The Pennsylvania Highlands: Phase I
Final Report

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Final Report Prepared for:

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April 2007

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Executive Summary

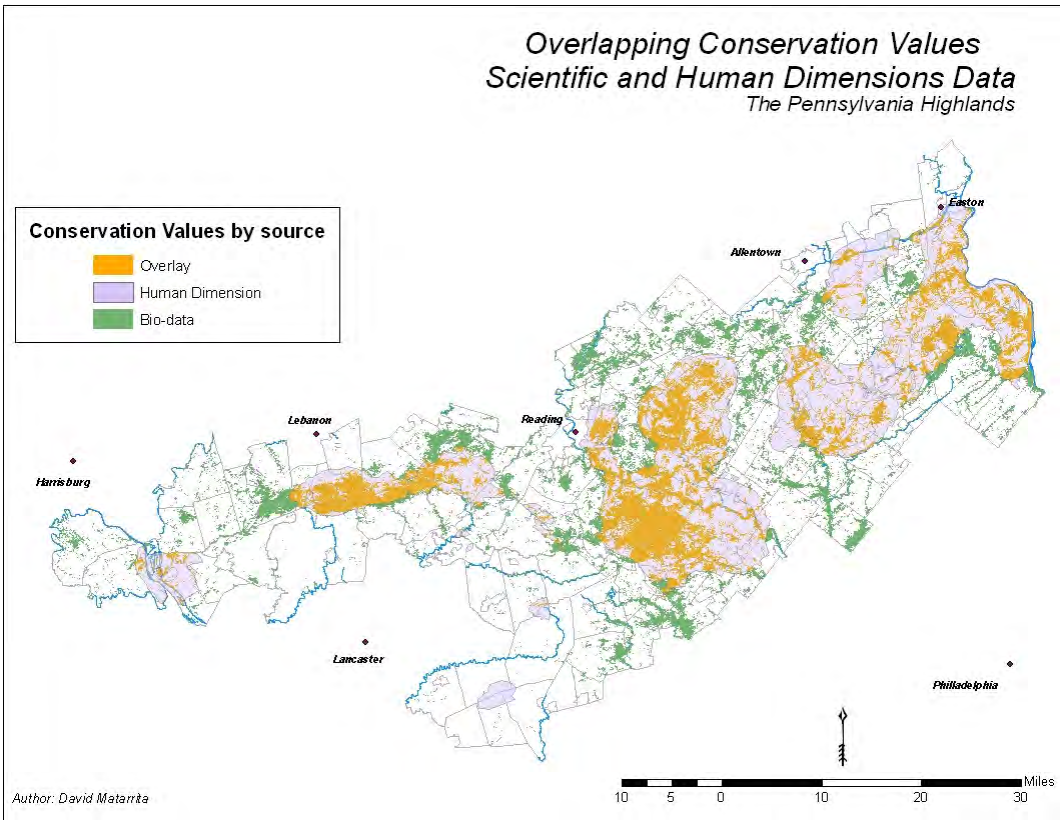
The Connecticut, New York, New Jersey, and Pennsylvania Highlands have uniquely abundant natural and cultural resources that provide economic, ecological, and social value to a significant portion of the nation's citizens. The recent New York and New Jersey Highlands study (2002) suggested five major conservation goals for this important natural area: (1) manage future growth; (2) maintain an adequate supply of quality water; (3) conserve contiguous forests; (4) provide appropriate recreational opportunities; and (5) promote economic prosperity compatible with the previous four goals.

The Pennsylvania Highlands Phase 1 project conducted by the Penn State University Human Dimensions unit had four broad objectives: (1) assess the condition of natural resources in the Highlands; (2) analyze land cover change and potential land use; (3) identify significant areas to conserve and protect; and (4) develop strategies to protect the long-term integrity of the region. This project report is organized around five principle resource conservation values: Water; Biodiversity; Recreation, Open Space, and Cultural Resources; Farmland; and Forestland.

Accomplishing this assessment involved two major components. First, we conducted a GIS-based assessment involving existing data layers relating to the conservation values that used expert opinion to identify and weight conservation values. The second element involved collecting stakeholder input to separately identify important conservation areas. The blending of these two approaches focused on important opportunities for conserving important areas relative to the five conservation values.

Conducting the GIS-based conservation assessment for the Highlands involved creating a separate 30-meter resolution map layer for each of the five conservation values. These layers were then combined in a composite map. This map reflected the joint distribution of values across area of interest. The top two quintiles (top 40%) were highlighted in the composite map.

The stakeholder phase of the project gathered community input for the identification of important natural resource areas for conservation. This process involved gathering data using key informant interviews and public meetings. In the latter, three mapping exercises and facilitated discussions identified important areas for conservation. The resulting maps well reflected those created using the GIS-based biodata, highlighting common places for conservation throughout the Highlands.



This map highlights the areas of high conservation value for both GIS and public generated data and their intersections. The latter (indicated in yellow) is particularly evident in the central and northwestern parts of the Highlands. Our map also highlights those areas absent overlap. This pattern is particularly evident in areas closer to the eastern border of the Highlands. There, the public identified more areas for high conservation value. Conversely, the biodata illustrates regions in the north and south central areas of the Highlands not identified by the public.

Introduction

Study Site Description

The Connecticut, New York, New Jersey, and Pennsylvania Highlands have uniquely abundant natural and cultural resources that provide economic, ecological, and social value to a significant portion of the nation's citizens. The recent New York and New Jersey Highlands study (2002) suggested five major conservation goals for this important natural area: (1) manage future growth; (2) maintain an adequate supply of quality water; (3) conserve contiguous forests; (4) provide appropriate recreational opportunities; and (5) promote economic prosperity compatible with the previous four goals.

Geographically, the Pennsylvania Highlands (hereafter referred to as the Highlands) extends from Northampton County in the east, where it meets with the New Jersey Highlands, south-southwest into Berks County with two extensions (one into northern York County and one into southern Lancaster County). This area, which encompasses much of the Lehigh Valley, borders the Delaware River into northern Bucks County and is traversed by several major highways (I-78; I-476; and state 422). In total, the Highlands include more than 179 local municipalities extending over nine counties in southeastern Pennsylvania.

Given its proximity to many of the Commonwealth's central and eastern urban centers, this large land area is under exceptional pressure, reflecting increased exurbanization. Residential development, reflecting the desire of urbanites to move to more suburban areas and have a home in a planned subdivision, is common in this region and reflects the suitability of these lands for conversion to alternative uses. Expanding commercial and industrial development is also common on lands formerly in production agriculture or forests. The presence of numerous rural and small communities throughout the Highlands reflects this pattern of activity. Conversion of the remaining forest and agricultural lands to these uses will continue to have a major impact on the character of the region.

The purpose of this study was to:

(1) Assess the condition of natural resources in the Highlands;
(2) Analyze land cover change and potential land use;
(3) Identify significant areas to conserve and protect; and
(4) Develop strategies to protect the long-term integrity of the region.

Penn State's responsibilities focused on the development of complementary materials for assessing the importance of five principle resource conservation values, each relating to one of the core sectors for study, i.e., water, biodiversity, farmland, forestland and recreation, open space, and cultural resources.

Water

Water resources for the purpose of the assessment include rivers, streams, lakes, and other water bodies, as well as underground sources of water. The Delaware and Susquehanna River serve as bookends for the Highlands to the east and west respectively. In addition, the Highlands contribute to other stream and river systems including the Schuylkill which flows from the region.

People in the region benefit from water resources as they clearly link to the other conservation values assessed in the project. As well, they contribute significantly to aesthetic and quality of life values in the region.

Biodiversity

Collectively, faunal and plant diversity are important components in defining natural communities. The spatial distribution of important natural communities helps describe biodiversity.

This objective examined the status of Highlands' biodiversity and examined its geographic distribution throughout the region. A secondary objective was to map the spatial distribution of areas important for maintaining threatened or endangered species and natural communities that supported and maintained the high diversity of the Highlands. The habitats and communities important to biodiversity included critical animal and plant habitats and significant natural vegetative communities.

Farmland

Agriculture is an important economic and cultural activity in some sections of the Highlands. This objective identified productive farmland resources, particularly those areas with the highest value for maintaining agriculture as a viable activity. Landscape features related to farmland conservation included working farms with cultivated lands ranked by soil productivity and contiguous areas and preserved farms with buffers.

Forestland

Forests provide wood, wildlife habitat, watershed protection, recreational opportunities, and other benefits to the environment and to the community. Therefore, the identification of important forest resources was essential to this study. In this study, forestland included contiguous forest tracts of both public and private ownership.

Recreation, Open Space, and Cultural Resources

The Highlands, when considered in its broadest context, represent an important green space. This space provides numerous opportunities for outdoor recreation and leisure activities. The objective here was to document the importance of the Highlands as a recreational, open space, and cultural resource. Both land and water were considered important resources for these activities.

This component of the project focused on public and privately owned open spaces and other conservation lands. To identify recreational opportunities, the project mapped information on municipal parkland, non-profit land trusts, privately owned conservation lands, or privately owned open space. Landscape features related to recreation, open space, and cultural resources included: recreational trails, with buffer zones; scenic view sheds; visible ridge tops; existing parks and preserves, with buffer zones; historic, cultural, or recreational resource areas or sites, with buffer zones; and recreational waters and shoreline buffer zones.

GIS-based Conservation Assessment

Methods

A GIS-based conservation assessment was conducted for the Eastern Pennsylvania Highlands area at the request and under the general guidance of the US Forest Service. Each of the five conservation values was separately mapped as a 30-meter resolution layer to show the distribution of values across the study region. These layers were then combined in a composite that did not explicitly favor or penalize any broad category. That is, the purpose of the composite was to reflect the joint distribution of values across all areas of interest. The top two quintiles (top 40%) were highlighted in the composite.

For simplicity of explication, each layer model was structured as a summation of factor scores which was then value coded as decile numbers. The decile numbers were summed to obtain a composite. Quintiles were then identified using this summation. The value factors and their scoring contributions were determined by an open panel of experts and interested participants during a series of meetings held at the offices of the Pennsylvania Bureau of Topographic and Geologic Survey in Middletown, Pennsylvania.[1]

To avoid confusion in what follows, we offer a limited explanation of the role of quantiles in GIS applications. Quantiles are fractions of the spatial units (30-meter cells) under consideration. A quartile is one quarter of the cells, a quintile one fifth, a decile one tenth, and a percentile one hundredth. GIS considers cells with zero values background and does not include them in counts. For several layers, e.g., agriculture, many cells did not possess value factors recognized for agriculture – notably cells on high, steep, rocky forested slopes. Therefore, a decile of the cells is one tenth of those having nonzero value – which may be considerably less than one tenth of the entire expanse of the study area. Large numbers of cells having tied values can also cause anomalies in the balance among quantiles. Tied cells must all go in the same quantile, because doing otherwise would introduce apparent differences among cells that are actually the same. This effect is most likely to be evident when there are only a few possibilities for the values of cells.

[1] Prof. Wayne Myers of the Penn State University School of Forest Resources acted as the coordinator of the GIS-based conservation assessment for Pennsylvania. GIS operations for the Pennsylvania assessment were conducted by the Natural Lands Trust. The GIS assessment was part of the overall Pennsylvania effort under the direction of Prof. J.C. Finley and Prof. A.E. Luloff of Penn State University.

The five conservation types and the procedures used to describe the values for given layers are described below. Table 1 provides further definition of buffers, weightings, and data sources used in building the maps used in this segment of the study.

Water Model

The water model had eleven components with 89 as a maximum possible overall score. Ten points went to prime aquifer recharge areas according to a productivity rating for the aquifer. Ten points went to pollution susceptibility of aquifer recharge areas using the DRASTIC model. Ten points went to groundwater protection zones and surface water protection zones on a presence or absence basis. Ten points went to 150-ft riparian buffers according to a Natural Lands Trust ranking of vegetation quality in the buffer. Ten points or four points went to steep slopes according to the steepness of the slope. Five points went to 100-yr floodplains. Ten points went to wetlands according to a Natural Lands Trust analysis and ranking of wetlands. Hydric soils received two points. Exceptional value streams with 150-ft buffer received two points. Ten points were allocated according to watersheds ranked by percent of area forested. Impervious areas and impaired stream reaches were treated as being devoid of conservation value.

Biological Model

Biodiversity was the most complex layer with 14 components and a maximum possible overall score of 100. Ten points each went to habitat values for mammals, birds, and fish. Seven points each went to aquatic and terrestrial herptiles. Five points went to important bird areas and four points to important mammal areas. Ten points went to rare species. Two points were given for green infrastructure. Ten points went to interior forest landscape blocks. Ten points went to unfragmented natural vegetation landscape blocks. Ten points went to existing parks and preserves with buffers. Matrix habitats received two points and CREP zones received three points.

Recreational, Open Space, and Cultural Model

The recreational/cultural layer had five components with an overall score of 46. Ten points went to recreational trails with buffers. Ten points went to high quality scenic visible ridge tops. Ten points went to existing parks and protected lands with buffers. Six points went to historic, cultural, recreational resources with buffers. Ten points went to recreational waters and shorelines with buffers.

Farmland Model

The agriculture layer had four component scores of factors considered to confer agricultural value, with a maximum possible overall score of 30. One component was prime agricultural soils with a contribution of 10 on a presence or absence basis. A second component was cultivated lands according to type in 1994 and 2000 mappings. Row crop in both mappings was 10, row crop in one mapping was five, and hay/pasture in both mappings was three – otherwise zero. A third component was Agricultural Security Areas with five points on a presence or absence basis. A fourth component was

preserved farms and buffers with five for the farm, four for first 500 ft of buffer, and three for second 500 ft of buffer – otherwise zero.

Forestland Model

The forest layer had three components with 30 as a maximum possible overall score. Ten points came from ranking of forest soil productivity by the Natural Lands Trust according to soil type and tree species. Ten points came from forest cover on a presence or absence basis. Ten points came from interior (large) forest areas according to size with 5,000 acres getting 10, 1,000 to 5,000 acres getting eight, 500 to 1,000 acres getting six, 100 to 500 acres getting four, and 25 to 100 acres getting two.

Scoring Matrix and Layer Maps

Table 1 contains a matrix summarizing the scoring and data sources for the individual layers of the Eastern Pennsylvania Highlands conservation assessment. Figures 1-5 show maps of the respective layers coded as deciles.

Table 1. Scoring matrix and data sources for Pennsylvania conservation layers.

Conservation Values for the Pennsylvania Highlands				
	Data Layer	**Code**	**Weight**	**Remarks**
	WATER RESOURCES			
W1	Aquifer Recharge Areas (bedrock), ranked	38/1	10 to 2	PA DCNR: units rank by yield
W2	Aquifer Recharge Areas ranked according to pollution susceptibility	38/2	10 to 0	PA DEP (2005) DRASTIC analysis
W3	Aquifer (wellhead) Protection Zone	38/3	10	PA DEP (2005) Zone II only
W4	Surface Water Supply Protection Zone	38/4	10	PA DEP (2005) Zone A only
W5	Riparian Zone (with 150' buffer), ranked	38/5	10 to 0	NLT [2] riparian analysis: rank by buffer vegetation quality
W6	Steep Slopes > 25% 15% – 25%	38/6	10 4	
W7	Floodplain (100 year, not urbanized)	38/7	5	
W8	Wetlands, ranked	38/8	10 to 0	NLT analysis and ranking
W9	Hydric Soils	38/9	2	
W10	Watersheds ranked by percent of area forested	38/10	10 to 0	NLT analysis and ranking
W11	Exceptional Value Streams (with 150' buffer)	38/11	2	PA DEP (2005)

[2] NLT: Natural Lands Trust, whose "Smart Conservation" analysis of southeastern Pennsylvania was the source of many interpreted data layers used in the Pennsylvania Highlands Resource Assessment

W13	Impervious surface (> 25% impervious surfaces)		Mask: sets cell to zero	
W14	Stream quality below state threshold for listed uses ("non-attaining reaches" of streams)		Mask: sets cell to zero	PA DEP (2005) Clean Water Act: Sec. 305(b) Sec. 303(d)
W15	Stream quality impaired by acid mine drainage (affected reaches of streams)		Mask: sets cell to zero	PA DEP
	BIOLOGICAL RESOURCES			
B1	Mammals Habitat Conservation Value, ranked	39/12	10 to 0	NLT analysis by species with cumulative taxa results
B2	Fish Habitat Conservation Value, ranked	39/13	10 to 0	NLT analysis by species with cumulative taxa results
B3	Birds Habitat Conservation Value, ranked	39/14	10 to 0	NLT analysis by species with cumulative taxa results
B4	Aquatic Herps Habitat Conservation Value, ranked [3]	39/15	7 to 0	NLT analysis by species with cumulative taxa results
B5	Terrestrial Herps Habitat Conservation Value, ranked	39/16	7 to 0	NLT analysis by species with cumulative taxa results
B7	Important Bird Areas, Core Buffer	39/17	5 3	Audubon Society
B8	Important Mammal Areas	39/18	4	Audubon Society
B9	Plant and Animal Rarity, ranked	39/19	10 to 2	PA Natural Heritage Program, eco-regionally ranked by NLT
B10	Green Infrastructure Hubs, ranked	39/20	2 to 0	NLT analysis
B11	Interior Forest Landscape Blocks, ranked	39/21	10 to 0	NLT analysis and ranking of MRLC data (1992-1994) [4]
B12	Un-fragmented Natural Landscape Blocks, ranked	39/22	10 to 0	NLT analysis and ranking of MRLC data (1992-1994)
B15	Parks & Preserves with Buffers, ranked by landcover type	39/23	10 to 0	Includes lands with conservation easements
B16	The Nature Conservancy's Matrix Habitat sites	39/24	2	The Nature Conservancy
B17	Conservation Reserve Enhancement Protection Areas (CREP, leased conservation areas)	39/25	3	USDA Natural Resources Conservation Service
	RECREATIONAL OPEN SPACE & CULTURAL RESOURCES			
R1	Recreational Trails Buffer to 150' Buffer from 150' to 300'	42/33	10 8 6	
R2	Visible undeveloped Ridgetops & Hilltops With natural vegetation With other vegetation	42/34	 10 5	AMC analysis [5]

