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Sticks, Carrots, and Reforestation Investment

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Abstract

Environmental regulations and public financial assistance programs are the typical "sticks" and "carrots" facing non-industrial private forest (NIPF) landowners in the U.S. This paper presents a theoretical framework and empirical evidence on the impacts of the Endangered Species Act and public financial assistance programs—cost-share programs and a tax incentive program—on reforestation investment behavior. The results indicate that NIPF landowners' reforestation investment is influenced negatively by environmental regulations and positively by public financial assistance programs. The results imply that both sticks and carrots can be used simultaneously to influence NIPF landowners' reforestation behavior.

Keywords: Endangered Species Act, public financial assistance program, reforestation, investment, Red-Cockaded Woodpeckers, selectivity

I. Introduction

Non-industrial private forests cover 60 percent of the forest area and account for about half of the timber supply in the U.S. As harvesting declines on public lands, non-industrial forests are expected to supply about 60 percent by the year 2030 (Haines 1995). In addition, non-industrial private forests provide many private and social benefits that are not traded in markets. Thus, non-industrial private forest (NIPF) landowners have been the primary focus of many public policy instruments, which may be coercive "sticks" or incentive-based "carrots." Environmental regulations are often labeled as sticks, while public assistance, including cost-share programs and reforestation tax incentives are the most frequently used carrots.

Many studies have been conducted on the effectiveness, efficiency, and equity implications of federal and state financial assistance programs (e.g., Royer 1987; Romm et al. 1987; Lee et al. 1992), but none could be found on regulations. This paper presents the results of an initial attempt to directly measure the influence of an environmental law, the Endangered Species Act (ESA), and public financial assistance programs on NIPF landowner investment behavior. The study differs from other investigations of this question insofar as it is based on econometric analysis of recorded reforestation activities under two different regulatory conditions, using a large sample of data and looking at the impacts of both sticks and carrots on NIPF landowners reforestation behavior.

The results of this paper show that both sticks and carrots influence NIPF landowners reforestation behavior in opposite directions. The results come from a unified modeling approach and a consistent data set, which provides a more comprehensive framework than previous studies. The results are also consistent with economic theory. This paper begins, in the next section, by describing the ESA in general and specific regulations applicable to the endangered species considered in this study—the Red-Cockaded Woodpeckers (RCW). This is followed by a discussion on the theoretical framework and econometric methods adopted. The remaining sections present, data, empirical findings, conclusions and policy

implications.

II. The Law, the Birds, and the Regulation

The modern version of the Endangered Species Act (ESA) was enacted in 1973, and it has been amended several times since. The ESA imposes different burdens on public and private landowners. Public land management agencies are charged in the act with substantial conservation and recovery obligations that private landowners do not share. Private land is implicated in the ESA primarily with regard to its prohibitions against "taking" endangered species, which apply once a species is listed as endangered or threatened.

Under ESA, no person may take endangered or threatened species. In the ESA, "the term 'take' means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct [ESA Section 3 (19)]." In regulations (50 CFR Section 17.3 (1999)), the U.S. Department of Interior has defined the statutory term "harm" as follows: "Harm in the definition of 'take' in the Act means an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering." This regulatory definition has been upheld by the U.S. Supreme Court (*Sweet Home v. Babbitt*, 11 S.Ct. 714, 1995), and it is the fulcrum on which the government levers regulation of private land. Since habitat modification may be a "take", the normal forestry activities of landowners fall within the purview of the U.S. Fish and Wildlife Service on lands with endangered or threatened species (Flick, Tufts, and Zhang 1996).

More than 80 percent of listed endangered species have habitats on private lands, most of which are forest and agricultural lands (GAO 1994). Further, the list of endangered or threatened species is growing continually with no limit in sight. The potential reach of the act over private land is therefore very large yet uncertain. Private landowners may be subject to habitat regulation both from the listing of new species and from the further specification of guidelines and regulations governing the management of

already listed species. Nationally, then, the principle means of protecting endangered species on private lands is by using a stick, or regulatory prohibitions. Few public incentive programs have been offered to private landowners for protection and enhancement of endangered species on their lands until very recently (Eisner et al. 1995).

