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ANALYSIS

Forest owner incentives to protect riparian habitat

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Abstract

Private landowners increasingly are asked to cooperate with landscape-level management to protect or enhance ecological resources. We examine the willingness of nonindustrial private forest owners in the Pacific Northwest (USA) to forego harvesting within riparian areas to improve riparian habitat. An empirical model is developed describing owners' willingness to accept an economic incentive to adopt a 200-foot harvest buffer along streams as a function of their forest ownership objectives and socioeconomic characteristics. Results suggest that owners' willingness to forego harvest varies by their forest ownership objectives. Mean incentive payments necessary to induce owners to forego harvest in riparian areas are higher for owners possessing primarily timber objectives ($128–137/acre/year) than for owners possessing both timber and nontimber objectives ($54–69/acre/year) or primarily recreation objectives ($38–57/acre/year). © 2000 Published by Elsevier Science B.V.

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1. Introduction

Traditionally, one objective of public lands management in the United States has been to compensate for the loss of ecological resources occurring on private lands by providing wildlife habitat, watershed protection, and natural areas for outdoor recreation. Our nationwide network of parks, wildlife refuges, wilderness areas, and other preserves is testament to this mission. However, allocating public lands among competing uses has become more and more difficult as society's demands for all uses have increased (Franklin, 1992; Lee, 1992). Also, it is increasingly acknowledged that many ecological processes extend beyond public lands boundaries and require management on a larger scale (Amoros et al., 1987; Swallow and Wear, 1993; Sample, 1994; Gottfried et al., 1996; Swallow, 1996; Swallow et al., 1997). In light of these challenges, resource

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managers have tried to augment ecological protection on public lands with increased regulation of private lands, often to the dismay of private landowners. Growing resentment among landowners toward the regulation of private property has fostered an interest in policies that provide positive incentives to landowners to cooperate with ecosystem managers (Gottfried et al., 1996; Swallow, 1996) or encourage voluntary cooperation by appealing to landowners' sense of shared responsibility.

An example of this positive approach is the Oregon Coastal Salmon Restoration Initiative (hereafter called the salmon initiative). Historical declines in Pacific Northwest coho salmon (*Oncorhynchus kisutch*) populations led the National Marine Fisheries Service (NMFS) to consider listing the species as threatened under the Endangered Species Act. To avoid the listing and retain state control over natural resources, a coalition of state agencies and private interest groups developed the salmon initiative as a plan to restore coastal salmon populations to sustainable levels (Oregon Coastal Salmon Restoration Initiative, 1997). The salmon initiative contributed to the initial decision of NMFS to not list the coho salmon as threatened in northern Oregon, although NMFS did eventually list the species following a suit filed by environmental groups. Oregon's salmon initiative is novel in its reliance on a broad-based appeal to Oregonians' shared responsibility for restoring threatened and endangered species. It relies on community-based action in the form of voluntary efforts by private landowners and local interest groups such as watershed councils and soil and water conservation districts (Oregon Coastal Salmon Restoration Initiative, 1997).

Crucial to coho salmon restoration in the Pacific Northwest is the establishment of watershed reserves where human activity is curtailed or eliminated (Reeves et al., 1995). One focus of the salmon initiative is on the forest management practices of nonindustrial private forest (NIPF) owners. NIPF ownerships account for 36% (644 000 acres) of the private timberland in western Oregon (MacLean, 1990), and are more likely to be located in riparian areas than are forest industry and public lands (Bettinger and Alig, 1996). NIPF owners are believed to base their forest management decisions on nontimber values, such as aesthetics and wildlife, in addition to timber production (Hartman, 1976; Binkley, 1981; Strang, 1983; Bowes et al., 1984; Max and Lehman, 1988; Hyberg and Holthausen, 1989), causing them to respond to economic forces in complex and unpredictable ways (Dennis, 1989, 1990; Newman and Wear, 1996; Kuuluvainen et al., 1996). The success of the salmon initiative will depend in part on the willingness of NIPF owners to adopt forest practices that protect or enhance riparian habitat.

Several hypotheses exist regarding why firms or individuals voluntarily comply with environmental regulations or participate in environmental programs. For example, firms may wish to project an image of producing environmentally benign products (Arora and Gangopadhyay, 1995; Arora and Cason, 1996) or may seek rents arising from reduced output of competitors less able to comply (Maloney and McCormick, 1982). However, timber production on NIPF lands is not well integrated vertically with retail marketing of forest products, nor do NIPF owners often have much control over timber prices, so these hypotheses may not apply. Voluntary compliance or participation also can be a rational response to fear of stricter regulation in the future (Arora and Cason, 1996), and the salmon initiative was intended to head off unwanted federal regulation. Still, voluntary compliance or participation may arise because individuals receive some benefit from a proposed environmental improvement (Arora and Cason, 1996; Gottfried et al., 1996). For example, it has been suggested that NIPF owners will be attracted to programs which help them achieve their forest ownership goals or enhance their own particular values regarding forest management (Bliss and Martin, 1988, 1989). The willingness of NIPF owners to adopt practices intended to protect or enhance riparian habitat likely depends on owners' objectives regarding forest ownership and whether these objectives are consistent with protecting or enhancing riparian habitat.

