13 Spatial Assessment of a Voluntary Forest Conservation Programme in North Carolina

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North Carolina's Natural Heritage Program (NHP) identifies priority areas for biodiversity conservation and encourages landholders to participate in biodiversity conservation. While there are many other programmes promoting stewardship and conservation of forests and other natural resources, this chapter focuses on participation in the two voluntary programmes offered by the NHP. The chapter also focuses on private lands, which present a greater challenge for biodiversity conservation than public lands. Understanding how private landholders respond to conservation policies is important because they own a significant proportion of forest and other natural areas in North Carolina. Voluntary programmes are increasingly important in US environmental policy, and this study contributes to the literature by evaluating their effectiveness in the private land conservation arena.

The North Carolina NHP is part of the Division of Parks and Recreation within the Department of Environment and Natural Resources. The NHP inventories, catalogues and facilitates protection of the most rare and the most outstanding elements of natural diversity. The elements include plants and animal species that are rare and/or natural communities that are so significant that they merit special consideration. Based on these elements and the feasibility of protection, the NHP has designated approximately 7% of the state as significant areas. The NHP's purpose in designating areas is to allow the public to weigh the significance of various sites and evaluate the likelihood and nature of ecological impacts; to encourage informed evaluations of the trade-offs between biodiversity and development; and to establish priorities for protection of the state's most significant natural areas (North Carolina Natural Heritage Program, 2000).

Landowners can participate in the NHP by registering or designating their land under the programme (considered 'protection'). This chapter considers whether forested lands and lands designated as relatively more important by the NHP are more likely to be protected. Next, this chapter seeks to identify factors correlated with protection, using spatial and logistic regression analysis. The potential determinants of protection are derived from a GIS database, including physical, biological, socio-economic and historical features (Western North Carolina Data System, 2000). This analysis builds on the findings of Mansfield *et al.* (2000) about protection activities (including registration with NHP) in all significant natural heritage areas (including public and private) in the state. We focus in particular on registration and dedication of natural heritage areas by private landowners in western North Carolina. Our analysis suggests how the state or a non-profit agency could encourage landowners to

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conserve more land and indicates whether state programmes for identifying significant natural heritage areas can impact conservation by private landholders.

Natural Heritage Program

The NHP was established in North Carolina in 1975. In conjunction with the Nature Conservancy, the NHP maintains a database of Significant Natural Heritage Areas (SNHA) in the state. The database includes both protected and unprotected sites. They are defined along ecological boundaries and may contain multiple tracts of land under different ownership. According to the NHP (North Carolina Natural Heritage Program, 2000), 'the sites included on this list are the best known representatives of the natural diversity of the state and therefore have priority for protection'.

SNHAs are identified partly based on the NHP's inventory of significant elements. The elements (plants, animals and communities) are ranked according to their rareness on a national, statewide or regional scale. The NHP also ranks each SNHA by ecological significance into categories based on its national, statewide and regional significance. In ranking the sites, the NHP focuses on the rareness of entire natural communities in addition to individual elements. The NHP database includes both the number of element occurrences and the ranking of each site.

The primary boundaries around sites enclose the actual element occurrences and any additional space that needs similar direct protection. Plant species boundaries are the extent of observed and probable occurrence. For animals, the sizes of sites are determined based on known home ranges and appropriate habitat surrounding the area where the animal has been sighted. The size of a site does not depend on the rank of its elements, because the rarity of a species does not determine the area of habitat it requires. In general, however, the site size is determined by the amount of undisturbed community or species habitat, rather than by the theoretical optimal size.

Information for the inventories comes primarily from two sources. First, a network of academicians and private and agency biologists share information collected through their personal work and research. Second, inventories are funded through contracts or grants and carried out as cooperative efforts of the NHP and a variety of other agencies. City and county planning offices, local conservation groups and state conservation agencies help with these inventories. These cooperating organizations often contribute funds to comb the county (or other region) to identify significant elements and areas. Although many agencies contribute to the inventory, only trained community ecologists and biologists may declare a SNHA (L. Pearsall, Natural Heritage Program, 2001, personal communication).

Mechanisms of protection

The NHP offers two types of voluntary agreements to protect SNHAs. The most frequently used is the Registered Heritage Area (RHA), which offers the lowest level of protection for a site. Established in 1985, RHAs are voluntary management agreements that are not legally binding and provide no monetary incentives (such as reduced taxes). Under a RHA, the landowner agrees not to take any action that will harm the species or other ecologically significant features of the land. A RHA may even specify a management plan for the SNHA. In theory the site can be removed from the registry if the landowner allows activities that are harmful to the significant natural resource.