Some scholars have argued that regulations like the ESA weaken private property rights, reduce property values, and lower the optimal levels of private investment (e.g., Epstein 1985). Other things being equal, landowners would avoid management activities that would attract endangered species onto their lands and would invest less in land that has endangered species or land that is close to endangered species habitats. This belief continues to produce advocates for protection of private property rights, not only from private landowner organizations but also from public agencies and some environmental groups. Recently, the U.S. Fish and Wildlife Service, with the support of some environmental groups, especially the Environmental Defense Funds, designed and implemented the "Safe Harbor Program," "No Surprise Policy," and "No Take Regulation" (EDF 1995; Zhang 1999a). These policies were in part designed to mitigate the existing incentives to manage against endangered species on private lands.

However, the view that the ESA reduces the value of private lands and lowers investments in forest resources is rarely supported by quantitative evidence. In other words, the influence of the ESA on landowner investment behavior has been a subject of speculation and debate, but very little empirical study. There have been a number of theoretical and policy studies on private rights and their holders' investment behavior and performance (e.g., Cotter and Ulen 1988; Zhang and Pearse 1996, 1997; Posner 1998), some isolated case studies of the ESA (e.g., Mann and Plummer 1995), and the impact of endangered species on public lands (e.g., Hyde 1989, Cleaves et al. 1994).

The RCW has generated much controversy. Listed as an endangered species in 1970, the RCW chisels out its den cavity in live mature pine trees, a task that may take as long as four years. The RCW prefers mature pine trees that have been infected with red heart fungus, which tends to weaken the

heartwood and make the birds' excavation somewhat easier. Furthermore, the RCW prefers open park-like stands containing little understory and usually forages for insects on mature pine trees near its den. If the pine stands are open and hardwood competition grows up in the understory, the birds will abandon the site. Prescribed burning can control the undergrowth, preventing this cause of nest abandonment.

The significance of the RCW is that it needs medium to large size tracts of mature southern pine forests for its habitat. Southern pines are the most important commercial species in the South. Since the South accounts for nearly half of the timber harvests in the country (Powell *et al.* 1992), and since more than 70 percent of southern forests are privately owned, protecting the RCW will likely alter some private forest management activities. Therefore, protecting the RCW may have larger economic impacts among landowners than any other currently listed species excepting the Northern Spotted Owl (Souder 1995).

The U.S. Fish and Wildlife Service has a manual that specifies regulations applicable to private forests with RCW (U.S. Fish and Wildlife Service 1992). The manual contains definite restrictions on private landowners' forest management. For example, the guides specify no cutting of cavity trees, and no damaging of cavity trees that results in death. Damage may include negligent exposure to herbicides or fires. They specify no removing or damaging any pine trees greater than 10 inches dbh (diameter at breast height) without assessing the RCW's existing stocking rate and potential cavity tree situation. No new roads may be built through a RCW habitat unless there is no reasonable alternative, and the Fish and Wildlife Service must approve construction activities. There are also guides for foraging areas. In total, the guides restrict management, and provide several topics open to competing interpretations. (Flick, Tufts, and Zhang 1996).

Some studies have documented the impacts of RCW on land value and timber harvesting (Cleaves et al. 1994; Zhang 1999b), but none can be found on silvicultural investment. How would the ESA and the RCW-related regulations impact silvicultural investment given that the RCW does not nest in small, young trees? The answers are fourfold. First, unlike the Northern Spotted Owls, RCW is a territorial bird,

meaning that it usually does not fly far away from its den. Landowners near existing RCW populations run a continual risk of having the birds move into their mature pine stands. Therefore, a landowner that does not want to be restricted to the ESA may decide not to invest in the reforestation and management of pine. In such cases, mixed stands of pine and hardwood or stands predominantly of hardwood will grow, and the land will be unsuitable as RCW habitat. Second, all landowners near RCW populations may need a permit in order to cut any timber, which may demoralize them from continuing active management and investment. Third, some silvicultural treatments are restricted in a RCW habitat. This may increase the opportunity costs, and thus deter investment. Finally, there is a misperception that RCW lives in all southern pine forests (Ledford 1998). In all these cases, the real or perceived transaction costs of investing in pine forestry are higher. Working consistently with the federal government under the potential of criminal and civil enforcement proceedings is stressful, costly, and time-consuming.