In this paper, we examine the reasons why NIPF owners own forest land and their willing-

ness to adopt harvest restrictions to protect or enhance riparian habitat, in return for a federal income tax reduction. Data are 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 forego harvest in riparian areas for 10 years as a function of the tax reduction offered, their socioeconomic characteristics, and their forest ownership objectives. Mean willingness-to-accept values are estimated and compared across owners possessing different categories of timber and nontimber objectives to determine if some NIPF owners would be more willing than others to protect or enhance riparian habitat.

2. Conceptual framework

Although for many species joint production functions for wildlife habitat and timber are poorly understood, ecologists tell us that habitat for coho salmon generally is enhanced by longer forest rotations. Adequate tree stocking reduces streambank erosion, maintains cool stream temperatures and optimal light levels, provides food from forest litter, and provides large woody debris important to the structure of aquatic ecosystems (Franklin, 1992). A significant factor influencing the potential success of the salmon initiative will be the improvement and restoration of salmon habitat by increasing tree stocking in riparian areas owned by NIPF owners. Swallow et al. (1990) note that nonconvexities related to the production of many nontimber services can lead forest owners to harvest sooner than is socially optimal. In this case, forest owners might harvest within riparian areas according to a forest rotation age that is less than the optimal rotation age for the joint production of timber and coho salmon. If so, public programs or incentives could be used to persuade forest owners to delay harvest to achieve socially optimal rotation ages that also protect or enhance coho salmon habitat.

Although some NIPF owners likely could be persuaded to enact forest management practices to protect or enhance riparian habitat voluntarily, a concern of many 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 economic incentive in return for agreeing not to harvest within riparian areas for a period of 10 years to protect or enhance coho salmon habitat. Forest owners would decide to participate or abstain from such a program by maximizing the utility they expect to derive from their riparian forest land over the 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 outputs, and reasons they own forest land (Gregory, 1972). We expect these factors also to influence forest owners' perceived opportunity costs associated with foregoing harvests for 10 years. We hypothesize that the probability that any forest owner would be willing to forego harvest within riparian areas is a function of the importance the owner places on the nontimber values relative to the timber values derived from their forest land. In this case, nontimber values could include direct fishing opportunities, aesthetics of seasonal salmon runs, and satisfaction in aiding threatened species, among others. Forest owners who emphasize nontimber values are likely more willing to forego harvests within riparian areas than those who do not emphasize nontimber values, and the economic incentive required to induce those owners to forego harvest would be less.

Assume that a forest owner's expected utility derived from forest land is $u(j, y;\mathbf{s})$, where $j=1$ if the owner retains the right to harvest within riparian areas, and $j=0$ if the owner enrolls in the program and foregoes harvests within riparian areas for 10 years. The term y is the forest owner's exogenous income and $\mathbf{s}$ is a vector of observable socioeconomic characteristics included to account for differences in preferences across socioeconomic categories (Swallow et al., 1994). We also include in the vector $\mathbf{s}$ additional information regarding individual preferences for timber and nontimber values as revealed by their forest own-

ership objectives. Including such information enables the marginal utility of foregone harvest opportunities to vary across owners possessing heterogeneous timber and nontimber forest ownership objectives.

Following standard analytical procedures regarding discrete choice contingent valuation questions, we assume that the function $u(j, y;\mathbf{s})$ is comprised of an observable component $v(j, y;\mathbf{s})$ and an unobservable component ε_j such that $u(j, y;\mathbf{s}) = v(j, y;\mathbf{s}) + \varepsilon_j$ (McFadden, 1973; Hanemann, 1984). Let the expected utility of the forest owner choosing to forego harvest within riparian areas be $u_0 \equiv u(0, y + \text{OFFER};\mathbf{s})$, and let the expected utility of the owner choosing not to forego harvest be $u_1 \equiv u(1, y;\mathbf{s})$. The owner will choose to forego harvest if

$$v(0, y + \text{OFFER};\mathbf{s}) + \varepsilon_0 \geq v(1,y;\mathbf{s}) + \varepsilon_1 \quad (1)$$

or

$$v(0, y + \text{OFFER};\mathbf{s}) - v(1,y;\mathbf{s}) \geq \varepsilon_1 - \varepsilon_0. \quad (2)$$