[3] "Herps" is the ecologist's shorthand for reptiles and amphibians
[4] US Geological Survey satellite data: "Multi-Resolution Land Characteristics"
[5] Appalachian Mountain Club terrain analysis using Digital Elevation Model, watersheds, and land cover data

R4	Parkland dedicated to public access and use Land protected by conservation easement Buffer to 1000' Buffer from 1000' to 2000' Buffer from 2000' to 3000'	42/35	10 8 6 4 2	PA DCNR and Highlands Counties
R5	Historical or Cultural site with 150' buffer	42/36	6	Most features are points
R6	Lake, reservoir with public access Buffer to 300' Canoe-able river or stream Buffer to 150' Buffer from 150' to 300' Trout production stream Buffer to 150' Trout maintenance stream Buffer to 150' Other lakes Buffer to 300' Cold water fishery Warm water fishery	42/37	10 8 10 8 6 8 6 6 4 6 4 5 5	
	AGRICULTURAL RESOURCES			
A1	Prime Agricultural Soils	41/29	10	USDA Natural Resources Conservation Service
A2	Agricultural crops in both 1994 and 2000 Agricultural crops in either 1994 or 2000 Hay or pasture in both 1994 and 2000 Hay or pasture in either 1994 or 2000	41/30	10 5 3 0	NLT analysis of MRLC data (1994-2000) [6]
A3	Preserved farms (agricultural easement) Buffer to 500' Buffer 500' to 1000'	41/32	5 4 3	
A4	Agricultural Security Area	41/31	5	PA Department of Agriculture
	FOREST RESOURCES			
F1	Soils ranked by silvicultural potential	40/26	10 to 0	NLT analysis by species and soil type
F2	Forested Landcover	40/27	10	NLT analysis of MRLC data (2000)
F3	Interior Forest Blocks >5000 acres >1000 to 5000 acres >500 to 1000 acres >100 to 500 acres 25 to 100 acres	40/28	 10 8 6 4 2	NLT analysis of MRLC data (2000)

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[6] US Geological Survey satellite data: "Multi-Resolution Land Characteristics."

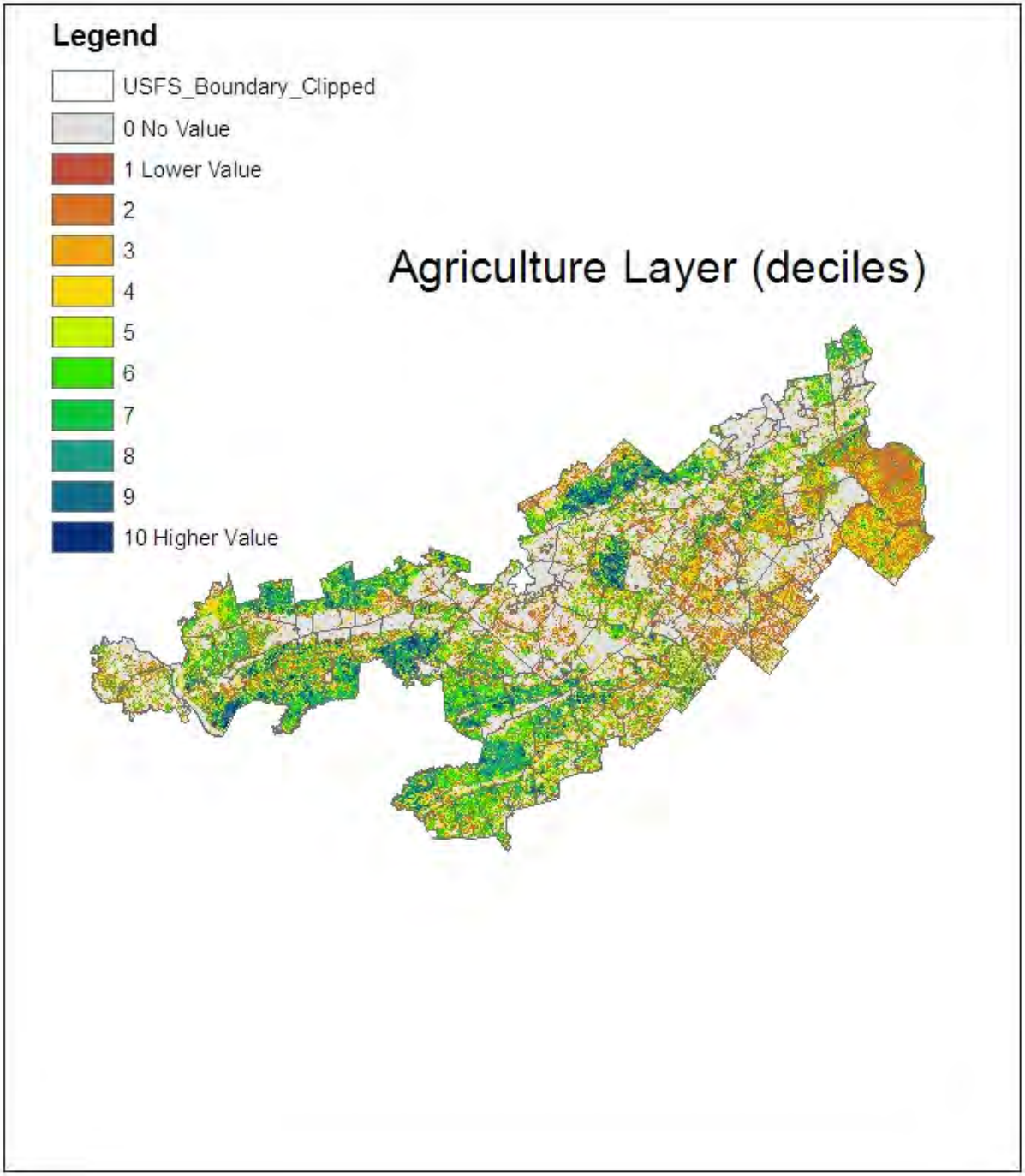

Figure 1: Decile map of agricultural conservation values.

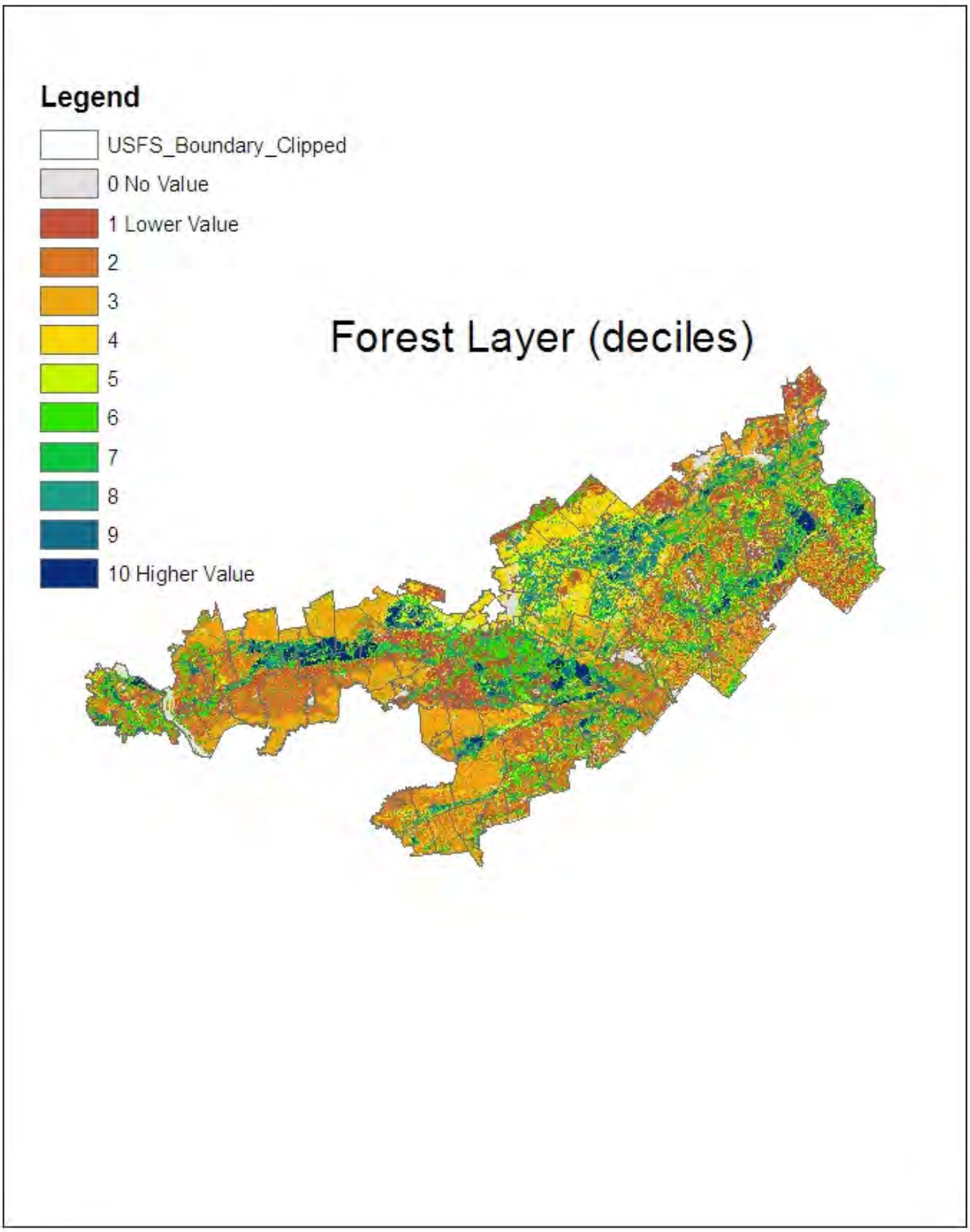

Figure 2: Decile map of forest conservation values.

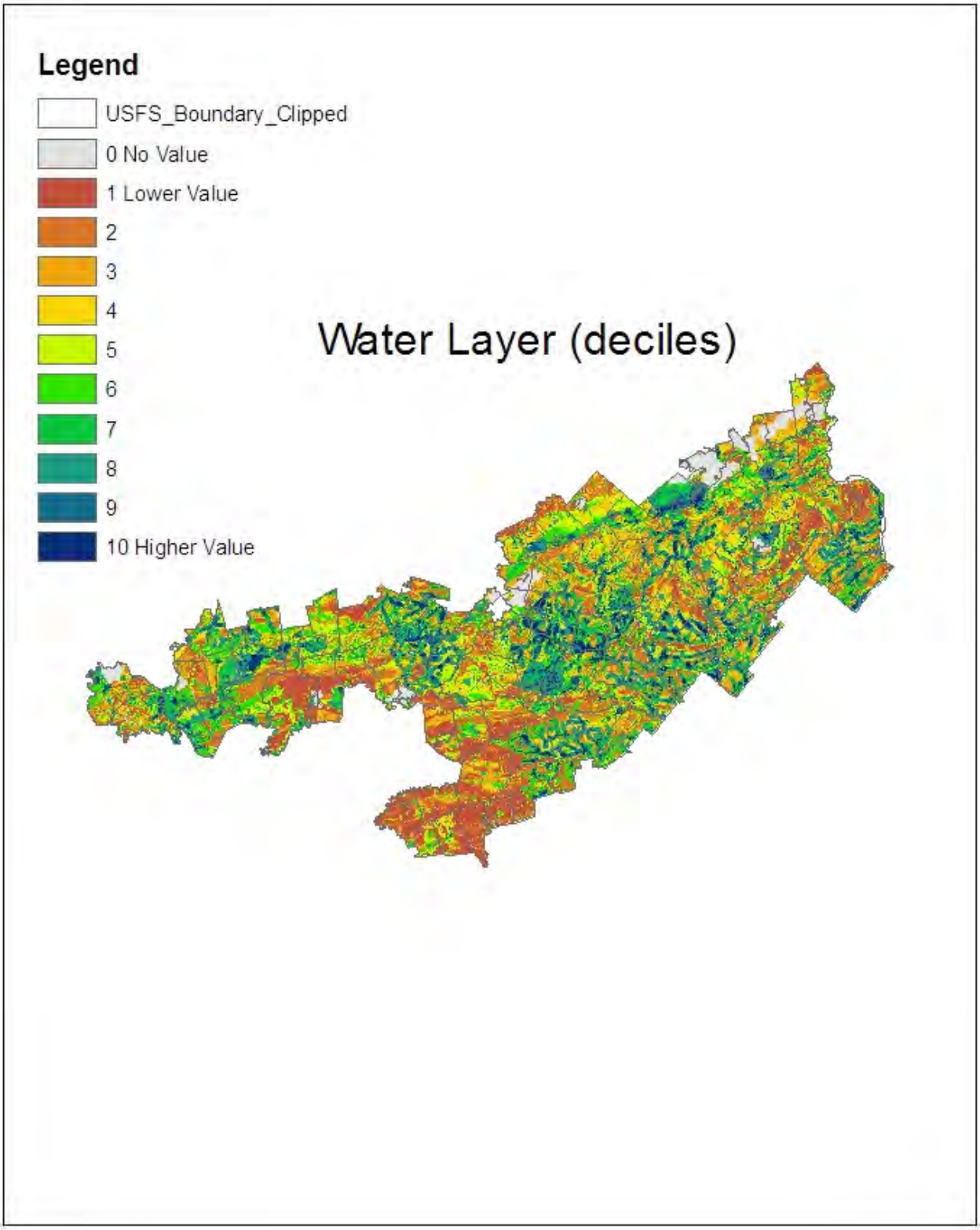

Figure 3: Decile map of water conservation values.

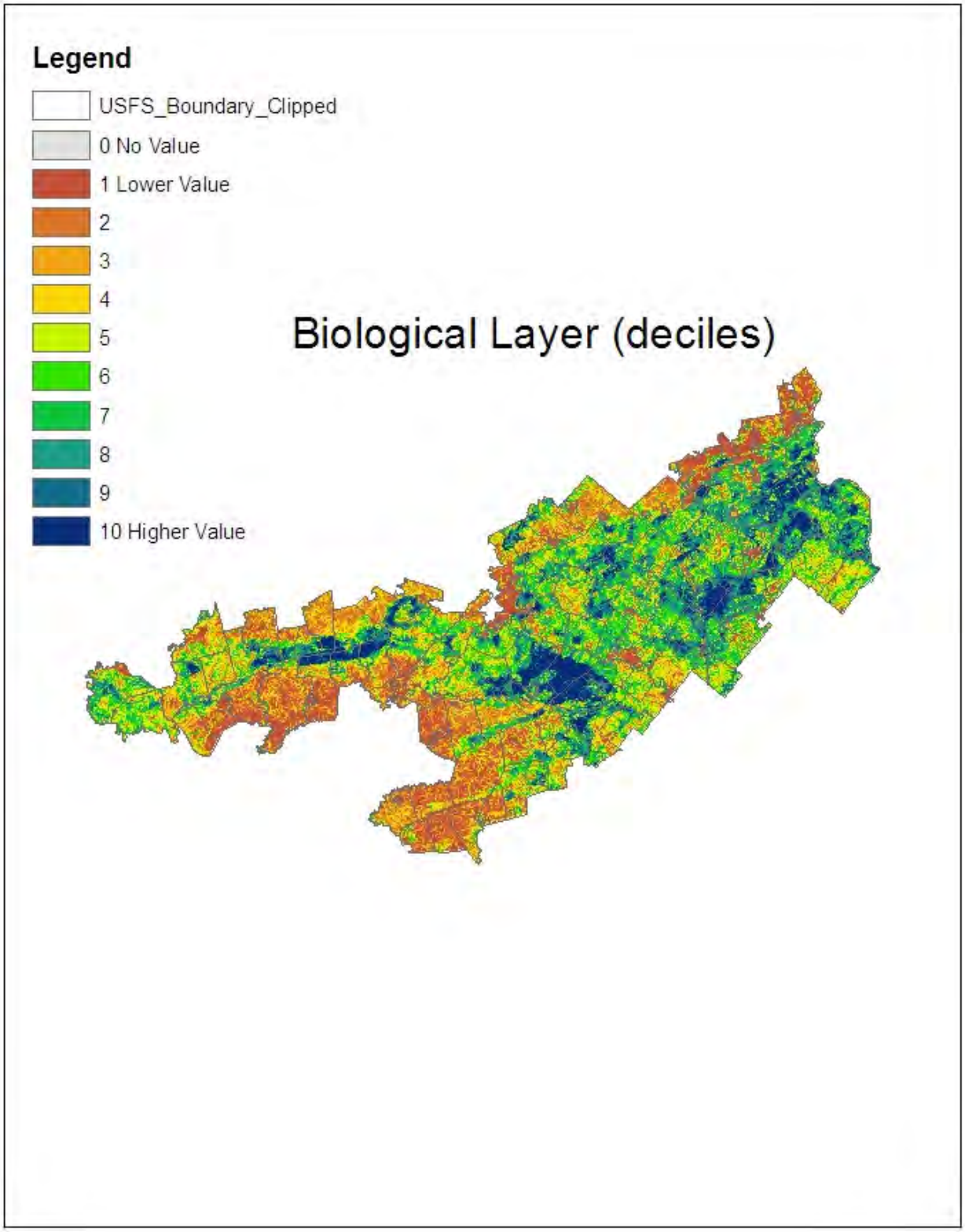

Figure 4: Decile map of biological conservation values.

