Journal of Agricultural and Applied Economics, 39,3(December 2007):557–569

Analyzing Landowner Demand for Wildlife and Forest Management Information

Ian A. Munn, Anwar Hussain, Ben West, Stephen C. Grado, and W. Daryl Jones

Determining appropriate topics and target audiences is essential to design effective educational outreach programs. Based on landowner responses to a mail survey, we determined both the importance and the availability of wildlife and forest management information topics to Mississippi landowners. Combining this information clearly identified the appropriate subject matter for outreach programs—topics important to landowners and for which information was relatively unavailable. The importance of wildlife and forest management information relative to its availability depended on the region, land use patterns, and landowner characteristics, thus demonstrating which segments of the population should be targeted to maximize program impact.

Key Words: complementary log-log link, landowner information needs, odds ratio, ordinal regression, outreach program budget

JEL Classifications: C25, Q16, Q23, Q26

Landowner demand for wildlife and forest management information derives from the potential contribution of this information to their land management objectives. The relative importance of various types of wildlife and forest management information can, however, change for a variety of reasons, such as landowner capacity to absorb information, production technology, and/or market dynamics (Feather and Amacher; Just et al.; Lichtenberg and Zimmerman). Consequently, landowner interest in wildlife and forest management information can be expected to change accordingly. Current research on the state of public wildlife and forest management education programs, however, seems to be disproportionately focused on the supply rather than demand side issues of wildlife and forest management information. Commenting on the state of forestry extension education in Mississippi, for instance, Londo noted that a vast majority of the state landowners did not have enough knowledge of conservation programs even though such information is freely available from the forestry and wildlife extension service. Bensel reported that in northwestern Pennsylvania the term "forest

Ian A. Munn, Anwar Hussain, and Stephen C. Grado are professor, assistant research professor, and professor, respectively, Department of Forestry, Forest and Wildlife Research Center, Mississippi State University, Mississippi State, MS. Ben West and W. Daryl Jones are associate professor and assistant professor, respectively, Department of Wildlife and Fisheries, Forest and Wildlife Research Center, Mississippi State University, Mississippi State, MS.

The authors wish to thank Dr. Richard Williams for his technical support on implementing the complementary log-log model and Dr. Changyou Sun for helpful comments on an earlier version of the paper. In addition, the authors are grateful for the insightful review comments provided by three anonymous referees. Their suggestions resulted in substantial improvements to the manuscript. Funding for the project was provided by the Natural Resources Enterprises Program, U.S. Fish and Wildlife Agency.

certification" meant something different to various landowners and that some already believe they are certified because of their participation in otherwise similar programs that tout sustainability. Measells et al. found that few landowners benefit from available forestry educational programs. In the face of scare public funds, the results of these studies actually raise questions about (1) the amount and composition of wildlife and forest management information currently supplied by forestry and wildlife extension officials, (2) landowners' understanding of the information, and (3) whether they benefit from it.

The following questions, in particular, arise. Is there a mismatch between what information landowners want and what information is provided? Have existing program services become redundant because landowners' needs have evolved? Are forestry and wildlife program managers using ineffective conveyance methods? Answers to these questions are important because limited public resources and changing information needs of nonindustrial private landowners suggest that wildlife and forest managers need to make their educational programs more relevant. In the past five years, one-third of the United States and its territories reduced overall forestry program expenditures with the remaining states making major reallocations across various program components because of budgetary constraints (National Association of State Foresters).

Subscribing to the notion that landowners are rational and would maximize the use of available information, in this paper we analyzed the potential for a mismatch between what wildlife and forest management information is available and what is needed by Mississippi landowners. In particular, we asked landowners to rank both the importance and availability of information for several wildlife and forest management topics. By analyzing their responses, we were able to identify topics that landowners deemed relatively important to their land management goals and for which information was relatively unavailable. For these topics, we used a predictive model that related landowner opinions about the importance of wildlife and forest management information relative to its availability to a set of covariates. These covariates included landowner economic and demographic characteristics, location and size of their forestland ownership, and land use pattern. Answers to these questions should make up for the limitations of previous research on the subject (e.g., Measells et al.) as well as help wildlife and forestry extension program officials in reorienting the focus of existing outreach programs in accordance with landowner needs and priorities, while making the most of available public funds for wildlife and forest management programs in Mississippi and states with similar economic and demographic and land use characteristics.

Landowner Demand for Information

Stigler theorized that the amount of information that economic agents collect before making economic decisions is an investment act. Rational agents would, thus, be expected to equate expected marginal benefit of a given piece of information to the associated expected marginal cost. In the context of timber market sales, Munn and Rucker demonstrated how landowners perceive information as a factor of production; Ortmann et al. provided a related analysis in agriculture.