Assuming a Weibull distribution for the error term ε_j, the difference $\varepsilon_1 - \varepsilon_0$ is distributed as a logistic. The logit model implies that the probability P_F that an owner chooses to accept the economic incentive and forego harvest is

$$P_F = \frac{1}{1 + e^{-(\Delta v)}} \quad (3)$$

where Δv equals the utility difference (Eq. (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 concerning forest ownership. These objectives likely are complex, and a single survey question or variable may be inadequate to identify or describe them. One alternative is to present forest owners with a series of questions asking them to weight the importance of several possible reasons for owning forest land. Their responses can be analyzed using a combination of factor and cluster analysis to classify respondents into separate groups having similar forest ownership objectives. Kuuluvainen et al. (1996) use a similar method to classify Finnish forest owners according to their forest management objectives. The method enables us to examine how the willingness of forest owners to forego harvest in riparian areas varies across groups. Two analytical tasks are: (1) to use factor analysis and cluster analysis of forest owners' responses to questions regarding their reasons for owning forest land to classify owners by their forest ownership objectives; and (2) to estimate forest owners' utility and willingness to forego harvest in riparian areas. Both tasks rely on data from a survey of NIPF owners.

3. Survey of forest owners

A telephone survey of NIPF owners in the 19 counties of western Oregon and the 19 counties of western Washington was conducted during July and August, 1994. All counties are west of the crest of the Cascade Mountains. NIPF owners account for about 27% (3.8 million acres) 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 areas of NIPF forest land in each county, as identified by county tax assessors. Professional telephone interviewers contacted NIPF owners randomly from each county sample until a target number of usable surveys (about 1000) was achieved. The survey instrument initially was tested with NIPF owners and reviewed by state agency representatives and other professionals having previous NIPF survey experience. A total of 1731 NIPF owners were called and 1004 usable surveys were obtained, for a 58% response rate. The average interview time was 20 min.

The survey asked NIPF owners about their forest management and harvest activity, use of government forestry assistance programs, and attitudes toward forestry regulations. Detailed description of the complete survey can be found in Johnson et al. (1999). Two sections of the survey asked NIPF owners about their reasons for owning forest land and their willingness to accept compensation in return for adopting specific forest management practices to improve wildlife habitat. A total of 461 respondents provided use-

able observations for this group of questions, including all relevant socioeconomic and demographic questions. For this study, respondents also were asked whether they would be willing to forego harvesting within riparian areas for a period of 10 years to improve riparian habitat in return for a federal income tax reduction. The survey provided 403 observations of this particular question. The full sample (461) is reduced by 58 respondents who indicated that the survey question regarding their willingness to forego harvest within riparian areas was not applicable. The remaining subsample (403) is assumed to include only respondents who own riparian forest land.

4. Forest owners' objectives

One purpose of the survey was to identify meaningful subgroups of owners possessing similar timber and nontimber objectives. Survey respondents were presented with a list of possible reasons for owning forest land (Table 1) and asked to rate on a scale from 1 to 5 (1, not at all important; 5, very important) how important each reason is regarding why they own forest land. The specific wording of these questions was:

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

The list of seven potential reasons for owning forest land come from Birch (1996) and encompass 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 perspectives of individual owners. For example, the variable 'estate to pass to children' may be correlated with timber objectives for owners who view forests as financial assets to pass on to their children, but may be correlated with nontimber objectives for owners who view forests as green space held in trust for their children. Respondents' importance ratings of possible reasons for owning forest land were analyzed using principal component (factor) analysis and rotated using the VARIMAX method (Kaiser, 1958; Mulaik, 1972), yielding a matrix of correlations between rating variables and factors. Three factors were retained for analysis and ac-

Table 1
VARIMAX rotation factor pattern of importance ratings of reasons for owning forest land[a]

Reason	Factor		
	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

[a] Sample includes 461 forest owners. The three factors represent 61.9% of the variation in variables.

Table 2
Survey respondent groups based on forest ownership objectives[a]

Owner objective group	n	Mean of standardized 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

[a] The standardized factor scores for the entire sample have a mean of zero and a standard deviation of one. Sample includes 461 forest owners.

count for 62% of the variation in importance ratings of reasons for forest ownership (Table 1).

The first factor has high positive loading coefficients for '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 which tend to represent nontimber objectives, such as 'enjoyment of green space' and 'recreation', are close to zero or negative. Together, the loading coefficients suggest a "timber and investment" factor. 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 enjoyment of owning land. 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 aesthetic and recreational services provided by forest land.

