

# EFFECTIVENESS OF THE FOREST STEWARDSHIP PROGRAM IN CONSERVING NATURAL RESOURCES ON PRIVATE LANDS IN INDIANA

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**Abstract.**—Forest ecosystems are a dominant component of the nation's landscape but are a challenge to manage because of diverse ownership and policy objectives. Privately owned, nonindustrial lands comprise nearly half of all forests in the United States (42 percent); nearly 10.3 million citizens own 393 million acres. A number of landowner assistance programs are designed to help conserve natural resources on private lands in the United States. However, little research has been done that evaluates the impact of these programs on the conservation of natural resources on private lands. In this study we focused on the Forest Stewardship Program, which is termed the Classified Forest Program (CFP) in Indiana. Through a spatial analysis, we assessed: (1) the effectiveness of the CFP in addressing high-priority lands; (2) how the distribution of high-priority land varies by land enrolled in the CFP and private forest lands not enrolled in the program; and (3) the effectiveness of the CFP in conserving threatened and endangered wildlife habitat, riparian corridors, and contiguous patches of forest land. We found significant differences between conserved resources on private lands enrolled in the CFP, and private lands outside the program, which shows the significant impact of the Forest Stewardship Program on conserving natural resources in Indiana.

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## INTRODUCTION

With 42 percent of the forest land (393 million acres) in the contiguous United States owned by 10.3 million family forest owners, (Butler and others 2004), these owners have a tremendous impact on the environmental and biological quality of forest land in the United States. In Indiana, private forest owners are the dominant ownership regime with only 14.9 percent of the entire state area is in public ownership (federal and state). According to latest statewide available data, 20.4 percent of the land in Indiana is forested (MRLC Consortium 2001), of which private forest lands comprise 75.1 percent. Private forest land management is impacted by the fragmentation of parcels, ownerships, and forests (Sampson and DeCoster 2000). Increasingly greater numbers of forest landowners, who in turn own smaller parcels, exacerbate the difficulty of retaining the cohesive landscapes necessary for sustaining biological diversity and ecosystem health (Plantinga and others 2007). The government uses many policy instruments to address the issue of conserving forest lands in the United States. However, little research has been done that evaluates the impact of landowner assistance programs on the conservation of natural resources on private lands.

## OBJECTIVES

In this study we looked at the Forest Stewardship Program in Indiana, where it is called the Classified Forest Program. We assessed the following: (1) the effectiveness of the CFP in addressing high priority lands; (2) how the distribution of high-priority land varies by land enrolled in the CFP versus private forest lands not enrolled in the program; and (3) the effectiveness of the CFP in conserving threatened and endangered wildlife habitat, riparian corridors, and contiguous patches of forest land.