Landowner demand for wildlife and forest management information may be affected by 1) landowner economic and demographic characteristics, 2) location and size of forestland ownership, 3) land use pattern, and 4) the cost of information. Landowner economic and demographic characteristics (e.g., gender, race, age, education, household income, and residence) are important because they proxy landowner management objectives (Amacher, Conway, and Sullivan). Blatner, Baugartner, and Quackenbush, for instance, noted that in the state of Washington, landowners with low incomes and education and those residing farther away from their forested holdings appeared to be less interested in management assistance. Magill, McGill, and Fraser found that in West Virginia, landowners' need for information topics depended on their demo-

Table 1. Wildlife and Forest Management Information Topics of Potential Interest to Landowners

Wildlife management
General wildlife management
Food plot establishment and management
Management of aquatic or wetland resources
Management for specific wildlife species
Harvest strategies for game animals
Economic and financial
Cost-sharing programs (forestry, wildlife)
Business planning for a fee-hunting and/or wildlife-related fee access operation
Marketing a fee-hunting and/or wildlife-related fee access operation
Compatibility of wildlife management with other land uses (e.g., forestry, agriculture)
Legal and institutional
Laws and regulations about wildlife management
Tax implications of a fee-hunting and/or wildlife-related fee access operation
Liability concerns related to fee-hunting and/or wildlife-related fee access

graphic characteristics and ownership objectives. In particular, they found that landowners with large incomes and those who resided on their property were more interested in wildlife and forest management topics than landowners who had low incomes and did not reside on their lands. Furthermore, information in the form of training workshops on forest damage prevention, liability issues, property rights, and taxes were the most preferred. The authors concluded that it might be possible for extension officials to encourage sustainable forest management while simultaneously promoting landowners' private objectives, provided that efforts were focused on a proper mix of information topics.

The amount of land a landowner owns and its location proxy the size and nature of the producing unit. They are, thus, likely to constrain the landowner's choices as a producer and consequently affect the supply of products. All else equal, size of ownership affects the choice of production technology and the range of products that can be produced. Location is a complex property attribute that likely influences the land's suitability for a variety of uses. Any helpful information about the size and location of the property and how it might be turned to the landowner's advantage is likely to be valued.

Land use pattern (i.e., proportion of land allocated to various uses such as agricultural crops, pastureland, aquaculture, forests, wildlife food plots, residential uses, and so on) in part reflects market demand for end products and points to uses that maximize financial returns and/or utility, given landowner characteristics and size of ownership and its location. For instance, a parcel of land may be good for growing trees, but if there are no markets, landowners are not likely to plant trees. Any information that would guide landowners regarding market conditions and how they could profitably be incorporated into wildlife and forest management strategies will likely be valued.

The cost of information is probably the most obvious factor influencing landowner demand for wildlife and forest management information. As wildlife and forest extension personnel typically provide this information to the landowner at no cost, the relevant cost to the landowner is the opportunity cost of the time spent acquiring the information. Other things being equal, the higher the cost of acquisition, the lower the demand for such information.

The list of wildlife and forest management information topics provided in Table 1 is particularly relevant. Although this list does

not include traditional forestry techniques (e.g., thinning regimes, site preparation, natural regeneration versus planting, and so on), wildlife habitat management is done largely through forest management involving these techniques.

Methods

Data Generation

Requisite data for this research were generated as a part of a broader study on wildlife enterprises in Mississippi. Landowners owning a minimum of 100 acres in Mississippi were identified and randomly selected from the county property tax records. One hundred acres was chosen to eliminate urban and suburban properties within the property tax records. In October 2003, 2,000 questionnaires were mailed to a stratified random sample of Mississippi landowners. Consistent with Dillman's survey approach, landowners were mailed a reminder postcard one week after the first mailing and a second questionnaire four weeks after the postcard. The sample was stratified into four land ownership classes: 1) 100 to 199 acres, 2) 200 to 499 acres, 3) 500 to 999 acres, and 4) 1,000 or more acres. Thirty percent of the sample ($n = 600$) was sent to the 100- to 199-acre ownership class, another 30% ($n = 600$) to the 200- to 499-acre ownership class, 16% ($n = 320$) to the 500- to 999-acre ownership class, and 24% ($n = 480$) to the 1,000-or-more-acre ownership class. To ensure a certain minimum number of large landowners in the sample, those in the larger ownership classes were oversampled. During estimation, this feature was accounted for by using sampling probability weights.

A total of 484 questionnaires were returned for a 30% response rate. Formal tests were not performed to assess potential nonresponse bias; however, several factors alleviated concerns about nonresponse bias. Response bias related to ownership size is adjusted for by the weighting scheme used in the analysis, which was based on the number of responses by ownership size category. Response bias associated with other landowner characteristics correlated with ownership size would also be adjusted for, at least in part. Age, education level, and participation in government programs were significantly correlated with ownership size. The weighting scheme for ownership size, therefore, adjusts for biases with respect to these key variables. Mean values for key variables (e.g., average ownership by size class, land allocation by major use, i.e., forestry, agriculture) were very similar to those of Jones et al. despite different survey designs in the two studies, suggesting that response bias was not prevalent. Nonetheless, the possibility of nonresponse bias exists, and results should be viewed accordingly.