The factor loading coefficients were used to compute a set of standardized factor scores (Reyment and Joreskog, 1993) for each respondent. We performed cluster analysis on the standardized factor scores using nearest centroid sorting (Anderberg, 1973), to categorize respondents into four separate groups. Timber producers represent 19.5% of the sample and tend to have positive scores for the timber and investment factors, and negative scores for the owner gratification and recreation factors (Table 2). Timber producers appear to possess solely timber values. Multiobjective owners (40.1%) tend to have positive scores for the timber and investment factors, but also have positive scores for the owner gratification and recreation factors. Multiobjective owners appear to include both timber and nontimber values in 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 and owner gratification factors, with high scores for the recreation factor. Recreationists appear to be most interested in producing recreation values, possibly fishing and hunting opportunities, for example. Passive owners (15.9%) tend to have positive scores for the owner gratification factor, and negative scores for the timber and investment and recreation factors. Passive owners do not appear to own forest land for any specific stated purpose. For these owners, forests may just have been included with the parcel of land on which they chose to live.

Mean values of explanatory variables describing characteristics of the riparian owners subsample (403) are provided in Tables 3 and 4. Respondents classified as recreationists and passive owners tend to own smaller tracts of forest land (44.6 and 40.0 acres) than do respondents classified as multiobjective owners and timber producers (107.8 and 124.3 acres). Respondents

classified as timber producers and multiobjective owners are more likely to depend on timber sales as their primary source of income (11.1 and 12.6%) relative to other owners, possibly reflecting economies of scale associated with larger tract sizes (Row, 1978). Statistical differences also exist in the socioeconomic characteristics of owner objective groups. For example, timber producers tend to fall in the higher age categories relative to other owners. Recreationists tend to fall in higher education and income categories. Passive owners tend to fall in lower income categories.

Table 3
Explanatory variables and mean characteristics of the subsample of riparian forest owners[a]

Variable	Definition	Mean
ACRES	Total forest acreage owned in Oregon and Washington	84.2
SALES INCOME	1 = timber sales are primary income, 0 = otherwise	0.092
PLAN CUT	1 = plans to harvest trees within next 10 years, 0 = otherwise	0.583
AGE1	1 = 18–39 years, 0 = otherwise	0.129
AGE2	1 = 40–59 years, 0 = otherwise	0.531
AGE3	1 = 60 or over, 0 = otherwise	0.340
EDUCATION1	1 = high school, 0 = otherwise	0.286
EDUCATION2	1 = associates degree, 0 = otherwise	0.350
EDUCATION3	1 = bachelors degree, 0 = otherwise	0.218
EDUCATION4	1 = advanced degree, 0 = otherwise	0.146
INCOME1	1 = $0–25,000, 0 = otherwise	0.144
INCOME2	1 = $25,000–50,000, 0 = otherwise	0.449
INCOME3	1 = $50,000–100,000, 0 = otherwise	0.303
INCOME4	1 = greater than $100,000, 0 = otherwise	0.104
TIMBER PRODUCER	1 = timber producer, 0 = otherwise	0.179
MULTI OBJECTIVE	1 = multiobjective owner, 0 = otherwise	0.412
RECREATIONIST	1 = recreationist, 0 = otherwise	0.248
PASSIVE OWNER	1 = passive owner, 0 = otherwise	0.161
OFFER	Tax reduction offered ($100s)	–

[a] Subsample includes 403 riparian forest owners, of the 461 sample of forest owners.

Survey respondents were asked to indicate their level of agreement with various environmental statements (Table 5). On average, respondents possessing timber objectives are less likely to agree with the statement, "There should be additional harvest restrictions on private forest lands to protect riparian ecosystems", than are respondents possessing multiobjective, recreationist, and passive objectives. Respondents possessing timber objectives also are less likely than other respondents to agree with the statement, "Harvest should be restricted on private forest land to protect endangered species". Finally, multiobjective, recreationist, and passive respondents are more likely to agree with the statement, "I would be willing to alter the amount and timing of my harvest if it is necessary to maintain a healthy ecosystem", than are timber producers. Respondents possessing nontimber objectives appear to be in greater agreement with statements suggesting that forest practices pursue environmental goals than are respondents interested primarily in timber production.

