The Effects of Scale on Conservation Prioritization
for the Southern Piedmont, NC

By:

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Abstract

Opportunistic conservation, in which organizations wait for a crisis situation or for landowner initiation, is increasingly being abandoned in the land trust community for conservation prioritization. The advent of Geographical Information Systems (GIS) easily allows for the integration of geospatial data into a type of suitability analysis, allowing an organization to rank prospective sites. When prioritizing efforts, however, the question of what scale at which the analysis should be completed is an inevitable challenge. In this study, both county- and regional-level prioritizations were completed for the 10 counties of the Yadkin-Pee Dee River Basin in the Southern Piedmont of North Carolina, the operating region for the LandTrust for Central North Carolina (LandTrust). In the county-level analysis, the top 10 parcels from each county were identified, while in the regional-level analysis, the top 100 parcels overall were identified. Finally, the LandTrust’s currently protected properties were evaluated to determine their conservation value. The analysis, based on the goals of the LandTrust, incorporates species and ecosystem, water feature, and adjacency to protected property criteria. Results suggest that conservation value is not equally distributed across the region; rather, more value is found in 2 counties (Richmond and Montgomery). The LandTrust may not want to exclusively focus on these counties, however, especially due to the heavy state and federal involvement in these areas. Additionally, the agricultural counties of the region may benefit from the protection of water quality. Analysis of the LandTrust’s currently protected properties shows that while much conservation value has been protected through their efforts, there are a number of unprotected properties remaining that may have more overall value than their past projects. Therefore, it will be important for the LandTrust to continue protecting properties throughout their region, but also to incorporate the results of the regional prioritization into their conservation efforts, so as to more effectively achieve their goals.
Acknowledgements

I would like to thank the staff of The LandTrust for Central North Carolina, especially Michele d’Hemecourt and Crystal Cockman for collaborating with me on this project. Additionally, I am appreciative of my internship with the Conservation Trust for North Carolina which provided me with knowledge and insight into the land trust community. I am also grateful for the direction and suggestions provided by Dr. Dean Urban and my advisor, Dr. Patrick Halpin. Finally, I would like to express my gratitude to Andrew Hartzler for his support throughout this process.
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Introduction

Many regions of the United States are experiencing increased development of once forested or agricultural lands. North Carolina is one of the most rapidly growing states, seeing an increase in population of approximately 7.9%, from 8.1 million in 2000 to 8.7 million in 2005 (U.S. Census Bureau 2006). The population is expected to further increase to 10.8 million by 2020 (NC DENR 2007). With this influx of people, the rate of land conversion from farm and forest to development has increased 16% from 1982 to 1997, and estimates suggest that the state is losing 277 acres a day to development (NC DENR 2007). Historically, areas like the southern Piedmont experienced an initial deforestation for agriculture, but rebounded through a subsequent reforestation when the agricultural fields were abandoned, creating a complex landscape of fields and forest of varying ages (Oosting 1942). While North Carolina is traditionally a rural state, many of these areas are being developed, and the implications of such land use conversions are many.

Land use conversion for development can negatively affect common and rare species alike, through the outright destruction or degradation of habitat. Species that require a narrow range of habitat characteristics may be displaced by habitat destruction and potentially extirpated entirely from a region, affecting overall diversity. Species that are habitat generalists may survive in less optimal conditions, but typically with a decrease in fitness (Fahrig 2003). While the Endangered Species Act (ESA) protects listed animal species by prohibiting alterations of their habitat, Wilcove et al. (1998) found habitat destruction and degradation as the primary threat affecting 85% of the listed species they studied. Despite status under the ESA, listed species are greatly
affected by the actions of private landowners. When a listed species is found on private land, it is approximately 9 times more likely to decline in viability than species found on government-owned and managed land (Noss 1997). Moreover, listed plants are not afforded the same protection as animals under the ESA, and they may be destroyed by a private landowner as he is recognized to hold the right to the production of the land (Cf. 16 U.S.C. § 1532(8), § 1532(14)). Clearly many species are not sufficiently protected, even with state or federal legislation.