The second type of agreement is a Dedicated Nature Preserve (DNP), which offers property, income and estate tax benefits (similar to conservation easements). In 1985, the Nature Preserves Act authorized the use of conservation easements to create DNPs. The conservation easements programme was established as part of the Historic Preservation and Conservation Agreements Act of 1979 (North Carolina General Statute 121-34 to 42). To receive the income and estate tax benefits, a DNP must be protected in perpetuity.

After SNHAs have been identified, the NHP sends letters to the owners inviting them to participate in either of the two aforementioned protection mechanisms. Depending on the NHP's assessment of the significance of a site, staff may follow up by visiting the landowners. Many private landowners prefer the non-binding, flexible management agreement of a RHA. Sites often include both

public and private lands, both of which are eligible to participate in either of the protection mechanisms. Thus, a SNHA that includes some private lands may be partially protected only by the public landowners, by some combination of private and public landowners, or only by private landowners. This chapter considers the latter two cases.

Other Conservation Options

Landowners in North Carolina have several options for proactively managing their land for biodiversity (Blank, 1999). Many different policies and programmes have been developed to encourage conservation and preservation (which may entail no management) of natural areas. While this is a positive indicator of public demand for preservation of natural resources, the myriad of options may also have slowed participation rates in the NHP. Public and private landholders must decide which programme(s) best meets their needs. These programmes may or may not require a perpetual easement on the property (e.g. conservation easements). Some provide technical assistance and incentive payments for required management practices (e.g. Forest Stewardship Program) while others assist landowners with either technical support or financial assistance for restoration of the habitat or preservation (e.g. North Carolina's Wetlands Restoration Program).

Land trusts are created and administered by non-profit groups to preserve the natural heritage of the countryside through direct land protection, such as conservation easements, voluntary protection agreements, estate planning, donations and bargain sales. Connected as a statewide system, the Conservation Trust for North Carolina has more than 20,408 ha of woodlands, farmlands, greenways and waterways across the state (Blank, 1999). Land trusts may elect to register or dedicate land under the NHP, but they also may pursue a variety of other options for protecting land.

Previous studies

Previous research has considered the conservation motives of landowners, and in particular the motives and objectives of non-industrial private forest (NIPF) owners. One type of landowner important in the US Southeast is the 'absentee landowner' (Amacher *et al.*, 1998). According to this study, more people are investing in land that is distant from their residence. Compared to resident owners, these absentee landowners are less likely to hunt on their land, are generally wealthier but more in debt, and are less likely to harvest, more likely to reforest, and more likely to perceive high risk to forestry investments. Amacher *et al.* (1998) conclude that these 'absentee landholders' are also more likely to participate in conservation programmes.

Another study in Michigan identified differences in landholder habitat management between income-farmers versus non-income farmers as well as new residents versus long-time residents (Ryan, 1998). One of the major differences is that income-farmers and long-time residents prefer more domesticated farm and developed areas while new residents and non-income farmers are attracted to the more natural landscapes of the river and woods. This study also finds that concern for natural features does not appear to be affected by distance, so support for preserving areas and improving water quality could be cultivated throughout a large area (Ryan, 1998).

Megalos' (1999) study in North Carolina found regional differences in landowner willingness to participate in forestry incentive programmes.[1] The study showed that landowners in the coastal plain and rural counties were more likely to participate in programmes with financial incentives than were owners in the piedmont, mountains and urban counties. In terms of education and technical assistance incentive programmes, Megalos again found that coastal plain landowners were more in favour of technical assistance and educational incentives than owners in the piedmont and mountain regions were. Landowners generally preferred private rather than publicly provided technical assistance (Megalos, 1999). Only about four out of ten landowners were aware of financial assistance or cost-share opportunities, suggesting that these incentive programmes designed to shape landowner behaviour may have limited impact due to lack of awareness of them (Megalos, 1999).

Fraser and Magill (2001) found that West Virginia landowners receiving forest management assistance generally proceed to prepare forest management plans, while those not receiving assistance generally do not prepare plans. The size of

ownership is also correlated with the development of management plans. Furthermore, landowners who used services of public agencies typically owned less than 40 ha of land, while landowners who preferred to use consultants or other land management professionals averaged over 122 ha. The number of uses and activities increase in proportion to the level of assistance landowners received. The authors conclude that if a property owner is receiving assistance then the owner is more likely to continue current management and pursue additional management measures on their properties, including conservation measures.