Two survey questions were relevant to the objectives of this paper. 1) How important is information about each of the following topics in reaching management objectives on your property? Respondents were asked to circle the appropriate rank ranging from 1 = not important to 5 = very important. 2) How much information about each of the topics do you believe is currently available to you? Respondents were asked to circle the appropriate level ranging from 1 = no information to 5 = complete information? The specific topics are listed in Table 1. An ordered response variable (Z_i) representing landowner information need was derived by combining landowner responses to these two questions,[1] whereby Z_i could take a specific value in the choice set C (Table 2). The response variable Z_i is essentially a measure of need for information based on the importance of information relative to its availability, taking values in the set {"no need = 0 = Z_i," "some need = 1 = Z_i," "need = 2 = Z_i," "high need = 3 = Z_i," "very high need = 4 = Z_i"}. The resulting distribution of landowner need (Z_i)

[1] West and Messmer confronted a similar problem to assess how important a given wildlife management information topic was and whether enough information was available given the importance. However, the method they used to assess a disconnect between importance and availability of information topics ignored the fact that importance and availability were defined on different scales and could not be treated as they did.

Table 2. Landowner Choice Set (C)[a] Based on Importance and Availability of Selected Wildlife and Forest Management Information Topics

Availability (n) 1 (no information) 5 (complete information)	Importance (m): 1(not important), 5(very important)				
	1	2	3	4	5
1	0	1	2	3	4
2	0	0	1	2	3
3	0	0	0	1	2
4	0	0	0	0	1
5	0	0	0	0	0

[a] The landowner choice set C with elements 0, 1, 2, 3, 4 was derived on the basis of the rule: $C = \begin{Bmatrix} m-n & \text{if} & m \geq n \\ 0 & \text{if} & m < n \end{Bmatrix}$.

for each of the 12 wildlife and forest management–related information topics is summarized in Table 3. Clearly, the distributions are skewed regardless of the topic; average scores for individual topics, however, vary, ranging from 0.56 (food plot establishment and management) to 1.30 (liability concerns related to fee-hunting and/or wildlife-related fee access). The average served as a relative ranking of the need for information about the various topics. The wide range of average need scores indicated that the need for additional information was not uniform across topics. In particular, laws and regula-

Table 3. Distribution of Mississippi Forestland Landowner Need Scores Based on Importance and Availability for Selected Wildlife and Forest Management Outreach Information Topics

Outreach Information Topic	Importance relative to availability (Z_i)						
	0	1	2	3	4	Sample	Mean
Food plot establishment and management	205	53	31	6	9	304	0.56
Marketing a fee-hunting, recreational, and/or wildlife-related fee access operation	159	28	27	7	6	227	0.56
Management of aquatic or wetland resources	170	36	29	6	10	251	0.61
Harvest strategies for game animals	184	55	30	8	13	290	0.66
Management for specific wildlife species	182	54	42	6	12	296	0.69
Tax implications of a fee-hunting, recreational, and/or wildlife-related fee access operation	152	33	24	11	12	232	0.70
Business planning for a fee-hunting, recreational, and/or wildlife-related fee access operation	146	33	25	15	8	227	0.70
General wildlife management	178	71	45	6	11	311	0.72
Laws and regulations about wildlife management	181	53	37	11	15	297	0.74
Cost-sharing programs	137	40	42	17	14	250	0.92
Compatibility of wildlife management with other land uses (e.g., forestry, agriculture)	152	44	45	17	20	278	0.95
Liability concerns related to fee-hunting, recreational, and/or wildlife-related fee access	112	43	48	32	26	261	1.30

tions about wildlife management, cost-sharing programs, general wildlife management, compatibility of wildlife management with other land uses, and liability concerns related to fee hunting were the five highest-ranked topics.

While interpreting these descriptive statistics, note that only observations with complete responses to both the importance and the availability question were used. Thus, sample observations with responses such as "do not know" or "not applicable" were discarded. Given the resulting truncated data, regressions were run for all the 12 topics, but in-depth analysis was confined to only five topics with the greatest mean need. Descriptive statistics of the five ordered dependent variables and set of explanatory variables are reported in Table 4.

Theoretical Framework

Landowner need for additional wildlife and forest management information depends on how the information might contribute to the achievement of land management objectives and whether enough of it is already available. For instance, if information on cost-sharing programs is important to a landowner but is readily available, the landowner is not likely to place any value on additional units of such information. In contrast, if information on the topic is important and not enough is currently available, the landowner may be expected to assign some positive value to such information. Since we do not have quantitative estimates on how valuable a given piece of information is to a landowner but rather the ordered response (Z_i), the responses are ordinal in nature. The variable Z_i may be considered as a discretized representation of a latent continuous response variable (ranging from $-\infty$ to ∞) that indicates how valuable additional information on a given topic is to a landowner.

