GIS Analysis of Forest Fragmentation in Berks County:
Assessing Changes in Forest Patches from 2006-2019
Final Report

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Abstract

The shape, size, and distribution of forest patches can impair the ecological integrity of forests. Invasive plant species are more likely to penetrate the edges of forests, while core forest areas tend to be host to greater species diversity and higher amounts of biomass. This study uses National Land Cover Data (USGS, 2006 & 2019) to compare changes in forest patches in and around Berks County, Pennsylvania. Three unique study areas were identified, including the Berks County Greenway, HUC-10 level watersheds that intersect Berks and Schuylkill Counties, and the portion of the Kittatinny Ridge that lies within this region. Spatial analysis was performed in ArcGIS Pro, and FRAGSTATS was used to calculate patch and class level metrics. The results of this study show that forest patches became smaller and more dispersed, core areas became more disjunct, and edge density increased. Natural land covers were also studied, and they showed similar patterns of change. Protected natural and forested patches were more resilient to change.

<u>Table of Contents</u>

List of Figures

List of Tables

Introduction

Berks Nature, a nonprofit organization whose mission involves environmental conservation in Berks County, PA, has identified forest fragmentation as a topic of concern. The shape and distribution of forests throughout a landscape can affect the quality and availability of wildlife habitat as well as influence water quality and the availability of recreational greenspace. Forests tend to become fragmented due to human development, including agriculture, which limits their ability to serve in these capacities (Von Thaden et al., 2022). This fragmentation can result in a lack of core forest area, which performs essential ecosystem functions.

Edge effects represent another area of concern for forests. Different edge effects can be seen depending on edge width. For example, invasive plant species are more commonly found within 30 m of forest edge in eastern deciduous forests (Flory & Clay, 2005; Allen et al., 2013). Forest edge effects also depend on bordering land cover. For example, forest edges bordering grassland may not show negative effects on forest species (e.g. Lacasella et al., 2014). Peak species abundance can be found 200-400 m away from high contrast edges (i.e., forests bordering a high degree of development), and 85% of vertebrates can be affected by forest edge effects (Pfeifer et al., 2017). Forest biomass and canopy height decrease in forest edges (100 m from edge) (Shapiro et al., 2016). In this study, a 30 m edge was used in order to account for the impacts of invasive species.

A GIS analysis of the current forest cover and how forest cover has changed over time can provide insights into where conservation efforts should be focused. The Berks County 2007 Greenway Plan outlined a strategy to connect forest patches and provide more recreational greenspace for residents. A GIS analysis can examine whether or not this plan was successful by examining change in forest cover and connectivity within the zones defined by the Greenway Plan.

Study Area

Three areas of study were included in this analysis: 1) all HUC-10 watersheds that intersect Berks and Schuylkill counties, combined into one boundary (Figure 1); 2) the portion of the Kittatinny Ridge corridor within the HUC-10 study area (Figure 2); and 3) the Berks County 2007 Greenway (Figure 3). The HUC-10 shell provides the natural backdrop of the total study area, and the two other study areas exist within it. The Kittatinny Ridge and Greenway were identified as special areas of interest within this landscape. The Pennsylvania Chapter of the Nature Conservancy (2021) describes the Kittatinny Ridge Corridor as part of a "biodiverse superhighway." It forms one leg of an unbroken chain of forested mountain ridges in the Appalachians, and provides critical, climate resilient habitat to a variety of species. Therefore, forest cover and fragmentation within this region is of particular concern. The Greenway was created in 2007 in order to create and preserve recreational greenspace, open space, and historic sites.

Study Area: HUC-10 Watersheds that Intersect Berks and Schuylkill Counties

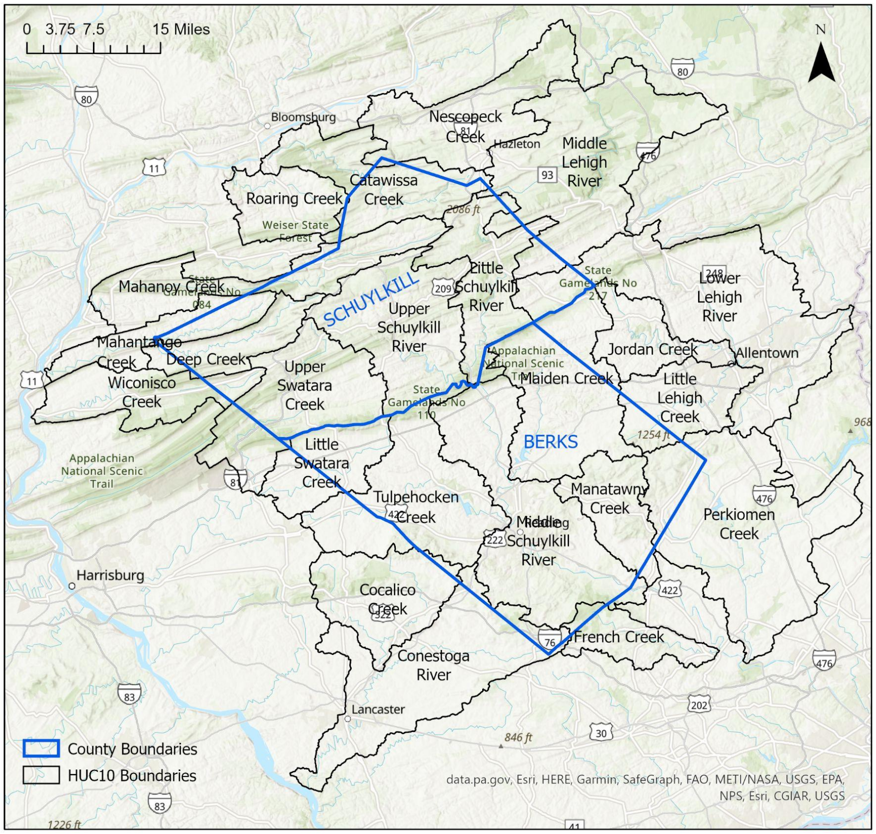

Figure 1: The HUC-10 shell study area, including all HUC-10 level watersheds that intersect Berks and Schuylkill counties.

