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Social and spatial relationships driving landowner attitudes towards aquatic conservation in a Piedmont-Blue Ridge landscape

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Abstract

More than half of land in the U.S. is privately owned and covers most of known endangered species habitat. An understanding of private landowners' attitudes towards conservation may help to bridge the science-practice gap in regards to conservation initiatives. Aquatic biodiversity is particularly imperiled; in the United States headwaters and isolated wetlands receive little protection through regulations, becoming a focus of conservation planning. In an effort to assess how landowners view such efforts, a 27-question mixed methods survey was mailed to 409 landowners in the Blue Ridge and Piedmont ecoregions of South Carolina with wetland areas and where land was owned by a family or individual, not a corporation. We received 70 completed surveys and analyzed the results using an

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encapsulated mixed methods approach that analyzed both scaled and qualitative questions. The combined results gave a more contextual understanding of conservation on private lands in the study area.

In this article we present a history of private land conservation and surveying landowners in understanding conservation potential. This demonstrates a need for a more comprehensive method needed in conservation planning. We then show our use of an integrated methodology, using quantitative and qualitative questions, to measure landowners' interest in conserving land. Through classification and spatial analysis, our study demonstrated that aquatic areas and wildlife are valued by and show influence on landowners' decisions. We also found that distance from protected area has a positive correlation to the willingness to protect aquatic areas. Landowners showed concern for threats of pollution from runoff and siltation. Disinterest in conservation seemed prevalent throughout many of the respondents' answers. These results suggest a relation to geographic distance and that the attitudes are more related near each other and specific places in the landscape. We conclude that any successful implementation of aquatic conservation initiatives must include focused outreach and communicating the benefits for society and landowners for building capacity for landscape-scale cooperation.

Keywords: Hydrology, Environmental science, Geography

1. Introduction

There is a significant gap between the science meant for use in conservation planning and the practice of such (Langemeyer et al., 2016; Bernstein and Mitchell, 2005; Knight et al., 2006; Wallace et al., 2008). Conservation planning has arisen as a field to systematically assess where and when biodiversity protections should be extended (Trombulak and Baldwin, 2010). As biodiversity is inadequately protected in the network of public lands (Rodrigues et al., 2004), and many threatened organisms are persisting primarily on privately-owned lands, much actual conservation practice involves working with landowners to affect conservation easements, implement Best Management Practices in order to conserve natural resources and reduce pollutants, and to employ other voluntary and/or fee-based mechanisms (Hilty and Merenlender, 2003; Trombulak and Baldwin, 2010). Private landowners may consider biodiversity conservation if they receive an economic benefit, or if their values system supports biodiversity conservation (Ginn, 2013). Because of this, Wallace et al. (2008) suggested a need for a better understanding of the value placed on social-ecological-economic systems involved in conservation to increase support for conservation planning on privately owned land. Approximately 60% of the United States is privately-owned; excluding Alaska the percentage rises to 71% (Hilty and Merenlender, 2003). A portion or the entire habitat for 85% of federally endangered species in the US is found on private land (U.S. General Accounting Office, 1994; Rissman et al.,

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2007), leaving a mere 15% strictly on public lands. Unlike public land, most of private land in the U.S. is mesic and higher in productivity and biodiversity (Scott et al., 2001; Rissman et al., 2007). Further, the private lands surrounding public lands are critical for maintaining biodiversity (Knight, 1999; Groves et al., 2000; Rissman et al., 2007) by creating more contiguous areas with greater ecological benefits (Fahrig, 2001; Kareiva and Wennergren, 1995; Andren, 1994; Groves et al., 2002; Strager and Rosenberger, 2006). The pressure to subdivide and develop private land has depleted and damaged water resources, habitat, and biodiversity (McKinney, 2002; Hansen et al., 2005; Wallace et al., 2008). Merenlender et al. (2004) mentioned a need for multidisciplinary research efforts to quantify the benefits and costs of incentive-based private land conservation especially on landowners who donate or sell easements. This would include landowners' understanding of tax breaks and associated costs and benefits, their desires or resistance to conservation in general, their recognition of biodiversity, and their communicative/philosophical reasons behind these views and levels of understanding.

Understanding what motivates a landowner's willingness to use land conservation mechanisms is complex, and linking it with actual behaviors, perceptions and plans can help determine where to focus conservation resources. Research in significant life experience suggests that outdoor experiences foster pro-environmental outcomes (Cachelin et al., 2009). This implies that landowners' choices may also be influenced by their experiences on their land as well as other outdoor experiences in their life. Information and strong environmental ethics also improve the chances that a landowner would use the option of conservation easements (LeVert et al., 2009), and the local knowledge of a landscape may significantly affect decisions regarding conservation strategies (Strager and Rosenberger, 2006; Strager and Rosenberger, 2007). Landowners who know their properties and understand potential natural and ecological benefits are likely to provide more detailed descriptions of benefit(s) for a baseline and conservation easement documentation (Wallace et al., 2008), thus potentially making conservation efforts take less time. There may be benefits that landowners do not recognize such as groundwater recharge, floodplain protection, community separation, connectivity, or buffering of public lands (Wallace et al., 2008). Understanding their interest in learning more about these and other benefits, and sharing their knowledge may lead to higher motivation for conservation strategies.