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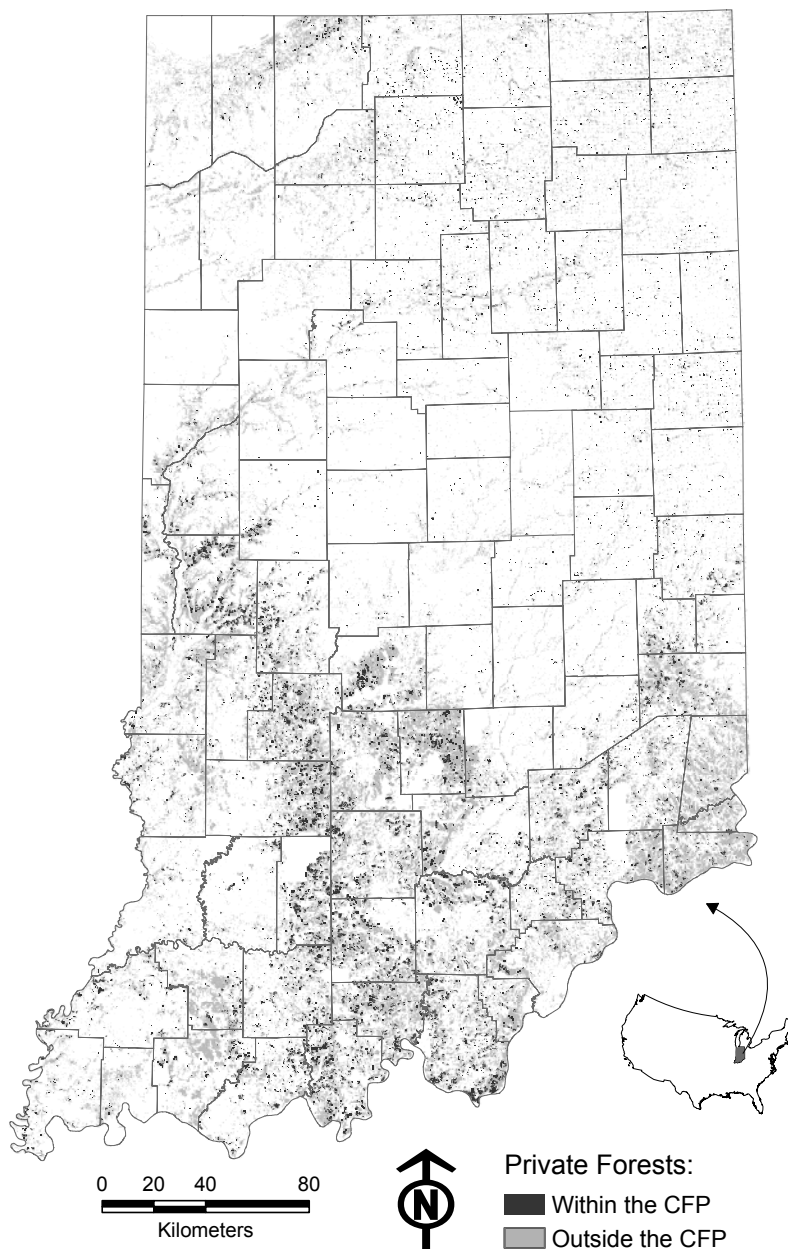


Figure 1.—Privately owned forests in Indiana within the Classified Forest Program (CFP) and outside the CFP.

## METHODS

Our study encompassed all privately owned forest land in the state of Indiana (Fig. 1). All publicly owned lands were masked out of the analysis. This study used data that originated from two projects. Private forests were digitized within the Forest Stewardship Program Classified Forest (CFP) database project. The Spatial Analysis Projects (SAP, described fully in later section) provided us with an aggregated layer of Forest Stewardship potential for the evaluation of natural resources within private forests.

### Forest Stewardship Plans Geodatabase

Indiana's CFP is specifically designed to help keep Indiana's private forests intact. Eligibility for this voluntary landowner incentive program is based on land tracts being a continuous forested area of 4

hectares or more that support a growth of native or planted trees and that have been set aside for the production of timber and wildlife, the protection of watersheds, or the control of soil erosion (Indiana Dept. of Nat. Res. 2007). Both native timber land and land planted to an acceptable species of trees are eligible for classification. Eligible woodlands may be either native forests containing at least 9.2 m<sup>2</sup> of basal area per hectare or at least 2,470 timber-producing trees (any size) per hectare. Tree plantations with at least 300 well established timber-producing trees are also eligible to be a Classified Forest. Certain activities cannot take place on Classified Forest lands: grazing by domestic livestock; building of houses, sheds, etc.; intentional burning unless prescribed under a written management plan; and growing Christmas trees. In return for meeting program guidelines, landowners receive property tax breaks, forestry literature, and periodic free inspections by a professional forester while the forest is enrolled in the program.

Copies of legal descriptions, surveys, and maps of the Classified Forest properties enrolled in the program in 2005 were collected from Division of Forestry, Indiana Department of Natural Resources (IDNR) offices, scanned, and then entered into a Geographic Information Systems (GIS) database using UCLID's IcoMap (4.0 Extracts Systems, LLC, Madison, WI 2006), an add-on program for ESRI's ArcGIS 9.1 (Environmental Systems Research Institute, Redlands, CA 2006). At the time of the data entry a color 1-m resolution set of aerial photographs from the summer 2005 (Indiana Geograph. Infor. Counc. 2005) was loaded to serve as a secondary check to ensure that parcels were being digitized in their correct location. All digitized polygons representing Classified Forest properties within the study area were linked to a landowner Microsoft Access database supplied by the IDNR Division of Forestry. The following database attributes were joined to the GIS layer: name of the owner, surveyed area, and type of enrollment (new property, addition, changed ownership, withdrawal). Each parcel was assigned a unique ID number. We defined a parcel as the total forest area enrolled in one plan for a given landowner. Parcels having multiple polygons of forest were referred to as having tracts, and are lettered A, B, C, etc. within a given parcel ID.