Landowner need is modeled in accordance with the random utility model (McFadden) described in Equation 1:

$$(1) \quad U_{ij} = V_{ij} + \varepsilon_{ij},$$

where V_{ij} is a deterministic component and ε_{ij} is a random component of the utility that captures unobserved characteristics of responses and/or landowners. A landowner responds in a particular way subject to

$$(2) \quad U_{ij} \geq \max U_{ik} \qquad \forall k \neq j, \quad j,k \in C,$$

where C is the set of all potential responses ["no need = 0 = Z_i," "some need = 1 = Z_i," "need = 2 = Z_i," "high need = 3 = Z_i," "very high need = 4 = Z_i,"] common to all landowners. A landowner response is j if and only if it provides a level of utility that is greater than or equal to that of any other response in the choice set. The probability that a landowner response is j is given by

$$(3) \quad P_i(j) = P_{ij} = P[X'_{ij}\beta + \varepsilon_{ij} \geq \max (X'_{ik}\beta + \varepsilon_{ik})],$$

where X'_{ij} is the vector of landowner, ownership, and land use characteristics relevant in explaining landowner need. Note that the opportunity cost of information acquisition is not included. Unfortunately, no good proxy for this cost was available. In all likelihood, however, this cost is minimal because wildlife and forest management extension programs are generally held at times that minimize conflicts with landowner income-earning opportunities.

To quantify relative significance of various explanatory variables hypothesized to influence landowner opinion scores, the complementary log-log model for ordinal response variable was employed.[2] The model derives from extreme-value distribution (McCullagh and Nelder, pp. 151–54; Powers and Xie,

[2] The use of ordinary linear regression would be inappropriate if the responses are ordinal because the spacing of these outcome categories cannot be assumed to be uniform (Daykin and Moffatt 2002, Liao 1994). The use of either ordered probit or logit would be inappropriate as well because these probability models assume a balanced distribution of outcome responses (Z_i = 0, 1, 2, 3 . . . k) across various response categories (J). The appropriate probability model to employ is the ordered complementary log-log model when the outcome responses (Z_i = 0, 1, 2, 3 . . . k) have a skewed distribution (Hardin and Hilbe 2007, p. 147; Dobson, 2002, p. 149; Long, 1997, p. 51).

pp. 83–84) and assumes that Z_i^* is related to X_{ij} according to the link function (Chen and Hughes; Simonoff):

$$\begin{aligned} &\log[-\log(1-\Pr(Z_i \geq j|X) = \tau_j + \beta' X \\ &\quad \Leftrightarrow \Pr(Z_i \geq j|X) \\ &\quad = 1 - \exp(-\exp(\tau_j + \beta' X)), \\ &\quad \text{where } j = 1,\ldots,J-1. \end{aligned} \tag{4}$$

In general, $Z_i = j$ if $\tau_{j-1} < Z_i^* \leq \tau_j$. For the ordered response variable need, the relation of unobserved Z_i^* to the observed Z_i may be described as

$$\begin{aligned} Z_i = 0 &\Rightarrow NON \quad \text{if } \tau_0 = -\infty \leq Z_i^* < \tau_1 \\ Z_i = 1 &\Rightarrow SN \quad \text{if } \tau_1 \leq Z_i^* < \tau_2 \\ Z_i = 2 &\Rightarrow N \quad \text{if } \tau_2 \leq Z_i^* < \tau_3 \\ Z_i = 3 &\Rightarrow HN \quad \text{if } \tau_3 \leq Z_i^* < \tau_4 \\ Z_i = 4 &\Rightarrow VHN \quad \text{if } \tau_4 \leq Z_i^* < \tau_{5=\infty}. \end{aligned}$$

The parameters τ ($j = 0, 1, \ldots, J-1$) are unobserved thresholds defining the boundaries between the different levels of need. These parameters are important in many ways. For instance, statistically significant threshold estimates support the idea that categories in the response variable are indeed ordered. In order for all probabilities to be positive, the restriction that $\tau_0 < \tau_1 < \tau_2 < \tau_3 < \ldots < \tau_{J-1}$ must hold. The parameters in an ordered complementary log-log model are estimated by maximum likelihood. The odds of a unit change in a given explanatory variable (X_l) on the ordered response variable is (Ananth and Kleinbaum; Simonoff):

$$OR_l = \exp\{\hat{\beta}_l[x_l^{(1)} - x_l^{(0)}]\}. \tag{5}$$

Results and Discussion

Estimation results of the ordered complementary log-log regressions for the five information topics with the greatest average need scores are reported in Table 5. Four of these models, namely, models corresponding to liability concerns related to fee hunting, laws and regulations about wildlife management, general wildlife management, and compatibility of wildlife management with other land uses, are highly statistically significant ($p < 0.001$), indicating that landowner scores on need are not independent of the covariates. One model corresponding to cost-sharing programs is significant at 5% ($p < 0.05$). The estimated threshold parameter τ_4 is invariably significant in all five models, τ_3 is significant in all models except the model pertaining to "liability concerns related to wildlife-related fee access," while τ_2 is significant in two models that concern "general wildlife management" and "compatibility of wildlife management with other land uses." Statistically significant thresholds estimates provide empirical support for treating the various response categories as separate categories; amalgamation of any adjacent response categories would entail loss of information. The model dealing with general wildlife management information topic dominates the remaining four models in terms of the number of significant coefficients.