III. Analytical Framework

Landowners under the prospect of ESA regulation and landowners who use public assistance programs may behave differently from other landowners regarding reforestation investment behavior. This behavior can be shown in a simple forest production model. To illustrate the main point of the analysis, we take the perspective of stand-level optimization. We assume the following:

(i) Capital markets are perfect so that timber producers can borrow and lend at a known real interest, r.

(ii) Stumpage prices, P, are constant;

(iii) Timber yield, Q(t, E) is a function of age t and silvicultural investment effort E, where $Q_i=\partial_q/\partial_i>0$; $Q_{ii}<0$ for i=t, E. The silvicultural investment will be wE where w is the unit cost of silvicultural effort, E.

(iv) If no endangered species are present, a landowner has a secure property right to the forest, and the probability of losing a portion of the forest is zero. There is a non-zero (δ)

probability of losing a portion (α, $0 \leq \alpha \leq 1$) of the forest if an endangered species moves into the forest and the ESA applies. This is a case of 'partial regulatory taking' where regulations only restrict a landowner's management activity without any compensation.

(v) Government cost-share is β percent ($0 \leq \beta \leq 1$) of total reforestation costs.

The analysis is considerably simpler and more intuitive if we use a model in which the planning horizon runs through one rotation. The landowner maximizes net return V to the fixed factor, land, over time t. Restating the problem to allow either land purchase at the beginning of the timber rotation and land sale at harvest time or continuous replacement of timber harvests leaves the problem unchanged.

In the case of simply focusing on one rotation, the objective is to maximize the expected present value of future cash flow considering regulatory uncertainty and public financial assistance. If the landowner does not lose any portion of his forest ($\alpha=0$), the expected value of the forest can be expressed as:

$$V_1 = P\, Q(t, I)\, e^{-rt} - (1-\beta)\, w\, E \qquad (1)$$

If he does lose a portion (α) of his forest ($\delta=1$), the expected value of the forest can be expressed as:

$$V_2 = (1 - \alpha)\, P\, Q(t, I)\, e^{-rt} - (1-\beta)\, w\, E \qquad (2)$$

The objective is then to maximize:

$$V(t, E) = (1 - \delta)\, [P\, Q(t, I)\, e^{-rt} - (1-\beta)\, w\, E] + \delta\, [(1- \alpha)\, P\, Q(t, I)\, e^{-rt} - (1-\beta)\, w\, E] \qquad (3)$$

This is a single rotation Faustmann formula with the addition of a stochastic uncertainty factor and government financial assistance programs (Gane 1968). It is the same as maximizing the difference between gross revenues and total costs where revenues are harvest receipts and costs are the annual opportunity costs of forest land use and silvicultural investment under regulatory uncertainty and public assistance. The model contains the weakness that it is risk neutral. However, if the result shows that a risk-neutral landowner responds negatively to policy uncertainty, risk-averse landowners will respond

negatively to policy uncertainty as well.

Equation (3) can be simplified as

$$V(t, E) = (1- \alpha \delta) P Q(t, I) e^{-rt} - (1-\beta) w E \quad (4)$$

We are interested in the investment decisions. First order condition for a maximum requires that

$$(1 - \alpha \delta) P Q_E e^{-rt} / (1-\beta) = w \quad (5)$$

Equation (5) shows the optimal condition for silvicultural effort, which should be increased until the marginal product of the last unit of effort equals its factor cost. When $\delta=0$ and $\beta=0$, equation (5) reduces to the traditional Faustmann result. When $\delta>0$ and $\beta=0$, the marginal product of effort decreases and consequently, the landowner will make less silvicultural efforts than otherwise. This implies that regulation lead to lower returns to investment and that the landowner will invest less than otherwise. On the other hand, if public assistance programs share a portion of a landowner's silvicultural investment ($\beta>0$), the marginal product of landowner effort will be increased. Thus, public assistance programs will make landowners more likely to invest and invest more.

Other things equal, stands near existing RCW clusters are more likely to be colonized than stands far away. Figure 1 illustrates the location relationship between landowners who have an endangered species on their lands and those who face possible occupation by the endangered species. Lands in zone one are active endangered species habitats and therefore are subject to the ESA. Lands in zone two are adjacent to or very close (within 1 mile) to the active RCW habitats, and there is a higher possibility of the endangered species moving to these lands if suitable habitats are provided. These lands will be subject to the ESA if RCW does come. Lands in zone three are farther away from the active RCW habitats and relatively safe from RCW occupation.