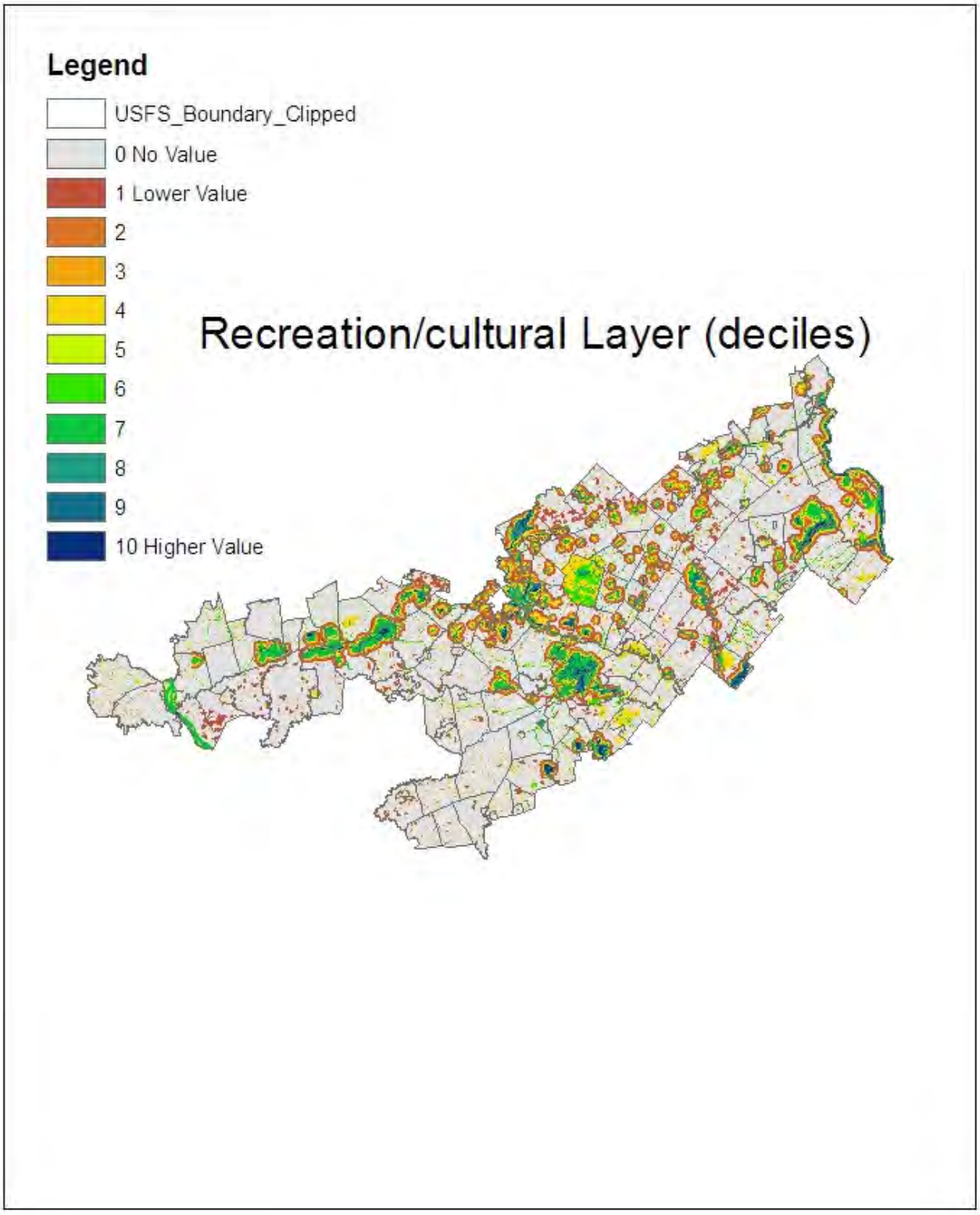

Figure 5: Decile map of recreation/cultural conservation values.

Composite map

A quintile map of the composite conservation values is given in Figure 6.

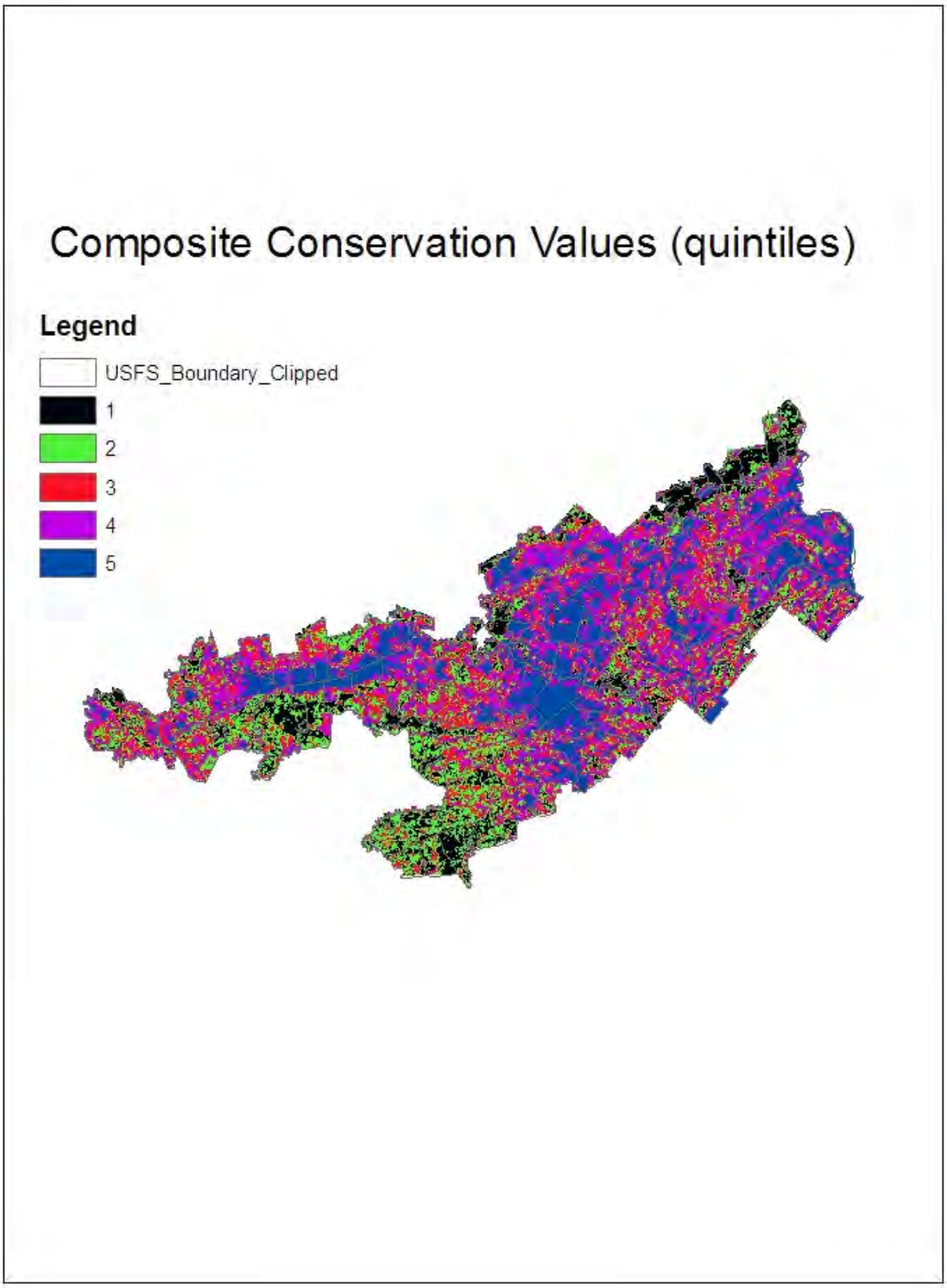

Figure 6: Quintile map of composite conservation values.

Community Input for Conservation Values in the Highlands

Methods

A unique element of this project was its focus on gathering community input for the identification of important natural resource areas for conservation. Led by an interdisciplinary team of faculty members from Penn State's College of Agricultural Sciences, working collaboratively with other members of the project team and local citizens across the Highlands, the project gathered and concatenated secondary data in a series of layers using municipalities (MCDs) as the base unit of analysis. We did this for two reasons. First, it allowed us to differentiate trends at a smaller scale than those detectable at a higher level, such as the county base used in the New York-New Jersey Highlands study. Second, the Commonwealth is a mosaic of government units with varying structures, functions, and authority. Home rule power and local decision making is central to government in Pennsylvania. When building this database we retained county demarcations to enable aggregations to the county level, insuring comparability with the earlier study and the companion study in Connecticut.

This study used two types of data – secondary, gathered and organized by MCDs from a variety of sources (USFS, USGS, BoF, PGC, Fish and Game, Census of Population and Housing – 1990-2000) and primary data gathered through key informant interviews and facilitated discussions. Our understanding of the Highlands' natural resources drew heavily from existing secondary data sets available to Penn State and developed for various cooperative projects.

Coupled to discussions with USFS staff, this initial data analysis guided selection of four study subregions within the Highlands. Once they were selected we began key informant interviews. Key informants provided a useful point of entry for this research. In addition, they provided rich and spontaneous replies to open ended questions and a clear view of the reality of a place, including broad patterns of relationships among actions and actors (Elmendorf and Luloff, 2001).

We used a key informant approach because it facilitated the gathering of data that cannot be established with secondary information, while remaining more feasible (in costs and logistics) than mail surveys covering the entire Pennsylvania Highlands area (Krannich and Humphrey, 1986, Israel and Beaulieu, 1990, Luloff, 1990). Informants are individuals knowledgeable about the subregion and were selected as being broadly representative of local interest groups. Initial key informant interviews in each subregion included representatives of the following groupings: (1) a county forester (extension and/or service); (2) a county agricultural agent; (3) a representative of the news media; (4) a forest industry business leader; (4) a local environmental organization; (5) a county and/or community planner; (6) long-term residents; (7) new exurban residents; (8) a leader of a local watershed association; (9) a leader from the recreation/tourism industry; and (10) a leader of some grouping which represents a minority, opposing, or underclass interest. Selection was accomplished using a modified snowball procedure. Informants were identified on the basis of directories, advice from people familiar with the community, and/or through conversations with local residents.

Additional informants were selected from persons mentioned by the initial informants and others, and interviews were conducted until redundant information was collected and we were reasonably certain we had compiled a fairly comprehensive account of key informant opinions about: (1) the impacts of exurbanization in their respective community; (2) values and perspectives concerning the uses of the Pennsylvania Highlands, (3) ideas about significant areas to be conserved and/or protected in the Highlands; and (4) ideas on what they thought would work to protect the long-term integrity of the region.

Interviews were tape-recorded when the subjects agreed to allow this to happen (all were recorded) *and* each interviewer took notes during the interview. Immediately at the end of the interview, the interviewer reviewed her/his notes, made additions so as to complete thoughts, and ensured that the records of the interviews were secured. All interviews were then compiled by subregion and content analyzed to identify common themes, concerns, and areas for conservation.

Based on our use of this technique in related studies we anticipated that roughly 20-25 key informants per study subregion would provide enough information for us to capture a complete perspective. To ensure a level of uniformity, the key informant interviews followed a predetermined script and were conducted between early August and late September, 2005, by a team of interviewers. Refer to Appendix A for a copy of the interview script. The script and protocol were approved by the Penn State University Institutional Review Board.

Following these procedures helped to guide the development of the facilitated group discussion protocols. The group discussion centered on broad parameters of concern and acted as the springboard for discussion among those in attendance. Following each group discussion, the research team was debriefed about what was heard and identified the participants' suggestions, concerns, deletions, and additions of areas of highest priority for conservation actions.

Information drawn from an analysis of these key informant interviews informed our facilitated discussions with wider community audiences in each of four locations in the Highlands. Through these discussions we assessed general citizen-stakeholder concerns about the Highlands and how it could be improved. The objectives of each of the facilitated group discussions were to: (1) assess stakeholder willingness to be involved in activities designed to improve and retain the Highlands; (2) assess the degree of importance stakeholders place on whether or not such activity is useful; and (3) to help identify strategies that can be devised to protect the long-term integrity of the region. Appropriate locations for each facilitated group discussion were selected in each of the four areas (i.e., we chose a neutral facility that could comfortably accommodate a cross-section of residents). Participants in the facilitated discussions completed three separate mapping exercises. These exercises were designed to allow us to triangulate responses in an effort to identify places with important conservation value. The Facilitated Group Discussions were completed over the period late October to Early November, 2005. See Appendix B for a listing of dates and locations for these sessions.

Results: Key Informants

In this stage of the study, we conducted 77 interviews with a total of 82 people during the key informant process. The following summary of key findings follows the set of questions used during the interviews.

What makes places special?

About half of the participants acknowledged that recreation value and water resources were important. In the context of recreation, they specifically mentioned activities that permitted people to enjoy nature while fishing, hunting, swimming, and running. About a third of the participants valued forestland, farmland and cultural/historical values equally. Interestingly, less than one in 10 specifically mentioned biodiversity.

Which of the five natural resources or core conservation values was most important?

By far, water resources garnered the most interest. This was followed by forest and farmland; recreation, open space, and cultural resources; and finally biodiversity. Biodiversity was the least mentioned value, either broadly or specifically.

Who is protecting special places?

Perhaps reflecting their participation in the Key Informant interviews, land trusts and conservancies were named nearly twice as often as any other group for having responsibility for protecting special places. The Natural Lands Trust, Heritage Conservancy, Wildlands Conservancy, The Nature Conservancy, and French and Pickering Creek Conservation Trust were the specific organizations named most often. As well, there was a strong tendency to recognize national and county organizations. Municipalities were the next most frequently named entity, followed by farmland preservation groups and watershed conservation organizations.

Who should protect these places?

This question served as a natural follow-on to the previous one. Surprisingly, the perspective had shifted. The respondents clearly and overwhelmingly said the state government should be responsible for the protection of special places. This was followed by municipalities, federal agencies, and county government.

What are your concerns or issues related to conservation values?

There was strong concurrence on threats to conservation values. The key informants were aware of the rapid pace of land development and the associated loss of open space. Spin-offs of development were the predictable increase in traffic as well as a perception of a reduction in quality of life.

Facilitated Group Discussions

Four facilitated group discussions were held in the study area (Appendix B). About 180 individuals, in total, participated in these sessions, which lasted about two hours in each location. The first meeting in Middletown was not well attended, as it was the local area's night for children to celebrate Halloween.

The agenda for each meeting was the same. We began the evening by providing a quick overview on the Highlands and a review of the general findings drawn from the key informant interviews. Following this, three mapping exercises and a series of small breakout groups were held. During the latter, responses to four specific questions were discussed (Appendix C). The focus of these questions was: (1) the identification of important places, (2) important conservation values, (3) their perceived threats and concerns, and (4) their reactions to the key informant findings. Table 1 provides a site summary.

In general, these participants could name specific places they believed were important to conserve. Most often they were associated with streams and rivers. The conservation values of interest were very consistent in that three of four groups emphasized water. All groups championed biodiversity and three of four groups said that biodiversity concerns should have received more emphasis from the key informants. As well, three of four groups recognized development as the largest threat to conservation.

Tables 2 depict the places most frequently named by site of facilitated discussion. It is evident that some places are not tied directly to water as the Oley Valley, an area recognized for a diverse landscape of forests and farms (Table 3). As well, the "Big Woods," a general description of the area that includes French Creek State Park, was seen as being very important. The Quakertown Swamp and the Big Woods also hold value because of their associated biodiversity, and in the latter site, forests were important.

While it is important to identify places of high conservation value, it is equally as important to understand how people perceive threats to these places. Table 4 displays a summary of conservation values by threats. Clearly, the largest perceived threat is from development and it cuts across all of the conservation values. That the participants saw biodiversity as important is also evident as it had the highest score. Change, the second most identified threat, is a subset of development. While participants understood the threats of development, this did not translate into concerns for conservation under the term "biodiversity."

Table 2. Summary findings from Pennsylvania Highlands facilitated group discussion by location and composite.

Location	Important Places	Conservation Values	Threats and Concerns	Reaction to KI Findings
Middletown	Many different places Conewago Creek	Water Biodiversity	Development Loss of habitat Water quality	Rank biodiversity higher
Ephrata	Welsh Mountain Texter Mountain Cocalico Creek	Water Biodiversity	Development Loss of habitat Water quality	Rank biodiversity higher
Pottstown	Rivers are important French Creek Schuylkill River	Water Biodiversity Cultural and Recreation	Development Loss of open space Loss of farms & forests	Rank biodiversity higher
Quakertown	Delaware River Quakertown Swamp	Biodiversity Cultural and Recreation	Water quality Development Loss of farms Loss of natural areas	No Consensus

Table 3. Places mentioned most frequently by facilitated discussion location.