Conservation easements acquired and administered by land trusts are a useful mechanism for private lands conservation, particularly in the United States (Brewer, 2004, Merenlender et al., 2004). To positively affect these kinds of agreements, land trusts need to know a particular landowner's likelihood to collaborate and likelihood to sell, as this factor is often involved in decision on whether or not to acquire a conservation easement (Strager and Rosenberger,

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2006). A study in Macon County, North Carolina showed that the public's willingness to pay for a conservation easement could reduce forestland conversion by 14–46% (Cho et al., 2005). In New Hampshire and Massachusetts a landowner's willingness to sell a conservation easement to a land trust was shown to be influenced by the variables of offer, communication of benefits, environment, recreation, whether land pays for itself, management/use, cooperation, and whether they were a resident or absentee owner (LeVert et al., 2009). It was suggested that the "culture" of an area might also influence the willingness to use conservation easements (LeVert et al., 2009). The Clean Water Act of 1972 (33 U.S.C. 1344) prompted multiple federal agencies to regulate and give incentives for conserving aquatic areas, especially wetlands (Davenport et al., 2010). Historically, the public views wetlands as "wastelands" (Kaplowitz and Kerr, 2003; Davenport et al., 2010). By contrast, services provided by wetlands include nutrient cycling, flood mitigation, water filtration, erosion control, aesthetics, outdoor recreation, and carbon storage (Euliss et al., 2006; Davenport et al., 2010). It has been demonstrated that restoring wetlands requires an interdisciplinary approach (Wagner et al., 2008; Davenport et al., 2010). Even so, there is a lack of understanding of the social dimensions of wetlands management (Johnson and Pflugh, 2008; Davenport et al., 2010). It is clear, however, that effective wetland conservation requires cooperation of funders, governments, and landowners (Michaelidou et al., 2002; Geist and Galatowitsch, 1999; Johnson and Pflugh, 2008; Davenport et al., 2010). Such cooperative management requires the involvement of local people (Sabatier et al., 2005; Wondolleck and Yaffee, 2000; Davenport et al., 2010) that may know little about wetlands (Johnson and Pflugh, 2008; Davenport et al., 2010). Riparian landowners are typically more accepting of conservation, but still lack access to reliable information regarding conservation (Johnson, 1996; Dutcher et al., 2004). In order to protect wetlands, social scientists have pointed out the need for understanding such residents' current connections to and views of wetlands (Davenport et al., 2010). This understanding could help develop communication programs or outreach designed to express the ecological and social benefits of wetlands (Geist and Galatowitsch, 1999; Jacobson, 2009; Davenport et al., 2010).

2. Theory/calculation

The goal of this study was to identify the social and spatial qualities that affected private individual or family landowners' attitudes broadly toward conservation through land trusts and particularly toward conservation of aquatic areas. In this study, we refer to aquatic areas as including wetlands, streams, rivers, lakes, and ponds. The attitudes we aimed to identify included landowner willingness to conserve land through land trusts, tendency to not conserve through land trust, familiarity with land trusts, and willingness to protect aquatic areas. We designed

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an encapsulated mixed methods survey to both categorize and understand motivations behind social variables that can identify the values and attitudes of landowners (Creswell, 2013). The survey consisted of a series of numerically valued questions and open-ended questions designed to elucidate the specific quantitative questions throughout the survey. This is done at the same time, encapsulated in the same survey, in an effort to more reliably compare both sets of data for more holistic results (Henderson et al., 1999).

The Study area, the upstate of South Carolina, has a complex history of land uses and socioeconomics, including rapid transitions to and from intensive agriculture, agricultural overuse and erosion, the rise and fall of a textile industry, forestry, extensive river impoundments and federal and state ownership presence (Richter et al., 2000; Scott, 2006). The southeastern United States has extensive riparian systems especially stream networks and associated wetlands, and is a global center for aquatic biodiversity (Harding et al., 1998).

3. Materials and methods

Our study area consisted of the Blue Ridge and Piedmont ecoregions in Oconee, Pickens, Greenville, Spartanburg, and Anderson counties of South Carolina (Fig. 1). We designed a survey to quantify and categorize social variables identifying the values and attitudes of the landowners with qualitative questions built in throughout the survey to provide a more complex understanding of the

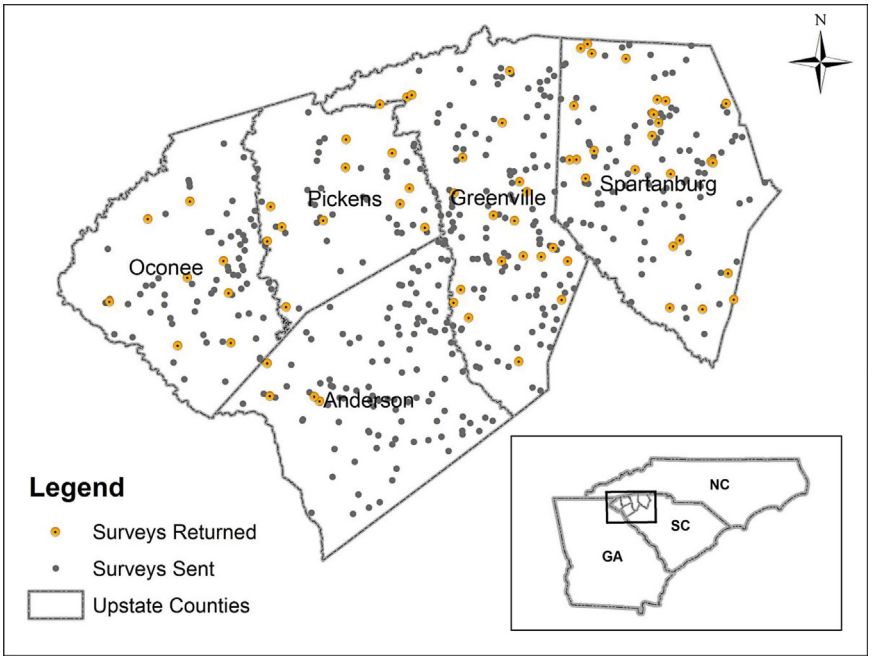

Fig. 1. Centroids of all parcels chosen randomly and of all parcels with returned surveys.

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categorical responses to the survey. The survey consisted of a series of twenty-seven numerically valued and open-ended questions on seven pages. The quantitative values were analyzed using multiple least squares regression to compare them with other values from the survey plus a series of spatial values (Table 1). The open-ended questions were analyzed using qualitative research methodology, involving a systematic method of coding using common words and meaning similarities (Saldaña, 2015). The coding was then used to establish patterns and provide context for the statistical results, as well as a spatial examination of results.