Habitat loss through land conversion also affects the landscape and can cause isolation among the remaining habitat patches. Patches of suitable habitat become lost in a matrix of development or other non-habitat land uses such as agriculture, decreasing the overall connectivity of the landscape and the ability of species to travel between habitat patches (Bender et al. 2003). In turn, this decrease in species movement can decrease genetic diversity as well. Habitat patch isolation can also increase edge effects, so that invasive species and disease may have more of an effect on the patch and its species. Additionally, as a patch becomes smaller, the likelihood that populations of species inside the patch will remain viable also decreases, as they are all competing for the same resources and have minimum area requirements for reproduction and survival (Debinski & Holt 2000).

Land conversion can also have negative effects on streams and wetlands through increased runoff from impermeable surfaces and agricultural fields, to the detriment of habitat and drinking water quality. Sources of water pollution include soil and sediments, especially those which are washed away when an area is logged; nutrients from fertilizers applied to agricultural fields or from animal wastes, such as nitrate and phosphate; and,
chemical pollutants from roadways, including oil and salt. Additionally, canopy cover over a stream decreases water temperature, which increases the capacity for dissolved oxygen in the water, critical to supporting aquatic life (Clinnick 1985). Vegetation is also essential for reducing the velocity of water before it flows into streams, thereby allowing for the deposition of particles in the buffer zone (Clinnick 1985). The importance of vegetative buffers is recognized in a number of programs aimed at protecting water quality through the conservation of buffers, including the North Carolina Clean Water Management Trust Fund (CWMTF; http://www.cwmtf.net/), and the creation of buffers, like the Conservation Reserve Program (CRP; http://www.nrcs.usda.gov/programs/crp/).

While harmful to surrounding ecosystems, environmental degradation does not always factor into the decision making process used by private landowners when considering whether to develop land. The land trust community seeks to educate and help private owners that wish to see their land protected from development in the future through methods such as fee simple acquisition and conservation easements. Acquisition requires the land trust to purchase the property, at fair market or a bargain sale price, while conservation easements allow the current landowner to retain the property with extinguished development rights. Both bargain sales and donations of easements allow for the protection of the property and tax incentives for the landowner due to the loss of income from the sale or from the diminished property value. The land trust movement is newer in the south, but to date there are 23 local land trusts operating under Land Trust Alliance policies in North Carolina. As of 2004, together they protect over 180,000 acres in 998 sites across the state (CTNC 2007).
Although managers would like to protect as much habitat and open space as possible, doing so is neither feasible nor practical. Most conservation organizations have limited financial and staff resources. It is therefore necessary for organizations to make difficult decisions in order to most effectively conserve sites. How to choose the sites to protect has been the subject of debate among academics, conservation organizations, and the government alike. Historically, sites were chosen for conservation based on a single-species or crisis situation approach. If a site was in eminent danger of being destroyed through development and was home to a rare species or contributed to open space, it would be a top priority for conservation. Protecting sites in this manner, however, may not be cost-effective (Pressey 1994). It is difficult for many owners approached with money from development companies to reduce the selling price for a land trust, making the amount needed for conservation extremely high. Other conservation sites have been chosen for their aesthetics and tourism value, or because they are unsuitable for agriculture or development. While these sites preserve open space and scenery, they may not aid in the protection of native species (Pressey 1994) or water quality. Land trusts specifically begin by protecting properties that are brought to them by landowners, who invariably see their property as valuable. Practicing these types of opportunistic conservation, however, may not ensure the protection of valuable properties. Citing conservation projects requires planning and not convenience in order to efficiently achieve the organization’s goals.

While increasingly common in academic and large organization projects (e.g. Sarakinos et al. 2001), local land trusts are more frequently employing Geographical Information Systems (GIS) as a tool to cite conservation projects. Similar to suitability
analysis (McHarg 1969, Miller et al. 1998, Collins et al. 2001), a number of data layers representing conservation features can be integrated to determine areas of high importance, allowing the land trust to set priorities across their area of operation. Unlike opportunistic conservation, such analyses allow a land trust to select where it would like to protect properties based on environmental and cultural data, increasing the impact of their work and funds and more accurately fulfilling the organization’s goals and mission statement.