Name	Middletown	Ephrata	Pottstown	Quakertown	**Total**
Oley Valley	0	2	13	2	**17**
Unami Creek	0	0	5	10	**15**
Quakertown Swamp	0	1	1	11	**13**
Big Woods	0	2	7	4	**13**
French Creek	0	0	10	2	**12**
Cocalico Creek	0	8	0	0	**8**
Lehigh Canal Towpath	0	1	1	5	**7**
Green Lane Reservoir	0	0	1	6	**7**
South Mountain	1	0	1	4	**6**
St. Peter's Wetland	0	0	6	0	**6**
Nockamixon State Park	0	1	0	5	**6**
Schuykill River	0	0	6	0	**6**
Welsh Mountains	1	2	2	1	**6**
Susquehanna River	3	2	0	0	**5**
Cooks Creek	0	0	0	5	**5**
Neversink	0	0	5	0	**5**
Middle Creek	0	3	2	0	**5**

Table 4. Places mentioned most frequently by the associated conservation value across all facilitated groups.

Name	Biodiversity	Farmland	Forestland	Recreation/ Culture	Water	Total
Oley Valley	**5**	**10**	**1**	**1**	**0**	**17**
Unami Creek	**4**	**0**	**6**	**2**	**3**	**15**
Quakertown Swamp	**11**	**0**	**0**	**0**	**2**	**13**
Big Woods	**7**	**0**	**5**	**0**	**1**	**13**
French Creek	**1**	**1**	**3**	**3**	**4**	**12**
Cocalico Creek	**1**	**0**	**1**	**3**	**3**	**8**
Lehigh Canal Towpath	**0**	**0**	**0**	**4**	**3**	**7**
Green Lane Reservoir	**0**	**1**	**0**	**1**	**5**	**7**
South Mountain	**2**	**0**	**4**	**0**	**0**	**6**
St. Peter's Wetland	**4**	**0**	**1**	**0**	**1**	**6**
Nockamixon State Park	**1**	**1**	**0**	**3**	**1**	**6**
Schuykill River	**0**	**0**	**0**	**0**	**6**	**6**
Welsh Mountains	**1**	**0**	**1**	**1**	**3**	**6**
Susquehanna River	**3**	**0**	**0**	**1**	**1**	**5**
Cooks Creek	**1**	**0**	**0**	**1**	**2**	**4**
Neversink	**1**	**0**	**3**	**0**	**1**	**5**
Middle Creek	**2**	**0**	**2**	**1**	**0**	**5**

Table 5. Cross-tabulation of threats and concerns by conservation values threatened across all facilitated groups.

Name	Biodiversity	Farmland	Forestland	Recreation/ Culture	Water	Total
Development	70	41	43	34	37	**225**
Change	11	8	10	10	4	**43**
Pollution	5	1	1	3	13	**23**
Logging	6	0	0	0	1	**7**
Invasive Plants	4	0	2	0	1	**7**
Mining	2	0	3	0	1	**6**

Wall Mapping Exercise

During the wall map exercise, each participant had the opportunity to place up to five dots on areas of concern in the Highlands. These maps were large, measuring 30 inches by 40 inches. While the decision on where to place dots was an individual choice, the exercise encouraged discussion as participants milled around the map discussing the location of potential areas they wished to acknowledge. There was no attempt to identify or name the places identified in this exercise.

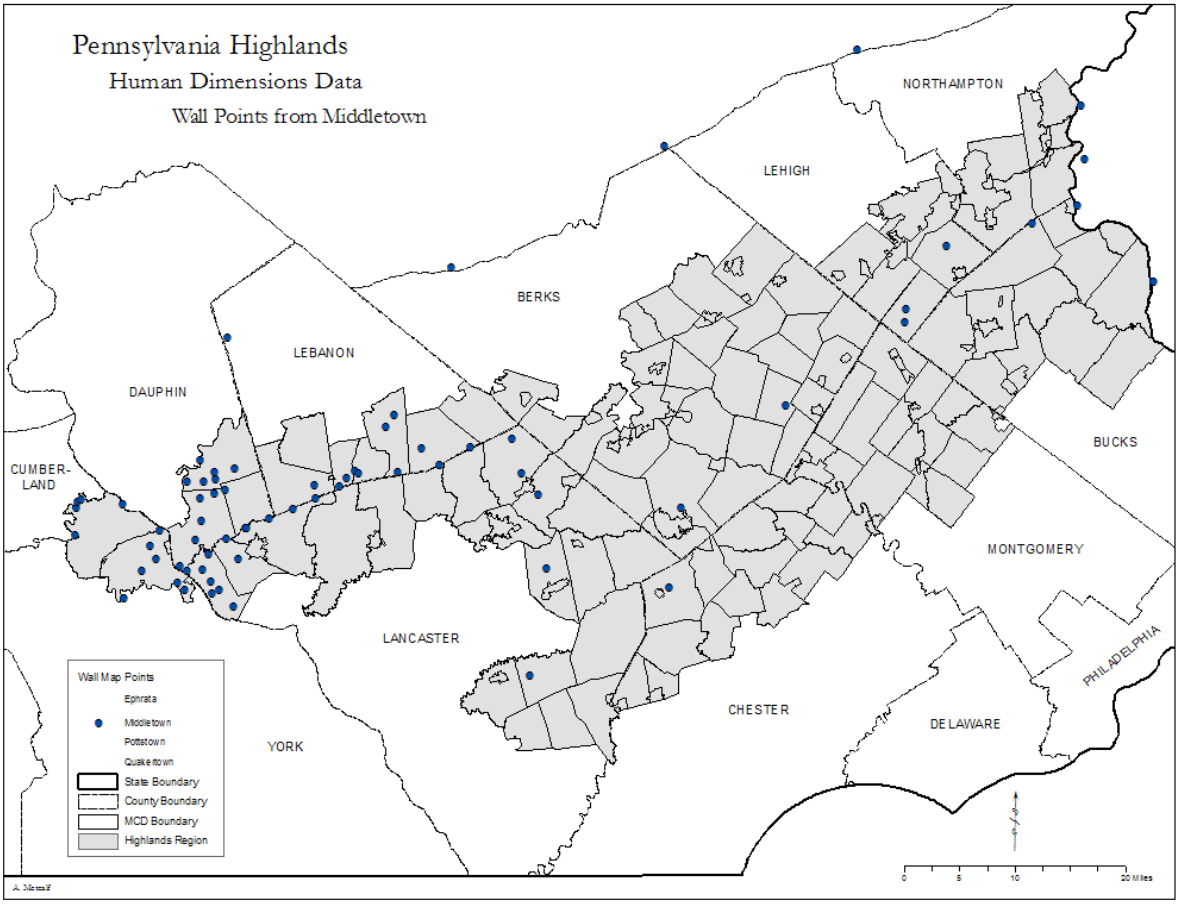

Figure 7: Middletown wall map depicting participant choices for areas of concern.

The attendance at the Middletown event was small as we unknowingly held this event on the same night local children celebrated Halloween. Figure 7 indicates the majority of dots were placed in the southwest section of the Highlands, However, participants placed dots across the region including as far east as the Delaware River. A series of dots lie beyond the boundaries of the Highlands. An individual placed these dots along the Appalachian Trail, an area of special concern to her and which she was encouraged to indicate on the map.

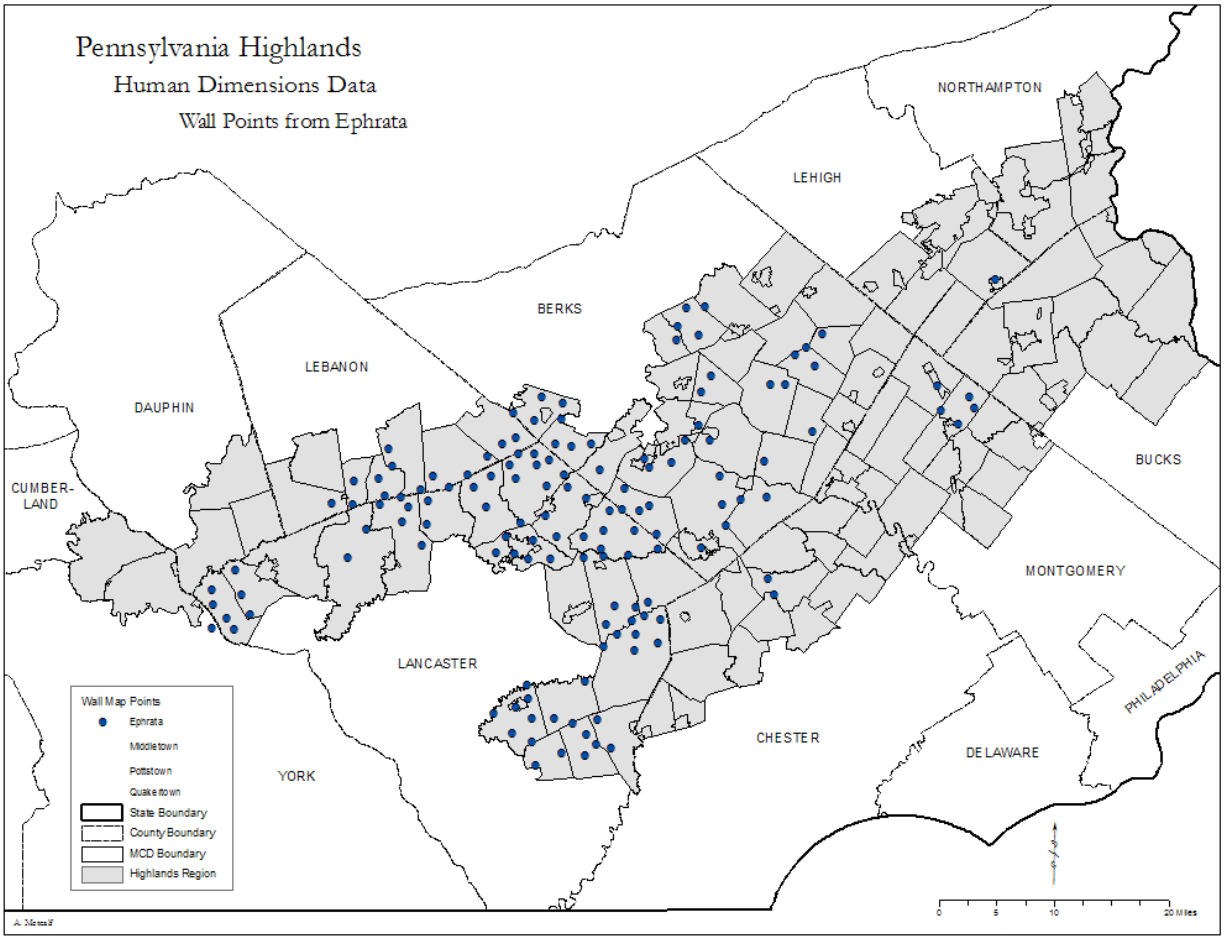

Figure 8: Ephrata wall map depicting participant choices for areas of concern.

The number of dots in Figure 8 reflects the greater attendance at the second meeting held in Ephrata. A heavy concentration of dots is found in the central part of the Highlands; however, a concentration of dots is found both in the southwest and towards the northeast. As with Middletown, participants revealed a level of interest in places across the study area.

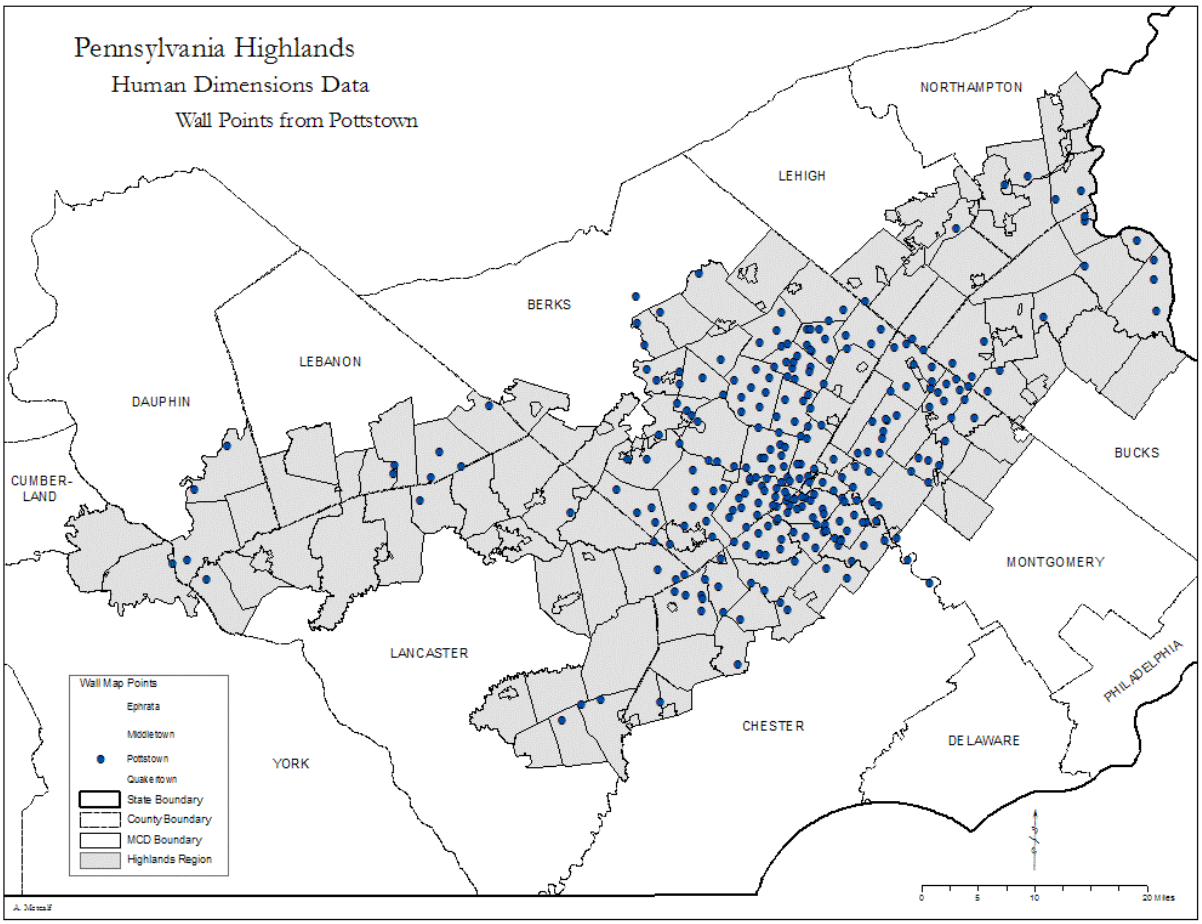

Figure 9: Pottstown wall map depicting participant choices for areas of concern.

The third meeting (Figure 9) in Pottstown had excellent attendance. A clear concentration of interest in the south-central region of the Highlands is depicted, and there are clusters in both the western and eastern reaches of the study region. These participants concern for river areas is reflected in the East, along the Delaware River, and by the series of dots extending beyond the Highlands along the Schuylkill River.

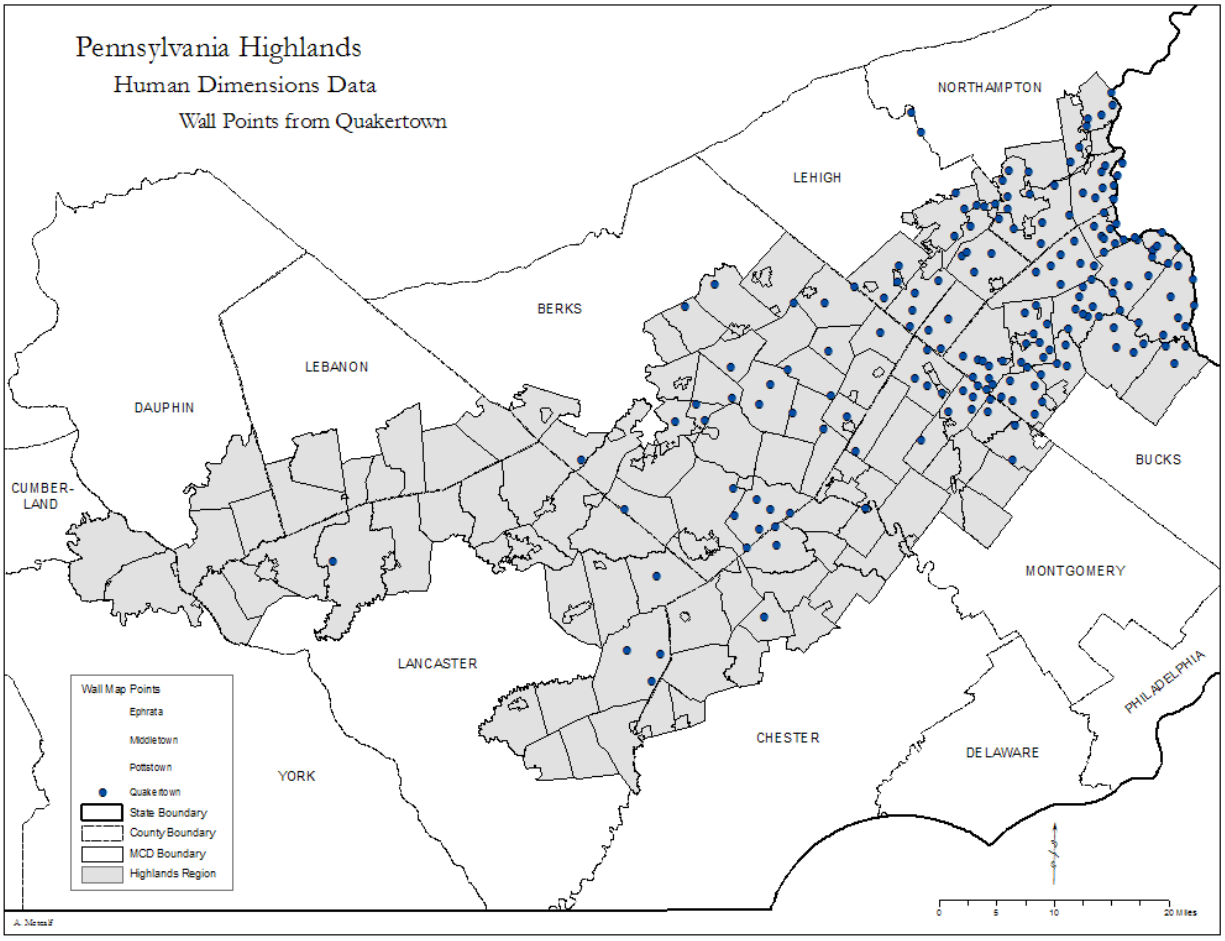

Figure 10: Quakertown wall map depicting participant choices for areas of concern.