Five hundred parcels were randomly selected from all 67,688 privately-owned parcels that intersected aquatic areas such as streams, rivers, lakes, ponds, and wetlands. Ninety one parcels were removed because they were owned by businesses or associations rather than individuals or families, leaving a total of 409 surveys sent out. Reminders were sent out a week after the survey. Seventy landowners (17%) returned answered surveys. Of the returned surveys, eight (11%) were from landowners in Oconee County, ten (14%) from Pickens County, twenty one (30%) from Greenville County, twenty six (37%) from Spartanburg County, and four (6%) from Anderson County. Twenty surveys were returned to sender by the postal service.

The quantitative questions were separated by topic (attitude towards land trusts and conservation easements; attitudes towards aquatic area conservation; knowledge of land trusts and conservation easements). The answers were normalized by giving numeric values to coincide with the respondents' level of agreement with the statement. Each question category was given the total sum of their respective values.

The objective of the quantitative analysis was to determine whether any spatial variables or land owner characteristics were related to the answers to questions regarding landowners' willingness to protect aquatic areas (WPA), confidence in their knowledge of land trusts and land trust practices (KLT), tendency to choose non-conservation options (TN), and agreement in using practices to protect land through land trusts (WC). The spatial variables were species richness, amphibian richness, distance from wetland, distance from protected areas, distance from urban areas, distance from the city of Greenville, and parcel size (Table 2 and Table 3).

Species richness and amphibian richness were predicted values from raster data available through the South Carolina Department of Natural Resources. Distance from areas and points were measured using the Euclidean distance tool in ArcMap 10. Parcel size was recorded in parcel layers provided by county tax offices. The questions used in calculating each score were not used as variables in the regression analysis of that score. This was the case for WPA, KLT, TN, and WC.

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Table 1. Quantitative statements analyzed using multiple least squares regress in comparison with additional survey and spatial values.

Used to Calculate:	Statements for which a landowner answers Strongly Agree, Agree, Disagree, or Strongly disagree with or is Undecided.
WPA	It is important to protect aquatic areas (creeks, ponds, wetland, etc.) in the Piedmont and Blue Ridge of South Carolina.
WPA	I highly value the aquatic areas on my property.
WPA	I highly value the wildlife that depend on these aquatic areas.
KLT	I am knowledgeable of the functions and purpose of Land Trusts.
KLT	I am knowledgeable of the functions and purpose of Conservation Easements.
KLT	I am knowledgeable of the functions and purpose of Reserved Life Estates.
TN	Regarding the property I will probably sell as is to non-family member.
TN	Regarding the property I will probably sell as is to family member
TN	Regarding the property I will probably develop and sell.
TN	Regarding the property I will probably leave in will or give to heir(s).
WC	Regarding the property I will probably leave to land trust by reserved life estate.
WC	Regarding the property I will probably protect with conservation easement.
WC	Regarding the property I will probably sell or donate to land trusts.
Statements for which a landowner answers Yes or No	
Do you know of local non-profit organizations that conserve natural areas?	
Do you know of statewide non-profit organizations that conserve natural areas?	
Do you know of national non-profit organizations that conserve natural areas?	
Is your property, particularly the portion containing aquatic areas, already protected by or in the process of being protected by a conservation easement?	
Demographic Characteristics	
Annual Income	
Level of Education	

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Table 2. Spatial variables used for comparison with their defining characteristic and sources.

	Definition	Data type	Source
Species Richness	Number of species recorded in area	Raster surface	https://gapanalysis.usgs.gov/
Amphibian Richness	Number of amphibian species recorded in area	Raster surface	https://gapanalysis.usgs.gov/
Distance from Urban Areas	Euclidean distance calculated from areas defined as urban by U.S. Census Bureau	Raster surface calculated from vector polygon shapefile	https://www.census.gov/geo/maps-data/data/tiger-cart-boundary.html
Distance from Greenville, SC	Euclidean distance calculated from major urban area in study area	Raster surface calculated from vector point shapefile	https://www.census.gov/geo/maps-data/data/tiger-cart-boundary.html
Parcel Size	Size in hectares of privately owned land parcels	Vector polygon shapefile	http://www.qpublic.net/sc/oconee/search2.html, http://www.co.pickens.sc.us/GIS, http://www.andersoncountysc.org/gis-e911addressing, http://www.gcgis.org/, http://www.spartanburgcounty.org/185/Geographic-Information-Systems

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Table 3. Parcel Size (Ha) for all private parcels, sampled private parcels, and parcels of returned surveys.

	Count	Minimum	Maximum	Mean	Standard Deviation
All privately owned parcels	67688	0.0001	1754.04	6.13	17.12
Randomly selected parcels	500	0.0085	98.14	6.41	13.045
Returned survey parcels	70	0.103	87.056	5.77	12.064

All remaining questions plus demographic characteristics were used in regression analysis.

The analysis proceeded in several steps. The first step was to analyze a series of simple regression models of the form

$$Y = \beta_0 + \beta_i * X_i + \varepsilon$$

letting WPA, KLT, TN, and WC be the response (or Y) variables, and the each of the spatial variables and land owner characteristics be the predictor (or X) variables. For each response variable, a single predictor was chosen with the best fit. The criterion for X with the best fit was the X that produced the smallest p-value for the hypothesis test H_0: $\beta_i = 0$.

