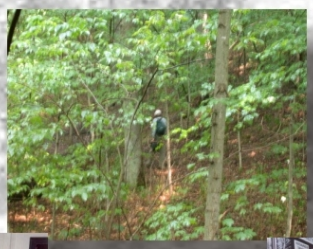
Boone County Forest Quality Assessment: An Ecological Evaluation, Prioritization, and Mapping

November 2002





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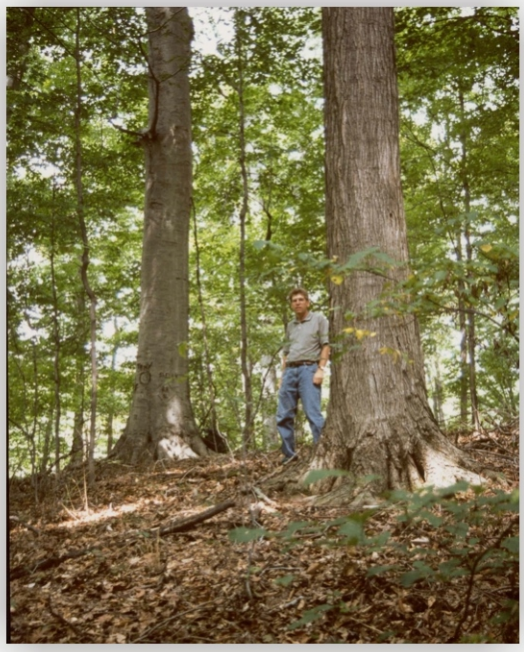
Photograph 1:
Example of Small Crown Forest
in Boone County Kentucky

Photograph 2:
Example of Medium Crown Forest
in Boone County Kentucky



Photograph 3:
Example of Large Crown Forest
in Boone County Kentucky

Boone County Forest Quality Assessment
Project Partners

(in general order of contribution)

Northern Kentucky University
Center for Applied Ecology

Northern Kentucky Urban and Community Forestry Council

Boone County Planning Commission

Northern Kentucky University
History and Geography Department

Northern Kentucky University
Center for Integrative Natural Science and Mathematics

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Boone County Forest Quality Assessment

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Boone County Forest Quality Assessment

EXECUTIVE SUMMARY

Forests are an important natural resource directly associated with community air and water quality, storm water runoff, land stability and soil erosion, wildlife and habitat diversity, outdoor recreation and education opportunities, and overall aesthetic quality. Forests are of varying ecological quality and functional value, therefore requiring professional, science-based evaluations for adequate assessment and prioritization. In the absence of a forest quality data layer, high quality forest resources are often overlooked or inappropriately considered in land use planning. Through partnership with the Northern Kentucky Urban and Community Forestry Council, the Boone County Planning Commission, the Northern Kentucky University (NKU) History and Geography Department, and the NKU Center for Integrative Natural Sciences and Mathematics, the NKU Center for Applied Ecology conducted an ecological evaluation, prioritization and GIS mapping of forests throughout Boone County, Kentucky.

Digital Ortho Quarter Quads (DOQQ) and aerial photographs (1999) were used to identify and map all woodland parcels meeting the project definition of forest. Subsequently, forests were divided into three tree crown size classes—*small*, *medium* and *large*—which was determined as the most representative indicator of forest ecological quality. Forest canopy and cover data from historical aerial photographs (1954) greatly helped to substantiate the presence and locations of older, higher quality forests. Countywide field inspections of public woodland areas were conducted to verify a percentage of the forest classification boundaries and assess the forest quality to crown class relationship. Results from the "*Forest Quality Data Layer"* indicate that approximately 59,396 acres or 37.8% of land area in Boone County falls within the fairly conservative project definition of forest. Of this amount, 39,132 acres (24.9% of land area) appear as Small Crown (*Low Quality*) Forest, 17,398 acres (11.1 % of land area) appear as Medium Crown (*Medium Quality*) Forest, and 2,867 acres (1.8% of land area) appear as Large Crown (*High Quality*) Forest. A breakdown of these categories by individual watersheds is provided.

The *Forest Quality Data Layer* produced by this project is to be used as a general guide for any type of landscape-level planning. As a result of this project, independent values for forest parcels in Boone County can now be determined through GIS analysis as per selected goals or desired attributes set by the planner or manager. Forest location and quality can be associated with other GIS databases (such as municipal boundaries, parks and other public lands, geology, soils, streams, wetlands, and topography) for query-specific evaluation and comparisons. This countywide forest quality assessment is an important first-step toward the inclusion of forest resources in the planning and decision-making process in Boone County, Kentucky.

