I. The Landscape of Allegheny County

A Landscape Formed by Water (After Prellwitz and Kyshakevych)

The present-day Ohio River flows southward from Pittsburgh, Pennsylvania, to its confluence with the Mississippi River at Cairo, Illinois. The Ohio River is formed by the confluence of the Monongahela and Allegheny Rivers, and shares characteristics of both. It is slowly eroding and downcutting the flat-lying sedimentary beds of shale, sandstone, limestone, claystone and coal that were originally deposited during the Pennsylvanian Period of geological time (about 310 million years ago). The history of the Ohio River as we know it today probably began about 60 million years ago (Wagner 1970). During this time, Western Pennsylvania was a broad, flat plain similar to those now seen in the mid-western United States. There was little elevation difference between the tops of any hills and the water levels of the Ohio. The topographic relief in Pittsburgh is now nearly 700 feet, as the level of the water in the Ohio at the Point (where the Monongahela and Allegheny Rivers meet) is 710 feet above sea level, and the tops of the highest hills are almost 1400 feet above sea level.

The Ohio River has not always flowed south, emptying into the Mississippi River. The Ohio River originally flowed north into Lake Erie, in the valley of the present-day Beaver River. An ice sheet advance dammed the north-flowing Ohio River, and water impounded behind it forming "Lake Monongahela." Sometime during this high water event, the southern portion of the Ohio River eroded through its divide in West Virginia, and started to flow southward. Figure I.1 is a pre-glacial river drainage pattern map of Western Pennsylvania. As the glacial ice finally retreated, the old Ohio River divide was eroded through, and all the water from the Allegheny and Monongahela (forming the Ohio River) flowed southward to the Mississippi River, at Cairo, Illinois, as it does presently.

Downcutting remains the major erosional style of the Ohio River, even though there is still some meandering and sidecutting. The water level of the Ohio has dropped about 200 feet since the third ice advance; this may give an idea of how slow erosional processes are on a major waterway. Figure I.2 is a map of the present drainage patterns in Western Pennsylvania, showing also the furthest advance of glacial ice.

Hydrological Overview (After Moxely)

Pittsburgh's three rivers have endured significant structural changes to enhance their navigability in the nearly three centuries since European migration. Early efforts concentrated on channel improvements. Snag, rock, and wreck removal, plus bar and shoal remediation decreased the economic and physical risks of river travel, making it somewhat speedier and hence cheaper. Wing dams concentrated river flow into narrow chutes, deepening channels over bars and ripples and lengthening the navigation season by alleviating some of the impact of low water. Despite these slight structural additions to the rivers, the flow was still natural.

The trend toward massive, deep-draft towboat-barge combinations near the end of the nineteenth century proved even the thirty-inch open channel to be inadequate to accommodate the burdens of river commerce. Modifying the slackwater system of the Monongahela Navigation Company, the Army Corps of Engineers pursued the complete canalization of the Ohio and other rivers. The first phase of the radical Ohio River project afforded six- then nine-foot slackwater from Pittsburgh to Cairo by 1929. When commercial waterborne tonnage continued to grow in the twentieth century, Army engineers updated the slackwater systems on Pittsburgh's most commercial rivers, the Ohio and the Monongahela. They replaced earlier generation lowlift navigable dams with a lesser number of high-lift non-navigable dams to modernize these rivers into interstate expressways. Over the course of nearly three centuries, the Allegheny, Monongahela, and Ohio have been progressively transformed from free flowing rivers into a stairstepped chains of deepwater river-lakes. The work continues today with the replacement of the dam at Braddock.

Pittsburgh's three rivers, once completely unrestrained natural hydrologic systems, today function as both ecology and infrastructure within the landscape of the modern built environment. They continue to defy complete control and provide a nuturing habitat for an increasing mix of plants and organisms.

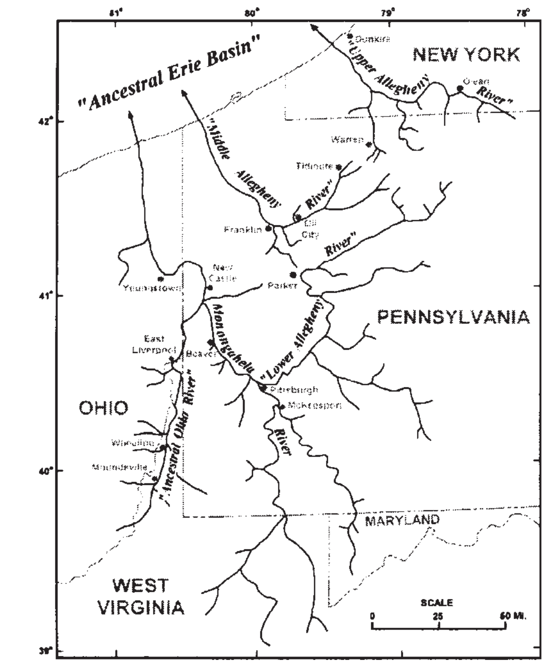


Figure I.1 The pre-glacial river drainage of Western Pennsylvania.

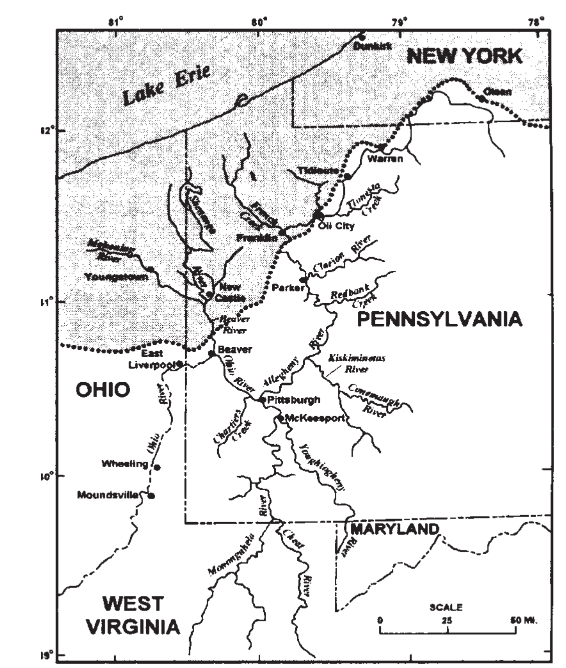


Figure I.2 The present drainage patterns and the furthest advance of glacial ice.