The second step was to determine if adding any additional X's would improve the fit. The residuals from the model with the best fit X were plotted against additional possible X's, providing visual evidence (like that in Fig. 2) of the possible

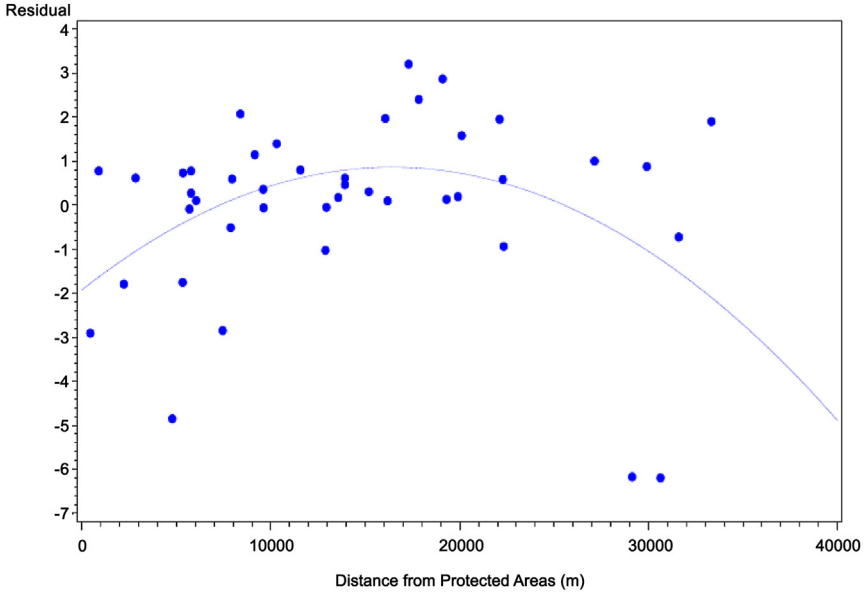

Fig. 2. Residuals for WPA plotted against distance from protected areas in meters.

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improvement to the model by adding an additional X. In other words, we used plots for visual evidence that adding an additional X would improve fit.

Note that additional X's could be interactions or multiples of X's like powers of the best fit X (such as X^2) allowing for a curvilinear relationship among the X and Y, and in later steps, products of X's in the model (such as X_1*X_2) allowing for an interactive relationship among the X's and Y. In addition to the plots, there was also a series of regression models of the form

$$Y = \beta_0 + \beta_1*X_1 + \beta_i*X_i + \varepsilon$$

Answers from a series of open-ended questions (Table 4) in the surveys were analyzed using coding method to simplify and categorize landowner attitudes. To do this, we identified keywords and phrases and compared commonalities with these from landowner to landowner. These common words and phrases were coded with a series of numbers. We then identified patterns in these series to consolidate into a series of six themes.

The qualitative answers were analyzed using a coding method (Saldaña, 2015) to simplify and categorize landowner attitudes towards and views of land trusts and aquatic areas. Keywords and statements were selected from all open-ended answers. Common words or similar phrases (describing locations; connections; land history; emotions; opinions etc.) were then identified for each individual question. These were labeled with a series of numbers for each question. This gave each respondent a series of numbers describing their answers. These series were matched with similar series to identify patterns in answers. These series were given general descriptions that were reviewed and then further consolidated into themes.

We conducted four least significant difference (LSD) t-tests to identify which themes were significantly different in regards to landowners' WC, TN, WPA, and

Table 4. Qualitative Subjects by associated questions.

Subjects of Qualitative Questions
What purpose do the property and aquatic areas serve to the landowners?
What about aquatic areas do landowners find important to protect?
How do they wish to alter the aquatic areas on their property?
How are the landowners using and how will they use the aquatic areas in the future?
Do neighbors views affect property and aquatic areas use?
How do landowners value their property and aquatic areas?
What affects landowners' decisions regarding land trusts?
What do landowners know and wish they knew about land trusts and conservation easements?

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KLT values. Each of these values was tested separately. Each theme was tested against all other themes individually.

4. Results

4.1. Results from scaled survey questions

The willingness to conserve (WC) was found to be correlated to the variables and principle components Q16, Species Richness, Q21.1, and Q7 (Table 5). The resulting regression equation accounted for 48% of the observed variance in Willingness to Conserve. The equation was as follows:

WC = -9.2031 + 2.7229(Q16) + 0.09595(Richness) +0.476(Q21.1) – 0.01638(Q7) (Richness)

For each additional species in an area, a landowners' willingness to conserve increased by 0.096 points.

The variable Q16 is the level of agreement a landowner gave for the statement "I highly value the wildlife that depend on these aquatic areas" referring to the streams, rivers, lakes, wetlands etc. on their parcel. With each increase from "Strongly Disagree" to "Strongly Agree", a landowner's willingness to conserve increased by a factor of 2.7 +/− 0.49, meaning a landowner is typically more willing to support conservation practices if they also highly value wildlife that depend on the aquatic areas.

The variable Q21.1 is the level of agreement a landowner gave for the statement that they will "Sell as is to non-family member". With each increase in from "Strongly Disagree" to "Strongly Agree", a landowner's willingness to conserve increased by a factor of 0.48. Meaning a landowner in this sample is more willing to conserve if they also would sell the land as is to a non-family member.

The variable Q7 is the level of agreement given for the statement "It is important to protect aquatic areas in the Piedmont and Blue Ridge of SC". A combination of Species Richness and Q7 actually slightly reduces WC.

Table 5. Quantitative research statistics for WC (R-Square = 0.4793).

	Intercept	Q16	Richness	Q21.1	Q7*Richness
Parameter Estimate	-9.20310	2.72290	0.09595	0.47600	-0.01638
Standard Error	2.79875	0.49898	0.02305	0.23054	0.00444
P-value	0.0022	< .0001	0.0002	0.0460	0.0007

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The Landowners' tendency to use non-conservation options (TN) was found to be negatively correlated by the variable Parcel Size in Hectares (Ha) (Table 6). The resulting regression equation accounted for 19% of the observed variance in TN. The equation was as follows:

$$TN = 10.57–0.116(Ha)$$

For each additional hectare in parcel size, the tendency to use non-conservation options decreases by a factor of 0.116 points. The meaning of these findings are that the larger the parcel size the less likely the landowner has a tendency to use non-conservation options for land management.

Landowners' knowledge of Land trusts (KLT) was found to be positively correlated to the variable YN23 (Table 7). The variable YN23 is the point 1 for yes and 0 for no to the question "Do you know of statewide non-profit organizations that conserve natural areas?" The resulting regression equation accounted for 24% of the observed variance in KLT. The equation was as follows:

$$KLT = 8.7 + 3.2(YN23)$$

If a landowner answered that they knew of such areas, their score rating knowledge of Land Trusts and Land Trust Practices, increased by 3.2 points.