The Quakertown meeting also had excellent attendance. As with the earlier maps, there is a concentration of dots proximal to the meeting location, but still extending across portions of the Highlands (Figure 10). There are two dots outside the bounds of the region. In this case, they appear to tie to water resources – here the Lehigh River.

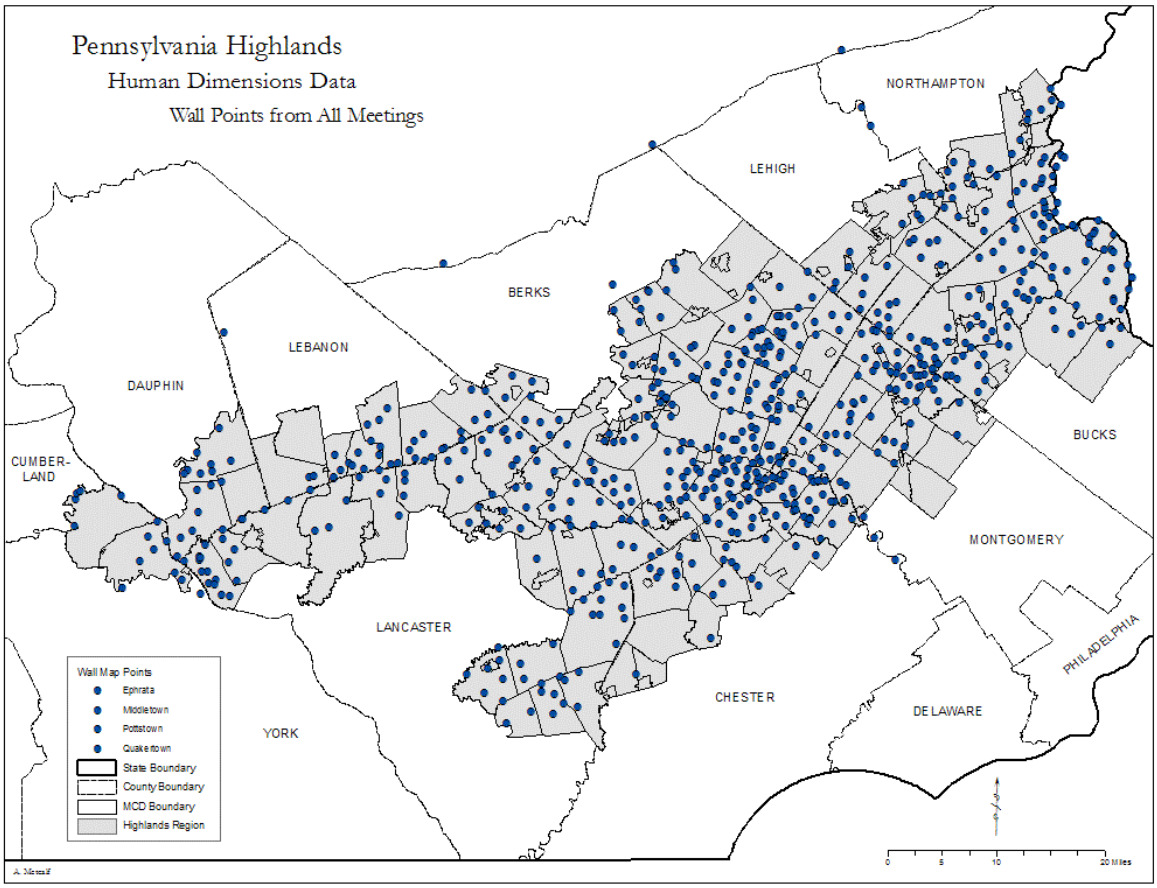

Figure 11: Composite wall map depicting participant choices for areas of concern.

The map depicted in Figure 11 brings the wall maps from all locations together. Generally, the maps indicate widespread concern across the Highlands. A heavy clustering in the south central region reflects concern for an area known locally as the "Big Woods." In addition, several other clusters are apparent including one just to the north and another northeast of the Big Woods.

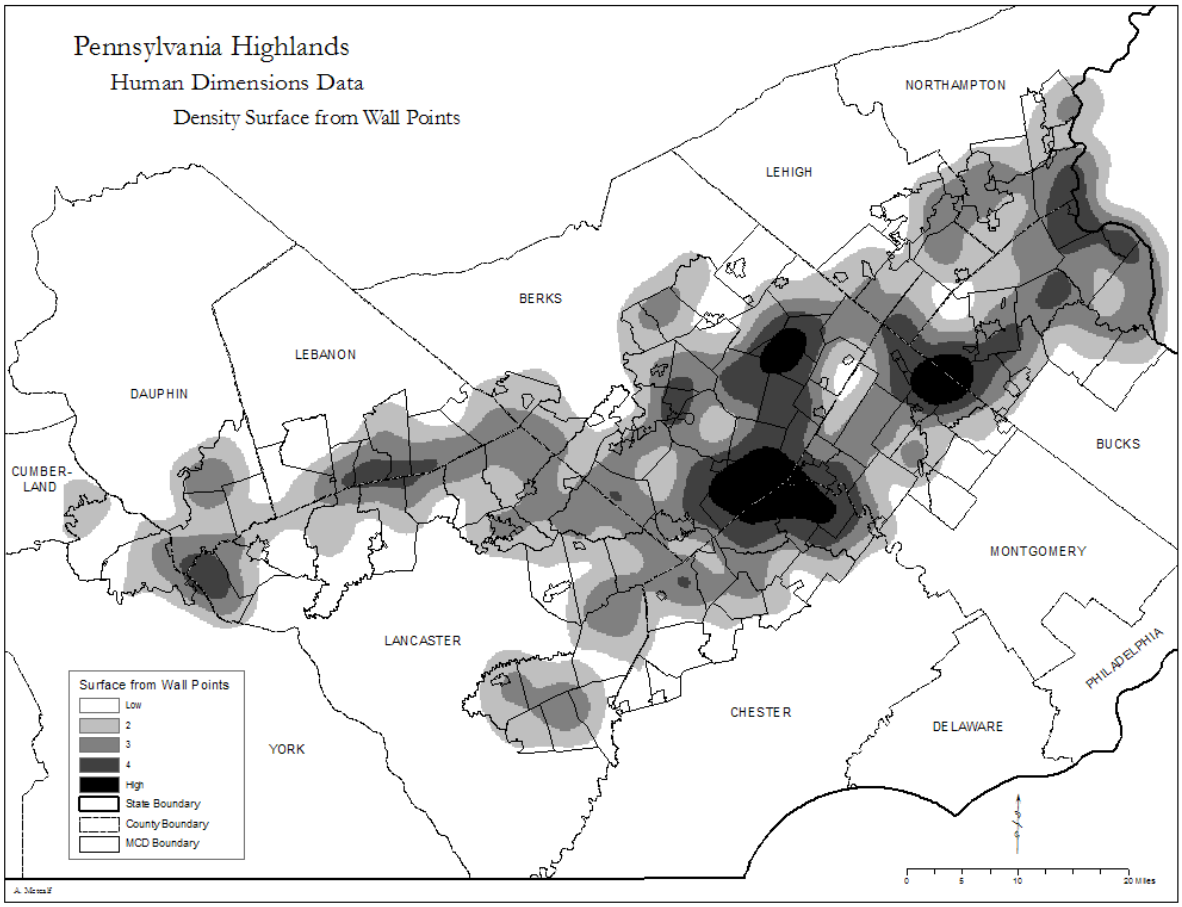

Figure 12: Density surface map for the Pennsylvania Highlands derived from the composite map of participant choices for areas of concern.

Figure 12 is a density surface map of the composite map shown in Figure 11. To create this map, an inverse distance criteria based on the center of each dot was employed. We accomplished this by digitizing each dot as it appeared on its individual map. In the case where multiple dots occupied a singular or near singular location, the dots were removed as they were digitized. The darkest polygons represent the places most often selected. This figure clearly identifies the Big Woods and two other locations of high public interest and concern (one directly north, and the other northeast of the Biog Woods). In addition, using this map, several other areas of concern are evident, including the Susquehanna and Delaware Rivers, and the Middle Creek/Mount Etna area.

Computer Mapping Exercise

In the second mapping exercise, individuals were instructed to work independently on one of many laptop computers we made available for them. To capture their input, we created a user interface that allowed participants to use a mouse-controlled stylus to pinpoint specific areas of concern. As they selected the location, the computer prompted them to identify the conservation value associated with this point, to provide a name for this location, and to identify the perceived threat for the selected site. Before they could

register their points, they were required to enter the identification number they had received when they registered for the meeting. This number facilitated a limited sociodemographic analysis of participants at these meetings. As with the wall map exercise, the participants were limited to five selections. For the most part, this request was honored.

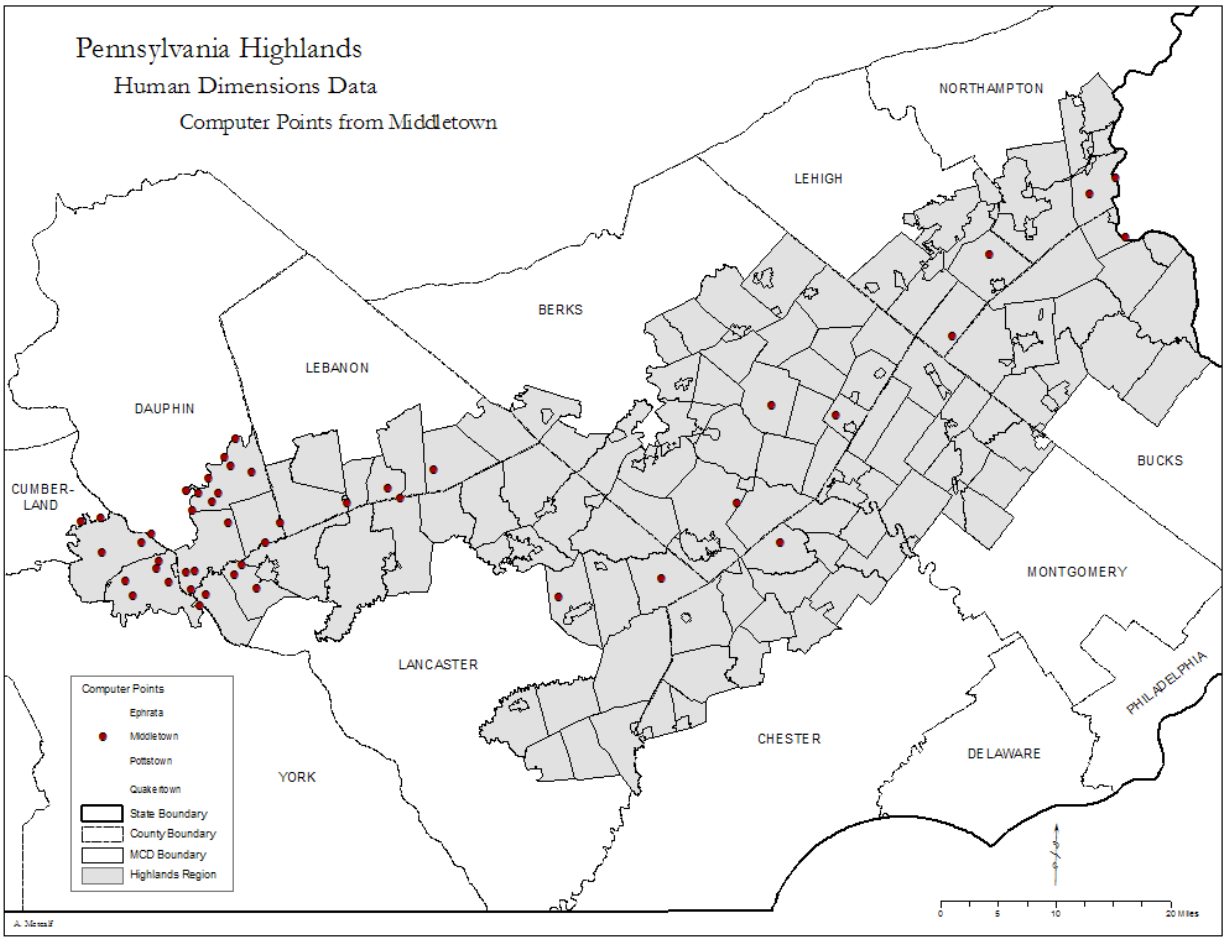

Figure 13: Points selected by Middletown participants in the computer exercise.

The computer map for Middletown (Figure 13) clearly focuses on the southwestern section of the Highlands, with some points occurring across the study site up to the Delaware River. The same pattern emerged in Ephrata (Figure 14) with a concentration in Lancaster County and some points across the entire region – in fact, the computer map identified several locations beyond what was evident on the wall map.

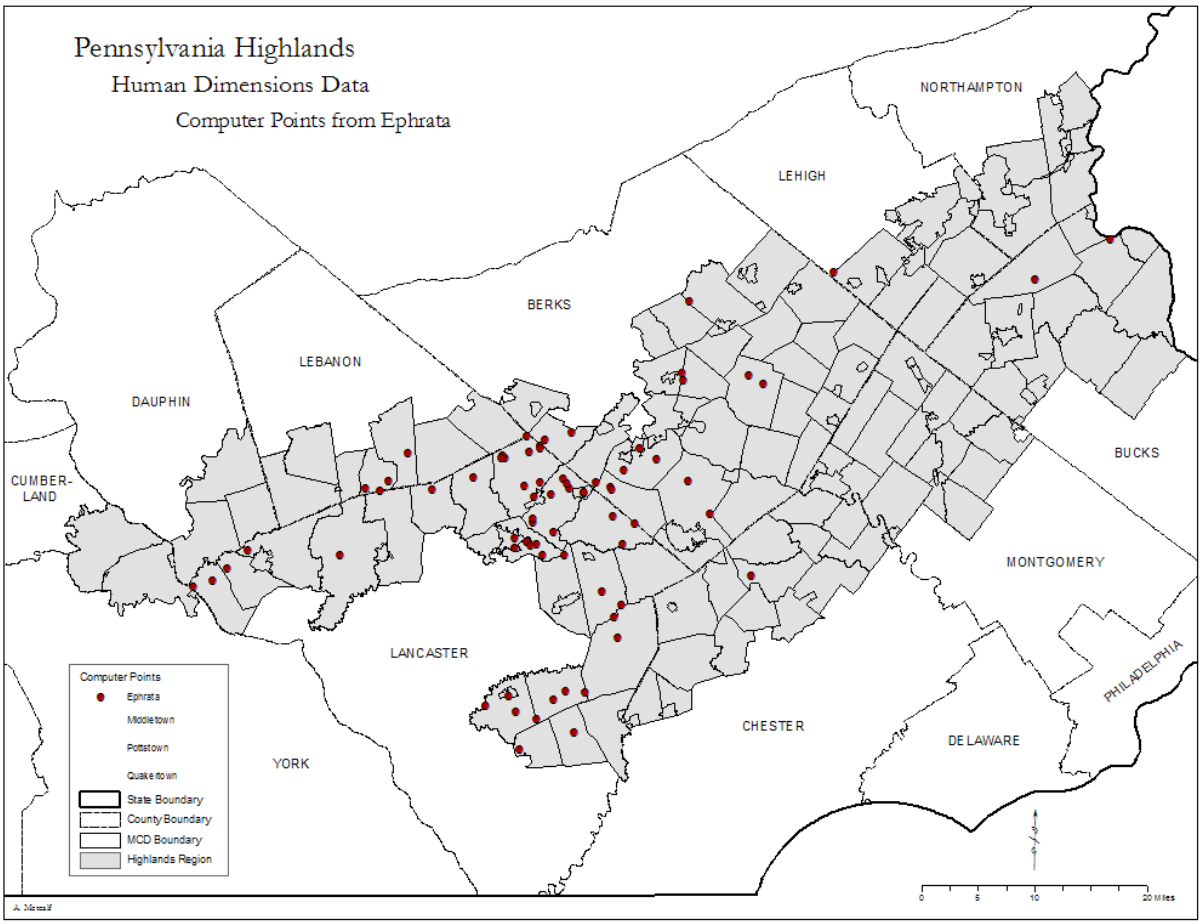

Figure 14: Points selected by Ephrata participants in the computer exercise.

