Fostering the Production of Nontimber Services Among Forest Owners with Heterogeneous Objectives

Jeffrey D. Kline, Ralph J. Alig, and Rebecca L. Johnson

ABSTRACT. Programs to enhance nontimber services increasingly focus on nonindustrial private forest (NIPF) owners. These owners are believed to possess multiple objectives, causing them to respond to economic forces and policies in complex and unpredictable ways. We examine NIPF owners in western Oregon and western Washington, using a survey to document their forest ownership objectives and willingness to accept incentive payments to forego harvesting to improve wildlife habitat. An empirical model is developed describing owners' willingness to accept incentive payments to delay harvest, as a function of their forest ownership objectives and socioeconomic characteristics. Mean incentive payments necessary to induce owners to forego harvest are higher for owners possessing primarily timber objectives ($301–314/ha/yr), than for owners possessing both timber and nontimber objectives ($254–257/ ha/yr) or primarily recreation objectives ($185–210/ ha/yr). An estimated supply curve describing the area of NIPF land on which owners would forego harvesting for 10 yr varies from relatively flat to fairly steep. Although many owners would require little or no incentive to forego harvest, others would require a significant incentive. Nontimber services likely could be enhanced by targeting incentive programs or technical assistance toward NIPF owners possessing nontimber objectives. For. Sci. 46(2):302–311.

Additional Key Words: Forest policy, nonindustrial private forest owners, endangered species, carbon sequestration.

Since Hartman (1976), many studies have examined the role of nontimber services in determining optimal forest management among nonindustrial private forest (NIPF) owners (Binkley 1981, Strang 1983, Bowes et al. 1984, Max and Lehman 1988, Hyberg and Holthausen 1989, Dennis 1989, 1990, Englin and Klan 1990, Swallow and Wear 1993). A general result of these analyses is that the presence of significant values for nontimber services tends to delay harvest by increasing the utility-maximizing rotation age, when nontimber services are an increasing function of stand age or volume. However, Swallow et al. (1990) show that nonconvexities in forest rotation models, which incorporate both timber and nontimber services, can result in suboptimal forest owner behavior if local optima induce owners to harvest too early. Public policies could be designed to provide incentives to forest owners to delay harvest to achieve global optima, resulting in more efficient management of private forests producing both timber and nontimber benefits.

The forest investment, management, and harvest behavior of NIPF owners has been a policy concern in the United States since colonial times (Binkley 1981). NIPF owners account for about three-fifths of the timberland area in the United States (Powell et al. 1993, Birch 1996). Historically, forest policy has focused on the perceived inadequacy of the timber supply produced on NIPF lands and ways to motivate greater investment, management, and harvest. These concerns have motivated several studies documenting NIPF owner behavior (see Alig et al. 1990 for a review), and analyses examining their response to forest investment, management, and harvest

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incentives (Thompson and Jones 1981, de Steiguer 1984, Royer 1987, Hyberg and Holthausen 1989, Hardie and Parks 1991, Johnson et al. 1997). More recently, NIPF lands are increasingly viewed as key resources for producing nontimber services, such as habitat for endangered species, watershed protection, and carbon sequestration. These new concerns have resulted in programs and policies intended to enhance the production of nontimber services on private forestland. For example, the USDA's Stewardship Incentive Program provides technical and financial assistance to encourage NIPF owners to keep their natural resource lands productive and healthy (NRCS 1996). Programs designed to sequester carbon on private forests have been proposed to mitigate global warming (U.S. Department of State 1997). The nonprofit organization The Nature Conservancy offers annual payments to forest owners in Virginia who agree to give up logging rights to their land (Springston 1998).

NIPF owners are believed to be motivated by multiple objectives that cause them to respond to economic forces in complex and unpredictable ways (Dennis 1989, 1990, Newman and Wear 1993, Kuuluvainen et al. 1996). The success of programs designed to foster the production of nontimber services on NIPF lands will depend, in part, on how well policy makers anticipate how different forest owners will respond to any management incentives offered. In this article, we examine the reasons NIPF owners own forestland and their willingness to accept incentive payments in return for adopting harvest restrictions to improve wildlife habitat. Data are available from a survey of NIPF owners in western Oregon and western Washington. Factor analysis and cluster analysis are used to classify forest owners by their timber and nontimber objectives. An empirical model is developed describing owners' willingness to delay harvest for 10 yr as a function of the incentive payment offered, their ownership objectives, and their socioeconomic characteristics. The empirical model is used to estimate a supply curve for enrollment of nonindustrial private forestland into a 10 yr forest conservation reserve.