### **Spatial Analysis Project Layers**

In 2004, the U.S. Forest Service initiated the Spatial Analysis Project, a pilot program to develop and test a consistent methodology to locate stewardship parcels, to assess the impact of the Forest Stewardship Program across the landscape, and to use the collected data analyses to make further improvements, if necessary, in the Forest Stewardship Program (U.S. Forest Service 2007a). Four states participated in the pilot program (Connecticut, Maryland, Massachusetts and Missouri). After the pilot phase of the SAP, Purdue University and the IDNR received funding in 2004 to digitize stewardship parcels and apply the SAP methodology (U.S. Forest Service 2007b). The purpose of the Spatial Analysis Project is to create an aggregated data layer for a state that represents levels of potential benefit from -- or suitability for inclusion in -- the Forest Stewardship Program as delivered by state forestry agencies and the U.S. Forest Service. The goal of the SAP was to spatially assess and analyze the status and distribution of existing Forest Stewardship plans and their proximity to important forest lands, thus enabling forest managers to better capture and articulate Forest Stewardship Program impact to date.

Private land program and GIS staff from the four states involved in the pilot SAP effort, along with Forest Service program and GIS staff, identified 12 factors which help quantify the "Stewardship potential" of a given piece of land and which were available as GIS data layers. The factors were differentiated into two groups: resource potential and resource threats. The resource potential factors are as follows: riparian zones, priority watersheds, forest patch size, natural heritage data, public drinking water supply sources, private forest lands, proximity to public lands, wetlands, and topographic slope. The resource threat factors

**Table 1.—Weighting of 12 data layers for the Spatial Analysis Project in Indiana**

| Data layer                   | Number of votes | Weighting (%) | Weighting applied |
|------------------------------|-----------------|---------------|-------------------|
| Fire risk                    | 6               | 0.78          | 0.007             |
| Impaired watersheds          | 44              | 5.74          | 0.057             |
| Slope                        | 48              | 6.27          | 0.062             |
| Natural Heritage Data        | 50              | 6.53          | 0.065             |
| Wetlands                     | 52              | 6.79          | 0.067             |
| Public water supply          | 55              | 7.18          | 0.071             |
| Proximity to public lands    | 56              | 7.31          | 0.073             |
| Forest health (pests)        | 67              | 8.75          | 0.087             |
| Risk of development          | 69              | 9.01          | 0.090             |
| Unfragmented forest (>20 ha) | 96              | 12.53         | 0.125             |
| Riparian corridors           | 98              | 12.79         | 0.128             |
| Private forests              | 125             | 16.32         | 0.163             |
| Total                        | 766             | 100.00        | 1.000             |

consisted of forest health, development level, and wildfire assessment. Certain lands such as water bodies, completely urbanized areas, and public lands were not eligible for inclusion in the Forest Stewardship Program and were excluded from analysis.

In assessing the resource threat of development, we adopted an approach developed by the North Central Research Station, Forest Inventory and Analysis Program. This approach uses housing density as a proxy for identifying areas of economically viable timber production. This group's analysis includes a national map of housing density for 2000 and estimated housing density for 2030, thus giving us a glimpse of where urbanization will compete for agricultural and forested lands (Stein and others 2005). Using data from Stein and others (2005), we coded housing density for 2000 and 2030 into one of three possible categories: 0 to 16 housing units per square mile, 17 to 64 housing units per square mile, and more than 64 housing units per square mile. Commercial tree production is most viable in cells with a housing density of 0 to 16 housing units per square mile. These areas are the least threatened and therefore of lower immediate priority than lands transitioning to the moderate housing density. Nonetheless, these low-density areas should be considered appropriate and priority targets for stewardship. Commercial tree production and harvesting is problematic when housing density is 16 to 64 units per square mile. Housing densities above 64 units per square mile reflect highly urbanized areas. Remaining patches of trees are too small and the logistics of harvesting make commercial timber activities generally infeasible.