Study Area: Portion of the Kittatinny Ridge Corridor which Intersects the HUC-10 Study Area

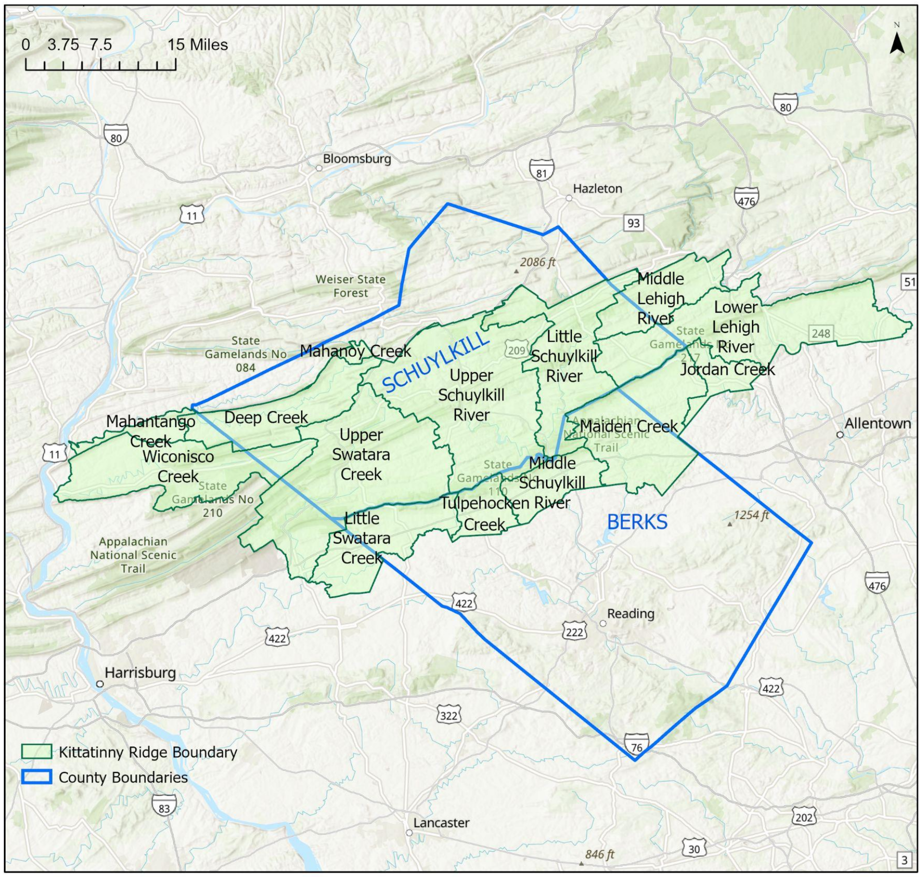

Figure 2: The portion of the Kittatinny Ridge Corridor that intersects the HUC-10 base study area. Berks and Schuylkill county boundaries are shown for context.

Study Area: Berks County Greenway (2007)