Boone County Forest Quality Assessment

Introduction

Planners, engineers, developers, non-profit organizations and government agencies currently store and retrieve "data layers" of community information through a computer-based Geographic Information System (GIS). Typical GIS data layers include aerial photographs, municipal boundaries, zoning units, buildings, roads, utility lines, topography, soils and streams. Accessing multiple GIS data layers at one time allows public and private decision-makers to make accurate, efficient and sophisticated analyses at a region-wide, community-wide or site-specific level.

Forests are an important natural resource directly associated with community air and water quality, storm water runoff, land stability and soil erosion, wildlife and habitat diversity, outdoor recreation and education opportunities, and overall aesthetic quality. As with streams, soils, and other natural resources, forests are of varying ecological quality and functional value, therefore requiring professional, science-based evaluations for adequate assessment and prioritization. In the absence of a forest quality data layer, high quality forest resources (often a century or more in age) are often overlooked or inappropriately considered in land use planning. Having the ability to recognize such areas in the long-range planning of parks, preserves, developments, recreational areas, educational areas, wildlife corridors, and neighborhood greenspace areas is invaluable.

Through partnership with the Northern Kentucky Urban and Community Forestry Council, the Boone County Planning Commission, the Northern Kentucky University (NKU) History and Geography Department, and the NKU Center for Integrative Natural Sciences and Mathematics, the NKU Center for Applied Ecology conducted an ecological evaluation, prioritization and GIS mapping of forests throughout Boone County, Kentucky (157,280 acres land base). The project represents the first countywide ecological forest quality assessment in Kentucky, according to the State Urban Forestry Program Specialist (Kentucky Division of Forestry), which provided partial funding of this project through their Urban and Community Forestry Grant Program.

As a result of this project, independent values for forest parcels in Boone County can now be determined through GIS analysis as per selected goals or desired attributes set by the planner or manager. Forest location and quality can be associated with other GIS databases (such as municipal boundaries, parks and other public lands, geology, soils, streams, wetlands, and topography) for query-specific evaluation and comparisons. This assessment does not deal with

products of the forest—it is an ecological assessment to be used as a landscape-level planning tool.

Forest Assessment Methods

Project goals and methods were refined through initial group discussions and follow-up consultations with project partners. The initial phase included the mapping of exact forest boundaries since the previous forest canopy layer (from USGS maps) was not of sufficient detail and accuracy to conduct an ecological assessment. Digital Ortho Quarter Quads (DOQQ) and aerial photographs taken in 1999 were used to identify and map each woodland parcel meeting the project definition of forest—minimum of 10% tree canopy covering 10 acres or more outside municipal boundaries or 5 acres inside municipal boundaries.

Student GIS technicians were trained by ERMC forest ecologists to analyze each of the DOQQ's for qualified forest tracts. Forests meeting the criteria were digitized on screen along the edge of the forest canopy boundary (excluding fence rows and narrow tree-lined property boundaries). This phase of the project took approximately 6 months and 300 labor hours to produce the "forest cover base map" for the entire county. Supervision by ERMC faculty and staff provided quality control throughout the process.

Forests digitized in the initial phase were then systematically evaluated for their ecological quality and integrity. This phase was accomplished by categorizing all forests into three tree crown size classes—*small*, *medium* and *large*—which was determined as the most representative indicator of forest ecological quality and integrity due to relationships of tree crown size to tree age, level of past site disturbance, rainfall interception and absorption, presence and extent of native and exotic species, etc. Unfortunately, the 1999 DOQQ's were not of sufficient resolution (on screen or as hard copy) to achieve adequate separation of the tree crown classes; therefore, high quality color 1998 aerial photographs (35" x 34") of the entire county were purchased from the Kentucky Department of Transportation PhotoLab to achieve the necessary spatial resolution.

All medium and large crown forests greater than 5 acres in size were delineated throughout the county on clear overlay placed over the 1998 photographs. Student GIS technicians digitized forest areas onto the 1999 forest cover base map produced in the initial phase. By default, all forests not determined to have large or medium crowns were designated as small crown forests. Small crown forested areas were delineated down to 5 acres in urban areas and 10 acres in rural areas.