Conceptual Framework

The timberlands of the Pacific Northwest have been among the most productive in the world. However, recent population growth in the region and changing public attitudes toward timber harvesting and its effect on nontimber values have fueled public debate regarding how forestlands should be managed in the future. Environmental advocates argue that habitat fragmentation caused by logging and road building threaten biodiversity and contribute to the decline of many bird, terrestrial, and fish species in the Pacific Northwest. They argue that these species would benefit from reduced rates of timber harvest and greater restrictions on harvests within riparian areas (Anderson and Olsen 1991), and harvest systems that more closely emulate natural disturbances such as fires and windstorms (Franklin 1989). Two examples include the benefits to spotted owls (*Strix occidentalis caurina*) provided by nesting cavities in old-growth timber, and the benefits to coho salmon (*Oncorhynchus kisutch*) provided by standing trees that shade riparian areas and maintain cooler stream temperatures. Although the specific habitat requirements of many wildlife species may result in potential nonconvexities along any utility function describing the value of nontimber services as a function of forest rotation age (Swallow et al. 1990), habitat for both spotted owls and coho salmon generally is enhanced by longer forest rotations. As a result, environmental advocates have sought ways to induce forest owners to extend forest rotation ages or forego harvesting timber entirely, to enhance habitat for these species.

Many people believe that the public goods characteristics of private forests obligate private forest owners to manage their land to produce both timber and nontimber services. However, a concern of many private forest owners is the personal cost of maintaining public benefits. Most significantly, these include the opportunity costs associated with reduced harvests (Kennedy et al. 1996). Suppose forest owners were offered an incentive payment in return for agreeing not to harvest timber on their forestland for a period of 10 yr to improve wildlife habitat. We assume that forest owners would decide to participate or abstain from such a program by maximizing the utility they expect to derive from their forestland over the 10 yr life of the program. A forest owner's reservation price—the lowest price at which an owner is willing to sell timber—varies among owners due to differences in their price expectations, timber preferences, and the reasons they own forestland (Gregory 1972). We would expect these factors also to influence forest owners' evaluation of the opportunity costs associated with not harvesting timber for 10 yr. The utility forest owners expect to derive from their forestland would be a function of their preferences and objectives regarding forest management.

We hypothesize that the probability that any forest owner would be willing to forego harvest to improve wildlife habitat is partly a function of whether the owner values nontimber services, in addition to the timber services produced on their forestland. Many of the nontimber services that forest owners may value, such as aesthetics and habitat for certain wildlife, generally are enhanced by longer rotations or by not harvesting altogether. We expect that forest owners who value nontimber services would be more willing to forego harvest than forest owners who place less value on nontimber services. We also expect that the incentive payment required to motivate owners who place greater value on nontimber services to forego harvest would be less than the incentive payment required to motivate owners who do not value nontimber services. Differences in forest owners' objectives can be accounted for in a specification of the utility that forest owners derive from their forestland.

Assume that a forest owner's expected utility derived from his or her land is $u(j,y;s)$, where $j = 1$ if the owner retains the right to harvest and 0 if the owner enrolls in the program and forgoes harvest for 10 yr. The term y is the forest owners' exogenous income and s is a vector of other observable attributes that affect their forest management decisions, including information describing their forest ownership objectives. The function $u(j,y;s)$ is comprised of an observable component $v(j,y;s)$ and an unobservable

component ε_j such that $u(j,y;s) = v(j,y;s) + \varepsilon_j$ (McFadden 1973, Hanemann 1984).

Let the expected utility of the forest owner choosing to forego harvest in return for an incentive payment offered be $u_1 \equiv u(0,y + OFFER;s)$, and let the expected utility of the owner choosing not to forego harvest be $u_0 \equiv u(1,y;s)$. The owner will choose to forego harvest if

$$v(0, y + OFFER; s) + \varepsilon_0 > v(1, y; s) + \varepsilon_1 \quad (1)$$

or

$$v(0, y + OFFER; s) - v(1, y; s) > \varepsilon_1 - \varepsilon_0 \quad (2)$$

Assuming a Weibull distribution for the error term ε_j, the difference $\varepsilon_0 - \varepsilon_1$ is distributed as a logistic. The logit model implies that the probability P_F that an owner chooses to accept the incentive payment and forego harvest is where Δv equals the utility difference (2), and can be estimated using the maximum likelihood procedure (Maddala 1983, Ben-Akiva and Lerman 1991).

Our specification of utility includes information regarding forest owners' objectives regarding their forestland. Because these objectives likely are complex, a single survey question may be inadequate to identify or describe them. One alternative is to present forest owners with a series of questions asking them to evaluate the importance of several different reasons why they own forest land. Their responses to such questions can be analyzed using analytical tools more common to the disciplines of psychology, sociology, and anthropology, such as factor analysis and cluster analysis, to classify or group forest owners possessing similar objectives. By including variables describing each owners' objective group into our specification of utility, we are able to account for differences in utility across owners possessing different objectives. Two analytical tasks are: (1) the use of factor analysis and cluster analysis of forest owners' responses to questions regarding their reasons for owning forestland, to classify owners by their forest ownership objectives; and (2) the estimation of forest owners' utility and willingness to accept an incentive payment to forego harvest. Both tasks rely on data from a survey of owners.