Study Area

Of the 14 million ha in North Carolina, an area of 7,755,102 ha (58%) is forested. The majority of the forestland is classified as timberland, while the remainder is classified as forested parks, wilderness areas, scenic areas and historic sites (Blank, 1999). In North Carolina, the 1990 Forest Inventory Analysis reports that approximately 76% of the forest area is owned by individuals, corporations, farmers, and institutions such as land trusts – collectively known as non-industrial private forestland owners. Forest industry owns about 13% and the remainder is in public (state and federal) holdings.

Western North Carolina is defined to include 24 counties, encompassing the Blue Ridge Mountains and the Great Smoky Mountains National Park. The region has abundant caverns, streams and mountain peaks that draw both tourists and development. In the face of recreational, second home and urban sprawl development pressures, protection of habitats and wildlife today is essential for the future of the region. A detailed database has been developed for this region (Western North Carolina Data System, 2000). Thus, this region makes an excellent case study of the role of the NHP in biodiversity conservation.

Methods and Data

To evaluate what has been protected under the NHP, we use Student's *t*-tests to compare the mean number of elements, ecological rank, size and percentage forest cover of protected and unprotected sites. To evaluate who has protected and possible motivations for participation in the programme, we consider patterns of correlation between protection and characteristics of the site and owner, using spatial portrayals and logistic regression.

The Appendix lists the variables considered in the analysis. The key variable is a binary indicator of whether or not a site has been protected as a RHA or DNP. This is obtained from the NHP database, along with the geographical location of each SNHA, its size, ecological rank, number of element occurrences, and number and type of owners.

Most explanatory variables were defined by extracted spatial data from the North Carolina Data system (GIS data for Decision in Regional Development) and the North Carolina Center for Geographic Information and Analysis. Through several spatial procedures, specific attributes were overlaid and compiled into a single database for statistical analysis.

All spatial data were manipulated to merge with the existing GIS data set from the NHP, which included a spatial characterization of all SNHAs and a separate dataset of protected SNHA.[2] Ecological number and rank were taken directly from the NHP dataset. Distances were calculated in metres, using the centroid or label point of the SNHA polygons. Distances were found from NHP sites to interstate highways, major cities, registered pig farms, chip mills, scenic rivers, wilderness areas, distinctive landscapes and designated trout waters.

Land cover variables were constructed using 1999 Multi-resolution Land Characterization (MRLC) data.[3] The initial 23 classes from the National Land Cover Data Classification System were condensed to nine categories: Water, Developed, Barren, Forest (including wetlands), Shrubland, Herbaceous (grasslands), Cultivated, Sediment and No data. We focus on the percentage of a site that is classified as forest.

NHP sites that overlap with land in the Conservation Tax programme, land trust priority areas, land trust properties, Federal-owned land, Wildlife Resources Commission gamelands and State-owned land were identified by intersecting the two features. Variables were coded as one for NHP sites that share location with any of the above categories.

County-level demographic variables serve as proxies for socio-economic drivers of land-use

change. Using the label points of the counties, one is able to symbolize polygons (counties) and find in which county a SNHA lies.[4] The specific county-level demographic variables to measure growth include the change in median income between 1979 and 1995, the change in agricultural land prices between 1992 and 1995, and the change in population density between 1985 and 1995.

Two additional variables were created to measure political influences. At the county level, the North Carolina State Board of Elections provides the percentage of votes for the Democratic and Republican candidates for President and Governor. Percentage of Democratic votes per county was used. The change between 1981 and 1991 in the sum of natural resources and parks budgets as a percentage of general county revenue was also calculated.

NHP in Western North Carolina

Western North Carolina has 504 SNHAs, or 28% of the state total. Of these, 161 (32%) are registered (134) or dedicated (27), covering 155,214 ha (72%) in 2000. Figure 13.1 shows the distribution of SNHAs, distinguishing those with some private ownership from those solely on public lands.

The majority of SNHAs (53%) were established in the late 1980s, as shown in Fig. 13.2. According to NHP staff, the Pisgah National Forest and the Great Smokey National Park were undergoing management transitions at that time, which resulted in registration or dedication of many SNHAs in these federal areas.

Private SNHAs

In the 24 counties of western North Carolina, 60% (305) of the SNHAs have some private ownership. Of these, 31 (10%) sites are protected by private landowners as either registered (26) or dedicated (7), covering 4088 ha (see Fig. 13.3).

What has been protected?