Reforestation is an investment activity. Investors, when making investment decision in a property, respond to expectations about future return and current consumption. The expectations of an investor are affected by the nature of their property rights (Epstein 1985; Posner 1998) and any government actions that

affect these rights may influence his investment decisions (Zhang and Pearse 1996). In addition, government financial assistance programs change landowner expectations, and technical assistance from consulting, public and industry foresters help landowners facilitate their investment. Everything else equal, we hypothesize that landowners close to an active RCW colony will reforest less quickly and will invest less.

There are two other categories of exogenous variables—the characteristics of the investment opportunity, which determines its "earning capacity," as compared to other investments, and the characteristics of the landowner, which constrain his ability to become an investor—affect an investment decision (McMahon 1964; Royer 1987). Thus,

$$I = f(G, M, C, K, T)$$

where I is investment or not investment (discretionary dependent variable) and the amount of investment in a tract of cutover forestland;

G is the government influence, including regulations, taxation policy (reforestation tax break), and cost-sharing incentive programs;

M is the earning capacity of an investment as dictated by market conditions and site productivity;

C is the characteristics of the landowner, especially his income, asset position and education;

K is the landowner's knowledge about the particular investment opportunities (e.g., his knowledge on the availability of reforestation tax break, cost-sharing programs, and technical assistance).

T is technical assistance from professional foresters.

This is a two-step selectivity model: the landowner first decides whether to reforest (or to invest) and then how much to invest. The effect of possible colonization by an endangered species, the RCW, will be captured by a variable that measures the distance of the land to a closest designated RCW habitat. Similarly, the effect of financial assistance programs on reforestation will be captured by a variable that

measures the awareness and actual usage of these programs.

III. Data

The study area covers 32 counties in the Sandhills and coastal areas of South Carolina and North Carolina (Figure 2). All of these counties currently have active RCW populations. A mail survey designed according to the Total Design Method (Dillman 1978) was conducted in the Fall of 1998. The survey contained 56 questions, focusing on timber harvesting and reforestation activities (and the lack of them) in the past 10 years. If timber harvests had been done, landowners were asked to provide location (the closeness to a known RCW habitat), harvesting method used for a maximum of three stands cut in the last 10 years, and all reforestation activities (if any) on the harvested area along with costs. Those who had not cut any timber in the last 10 years were only asked to respond to questions related to landowner characteristics.

Since some questions concerning the forest stand characteristics were fairly detailed and technical, landowners who could not answer them were asked to provide the names, addresses, and phone numbers of assistance foresters they used or their timber buyers. Then a follow-up telephone interview with these foresters or timber buyers was conducted to recover this information.

The sampling procedure was designed to achieve a representative and unbiased sample of relatively large NIPF landowners. The chance of small landowners having RCWs on their lands is small. Industrial forest landowners were excluded from this study because they have the time, space, and financial flexibility that NIPF landowners rarely have. In addition, some industrial forest landowners have signed special agreements with the U.S. Fish and Wildlife Service so that they can manage their forests without continual confrontation and delay.

The names and addresses of all forest landowners who owned more than 100 acres of forest lands in these counties were collected from individual county tax assessors. Seven of these counties provided only a list of owners of farm and forestlands over 100 acres. After deleting all known forest industry

landowners, a sample of one out of 10 landowners (and one out of every 15 for the seven counties with combined lists of forest and agricultural landowners) in each county was then selected for the survey. The final mailing list comprised of 1,742 randomly selected landowners.