Survey of NIPF Owners

A telephone survey of NIPF owners in 19 western Oregon and 19 western Washington counties was conducted during July and August 1994 (Johnson et al. 1999). All counties are west of the crest of the Cascade Mountains. NIPF owners account for about 27% (1.5 million ha) of the nonfederal timberland in the region (MacLean 1990, MacLean et al. 1992). A random sample was drawn from all NIPF owners in each county in proportion to the area of NIPF land in each county. NIPF owners from all western counties in Oregon and Washington were identified by county tax assessors. Professional telephone interviewers contacted NIPF owners randomly from a list of names and telephone numbers for each county until the target number of usable surveys (about 1,000) was achieved. The survey instrument was first tested with NIPF owners and reviewed by representatives of state agencies and other professionals having previous NIPF survey experience. The survey was designed to meet several different objectives and the average interview time was 20 minutes. A total of 1,731 NIPF owners were called and 1,004 usable surveys were obtained. This provided sufficient information to fulfill at least some of the survey objectives, for an overall response rate of 58%. NIPF owners were asked about their forest management and harvest behavior, participation in government forestry assistance programs, and attitudes toward government regulation of forestry activities.

Two specific sections of the survey asked NIPF owners about their reasons for owning forestland and their willingness to accept compensation in return for conducting specific forest management activities to improve wildlife habitat. Royer and Moulton (1987) found that NIPF owners in the Southern United States made use of tax credits, which in many cases complement other government-funded cost-sharing. In this study, NIPF owners specifically were asked whether they would be willing to forego harvesting timber from their forestland for a period of 10 yr in order to improve wildlife habitat. The survey provided 461 observations of this particular question when combined with all additional questions necessary to the construction of explanatory variables. The responses are analyzed along with information regarding respondents' reasons for owning forestland, to examine if respondents' willingness to forego harvesting timber would differ according to their forest ownership objectives. Some respondents who otherwise completed the entire survey refused to provide information regarding their income, education, or age, and so could not be included in the analysis. Because relatively little information exists regarding NIPF owners in general, we are unable to determine if this sample is representative of NIPF owners in the study region.

Describing NIPF Owners' Objectives

A series of questions presented respondents with several reasons for owning forestland (Table 1) and asked respondents to rate on a Likert scale (coded 1 = not at all important, 5 = very important) how important each reason is regarding

Table 1. VARIMAX rotation factor pattern of importance ratings of reasons for owning forestland.

	Factor		
Reason	Timber and investment	Owner gratification	Recreation
Timber production	0.803	–0.172	–0.023
Land investment	0.724	–0.073	0.072
Forest is part of farm	0.498	0.577	–0.322
Estate to pass to children	0.435	0.229	0.417
Forest is part of residence	–0.154	0.800	0.000
Enjoyment of green space	–0.113	0.658	0.402
Recreation	0.023	0.007	0.868
Eigenvalue	1.646	1.577	1.112
Proportion variance	0.235	0.225	0.159

NOTE: Sample includes 461 observations. The three factors represent 61.9% of the variation in variables.

why they own forestland. The specific wording of these questions was:

> We would like to know why you own forestland. I will suggest a possible reason for owning forestland and then I would like you to say how important each reason is for your owning forestland. The first reason is _____, is this reason very important, important, neither important or unimportant, unimportant, or not at all important?

Responses to the questions about reasons for owning forestland were analyzed using factor and cluster analysis to classify survey respondents into separate owner groups according to their forest ownership objectives. Kuuluvainen et al. (1996) use a similar method to classify Finnish forest owners according to their forest management objectives.

Factor analysis is used to identify unobservable, hypothetical variables (factors) that contribute to the variance of observable variables. Although factor analysis assists in the identification of the number of factors present and the variables whose variance is explained by each factor, the method is subjective and relies on previous knowledge and intuition for the interpretation of results (Mulaik 1972). We assume that respondents' ratings of how important each reason is for their owning forestland reflect their forest ownership objectives. Factor analysis uses the covariance among ratings to identify factors that account for the variation in ratings. We interpret factors as broader ownership objectives that are unobservable, but are manifested through respondents' importance ratings of specific forest ownership reasons with which they are correlated. The list of seven variables describing reasons for owning forestland used in the factor analysis comes from Birch (1996) and was selected because it encompasses both timber and nontimber objectives (Table 1).

The variables *timber production* and *land investment* can be thought of as indicating timber objectives, while the variables *enjoyment of green space* and *recreation* can be thought of as indicating nontimber objectives (Table 1). The variables *forest is part of farm*, *estate to pass to children*, and *forest is part of residence* are not related solely to either timber or nontimber objectives, but depend on the preferences of individual owners. For example, the variable *estate to pass to children* may be correlated with timber objectives for owners who view forests as a financial asset to pass on to their children, but may be correlated with nontimber objectives for owners who view forests as green space to be held for their children's future enjoyment. Responses to the survey questions regarding respondents' reasons for owning forestland were analyzed using principal component analysis and rotated using the VARIMAX method (Kaiser 1958, Mulaik 1972). Rotation results in matrices of correlations between rating variables and factors. Three factors were retained for analysis and account for 62% of the variation in the forest ownership objective ratings (Table 1).