Landowners' willingness to protect aquatic areas (WPA) was found to be correlated to the variables Q21.5 and Distance from government-owned protected areas (DPA) which was measured in meters (Table 8). The variable Q21.5 is the level of agreement they gave for the statement that they will "Leave to Land trust in reserved life estate". The resulting regression equation accounted for ~30% of the observed variance in WPA. The equation was as follows:

$$WPA = 12.9 + 0.78(Q21.5) – 3.5E\text{-}9(DPA^2)$$

With each increase in from "Strongly Disagree" to "Strongly Agree", a landowner's willingness to conserve increased by a factor of 0.78. Therefore, the more likely a landowner was to leave a parcel to a family member the more likely their willingness to protect aquatic areas was.

Table 6. Quantitative research statistics for TN (R-Square = 0.1864).

	Intercept	Ha
Parameter Estimate	10.57242	-0.11675
Standard Error	0.47921	0.04453
p-value	< .0001	0.0136

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Table 7. Quantitative research statistics for KLT (R-Square = 0.2413).

	Intercept	YN23
Parameter Estimate	8.70171	3.21945
Standard Error	0.62194	0.78705
p-value	< .0001	0.0001

4.2. Qualitative results

Six themes were, as seen in Table 9 and Fig. 3, developed using coding to profile landowner responses.

Theme 1, Disinterest in conservation (DI), represented disinterest in conservation and land use in general. For example, these landowners did not use or plan to use or alter aquatic areas on their property outside the use of lakes recreation by some. If they showed a slight interest in protecting aquatic areas, it was in a general sense, only mentioning words like "lakes" or "rivers." They had little knowledge of and no desire for knowledge of land trusts. Twenty one respondents were qualified as DI, and their locations did not cluster around any part of the study area (Fig. 2). The average parcel size in DI was 7.96 hectares (ha) with a standard deviation of 18.31 ha. Parcels ranged in size from 0.2 to 87.06 ha. DI parcels had a random spatial dispersion.

Theme 2 (N = 18), Interest in protection of aquatic areas (AP) showed an interest in government and local community policies to protect aquatic areas. Like DI, they showed no interest in using land trusts for conservation. The greatest interest was in protecting aquatic areas especially as water resources. They placed most importance on water quality. Most mentioned the importance of preventing point-source and non-point source pollution. The words "runoff," "siltation," and "erosion" were mentioned frequently. Approximately 56% of AP respondents were found in Spartanburg County (which returned 37% of the surveys) and 28% were found in neighboring Greenville County (which returned 30% of the surveys). The

Table 8. Quantitative research statistics for WPA (R-Square = 0.4793).

	Intercept	Q21.5	DPA^2
Parameter Estimate	12.94665	0.78023	-3.54011E-9
Standard Error	0.87199	0.34113	1.055591E-9
p-value	< .0001	0.0276	0.0018

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Table 9. Themes profiling landowner responses through coding.

Theme	Spatial Cluster	LT Interest	Description	n=	Code	Average Parcel Size
1	N	0	Disinterest in conservation	21	DI	7.96
2	Y	0	Interest in protection of aquatic areas	18	AP	6.96
3	N	0	Deep connection to land	17	DC	7.78
4	Y	1	Support for conservation	7	CS	2.65
5	N	0	Property rights and safety	4	PR	1.32
6	N	0	Fear of nature	1	FN	

average parcel size in AP was 6.96 ha with a standard deviation of 9.65 ha. Parcels ranged in size from 0.2 to 42.04 ha. AP parcels had a clustered spatial dispersion.

Landowners in theme 3 (N = 17), Deep connection to land (DC), showed a deep connection to and knowledge of their land and how they used it. All parcels in DC were used for direct resource extraction and multiple purposes such as agriculture, timber management, hunting and/or fishing, and family recreation activities. All respondents were ambivalent toward land trusts but highly valued the land for themselves and family members. Landowners expressed interest in the research and provided extensive answers. The average parcel size in DC was 5.05 ha with a standard deviation of 7.78 ha. Parcels ranged in size from 0.32 to 30.53 ha. DC parcels had a random spatial dispersion.

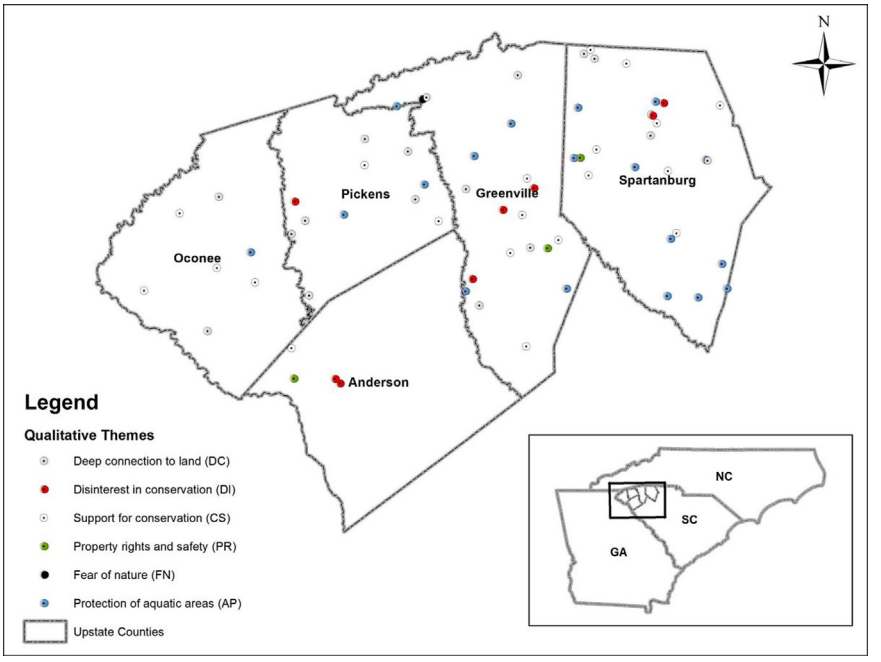

Fig. 3. Qualitative themes.