Our first step is to evaluate what has been protected under the NHP, in terms of ecological significance and land cover. Table 13.1 summarizes the number and extent of SNHAs in western North Carolina. On average, the SNHAs are 91% forested, 6% herbaceous groundcover, and 2% shrubland. More than half of the SNHAs (51%) have at least some herbaceous area, and 27% have at least some shrubland, but the areas covered by these vegetation types are in general much smaller than the area covered by forest. Protected SNHAs have a slightly greater proportion of forest (92%) than unprotected SNHAs on average, but in

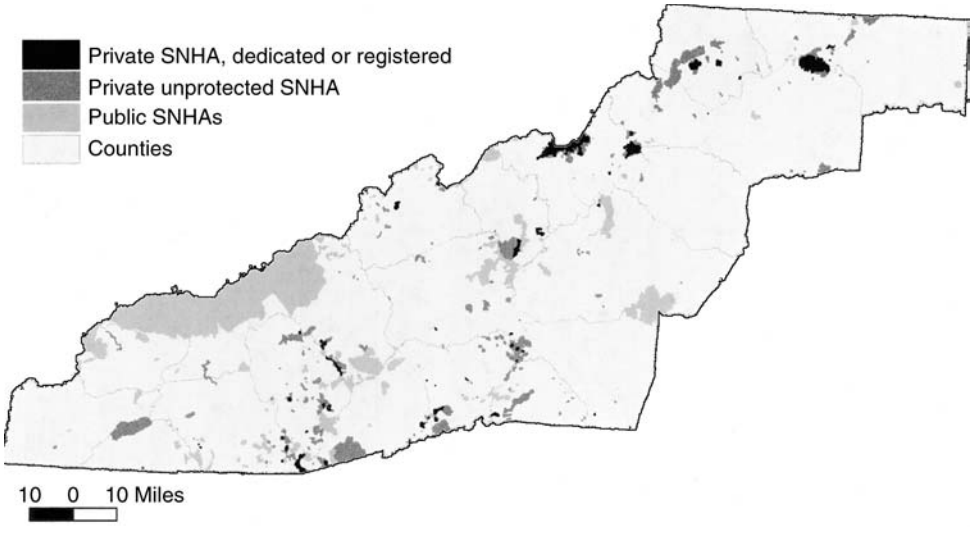

Fig. 13.1. Significant Natural Heritage Areas (SNHAs) in western North Carolina.

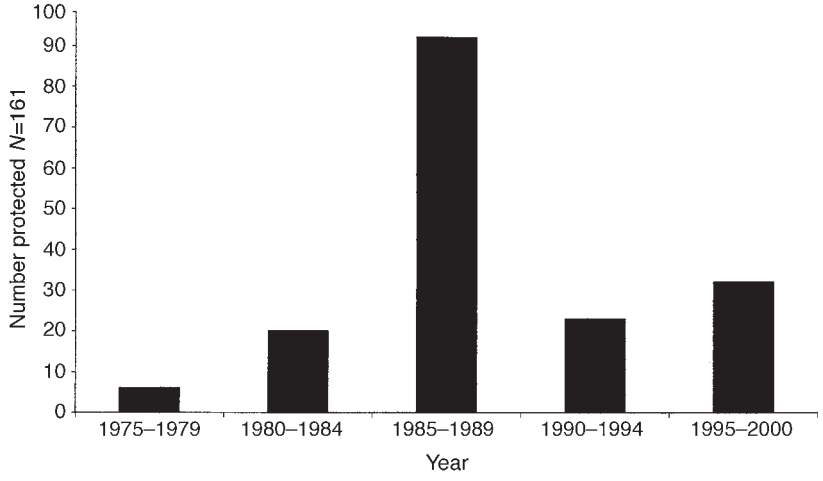

Fig. 13.2. Dedicated Nature Preserve (DNP) and Registered Heritage Area (RHA) establishment.