A variety of methods were used to delineate the boundaries between the forests of the three tree crown sizes. The process began by examining a large number of 1998 photographs to determine the range of tree crown sizes throughout the county. A number of public access sites in the county representing the range of forest crown classes were field inspected to evaluate forest conditions. At these sites the diameter-at-breast-height (dbh) was estimated for canopy trees. The range in tree dbh associated with the three crown classes was generally as follows—small crown size class <12" dbh; medium crown size class 12-18" dbh; and large crown size class >18" dbh.

Another method used to help assess forest quality was to compare aerial photographs of Boone County from 1954 and 1998. Forested areas in 1998 not appearing on 1954 aerial photographs due to agriculture, land clearing, etc., were unlikely to have grown into the large crown class (>18"dbh) in 50 years. Consequently, forested areas that developed since 1954 were primarily delineated as small crown forests. In contrast, forested areas that appeared to possess large crowns in both 1954 and 1998 were likely included in the large crown class. This comparison was cautiously conducted due to the prevalence of logging in the county and the rapid growth rates for some tree species on certain soils (e.g., deep floodplain soils). Forest canopy and cover data from the historical 1954 aerial photographs greatly helped substantiate the presence and locations of older, higher quality forests.

In some instances, topography was utilized to help draw boundaries between tree crown classes. In general, flat land and mild to moderate slopes tended to be cleared of trees for past farming activities, or were clear-cut or selectively cut more often than those on steep slopes. Consequently, boundaries between different tree crown classes were often marked by topographic changes. For forested areas in which differences between tree crown sizes were less distinct, topographic changes were used to assist in the delineation.

Once the forest layer was categorized into small, medium, and large tree crown classes, countywide road surveys and field inspections of public woodland areas were conducted to verify a percentage of the forest classification boundaries and assess the forest quality to crown class relationship. While in the field, ERMC ecologists further evaluated forest quality through five general criteria—tree size classes, forest tract size, native species diversity, percentage of invasive exotic plant species, and the occurrence of uncommon or rare species and habitats. This

process ultimately refined the forest quality mapping and provided general forest descriptions for each tree crown (and quality) category.

Results and Discussion

Results from the "*Forest Quality Data Layer"* indicate that approximately 59,396 acres or 37.8% of land area in Boone County falls within the fairly conservative project definition of "forest" (see Methods Section). Of this amount, 39,132 acres (24.9% of land area) appear as Small Crown (*Low Quality*) Forest, 17,398 acres (11.1 % of land area) appear as Medium Crown (*Medium Quality*) Forest, and 2,867 acres (1.8% of land area) appear as Large Crown (*High Quality*) Forest. Only 6.4 % of the land area within the municipal boundaries of Florence, Union, and Walton have forest patches of 5 acres or more (all three crown sizes are represented). In 1954 only 16% (25,602 acres) of Boone County was forested. Large crowned forests occupied approximately 0.3% (536 acres), medium crowned forests occupied 4.5% (7,058 acres), and small crowned forests occupied 11.4% (18,008 acres).

In comparing the watersheds of Boone County (Table 1), Gunpowder Creek has the greatest amount (not percentage) of forest (7,836 acres), followed by the Ohio River corridor (7,215 acres), and Woolper Creek (4,686 acres). The Gunpowder Creek watershed has the greatest amount of large crown forest (728 acres) followed by Middle Creek (668 acres), the Ohio River corridor (495 acres), and Garrison Creek (96 acres). Gunpowder Creek also has the greatest amount of medium crown forest (3,059 acres), followed by the Ohio River corridor (1,904 acres), Middle Creek (1,379 acres), and Big Bone Creek (997 acres).

In comparing the percentage of forest cover in the individual watersheds, Big South Fork has the greatest percentage (69.0%), followed by Taylor Creek (67.4%), Buzzard Branch (66.1%), and Middle Creek (64.7%). The Middle Creek watershed has the greatest percentage of large crown forest (14.9%), while Gum Branch has the greatest percentage of medium crown forest (47.2 %).