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Theme 4 (N = 7), Support for conservation (CS), showed support of conservation with no distrust or rejection of land trusts although they may or may not have shown knowledge of or interest in knowing more about land trusts. They placed importance on regulating urban or residential development. Some identified more specific areas in need of conservation. Like DC respondents, they expressed interest in research and provided extensive answers. CS respondents did show an interest in altering stream direction and shorelines - which may have been related to their ideas of land management and/or conservation. All respondents were found in or near urban areas. The average parcel size in CS was 0.82 ha with a standard deviation of 0.88 ha. Parcels ranged in size from 0.1 to 2.65 ha. CS parcels did not have a clustered spatial dispersion.

Theme 5 respondents (N = 4), Property rights and safety (PR), expressed great interest in protecting property rights, seeing conservation by land trusts and conservation in general as violation of property rights. With this they made no distinction between land trusts and government. Distrust and contempt was expressed for both land trusts and government. One PR respondent referred to conservation minded people as "enviro-wackos", a pejorative reference to environmental activists. Another, when asked if they wished to know more about land trusts, said "Everyone trying to tell the property owners what they can do on their property - Bug Off." Subjects also showed anger and questioned the ultimate purpose of the research. They were less extensive in their answers and skipped more than other responders. One made it impossible to identify spatial coordinates by removing the attached identification number despite assurance that name and specific parcel information would not be revealed in research. The average parcel size in PR was 0.32 ha with a standard deviation of 0.11 ha. Parcels ranged in size from 0.19 to 0.46 ha. PR parcels had a random spatial dispersion.

Theme 6, Fear of nature (FN), consisted of a single respondent, owning a 4.84 ha parcel, who expressed a fear of nature especially wildlife and streams. Despite this, the respondent expressed a value in the aesthetics of their natural surroundings. Safety, especially for children was a major issue conflicting with interest in conserving land, especially aquatic areas.

4.3. Mixing methods

LSD t-tests showed no significant differences for KLT or TN in any themes. There were no significant differences among themes 1–4 or between themes 5 and 6 for both WC and WPA. Therefore, significant differences were shown between the group of themes 1–4 and the remaining two themes, 5 and 6, for both WC and WPA.

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5. Discussion

5.1. Quantitative results

Our study identified several social and spatial qualities that appear to be related to private individual or family landowners' attitudes broadly toward conservation through land trusts and particularly toward conservation of aquatic areas. Our results for WC indicate that a landowner's willingness to use land trust methods to conserve their parcel increases with their valuing of wildlife that depend on aquatic areas, the animal species richness for the area in which their parcel occurs, and the likelihood they will sell the property to a non-family member. Their willingness to conserve decreased with a compound variable of the importance they place on protecting aquatic areas in the Piedmont and Blue Ridge of South Carolina and the animal species richness.

The coefficients for Q16 and Richness led us to conclude that persons who highly value wildlife in aquatic areas and own more land with greater species diversity are more likely to conserve. This may be good news for land trusts with objectives to protect biodiversity, especially as it relates to aquatic areas. These land trusts could expect a possible greater cooperation from owners of lands with high conservation value. We inferred from the coefficient for the variable Q21.1 that landowners who view their property as an investment may be more willing to use the options of conservation through land trusts. This, perhaps, could be due to tax incentives for lands protected by conservation easements; it could also have to do with the option to sell or trade the property to a land trust. This is consistent with the other findings related to shifting demographics from interest in charity to investment, regarding conservation easements represented in theme TN (McLaughlin, 2001; Small, 2003; Rissman et al., 2007; Janota and Broussard, 2008). The results could give more reason for land trusts to support communication of the importance of species richness and the relation between aquatic areas and biodiversity (Jacobson, 2009).

With our results for TN we inferred that a landowner's tendency to use non-conservation options seems to not be an inverse of their willingness to use conservation options. That is, even though a landowner may be willing to conserve their parcel, they may also be likely to choose an option that is non-conserving; or that a landowner is not less willing to conserve due to their tendency to choose non-conserving options. For example, a landowner may be willing to establish a conservation easement but also likely to sell the land for development.

The formula suggests that a landowner is less likely to take these non-conserving options when the parcel is larger. Land trusts typically aim to protect larger parcels not only for conservation objectives but because it takes nearly as much time and effort to protect a smaller parcel as one that is much larger (Strager and Rosenberger, 2007). To be most productive, land trusts may already have an

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outreach to larger landowners. Results may also suggest that landowners of large parcels do not score high on non-conservation options so may be scoring high in WCA.

Tendency to use non-conservation options, such as develop or sell for development, and willingness to conserve are not inversely related suggesting that they are in fact positively correlated. A landowner with a higher willingness or tendency to conserve could be just as likely to not conserve. This could be valuable information for land trusts to use in approaching owners of large parcels. There is evidence to conclude that land trusts should be proactive in talking to owners of larger parcels. They may wish to focus more on benefits of conservation strategies and less on the pitfalls of non-conservation decisions.

Our results for KLT would suggest that if a landowner has at least some knowledge of at least one statewide-operating land trust, their general knowledge of the function of land trusts and their conservation methods is higher than that of those who do not know of such organizations. This would suggest that being familiar with a statewide land trust may have a greater influence on a landowner's knowledge of land trusts than knowing of national or regional land trusts. The problem is that there is no statewide operating land trust in South Carolina (http://findalandtrust.org/states/south%20carolina45/land_trusts#statewide), only local and nationwide land trusts. This suggests confusion as to where certain land trusts operate. Local land trusts may have been thought of as statewide while not actually being so. Such local land trusts include Community Open Land Trust, Naturaland Trust, and Upstate Forever. All of these operate regionally in South Carolina rather than statewide. They also work in larger areas than a specific town, watershed, or county. This may be responsible for confusion between the words “local” and “statewide”. Thus, more clear descriptions of region work with landowners may help foster greater understanding and openness to communication.