5. Estimating willingness to forego harvest

The subsample of forest owners was asked their willingness to accept an economic incentive in the form of a federal income tax reduction, to forego all harvests within 200 feet of riparian areas for 10 years to improve riparian habitat. Current Oregon Forest Practices Act regulations require riparian harvest buffers of 0–100 feet, based on stream size (Oregon Department of Forestry, 1997). Washington Forest Practices Act regulations allow limited harvesting within riparian buffers, which vary from 25 to 100 feet in width, based on stream size (Washington Forest Practices Board, 1993). In this analysis, we assume that a 200-foot riparian harvest buffer would yield a positive ecological response. In practice, the riparian harvest buffer width necessary to achieve specific program objectives would need to be determined.

The question was drafted as a closed-ended discrete choice and worded as:

Table 4
Explanatory variable means of the subsample of riparian forest owners, by forest owner objective group[a]

Variable	Owner objective group			
	Timber producers ($n = 72$)	Multiobjective owners ($n = 166$)	Recreationists ($n = 100$)	Passive owners ($n = 65$)
ACRES	124.3[b]	107.8[b]	44.6[b]	40.0[b]
SALES INCOME	0.111	0.126[a]	0.060	0.031[a]
PLAN CUT	0.653[a]	0.626[a]	0.480[b]	0.554
AGE1	0.125	0.138	0.150	0.077
AGE2	0.417[a]	0.537	0.560	0.600[a]
AGE3	0.458[b]	0.325[a]	0.290[a]	0.323
EDUCATION1	0.320	0.295	0.260	0.261
EDUCATION2	0.333	0.386[a]	0.230[b]	0.462[a]
EDUCATION3	0.250	0.193	0.270	0.169
EDUCATION4	0.097[a]	0.126[a]	0.240[c]	0.108[a]
INCOME1	0.083[a]	0.121[a]	0.150[a]	0.261[c]
INCOME2	0.514	0.500[a]	0.370[a]	0.369
INCOME3	0.250[a]	0.271[a]	0.390[b]	0.308
INCOME4	0.153	0.108	0.090	0.062

[a] Superscript letters denote the number of means (a = 1, b = 2, c = 3) within each row that are significantly different from the reported mean at the 95% confidence level based on Student's t-test (degrees of freedom = 398). For example, the mean of ACRES for Timber Producers (124.3) is statistically different from two other means in the row. Sample includes 403 ripanan forest owners.

Forest land in western Oregon and Washington provides a variety of outputs in addition to timber. For example, forest land 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 within 200 feet of a riparian area in order to improve the riparian habitat on your forest land?

Table 5
Mean rating of agreement among riparian forest owners regarding protecting riparian ecosystems and endangered species, by forest owner objective group[a]

Statement	Owner objective group			
	Timber owners ($n = 72$)	Multiobjective owners ($n = 166$)	Recreationists ($n = 100$)	Passive owners ($n = 65$)
There should be additional harvest restrictions on private forest lands to protect riparian ecosystems	2.46[c]	2.97[c]	3.41[b]	3.39[b]
Harvest should be restricted on private forest land to protect endangered species	2.16[c]	2.59[b]	3.21[b]	2.87[a]
I would be willing to alter the amount and timing of my harvest if it is necessary to maintain a healthy ecosystem	3.14[c]	3.71[a]	3.86[a]	3.67[a]

[a] 1, strongly disagree; 5, strongly agree. Superscript letters denote the number of means (a = 1, b = 2, c = 3) within each row that are significantly different from the reported mean at the 95% confidence level based on Student's t-test (degrees of freedom = 398). For example, the mean value of 2.46 in the first row for timber producers is statistically different from all three other means in the row. Sample includes 403 riparian forest owners.

Tax reductions offered ranged from \$25 to 1000/acre/year. The maximum offer was selected to be reasonably comparable with the maximum potential opportunity cost incurred by a forest owner foregoing harvest. The opportunity cost of permanently foregoing harvest of 100- to 140-year-old Douglas fir in western Oregon is estimated at about \$760/acre/year (Johnson et al., 1994). The maximum tax reduction offered of \$1000/acre/year is over 30% greater, and the actual opportunity cost incurred by many respondents possessing younger stands would be less. Still, many respondents (10%) rejected the maximum tax reduction offered. No attempt was made to remove negative responses from the sample.

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

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

where $\boldsymbol{\alpha}$ is a vector of parameters which correspond to the vector of variables $\mathbf{s}$ describing respondents' socioeconomic characteristics and forest ownership objectives. Alternative utility difference specifications based on linear and log-linear versions of the utility function (Hanemann, 1984) also were tested but did not perform as well.