The LandTrust for Central North Carolina (LandTrust) is a local land trust currently reevaluating its land protection strategies. The LandTrust operates in the Yadkin-Pee Dee River Basin within the southern Piedmont of North Carolina, with the goal of protecting natural areas, open space, agricultural and timber lands, and historical sites. In the past, they have typically protected properties through the suggestions of landowners, or when a site is being considered for development. Recently, however, the LandTrust decided to develop a method of prioritizing their conservation efforts, so as to protect the most valuable parcels in their 10-county region. Specifically, the LandTrust is interested in protecting against the effects of land conversion: the destruction of habitat, decrease in water quality, and fragmentation of the landscape, while protecting the largest parcels in the region. The LandTrust is primarily focused on distributing conservation effort equally across the region, through identifying the 10 highest-ranking parcels in each of the 10 counties. The issue of scale, however, may be a very important determinant of where resources should be expended – at the local or regional, watershed level.
The objective of this project is to design a series of GIS models to enable the LandTrust to evaluate the parcels in its coverage area so that it may set conservation priorities. These models will be easily updatable to include new data as it becomes available, as well as easily modified should new criteria be added in the future. In addition to identifying the top 10 parcels in each county, the effects of scale will be analyzed by prioritizing the top 100 parcels in the entire region as a whole, to determine whether the LandTrust should be focusing on small-scale local conservation, or adopt a more watershed-wide approach. The same criteria for ranking the parcels will be applied to the LandTrust’s already protected properties, to determine how well their conservation methods have worked in the past.

Methods

Study Site

The LandTrust operates primarily in the Yadkin-Pee Dee River Basin portions of a 10-county region, including: Anson, Cabarrus, Davie, Davidson, Iredell, Montgomery, Randolph, Richmond, Rowan, and Stanly counties (Fig. 1). Development pressures are high in this area, as the region contains a number of large municipalities and is part of the Interstate 85 corridor. The region lies in what is known as the Piedmont Crescent, the counties between the rapidly developing city of Charlotte to the southwest and the state capital of Raleigh to the east. Further development in this area is expected, continuing the Atlanta, Georgia-Charlotte corridor further into North Carolina (Northwest Piedmont Council of Governments, 1996). The population of the river basin alone is expected to increase from approximately 1.4 million in 2000 to almost 2 million by 2020, a 36% increase (NC Division of Water Quality, 2003).
Figure 1 – The LandTrust’s 10 county region in the Piedmont Crescent includes a number of large municipalities.

The region contain a number of historic and conservation resources, including Reed Gold Mine State Historic Site, the Uwharrie National Forest, the Pee Dee National Wildlife Refuge, the Sandhills Game Lands, rare hillside seepage bogs, and a number of state and federally endangered and threatened species (NC Division of Water Quality, 2003). Currently, the LandTrust holds conservation easements for or owns 98 properties, with the majority in Rowan County (Fig. 2). Other conservation and governmental organizations, such as The Nature Conservancy, US Forest Service (through Research Natural Areas), Wildlife Resources Commission, and the Fish and Wildlife Service also
protect land within the region, resulting in the conservation of a number of significant sites.

Figure 2 – Both the LandTrust and other conservation organizations, such as The Nature Conservancy and state and federal government protect a number of sites across the region. (Other protected properties, however, may include USFS lands currently in production, which may not be compatible with conservation.)

**Model Construction**

The prioritization of conservation projects in the LandTrust’s region was completed at the parcel level, using data obtained from each of the counties. Preparation of this data varied, as each county has different data standards. Parcels representing roads and rivers were removed for a number of counties for simplification. The ranking priorities were based on criteria already used by the LandTrust, including the protection
of large parcels, the conservation of rare species habitat and ecosystem types, the protection of water quality, and proximity to currently protected properties. Geospatial data representing each of these goals was obtained from a variety of sources, summarized in Table 1. Models constructed using ArcInfo, version 9.2 were used to quantify the goals of the LandTrust, and to summarize the value of each parcel in the region (Appendix I).