The positive correlation between knowledge of land trusts and familiarity with statewide land trusts could possibly show that landowners typically understand a certain land trust as statewide even if that is not the case. Local/regional and nationwide operating land trusts may take this as an indication for a need for outreach explaining their objectives, express the importance of biodiversity, and to increase cooperation between their institution and private landowners (Hilty and Merenlender, 2003). They could also cooperate more with statewide trusts in large projects. There is still the possibility that landowners are confused about which land trusts are actually statewide and which are not. There is the possibility that landowners may have a lack of understanding between land trusts and federal government.

With our results for WPA we inferred that a landowner's willingness to protect aquatic areas is positively correlated with their willingness to leave their land to a

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Land Trust through a reserved life estate. The coefficient for distance from protected areas (DPA^2) suggests a possible resistance to protecting aquatic areas near areas already protected by government ownership. It also shows a possible curvilinear relationship between their willingness to protect aquatic areas and distance from protected areas, meaning that the willingness increases and then decreases with distance from these protected areas. If such were true, landowners near government-protected areas would be less willing to protect aquatic areas but willingness would increase with distance from protected areas but at some point, this effect may curve and willingness begins to decrease again. This may be due to other spatial or cultural factors that were not foreseen when analyzing the data. These distance relationships only make sense in our study area. The analysis did not include protected areas outside of the study area in other South Carolina counties or bordering states and there is a significant area of National Forest in NC, just across the state line from the study area. Land trusts could possibly use this information by emphasizing reserved life estates as an option for those who own lands with aquatic areas to protect, especially those within a reasonable distance from government protected areas. This could be valuable for establishing new or extending protected areas or habitat corridors that are within a certain distance from government-protected areas. This relationship may also indicate a need for communication of the value of clustered or contiguous habitat (Jacobson, 2009).

5.2. Qualitative results

Nearly one third of respondents were covered by DI, showing disinterest in conservation and land use outside of lake-related recreation. This theme shows a potential "swing-group" of landowners who have no strong opinion of conservation, in either a positive or negative light. This group of landowners may be open to communication of the benefits of conservation of land aquatic areas (Jacobson, 2009).

AP respondents had shown interests in government policies to conserve aquatic areas. From AP, land trusts could infer that there may be a need for outreach expressing the benefits of land trust parcels acting as buffers and greenways protecting water (Jacobson, 2009). This may be of value to trusts with at least part of their objectives involving greenspace in urban areas, highway corridors, and suburban development areas surrounding reservoirs. This theme may also be of value to land trusts working in cooperation with city planning committees for this same reason. Such land trusts and planning committees could try further research to explain the extent in numbers and details of attitudes in this theme. If there is not a recognizable resistance to government, it may be useful to make contacts through other non-regulatory local organizations like the county cooperative extension offices (Huntsinger, 1992; Wallace et al., 2008).

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DC represents a potential demographic that land trusts are not reaching. These landowners have "working landscapes", the very sort that land trusts see important as buffers for existing nature reserves (Rissman et al., 2007). If this is an objective of area land trusts, outreach programs could take a proactive approach in contacting and familiarizing themselves with such landowners. Landowners involved in agriculture and forestry have long been the focus of outreach and communication by extension programs at local universities and natural resource government agencies; land trusts could extend these efforts to include communication of the importance of biodiversity conservation and conservation easements (Jacobson, 2009). Habron's conclusion (Habron, 2002) that landowners who desired more information about survey results were more likely to adopt riparian conservation practices may prove to be promising regarding this theme. This theme covering nearly a quarter of respondents suggests a large untapped source for conservation.

CS, although expressing the greatest interest in conservation, may actually hold little land of value to land trusts, especially those trusts seeking large tracts. The interest in altering aquatic areas in this theme may also be a quagmire for trusts expecting to work with such. Although the landowners may show interest in conserving, they may also be persistent on their right to alter the course of streams or shape and vegetation of shorelines. Outreach could help reduce this conflict by communicating to landowners differences between aesthetic improvements and habitat improvements. The attitudes do suggest this theme does have potential for support of land trusts outside of direct land transactions. Such support could include financial donations or volunteer work. One respondent fitting this theme did in fact mention being involved in an outreach program for a local land trust.

Despite the expressed heavily emphasized rejection of conservation, most landowners of PR owned only small parcels (< 0.5 ha) and were but a very small proportion of all respondents (6%). These extreme views reflecting concern for property rights and government/academic intrusion into their lives might actually prove to be minor barriers or a detriment to land trust objectives. They are also less of a threat if they are found in mostly urban areas as were these respondents. There is a possibility that more landowners of this attitude exist but did not return surveys for reasons such as distrust of government. This may require further sampling and potentially contacting non-respondents.

FN shows a conflict with a fear of nature outweighing a landowner's desire to conserve. This theme shows potential barriers to conservation, especially when a landowner ultimately decides whether or not to keep or sell the parcel. The one respondent was only 5.35 kilometers from a government protected area with a parcel size of 4.84 hectares. A parcel such as this could potentially provide connectivity or buffer public protected areas like that described by Rissman et al.

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(2007) and Wright (1998). If this is a common theme in landowners, land trusts or other organizations may wish to emphasize parental communication in outreach programs. There is a risk of a type II error for themes, possibly meaning the proportions are wrong and themes such as 5 and 6 may be larger than respondent numbers show.

5.3. Insignificant variables

The spatial variables of amphibian species richness, distance from wetlands, distance from urban areas, distance from the city of Greenville showed no influence on WC, TN, WPA, or KLT. Only one respondent, mentioning the bullfrog, showed any knowledge of amphibians outside of general categories like "frog" and "salamander". Only seven respondents mentioned wetlands either generically or specifically. All of these landowners qualified as themes 2, 3, or 4. Land trusts, other conservation organizations, schools, and county extension offices may use this as a suggestion to communicate to the public on the functions of wetlands and diversity of amphibians.

The fact that distance from urban areas in general and distance from the city of Greenville, SC showed no significance suggests that landowners near cities may have little difference in attitudes from those far from cities. If this is the case for the population of landowners, one could infer that it is possible communication, outreach, and extension programs have had no difference in influence from urban to rural areas. Further research would be needed to measure the efficacy of such programs in the region.