The vector $\mathbf{s}$ includes the forest acres owned by respondents (ACRES) to account for nonconstant marginal returns to forest land (Table 3). Although it would be desirable to include additional variables describing the specific characteristics of timber stands owned by survey respondents, accurate data on stand characteristics are difficult to obtain from survey respondents on a consistent basis, and so such information regrettably is omitted. Variables are included to account for respondents' reliance on timber sales income (SALES INCOME) and plans for future harvest (PLAN CUT). We include respondents who said they plan to harvest in the future and those who said they do not plan to harvest in the future because any government program designed to induce forest owners to forego harvest would be unable to differentiate between the two. Several dummy variables are included to describe respondents' age, education, and income characteristics. Three dummy variables (MULTIOBJECTIVE, RECREATIONIST, and PASSIVE OWNER) identify respondents within each owner objective group to account for potential differences in willingness to forego harvest. A fourth dummy variable, TIMBER PRODUCER, is omitted for model estimation.

The model was estimated using LIMDEP (Greene, 1995) and describes the probability that respondents would forego harvesting within riparian areas for 10 years to improve riparian habitat (Table 6). The model was estimated using the size of respondents' forest holdings as weights to account for potential over-sampling of NIPF owners possessing smaller forest holdings. The model χ^2 value is 137.980 (degrees of freedom = 15, $P < 0.0001$) and predicts 68.2% of the observed responses correctly. The estimated coefficient for ACRES is negative and statistically significant ($P < 0.01$), consistent with increasing marginal returns to forest land from timber production (Row, 1978; Dennis, 1990). The estimated coefficient for the variable ln(OFFER) is positive, statistically significant ($P < 0.01$), and consistent with a positive marginal utility of money. The greater the tax reduction offered, the more willing respondents are to forego harvest within riparian areas.

The coefficient for SALES INCOME is negative ($P < 0.01$), indicating that respondents whose income is earned primarily from the sale of timber are less willing to forego harvest within riparian areas than are respondents who do not depend on timber sales for income. The coefficient for PLAN CUT is negative, but not statistically significant ($P > 0.78$), indicating that respondents who state that they plan to harvest within 10 years do not appear to be any less willing to forego harvest within riparian areas than are respondents who do not plan to harvest. Perhaps in this case, as Arora and Cason (1996) suggest generally, individuals are willing to comply with this hypothetical environmental program because they fear

stricter riparian regulation in the future, such as say, a permanent riparian harvest restriction without compensation.

Previous studies suggest that nontimber values are more common among affluent forest owners (Binkley, 1981; Dennis, 1989, 1990; Hyberg and Holthausen, 1989; Kuuluvainen et al., 1996). However, our results suggest that willingness to protect or enhance riparian habitat is fairly consistent across income categories. A chi-square test of the frequency distribution across education and income categories reveals some correlation between these variables. However, alternative model specifications omitting either the income or education variables have little effect on the signs, magnitudes, and statistical significance of the education and income coefficients.

The estimated coefficients and marginal effects for MULTIOBJECTIVE ($P<0.01$) and RECREATIONIST ($P<0.01$) suggest that respondents classified as multiobjective owners and recreationists are more willing to forego harvest within riparian areas to improve riparian habitat, than are timber producers (base case). Greater interest in nontimber values relative to timber values appears to indicate greater willingness among respondents to forego harvest within riparian areas to protect or enhance riparian habitat. The statistical insignificance of the estimated coefficient for PASSIVE ($P>0.88$) suggests that respondents classified as passive owners are no more willing to forego harvest in riparian areas than are timber producers.

6. Incentive payments and riparian habitat enhancement

The model coefficients can be used to estimate and compare likely willingness-to-accept values across respondent groups. Choice of the appropriate estimate of willingness-to-accept, median versus mean, entails a value judgment (Hanemann, 1984). We are less interested in the actual value than in differences in value across respondent groups, and so compute both mean and median values and do not address which is best. Mean willingness-to-accept (WTA) values are computed by combining Eqs. (3) and (4), and the estimated coefficients (Table 6) to solve

Table 6
Estimated coefficients of the discrete choice model describing respondents' willingness to accept a tax reduction to forego harvest within riparian areas for 10 years[a]

Variable	Estimated coefficient	t-Ratio	Marginal effect
Intercept	−2.943**	−3.262	−0.736
ACRES	−0.001***	−3.399	−0.000
SALES INCOME	−1.804***	−5.283	−0.451
PLAN CUT	−0.085	−0.284	−0.021
AGE2	0.927*	1.969	0.232
AGE3	1.435**	3.115	0.359
EDUCATION2	−0.090	−0.284	−0.022
EDUCATION3	−1.035**	−3.062	−0.259
EDUCATION4	0.969	1.774	0.242
INCOME2	0.320	0.660	0.080
INCOME3	0.760	1.487	0.190
INCOME4	0.690	1.285	0.172
TIMBER PRODUCER	–	–	–
MULTIOBJECTIVE	1.506***	4.736	0.376
RECREATIONIST	1.621***	3.725	0.405
PASSIVE	0.074	0.148	0.018
ln(OFFER)	0.313**	2.724	0.078