Small Tree Crowns—Low Ecological Quality Forests

Approximately 38% of the land area in Boone County is forested, however, the majority of that amount (65.9%) is in the small crown size classification—regarded in this study as having relatively low ecological quality. The majority of the small crown forests in Boone County are less than 50 years old and relatively more disturbed by human activities than larger crown forests. The majority of the small crown forests likely developed from lands that were deforested and farmed over a century ago, and abandoned after World War II as people shifted

from agricultural lifestyles. Many of these forests have regrown from previously pastured, tilled, or highly eroded soil that lacked a diverse native seed bank. In addition to having smaller trees, these low quality forests typically have low native plant diversity, high amounts of invasive exotic plants, diminished wildlife potential, and few to no uncommon or rare species and habitats.

Most of the trees present in small crown forests tend to be early successional native species like black locust, box-elder, red elm, white ash, white mulberry, hackberry, and honey-locust. The majority of these trees are wind-dispersed. Heavy-seeded tree species like oak and hickory are conspicuously missing from all forest strata—an indication that the native seedbank is substantially depleted, thus the "low ecological quality" rating. Unfortunately, the shrub layer in most of these low quality forests is heavily dominated by the invasive exotic shrub, Amur honeysuckle, especially in the northern and more urbanized portions of the county. Invasive exotics like Amur honeysuckle can deleteriously effect native habitats and forests by quickly colonizing (following disturbances) and out-competing native vegetation (for decades) if left unmanaged.

Major soil disturbances (through erosion of topsoil, plowing, bulldozing, etc.) can result in substantial or complete loss of the native seed bank, which can adversely affect future forest succession and quality. In addition, fragmentation of the landscape has produced more forest edge and therefore more light entering certain forests, favoring invasive exotic species like Amur honeysuckle. These exotic species in turn produce great quantities of viable seeds that are easily dispersed via bird, wind, water, etc. in the vicinity.

Since many of the higher quality trees produce heavy seeds that only disperse short-distances, it may take decades or centuries for such species to eventually migrate and establish in isolated low quality forested areas. In fact, many of the beautiful spring wildflowers that are characteristic of high quality forest remnants also disperse their seed very short distances (some only a foot or two each year by way of native ants). Showy native woodland wildflowers like trillium, bloodroot, bellwort, trout lily, wild ginger, spring beauty, Dutchman's breeches and squirrel corn are relatively common ant-dispersed species found in Boone County. These species are mostly restricted to higher quality forests and their "ant-assisted" natural dispersal may only extend 50-150 feet in a human lifetime.

Forest quality and rate of forest succession can be somewhat increased in these low quality forests by enhancement with heavy-seeded native species (trees, shrubs, and herbs) and by controlling invasive exotics. However, as a result of extreme topsoil loss and other major soil disturbances, many of the open lands and low quality forests in Boone County will likely take centuries to develop back into forests equal in ecological quality to the higher quality forests occurring in the county today. Low quality forests and woodlots that have relatively undisturbed topsoils and native seedbanks have the highest potential for developing into quality forest systems.

Medium / Large Tree Crowns—Medium / High Ecological Quality Forests

In contrast to small crown forests, medium and large crown forests (roughly 11% and 2% of the land area in Boone County, respectively) are much older and less disturbed by human activity. It appears that all of the medium and large crown forests in the county have been logged at least once, and cattle grazing in woodlands was probably prevalent as well. However, these forested areas share in common the fact that topsoils do not appear to have been plowed for crops or severely eroded by other means. As a result, topsoils in the medium and large crown forests are relatively undisturbed and likely contain healthy and diverse seedbanks of native trees, shrubs, and herbs.

Undisturbed topsoils not only harbor an array of dormant native seeds that perpetuate forest development and diversity, but they also function to dramatically increase the water holding capacity of soil. Well developed forests containing distinct canopy, subcanopy, shrub, and herbaceous layers, and relatively undisturbed topsoils have the greatest capacity to “intercept” and “hold” water during storm events. Topsoils also harbor highly beneficial mycorrhizal fungi and other soil organisms that are vital to overall forest health and functioning. Many of these soil organisms are responsible for the detoxification of naturally occurring and anthropogenic organic compounds. These are just a few of the reasons why medium and large crown forests are regarded in this assessment as having medium to high ecological quality.

While there is a substantial difference in forest quality between most small and medium crown forests, there is much less difference in forest quality between medium and large crown forests. It is estimated that most medium crown forests in the county will develop into forests of high ecological quality and function within 50-100 years, if allowed.