1.1 HYDROLOGICAL OVERVIEW: RIVERS & STREAMS

The landscape of Allegheny County is defined by a complex drainage pattern of streams and rivers. This hydrological pattern is the result of millions of years of erosion. The hydrological pattern is the major characteristic of the local landscape matrix. In addition to the four major (10th order or above) rivers there are 52 major sub-watersheds in the county. Because of urban development, many of these streams have been culverted or filled over time. Lost streams, based upon topographical analysis, are shown in red.

LEGEND

- River
- Stream
- Lost Stream
- Watershed Boundary

0 12,500 25,000 50,000 Feet

Author: John Oduroe

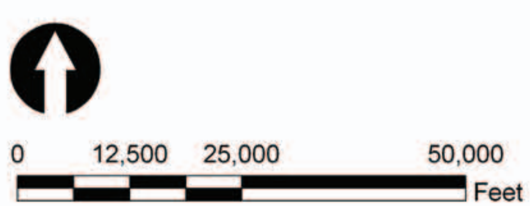
1.2 HYDROLOGICAL OVERVIEW: WATERSHEDS

The drainage pattern of streams and river defines the major sub-watersheds in the county. The 52 sub-watersheds each consist of a second order or greater stream draining into one of the major rivers. Less complex, small first order streams draining directly into the major rivers are not considered as sub-watersheds and are included in the area of the river itself. For the purpose of this study, the major rivers have been broken into series of dams, which create fixed elevation pools. This division of sub-watersheds and river pools has been used throughout this study as a basic unit of measurement.

LEGEND

River

Watershed Boundary



Author: John Oduroe

The Urban Context

Allegheny County covers an area of approximately 745 square miles. Its topography consists of rolling hills that are framed by four principal river valleys. Drainage flows from the north (Allegheny River), the east (Youghiogheny River), and the south (Monongahela River). These rivers join and become the Ohio which flows north west before turning southwards towards the Mississippi. In addition to the four major rivers, there are seventy-six tributary streams and sub-watersheds flowing into the main stem rivers in the County. In fact, for every mile of riverfront (90 miles), there are more than twenty miles of accessible stream edge (2024 miles).

With the exception of the Youghiogheny, each of the major rivers were the site of extensive industrial development over the past 150 years. The banks of the Monongahela Valley, with its connection to the coal fields in the south, became the predominant site of industrial development within the county. None the less, steel mills, glass factories, coke plants and eventually the chemical industries developed on the Allegheny and Ohio Rivers as well.

The regional street pattern is influenced by the rolling topography as well as the broad flat floodplains of the major rivers on the inside banks and the shallow flood plains abutted by steep slopes typical of the outside bends of a larger river. All floodplains, with few exceptions, have been filled and raised over the last two hundred years. Historically, many streets led directly to the rivers, but over the last 150 years, these streets and their attendant mixed-use of residence, commerce and small industry have been replaced by large industrial estates that in most cases are no longer in production. As a result, there is very little direct access to the rivers from neighborhoods and riverfront communities. Where there is the potential for access, the most urbanized or industrial sections of river bank are more often than not defined by an interesting mix of recovering vegetation and near vertical walls of fill, structural masonry, cement or steel. (See fig I.3)

Regional land ownership and subdivision basically followed three patterns: tracts divided after being surveyed by the owner, individual large city blocks bringing streets in between, and consolidation by joining two or more plots together to form a larger plot in most cases removing the street in between (typical of historic industrial development). The latter two methods are mostly seen on the waterfront. In addition, typically within a quarter mile or less of the rivers edge will be found at least one, and in some cases three to six, railway lines which were established to service the industrial economy. Even today, new highways are being planned that will dominate the Monongahela river edge.

Figure I.3 The Monongahela River Corridor from the surrounding hilltops. The community of Hazelwood sits on the far side of the river. (Photo 3R2N)

Figure I.4 The same area as I.3 viewed from a small plane flying over the Hazelwood community. (Photo 3R2N)

There are four cities in Allegheny County, all situated along the Monongahela River. They are Clairton, Duquesne and McKeesport, and Pittsburgh at the confluence of the Monongahela and the Allegheny where the Ohio is formed. Much of land along the three rivers would be considered urban with a mix of residential, commercial and industrial interests, except in the cases where a post-industrial site is vacant and classified as a brownfield property. Brownfield sites provide significant potential for redevelopment and the recapture of the range of diverse social, economic and environmental uses which would have been typical of the past centuries.