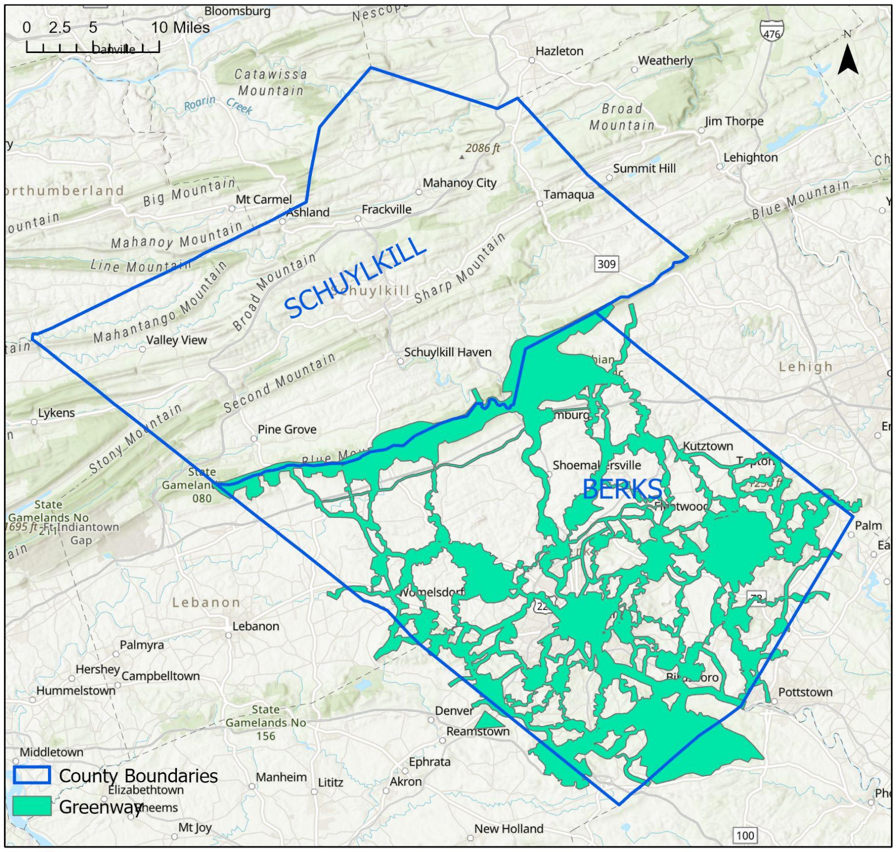

Figure 3: The Berks County 2007 Greenway Plan, including all nodes and corridors. Berks and Schuylkill county boundaries are shown for context.

Study Objectives

Objective 1: Analyze changes in the size, shape, distribution, edge density, core area, and connectivity of forest patches during study period (2006-2019).

This study aimed to determine the shape and distribution of forest patches within the three study areas using metrics such as core forest area, edge area, and fragmentation. Then these spatial characteristics were analyzed to see how they changed between 2006 and 2019. This objective also included determining whether or not the 2007 Greenway Plan was successful in increasing or maintaining in-tact forest cover within its boundaries.

Objective 2: Determine distribution and changes of largest natural land cover patches during the study period.

The goal of this objective was to locate the largest patches of natural land cover in the Berks County Greenway and the HUC10 watershed boundary that intersects Berks and Schuylkill Counties. These patches will be located during the 2006 and 2019 time periods in which changes between the two will be calculated. Additionally, specific largest patches will be examined to determine why they are where they are within the Greenway and watershed boundary.

Data and Methods

Objective 1: Analyze changes in the size, shape, distribution, edge density, core area, and connectivity of forest patches during study period (2006-2019).

Berks and Schuylkill county boundaries were extracted from the Pennsylvania County GIS data available from the Pennsylvania Spatial Data Access (PASDA). USGS HUC-10 watershed boundaries for the state were also acquired from PASDA. In ArcGIS Pro, the watersheds that intersect Berks and Schuylkill counties were selected as one study area. The Kittatinny Ridge 2021 boundary data file was supplied by the Kittatinny Coalition and clipped to these HUC-10 boundaries. The Greenway GIS data was supplied by a GIS consultant for Berks County Planning.

The National Land Cover Dataset (NLCD) categorical land cover data set (USGS, 2006 & 2019) was used to establish the land cover within the study areas for the years 2006 and 2019. This dataset has a resolution of 30 m. The dataset was reclassified in ArcGIS Pro to include the following simplified land cover classes: 1) water, 2) developed/urban, 3) barren, 4) forest, 5) shrub/scrub, 6) other vegetation, 7) agriculture, and 8) wetlands. These reclassified land cover rasters were then clipped to the three study areas, resulting in land cover rasters for each study area for 2006 and 2019. These rasters were exported from ArcGIS Pro and added into FRAGSTATS in order to determine how the shape and distribution of forest patches has changed over time, quantify edge contrast effects, and to identify current areas of concern. Additionally, 30 m buffers were added around each study area before uploading the rasters to FRAGSTATS in order to account for edge effects. This step ensured that forest patches along the edge of the study areas would not appear much smaller than they actually are.

The FRAGSTATS settings included a 60 m threshold for the connectivity and proximity indices. This means that FRAGSTATS searched 60 m from one forested patch to another to determine if separate patches were connected by this distance. In other words, forested patches could be considered connected by these indices if they were separated by up to one cell of another land cover type. The edge distance for patches was set to be 30 m, as 30 m was defined as the likely penetration depth of invasive plant species, based on published studies. Finally, a contrast edge distance table was defined in order to analyze high-contrast edges, which create a barrier for wildlife migration. When forest patches were adjacent to urban patches, the contrast edge distance was set to 1 (the maximum contrast). When forest patches were adjacent to agricultural patches, the contrast was set to 0.5. All other contrast edge distances were set to zero because the remaining land cover types were considered “natural.” Using these settings, the following class metrics were selected for all of the study areas (Table 1):

Table 1: Explanation of class metrics selected in FRAGSTATS (FRAGSTATS manual, version 4). Areas are in hectares, and other units are noted.

Abbreviation	Class metric and description
PLAND	Percent of landscape
PD	Patch density (# of patches per hectare)
LPI	Largest patch index (% of landscape occupied by largest patch)
ED	Edge density (meters of edge per hectare)
LSI	Landscape shape index (total edge perimeter within the landscape divided by landscape area). This metric treats all forest patches as if they were part of one patch, and compares the edge perimeter per area against what this value would be if the forest patch was one simple geometric shape. The higher this value is, the more irregularly shaped a landscape is.
AM	Area-weighted mean (mean patch sizes in hectares).
Shape_AM	Shape index as area-weighted mean (sum of patch perimeters/sum of patch area). Similar to LSI except LSI uses the sum of landscape perimeter/sum of landscape area.
Contig_AM	Contiguity as area-weighted mean. When a patch is only one pixel, contiguity is 0. Contiguity increases up to 1 as patches become more connected/larger.
CPLAND	Core area percent of landscape.
DCAD	Disjunct core area density (# of disjunct core areas per hectare).
CORE_MN	Mean core area per patch.
DCORE_MN	Disjunct core area distribution (mean area per disjunct core).
CWED	Contrast-weighted edge density (Meters of maximum-contrast edge per hectare in the landscape).
IJI	Interspersion and juxtaposition index (percent). Values are highest when the landscape is more fragmented/patches become more interspersed.
CONNECT	Connectance index (percent of patches connected within a user-specified distance). 60 m was used in this analysis.
AI	Aggregation index (percent). This is counted on a cell by cell basis. Zero is maximally disaggregated (no like adjacencies). The maximum aggregation is achieved when the patch type consists of a single, compact patch.
Division	Landscape division index (ranges from 0 to 1). Defined as the probability that two randomly selected cells are NOT situated in the same patch.