The first factor has high positive loading coefficients for variables that seem to represent timber objectives, such as *timber production* and *land investment*, as well as relatively high loading coefficients for the variables *forest is part of farm* and *estate to pass to children*. Factor loading coefficients for variables that tend to represent nontimber objectives, such as *forest is a part of residence*, *enjoyment of green space*, and *recreation* are close to zero or negative. Together, the loading coefficients suggest a *timber and investment* factor related to the production of income and wealth. The second factor has high positive loading coefficients for the variables *forest is part of residence* and *enjoyment of green space*, as well as relatively high loading coefficients for *forest is part of farm*. Factor loading coefficients for *timber production* and *land investment* are negative and the loading coefficient for *recreation* is near zero. These loading coefficients suggest an *owner gratification* factor related to the simple enjoyment of owning forest land. Finally, the third factor has a high positive loading coefficient for the variable *recreation*, as well as relatively high positive loading coefficients for the variables *estate to pass to children* and *enjoyment of green space*. These loading coefficients suggest a *recreation* factor related to the enjoyment of recreational services provided by forest land.

The factor loading coefficients can be used to categorize respondents according to their forest ownership objectives, by performing cluster analysis on a set of factor scores computed for each respondent using the factor loading coefficients. The factor loading coefficients (Table 1) were used to compute standardized factor scores (Reyment and Joreskog 1993) for each survey respondent. Cluster analysis was performed on the standardized scores to categorize respondents based on their prevailing objectives regarding forest ownership. The standardized scores have a mean of zero and a standard deviation of one, which aids in the interpretation of clusters (Table 2). Cluster analysis treats the standardized factor scores as coordinates in space and assigns each observation to a group (cluster) based on its Euclidean distance from all other observations. Although such groupings are somewhat subjective, they enable us to observe general differences in the characteristics and behavior of respondent groups possessing different forest ownership objectives. We used nearest centroid sorting (Anderberg 1973) to identify four separate groups of respondents based on their forest ownership objectives.

Timber producers represent 19.5% of the sample and tend to have positive scores for the *timber and investment* factor, and negative scores for the *owner gratification* factor and the *recreation* factor. Timber producers appear to be interested solely in financial values. *Multiobjective*

Table 2. Respondent groups based on forest ownership objectives.

Owner objective group	n	Mean factor scores: Timber and investment	Owner gratification	Recreation
Timber producers	90	0.639	–0.762	–0.931
Multiobjective owners	185	0.539	0.604	0.397
Recreationists	113	–0.596	–0.803	0.663
Passive owners	73	–1.233	0.651	–0.885

NOTE: Respondent objective groups (clusters) are based on nearest centroid sorting (Anderberg 1973).

Table 3. Explanatory variables and mean characteristics of the survey sample.

Variable	Definition	Mean
HECTARES	Total forest area owned in Oregon and Washington	33.1
SALES INCOME	1 = timber sales are primary income, 0 = otherwise	0.085
PLAN CUT	1 = plans to cut timber or firewood within next 10 yr, 0 = otherwise	0.596
AGE1	1 = 18 to 39 yr, 0 = otherwise	0.128
AGE2	1 = 40 to 59 yr, 0 = otherwise	0.514
AGE3	1 = 60 or over, 0 = otherwise	0.358
EDUCATION1	1 = high school, 0 = otherwise	0.281
EDUCATION2	1 = associates degree, 0 = otherwise	0.354
EDUCATION3	1 = bachelors degree, 0 = otherwise	0.213
EDUCATION4	1 = advanced degree, 0 = otherwise	0.152
INCOME1	1 = \$0 to \$25,000, 0 = otherwise	0.154
INCOME2	1 = \$25,000 to \$50,000, 0 = otherwise	0.440
INCOME3	1 = \$50,000 to \$100,000, 0 = otherwise	0.302
INCOME4	1 = greater than \$100,000, 0 = otherwise	0.104
TIMBER PRODUCER	1 = timber producer, 0 = otherwise	0.195
MULTIOBJECTIVE	1 = multiobjective owner, 0 = otherwise	0.401
RECREATIONIST	1 = recreationist, 0 = otherwise	0.245
PASSIVE OWNER	1 = passive owner, 0 = otherwise	0.159
OFFER	Tax reduction offered (\$)	—

NOTE: Sample includes 461 forest owners.

owners (40.1%) tend to have positive scores for the *timber and investment* factor, but also have positive scores for the *owner gratification* and *recreation* factors. Multiobjective owners appear to be interested in financial values, but also include nontimber services among their forest ownership objectives. Kuuluvainen et al. (1996) find a similar multiobjective group among Finnish forest owners. *Recreationists* (24.5%) tend to have negative scores for the *timber and investment* factor and the *owner gratification* factor, with high scores for the *recreation* factor. Recreationists appear to be most interested in producing aesthetic and recreation services. *Passive owners* (15.9%) tend to have positive scores for the *owner gratification* factor, but negative scores for the *timber and investment* factor and the *recreation* factor. Passive owners do not appear to have strong interests beyond their passive ownership of forestland. For these owners, forestland may just have been included on the parcel of land on which they chose to live.