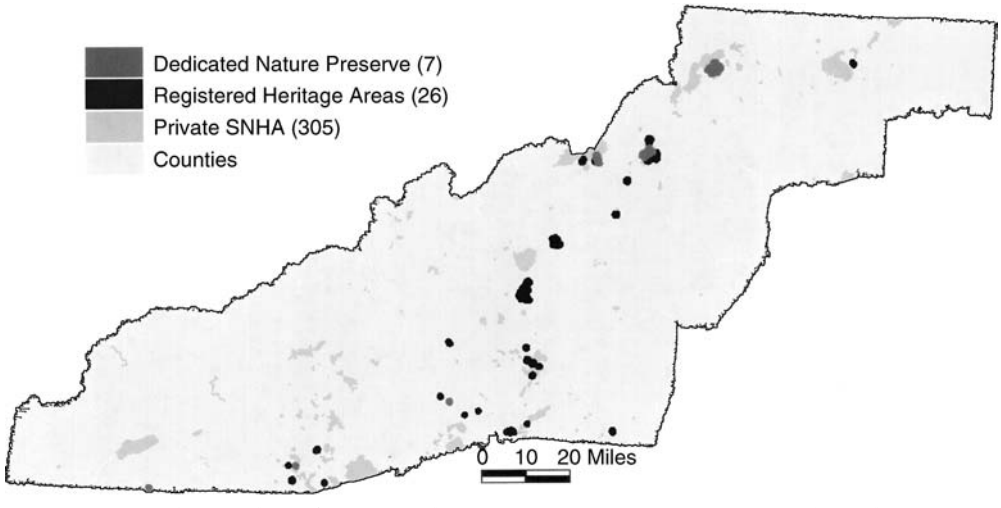

Fig. 13.3. Privately owned Significant Natural Heritage Areas (SNHAs) in western North Carolina.

general, land cover patterns do not differ significantly between protected and unprotected SNHAs. Turning to private SNHAs, forest cover again dominates, and there are no significant differences in land cover between protected and unprotected private sites.

In contrast to land cover, ecological significance does differ between unprotected and protected SNHAs. Following the same pattern as for all SNHAs, the privately protected SNHAs have equal ecological rank (average = 3) and a greater number of elements (average = 12) than all privately owned SNHAs (rank = 3 and number of elements = 9). A *t*-test indicates that the number of elements found on protected SNHAs is significantly higher (at the 10% level) than the number found on unprotected sites. This indicates that the conservation outcome of the voluntary protection mechanisms of the NHP has been to protect sites considered more important for biodiversity by the programme, at least by the criterion of number of elements.

Nevertheless, the percentage of sites registered or dedicated is fairly small. In the next section, we consider what may have motivated these few private landowners to register or dedicate their land with the NHP by analysing characteristics of the property and the owner(s).

Table 13.1. Descriptive statistics for SNHAs in western North Carolina.

	Number of SNHA	Total area (ha)	Percentage forested†	Ecological rank*	Number of elements*
All SNHA	504	245,647	91%	3 (0.808)	10 (11.4)
Protected SNHA	161	177,817	92%	3 (0.790)	14 (13.9)‡
All SNHA with private ownership	305	70,455	91%	3 (0.815)	9 (11.9)
All private protected SNHA	31	7,375	91%	3 (0.675)	12 (13.3)‡

*Mean (standard deviation).
†Average percentage of SNHA that is classified as forest.
‡Mean of protected SNHA significantly different at 10% confidence level from mean of non-protected SNHA, according to *t*-test.

Who has protected?: Model

Private owners of parcels in SNHAs have revenue-generating options ranging from harvest of timber and other forest products to conversion to agriculture or residential plots. They are assumed to compare these to the benefits of preservation in making a decision about whether to participate in one of the NHPs (Mansfield *et al.*, 2000). Private landowners provide the state with ecological goods and services such as biodiversity, species habitat and ecosystem functions. Participation in the Heritage Program is an indicator that they intend to continue providing these goods and services and is thus critical for the future of the state's natural resources.

Landowner participation depends on their desired levels of ecological goods and services, the ability of their land to provide these, perceptions of availability of and threats to these goods and services in the neighbourhood, opportunity costs of forgoing use of the land, preferences and income constraints, and knowledge about the programme. These factors are reflected in owner type, socio-economic characteristics of the county or tract, and ecological characteristics of the site and of the county or region. Our strategy is to identify patterns of association and specifically correlation between the probability of private protection and these factors, rather than generating a predictive or forecasting model. To model these patterns, the following logistic regression is estimated:

$$\text{Prob.}\{\text{protection}\} = \alpha + \beta_1(\text{ecological significance}) + \beta_2(\text{ownership}) + \beta_3(\text{socio-economic}) + \beta_4(\text{political}) + \beta_5(\text{land cover}) + \beta_6(\text{natural resources})$$

where α and β_i are coefficients to be estimated.

The dependent variable, whether or not a site is protected, is provided by the NHP. Potential explanatory variables in each category are listed in the Appendix and are first tested for association with the dependent variable through bivariate logistic regressions, with results also indicated in the Appendix. Ecological rank or number of elements measure ecological significance of a site. These variables are expected to be positively correlated with the probability of preservation because the landowner of more ecologically sensitive land will be subject to more external public and internal personal pressure to preserve.