[a] *, **, and *** show significance at $P<0.05$, $P<0.01$, and $P<0.001$; $N=403$, $\chi^2=137.980$ with degrees of freedom = 15 ($P<0.0001$). The estimated model correctly predicts 68.2% of the actual responses.

$$E(\mathrm{WTA}) = \mathrm{OFFER}_{max} - \int_0^{\mathrm{OFFER}_{max}} \left[\frac{1}{F(\mathrm{OFFER}_{max})} \frac{1}{1+e^{-(\Delta v)}} \right] d\mathrm{OFFER} \quad (5)$$

where OFFER_{max} is the maximum tax reduction offered to any respondent ($1000) and $F(\mathrm{OFFER}_{max})$ is the probability density function (Eq. (3)) evaluated at OFFER_{max} (Sellar et al., 1985; Boyle et al., 1988). Researchers commonly evaluate Eq. (5) using mean sample values for explanatory variables included in the estimated equation (see, for example, Swallow et al., 1994). Souter and Bowker (1996) suggest that a more appropriate computation of mean willingness-to-accept values is to solve Eq. (5) for each individual in the sample, then compute the mean of the individual consumer surplus estimates. We compute mean willingness-to-accept values for each owner objective group using both methods (Table 7). Median willingness-to-accept values are computed by setting Eq. (4) equal to zero as

$$\mathrm{WTA} = e^{-(\alpha/\beta)\mathbf{s}} \quad (6)$$

with the variables **s** set equal to their mean values (Table 4) for each group (Hanemann, 1984).

Our computations using truncated means (Sellar et al., 1985; Boyle et al., 1988) show that respondents classified as timber producers require the greatest economic incentive ($128 per acre per year), followed by passive owners ($123). Multiobjective owners and recreationists require the least economic incentive ($54 and 38/acre/year). Mean economic incentives computed following Souter and Bowker (1996) are comparable at $137 for timber producers, $123 for passive owners, $69 for multiobjective owners, and $57 for recreationists. Median willingness-to-accept values are $280 for timber producers, $137 for passive owners, $3 for multiobjective owners, and $1 for recreationists.

Although several methods have been suggested for computing confidence intervals for willingness-to-pay and willingness-to-accept values (Cameron, 1991 Duffield and Patterson, 1991; Park et al., 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 median and 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 economic incentives owners within each group would require are statistically different. The relatively small sample size within each respondent group may compound this problem.

Table 7
Mean and median willingness-to-accept values ($/acre/year), by forest owner objective group[a]

	Owner objective group			
	Timber producers	Multiobjective owners	Recreationists	Passive owners
Mean (Sellar et al., 1985; Boyle et al., 1988)[b]	128	54	38	115
Mean (Souter and Bowker, 1996)[b]	137	69	57	123
Median[c]	280	3	1	137

[a] Mean willingness-to-accept values for the entire sample computed using each method are $69 and 87/acre/year. The median value is $9/acre/year.

[b] Computed using Eq. (5) and the estimated model coefficients (Table 6).

[c] Computed using Eq. (6) and the estimated model coefficients (Table 6).

Potential differences in respondents' willingness to forego harvest in riparian areas can be observed by computing probabilities that respondents belonging to each owner group would accept incentives of varying amounts (Table 8). The probability that respondents would forego harvest in riparian areas is lowest among those classified as either timber producers or passive owners, ranging from 0.32 and 0.37 for incentive offers of $25/acre/year to 0.60 and 0.65 for incentive offers of $1000/acre/year. Probabilities are higher among those respondents classified as either multiobjective owners or recreationists, and range from 0.66 and 0.75 for incentive offers of $25/acre/year to 0.86 and 0.91 for incentive offers of $1000/acre/year. These probabilities could be used to estimate the area of riparian forest land that could be set aside at different incentive amounts, if the actual area of riparian forest land owned by nonindustrial private forest owners in western Oregon and western Washington was known. Researchers currently are developing geographic information system coverages depicting forest ownership and the location of riparian forest lands, which will enable such an analysis in the future.

Because multiobjective owners and recreationists possess nontimber values, they may feel that foregoing harvest within riparian areas enhances these values or is consistent with their nontimber objectives. Conversely, owners possessing primarily timber objectives may view the restriction on riparian harvest more in terms of foregone timber revenue and may see little personal gain in protecting or enhancing riparian habitat on their land. The relatively low probability of participation by passive owners indicates their disinterest, as well, in active forest management for nontimber values. The government may not be able to offer different types of owners different amounts to forego harvest in riparian areas, should such a program actually be implemented. However, apparent differences in forest owners' willingness to adopt riparian harvest restrictions suggest that program costs potentially could be minimized by designing programs which target those owners who would demand the least incentive.