Similarly, the computer map for Pottstown (Figure 15) revealed a high concentration of concern in the south central region, particularly the Big Woods area and north of that in the Oley Valley area. Interestingly, despite having the ability to enter up to five computer points, there were fewer data entries on this map than on the comparable wall map. The final computer map for Quakertown (Figure 16) and the wall map for this community were remarkably similar indicating a relatively high level of concern for areas in the northeastern corridor of the Highlands

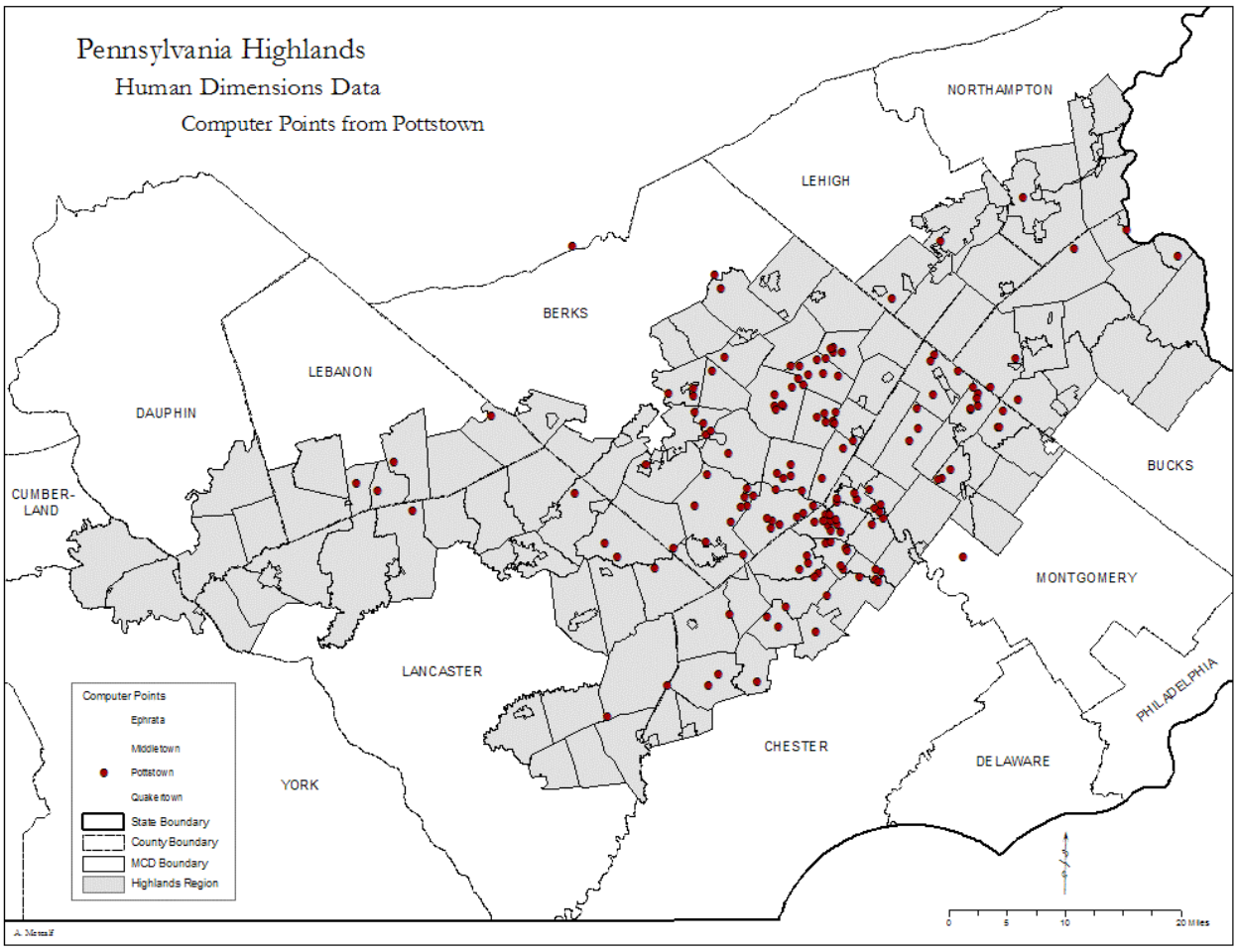

Figure 15: Points selected by Pottstown participants in the computer exercise.

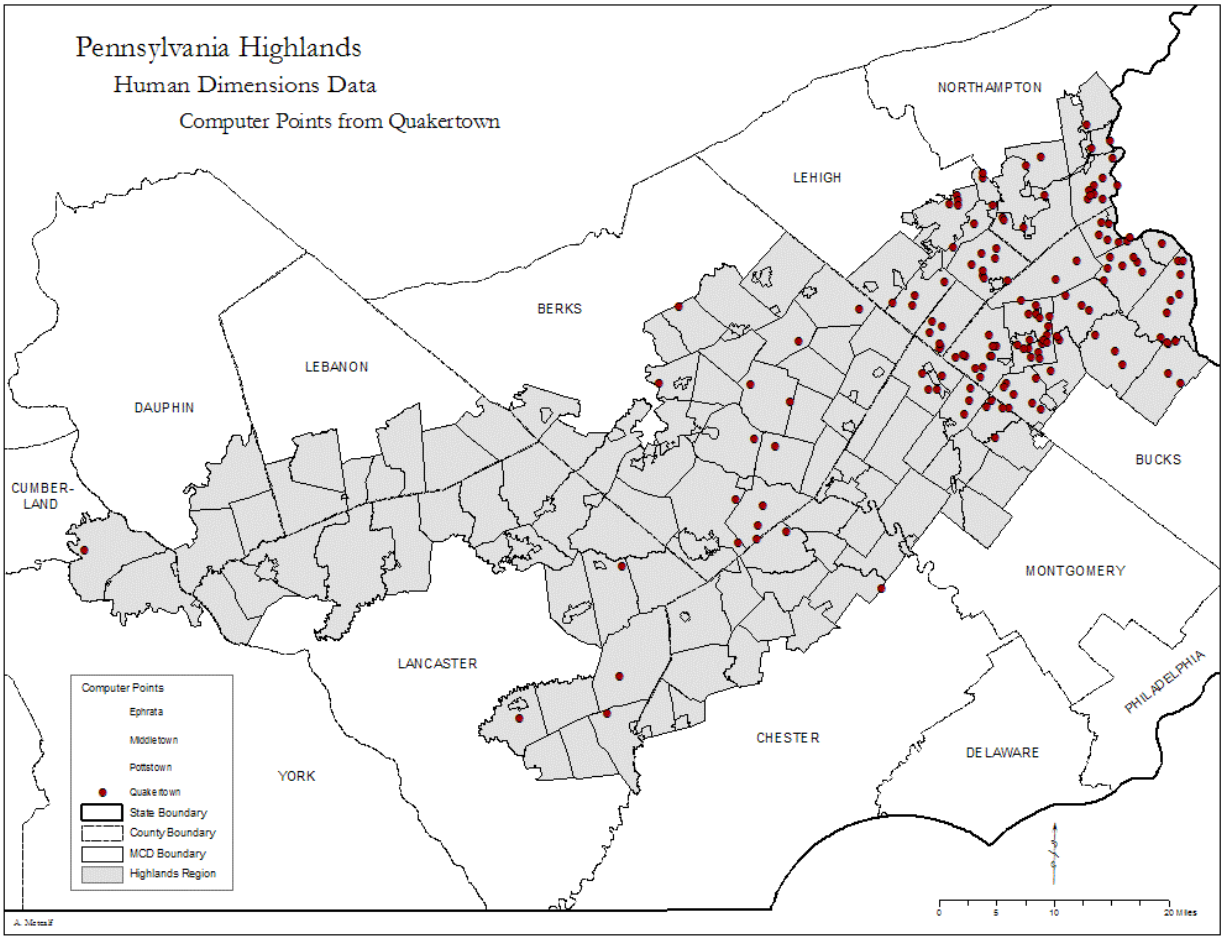

Figure 16: Points selected by Quakertown participants in the computer exercise.

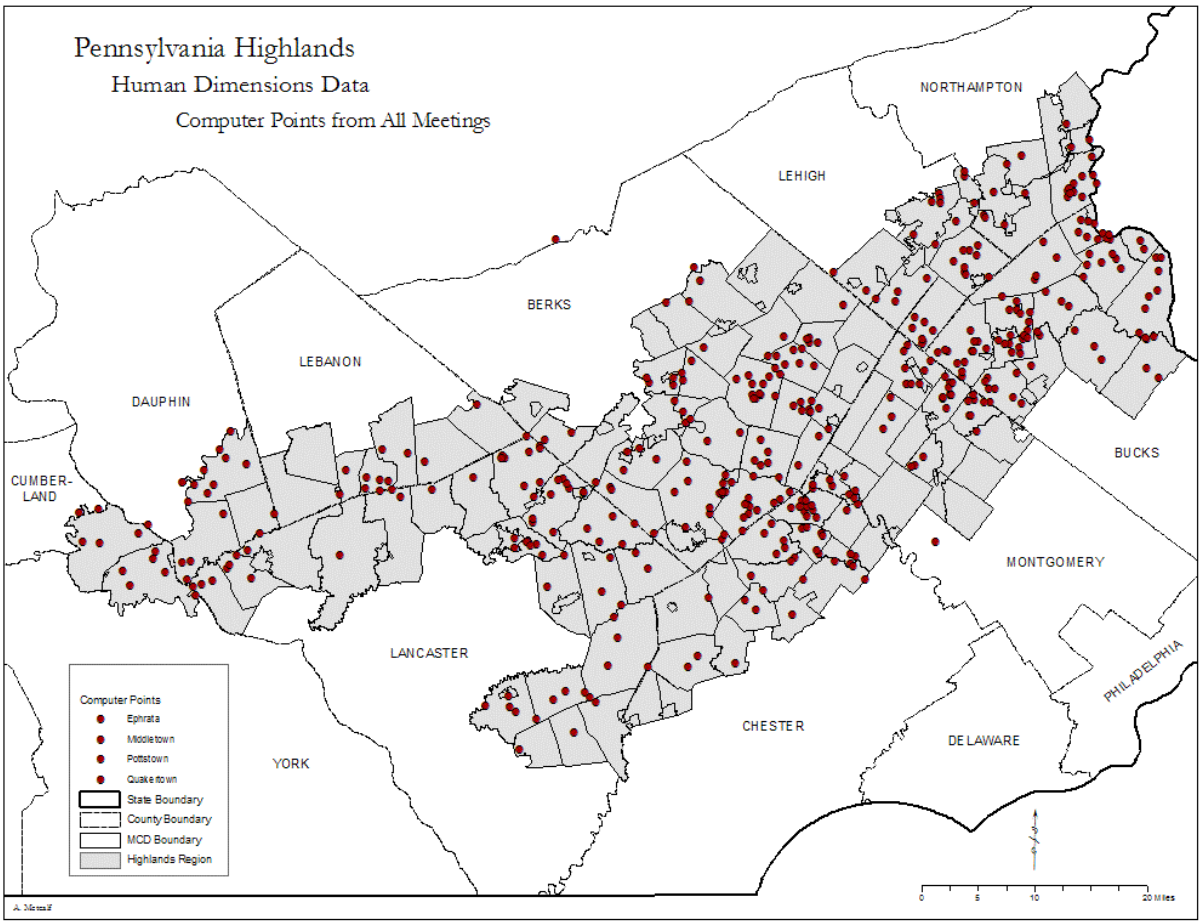

Figure 17: Composite computer map depicting participant choices for areas of concern.

The composite map (Figure 17) of the computer points for the Highlands indicates general interest across the entire region with several areas of heightened concern. Again, the Big Woods and Oley Valley emerge, but in addition the Unami Creek/Mill Hill/Green Land Reservoir area shows a concentration.

Density Surfaces

As with the wall map, we developed a density map (Figure 18) of the computer points. Clearly the Big Woods, Oley Valley, and Unami Creek/Mill Hill/Green Land Reservoir, as well as the Delaware River/Cooks Creek/Nockamixon/Stoudt's Valley area emerge as the regions of most concern.

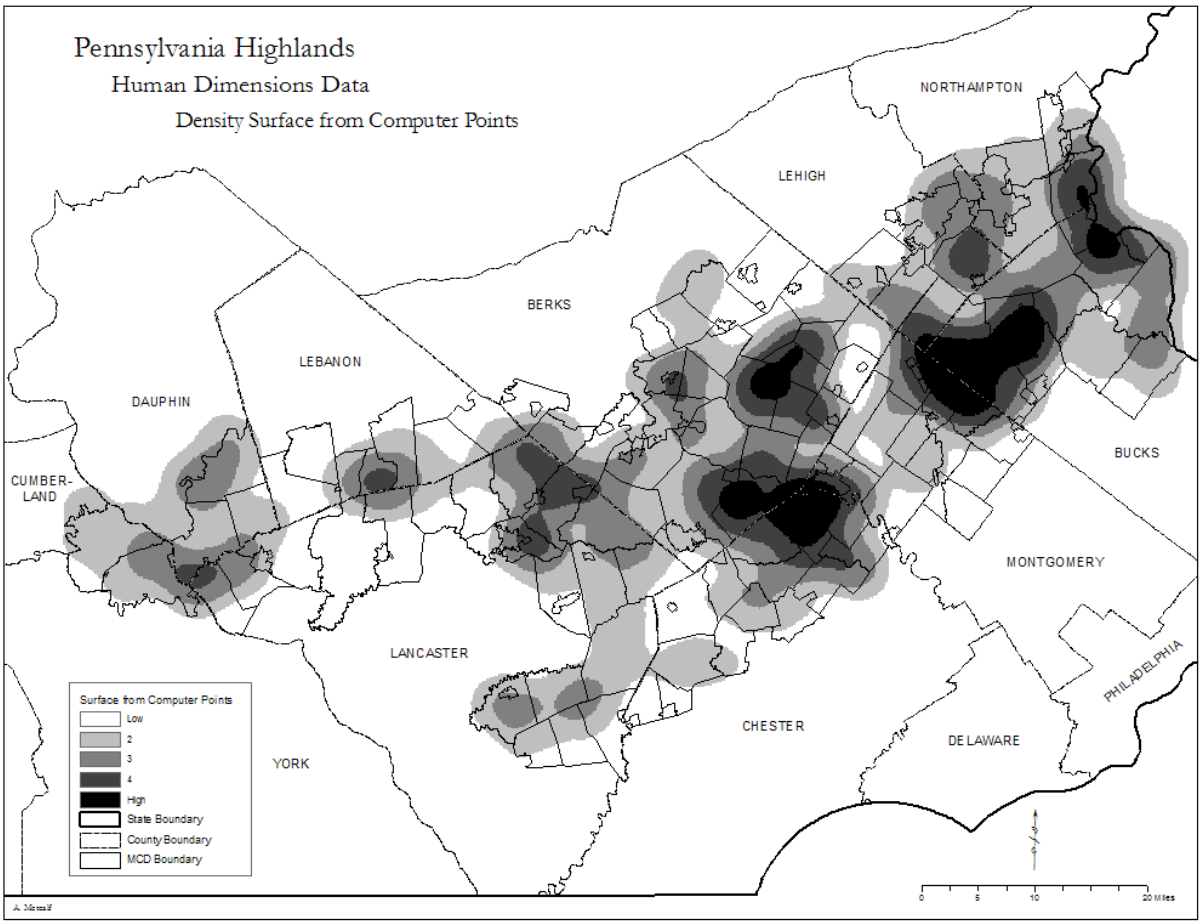

Figure 18: Density surface map depicting participant choices for areas of concern.

Pencil and Paper Exercise

The final mapping exercise was a paper and pencil effort where we asked each participant to draw polygons of the places they most highly valued. Size of polygon was not an issue – the key here was to make some shape on this paper providing us a spatial frame for understanding the places of high conservation value importance to the participants. The resulting polygons move us from point estimates to spatial area estimates. This data is displayed (Figure 19) using quintiles based on overlapping polygons (2-7; 8-14; 15-21; 22-28; 29-35). Interestingly, the Big Woods clearly emerges as the major area of concern – and other areas identified through the wall map and computer map efforts are visible as well.