Once the 12 common factors were identified, each state examined these 12 factors and determined the relative importance of each based on state-specific conditions. The Indiana Forest Stewardship Committee and employees of the IDNR Division of Forestry Cooperative Forest Management Section each went through a focus group session by which they prioritized the above 12 factors. Each participant was allocated a total of 25 votes with a maximum of five votes per data layer; participants could choose not to allocate votes to a data layer. The weightings for each of the 12 factors were then averaged across the two rounds of voting to yield our final weighting scheme (Table 1).

The 12 factors were then combined in a GIS overlay analysis which took into account the weight for each factor. The final product was a single data layer which represents the suitability of the land for inclusion in

the Forest Stewardship Program. Values from this analysis range from 0 to 1, with a value of 1 representing the highest level of suitability. To make interpretation of results easier and to allow for computation of area statistics, the continuous cell values were categorized into three classes based on natural break classification (Jenks 1963): (1) low: 0-0.093; (2) medium: 0.094-0.308; and (3) high: 0.309-1.000.

To assess the effectiveness of the Forest Stewardship Program, we overlaid parcel polygons on the stewardship potential layer that identifies low, medium, and highly suitable lands and tested the following hypotheses:

1. The CFP is successful in conserving forest resources with high forest stewardship potential.
2. A significantly greater proportion of CFP lands is of high forest stewardship potential compared to private forest lands not enrolled in the program and public lands.

For hypotheses (1) and (2) Chi-square test was used to determine whether: (1) three categories are significantly different for the lands within CFP; (2) the area distribution among three categories within the land enrolled in the CFP is significantly different from the area distribution among three categories outside the CFP.

To evaluate effectiveness in conserving valuable natural resources, we overlaid CFP parcel polygons on the GIS data layers that are of high conservation priority: riparian corridor buffers, contiguous forest patches, and habitats of threatened and endangered species. Each layer is represented by raster layer with 30-m pixel size. The riparian corridor buffers layer has a 100-m buffer around perennial streams and river features. The original vector data was obtained at a scale of 1:100,000 from U.S. Geological Survey (USGS) (U.S. Geol. Survey 2001,) buffered at 100-m distance from streams, and converted into 30-m grid cells. The threatened and endangered forest species habitat layer was created from mapped data on forest-dwelling endangered species sightings (plants and animals) in Indiana (provided by IDNR) buffered by 0.8 km. The contiguous forest patch layer includes forested areas greater than or equal to 20 ha of forest. The raster database of forest originated from National Land Cover Dataset of 1992 and was obtained from USGS (MRLC Consortium 2001). Forests were removed within 30-m buffer areas around federal and state roads to account for fragmentation of forest cover caused by roads, and forest patches at least 50 acres in size were identified. Lastly, we calculated area statistics for each resource for the areas within CFP and tested the following hypotheses:

1. The CFP is successful in conserving forests within riparian corridors as compared to non-CFP lands.
2. The CFP is successful in conserving forests with threatened and endangered species habitat as compared to non-CFP lands.
3. The CFP is successful in conserving contiguous patches of forest land as compared to non-CFP lands.

## RESULTS

As of 2005, 9,440 parcels (12,180 tracts) that were owned by 7,420 unique owners were enrolled in CFP in Indiana. The average size of parcel was 26.48 ha with a standard deviation of 38.7 ha and standard error of 0.35 ha. The smallest parcel was 0.97 ha and the largest was 603 ha. The total area of parcels enrolled in CFP and digitized was 197,345 ha, which is 2.1 percent of the entire state and 10.3 percent of the total forested land in Indiana. Our first task was to determine if there is a difference in SAP identified categories