Table 1 – Summary of GIS data used in model construction.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Year</th>
<th>Producer</th>
<th>Specific Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Heritage Element Occurrences</td>
<td>The locations of all the rare species and ecosystems in NC</td>
<td>2006</td>
<td>NC DENR, Div. of Parks and Recreation, Natural Heritage Program</td>
<td>To calculate the proximity of the parcels to the locations of endangered or threatened species or rare ecosystem types</td>
</tr>
<tr>
<td>Hydrography</td>
<td>Rivers and streams in NC</td>
<td>2004</td>
<td>BasinPro8</td>
<td>To calculate the proximity of the parcels to aquatic features</td>
</tr>
<tr>
<td>National Wetland Inventory</td>
<td>Areas of all wetland types as interpreted from satellite imagery</td>
<td>2006</td>
<td>US Fish and Wildlife Service, National Wetlands Inventory</td>
<td>To calculate the proximity of the parcels to wetlands</td>
</tr>
<tr>
<td>LandTrust Protected Properties</td>
<td>Locations of all properties protected by the LandTrust</td>
<td>2007</td>
<td>LandTrust for Central NC</td>
<td>To calculate the proximity of the parcels to already protected areas</td>
</tr>
<tr>
<td>Lands Managed for Conservation and Open Space</td>
<td>Areas conserve and priorities for conservation</td>
<td>2002</td>
<td>NC Center for Geographical Information and Analysis</td>
<td>To calculate the proximity of the parcels to already protected areas</td>
</tr>
<tr>
<td>Land Use/Land Cover</td>
<td>Land use and land cover classifications for NC as interpreted from satellite imagery</td>
<td>2001</td>
<td>US Geological Survey, 2001</td>
<td>To exclude parcels with non-compatible land uses as well as to predict threats</td>
</tr>
<tr>
<td>County parcels</td>
<td>The parcel data for each county</td>
<td>Ranging from 2000 to 2007</td>
<td>County GIS departments</td>
<td>The planning units for the prioritization</td>
</tr>
</tbody>
</table>

**Land use model**

Not all of the 500,000 total parcels in the 10 county region are appropriate for conservation, and unsuitable parcels were initially eliminated using both the land use classification as well as size. Land uses that are incompatible for conservation were
excluded. All types of development were removed from the classification, ranging from low-density residential to high-density commercial and industrial. While the low-density category also includes recreation areas and vegetation planted for aesthetics, it was assumed that these areas are already managed and would likely contribute little to rare species habitat. Agricultural lands were excluded despite the growing interest in working farm easements, because without further information about the type and size of the agricultural production, they are difficult to prioritize. Additionally, the goal of conserving rare species is not compatible with agricultural practices, as evidenced by the high number of endangered species negatively affected by cultivated lands (Czech et al. 2000).

Zonal statistics to calculate the majority land use of each parcel were used to determine whether a parcel should be retained. Parcels with a majority of desirable land use were retained, and then further paired down based on parcel size. Any parcel less than 40 acres in size was removed from the analysis, as the LandTrust does not typically protect parcels this small, due to their negligible conservation benefits versus the cost and effort required to ensure protection. Adjoining suitable parcels were not aggregated to accommodate the 40 acre size requirement, due to the difficulty of acquiring multiple parcels owned by different individuals, and therefore the final parcels retained may be an underestimate. Based on the land use model output, percent and number of acres of incompatible land uses were calculated for each of the counties and the region to determine the need for land conservation in the area.
Calculation of species and ecosystem value

The protection of rare species and ecosystem types is one of the LandTrust’s priorities, and their total value across the region was calculated using Natural Heritage data. Both element occurrences of species and ecosystem types, as well as macro- and megasite locations were considered. All element occurrence records were used, including those that represent extinct species or those with low viability, as the points may still indicate good-quality habitat that may be used by the species in the future. The spatial precision of each occurrence, represented by an uncertainty distance in meters, was used to buffer each point to determine the window in which the species may be found. Aquatic species, which typically have the lowest accuracy, were buffered and then the streams falling within this area were isolated. Only these streams were included as potential species habitat, to help decrease unnecessary buffer on land. For terrestrial and wetland species, any occurrence with a low accuracy was given a score of 1, and those with high accuracy a score of 2. Macro- and megasites were all current and do not have precision values associated with them, and required no additional processing. The element occurrence and macro- and megasite rasters were all added to calculate the total species and ecosystem value for the entire region, ranging from 0 to 6.

Calculation of water features value

Buffering capacity of protected land is an important characteristic for water quality, which is also a priority for the LandTrust. The hydrography of the Yadkin-Pee Dee River Basin was used to identify a parcel’s proximity to streams or rivers. A 50 foot buffer was applied to the water features, as this is the minimum buffer value as identified by best management practices in North Carolina (NC DENR 2003). Additionally, the
National Wetlands Index (NWI) was buffered to 50 feet as well, and the wetlands buffers were subsequently added to the stream buffers to create a total water feature value raster for the entire region.