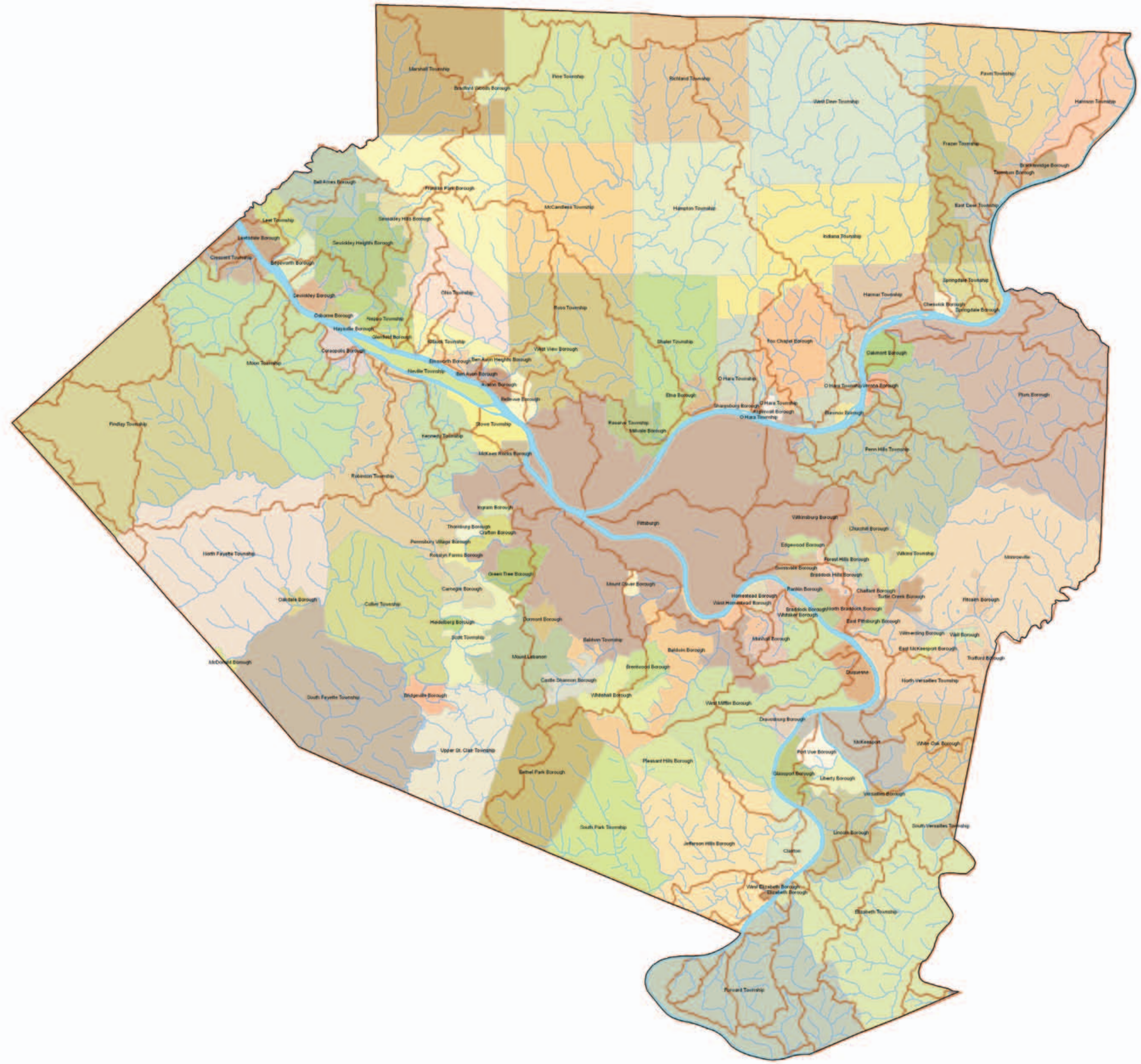
Recently one of the largest brownfield properties, the former US Steel works in the Borough of Homestead, has been redeveloped as a mix of waterfront apartments and large box commercial development. This site is notable for its lack of relationship to the river, the recovering natural environment or the structurally significant (for the town) historic main street. At the same time the property is an economic success. A more integrated urban model of brownfield redevelopment has been recently completed on the South Side of Pittsburgh where there is some attempt to extend the existing plan of streets to the rivers edge and reflect the 2-3 story densities that are typical of that older main street environment. A waterfront park, developed there previously, provides a glimpse of what the rivers edge might have looked like two hundred years ago. It can be accessed via a trail that links to and through the development.

Map 1.3 Hydrological Overview: Watersheds & Municipalities

Municipal boundaries are a legal-cultural product of historic land use, ownership and political interest. Typically municipal boundaries are informed but not in any way constrained by landscape ecology, topography or hydrology. The fact that the City of Pittsburgh now encompasses land on the North Side of the Allegheny River, the South Side of the Monongahela and the interstitial pie-slice between the rivers is a very good ex-

1.3 HYDROLOGICAL OVERVIEW: WATERSHED & MUNICIPALITIES

The hydrological pattern of river pools and sub-watersheds is very different from the complex political pattern of the 130 distinct municipalities that make up Allegheny County. Each of these separate municipalities has its own local government regulating land-use and development decisions. In some cases, rivers and streams act as the political boundary between municipalities. However, only a few small sub-watersheds are entirely within a single municipality.



LEGEND

- River
- Stream
- Watershed Boundary
- Each Color Indicates a Separate Municipality

0 12,500 25,000 50,000 Feet

Author: John Oduroe

Figure I.5 The hydrology of Allegheny County, including lost streams in red.

Figure I.6 The major sub-watersheds of Allegheny County.

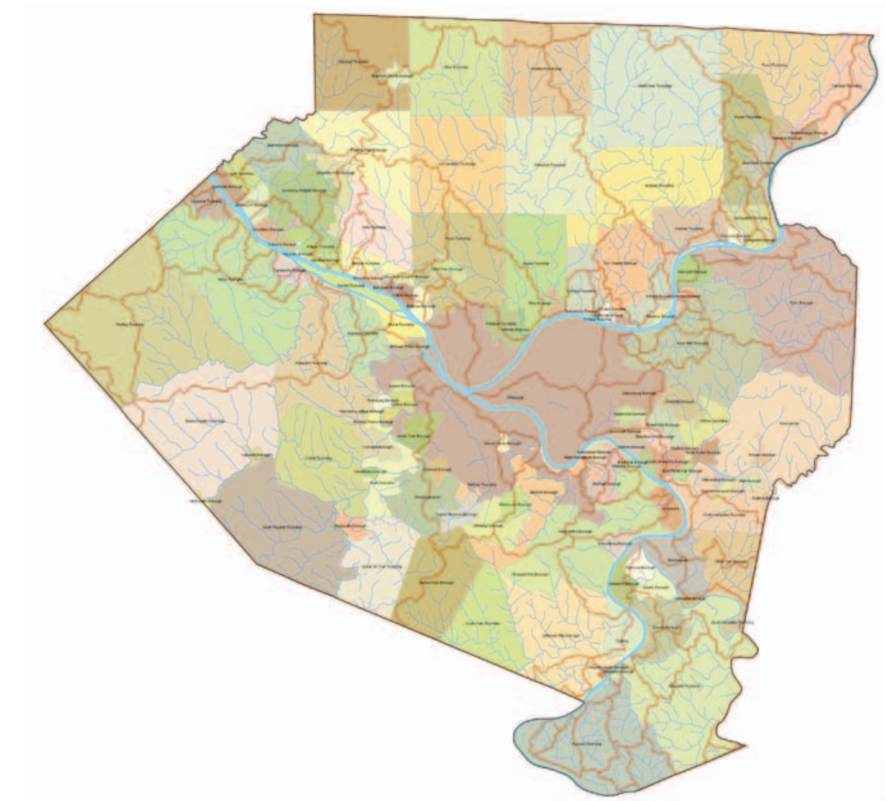


Figure I.7 The 130 separate municipalities of Allegheny County overlaid with the sub-watersheds.