Most of the medium and large crown forests located in uplands, especially on north- and east-facing slopes, are Mesic Hardwood Forests. These forests are typically dominated by a mixture of tree species including sugar maple, American beech, tulip-tree, Shumard oak, red oak, shagbark hickory, bitternut hickory, Ohio buckeye, yellow buckeye and basswood. The shrub layer is typically dominated by pawpaw, spicebush and black-haw. Drier south- and west-facing slopes are dominated by Oak Forests, especially in the unglaciated southern portion of the county. These forests are typically composed of white oak, black oak, chinkapin oak, red oak, shagbark hickory, pignut hickory, and ironwood. Common shrubs include flowering dogwood, witch-hazel, and gray dogwood.

In the valley and bottomland areas medium and large crown forests are composed of Lowland Forest. These forests are typically dominated by silver maple, red maple, green ash, cottonwood, sycamore, and black willow. Some of the common shrubs include elderberry, bladdernut, and black-haw. Although Mesic Hardwood Forests typically have higher native herb diversity due to large amounts of spring ephemeral wildflowers, nearly all the medium and large crown forests assessed during the study (regardless of forest type) had herbaceous layers with medium to high native species diversity.

Within the large crown size classification, one five-acre remnant of “old-growth” forest (trees estimated to be >36 inches dbh from aerials and driveby) exists on private property several miles southwest of Burlington in both the 1954 and 1998 aerial photographs. This remnant has the largest crowns in the county (trees could be 2-3 centuries old) and appears to be dominated by American beech. Further field investigations will likely identify additional small remnants (<5 acres) of old-growth forest, but finding larger tracts is unlikely. Dinsmore Woods and Boone County Cliffs State Nature Preserves (Middle Creek watershed) contain some of the best remaining examples of mature woods in the county. In addition, it appears that sizable amounts of high quality forest abut Boone County Cliffs. Together these tracts possess the largest contiguous high quality forest remnant in the entire county. Moreover, this high quality forest remnant is essentially surrounded by sizable tracts of medium quality forest, providing excellent physical and biological buffer.

Forest Quality Assessment Limitations

Certain generalizations can be made about forest quality of each tree crown category, however, within each category there can also be a relatively broad range of forest quality. For example, a forest may have medium crowns, but because of extensive selective cutting, off-road vehicle

disturbance, or grazing, the overall forest quality may be substantially reduced. Likewise, small crown forests occurring on relatively undisturbed soils might have higher ecological quality, higher habitat restoration potential, etc. than typical small crown forests on highly disturbed soils. Some highly disturbed forests recover faster than others simply because there are available seed sources in adjacent woodlots. In addition, there may be certain forest-types such as Oak Barrens that naturally have small trees. Oak Barrens tend to be located on dry south-facing slopes or rigdetops that were historically maintained by natural fires.

This assessment does not deal with timber quality, quantity, or marketability. The *Forest Quality Data Layer* produced by this project is to be used as a general guide for assessing forest quality for any type of landscape-level planning. Since forest quality delineations were conducted from aerial photographs, precise forest quality boundary determinations will require additional field reconnaissance. The forest quality mapping is general in nature and can be roughly compared to the mapping of soil-types typical of county soil surveys. The soil survey map provides a general guideline to where particular soil-types occur, but specific delineations of soil-type boundaries require detailed on-site determinations. The forest layer, however, is subject to quite rapid changes over time and should be updated periodically.

Concluding Remarks

This countywide forest quality assessment is an important first-step toward the inclusion of forest resources in the planning and decision-making process in Boone County, Kentucky. As it takes centuries for forests to attain high ecological quality and function, it is important to promote the significance of our existing community and urban forests and the need for informed decision making in the planning, development, conservation, and long-term management of this valuable resource for today and future generations. The cooperating partners of this project encourage all organizations, agencies, businesses, and individuals to make full-use of the contained forest quality assessment information. The *Forest Quality Data Layer* produced by this project will be available to the public through the Boone County Planning Commission. A GIS map of the forest quality layer is appended to this report.

Acknowledgements

The ERMC would like to express sincere thanks to Gary Wolnitzek , Don Girton (Northern Kentucky Urban and Community Forestry Council), Dan Richards (Boone County Planning Commission), and Dr. Macel Wheeler (NKU Department of History and Geography) for participating in numerous technical design discussions and providing encouragement throughout the project. Special thanks go to Mary Kathryn Dickerson (Boone County Conservation District) and Ron Meyer (Kentucky Division of Forestry) for providing historical aerial photographs. Special recognition is extended to Sean Dougherty and Mike Jeggle for providing quality GIS technical support, student training, and project management.