Turning to the ownership category, SNHAs are defined along ecological boundaries and may contain multiple tracts of land under different ownership. Thus one ownership variable is the number of owners of land in a SNHA. Multiple owners might present a coordination problem and therefore hinder participation. For example, multiple owners might not be able to organize and agree on participation in the programme. Types of owners may also be significant, in particular universities, land trusts and non-governmental organizations may be motivated more by public biodiversity benefits. This may create neighbourhood effects, with private landholders more likely to protect SNHA that share boundaries with government and land trust property, because of increased value placed on open space. Private owners may have chosen to live close to these areas because they enjoy natural areas, or they may have developed an appreciation through the close association. Therefore the intersection of Federal and State lands is expected to be correlated with the protection of private lands in the same SNHAs as the NHP.

Socio-economic variables are expected to have mixed signs. For example, change in land

value might be negatively associated with protection due to the increasing cost of protection, while high tourism sales might encourage participation in order to attract nature tourists.[5] Distances to cities and major highways are expected to be positively related to the probability of protection, as areas close to cities and highways are more likely to be highly valued for other uses. On the other hand, tourism revenues are expected to be positively associated with protection, because much of the tourism in western North Carolina is associated with appreciation of natural areas.

One difficulty with these variables is that they are county-level proxies for landowner characteristics (Mansfield *et al.*, 2000). Rapid development and growth in income, population and land value mean more competition for undeveloped land and a greater opportunity cost for preservation. However, development also puts unprotected natural communities at greater risk than similar communities in counties that are not developing. Faced with greater threats, pressure to preserve may increase. Growth in income and development may also provide more resources for preservation activities at the local level, and potentially may proxy for changing preference for open space and environmental protection as development changes the landscape.

Voting patterns (percentage voting Democrat) and changes in the parks and natural resource budgets represent political determinants.[6] These variables should reflect landholder preferences regarding land preservation and the availability of public support for conservation management and protection options. The 'Park&Rec Budget' as defined in 1990 includes monies for conservation, promotion and development of natural resources, such as soil, water, forests, minerals and wildlife. Thus a positive correlation would indicate that public interest has a relationship with land management.

Percentage of land in forest is expected to be positively associated with the probability of protection because of the public perception that forests are a rich source of biodiversity and an important ecosystem. Studies of NIPF also indicate that many of these landowners have some conservation motives. Natural resources determinants are expected to positively influence protection. Designated trout waters, wilderness areas and scenic rivers indicate similar management objectives as the NHP (preserving the natural habitat). Therefore it is expected that SNHAs in close proximity to these natural resources are more likely to be protected.

Who has conserved?: Results

Table 13.2 presents a logit model of the probability of protecting land in the NHP in the mountain province. While several specifications were tested, the requirement for the model was that at least one variable (e.g. distance to city) from each category of determinants (e.g. socioeconomic) was included in the equation. The results of bivariate regressions (see Appendix) informed the final specification. Full descriptive statistics, results of the bivariate regressions,

Table 13.2. Logit model of SNHA protection.

Variables	Estimated coefficient	*P* value
Constant	–5.33	< 0.0001
Ecological rank	0.91	< 0.0001
Number of owners	1.17	< 0.0001
PC Federal/land trusts	0.54	0.0009
PC City/road	–0.36	0.0047
Tourism	–1.80	0.0691
'Parks&Rec Budget'	0.20	0.1964
Percentage forest	–0.24	0.7773
PC Natural resources	–0.10	0.3229
Number of observations	305 (all SNHAs that include private lands)	
Log likelihood	–172	
Pseudo R^2	0.2449	

Dependent variable = protected (whether or not RHA/DNP).

and alternative specification are presented in Cassingham (2001). In categories with highly collinear variables, principal component analysis was used to create a new variable that captures the highest variance of the group of variables.

As expected, the ecological rank of the site is positively and significantly related to the probability of protection. A higher ecological ranking is more apt to interest the landowner in protection. The number of owners also has a strong correlation with protection. In this data set, the number of owners is collinear with the number of owner categories (non-governmental organizations, land trusts, universities, and state, local and federal agencies). The strong correlation with protection therefore may be due to a positive effect of joint ownership with public and non-profit owners. Government agencies, universities and land trusts may have similar management objectives as the NHP and be more inclined to participate in its protection programmes, thereby raising the awareness and interest of neighbouring private landowners.

Federal/land trust property is a principal component of dummy variables for intersection with state lands, land trust property and federal land. Consistently across specifications the coefficient is positive and significant. The open natural habitat of these areas may encourage the private owner to maintain open space contiguous with the already protected habitat of the federal, state and land trust property.