**Table 2.—Proportion of three Forest Stewardship potential categories within the private lands enrolled in Classified Forest Program (CFP) in Indiana**

| Forest Stewardship potential category  | Hectares                                                          | %     |
|----------------------------------------|-------------------------------------------------------------------|-------|
| Private lands, enrolled in CFP program |                                                                   |       |
| Low                                    | 18,535                                                            | 9.4   |
| Medium                                 | 49,354                                                            | 25.0  |
| High                                   | 129,281                                                           | 65.6  |
| Total                                  | 197,345                                                           | 100.0 |
| Chi-square statistics                  | $\chi^2 = 50.43$ ; $\chi^2_{.0001} = 18.42$ ; $df=2$ ; $p<0.0001$ |       |

**Table 3.—Distribution of three Forest Stewardship potential categories within the private forest area enrolled in the Classified Forest Program (CFP), outside the program, and within the entire state of Indiana**

| Forest Stewardship potential category                                           | Private forests enrolled in CFP, ha (%) | Private forests not enrolled in CFP, ha (%)                 | Private forests of the entire state, ha (%) |
|---------------------------------------------------------------------------------|-----------------------------------------|-------------------------------------------------------------|---------------------------------------------|
| -----Hectares -----                                                             |                                         |                                                             |                                             |
| Low                                                                             | 136 (0.1)                               | 5,409 (0.4)                                                 | 5,745 (0.3)                                 |
| Medium                                                                          | 37,156 (22.6)                           | 536,428 (36.7)                                              | 622,953 (32.6)                              |
| High                                                                            | 126,909 (77.3)                          | 920,552 (62.9)                                              | 1,282,562 (67.1)                            |
| Total                                                                           | 164,201 (100.0)                         | 1,462,389 (100.0)                                           | 1,911,260 (100.0)                           |
| Chi-square statistics                                                           |                                         |                                                             |                                             |
| Chi-square statistics for private forests enrolled in CF and not enrolled in CF |                                         | $\chi^2 = 8.87$ ; $\chi^2_{.05} = 5.99$ ; $df=2$ ; $p<0.05$ |                                             |

of valuable lands within CFP-enrolled properties. The distribution of area was the following: 65.6 percent of CFP enrolled lands were in the highly suitable category, 25.0 percent were in the medium category and 9.4 percent were in low suitability category (Table 2). The  $\chi^2$  test showed a significant ( $p<0.0001$ ,  $df=2$ ) difference of existing distribution from the hypothesized (when nontargeted by the program) distribution of SAP categories. This finding supports our hypothesis that CFP is effectively targeting lands that are estimated as highly valuable by the SAP project.

Results of the comparison between private forest lands within the CFP to private forest lands not enrolled in the program, and to private forest lands of the entire state, show that enrolled areas have a higher proportion of valuable lands (77.3 versus 62.9 and 67.1 percent respectively, Table 3). The conducted  $\chi^2$  square test ( $p<0.05$ ,  $df=2$ ) rejected the null hypothesis that distribution of categories among the above-named areas is equal and supports an alternative hypothesis of the selective nature of CFP (Table 3).

CFP-enrolled lands have 10.2 percent of their area located within riparian corridors (Table 4). Private lands outside the program have 14.2 percent of their forested area within riparian corridors, which is similar to the entire state (13.4 percent). The proportion of contiguous forested area shows that 92.9 percent of the CFP-enrolled lands are located within unfragmented forests, while the proportion on private lands outside the CFP is much lower (69.8 percent, table 4). The proportion of threatened and endangered species of forest habitats area within the CFP is 14.3 percent while the proportion for the lands outside the CFP is somewhat lower (9.7 percent, Table 4).