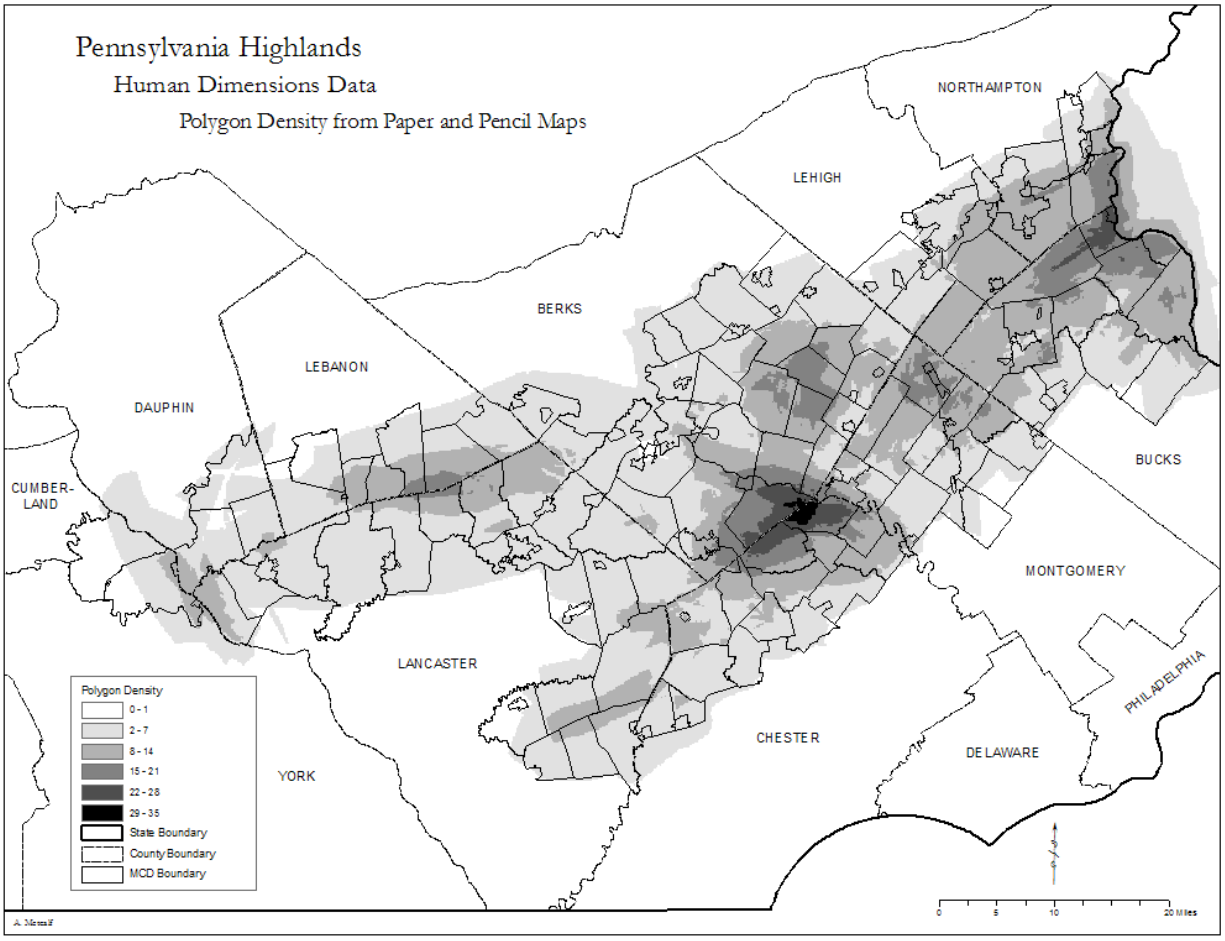

Figure 19: Composite pencil and paper map depicting participant choices for areas of concern.

Composite Maps

The next series of figures present maps aggregating information contained on each of the three mapping exercises – the wall, computer, and pencil and paper maps. Thus, these figures are the integrated maps core to properly understanding and expressing the public input dimensions. This is a nested process, in that we first show how the pencil and paper map and wall map come together, then do the same with pencil and paper and computer maps, and finally bring all three (pencil and paper, computer, and wall maps) together.

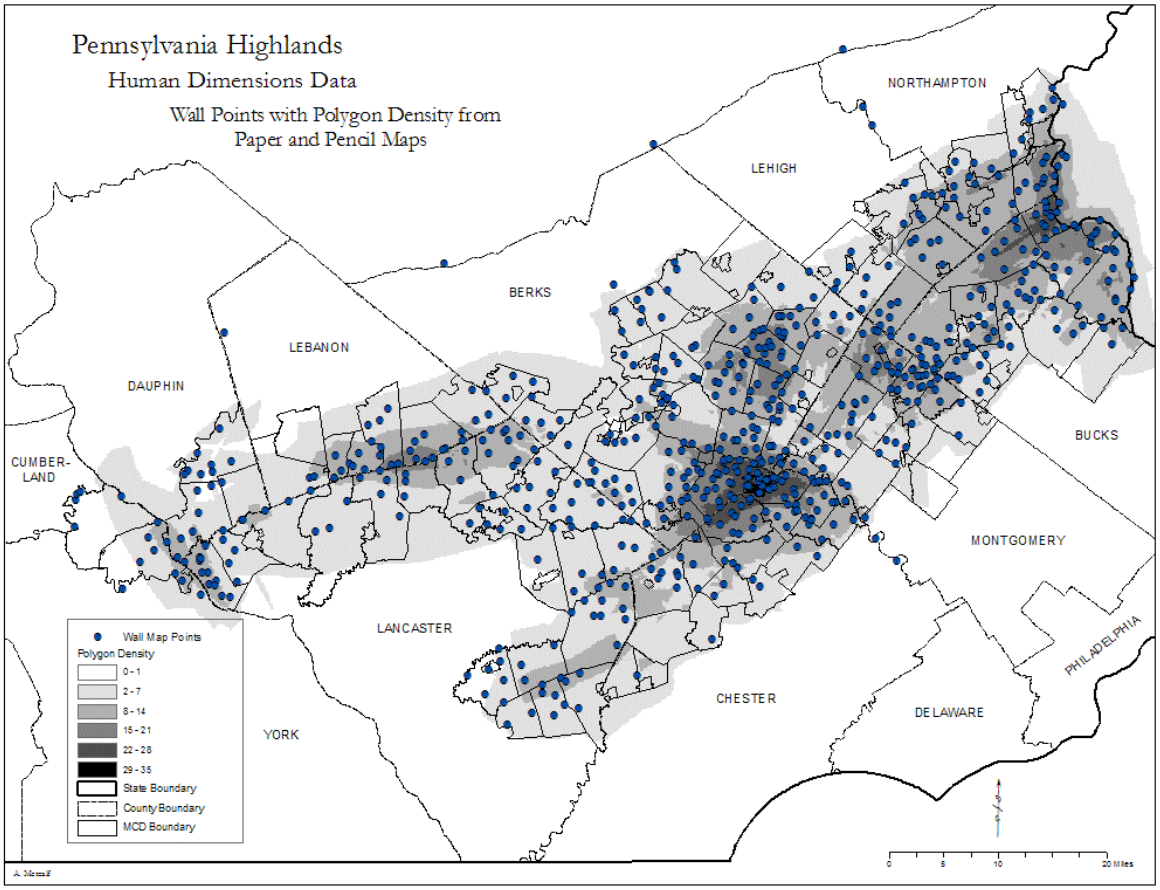

Figure 20: Combined pencil and paper and wall maps.

The first (Figure 20) map shows how the polygons form the paper and pencil maps and wall points come together. The overlap is obvious. The next map (Figure 21) shows the computer points and pencil and paper polygons and the patterns remain the same. Redundancy can be a very good thing – especially when demonstrated through multiple measures of the same issues.

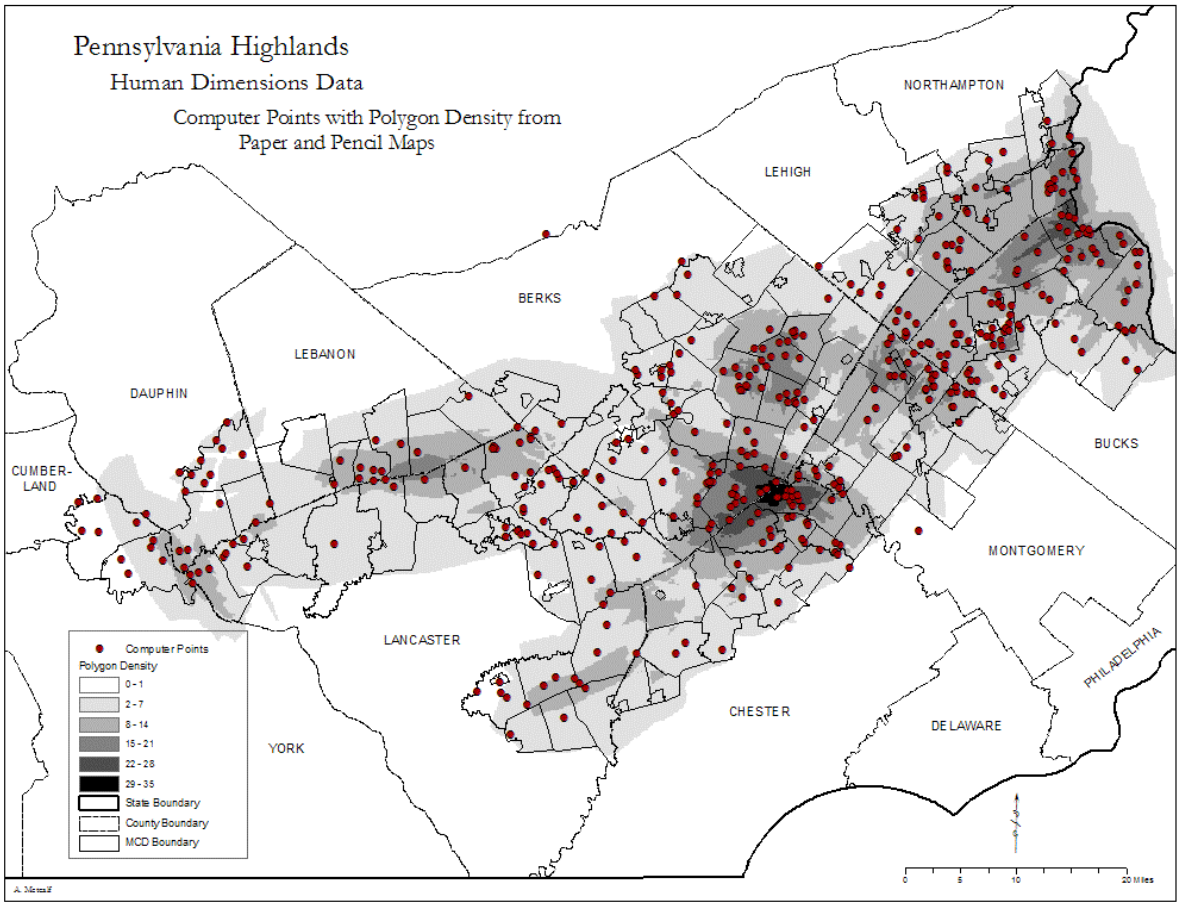

Figure 21: Combined pencil and paper and computer maps.

In Figure 22 we bring the pencil and paper, wall, and computer maps together. The computer dots are red, the wall maps are blue, and the pencil and paper input are the shaded grey polygons.

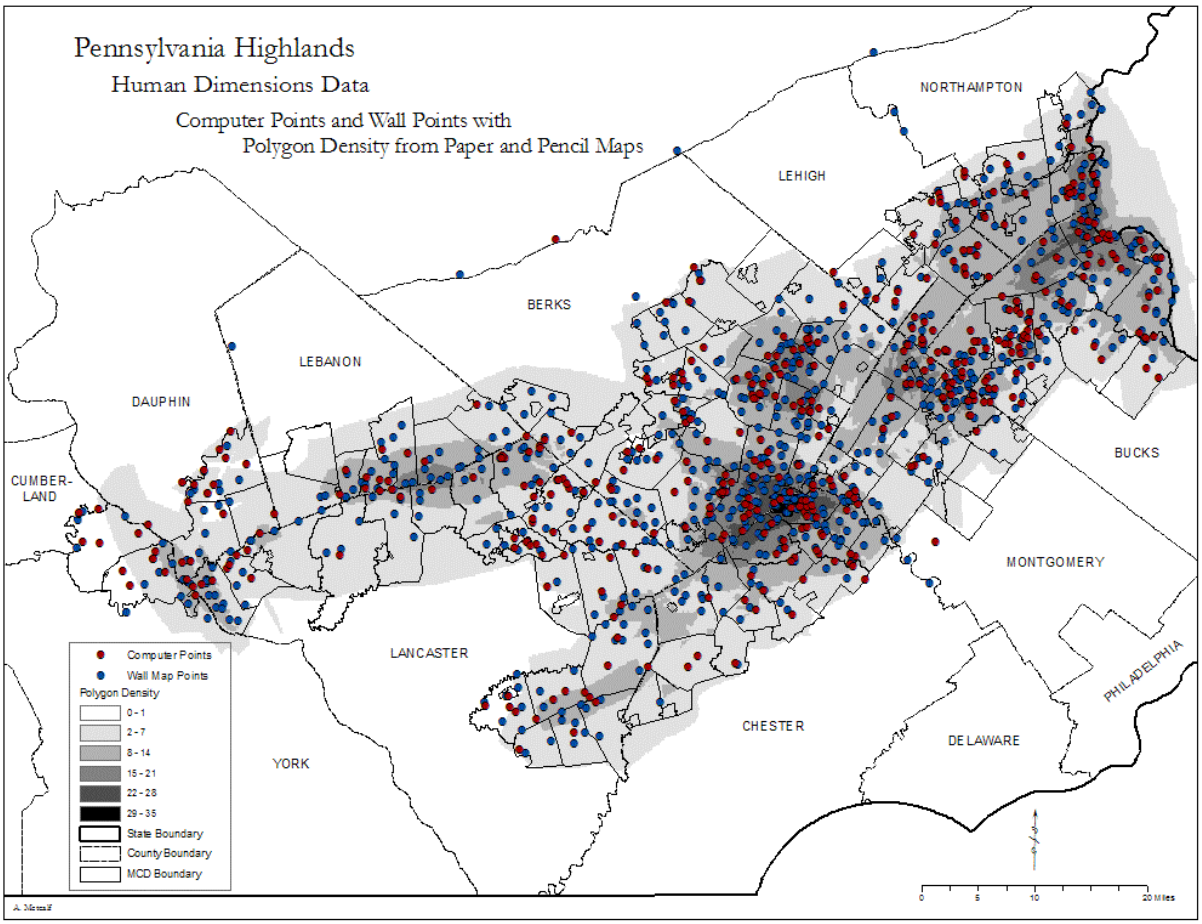

Figure 22: Combined pencil and paper, computer, and wall maps.

The final mapping exercise combines all three layers (pencil and paper, wall, and computer maps) into one density surface map. Again, this data is presented in five categories that range from low to high in terms of levels of importance. The scores represent an average of pixel weights across each of the three mapping approaches. The same areas of high concern are identified in this process. What are they? Figure 23 provides the sites and the names associated with the density points as indicated by participant input and published maps.

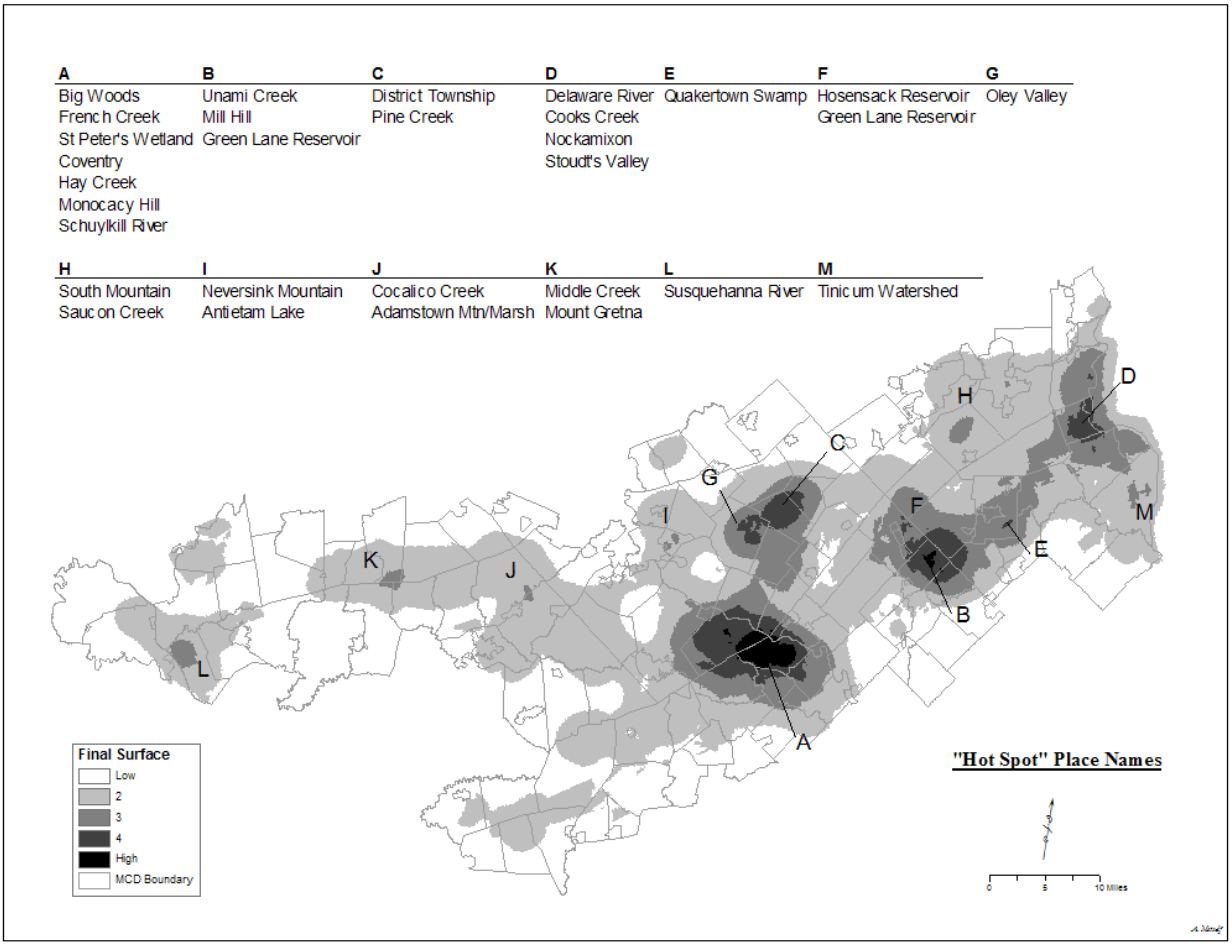

Figure 23: “Hot Spot” place names using a density composite map of all three mapping exercises.