Socio-economic characteristics of the region were expected to affect private landholders' decisions to participate, either because they represent characteristics of the landholder or because they indicate external pressures. County level administration and characteristics are likely to both influence and reflect local private landowner perceptions because protection takes place at a local level and often in small communities (i.e. 95% of counties in North Carolina are non-urban). However, the change in the budget for natural resources and parks in the counties is not significant. A principal component of distance to cities and distance to highway was used due to the high correlation between them. The coefficient is negative and significant at the 1% level. Thus, SNHAs closer to cities and highways have a higher probability of protection, perhaps due to greater perceived threats to their biodiversity. Tourism in this regression is negative and significant at the 10% level. This could reflect higher revenues from commercial tourism rather than tourism derived from ecological bearings.

This model, as well as other specifications tested, suggests that land cover is not an important factor: owners are as likely to protect forestland as any other land cover. Likewise, distances to other natural resources, and a principal component of such distances, showed no significance.

Discussion

The percentage of SNHAs that have been registered or dedicated by private landowners is fairly small. In western North Carolina, the NHP database lists 305 sites with partial ownership as private. Out of these, only 31 private owners (10%) have opted for one of the protection mechanisms offered by the NHP. Perhaps because of this limited private participation, NHP staff have started to place more emphasis on encouraging private landholders to sell SNHAs to land trusts, rather than just registering them with the NHP. For example, corporate landholders who have consolidated many smaller parcels are often reluctant to register the land but may be interested in selling it to a land trust for tax benefits. NHP can then convert the land to a Dedicated Nature Preserve. While the percentage is small, however, we argue that it is worthwhile considering what factors are correlated with private participation in the NHP, as an example of a voluntary conservation programme. Next, we summarize the factors that may have motivated private landholders to register or dedicate their land with the NHP.

The summary statistics show that sites with a higher number of 'elements' are more likely to be protected by private owners. Ecological rank or number of elements is significant even when other variables reflecting ecological characteristics (percentage forest, distance to roads and other designated natural resources) are included in a multivariate logistic regression. This provides some evidence that the NHP is accomplishing its objective of protecting the most ecologically significant sites. The NHP currently does target owners of more highly rated lands, and these appear to be more likely to participate in the programme. If the NHP wants to encourage broader participation, it may need to modify its programme of information dissemination or offer other incentives.

Other factors associated with private protection of SNHAs were related to land ownership and socio-economic characteristics of the region. The more owners of a site, the more likely it is to be protected. Evidently, multiple ownership does not create a coordination or free-rider problem. The presence of federal or land trust lands also increases the probability of protection by private owners, suggesting that there is not a 'crowding out' effect in voluntary land conservation. Contrary to expectations, we find that SNHAs closer to roads and urban areas, but in counties with lower tourism revenues, are more likely to be protected. Areas closer to roads or urban areas may be perceived as more threatened. Overall tourism revenues may not accurately reflect the degree of dependence on nature-oriented tourism, or private landholders may not recognize their role in providing a landscape conducive to tourism.

Some variables expected to play an important role in conservation decisions, such as land values, are not statistically significant. This may be because of the use of county-level variables. Clearly, information on characteristics of the individual landholders would be most useful, but future research should also consider the use of tract-level variables. Discussions with NHP staff and the regression results suggest that there may be many idiosyncratic factors that affect protection. Examining the NHP in a smaller area, for example one or two counties with tract level and other more detailed data, could perhaps identify some of the key factors which could then be tested at the regional or state level.

Another approach for the NHP would be to focus only on the inventory, identifying the SNHAs and elements. Other programmes with greater public awareness would then concentrate on land acquisition and protection. This study suggests that the information provided by the NHP inventory about the significance of a site may be an important tool for encouraging private landowner cooperation with conservation programmes, such as the Million Acre Initiative with its goal of preserving 1 million additional acres of open space in North Carolina by 2010.

Federal and state regulations and incentive programmes have recognized the importance of private lands to the sustainability and conservation of rare ecological habitat. Even with public support and effort, conservation programmes leave much land exposed to subdivision and development pressure. The resulting loss of natural habitat inhibits ecological and economic values including biological diversity for public benefit. Currently landowners, resource managers, and community leaders struggle to find solutions to fragmented ecosystems and community development pressures. Voluntary programmes such as the NHP are one solution. Our analysis suggests that fragmented (multiple) ownership and proximity to roads and urban areas need not be barriers to private conservation of areas identified as ecologically significant. Programmes such as the NHP can play an important role in raising awareness about the conservation values of lands, allowing landowners to weigh these against the more obvious returns from development, and thus opening the door to voluntary conservation.

Endnotes

[1] Megalos (1999) also characterizes NIPF landowners in North Carolina as predominantly male, an average of 62 years old, with some college education and a 1995 income of US$30,000–50,000. The typical NIPF owner has more than 36 ha of land and has owned it on average for more than 20 years. Further, the majority of landowners reside on their tract, and nearly half of respondents describe themselves as retirees.