PROX_AM	Proximity index as area-weighted mean. Distinguishes sparse distributions of small habitat patches from configurations where the habitat forms a complex cluster of larger patches (60 m search radius specified). This is a dimensionless index. Higher values indicate more patches of the same size within the search radius.

Objective 2: Determine distribution and changes of largest natural land cover patches during the study period.

The National Land Cover Dataset was used to analyze the land cover within the Berks County Greenway and the entire HUC10 watershed area for Berks and Schuylkill Counties for the years of 2006 and 2019. Like Objective 1, the raster data were reclassified in ArcGIS Pro but instead of eight new land cover classes, only two were created: natural and unnatural. Natural land covers were forest, shrubland, herbaceous, and wetlands. Unnatural land covers included water, developed, barren, and agricultural. This classification is meant to focus more broadly on potentially important habitat areas in addition to forest. Water was reclassified into an unnatural land cover due to the large number of manmade lakes and reservoirs scattered throughout the study area. The newly classified raster datasets for 2006 and 2019 were exported as TIFF files, for a total of four files, to be used for processing in FRAGSTATS.

The 2006 and 2019 TIFF files were imported into FRAGSTATS in which the fixed edge depth was set to 30 meters and the setting to generate patch IDs was selected. Creating patch IDs allows FRAGSTATS to generate results that can be used to visualize individual patch metrics. Patch metrics for analysis of patch area, core area, and perimeter-area ratio were selected and the FRAGSTATS program was run (Table 2). The result of the FRAGSTATS processing was a spreadsheet of the calculated patch metrics for the Greenway and the HUC10 boundary.

Table 2: Explanation of patch metrics selected in FRAGSTATS (FRAGSTATS manual, version 4).

Abbreviation	Patch metric and description
AREA	Area equals the area (m^2) of the patch, divided by 10,000 (to convert to hectares).
CORE	Core equals the area (m^2) within the patch that is further than the specified edge distance from the patch perimeter, divided by 10,000 (to convert to hectares).
PARA	Perimeter-area ratio is a simple measure of shape complexity but without standardization. This metric equals the ratio of the patch perimeter (m) to area (m^2)

The four newly created TIFF files (two for the Greenway Plan and two for the HUC10 boundary) were added to ArcPro along with their respective FRAGSTATS tabular results. The TIFF files were converted to integer raster data sets using the Int Tool so an attribute table could be created which is necessary for joining the FRAGSTATS results to the raster data. The new integer rasters were converted into polygons by utilizing the Raster to Polygon Tool and their respective patch metric tables were joined by their patch IDs. The unnatural and no data classes were filtered from each dataset so only the natural landcovers and their attributes could be examined. The five largest patches within each study for each year were located based on area classification and overlaid on a topographic map to determine the factors that lead to their large size.

Results and Discussion

Objective 1: Analyze changes in the size, shape, distribution, edge density, core area, and connectivity of forest patches during study period (2006-2019).

Calculated FRAGSTATS metrics for the three areas of interest are shown in Table 3.

Table 3: Results of the FRAGSTATS analysis on forest land cover in the three study areas in 2006 and 2019. Change from 2006-2019 shown in red.

Class metric	HUC-10 watersheds 2006	HUC-10 watersheds 2019	Kittatinny Ridge 2006	Kittatinny Ridge 2019	Greenway 2006	Greenway 2019
PLAND	47.65	46.92 (-0.73)	58.01	56.72 (-1.29)	58.96	58.66 (-0.30)
PD	2.60	2.66 (+0.06)	2.26	2.36 (+0.10)	2.90	2.92 (+0.02)
LPI	1.59	1.58 (-0.01)	2.69	2.63 (-0.06)	5.49	5.48 (-0.01)
ED	55.86	57.26 (+1.39)	54.31	56.39 (+2.09)	56.36	57.50 (+1.14)
LSI	207.84	214.63 (+6.79)	101.86	106.89 (+5.02)	69.60	70.91 (+1.31)
AM	2591.12	2515.55 (-75.57)	2449.21	2341.25 (-107.96)	1532.33	1507.74 (-24.59)
Shape_AM	4.92	5.23 (+0.16)	4.32	4.73 (+0.41)	3.46	3.62 (+0.16)
Contig_AM	0.90	0.90 (±0.00)	0.92	0.92 (±0.00)	0.91	0.91 (±0.00)
CPLAND	37.20	36.22 (-0.98)	47.69	46.03 (-1.66)	46.58	46.09 (+0.50)
DCAD	2.51	2.58 (+0.07)	2.22	2.31 (+0.09)	2.72	2.79 (+0.07)