Mean values of explanatory variables describing characteristics of the survey sample (Table 3) are provided for each respondent group in Table 4. Respondents classified as either recreationists or passive owners tend to own smaller tracts of forestland (22.3 and 15.3 ha) than do those respondents classified as multiobjective owners (41.0 ha) or timber producers (44.5 ha). Respondents classified as multiobjective owners own 49.8% of the forestland accounted for by the survey sample, followed by timber producers (26.3%). Recreationists and passive owners own the least forest area of all respondents in the survey sample (16.6% and 7.3%).

Respondents classified as either timber producers or multiobjective owners are more likely to depend on timber sales as their primary source of income (10.0% and 11.4%) relative to other owners, possibly reflecting the economies of scale associated with larger tract sizes (Row 1978). A few statistical differences also exist in the age, education, and income of respondents across owner groups. For example, timber producers tend to be distributed among higher age categories relative to other owners. Recreationists tend to be distributed among higher education and income categories, while passive owners tend to be distributed among lower income categories.

Table 4. Explanatory variable means by respondent objective group.

	Owner objective group			
Variable	Timber producers $n = 90$	Multiobjective owners $n = 185$	Recreationists $n = 113$	Passive owners $n = 73$
HECTARES	44.5[2]	41.0[2]	22.3[2]	15.3[2]
SALES INCOME	0.100[1]	0.114[1]	0.062	0.027[2]
PLAN CUT	0.667[1]	0.638[1]	0.504[2]	0.548
AGE1	0.122	0.140	0.150	0.068
AGE2	0.400[3]	0.536[1]	0.540[1]	0.562[1]
AGE3	0.478[2]	0.324[1]	0.310[1]	0.370
EDUCATION1	0.323	0.287	0.265	0.246
EDUCATION2	0.333	0.384[1]	0.257[2]	0.452[1]
EDUCATION3	0.233	0.189	0.248	0.192
EDUCATION4	0.111[1]	0.140[1]	0.230[3]	0.110[1]
INCOME1	0.111[1]	0.136[1]	0.169	0.233[2]
INCOME2	0.500[1]	0.486[1]	0.354[2]	0.384
INCOME3	0.267[1]	0.270[1]	0.380[2]	0.301
INCOME4	0.122	0.108	0.097	0.082

NOTE: [1], [2], and [3] denote the number of means within each row that are significantly different from the reported mean at the 90% confidence level based on Student's *t*-test ($df = 456$). Sample includes 461 forest owners.

Estimating Forest Owners' Willingness to Forego Harvest

Survey respondents were presented with a series of questions asking their willingness to accept an incentive in the form of a federal income tax reduction, in return for adopting a specific forest management restriction on their land. For this analysis, respondents were asked if they would be willing to forego all timber harvest for 10 yr to improve wildlife habitat. The specific wording of the question was:

> Forestland in western Oregon and Washington provides a variety of outputs in addition to timber. For example, forestland may be managed to provide wildlife habitat or recreation opportunities. If your federal income taxes were reduced by $____ per acre annually for 10 years, would you be willing to forego harvesting timber from your forestland to improve wildlife habitat?

Tax reduction offers ranged in value from $25 to $1,000/ac (about $62 to $2,471/ha) per year. The upper limit of this range was selected to be reasonably comparable to the maximum potential forest owner opportunity cost incurred by forgoing harvest. Johnson et al. (1994) estimate the opportunity cost of permanently forgoing harvest of a 100- to 140-yr-old Douglas fir stand in western Oregon at about $1,878/ha/yr. The maximum incentive payment offered in our survey of $2,471/ha/yr is over 30% greater than the Johnson et al. (1994) estimate, and the actual opportunity cost incurred by many respondents possessing younger stands would be less. Still, many respondents (33%) rejected the maximum incentive payment offered.

The unwillingness of many respondents to accept relatively high incentive payments to forego harvesting could be due to many factors. The placement of the harvest question within a series of questions regarding different forest management restrictions could have induced strategic behavior in some respondents. For example, some respondents may have rejected the 10 yr harvest restriction to express their preference for a specific management restriction described in an earlier question. Reasonable steps were taken in the survey process to ensure that respondents considered each question independently; however, these steps may not have been sufficient to ensure complete independence among individual questions. The unwillingness of many respondents to accept high incentive payments also could be due in part to the hypothetical nature of the question. Some respondents who refused high incentive payments may actually accept them if a real offer were made. Also, some respondents may have refused high incentive payments to protest *any* potential management restrictions on their land—hypothetical or real—regardless of whether they would receive compensation or not. Some respondents may fear that restrictions for which they initially receive compensation may eventually be imposed without compensation in the future. Because such wariness would undoubtedly be encountered should such an incentive program actually be implemented, we made no attempt to remove potential protest responses from the sample.