Figure I.8 A wooded stream valley in close proximity to the urban environment. The neighborhood of Oakland is visible in the distance identifiable by the University of Pittsburgh's Cathedral of Learning tower. (Photo 3R2N)

ample. None of this is a problem until society and its municipal political interests begin to think about the zoning and regulation of riparian land (land along a river or stream). The management and oversight of natural ecosystems can be instigated by environmental benefits or environmental threats, the latter being particularly actionable on the basis of public safety. The former, primarily an aesthetic and emergent economic value, is more difficult to pursue due to the bias of the Pennsylvania courts. (See Cy Fox, on legal strategies for preserving and conserving land, p. 91-102)

In the small maps above, you can see the relationship between the natural watershed-based hydrologic boundaries of our regional streams and water ways and the boundaries of municipal government. In the first map, take notice of the streams marked in red—these are "lost streams" of Allegheny County. These are natural surface drainages that have been overwhelmed by the development of impervious surfaces typical of older urban development (modern construction methods retain stormwater on the development site) and, through a mixture of flooding and pollution, become enough of a public nuisance that they are placed underground in sewers. (And in turn, they become a primary component of our wet weather problem.) It is effective to look at the center map, and particularly the large watershed of Chartiers creek, bottom left which drains to the Ohio. Chartiers Creek is both a multi-state and multi-municipal watershed where upstream development adversely effects downstream communities that are close to the floodplain. The issue is not flood water, water is the effect. The issue is unrestrained development and its impact on hydrology and ecosystems, and the constraints of the political boundaries that we rely upon to manage development, public safety and the public good.

Map 1.4 Hydrological Overview: Watersheds & the Built Environment

On the following page, the map illustrates the concentrations of development in Allegheny County on a watershed basis. In the recently flooded (2004) watersheds of Chartiers Creek, Girtys Run, Pine creek and Streets Run, there is a high level of development in the municipalities located in the upper watersheds of these streams.

1.4 HYDROLOGICAL OVERVIEW: WATERSHED & THE BUILT ENVIRONMENT

Allegheny County is an extremely urbanized setting. The city of Pittsburgh is centered at the confluence of the three rivers. Early patterns of development followed the lowlands of the river and stream valleys. Much of the early development of the region was led by industrial uses sited along the river valley floodplains. Early major roads and railroads followed these valleys connecting towns and industrial sites. Early and mid twentieth century development expanded the neighborhoods of the city to the east and south. New highway infrastructure enabled recent major development to the west and north of the county in the last thirty years.

LEGEND

- River
- Stream
- Watershed Boundary
- Major State Road
- Road
- Railroad
- Building
- Woodland

0 12,500 25,000 50,000 Feet

Author: Jonathan Kline

Conclusions on the Urban Landscape

Human history is defined by the extraction of value from natural resources to support and promote the development of culture and its infrastructure—cities. Pittsburgh, more than most cities, and Allegheny County as a region have benefited enormously from the extraction of wealth from our natural resources and the use of the commons (air, water, soil) as sinks for industrial waste.

Water and air are ubiquitous public goods or commons that are not noticed until they are either missing or so significantly damaged that we see the immediate need to take action. This has been the case in the past with air quality. It is the case today as we awaken to the enormous economic opportunity of recreational use of the rivers and streams. Rivers and streams that, more often than not, continue to be the sink, or, to unequivocally clarify the metaphor, the toilet of the human wastes of the region. Black skies in the daytime were an overt indication of air pollution in our recent past. Flooding is another obvious indication of development problems, particularly flooding on streams that have a history of settlement in the floodplain or a history of hydraulic improvements that seem to work for a while, but not in perpetuity. Girty's Run is our best local example with improvement that began in the 1930's.

Like everything in life, there are limits. Yet our regional mind-set is one of aggressive development, without any sense of constraint. Growth is good, and environmental regulation is bad. The authors of this report agree that as a rule, growth is good, however we would add some golden rules to that obviously one-sided economic ideology.

I. Infrastructure is the cultural response to ecosystem failure.

II. Infrastructure designed to replace natural hydrological systems is expensive to construct, expensive to maintain and almost impossible to replace at the end of its natural life-cycle.

III. Nature is the best no cost / low cost system that we have. Green infrastructure has evolved over centuries and it sustains water quality and maintains historic flow patterns.

Figure I.9 Children playing in the river water on the Allegheny (Photo 3R2N)

II. The Demographic Context of Allegheny County

Looking at the 2000 Census Data

Allegheny County 2000 Census information was obtained from the Pennsylvania Spatial Data Clearinghouse, known as Pennsylvania Spatial Data Access, (or PASDA, www.pasda.psu.org.) According to their website, "PASDA is the official public access geospatial data clearinghouse for the Commonwealth of Pennsylvania." For the purpose of this report, social, economic and housing census data have been reorganized to fit the watershed scale in Allegheny County.

A Hydrology-Based Measurement

Typically census-based social and economic data are displayed in terms of "block groups" which is a subdivision of a U.S. census tract. A block group is the smallest geographic unit for which the Census Bureau tabulates sample data. Block groups generally contain between 250 and 550 housing units, with 600 to 3,000 people (see http://www.library.wisc.edu/guides/govdocs/census/geoalpha.htm).