Table 1. Total acreage and percentage of forest in Boone County watersheds, and the acreage and percentage of the watershed forest by crown class.

Watershed	Forested acres in watershed	Percent of watershed forested	Canopy Cover					
			Small		Medium		Large	
			acres	%	acres	%	acres	%
Allen Fork	914	20.30%	629	68.80%	243	26.60%	42	4.60%
Ashby Fork	1,920	55.60%	1,581	82.30%	309	16.10%	30	1.60%
Banklick Creek	114	13.40%	102	89.50%	12	10.50%	0	0.00%
Beaver Branch	376	27.40%	319	84.80%	57	15.20%	0	0.00%
Big Bone Creek	3,691	49.20%	2,614	70.80%	997	27.00%	80	2.20%
Big South Fork	474	69.00%	257	54.20%	198	41.80%	19	4.00%
Bullock Pen Creek	445	15.00%	400	89.90%	37	8.30%	8	1.80%
Buzzard Branch	541	66.10%	336	62.10%	205	37.90%	0	0.00%
Cruises Creek	123	16.00%	118	95.90%	5	4.10%	0	0.00%
Dark Hollow Branch	307	27.50%	184	59.90%	123	40.10%	0	0.00%
Double Lick Creek	610	40.20%	330	54.10%	244	40.00%	36	5.90%
Elijahs Creek	1,090	25.20%	853	78.30%	191	17.50%	46	4.20%
Fowler Fork	268	9.20%	190	70.90%	24	9.00%	54	20.10%
Fuller Branch	217	15.70%	174	80.20%	43	19.80%	0	0.00%
Garrison Creek	1,680	45.00%	1,287	76.60%	295	17.60%	98	5.80%
Gum Branch	1,479	56.00%	759	51.30%	698	47.20%	22	1.50%
Gunpowder Creek	7,836	40.00%	4,049	51.70%	3,059	39.00%	728	9.30%
Landing Creek	1,953	60.40%	1,122	57.50%	747	38.30%	84	4.30%
Lick Creek	3,011	59.50%	2,578	85.60%	358	11.90%	75	2.50%
Little Salem Creek	206	14.90%	176	85.40%	30	14.60%	0	0.00%
Little South Fork	1,734	51.20%	1,106	63.80%	606	35.00%	22	1.30%
Long Branch	521	28.40%	288	55.30%	174	33.40%	59	11.30%
McCoys Fork	875	17.70%	592	67.70%	283	32.30%	0	0.00%
McPherson Branch	299	33.90%	205	68.60%	69	23.10%	25	8.40%
Middle Creek	4,488	64.70%	2,541	56.60%	1,379	30.70%	668	14.90%
Mud Lick Creek	4,515	30.10%	3,135	69.40%	1,360	30.10%	20	0.40%
North Fork of Tenmile Creek	153	7.30%	112	73.20%	41	26.80%	0	0.00%
Ohio River	7,215	30.30%	4,816	66.80%	1,904	26.40%	495	6.90%
Riddles Run	1,585	58.10%	913	57.60%	623	39.30%	49	3.10%
Sand Run	1472	46.10%	1,043	70.90%	385	26.20%	44	3.00%
Second Creek	888	59.40%	571	64.30%	307	34.60%	10	1.10%
South Fork of Gunpowder Creek	971	9.50%	713	73.20%	211	21.70%	47	4.80%
Taylor Creek	2,042	67.40%	1,450	71.00%	562	27.50%	30	1.50%
Tenmile Creek	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Verona Branch	271	22.00%	151	55.70%	120	44.30%	0	0.00%
Wolf Pen Branch	316	16.20%	226	71.50%	90	28.80%	0	0.00%
Woolper Creek	4,686	31.30%	3,211	68.50%	1,402	29.90%	73	1.60%