[2] The two sets were joined by the intersect process of Arc View Geoprocessing, by which polygons sharing a common boundary are joined.

[3] This land cover data set was produced as part of a cooperative project between federal agencies to produce a consistent, land cover data layer for the USA based on 30-m Landsat Thematic Mapper.

[4] An alternative approach to assigning SNHA characteristics across county lines would be to assign the characteristics of the county with the majority of hectares or an average of the characteristics weighted by SNHA area in each county.

[5] Contrary to expectations, we find that neither the change nor the current level of land value is significantly related to the probability of protection, and these variables are therefore omitted from the final model.

[6] The variable 'Parks&Rec Budget' was taken from Mansfield *et al.* (2000) and is defined as the change in the natural resources and parks and recreation budgets from 1981 to 1991 as a percentage of total general revenue. The sum of the budgets for the Parks and Recreation Department and the Natural Resources were then added together and divided by the total general revenue for

both 1981 and 1991. The data for the parks and natural resource budget were drawn from Census of Governments (Mansfield *et al.*, 2000).

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Appendix

	Variable	Mean (SD)	Significance
	Dependent variable		
✓	Protected = 1 if site is either DNP or RHA	0.319 (0.446)	
	Ecological significance		
✓	Ecological ranking (4 = highest, 1 = lowest)	2.88 (0.816)	< 0.0001
	Number of elements (plants or animals)	9.30 (11.9)	< 0.0001
	Distance to Clean Water Management Trust Fund Sites*	12,790 (7,984)	0.6530
	Distance to Land Trust Priority Lands*	1,534 (12,792)	0.1634
	Distance to Conservation Tax Credit Programme*	22,648 (14,966)	0.1489
	Ownership		
	Size (ha)	231 (691)	0.0052
✓	Number of owners	4 (1.37)	< 0.0001
	Owner college	0.010 (0.009)	0.2556
	Owner corporate	1 (0.052)	0.1297
✓	First Principal Component of intersections of SNHAs with land trusts, priority federal land trust areas, federal lands, state lands and conservation tax programme	–4.26 (1.15)	< 0.0001
	Socio-economic		
	Distance to interstate highway*	94,606 (78,938)	0.6672
	Distance to nearest city of population > 50,000*	161,615 (114,682)	0.5031
	Distance to registered pig farms*	74,938 (49,976)	0.4088
	Distance to chip mills*	45,072 (27,940)	0.9566
	Change in agricultural land values in county between 1991 and 1992	644 (482)	0.2500
	Estimated market value of land and buildings: average per acre (dollars) from 1997 Census of Agriculture	3,153 (926)	0.1822
	Change in population density of county between 1985 and 1995		
	Change in median income of county between 1979 and 1995	812 (9.50)	0.5426
	Gross sales of Cottages, Motels, Hotels of county between 1996	$15,533 ($4,291)	0.6197
✓	and 1997	$14 million ($23)	0.0678
✓	First Principal Component of distance to major highways and cities with population > 50,000	–1.12 (1.37)	0.9030
	Political		
✓	Change in Parks and Natural Resource Budget of the county	0.272 (1)	1.701
	County percentage of votes for Democratic governor	–2.26 (1.15)	0.110
	County percentage of votes for Democratic president	–1.12 (1.37)	0.103
	Land cover		
✓	Percentage of forest cover in site	0.910 (0.196)	0.4606
	Percentage of shrubland cover in site	0.015 (0.054)	0.5802
	Percentage of herbaceous cover in site	0.079 (0.185)	0.0686
	Natural resources		
	Distance to designated trout waters*	4,520 (3,166)	0.7649
	Distance to wilderness areas*	37,137 (25,488)	0.0711
	Distance to scenic rivers*	8,174 (6,448)	0.7962
	Distance to distinctive landscapes*	20,298 (22,120)	0.5441
	Distance to critical habitat*	14,477 (16,157)	0.2313
	County designated as a priority wetland sub-basin	0.537 (0.499)	0.0264
✓	First Principal Component of distance to scenic rivers, distinctive landscapes, critical habitat and designated trout waters	2.04 (1.38)	0.3382

Notes:
Sample = 305 SNHAs with private ownership in Western North Carolina.
Variables used in logistic model are indicated with a tick in the first column.
Significance is the probability value from a bivariate logistic regression on the probability of protection; values < 0.01 indicate a statistically significant association of the variable with the probability of protection.
*Distances are measured as minimum distance from centroid of site to edge of specified site.