Mapping census data to the scale of regional stream-watersheds is intended as a general tool to enable the readers of this report to correlate watershed specific ecological opportunities and impacts with relative income, ownership and population density. If a stream is heavily impacted by urban sewage for instance, a high level of home ownership and median income would indicate a context in which the problem has good potential for resolution. In turn, a stream-watershed with significant impacts and low income and low home-ownership may very well necessitate state and federal support mechanisms that the previous example would not. In the case of a stream with a healthy ecology and the land-use characteristics that support sustained health, it makes good economic sense for the rich and poor alike to protect natural "green infrastructure" systems. Natural green infrastructure exists without costly human investment in the infrastructure and treatment systems that protect the environment from human impact. Forested lands, natural streams and floodplains that are protected from development insure long term water quality and manage water quantity in a manner that is economically efficient, culturally sustainable and aesthetically pleasing. Natural infrastructure buffers human impact on the landscape, up until the point of significant failure. It is at that point that municipalities need to make costly investments in engineered infrastructure systems to support dense human populations. Understanding the social, economic and ecological characteristics of each of the stream-watersheds of Allegheny County helps us understand where ecosystems services actually occur, who has the best environmental quality in the region, which in turn translates into the potential for public involvement to seek environmental equity in access, health and ecosystem services.

Map 2.1 Population Density: Watershed and Block Group

Population density in a watershed can indicate two things. First, the likelihood of human impact on natural ecosystems, particularly water quality in areas where surfaces drain to open streams. Secondly, the potential for human investment in water quality, especially where it provides recreational, and aesthetic benefits which are proven drivers of housing value and economic regeneration when such benefits are available in an urban setting.

Map 2.2 Median Income: Watershed and Block Group

Is it any surprise that the two communities (Fox Chapel and Sewickley) with the highest income are also the areas with the highest environmental and ecological quality? Does it come as any surprise that the communities with the most environmental challenges along the Monongahela River are also the lowest income communities? An important ecological opportunity exists in the Streets Run Watershed, a site that is currently being targeted for intensive U.S. Army Corps of Engineers investment in stormwater infrastructure to replace a failing ecosystem overwhelmed by improper upstream development. The differences between the have and the have-nots would appear to be the ability to sustain low cost green infrastructure in the face of housing needs and development interests.

Figure II.1 Onboard a 3 Rivers 2nd Nature River Dialogue (Photo 3R2N)

2.1 POPULATION DENSITY BY WATERSHED

Map is based on U.S. census 2000 summary file 3 data. Figures represent the total population of the watershed or blockgroup normalized by the watershed or blockgroup acreage.