*Calculation of the adjacency value*

The final priority of the LandTrust is protecting large areas of land, especially through the protection of parcels adjacent to conservation properties. To calculate this value, the parcels adjacent to the protected conservation properties were identified. Conservation properties included those protected by the LandTrust and those protected by other organizations. They were considered separately, enabling the ranking of the LandTrust’s current properties, to determine how much conservation value they protect. To prioritize future parcels, the two adjacent parcel rasters were combined to create an overall value raster depicting the parcels adjacent to already protected properties.

*Total conservation value*

The total conservation value raster was calculated by adding the species and ecosystem, buffer quality, and adjacency values. The individual elements were weighted equally, because the LandTrust identifies all 3 as important goals, behind only the size of the parcel. The resulting total conservation value ranges from 0, for no valuable features present, to 16, indicating that the area has all of the features described above. The area of each value class was also calculated for each of the counties and across the entire region.

*Prioritization*

The total conservation value raster was aggregated to the parcel level by analyzing the counties separately to determine the 10 highest-ranking parcels in each. The sum of the conservation value within each parcel was calculated using zonal
statistics, which was then divided by the parcel’s total acreage, giving the average value across the parcel. The county-level prioritization was completed by selecting the top 10 in each of the counties, based on their conservation value score. For the regional-level prioritization, the parcels were prioritized in the entire region by merging all the potential parcels. From this prioritization, the top 100 parcels from the entire region were isolated and compared to those identified in the county-level parcel prioritization. Additionally, the value of the LandTrust’s currently protected properties was calculated separately using a modified total conservation value raster that did not include the adjacency value for these properties, in order to assess the value of the property prior to protection.

**Results**

*Land use*

The land use model greatly reduced the number of parcels in the region based on their land use classification and size. The entire region initially consisted of 465,780 parcels, and only 10,887, or 2.34%, were retained for the prioritization. Anson County retained the highest number of parcels, at 9.85%, followed by Montgomery County at 6.16% (Fig. 3). Number of parcels, however, can be misleading, as urban areas may have many small parcels, while rural areas may have fewer parcels of larger size, making it important to also examine the total number of acres retained. The entire region totaled 2.74 million acres, and approximately 45% or 1.23 million acres were retained. Anson County retained 75.14% of its acres, while Montgomery retained 69.63% (Fig. 4). Richmond County, which only retained 3.81% of its parcels but retained 65.99% of its acres, may have many remaining large parcels that are suitable for conservation. It is not surprising, therefore, that Montgomery, Richmond, and Anson Counties have the highest
percent of acres compatible with conservation, while Davie, Iredell and Rowan Counties have the least (Table 2).

Figure 3 – Total and retained parcels for each of the counties, in thousands of parcels.
Figure 4 – Total and retained acres for each of the counties, in thousands of acres.

Table 2 – Percent of desirable and undesirable land use acres in each county and the region.

<table>
<thead>
<tr>
<th>County</th>
<th>Total Acres</th>
<th>Percent Undesirable</th>
<th>Percent Desirable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anson</td>
<td>343650.29</td>
<td>22.95</td>
<td>77.05</td>
</tr>
<tr>
<td>Cabarrus</td>
<td>233415.84</td>
<td>46.38</td>
<td>53.62</td>
</tr>
<tr>
<td>Davidson</td>
<td>363272.64</td>
<td>38.95</td>
<td>61.05</td>
</tr>
<tr>
<td>Davie</td>
<td>170615.10</td>
<td>44.17</td>
<td>55.83</td>
</tr>
<tr>
<td>Iredell</td>
<td>379680.93</td>
<td>49.83</td>
<td>50.17</td>
</tr>
<tr>
<td>Montgomery</td>
<td>320948.01</td>
<td>15.11</td>
<td>84.89</td>
</tr>
<tr>
<td>Randolph</td>
<td>505762.79</td>
<td>36.73</td>
<td>63.27</td>
</tr>
<tr>
<td>Richmond</td>
<td>306965.82</td>
<td>21.69</td>
<td>78.31</td>
</tr>
<tr>
<td>Rowan</td>
<td>335154.37</td>
<td>45.23</td>
<td>54.77</td>
</tr>
<tr>
<td>Stanly</td>
<td>258959.22</td>
<td>45.16</td>
<td>54.84</td>
</tr>
<tr>
<td>Region</td>
<td>3218425.00</td>
<td>36.12</td>
<td>63.39</td>
</tr>
</tbody>
</table>
Conservation value