CORE_MN	14.31	13.59 (-0.71)	21.07	19.51 (-1.56)	16.05	15.76 (-0.29)
DCORE_MN	14.84	14.05 (-0.79)	21.45	19.96 (-1.49)	17.15	16.51 (-0.64)
CWED	36.60	36.91 (+0.30)	34.81	34.64 (-0.17)	35.31	35.67 (+0.36)
IJI	64.59	66.57 (+1.98)	61.62	66.65 (+5.03)	68.29	69.58 (+1.28)
CONNECT	0.00	0.00 (±0.00)	0.02	0.02 (±0.00)	0.03	0.03 (±0.00)
AI	91.17	90.81 (-0.36)	92.91	92.47 (-0.44)	91.81	91.63 (-0.18)
Division	1.00	1.00 (±0.00)	1.00	1.00 (±0.00)	0.99	0.99 (±0.00)
PROX_AM	16284.27	15683.19 (-601.08 or -3.7%)	12267.57	11694.27 (-573.29 or -4.9%)	4392.25	4365.83 (-26.42 or -0.60%)

Metrics within the three study areas tended to follow similar patterns. Forest patches across the board became smaller, more irregular, less connected, and edge area increased. These results indicate a potential trend in declining ecological function of forest patches within the study area. However, these changes tended to occur on a small scale, often changing by less than 1%. The Kittatinny Ridge suffered the highest magnitude of change for most metrics. The Greenway tended to perform the best, and change within the HUC-10 shell usually fell between the other two study areas.

Changes in Patch Size and Shape

The percent of forest cover within the landscape (PLAND) decreased in all three study areas. Percent of forest cover decreased the most in the Kittatinny Ridge (-1.29%) and decreased the least within the Greenway (-0.30%). This shows that while forest cover did not increase in the Greenway, the Greenway may have prevented forest cover from being lost during this time period. The largest patch index (LPI) revealed that the largest forest patch in each study area decreased slightly, particularly in the Kittatinny Ridge (-0.06%). The landscape shape index (LSI) revealed that forest patch shape irregularity increased in all three study areas. This increase was the smallest in the Greenway (+1.31) and largest in the HUC-10 study area (+6.79). The area weighted mean patch size (AM) showed that average patch size decreased in all study areas, with the change being the most severe in the Kittatinny Ridge (-106.96 ha) and least severe in the Greenway (-24.59 ha). These changes equated to a 4.4% loss in average forest patch size in the KR and 1.6% loss in the Greenway. The area-weighted mean shape area (SHAPE_AM) showed that the ratio of patch edge versus patch area increased slightly in all three study areas, and was the most severe in the Kittatinny Ridge (+0.41). The aggregation index (AI) in all three study areas started off at over 90%, which indicates that individual forest cells tend to be connected in regularly shaped patches. However, this value slightly decreased from 2006-2019 in all three study areas and was most severe in the Kittatinny Ridge (-0.44%) and least severe in the Greenway (-0.18%)

Changes in Patch Distribution & Connectivity

Results related to fragmentation and connectivity showed either no change or increasing patchiness. Patch density (PD) increased in each study area, although this change was highest in Kittatinny Ridge (+0.10 patches per hectare), and lowest in the Greenway (+0.02 patches per hectare). This increase in patchiness was relatively small for each study area. The contiguity index as an area-weighted mean (CONTIG_AM) did not change in any of the study areas, which means that patches did not become larger or more connected. Although there was no change, this metric revealed that contiguity is highest in the Kittatinny Ridge (0.92) and lowest in the HUC-10 study area (0.90). The results of the interspersion and juxtaposition index (IJI) revealed that forest patches became more dispersed in all of the study areas, especially in the Kittatinny Ridge (+5.98%). Again, the Greenway fared the best as patch dispersion increased by only 1.28%. The connectance index (CONNECT) showed no change in any of the study areas, but it revealed that the Greenway and Kittatinny Ridge forest patches were sometimes connected considering a distance of 60 m between patches, although these values were very small (0.02% connected in the KR and 0.03% connected in the Greenway). The division index (DIVISION) revealed that there was a very high chance that any two randomly selected forest cells would not be located in the same patch. This value was virtually 100% in the HUC-10 and KR study areas, and 99% likelihood of division in the Greenway. There was no change in the division index from 2006 to 2009. The proximity index as area-weighted mean (PROX_AM) results showed that patches became sparser and smaller in all three study areas when considering a 60 m search radius. The Kittatinny Ridge suffered the most change in patch proximity, declining by 4.9.%. The Greenway fared the best, as patch proximity declined by only 0.60%.

In regard to forest connectivity and fragmentation, this study is limited by the resolution of the data (30 m). Each land cover cell is 900 m^2, so it is likely that cells classified as non-forest land cover types also contained trees. Individual trees and small forest patches can serve as paths for wildlife between otherwise discontiguous forest patches, particularly if the trees are old growth (Von Thaden et al., 2022). Furthermore, scrub/shrub and other vegetated landscapes may also serve to provide contiguous wildlife habitat between forest patches. Therefore, forest patches are likely more connected than they appear from the results of this study.