Summary

There were three components to gathering community input in the Pennsylvania Highlands Project: Key Informant Interviews, Facilitated Group Discussions, and Map Exercises. The purpose of this work was to create a public input data layer, and to put it online to get further commentary.

The researchers incorporated the "core conservation values" that derived from the 1992 and 2002 New York-New Jersey Highlands studies – water, forest lands, agricultural lands, biological diversity, and recreational/cultural resources – in the interview instrument and in the computer mapping exercise. The key informant interview instrument was designed to guide interviews. The use of open-ended questions encouraged informants to volunteer information, rather than simply respond to queries (see Appendix A for a copy of the Key Informant instrument).

Key Informants were people whose experience and position in the community suggested they'd be knowledgeable about its values and concerns. Key informants were asked for leads to other informants. As it turned out, there was a higher representation of conservation organizations among the key informants than expected. Seventy-five interviews produced 82 informants.

Public meetings were held in each of four sub-regions. Participants were invited to gather in small groups for Facilitated Discussions, and to convey their own conception of the region and its important places using three different mapping exercises. Meetings were in: Middletown (15 attended), Ephrata (41 attended), Pottstown (67 attended), and Quakertown (57 attended); total number of participants was 180.

Despite the sweep of discussion, and coverage from one end of the Pennsylvania Highlands to the other, this is not a survey of the general public. The research team did not conduct a poll as part of this effort although they see it as an essential element for validating the results with the concerns of the wider general public not involved in the process describe herein.

Input from Key Informants

When asked who is protecting the places they identified as special earlier in the interview, informants named land trusts and conservancies twice as often as any other, followed by municipalities, farmland preservation groups, and watershed groups. When asked who should protect them, informants named state government overwhelmingly, followed by municipalities, federal government, and county government. Informants' concerns about their special places and communities related to growth and its impacts; the loss of open space, increased traffic, and impaired quality of life.

Input from Facilitated Group Discussions

Information was gathered in several ways, allowing open discourse, group discussion, group mapping, individual mapping on paper, and computer mapping. The aim was to gather triangulated information and to provide a range of opportunities for group and individual responses to the same tasks. As well, the research team wanted to insure that all participated in whatever ways they found comfortable and effective. As anticipated, not everyone participated in every activity. Finally, information entered on the computer could be analyzed according to self-identified personal data (data employed in this analysis were purged of any references to names or addresses).

The summary of results from the four public meetings was extensive, revealing, and presented in chart and map form. In general, results from the three mapping exercises correlated very well. Special places, whether entered as dots on a wall map, computer points, or polygons on a paper and pencil map clustered in the same parts of the Highlands. That there was congruence across the three mapping exercises was heartening, especially since those involved came from the same population, although not everyone at the meetings participated in every exercise.

No attempts were made to filter local interest when combining the maps. This reflected the fact that the purpose was to show the Highlands as a region, not to compare sub-regions. Indeed, the subregions were established simply to facilitate the data gathering process.

Areas of concern covered the entire Highlands region, from the most westerly part to the Delaware River. The distribution of points was not uniform; when a density surface map was generated, the patterns became quite apparent. Ten “Hot Spots’ of point density were identified on a composite map that used all three mapping exercises. These “Hot Spots” were named according to the dominant features within them or by what the participants called the area.

Although participants at the public meetings had a chance to rank the five natural resource categories, the question of why important places are important was open-ended. The composite map suggested a significant level of common concerns across the numbers of people who attended each of the four meetings.

Merging the Public Data with the Bio Data

In order to assess the congruence between the findings of the public generated data (gathered through the key informant interviews and mapping exercises), it was necessary to create, based on existing maps from both sources of data, a map that represented the existing overlapping information.

To do this, existing maps created from information gathered through the public input process and the spatial biodata were collected. These data were differently organized and spatially presented. Such differences needed to be reconciled prior to merging the two different information sources. The biodata represented conservation values in the Highlands were presented in deciles. Thus, the biodata map illustrated 10 different conservation values that ranged from low to high.

However, the Highlands Conservation Act stipulated that only land in the top 40% of the conservation value scale could be set aside for conservation. Therefore, the ten conservation values in the biodata were grouped into two broad categories – those valued one to six were scored as low conservation values, and those scoring seven to ten were scored as having high conservation value.

A similar procedure was used with the public generated data. Conservation values on this map were originally presented in quintiles. This data was also dichotomized into two groups. The first group consisted of those scores ranging from one to three which were considered low conservation value, and those receiving either a value of four or five which were considered high conservation value.

After making these adjustments, two maps were created. The first map illustrates the high and low conservation value areas for both the biodata and public data (Figure 24). Low conservation values, reflecting the respective dichotomies, were used since our interest focuses on identifying high conservation value areas in the Highlands.

The second map (Figure 25) displays three different layers (identified with three different colors). The first layer describes the areas the public identified as being of high conservation importance (color coded light purple). Next, the biodata layer (color coded green) was introduced indicating the highest conservation valued areas identified through that process. Finally, using ESRI's intersection tool ArcMap, the third layer (color coded orange) was created. This layer illustrates the areas of overlap between the information provided by the public and the biodata.

Findings and Conclusions

Figure 24 indicates a sizeable area that represents high conservation value for both the biodata (color coded red) and public data (color coded green) as well as low conservation values for both sources of data (color coded gray). Overlapping areas, i.e., places where the biodata and public data agree are indicated in purple.

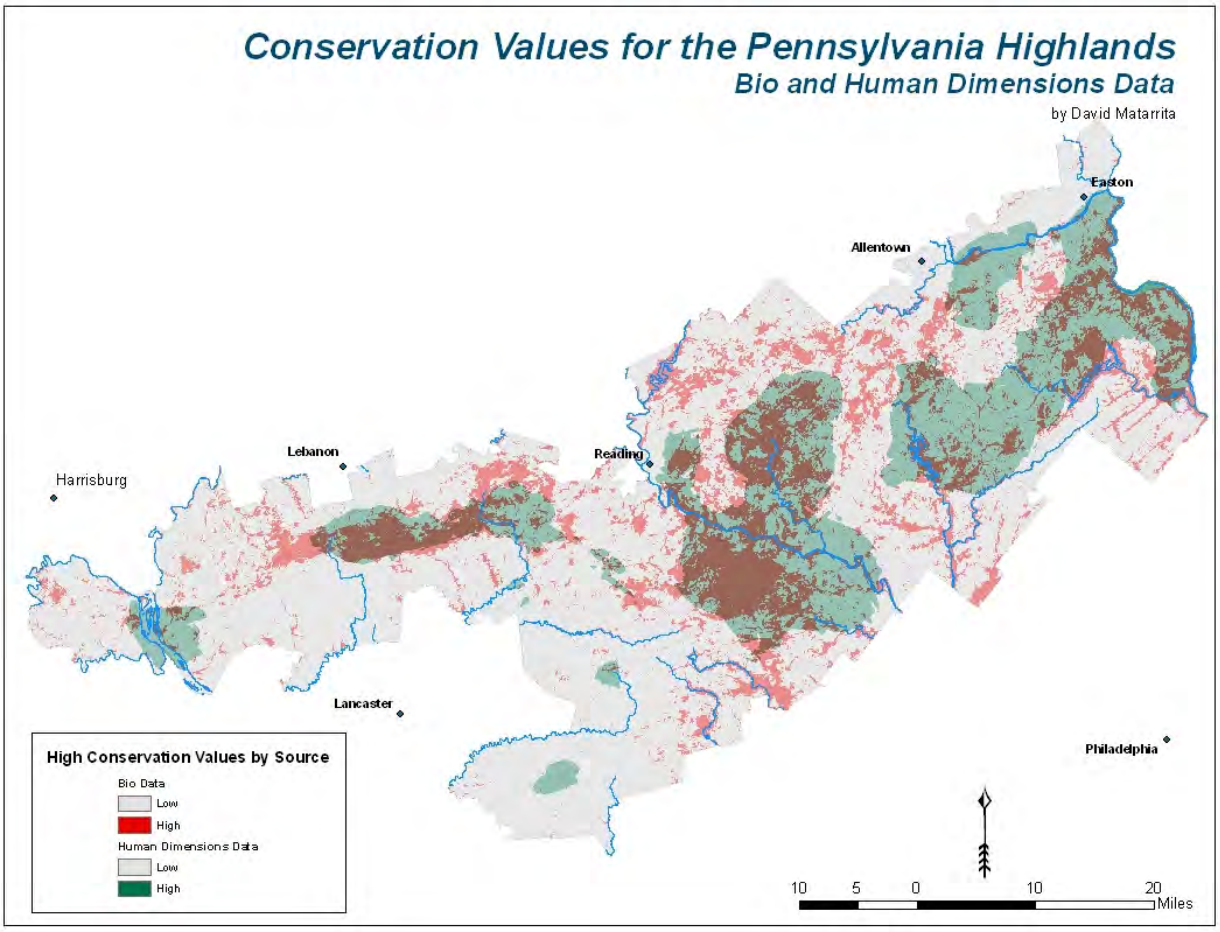

Figure 24: High conservation values for biodata and human dimensions data.

This pattern is more clearly observed in Figure 25. This map highlights only the areas of high conservation value for both sources and their intersection areas. This is particularly evident in the central and northwestern parts of the Highlands. Figure 18 also highlights other areas where the high conservation value data from both sources do not overlap. This is particularly evident in areas closer to the eastern border of the Highlands. There, the public identified more areas for high conservation value. Conversely, the biodata illustrates regions in the north and south central areas of the Highlands not identified by the public.

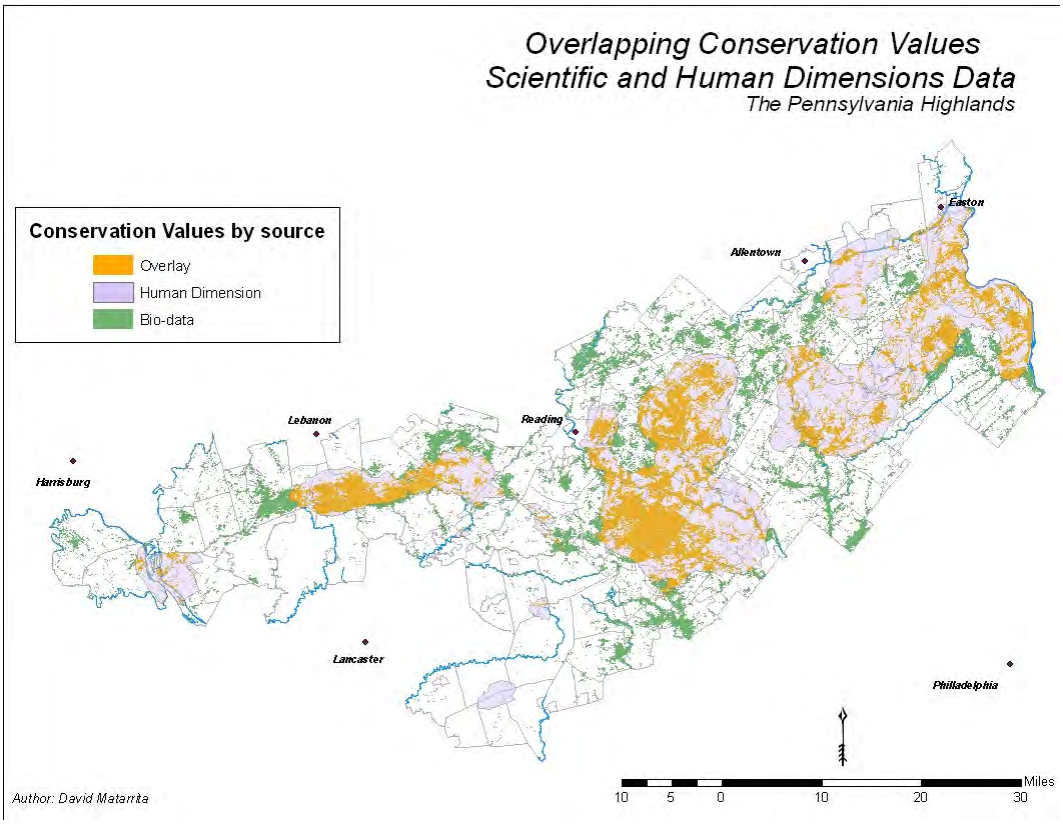

Figure 25: Overlapping conservation values.

Figures 24 and 25 clearly illustrate several areas within the Highlands that are of high conservation value regardless of source of identification. These places are areas that need to be considered for their importance.

This project demonstrated that it was possible to gather information from the public that accurately and consistently reflected their conservation values. Moreover, this information was found to correspond to a high degree with the conservation areas identified through biodata. The latter information reflected more finely tuned calibrations of importance and are routinely used in such assessments. Data provided by the public input lacks specificity reflecting the difficulty of asking individuals to finitely identify specific locations on any map, regardless of scale. This difficulty has generally led to a heavier reliance on scientifically generated conclusions for use in such studies. Here, our use of a multiple-method research design, which capitalized on the ability to digitize and transform qualitative-based data (including paper and pencil, wall map, and computer map information) into a coherent framework, enabled us to bring the public to the table in identifying high conservation values areas. Public input cannot be taken for granted in any project designed to improve the quality of life of local residents by conserving the areas natural resources. The Highlands Project demonstrated the ability of the public to play an informed role in making decisions regarding natural resource uses and conservation.

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Appendix A

Key Informant Interview Script

Key Informant Schedule

Pennsylvania Highlands Conservation Values Assessment

Name: _____ Title: _____

Time in position: _____(yrs.) **Length of time in community**: **_____** (yrs.)

Address: _____

City: _____ State: _____ Zip Code: _____ County: _____

Phone: _____ Email: _____

Subregion: NBL___LDLY___BMC___ Date: _____ Time: _____

Interview Location: _____

Interviewer(s): _____

(1) First, as you think about the Pennsylvania Highlands, do you have any places that you consider special? What makes them special? (Probe: we are interested in what makes these places special using a broad set of consistent factors including the following – water resources; biological diversity – plants and animals; recreation, open space, and cultural resources; farmland; and forestland. Thus, if they like say Blue Marsh Lake State Park, we would want to know that they really like – swimming there, hiking there, its forests, whatever.)

(2) If you were asked to describe the special features/nature of this(ese) place(s) to someone else, what kind of maps and/or pictures would you use?

(3) Are you concerned about any things that threaten the quality of these places? What specifically are you concerned about? What could/should be done to alleviate these concerns?

(4) Are you aware of any groups and/or organizations that are interested in working to protect the special places that you have identified? Who are they? What are their objectives and why?

(5) Are you aware of other groups working in opposition to or advocating alternative approaches and uses for the special places? Who are they? What are their objectives and why?

(6a) The Pennsylvania Highlands contains many natural resources – water resources; biological diversity; recreation, open space, and cultural resources; farmland; and forestland.

As you think about these five broad categories, which do you think is most important to protect? Why? How would you go about protecting this resource?

Who should be responsible for doing this? (Probe: "Who" refers to different levels of government and various agencies/organizations – federal, state, local; non-governmental; trusts; conservancies; and/or individuals. Our goal here is to gain specificity for who should have responsibility).

(6b) (NOTE: *IF the key informant does <u>not</u> feel it is important to protect any of these broad categories it is critical to find out why*.) Why do you feel this way? What are your concerns, if any about, conserving any natural resources in the Pennsylvania Highlands?

(7) We would like for you to think about your special places in the future. Please think about how your special place(s) might change over the next five to ten years.

(7a) What kind of mental images of your special place(s) do you envision? What will drive or influence the changes (positive or negative) you envision over this period?

(7b) How will such changes in your special place(s) affect your quality of life? What are the most important factors responsible for these changes?

(8) Suppose you were asked to identify the *three* things that contribute the most to a Highlands place being special to you, what would you say? Why? (NOTE: These reasons could be environmental, economic, intrinsic, recreational, spiritual, social, or something else).

(9) How long would it take to traverse your special place(s) when you visit there:
a) An hour or so of walking
b) A day's hike
c) A day's drive

(9b) How often do you visit this special place during the year?

(10) Education?

(11) How long have you lived in this community?

(12) *Recommendations:* Can you think of anyone else I should talk to about the Pennsylvania Highlands and issues we have discussed?

_____

THANK YOU FOR YOUR TIME AND ASSISTANCE.

Can I contact you again if I have any more questions?

A member of our project team will be calling you to indicate when and where a public meeting on the results of these interviews will be held sometime this fall.

Appendix B

Facilitated Meeting Dates and Locations

Location	Date
Middletown, PA	October 27, 2005
Epharta, PA	November 1, 2005
Pottstown, PA	November 3, 2005
Quakertown, PA	November 9, 2005

Appendix C

Facilitated Discussion Small Group Questions

Pennsylvania Highlands
November 3, 2005
Pottstown, PA

6:30-7	Arrive/registration/refreshments
7-7:10	Jim/Al introductions & description of meeting process
7:10-7:30	Introduction of Highlands Project (Ed) and project findings
7:30-8	Wall map/computer maps (facilitators rotate)
8-8:30	Small group discussion 1. As you complete the maps, what places are most important to you? 2. For what reason (probe: What conservation values do you associate with the place?) 3. Why are you concerned about his place? 4. Does the key informant presentation/findings you've just heard about, agree with your perspective of important places for conservation action in the PA Highlands?
8:45	Reassemble