The final survey sample had 1,696 landowners since 48 surveys (3%) were returned unopened. Five hundred and eight of the surveys were completed and returned, representing a response rate of 30 percent. A follow-up telephone survey of a randomly selected sample of 50 (3%) of the non-respondents reveals that non-respondents are not correlated to the size of ownership, income, education, age, and county origins. The overall estimated error for the survey results is plus or minus 4 percent at the 95 percent confidence level. Some 190 respondents did not cut any timber in the last 10 years, leaving 318 respondents. Some stands are harvested through thinning, shelterwood, and selection. Since reforestation is not needed in these stands, they are excluded. Excluding stands that are harvested in 1998 (as landowners may not have time to replant) and sites (4) whose primary uses have not been changed to non-forestry activities after timber harvesting leaves 326 cutover sites (each respondent could have a maximum of 3 sites). However, information on characteristics of 83 stands was not available as some landowners did not respond to the questions and did not provide the name of assistance forester or timber buyers. The final useful observations used in this study are 243. Table 1 describes the variable definitions used in the statistical analysis, their mean values, and standard deviation.

Reforestation investment

Two dependent variables are used in this study, REPLANTING and INVESTMENT. If landowners decide to replant, they will have silvicultural investment. For the purpose of this study, INVESTMENT in each cutover site was calculated as a weighted average by multiplying the private (without cost share) per acre cost of all silvicultural treatments—including mechanical site preparation, chemical site preparation, burning, machine planting, and hand planting—and the area of each treatment, which was then divided by the size of the site. These costs were inflated or deflated to their equivalent of

1997 dollar values using the U.S. consumer price index. The mean value of reforestation investment for all cut sites is, as indicated in Table 1, $111.92/acre, and the mean value for the replanted sites $140.05.

Government Influence

Of the independent variables in the two regressions, that for the location (ZONE) is of special interest in this study. Zone was assigned a value of one if the stand was adjacent to or within one mile of a known RCW habitat and zero otherwise (i.e., if the site was more than one mile away from a known RCW habitat or the owner did not know or was not sure how far the stand was from an RCW habitat). Since proximity to existing habitat increases the odds of colonization, which would bring the ESA regulations to bear, the coefficient for this variable is expected to have a negative sign in both models.

Four dichotomous cost-share and reforestation tax incentive variables were used in this study. The awareness of availability of cost share and reforestation tax incentives prior to reforestation was expected to have a positive effect on the probability of reforestation. The actual usage of reforestation tax incentive was expected to have a positive effect on reforestation investment because it lowers tax. However, usage of cost share programs was expected to have a negative effect on reforestation investment due to the substitution (public fund was substituted for private capital) effect of cost share (Cohen 1983; Boyd 1984). Although Lee et al. (1992) do not find any substitution effect between public and private capital in tree planting, their data are aggregated so that their results may not be comparable with a study (ours) that uses micro or individual landowner data. No studies that have used micro data have provided any reference on the existence and magnitude of the substitution effect.

Earning Capacity

The earning capacity of reforestation investment is influenced by market conditions, returns of alternative investment vehicles, and the growing capacity of the land itself. The market signals were represented by a southern pine sawtimber stumpage variable and planting cost. Since southern pine pulpwood stumpage and sawtimber stumpage are highly correlated (r=0.59), pulpwood stumpage was not

included in this study. These variables were not assumed to be the specific market conditions faced by individual landowners, but rather as a measure of relative price setting of the specific state (stumpage) and of all coastal plains in 9 southern states (planting cost). Many studies have failed to find any linkage between current stumpage price and the likelihood of reforestation partly because returns from reforestation occur in most cases only when the timber becomes mature and because the aggregate nature of the stumpage price data. Thus price expectation rather than current price is more relevant. Without any guidance about price expectation, we assume it comes from these relative stumpage prices. Similarly, the cost variable was assumed to be an indicator of the relative cost setting from which landowner expectations about reforestation expense was formed. High average costs were expected to lower the likelihood of reforestation. To avoid serial correlation, the cost variable was not included in the reforestation investment equation.

The returns of alternative investments were represented by the annual rate of return of 3-month U.S. government treasury bills and a composite index of long-term (over 10 years) government bond yield. The usage of both short-term and long-term interest rates is justified on the ground that T-bill rate does not have an inflation component, that landowners could use harvesting revenue for short-term consumption and investment, and that the duration of long-term bond is comparable to that of reforestation investment. Both variables were expected to have a negative impact on the likelihood of reforestation and reforestation investment. The land productivity variable, measured as site index, was expected to be positive, and the sign of the size variable was expected to be negative, reflecting the economy of scale in reforestation.