Changes in Forest Edge

The edge density (ED) in each study area increased, and the trend continued that this increase was the highest in the Kittatinny Ridge (+2.09 m/ha) and the lowest in the Greenway (+1.14 m/ha). Contrast-weighted edge density (CWED) was one of two metrics with different change patterns depending on study area. In the HUC-10 and Greenway study areas, CWED increased, which means that forest patches were more likely to border developed or urban patches. This value increased by +0.30 m/ha of high-contrast edge in the HUC-10s and +0.36 m/ha in the

Greenway. CWED decreased in the Kittatinny Ridge (-0.17 m/ha), and it is the only metric in which this study area performed better than both the HUC-10s and Greenway.

Changes in Core Forest Area

The core area percent of landscape (CPLAND) was one of only two metrics in which the overall pattern of change was different among the three study areas; CPLAND increased slightly in the Greenway (+0.50%) but decreased by -0.98% in the HUC-10 study area and -1.66% in the Kittatinny Ridge. Mean core area (CORE_MN) decreased in all study areas, with the largest decrease seen in the Kittatinny Ridge (-1.56 ha) and the smallest decrease in the Greenway (-0.29 ha). The disjunct core area distribution (DCORE_MN) decreased in all three study areas, which indicates the average size of a disjunct core area within a patch went down. However, disjunct core area density (DCAD) increased slightly in all three study areas. The number of disjunct core areas increased by +0.07 per ha in the HUC-10 and Greenway study areas and by +0.09 per ha in the Kittatinny Ridge. This means that while the size of each disjunct core went down, the frequency of disjunct areas within the landscape increased.

Objective 2: Determine distribution and changes of largest natural land cover patches during the study period.

Metrics within the two study areas followed the same patterns by showing loss of natural land cover and fragmentation between the patches in which area and core area decreased while the perimeter area-ratio increased.

Greenway Natural Land Cover Patches

Three patch metrics of area, core area, and perimeter-area ratio were used to quantify natural land cover changes within the Berks County Greenway area (Table 4). The area of each natural land cover patch for the entire study boundary decreased by about 0.19 hectares per patch while the core area decreased by roughly 0.18 hectares per patch. These numbers may not reflect the true dynamic of change among all the natural land cover patches due to large differences in area between the largest and smallest patches. However, an increase in perimeter-area ratio of 4.99 suggests that fragmentation and an increase in edges among the natural land cover is occurring within the Greenway.

Table 4: Average values (hectares) for each natural area patch metric calculated in FRAGSTATS for the Greenway and HUC10 watershed boundary. Change from 2006-2019 shown in red.

Patch Metric	Greenway 2006	Greenway 2019	HUC10 2006	HUC10 2019
Area	19.45	19.26 (-0.19)	19.27	19.20 (-0.07)
Core	15.22	15.04 (-0.18)	15.27	15.19 (-0.08)
Perimeter-Area	710.96	715.95 (+4.99)	764.94	765.32 (+0.38)

Evaluation of the largest natural land cover patches within the Greenway revealed that they all remained relatively unchanged between 2006 and 2019 (Table 5). There were two notable observations as to why these large patches occurred and remained unchanged over the span of the study period: 1. The patches were already located in protected areas such as federal and state parks and state gamelands, and 2. The mountainous topography of the patches does not allow for large-scale conversions to unnatural land covers such as agriculture or developed land. The first observation was noted by overlaying the patches on a topographic map and noticing the correlation between the size and protected lands. For example, patch 1 (Figure 4) overlays Blue Mountain, characterized by rugged topography, and the Appalachian Trail, a federally protected area of land. Another example included in Figure 4 includes patch 5 which includes the Long Mountain and French Creek State Park areas. The patch for French Creek State Park differs from the rest in that it is closer in proximity to more unnatural and urbanized areas which may be why it experienced a loss of area compared to the other patches.

Table 5: Area (in hectares) of the five largest natural land cover patches located within the Berks County Greenway for 2006 and 2019. Change from 2006-2019 shown in red.

Patch	2006 Area	2019 Area
Blue Mountain/Appalachian Trail	1643.76	1643.76 (0)
State Gamelands 110/Weiser State Forest	2467.8	2645.1 (+177.3)
State Gamelands/Appalachian Trail	4411.08	4466.43 (+55.35)
State Gamelands 080	2068.47	2068.2 (-0.27)
Long Mountain/French Creek State Park	1625.04	1614.69 (-10.35)