Explanatory variables that consistently have a positive impact on landowner need include household income and land allocated to aquaculture. As indicated by the estimated odds ratios (Table 6), landowners with annual income of \$40,000 to \$80,000 are 97% to 217% more likely than landowners with less than \$40,000 annual income (base category) to need information on general wildlife management, laws and regulations about wildlife management, cost sharing, and compatibility of wildlife management with other land uses.[3] Likewise, landowners with 1% more land allocated to aquaculture compared to bottomland hardwoods (base land use category) are 4% to 7% more likely to need additional information on general wildlife management, cost-sharing programs, and compatibility of wildlife management with other land uses. This finding has special policy significance in light of the fact that aquaculture is a leading sector in Mississippi. As the sector is un-

[3] The percent changes were calculated based on $[\exp(\beta_j) - 1] \times 100$, where $\exp(\beta_j)$ is the estimated odds ratio (or the exponential of estimated parameter β_j) as reported in Table 6.

Table 4. Descriptive Statistics of Variables Used in the Analysis

Variable	Definition	Mean[a]	Standard Error
Dependent variable: Landowner need score (Z_i) of the importance and availability of wildlife and forest management information			
Z_i: 0–4	Topic: General wildlife management	0.72	1.02
Z_i: 0–4	Topic: Laws and regulations about wildlife management	0.74	1.13
Z_i: 0–4	Topic: Cost-sharing programs	0.92	1.22
Z_i: 0–4	Topic: Compatibility of wildlife management with other land uses	0.95	1.27
Z_i: 0–4	Topic: Liability concerns related to wildlife-related fee access operation	1.30	1.38
Explanatory variables (X)			
Economic and demographic characteristics			
Gender	If gender is male, gender = 1, else 0	0.88	0.02
Race	If race is Caucasian, race = 1, else 0	0.92	0.02
Age	If landowner's age is 65 or more years, age = 1, else 0	0.45	0.03
Annual income			
Low	If landowner annual income is less than $40,000, low income = 1, else 0 [Base]	0.28	0.03
Medium	If landowner annual income is $40,000–$80,000, medium income = 1, else 0	0.49	0.03
High	If landowner annual income is more than $80,000, high income = 1, else 0	0.24	0.03
Education			
High school	If landowner has high school–level education, school = 1, else 0	0.27	0.03
Junior college	If landowner has junior college–level education, college = 1, else 0	0.33	0.03
University	If landowner has university-level education, university = 1, else 0 [Base]	0.40	0.03
Residence	If landowner resides within 20 miles of the property, residence = 1, else 0	0.61	0.03
Lessor	If landowner leased land for hunting, lessor = 1, else 0	0.13	0.02
Location and size of ownership			
Mississippi region			
Northwest	If land is located in northwest MS, northwest = 1, else 0	0.12	0.02
Southwest	If land is located in southwest MS, southwest = 1, else 0	0.35	0.03
Southeast	If land is located in southeast MS, southeast = 1, else 0	0.25	0.03
Northeast	If land is located in northeast MS, northeast = 1, else 0 [Base]	0.28	0.03
Miles	Distance (in miles) from the nearest major city to the property	47.39	1.68
Size of ownership			
Small	If landowner owns less than 200 acres, small = 1, else 0 [Base]	0.45	0.03
Medium	If landowner owns 200–499 acres, medium = 1, else 0	0.32	0.03
Large	If landowner owns more than 500 acres, large = 1, else 0	0.24	0.02
Land use pattern			
Crops	% Land in crops, pastures and fallow fields	21.74	1.58
Aquaculture	% Land in farm or stock ponds/aquaculture	0.81	0.18
Other agriculture	% Land in orchards and other agricultural uses	0.64	0.27
Cutover forest	% Land cutover forest land	6.17	1.04
Managed pine	% Land in planted pines	24.97	1.96
Mixed pine–hardwoods	% Land in natural pines/upland hardwoods/mixed pine–hardwoods	32.04	2.03

Table 4. (Continued)

Variable	Definition	Mean[a]	Standard Error
Ponds, lakes	% Land used by natural water bodies (permanent and semi-permanent)	1.30	0.23
Wildlife food plot	% Land in wildlife food plots	1.28	0.26
Other land uses	% Land in other uses (power lines, right-of-ways, residence, other)	2.13	0.24
Bottomland hardwood	% Land in bottomland hardwoods [Base]	8.91	0.89

[a] Descriptive statistics based on the sample (N = 311) corresponding to general wildlife management topic.

dergoing structural adjustments in the face of foreign competition (Dean, Hanson, and Murray) and given that aquaculture ponds may also be suitable for waterfowl hunting and other wildlife-related recreational activities, it is understandable that landowners would need additional information on these topics as they seek alternative profitable uses for these lands.