We model respondents' expected utility derived from their forestland as a function of the productive capability (ha) of their forest holding, their ownership objectives, and their socioeconomic characteristics. A log-linear approximation of the utility difference function Δv (Bishop and Heberlein 1979, Hanemann 1984, Sellar et al. 1986, Boyle and Bishop 1988) is specified as

$$\Delta v = a(s) + \beta \ln(OFFER) \tag{4}$$

where a is a vector of parameters which correspond to the vector of variables s describing respondents' forest ownership objectives and socioeconomic characteristics. The individual characteristics of survey respondents (s) are included as explanatory variables in the specification of Δv to account for differences in preferences among respondents possessing different ownership objectives and socioeconomic characteristics (Swallow et al. 1994).

In our specification, the vector s includes the forest area owned by respondents (HECTARES) to account for nonconstant marginal returns to forestland (Table 3). Variables also are included to account for respondents' reliance on timber sales income (SALES INCOME) and plans for future harvests (PLAN CUT). We include both those respondents who said they plan to harvest in the future and those respondents who said they do not plan to harvest in the future. Any government program designed to induce forest owners to forego harvest would be unable to distinguish owners who intend to harvest from those who do not. Several dummy variables are included to describe respondents' age, education, and income characteristics. Three dummy variables (MULTIOBJECTIVE, RECREATIONIST, and PASSIVE OWNER) are included to identify respondents within one of the four respondent groups to account for potential differences in their willingness to forego harvest. A fourth dummy variable TIMBER PRODUCER is omitted for model estimation. Although it would be desirable to include variables describing the specific characteristics of timber stands owned by survey respondents, accurate data on stand characteristics are difficult to obtain from NIPF owners on a consistent basis, and so such information is omitted from the model.

The model was estimated using LIMDEP (Greene 1995) and describes the probability that respondents would forego harvesting for 10 yr to improve wildlife habitat (Table 5). The model was estimated using the size of respondents' forest holdings as weights to account for potential oversampling of NIPF owners possessing small forest holdings. The estimated model performs well with a χ^2 value of 174.756 ($df = 15$, $P < 0.0001$). The estimated coefficient for the variable HECTARES is negative and statistically significant ($P < 0.01$). Dennis (1990) suggests that NIPF owners are more likely to manage and harvest timber as tract size increases because the marginal utility of forestland producing nontimber services is decreasing. Row (1978) hypothesizes that economies of scale in timber production associated with diminishing average fixed costs yield greater marginal net returns to larger forest tracts. These studies imply that because an owner's expected utility derived from timber production would increase with forest tract size, respondents owning larger tracts would be less willing to forego harvest. The negative and statistically significant coefficient for HECT-

Table 5. Estimated coefficients of the discrete choice model describing respondents' willingness to accept an incentive payment to forego harvest for 10 yr to improve wildlife habitat.

Variable	Estimated coefficient	*t*-ratio	Marginal effect
Constant	−1.960**	−2.239	−0.342
HECTARES	−0.006***	−5.450	−0.000
SALES INCOME	−0.743**	−2.077	−0.130
PLAN CUT	−1.676***	−5.886	−0.292
AGE2	0.565	1.157	0.099
AGE3	0.910*	1.818	0.159
EDUCATION2	−0.445	−1.363	−0.078
EDUCATION3	0.471	1.346	0.082
EDUCATION4	0.820**	1.992	0.143
INCOME2	0.762*	1.742	0.133
INCOME3	0.867*	1.854	0.151
INCOME4	2.466***	4.511	0.430
MULTIOBJECTIVE	0.550*	1.776	0.096
RECREATIONIST	0.611*	1.668	0.107
PASSIVE	0.562	1.050	0.098
ln*(OFFER)*	0.263**	2.418	0.046

NOTE: *, **, and *** show significance at 10, 5, and %, $N = 461$, $\chi^2 = 174.756$ with $df = 15$ ($P < 0.0001$). The estimated logistic model was weighted according to the forest area owned by respondents.

ARES is consistent with the hypothesis that marginal returns to forestland from timber production are increasing. The estimated coefficient for the variable ln(OFFER) is positive, statistically significant ($P < 0.05$), and consistent with a positive marginal utility of money. The greater the tax reduction offered, the more willing respondents are to forego harvest for 10 yr.

The coefficient for SALES INCOME is negative and statistically significant ($P < 0.05$), indicating that respondents whose income is earned primarily from the sale of timber are less willing to forego harvest than are respondents who do not depend on timber sales as a primary source of income. The coefficient for PLAN CUT describing respondents who plan to cut timber or firewood within 10 yr is negative and statistically significant ($P < 0.01$). Respondents who plan to cut within 10 yr are less willing to enroll in a program requiring them to forego harvest than are respondents who do not plan to cut.