The results of the species and ecosystem value calculation show a hotspot near the Sandhills Game Lands and along the Yadkin River (Fig. 5). Circular areas of value represent buffered element occurrences, but because of their low precision, they were not weighted as heavily as more precise occurrences. The water features value (Fig. 6) also clearly defines the Yadkin and Pee-Dee Rivers, along with the other smaller water bodies in the region. Finally, the adjacency value shows a concentration of protected and subsequently, adjoining properties in Anson and Montgomery Counties, due to the Sandhills Game Lands and the Uwharrie National Forest (Fig. 7).

The total conservation value of the 10-county region ranges from 0 to 16 features (Fig. 8). The areas of highest value include the land along and to the east of the Yadkin River and around the Sandhills Game Lands. Because the LandTrust only works within the Yadkin-Pee Dee River Basin, however, much of the highly valued area near the Game Lands is outside of their primary focus area, and was excluded from the final prioritizations. Approximately 64 percent of the entire region’s acres are ranked as 0 conservation value, with Randolph County having the highest acreage of 0 conservation value at 82 percent. Montgomery and Richmond Counties were the only counties to have the highest conservation value of 16, at approximately 9 acres combined.
Figure 5 – The overall species and ecosystem value of the region.

Figure 6 – The stream and wetland value of the region.
Figure 7 – The adjacency to protected properties value of the region.

Figure 8 – The total conservation value for the entire region.
County parcel prioritization

The prioritization at the county level yielded the scores for each property, and the top 20 parcels from each county are shown in Figures 9 and 10. There was high variation between the conservation value to acreage ratio between the counties, however, as shown in Table 3. Davidson County had the highest maximum ratio, and therefore the highest-ranking parcel, at 447.20. Both Cabarrus and Anson Counties had low maximum and means, suggesting that these counties’ parcels are not as valuable as those found in other counties.

Table 3 – Maximum and mean conservation value to acreage ratio for parcels in each of the 10 counties.

<table>
<thead>
<tr>
<th>County</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anson</td>
<td>339.67</td>
<td>28.81</td>
<td>37.35</td>
</tr>
<tr>
<td>Cabarrus</td>
<td>332.01</td>
<td>27.71</td>
<td>39.45</td>
</tr>
<tr>
<td>Davidson</td>
<td>447.20</td>
<td>30.96</td>
<td>39.80</td>
</tr>
<tr>
<td>Davie</td>
<td>306.27</td>
<td>49.12</td>
<td>39.93</td>
</tr>
<tr>
<td>Iredell</td>
<td>328.72</td>
<td>37.11</td>
<td>47.98</td>
</tr>
<tr>
<td>Montgomery</td>
<td>434.20</td>
<td>66.65</td>
<td>86.01</td>
</tr>
<tr>
<td>Randolph</td>
<td>319.12</td>
<td>45.23</td>
<td>62.86</td>
</tr>
<tr>
<td>Richmond</td>
<td>435.22</td>
<td>54.62</td>
<td>72.40</td>
</tr>
<tr>
<td>Rowan</td>
<td>403.06</td>
<td>41.85</td>
<td>58.38</td>
</tr>
<tr>
<td>Stanly</td>
<td>339.63</td>
<td>34.34</td>
<td>47.38</td>
</tr>
</tbody>
</table>
Figure 9 – Top 20 parcels for Iredell, Davie, Rowan, Davidson, and Randolph counties.
Figure 10 – Top 20 parcels for Cabarrus, Stanly, Montgomery, Anson, and Richmond counties.
Current LandTrust Properties Ranking

A total of 179 currently protected LandTrust properties were also ranked, with the resulting conservation value to acreage ratio ranging from 0 (for 17 different sites) to 286.57 (for one of the Westmoreland Preserve properties). The lowest ranked parcels included 5 other Westmoreland Preserve tracts, as well as a number of farms and the Pisgah Covered Bridge site. Overall, the mean ratio was 55.50 with a standard deviation of 58.57.