**Table 4.—Proportions of selected natural resources within forest areas of different ownership status in Indiana**

| Enrollment status of private forests                 | Total area of resource, ha (%) | Total forested area, ha (%) | Proportion from the entire state private forests, % |
|------------------------------------------------------|--------------------------------|-----------------------------|-----------------------------------------------------|
| Forested riparian corridor area                      |                                |                             |                                                     |
| Enrolled in CFP                                      | 16,701 (10.2)                  | 164,201 (100)               | 41.7                                                |
| Not enrolled in CFP                                  | 207,737 (14.2)                 | 1,462,389 (100)             | 58.3                                                |
| Entire state                                         | 255,839 (13.4)                 | 1,911,260 (100)             | 100.0                                               |
| Contiguous forest (>20 ha)                           |                                |                             |                                                     |
| Enrolled in CFP                                      | 152,565 (92.9)                 | 164,201 (100)               | 57.1                                                |
| Not enrolled in CFP                                  | 1,021,347 (69.8)               | 1,462,389 (100)             | 42.9                                                |
| Entire state                                         | 1,449,015 (75.8)               | 1,911,260 (100)             | 100.0                                               |
| Threatened and endangered species of forest habitats |                                |                             |                                                     |
| Enrolled in CFP                                      | 23,429 (14.3)                  | 164,201 (100)               | 59.5                                                |
| Not enrolled in CFP                                  | 142,026 ( 9.7)                 | 1,462,389 (100)             | 40.5                                                |
| Entire state                                         | 272,935 (14.3)                 | 1,911,260 (100)             | 100.0                                               |

## DISCUSSION

One of the shortcomings pointed out by researchers when studying conservation programs is a lack of biological monitoring, namely quantitative monitoring of biological targets, which hampers assessment of conservation programs' effectiveness (Kiesecker and others 2007). At the same time, geospatial technology including remote sensing and GIS is a readily available tool for monitoring and assessment of conservation program conditions (Williams and others 2006). In our study we used available GIS data to determine if the CFP in Indiana addresses areas that are defined by SAP research as highly suitable for natural resources conservation. We found that although prior to 2005 the CFP in Indiana did not target areas specifically selected because of high biological value, 65.6 percent of lands enrolled in the program were of high conservation quality. According to Chi-square analysis of the distribution of stewardship potential categories within CFP, lands within CFP show a difference from random distribution of such categories. In a similar analysis of upland-nesting duck species in North and South Dakota, Reynolds and others (2006) found that 75 percent of Conservation Reserve Program contracts were in medium to high duck population category (19-10 pairs/km<sup>2</sup>) and 25 percent in areas of low populations (less than 10 pairs/km<sup>2</sup>). Comparison of proportions on lands within CFP to proportions outside the program shows significant difference in stewardship potential categories. However, while encompassing a larger proportion of highly suitable lands within the CFP (77.3 percent), the area proportion is not dramatically larger than that outside the program (62.9 percent) or the entire state (67.1 percent), apparently due to the nonselective nature of the program.

The question arises as to what might be defined as effective conservation. Merriam-Webster's Collegiate Thesaurus defines "effectiveness" as the power to produce a desired result (Merriam-Webster 2003). The objectives of the Indiana Classified Forest and Wildlands Act are "to encourage better woodland and wildlife stewardship, and protection of Indiana watersheds"(IDNR 2007). Although this legislation has specific requirements for lands that may be enrolled in the program, it defines only vaguely what resources should be conserved and does not quantify how much of those resources should be retained in order to provide a better stewardship.

In a similar assessment of grassland habitats within the Operation Burrowing Owl program in Canada, authors found burrowing owls on 66 percent of conserved sites, as opposed to 49 percent of random sites. They concluded that the program was effective in conserving habitats (Warnock and Skeel 2004). Our analysis of high-priority lands shows that the difference between proportions of contiguous forest within enrolled and nonenrolled private forests is 23.1 percent. The difference in proportions of riparian corridors is -4.0 percent (minus sign denotes that a smaller percentage was conserved on CFP-enrolled land), and habitats of threatened and endangered species (TES) 4.6 percent. We conclude that the most successfully conserved resource is contiguous forest, followed by TES habitats and riparian corridors.

Our study implies that the Forest Stewardship Program in Indiana has great potential for conserving natural resources on private forest lands of the state. We found that GIS analysis can considerably enhance implementation of landowner assistance programs. If a conservation program aims at natural resources on a broader scale, it is highly desirable to take a comprehensive approach when lands are assessed for enrollment into such a program due to intricate, and not always well understood, relationships among ecosystem components. The latter may include wildlife and plant habitats, water resources, threats to natural resources from pests or development, and so on. This list may differ depending on the region of interest. Better results can be achieved by targeting areas of high conservational priority. For example, owners can be encouraged by means of higher incentives for enrolling parcels located on the land that are highly suitable for forest stewardship. Incentives such as this example might be worth considering to improve protection of Indiana's riparian lands.

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