Estimated coefficients for the socioeconomic variables indicate some statistically significant differences across socioeconomic categories, in respondents' willingness to forego harvest. For example, the coefficient for EDUCATION4 is positive and statistically significant ($P < 0.05$), suggesting that respondents who possess an advanced college degree are more willing to forego harvest than are respondents who do not possess such college degrees. Estimated coefficients also are positive and statistically significant for INCOME2 ($P < 0.10$), INCOME3 ($P < 0.10$), and INCOME4 ($P < 0.01$), and increase in magnitude with higher income categories. Previous studies suggest that nontimber services are valued more highly by affluent forest owners because nontimber services may be superior goods (Binkley 1981) and because income reduces the relative marginal utility of revenue earned from timber sales (Hyberg and Holthausen 1989, Dennis 1989, 1990, Kuulevainen et al. 1996). If affluence is indicated by higher education or income levels, then these hypotheses are supported by our results. A chi-square test of the frequency distribution across the education and income categories reveals that some correlation does exist between these variables. Alternative model specifications that omit either the income variables or the education variables were found to have little effect on the signs, magnitudes, and statistical significance of the education and income coefficients.

Estimated coefficients for the MULTIOBJECTIVE and RECREATIONIST variables are positive and statistically significant ($P < 0.10$, $P < 0.10$). This suggests that, all things being equal, multiobjective owners and recreationists are more likely to forego harvest to improve wildlife habitat than are respondents classified as timber producers. The estimated coefficient for PASSIVE is positive but not statistically significant ($P > 0.25$) and suggest that passive owners are no more willing to forego harvest to improve wildlife habitat than are owners classified as timber producers. Owners classified as either multiobjective owners or recreationists possess a stronger interest in nontimber values relative to owners classified as timber producers. Greater interest in nontimber values relative to timber values appears to indicate greater willingness among respondents to forego harvest to improve wildlife habitat.

Incentive Payments and the Supply of NIPF Conservation Land

Mean willingness-to-accept (WTA) values can be computed by combining (3), (4), and the estimated coefficients of (Table 5) to solve

$$E(WTA) = OFFER_{\max} - \int_0^{OFFER_{\max}} \left[\frac{1}{F(OFFER_{\max})} \bullet \frac{1}{1+e^{-[\Delta v]}} \right] dOFFER \quad (5)$$

where $OFFER_{\max}$ is the maximum incentive payment offered to any survey respondent ($1,000) and $F(OFFER_{\max})$ is the probability density function (3) evaluated at $OFFER_{\max}$ (Sellar et al. 1985, Boyle et al. 1988). Researchers commonly have evaluated (5) using the mean sample values of all explanatory variables included in estimated equations (see for example, Swallow et al. 1994). However, Souter and Bowker (1996) suggest that a more appropriate method of computing mean willingness-to-accept values is to solve (5) for each individual included in the sample and compute the mean of the individual consumer surplus estimates. We compute expected willingness-to-accept values using both methods, for each respondent group. These values are equivalent to the mean incentive payment at which respondents of each group would be willing to forego harvest for 10 yr to improve wildlife habitat (Table 6).

Our computations using truncated means (Sellar et al. 1985, Boyle et al. 1988) show that respondents classified as timber producers demand the greatest incentive payment ($314/ha/yr), followed by respondents classified as multiobjective owners ($254). Recreationists and passive owners demand the least incentive payment ($185 and $220). The willingness-to-accept estimates computed following Souter and Bowker (1996) are $301 for timber

Table 6. Mean willingness-to-accept values, by forest ownership objective group.

	Owner objective group			
Mean willingness-to-accept value ($/ha/yr)[a]	Timber producers	Multiobjective owners	Recreationists	Passive owners
Sellar et al. (1985) and Boyle et al. (1988) method	314	254	185	220
Souter and Bowker (1996) method	301	257	210	227

[a] Computed using Equations (3) and (4) and the estimated model coefficients of Table 5. Mean willingness-to-accept values for the entire sample computed using each method are $242 and $250/ha/yr.

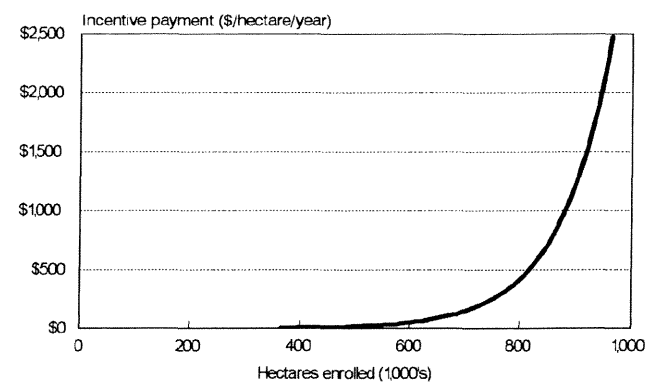
producers, $257 for multiobjective owners, $210 for recreationists, and $227 for passive owners. Respondents who possess less interest in financial values, such as recreationists and passive owners, appear to require less incentive to forego harvest to improve wildlife habitat than respondents, such as multiobjective owners, who possess an interest in both financial and nontimber values. Respondents who possess predominantly financial objectives, such as timber producers, appear to require the greatest incentive to forego harvest.