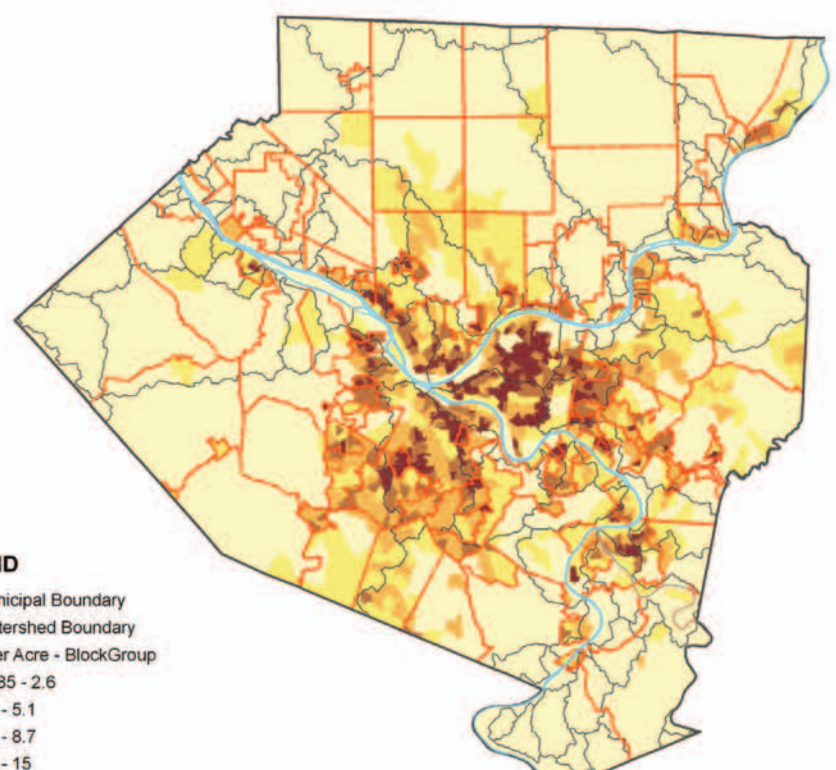
LEGEND

- Rivers
- Watershed Boundary
- Municipal Boundary

People per Acre - Watershed

- 0.075 - 0.88
- 0.89 - 1.8
- 1.9 - 3.2
- 3.3 - 5.4
- 5.5 - 9.8

POPULATION DENSITY BY BLOCK GROUP

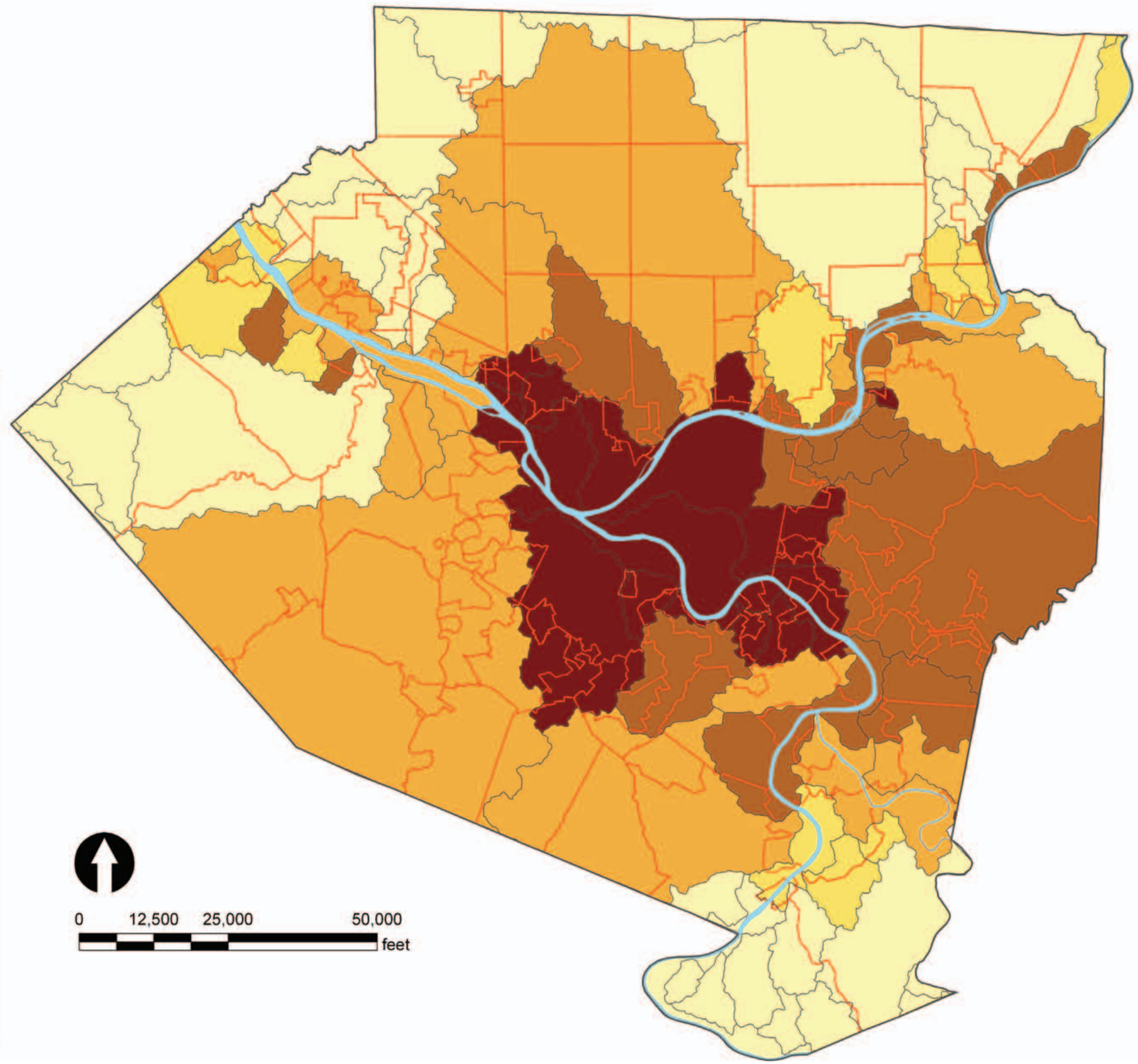


LEGEND

- Municipal Boundary
- Watershed Boundary

People per Acre - BlockGroup

- 0.085 - 2.6
- 2.7 - 5.1
- 5.2 - 8.7
- 8.8 - 15
- 16 - 150



Authors: John Oduroe & Jonathan Kline

2.2 MEDIAN INCOME BY WATERSHED

Map is based on U.S. census 2000 summary file 3 data. Figures represent the median yearly household income within a watershed or blockgroup.