Regional parcel prioritization

The regional parcel prioritization is heavily skewed toward certain areas within the river basin, including Richmond County and along the Yadkin River (Fig. 11). Most counties primarily consist of low scoring parcels. When the top 100 parcels are isolated, Montgomery and Richmond Counties clearly have the most retained (Table 4). While Montgomery County has 28 of the parcels, however, they score in the lower portion of the top 100 (Fig. 12). Richmond County contains 39 of the top 100 parcels, and many are in the top 50, suggesting that this county is quite valuable. The other counties, especially Davidson, Davie, and Randolph have only a couple of top ranking parcels.

Table 4 – Regional prioritization results by county.

<table>
<thead>
<tr>
<th>County</th>
<th>Number in Top 100</th>
<th>Mean Value</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anson</td>
<td>6</td>
<td>314.49</td>
<td>13.36</td>
</tr>
<tr>
<td>Cabarrus</td>
<td>5</td>
<td>315.05</td>
<td>11.44</td>
</tr>
<tr>
<td>Davidson</td>
<td>2</td>
<td>380.61</td>
<td>66.59</td>
</tr>
<tr>
<td>Davie</td>
<td>2</td>
<td>301.33</td>
<td>4.89</td>
</tr>
<tr>
<td>Iredell</td>
<td>6</td>
<td>309.19</td>
<td>10.68</td>
</tr>
<tr>
<td>Montgomery</td>
<td>28</td>
<td>318.43</td>
<td>26.89</td>
</tr>
<tr>
<td>Randolph</td>
<td>2</td>
<td>313.16</td>
<td>5.96</td>
</tr>
<tr>
<td>Richmond</td>
<td>39</td>
<td>361.63</td>
<td>33</td>
</tr>
<tr>
<td>Rowan</td>
<td>7</td>
<td>339.33</td>
<td>34.52</td>
</tr>
<tr>
<td>Stanly</td>
<td>3</td>
<td>324.06</td>
<td>13.15</td>
</tr>
</tbody>
</table>
Figure 11 – The conservation value to acreage ratio for the entire region, further suggesting that there are distinct areas of higher value within the 10 counties at the parcel level.
Figure 12 – The top 100 ranking parcels in the region, with the majority in Richmond and Montgomery counties.
By comparing the county- and regional-level prioritizations by means of the total acres, the difference in value across the region becomes evident (Table 5). Counties such as Anson, Davie, and Stanly do not retain as many acres in the regional prioritization as in the county prioritization. For example, the 10 highest-ranking properties in Anson County totaled 2,272 acres. Only 6 properties were retained in Anson County in the regional-level prioritization, for a total of only 1,213 acres – a loss of 1,059 acres. Richmond County, however, gains over 4,500 acres in the regional prioritization because of the concentration of priority properties in this county, 39 in all.

Table 5 – Total number of acres found as high priorities in each of the counties in both prioritizations, as well as the difference between the two prioritizations.

<table>
<thead>
<tr>
<th>County</th>
<th>County-level</th>
<th>Regional-level</th>
<th>Gain/Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anson</td>
<td>2272.5</td>
<td>1213.38</td>
<td>-1059.12</td>
</tr>
<tr>
<td>Cabarrus</td>
<td>1467.84</td>
<td>782.02</td>
<td>-685.82</td>
</tr>
<tr>
<td>Davidson</td>
<td>1052.97</td>
<td>390.38</td>
<td>-662.59</td>
</tr>
<tr>
<td>Davie</td>
<td>1362.47</td>
<td>494.28</td>
<td>-868.19</td>
</tr>
<tr>
<td>Iredell</td>
<td>2669.3</td>
<td>2027.72</td>
<td>-641.58</td>
</tr>
<tr>
<td>Montgomery</td>
<td>1042.27</td>
<td>2842.28</td>
<td>1800.01</td>
</tr>
<tr>
<td>Randolph</td>
<td>886.27</td>
<td>170.77</td>
<td>-715.5</td>
</tr>
<tr>
<td>Richmond</td>
<td>1119.27</td>
<td>5713.39</td>
<td>4594.12</td>
</tr>
<tr>
<td>Rowan</td>
<td>1294.61</td>
<td>1039.1</td>
<td>-255.51</td>
</tr>
<tr>
<td>Stanly</td>
<td>1215.13</td>
<td>414.58</td>
<td>-800.55</td>
</tr>
<tr>
<td>Total</td>
<td>14382.63</td>
<td>15087.9</td>
<td>705.27</td>
</tr>
</tbody>
</table>