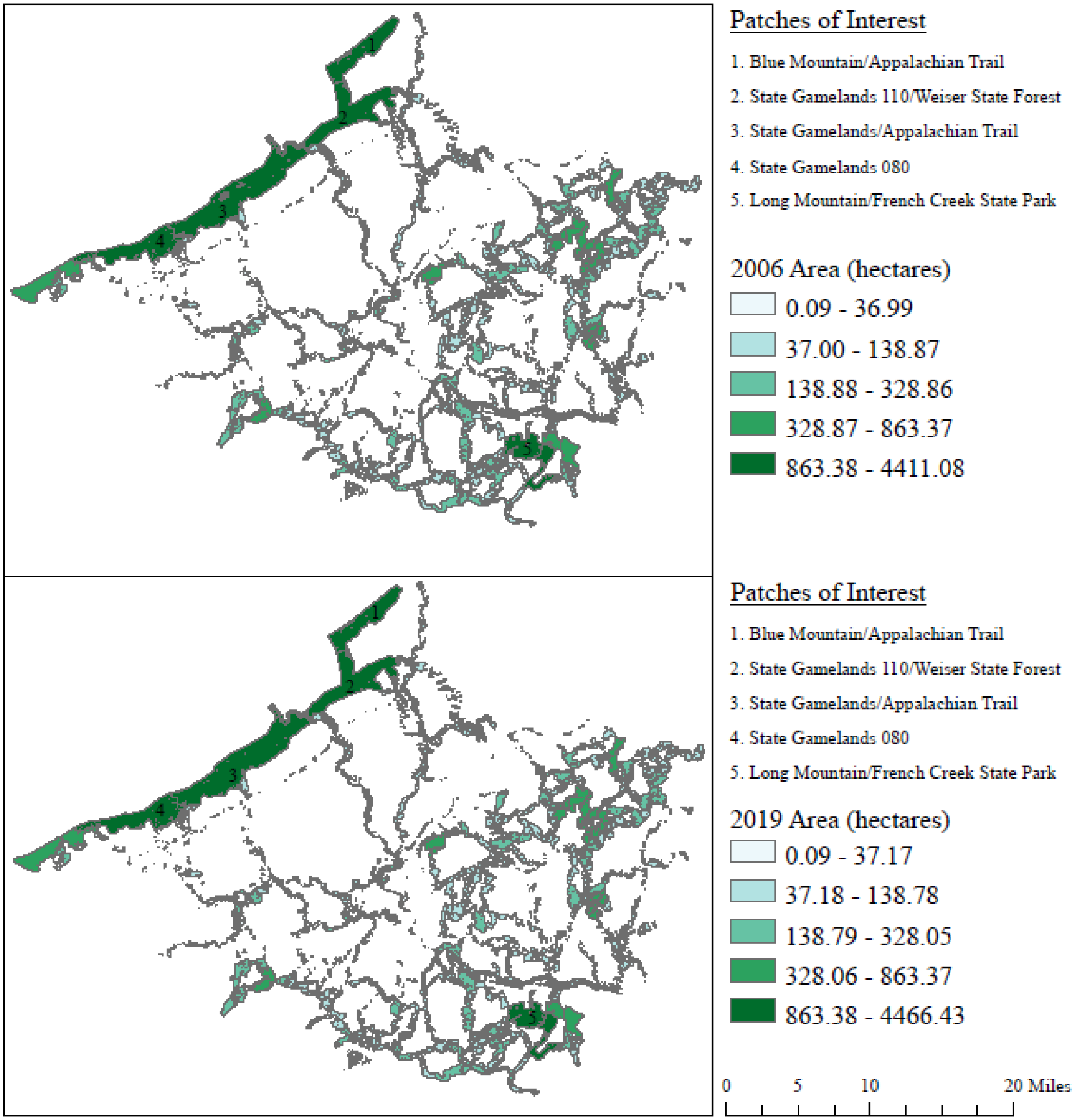

Figure 4: Area of each natural land cover patch within the Greenway area for Berks County with the five largest patches of interest highlighted for the years of 2006 and 2019.

HUC10 Natural Land Cover Patches

The patch metrics used to quantify natural land cover changes for the Greenway were also used to quantify changes in the HUC10 watershed area of Berks and Schuylkill Counties (Table 4). The area of each natural land cover patch for the entire HUC10 study area decreased by 0.07 hectares on average while core area decreased by 0.08 hectares per patch, on average. Similar to the Greenway results, these numbers may not reflect the dynamics of change among all natural land cover patches due to the differences between the largest and smallest patches and the number of patches of each size. An increase of perimeter-area ratio of 0.38 does suggest fragmentation of the natural land cover but not as much as the Greenway.

Examination of the largest natural land cover patches exhibited very similar patterns to the Greenway Plan results in that the largest patches coincided with either federal and state protected lands or mountainous terrain. These largest patches exhibited a greater amount of change throughout the study period as compared to the Greenway Plan (Table 6) but these changes may also be relative to greater patch size. (One item to note is that patches already mentioned in the previous section about the Greenway were excluded from the HUC10 map for discussion purposes). Patches that remained largely unchanged within the study area were those in protected areas while patches that experienced the most change were in unprotected areas. Two patches exhibiting the greatest amount of change were patches 3 and 4 (Figure 5, Table 6). Patch 3, located on Buck Mountain, experienced a loss of 300.78 hectares while patch 4 located on a different section of Buck Mountain and Round Head Mountain gained 114.48 hectares. The primary loss of natural land area in patch 3 was due to the development of a residential area in the center of the patch from 2006 to the present. The development of that area not only decreased total patch area but decreased core area and increased perimeter-area ratio. The gains in natural land cover in patch 4 can be attributed to land reclamation from the old coal mining industries that were present in the area. From 2006 to 2019 it is likely that barren lands have been reclaimed by trees and shrublands through natural and human restoration efforts.

Table 6: Area (in hectares) of the five largest natural land cover patches located within the HUC10 watershed boundary of Berks and Schuylkill Counties for 2006 and 2019. Change from 2006-2019 shown in red.