7. Conclusions and policy implications

The Oregon Coastal Salmon Restoration Initiative is a novel attempt to restore coho salmon by appealing to Oregonians' shared sense of responsibility for ecological health. The willingness of NIPF owners to participate in protecting and enhancing riparian habitat will be one factor determining the salmon initiative's success. Our analysis suggests that a significant proportion of these owners are motivated by objectives other than timber production, and for many owners, protecting and enhancing habitat for threatened or endangered species is consistent with the reasons they own forest land. These characteristics may present policy makers with an opportunity to achieve salmon initiative goals simply by fostering

Table 8
Probabilities that respondents will accept incentive offers of varying amounts to forego harvest in riparian areas, by forest owner objective group

Incentive offer ($/acre/year)[a]	Owner objective group				All owners
	Timber producers	Multiobjective owners	Recreationists	Passive owners	
25	0.32	0.66	0.75	0.37	0.58
50	0.37	0.71	0.79	0.42	0.63
100	0.42	0.75	0.82	0.48	0.68
500	0.55	0.83	0.89	0.60	0.78
1000	0.60	0.86	0.91	0.65	0.81

[a] Computed using Eq. (3), mean values of explanatory variables (Table 4), and the estimated model coefficients (Table 6).

these goals among select NIPF owners. Perhaps the participation of at least a portion of NIPF owners could be enlisted through relatively low cost programs designed to provide technical assistance and education regarding forest practices that benefit riparian species.

On the other hand, our analysis shows that NIPF owners who possess primarily timber objectives tend to own larger tracts of land and a larger proportion of all NIPF land, making their participation in landscape-level riparian management desirable. Policies which provide economic incentives, such as tax relief or cost sharing, may be needed to induce the cooperation of a greater proportion of NIPF owners to overcome opportunity costs associated with habitat enhancement activities. An administrative framework for such a program already exists in the Stewardship Incentive Program. Administered by the USDA Forest Service through state forestry agencies, the Stewardship Incentive Program provides technical and financial assistance to encourage NIPF owners to keep their lands and natural resources productive and healthy (Natural Resources Conservation Service, 1996). Although second highest nationally in terms of acreage enrolled, NIPF owner participation in Oregon remains under one-half a percent, and riparian habitat protection and enhancement activities represent only a small proportion of program activity in the state (New et al., 1997). The specific goals of the salmon initiative, coupled with the notion that many NIPF owners likely would respond to technical assistance and modest economic incentives that foster riparian protection and enhancement practices, would seem to justify expanding the riparian components of the Stewardship Incentive Program in Oregon.

Gottfried et al. (1996) note that landscape-level management can impose unnecessary costs on all landowners if only a small proportion of ownerships provide the "necessary economies of configuration". The forest land of one or several specific NIPF owners may offer greater riparian habitat potential than the forest land of other owners. Ecologists are in the process of identifying potential differences in the quality of riparian habitat as it is distributed across the landscape. Such information would enable programs like the salmon initiative to maximize program efficiency by focusing technical assistance, education, and economic incentives in localities that offer the greatest potential ecological improvement at the lowest program or social cost.

Finally, landscape-level management of ecological processes can involve tradeoffs among different environmental benefits arising from different management scenarios. Until recently, endangered species protection tended to focus more on the specific needs of species than on the interests of private landowners. Including landowners' objectives within a broader ecosystem approach to habitat restoration may yield greater acceptance of ecosystem management goals and greater cooperation in implementing management prescriptions. Concern for balancing the interests of society with the sanctity of private property has arisen largely due to the adversarial nature of federal polices regarding endangered species protection. Recent events in the Pacific Northwest, which seemed to pit the survival of spotted owls against the survival of rural people whose jobs depend on timber, fueled contempt and distrust for governmental and environmental interests. Indeed, today's ideological climate tends to reject a centralized, government planning approach to ecological problems (Gottfried et al., 1996). New approaches to environmental policy, such as the Oregon Coastal Salmon Restoration Initiative, attempt to sidestep potential conflict by fostering collaboration and trust through shared responsibility. If voluntary environmental compliance is most successful when it maintains individual self-esteem and group identification (Firey, 1960, 1963) and links ecological identity with community life (Lee, 1992), then efforts such as the Oregon Coastal Salmon Restoration Initiative, which places the recovery of threatened and endangered species in the hands of all citizens, may permit a resource allocation that is superior for everyone.

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