Discussion

While it is possible to capture high quality sites through opportunistic conservation, the results of ranking the LandTrust’s protected properties show how important planning is to efficiently protect land. Even though cultural and agricultural values are not included in these prioritizations, this analysis shows that there are remaining parcels that are just as if not more deserving of conservation as the properties
already protected by the LandTrust. Most noticeably, the highest-scoring LandTrust property had a conservation value half that of the highest-scoring parcel from the region. Without determining where an organization’s conservation goals can best be achieved, it is difficult to protect the highest quality properties. In a world of limited time and resources, it seems critical for even the smallest of land trusts to have a sense of where their efforts are needed the most.

The LandTrust is interested in maximizing its efficiency through targeting the 10 highest-ranking parcels. This is important not only for protecting the best remaining properties in each county, but also for maintaining landowner and resident support. By showing that conservation is both possible and important in even highly agricultural or urban counties, the LandTrust can help to reinforce that conservation is not just for the wealthy or for more developed or threatened counties; rather, it is important for everyone to appreciate and incorporate a land ethic, an ideology that may be helpful in preventing future land use conversion.

The regional model has the benefit of eliminating artificial political boundaries, however, instead focusing on the natural boundary of the river basin. By focusing on the region, it becomes evident that there are some highly valuable areas, especially east of the Yakin River. Intensifying efforts in this area could be a better method of protecting habitat while increasing the connectivity of major protected properties like areas of the Uwharrie National Forest or the Sandhills Game Lands. It could be argued, however, that because the government and other conservation organizations play such a large role in this region that the LandTrust should focus more on the local level in other parts of their 10 county priority area.
When making the final decision in how to prioritize efforts, the LandTrust must also consider the limitations of the model. Neither the county- nor regional-level scenario can absolutely predict high value due to the limitations of the data used. The most recent version of the National Land Cover/Land Use dataset is from 2001, and many suitable properties identified in this analysis may have been converted due to the increasing development pressures in this area. Additionally, there is the potential for bias in the Natural Heritage data, as some counties are more thoroughly explored due to funding or expertise.

While this model considers ecological features, it does not include cultural or historical data, another of the LandTrust’s goals. If criteria were added for these or other values, they could greatly change the ranking of the parcels. The value of LandTrust properties would likely increase as well, especially sites such as the Pisgah Covered Bridge, one property protected specifically for historical and community values, but that scored 0 in this analysis. Updating the model for new or additional data when it becomes available and reassessing the parcels should be undertaken. Therefore, it is important to remember that this prioritization, as many others, is to serve as a guide, directing the LandTrust to areas where further inquiry is necessary. Should a property be developed, or if the landowner does not wish to participate in conservation, then the LandTrust may move down the list to protect the next best properties.

**Recommendations**

The LandTrust should continue protecting properties in their region when approached by a landowner or faced with a crisis situation, especially if the candidate properties fit into their criteria and can be protected for a reasonable cost. The bulk of
their proactive effort, however, should be directed toward the parcels that scored highly in the regional prioritization. While Richmond and Montgomery counties may receive the most attention from the LandTrust, it is important to remember that some of the other counties, such as Anson and Iredell may be better suited for agricultural easements, which were not given consideration in this analysis. While focusing on the prioritization properties, it will be helpful to consider Clean Water Management Trust Fund or Natural Heritage Trust Fund grants, because the highly-ranking parcels have characteristics important for obtaining funding from these statewide sources, including protection of water quality and preservation of rare species habitat. While proactive conservation is expensive in its own right, including research, public relations, and outreach, there are sources of funding that may be particularly helpful. If the LandTrust mixes opportunistic and proactive ecological and agricultural protection, they would be capable of protecting a diverse set of lands, helping the organization to achieve its goals while also ensuring that the region retains its natural and cultural qualities.
References


Appendix I

Land Use Model
Calculation of species and ecosystem value

Calculation of water features value
Calculation of the adjacency value
Analysis