Explanatory variables that consistently have a negative impact include gender, residence, and proportion of land in natural water bodies, such as ponds, lakes, and streams. Stated in odds ratio terms, male landowners are 44% to 73% less likely than female landowners (base category) to need information on general wildlife management, compatibility of wildlife management with other land uses, and liability concerns related to wildlife-related fee access. Landowners residing on their forest properties are 41% to 44% less likely than otherwise similar landowners who do not reside on their property (base category) to need information on compatibility of wildlife management with other land uses and liability concerns related to wildlife-related fee access. Landowners with 1% more land in ponds, lakes, and streams compared to bottomland hardwoods (base category) are 7% to 10% less likely to need information on general wildlife management and liability concerns related to wildlife-related fee access.

Explanatory variables whose signs vary depending on the topic include education, leasing hunting rights, and ownership location. In particular, landowners with a junior college education, while 45% less likely to need information on general wildlife management and cost-sharing programs, are 68% more likely to need information about liability concerns than landowners with high school education (base category). Landowners who lease hunting rights, while 48% less likely than nonlessors to need information on laws and regulations, are 66% more likely than nonlessors to need information on cost-sharing programs. Likewise, while landowners with properties in southwest Mississippi are 48% less likely than northeast Mississippi landowners (base category) to need information on laws and regulations, they are 56% more likely to need information on general wildlife management.

Overall, these results are intuitively appealing. First, the finding that lessors are less likely than nonlessors to need information on "laws and regulations about wildlife management" suggests that lessors likely researched the relevant laws and regulations prior to leasing their lands. On the other hand, since lessors are generally business oriented, it is reasonable to find that they need more information on cost-sharing programs. Second, the finding that large landowners are less likely than small landowners to need information on the compatibility of wildlife and forest management with other uses of land makes sense. Landowners with large ownerships have greater opportunity to avoid compatibility issues simply by dedicating different portions of their property to different uses. As ownership size decreases, the feasibility of this

Table 5. Estimated Parameters Based on Ordered Complementary Log-Log Regression of Factors Influencing Landowners' Need Scores of Importance and Availability of Wildlife and Forest Management Information

Variable	General Wildlife Management	Laws and Regulations	Cost-Sharing Programs	Land Use Conflicts	Liability Concerns
Economic and demographic characteristics					
Gender	−0.579**	−1.323***	0.388	−0.819***	−0.610**
Race	−0.289	−0.102	−0.722*	0.756	0.076
Age	0.274	−0.221	−0.141	0.026	−0.017
Education					
Junior college	−0.604***	−0.021	−0.600**	−0.234	0.516**
University	−0.306	0.461	−0.310	−0.380	−0.065
Annual income					
Medium	0.913***	0.680**	0.912***	1.154***	0.214
High	0.810***	0.320	0.647***	1.213***	−0.170
Residence	−0.276	−0.169	−0.042	−0.581***	−0.529***
Lessor	0.109	−0.658**	0.504*	−0.288	−0.323
Location and size of ownership					
Mississippi region					
Northwest	0.095	−0.438	−0.039	0.159	−0.859***
Southwest	0.446*	−0.661**	−0.110	0.399	−0.362
Southeast	0.142	−0.100	−0.140	0.065	−0.579**
Miles	0.000	−0.002	−0.003	−0.010**	0.003
Size of ownership					
Medium	0.142	0.319	−0.233	−0.320	0.214
Large	−0.042	0.350	−0.486	−0.544**	0.087
Land use pattern					
Crops	0.002	0.002	0.003	0.002	0.001
Aquaculture	0.069***	0.006	0.035***	0.040***	0.023
Other agriculture	0.027**	0.014	0.003	0.004	−0.008
Cutover forest	0.000	0.006	0.004	0.004	0.000
Managed pines	0.004	0.005	0.002	0.005	0.007
Mixed pine–hardwoods	0.008	0.009	−0.001	0.009	0.006
Ponds, lakes, streams	−0.100***	−0.001	0.006	−0.014	−0.076**
Wildlife food plots	−0.008	0.017	−0.024	−0.006	0.083***
Other land uses	0.034***	0.013	0.004	0.025	−0.001
τ_1	0.797	−0.021	0.088	0.799	−0.243
τ_2	1.740***	0.751	0.684	1.403*	0.264
τ_3	3.057***	1.807**	1.709**	2.410***	1.024
τ_4	3.555***	2.379***	2.517***	3.005***	1.974***
Wald $\chi^2(24)$	73.010	48.770	36.530	59.220	51.890
Pr > χ^2	0.000	0.002	0.049	0.000	0.001
McFadden R^2	0.064	0.066	0.040	0.072	0.062
Observations	311	297	250	278	261

* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

Table 6. Estimated Odds Ratios[a] for the Statistically Significant Factors Influencing Landowner Need Scores of Importance and Availability of Wildlife and Forest Management Information Based on Ordered Complementary Log-Log Regression

Variable	General Wildlife Management	Laws and Regulations	Cost-Sharing Programs	Land Use Conflicts	Liability Concerns
Economic and demographic characteristics					
Gender	0.561	0.266	—	0.441	0.543
Race	—	—	0.486	—	—
Age	—	—	—	—	—
Education					
Junior college	0.547	—	0.549	—	1.675
University	—	—	—	—	—
Annual income					
Medium	2.491	1.974	2.490	3.171	—
High	2.248	—	1.910	3.364	—
Residence	—	—	—	0.559	0.589
Lessor	—	0.518	1.655	—	—
Location and size of ownership					
Mississippi region					
Northwest	—	—	—	—	0.423
Southwest	1.563	0.516	—	—	—
Southeast	—	—	—	—	0.561
Miles	—	—	—	0.990	—
Size of ownership					
Medium	—	—	—	—	—
Large	—	—	—	0.580	—
Land use pattern					
Crops	—	—	—	—	—
Aquaculture	1.072	—	1.036	1.041	—
Other agriculture	1.027	—	—	—	—
Cutover forest	—	—	—	—	—
Managed pines	—	—	—	—	—
Mixed pine–hardwoods	—	—	—	—	—
Ponds, lakes, streams	0.905	—	—	—	0.927
Wildlife food plots	—	—	—	—	1.087
Other land uses	1.034	—	—	—	—

[a] Calculations based on $\{[\exp(\beta_j) - 1] \times 100\}$, where β_j refers to the estimated parameters reported in Table 5.

option decreases. The incremental benefit of additional information regarding the compatibility of wildlife management with other land uses is not likely to be as important to large landowners. Third, the finding that landowners with a junior college education are less likely than landowners with a high school education (base category) to need additional informational on general wildlife management and cost-sharing programs makes sense. It is, however, puzzling that they are more likely than landowners with high school education to emphasize the need for additional information on liability concerns related to wildlife-related fee access. Finally, the negative coefficient on the variable "miles" indicates that landowners with properties located away from urban centers are less likely to need additional

information on compatibility of wildlife management with other land uses is reasonable because it is generally close to urban centers where the opportunity cost of alternative land uses is generally higher.

These results in particular build on Measells et al., who reported no significant differences between Arkansas, Louisiana, Mississippi, and Tennessee forestland landowners except for education, and ethnicity. This study demonstrates that while landowners may be relatively homogeneous in many regards, their need for information differs greatly depending on information topic, substate regions, land use pattern, and economic/demographic characteristics.

Conclusions

Just because a topic is important does not imply that landowners would like to have more information in this area. As landowners learn about a topic or as information requirements change because of new realities of doing business, they start looking for other information. In this regard, the set of topics relating to the "legal aspects of doing business" deserve the attention of extension personnel because Mississippi landowners want to know more about topics including laws and regulations about wildlife management, fee access–related liability, and cost-sharing programs. Likewise, landowners need to have more information about the compatibility of wildlife management with other land uses. Implicit here may be concerns about legal aspects of land management given constraints imposed by environmental regulations (e.g., Endangered Species Act) in terms of how landowners can use their land.

A one-size-fits-all approach should be avoided by forestry and wildlife extension personnel when designing and targeting landowner programs. Insights gained from the predictive model suggested that landowner information needs varied depending on landowner characteristics, size and location of ownership (e.g., Mississippi northeast, southeast, or northwest ecological regions) and land use pattern (share of land under various agricultural production and forestry uses) in each region. Knowledge of landowner characteristics (e.g., education, residence, size of ownership, household income) provides discretion in targeting informational needs of different landowners. We identified statistically significant differences in response ratings based on the following landowner characteristics: gender, income level, education level, and residence location. We did not, however, discern any pattern in response ratings with changes on forestry land uses. Designing programs with these insights in mind, that is, targeting different programs to different landowner groups, should allow extension agents to efficiently utilize available public funds. More important, during periods experiencing tight budgets, cuts should be made not across the board but rather on a selective program basis in light of established landowner needs.

Given the multifaceted nature of subjective issues such as the importance of topics and whether enough information is available, it will be important to supplement mail survey–based results with focus group discussions about landowner informational needs. Furthermore, as Frisvold, Fernicola, and Langworthy demonstrated that demand for information is endogenous, future research would advance our understanding better by jointly modeling the demand for and supply of information on topics of interests.

[Received July 2006; Accepted May 2007.]

References

Amacher, G.S., M.C. Conway, and J. Sullivan. "Econometric Analyses of Nonindustrial Forest Landowners: Is There Anything Left to Study?" *Journal of Forest Economics* 9(2003):137–64.

