is improving the biodiversity and the functioning of the ecology on their land. The implication of this finding is that state and district foresters can utilize their knowledge and expertise for education purposes, to communicate with landowners about the biodiversity status and ecological functioning of the land as a way to prompt landowner implementation of various types of stewardship activities. While we cannot control for biased responses or show causation or direction between perceived biodiversity status, ecological system functioning, and willingness to take conservation actions, our results do suggest a need for this type of communication between forestry professionals and landowners and for the systematic testing of this outcome through controlled experiments and on-site social-ecological case studies.

Our results are useful to researchers, policy makers, and professionals seeking to better understand, develop, and refine private land conservation programs. This study moves discussion beyond the motives driving program participation discourse into the realm of outcomes and landowner perception of ecological functioning and biodiversity. For policy makers and professionals, the results highlight the relationship between the land use type and the implementation of additional conservation management strategies amongst private landowners. This result may also be applicable to other government led private land conservation programs, such as those in Wisconsin, Ontario, and New Zealand, where contemporary thought positions private land conservation programs within a mixed land-use framework, as opposed to solely a preservationist approach (Norton 2000). Finally, this study provides a direction for future scholarship combining survey data and previously missing ecological data to enhance assessments that will allow professionals to better understand landowners’ perception of biological change and ecological functioning.
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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher’s web site:

**Appendix A**

**Table S1.** Frameworks considered for the analysis of unintended feedbacks in conservation

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