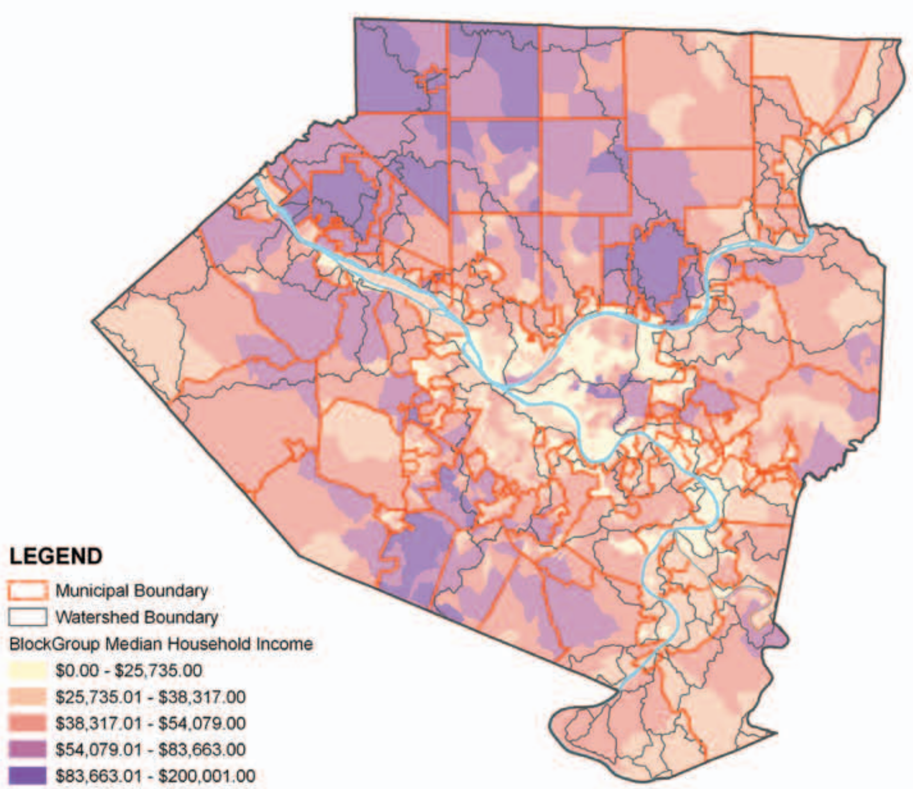
LEGEND

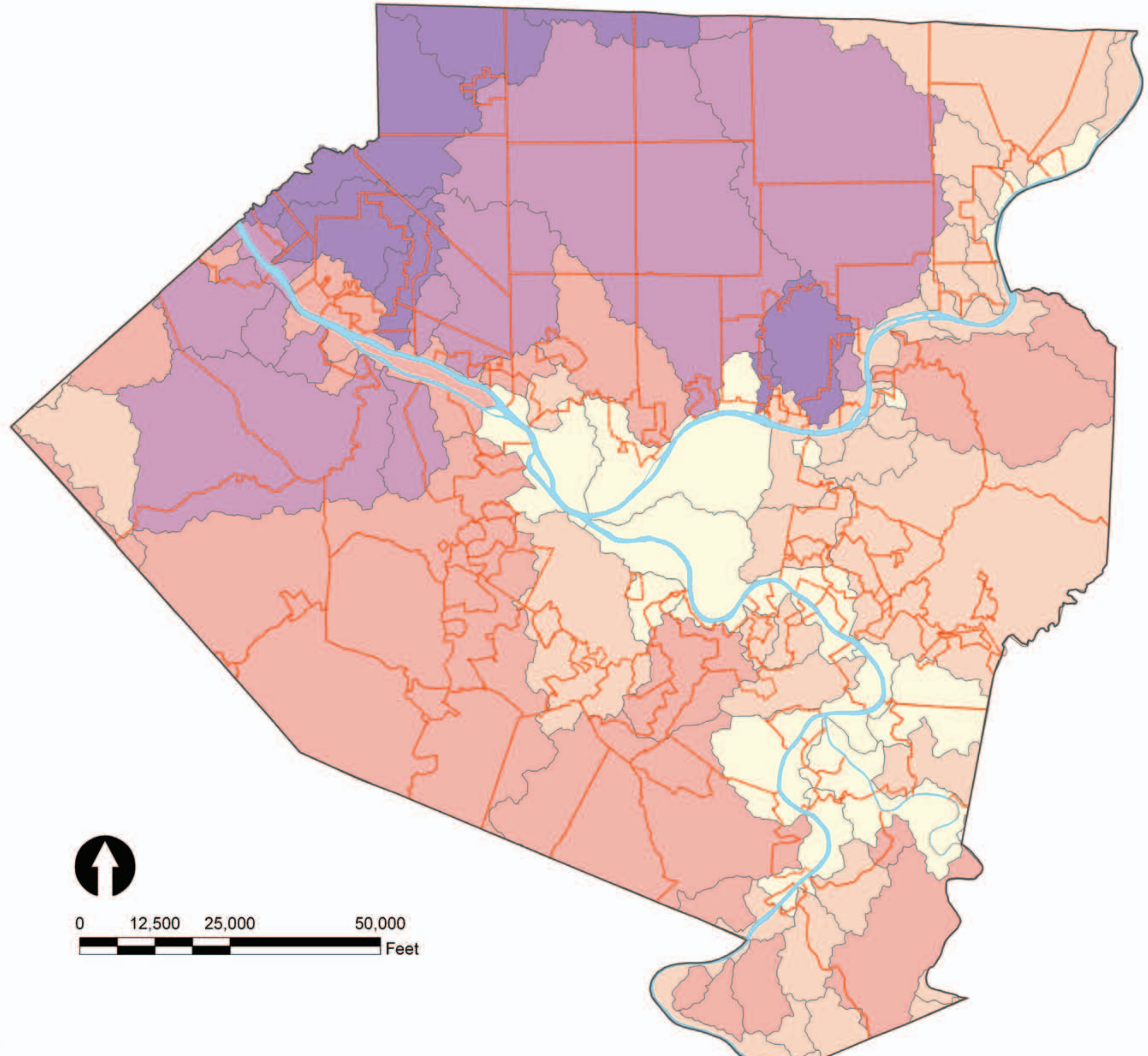
- Rivers
- Municipal Boundary
- Watershed Boundary

Median Household Income of Watershed

- $25,859 - $32,647
- $32,647 - $39,878
- $39,878 - $47,505
- $47,505 - $63,687
- $63,687 - $115,314

MEDIAN INCOME BY BLOCK GROUP





Author: John Oduroe & Jonathan Kline

Housing Conditions in the County

Allegheny County sprawls outward from the city of Pittsburgh. Map 2.1 shows population density decreasing the further you get away from the city. Map 2.2 shows significant economic strength to the north and west, with significant weakness in the south along the Monongahela River. It is in the north and the west that the region is seeing the most significant growth and development; development that is radically altering the hydrological characteristics of the land, adding significant infrastructure costs and creating downstream flooding problems for the riverfront communities that are not benefiting from development in the hills. To the south, new housing is relatively nonexistent and an array of nonprofit and municipal interests continue to pursue the ideals of a neo-industrial economy.

Map 2.3 Vacant Housing Units: Watershed and Block Group

Roads, railways and highway infrastructure, as a result of the historic industrial mindset, have been developed along the historic floodplains of Allegheny County. The river towns which might, under a different scenario, provide a significant opportunity for pleasant, yet dense urban development are the sites of the most significant vacancies in the region. The Monongahela and Allegheny River corridors continue to be the sites of dilapidated industrial infrastructure, up to six railways lines per river bank with roadways being planned, extended or widened through these regions daily. Riverfront housing, or housing that is proximate to the rivers, is not, nor has it been, a valuable commodity during the last century. As a result, there are many vacant properties along our rivers.

Map 2.4 Rented Housing Units: Watershed and Block Group

Rental housing is most significant in the city, then it moves along the rivers and into the south hills and east hills. The north hills, with significant housing, shows the least amount of rental stock. Homeowners have been moving away from the rivers and the city. It is the low priced wooded hills that are the primary target of development and development support.

Map 2.5 Owned Housing Units: Watershed and Block Group

This map shows two variations: mapping by watershed and mapping by block group. The latter shows the true distribution of owned properties in the county. The former gives us a sense of the watersheds which have strong communities of home owners. The patterns are familiar with home ownership strengths to the north and west, and weaknesses to the south and east, and along all three rivers.

Meanwhile, housing prices on the southside of Pittsburgh have begun to soar. The South Side Riverfront Park provides the best public access to the river that the city has, and nonprofit waterfront groups assure the development of trails and other access amenities through some of the most difficult historic land use areas. There are obvious models along the Allegheny River as well; from Washington's Landing to new development and land fill along the mouth of Squaw run, which drains Fox Chapel. The former provides environmental benefit to the region by cleaning up a brownfield site and providing housing and recreational access amenities. The latter fills a remnant wetland to create new housing in proximity to the Fox Chapel Yacht Club.

Figure II.2 Occupied houses in the Nine Mile Run Watershed. (Photo 3R2N)

Figure II.3 A vacant building on Braddock Ave. in Braddock, PA being torn down due to wind damage sustained hours before. (Photo 3R2N)

2.3 VACANT HOUSING UNITS BY WATERSHED

Map is based on U.S. census 2000 summary file 3 data. Percentages represent the proportion of vacant housing units within a watershed or blockgroup.