Ananth, C.V., and D.G. Kleinbaum. "Regression Models for Ordinal Responses: A Review of Methods and Applications." *International Journal of Epidemiology* 26(December 1997):1323–33.

Bensel, T. "Promoting Certified Sustainable Forestry on Private Woodlots in North-Western Pennsylvania: Challenges and Opportunities." *Local Environment* 6(August 2001):257–78.

Blatner, K.A., D.M. Baugartner, and L.R. Quackenbush. "NIFP Use of Landowner Assistance and Education Programs in Washington State."

Western Journal of Applied Forestry 6(October 1991):90–94.

Chen, C., and J. Hughes. "Using Ordinal Regression Model to Analyze Student Satisfaction Questionnaires." *IR Applications* 1(2004):1–13.

Daykin, A.R., and P.G. Moffatt. "Analyzing Ordered Responses: A Review of the Ordered Probit Model." *Understanding Statistics* 1(2002):157–66.

Dean, S., T. Hanson, and S. Murray. *Economic Impact of the Mississippi Farm-Raised Catfish Industry.* Publication 2317, Extension Service, Mississippi State University, 2003.

Dillman, D.A. *Mail and Telephone Surveys: The Total Design Method.* New York: John Wiley & Sons, 1978.

Dobson, A.J. *An Introduction to Generalized Linear Models.* London: Chapman & Hall/CRC, 2002.

Feather, P.M., and G.S. Amacher. "Role of Information in the Adoption of Best Management Practices for Water Quality Improvement." *Agricultural Economics* 11(December 1994):159–70.

Frisvold, G.B., K. Fernicola, and M. Langworthy. "Market Returns, Infrastructure and the Supply and Demand for Extension Services." *American Journal of Agricultural Economics* 83(August 2001):758–63.

Hardin, J.W., and J.M. Hilbe. *Generalized Linear Models and Extensions.* College Station, TX: Stata Corp, 2007.

Jones, W.D., I.A. Munn, S.C. Grado, and J.C. Jones. *Fee Hunting: An Income Source for Mississippi's Non-Industrial, Private Landowners.* FWRC Bulletin No. 164, Mississippi State University, 2001.

Just, R.D., S.A. Wolf, S. Wu, and D. Zilberman. "Consumption of Economic Information in Agriculture." *American Journal of Agricultural Economics* 84(February 2002):39–52.

Liao, F.T. *Interpreting Probability Models.* Thousand Oaks, CA: Sage, 1994.

Lichtenberg, E., and R. Zimmerman. "Information and Farmers' Attitudes About Pesticides, Water Quality, and Related Environmental Effects." *Agriculture, Ecosystems and Environment* 73(May 1999):227–36.

Londo, J.A. "An Assessment of Mississippi Nonindustrial Private Forest Landowners Knowledge of BMPs." *Water, Air, and Soil Pollution* 4(2004):235–43.

Long, J.S. *Regression Models for Categorical and Limited Dependent Variables.* Thousand Oaks, CA: Sage, 1997.

Magill, D.J., D.W. McGill, and R.F. Fraser. "Refining Outreach to Woodland Owners in West Virginia—Preferred Topics and Assistance Methods." *Journal of Extension* 42(August 2004), Internet site: www.joe.org/joe/2004august/rb5.shtml.

McCullagh, P., and J.A. Nelder. *Generalized Linear Models.* London: Chapman & Hall, 1989.

McFadden, D. *Econometric Analysis of Qualitative Response Models*, Z. Griliches and M. Intriligator eds. *Handbook of Econometrics*, Volume 2. Amsterdam: North-Holland, 1984, p. 1395–446.

Measells, M.K., S.C. Grado, H.G. Hughes, M.A. Dunn, J. Idassi, and B. Zielinske. "Nonindustrial Private Forest Landowner Characteristics and Use of Forestry Services in Four Southern States." *Southern Journal of Applied Forestry* 29(November 2004):194–99.

Munn, I.A., and R.R. Rucker. "The Value of Information Services in a Market for Factors of Production with Multiple Attributes: The Role of Consultants in Private Timber Sales." *Forest Science* 40(August 1994):474–96.

National Association of State Foresters. *Forestry Statistics:1998–2002.* Internet site: www.stateforesters.org/news.html 2004 (Accessed December 2005).

Ortmann, G.F., G.F. Patrick, W.N. Musser, and D.H. Doster. 1993. "Use of Private Consultants and Other Sources of Information by Large Cornbelt Farmers." *Agribusiness* 9(July 1993): 391–402.

Powers, D.A., and Y. Xie. *Statistical Methods for Categorical Data Analysis.* New York: Academic Press, 2000.

Simonoff, J.S. *Analyzing Categorical Data.* New York: Springer-Verlag, 2003.

Stigler, G.J. "The Economics of Information." *Journal of Political Economy* 69(June 1961): 213–25.

West, B., and T.A. Messmer. "Impacts and Management of Duck-Nest Predation: The Managers' View." *Wildlife Society Bulletin* 32(September 2004):772–81.