5.4. Qualitative-quantitative relations

DI, AP, DC, and CS did not show any significant differences among them for WPA and WC.

This indicates that they were fairly homogenous in their survey-based measures of willingness to conserve and WPA. There were significant differences between these themes and the remaining themes, PR and FN. DI, AP, DC, and CS had higher mean scores than PR and FN for WC. This may suggest more willingness to conserve using land trusts and specifically conserve aquatic areas among themes 1–4. We could infer that it is possible that a single FN landowner, who fears nature, although expressing support for conservation, is less willing to conserve their land but that inference is of course limited by the sample size. WPA, like WC, showed significant differences between the first four themes and the remaining themes, PR and FN. DI, AP, DC, and CS had the highest mean values for WPA while PR and FN had the lowest. This suggests a commitment to protect aquatic areas landowners in the first four themes. The lack of differences in TN and KLT suggests these values have little or no connection to the identified themes. It also

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means that landowners who associated land trusts with government, PR, thought they knew more about land trusts than their qualitative answers had shown.

6. Conclusions

Results support Tobler's first law of geography (Tobler, 1970) and show that the willingness to conserve is influenced positively by the predicted species richness of the area in which the parcel occurs, the value landowners place on wildlife in aquatic areas, and the likelihood they will sell the land to a non-family member. It is negatively influenced by a compound variable of the level of importance in protecting aquatic areas and the species richness. The willingness to conserve and the tendency not to have a direct relationship. A landowners' tendency to make non-conservation decisions decreases with increasing parcel size. Supposed familiarity with state-wide operating land trusts increases a landowner's knowledge of land trusts and land trust practices. A landowner's willingness to protect aquatic areas is positively correlated with their willingness to leave their land to a Land Trust through a reserved life estate. The willingness to protect aquatic areas rises and then eventually decreases again in a curving relationship with distance from protected areas. Themes showed elements of apathy, interest, rejection, concern, and a sense of connection. Themes 1 and 3, with communication, show potential for conservation lands. Themes 2 and 4 showed potential sources of support outside of land transactions. Themes 5 and 6 show a possible minority resisting or fearing conservation through land trusts. In all instances, outreach and communication on the details and benefits of conservation is a potential option for land trusts in the region.

Our research suggests that land trusts should expand communication and outreach to encompass the subjects of biodiversity, aquatic ecology, and land planning and how these relate to landowners' objectives. Land trusts should also take distance from protected areas into account when planning where to focus their outreach and aquatic area conservation efforts, perhaps by using our formula for 'Willingness to Protect Aquatic Areas' in combination with spatial data for desired parcels, wildlife corridors, and/or property value.

The need for communicating to the public (Jacobson, 2009) is probably not specific to the region but could in fact be an opportunity for land trusts in the greater landscapes including all private lands in South Carolina, the Blue Ridge Mountains and Piedmont, and in the US in general. The values landowners hold are probably not endemic to the area surveyed or the respondents; however our area does have a long history of anti-government sentiment (dating back to the Civil War and Reconstruction eras) (Edgar, 1998), some views we collected may have been extreme relative to national averages. Nonetheless, our results and conclusions could be valuable to land trusts outside of the surveyed area,

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especially bordering areas such as the remaining South Carolina Upper Piedmont, northern Georgia, and western North Carolina, all of which are encompassed by the same Upper Piedmont and Blue Ridge ecoregions (Ricketts, 1999) and have similar social and cultural histories. The willingness to conserve, tendency to do otherwise, knowledge of land trusts, and willingness to protect aquatic areas probably show similar patterns in these adjacent areas. The themes and landowners' attitudes to conserving aquatic areas may also be of value to other conservation organizations, planning committees, and government agencies. Likewise, the methods employed could be extended to sample other areas to test for geographic differences in responses at greater spatial extent.

Our research indicates what drives landowners' attitudes towards land trust conservation and the protection of aquatic areas in a region of the United States with rich aquatic resources and also a strong history of private property rights. In accordance with United States' historic veneration of property rights, the American southeast has one of the least-regulatory environmental-control systems in the world (Mortimer, 2008). A study in the neighboring state, North Carolina, found property rights and independence as important principles for landowners in the upper Piedmont (Daley et al., 2004).

Land trusts should take note: if people perceive land trust activities as impinging upon perceived or real property rights (keeping in mind our respondents with the strongest views held little property) rather than enabling landowners to retain ownership while providing ecological services for society, then land trusts in this and similar regions will likely fail. Overcoming such barriers of perception and understanding may become one of the most important conservation activities in the biologically rich southeastern United States. Studies such as ours may help to bridge these gaps between conservation science and practice. Such investigations bring together social and natural sciences in the hope of identifying interdisciplinary solutions to natural resource conservation problems. This should be incorporated with conservation planning like the already suggested parcel size and budget constraints (Davies et al., 2010). Future research should focus on a more detailed understanding of the reason the largest theme shows a lack of interest in conservation. Other topics should include more detail of landowners' knowledge of land trusts' methods for conservation and an explanation of why certain areas and themes have a lower response in surveys – is this apathy towards research, towards conservation in general, aquatic areas, a combination of the above, or another as yet unexplained factor?

New land and water conservation projects should be based on the best available natural science: what organisms and ecosystems to protect, where, and when (under climate and land use change scenarios) (Moilanen et al., 2009). They should also be based on the best available social science. Such research can help to

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operationalize a conservation plan hitherto confined to digital space. Moving conservation from maps and models, and published papers, to resilient landscapes in which people live and work depends upon such multidisciplinary efforts which in turn, depend upon knocking down traditional barriers to collaboration.

Declarations

Author contribution statement

Samuel N. Chambers: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Robert F. Baldwin: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data.

Elizabeth D. Baldwin: Conceived and designed the experiments.

William C. Bridges, Nakisha Fouch: Contributed reagents, materials, analysis tools or data.

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