Although several methods have been suggested for computing confidence intervals for willingness-to-pay and willingness-to-accept values (Park et al. 1991, Duffield and Patterson 1991, Cameron 1991), these methods tend to be sensitive to sample size and the chosen error distribution (Cooper 1994). Also, the computation of confidence intervals for truncated means derived from log-linear specifications is complex. Our computations of confidence intervals based on Park et al. (1991) for untruncated mean willingness-to-accept values derived from alternative linear specifications showed them to be overlapping. The statistical significance of dummy variables describing respondent groups suggests that differences do exist across owner groups in the likelihood that owners would be willing to forego harvest in riparian areas. However, our results do not support the conclusion that the financial incentives that owners within each group would require are statistically different. The relatively small sample size within each respondent group may compound this problem.

Assuming that our sample of NIPF owners is representative of all NIPF owners in western Oregon and western Washington, we estimate the potential supply of NIPF land on which owners would forego harvesting for 10 yr in return for incentive payments. Using the model coefficients (Table 5), we compute the probability that forest owners in each owner objective group would forego harvest on their land for 10 yr if offered an incentive payment ranging from $25 to $1,000. The probabilities are multiplied by the estimated area of forestland in western Oregon and western Washington owned by NIPF owners of each objective group. The area of forestland owned by NIPF owners of each objective group is estimated by multiplying the proportion of forest area owned by survey respondents of each group, by the timberland area owned by NIPF owners in western Oregon and western Washington (1,556,649 hectares). Finally, we plot the aggregated area values against the incentive payments offered.

The resulting supply curve (Figure 1) shows the estimated potential supply of NIPF land in western Oregon and western Washington on which owners would be willing to forego harvesting for 10 yr in return for a given level of incentive payment offered. The supply curve intersects the x-axis to the right of the origin and initially is relatively flat, indicating that many NIPF owners would require little or no incentive to forego harvest for 10 yr to improve wildlife habitat. On the other hand, some NIPF owners would demand a significant incentive to forego harvest, as indicated by the steep slope of the right-hand portion of the curve. The potential cost of any program designed to induce NIPF owners to forego harvest to improve wildlife habitat would vary depending on the target enrollment and the specific forest management objectives of the NIPF owners who enroll.

For comparison, grassland enrollment in the Conservation Reserve Program in Oregon and Washington totaled about 809,000 ha between 1986 and 1993 at an average cost of $210/ha enrolled per year. Total Conservation Reserve Program costs in these states, including costs to establish grass cover, totaled about $2 billion (Plantinga et al. 1998). Figure 1 shows that ensuring the enrollment of 809,000 ha of forestland in western Oregon and western Washington in a *forest conservation reserve* would cost an estimated $551/ha/yr and total $4.46 billion over a 10 yr program. Whether the additional cost associated with enrolling forestland in a forest conservation reserve is a better investment than enrolling grassland in the Conservation Reserve Program would depend on the value of benefits derived from forest conservation land compared to those derived from grassland. For example, the specific needs of some endangered species, such as the spotted owl, may make forest conservation land a better investment, while other species, such as the coho salmon, may benefit by protecting both forest and grassland riparian areas.



NIPF land in western Oregon and western Washington totals 1,557 thousand hectares.

Figure 1. Estimated potential supply of NIPF land enrolling in a 10 yr Forest Conservation Reserve in Western Oregon and Western Washington.

Conclusions

Previous studies suggest that the prevalence of nontimber values among NIPF owners reduce owners' interest in harvesting timber. We empirically identify nontimber values as they are manifested through NIPF owners' forest ownership objectives and show how these values would affect owners' likely responses to incentive programs designed to enhance nontimber services. Although some owners primarily are interested in producing timber, others include the production of nontimber services, such as recreation and aesthetics, among the reasons they own forestland. These results suggest that NIPF owners are not likely to respond consistently to forest policies designed to motivate certain investment, management, and harvest behavior. Programs which offer cost-sharing or technical assistance to increase timber production on NIPF lands may have limited success if a significant proportion of owners do not possess strong timber objectives. Likewise, programs which seek to enhance nontimber services, such as improving habitat for endangered species, will be ill-received by those owners primarily interested in timber production. Programs that target those forest owners whose objectives are most consistent with program goals likely possess the greatest potential for success. Tailoring different programs to the multiple objectives of NIPF owners may motivate greater joint production of timber and nontimber services, resulting in more efficient forest policy.

Many forest owners perceive significant opportunity costs associated with reduced timber harvests. Recent conflicts over spotted owls and coho salmon in the Pacific Northwest have motivated national interest in programs which strike a balance between the timber interests of private forest owners and the nontimber interests of society. These nontimber interests may include many complimentary benefits such as habitat for endangered species, watershed protection, and carbon sequestration, among others. Offering incentive payments to forest owners to provide nontimber services could provide a politically acceptable alternative to regulatory approaches. However, given the significant interest in nontimber values among many NIPF owners in western Oregon and western Washington, a potentially less expensive alternative for achieving nontimber policy goals, at least partially, might be to target extension education, technical assistance, and cost sharing toward NIPF owners who share nontimber goals. Future analyses could be improved by integrating information regarding owners' forest resources with information regarding owners' objectives and behavior.

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