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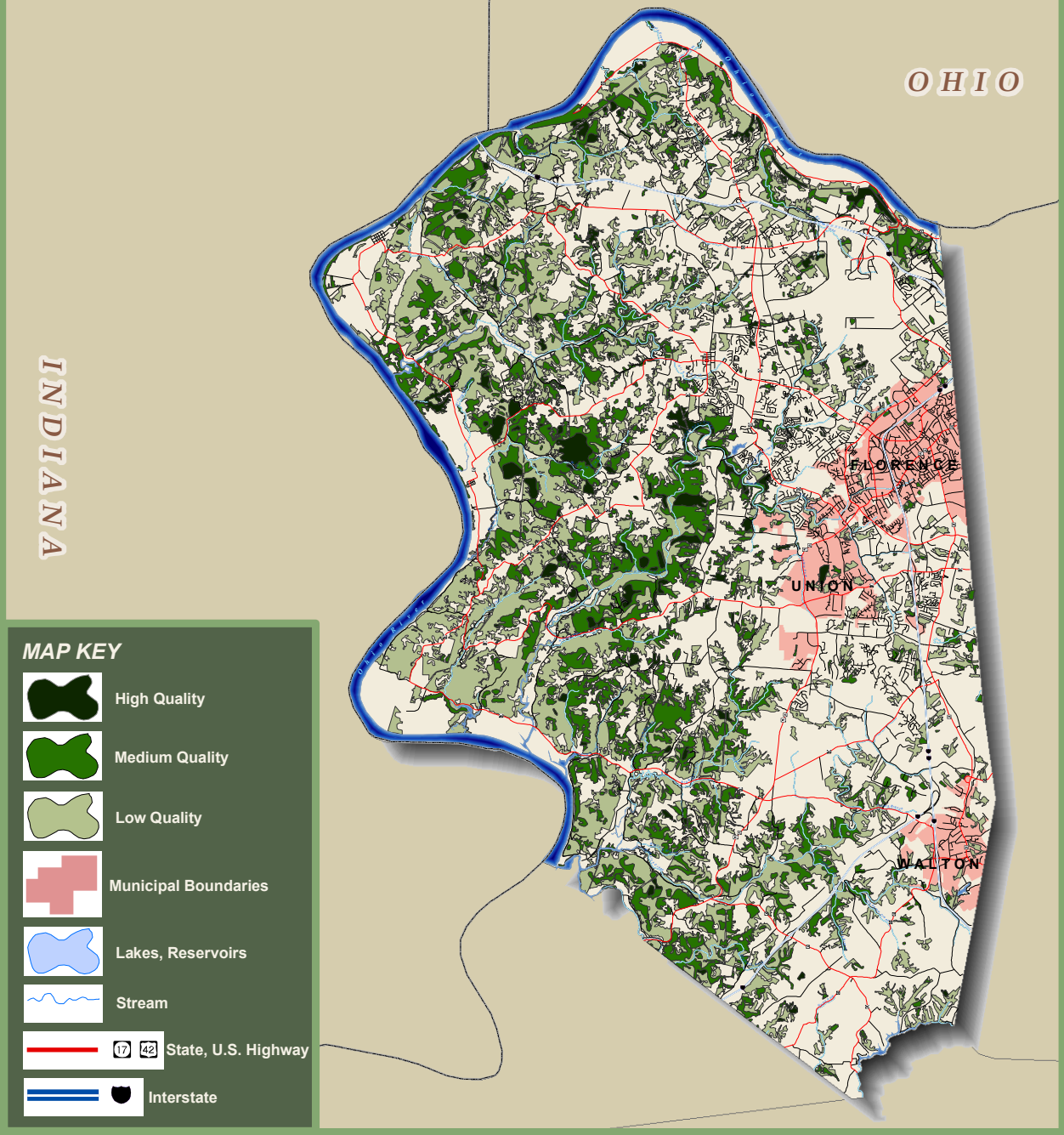

MAP KEY

- High Quality
- Medium Quality
- Low Quality
- Municipal Boundaries
- Lakes, Reservoirs
- Stream
- State, U.S. Highway (17, 42)
- Interstate

The forest quality assessment was conducted through partnerships formed between the NKU Center for Applied Ecology, the Northern Kentucky Urban and Community Forestry Council, the Boone County Planning Commission, the NKU History and Geography Department, and the NKU Center for Integrative Natural Science and Mathematics.

Forested areas were delineated using high-resolution 1998 aerial photographs purchased from the Kentucky Department of Transportation PhotoLab. Forest quality is primarily based on current tree crown size classification (small, medium, and large) and further refined by comparisons with historical landscape disturbances apparent in 1954 aerial photographs.

November 2002

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Projection: Kentucky State Plane North
Datum: North American Datum 1983

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