Patch	2006 Area	2019 Area
State Gamelands 264	8187.75	8219.79 (+32.04)
Catawissa Mountain/State Gamelands 058	11899.26	11900.97 (+1.71)
Buck Mountain	9486.18	9185.4 (-300.78)
Buck Mountain/Round Head Mountain	9586.35	9700.83 (+114.48)
Bald Mountain/State Gamelands 141	16748.73	16722.63 (-26.1)

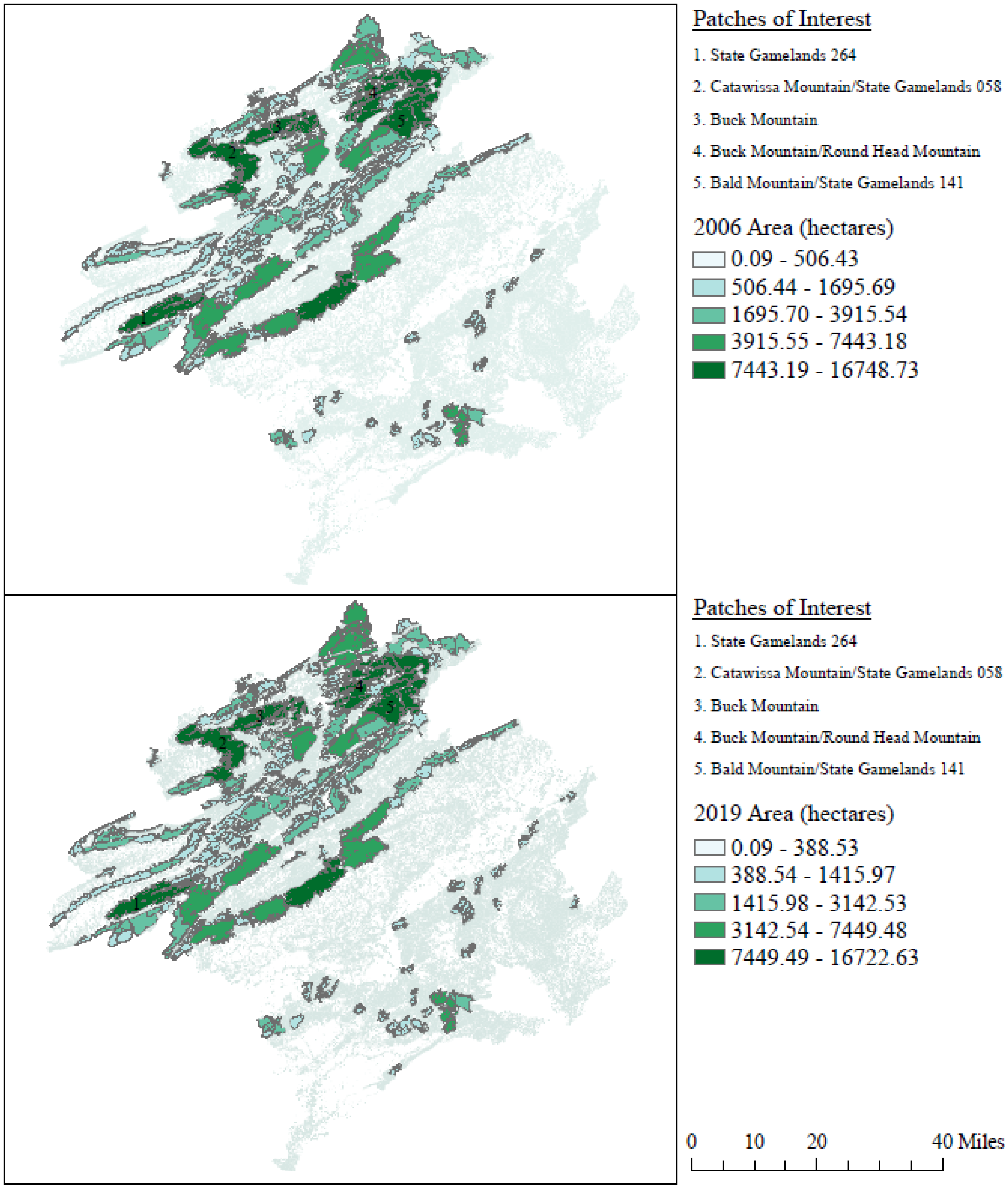

Figure 5: Area of each natural land cover patch within the HUC10 watershed area for Berks and Schuylkill Counties with the five largest patches of interest highlighted for the years of 2006 and 2019. Note: the largest patches labeled in Figure 3 were not selected for this figure.

Summary and Conclusions

The results from objective one showed that forest patches within the study regions have experienced changes in area, shape, distribution, connectivity from 2006 to 2019. Forest patches generally decreased in size, increased in density, and became more irregularly shaped. Connectivity between patches started off low and did not change. Core forest area decreased and edge area increased. Core areas tended to become more disjunct, and edge areas became denser. The Kittatinny Ridge study area experienced the highest magnitude of change, while the Greenway was the most resilient to change. Changes in forest patches in surrounding HUC-10 usually fell somewhere between the other two study areas. The general pattern of change indicates a potential trend in ecological degradation throughout the study areas, although these changes tended to be minor in scale.

Objective two explored the changes in patch metrics for natural land cover patches in the Berks County Greenway and the intersecting HUC-10 watershed boundary of Berks and Schuylkill Counties, and considered individual patches of interest. From a broad perspective, natural land cover patches decreased in both total area and core area and an increase in perimeter-area ratio suggests fragmentation. A further look into the largest natural patches revealed that many are a result of protected lands that preceded the establishment of the Greenway while state or federally protected natural patches within the Greenway are much smaller and fragmented. This does not negate the conservation efforts of the Greenway Plan; however, if this type of investigation were to be performed again, many of the larger patches should be filtered out.

References

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