Technical Assistance

Landowners' contact with professional foresters in timber harvesting was expected to have a positive influence on both the likelihood of reforestation and reforestation investment.

Landowner Characteristics

Many studies have shown that there is a linkage between landowner characteristics and forest

management behavior (e.g., Romm et al. 1987). Two income categories were identified in this study and the income variable included was expected have a positive influence on reforestation. In addition, knowledge level and active nature of the landowner on forestry, as measured as the experience in forestry training and continuous forestry education, was expected to have a positive effect on reforestation and reforestation investment. Finally, elder landowners were expected to be less likely to take on reforestation and invest less than other landowners.

IV. Empirical Findings

The empirical findings rely on a two-step selectivity model. In the first step, a probit model is utilized on all 243 observations to test the factors influencing the likelihood of reforestation. The residuals in the first model is then retained and a selection model (OLS techniques) was used on a sample of 194 landowners that had replanted within 2 years after timber harvesting. The probit model fits well. However, the selectivity model is not as promising. More importantly the coefficient for Lambda is not significant, indicating that the linkage between the two steps (models) does not exist. A linear regression using OLS on the 194 observations was tried, and not surprisingly, the results are similar to these reported here. In addition, a maximum likelihood method was also used, and the results were not much different, either.

The results of the full model and reduced model are presented in Tables 2 and 3, respectively. Of the parameters estimated in each equation, 5 are significant at the 10 percent level or better in the reforestation model, and 3 are significant at the 10 percent level and another 4 are significant at the 20 percent level in the reforestation investment model. Most of the signs and values appear reasonable. None of the variables with unexpected sign are significant at the 20 percent level.

The variable for closeness to a known RCW habitat, Zone, is negative and significant in the reforestation models at the 5 percent level. Therefore, possible regulatory intervention to sites close to known endangered species habitats has a significant negative impact on landowners' decisions to reforest. These results indicate that, after allowing for other influences, the possibility of reforestation is about 5

percent lower when the stand is close to known RCW habitat.

The coefficients for the variables representing the awareness of cost-share programs and use of technical assistance are positive and significant, implying that landowners who are aware of government cost share programs and have used professional foresters are more likely to replant within 2 years of harvesting. On the other hand, (high rate of alternative short-term investment vehicles and planting cost) have negative impacts on the likelihood of reforestation. The marginal impacts of these variables are 8, 18, -4, and -0.3 percent, respectively.

The results of the reforestation investment model show that the usage of government cost-share has a negative influence on the amount of capital spent by NIPF landowners. This means that substitution does happen between public and private capital. However, the rate of substitution is only about 15 percent, far less than the finding of 30 to 60 percent in Cohen (1983). On the other hand, if landowners use reforestation tax incentives, they will invest more than otherwise. In addition, income becomes a significant factor in influencing reforestation investment. Relatively wealthy landowners will invest 18 percent more than other landowners.

Three other variables, land productivity, landowners' knowledge of forestry, and landowners' age are marginally significant at the 20 percent level. The results indicate that high quality sites receive more investment and active and more knowledgeable landowners invest more while elder landowners invest less, as expected.

V. Conclusions

The purpose of this study was to assess, quantitatively, the notion that environmental regulations such as the Endangered Species Act and government financial assistance programs influence NIPF landowners' reforestation behavior. The conventional logic is clear enough: governmental regulatory limitations on forest land use and management lower landowners' expectations on future return while the government financial assistance programs just have the opposite effect. Thus, landowners will not reforest

quickly and invest less if they perceived that their lands will more likely to be subject to the ESA or any other similar regulations, and they will be more likely to reforest quickly and invest more if government financial assistance programs are available.

The findings of this study support this general argument. To this extent, they are broadly consistent with the conclusion of other studies on property rights (Feder et al. 1988; Zhang and Pearse 1996, 1997) and on the Endangered Species Act in popular articles and books (Mann and Plummer 1995; Stroup 1996). They are also consistent with the findings that government financial assistance programs increase the possibility of reforestation on NIPF lands (Royer 1987; Royer and Moulton 1987).

The implications of these findings are significant. Of the vast majority of endangered species that have some or all of their habitat on private lands, the likelihood of them thriving there is not bright if the current policy is not changed. A full recovery of these species, as mandated in the Endangered Species Act, is even more remote as private landowners have little incentive to provide additional habitats to endangered species, but to preclude them from coming onto their lands. Facing isolation, many groups of endangered species could eventually die out. Moving all of these species onto public lands seems to be an unpractical solution for most endangered or threatened species.

Having realized this situation, many environmental groups as well as landowner organizations have started to lobby for more flexible regulations and more programs that provide positive incentives for landowners. They have called for cost-share programs and tax breaks for landowners that provided habitat for endangered species (e.g., EDF 1996). A more dramatic solution is to provide for compensation or rental payments for landowners who provide endangered species habitats on their land (e.g., Epstein 1985; Bourland and Stroup 1996). To a large extent, public opinion has been in favor of compensating landowners' loss due to existence of endangered species on their lands and of strengthening the ESA (Czech and Krausman 1999). This study shows that government financial assistance programs can be used to alleviate the disincentive provided by the ESA in reforestation investment. There remains a policy

problem, however, in that the number of endangered species, the regulations governing private behavior, and the negative response of landowners will all grow naturally from continuing activity under the Endangered Species Act. Financial assistance, however, unless it is in the form of tax incentives, requires annual action by Congress.

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Table 1. Variable definitions and sample statistics

Variable	Definition and Data Source	Mean	Standard Deviation
Dependent variables			
REPLANTING	Dummy: 1 if replanting, 0 otherwise	0.80	0.40
INVESTMENT	Expenditure per acre in constant 1997 dollars, covering mechanical site preparation, chemical site preparation, burning, machine planting, and hand planting within 2 years after harvesting	111.68	83.14
Government influence			
Zone	Closeness to a know RCW habitat (dummy: 1 if adjacent or within one mile of a known RCW habitat, 0 otherwise)	0.40	0.49
Aware of cost share	Dummy, awareness of federal and/or state cost share program before reforestation	0.88	0.32
Aware of tax incentive	Dummy, awareness of reforestation tax incentive before reforestation	0.77	0.42
Used cost share	Dummy: 1 if used any cost share program, 0 otherwise	0.60	0.49
Used tax incentive	Dummy: 1 if used reforestation tax incentive, 0 otherwise	0.45	0.50
Earning capacity			
Sawtimber stumpage	Annual average of southern pine sawtimber stumpage in constant 1997 dollars, from Timber-Mart South, Inc. (1999)	263.08	52.70
Site index	A measure of land productivity (the average height of dominant trees at age 50)	80.53	14.19
Size	Number of acres of the site	96.42	97.20
T-bill rate	Annual rate of return on 3-month U.S. government Treasury bills, from U.S. Federal Reserve Board	4.98	0.94
Treasury long-term bond yield	Unweighted average of yields on all issues of bonds outstanding which are neither due nor callable in less than 10 years, from U.S. Federal Reserve Board	6.81	0.79
Planting cost	Average cost of hand and machine planting in southern coastal plains, From Dubois et al. (1999)	68.71	4.85
Technical assistance			
Used forester	Dummy: 1 if used assistance foresters in timber harvesting, 0 otherwise	0.70	0.46
Landowner characteristics			
Income	Dummy: 1 if the landowner household income is greater than $100,000, 0 otherwise	0.38	0.49
Knowledge of forestry	Dummy: 1 if the landowner sometimes attends forest landowner meeting or forestry continuing education program, 0 otherwise	0.55	0.50
Age	Dummy: 1 if the landowner is 65 years' old or more, 0 otherwise	0.34	0.47

Table 2. Results of selectivity model

Variable	Probit (reforestation) model				Reforestation investment	
	Coefficient	t-ratio	Marginal effect	t-ratio	Coefficient	t-ratio
Government influence						
Zone	-1.086	-2.662***	-0.045	-1.458*	2.548	0.239
Aware of cost share	1.998	2.824***	0.081	1.513*		
Aware of tax incentive	-0.580	-0.992	-0.024	-0.907		
Used cost share					-21.466	-1.744**
Used tax incentive					22.104	2.179***
Earning capacity						
Sawtimber stumpage	-0.006	-1.257	-0.000	-0.907	0.037	0.311
Site index	0.005	0.374	0.001	0.371	0.447	1.288*
Size	-0.002	-1.031	0.000	-0.910	-0.039	-0.698
T-bill rate	-0.898	-2.879***	-0.036	-1.598*	4.101	0.576
Treasury long-term bond yield	0.232	0.615	0.009	0.573	6.933	0.723
Planting cost	-0.078	-1.706**	-0.003	-1.294*		
Technical assistance						
Used forester	3.384	6.832***	0.181	1.916**	-14.252	-0.440
Landowner characteristics						
Income	-0.182	-0.508	-0.010	-0.483	24.999	2.349***
Knowledge of forestry	0.045	0.120	0.002	0.119	12.953	1.303*
Age	-0.241	-0.619	-0.013	-0.581	-15.766	-1.518*
Other variables						
Constant	5.504	1.505*	0.294	1.337*	91.094	1.610*
LAMBDA					-19.423	-0.489
R2	0.600				0.134	
R2 adjusted	0.577				0.068	
F test	26.420				1.960	
Chi-squared	164.313					
Log-likelihood					-1094.935	

* Significant at the 20 percent level.
** Significant at the 10 percent level.
*** Significant at the 5 percent level.

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Table 3. Results of selectivity model in reduced form

	Probit (reforestation) model				Reforestation investment	
Variable	Coefficient	t-ratio	Marginal effect	t-ratio	Coefficient	t-ratio
Government influence						
Zone	-0.921	-2.742****	-0.064	-1.820**		
Aware of cost share	1.271	3.296***	0.089	1.818**		
Used cost share					-19.965	-1.695**
Used tax incentive					20.389	2.044***
Earning capacity						
Site index					0.383	1.063
Planting cost	-0.027	-0.788	-0.002	-0.753		
T-bill rate	-0.451	-2.316***	-0.032	-1.870**		
Technical assistance						
Used forester	3.148	7.144***	0.220	2.411***		
Landowner characteristics						
Income					23.574	2.321***
Knowledge of forestry					14.646	1.510*
Age					-13.977	-1.340*
Other variables						
Constant	3.023	1.045	0.212	1.006	99.336	2.924***
LAMBDA					-3.345	-0.197
R2	0.594				0.115	
R2 adjusted	0.587				0.082	
F test	87.090				3.460	
Chi-squared	156.146					
Log-likelihood					-1094.935	

* Significant at the 20 percent level.
** Significant at the 10 percent level.
*** Significant at the 5 percent level.

Figure 1. Endangered species habitat zone and its surrounding areas

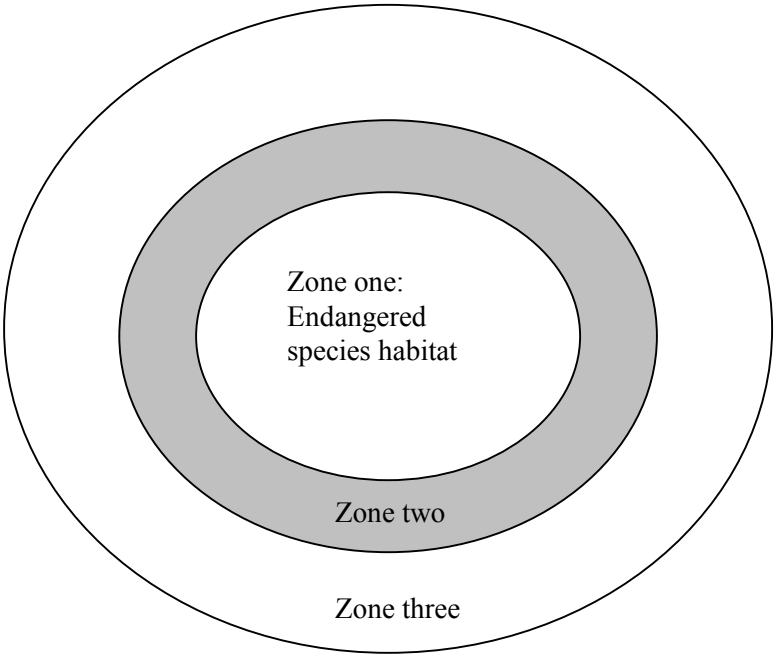

Figure 2. Geographical regions of North and South Carolina included in the reforestation survey