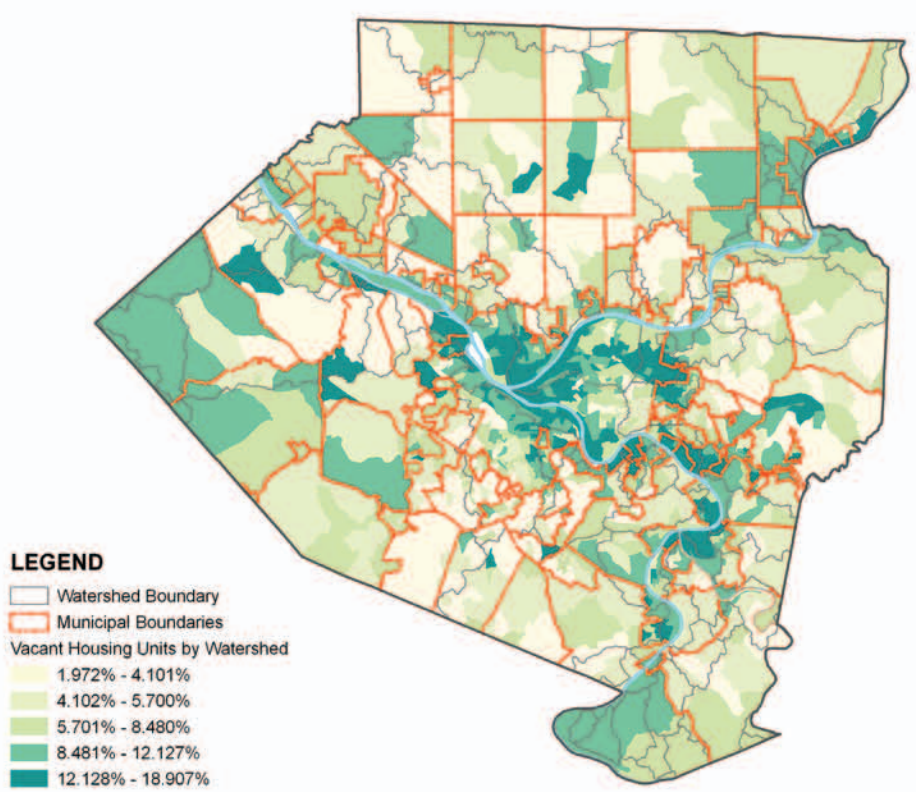
LEGEND

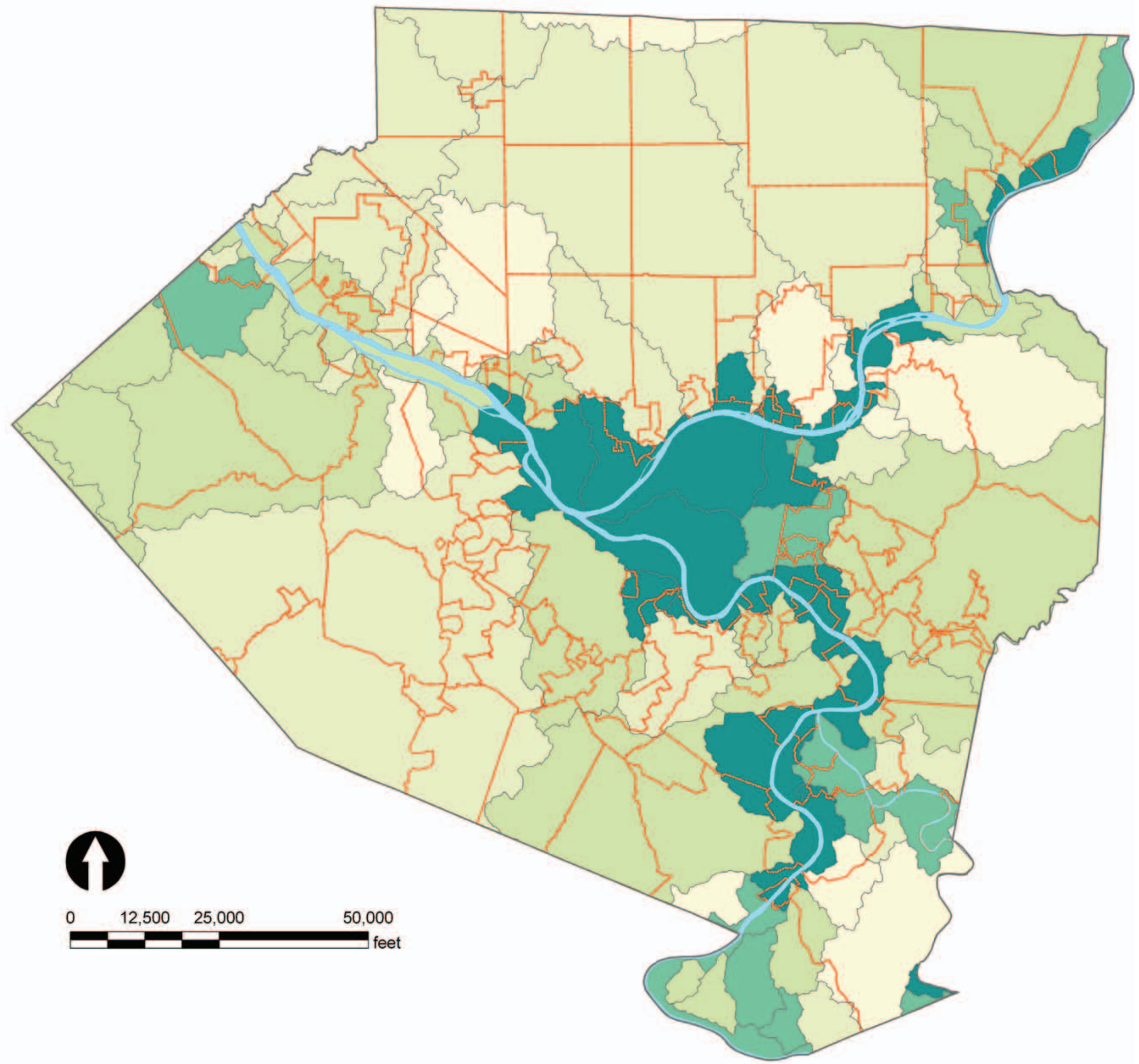
- Rivers
- Municipal Boundaries
- Watershed Boundary

Vacant Housing Units by Watershed

- 1.972% - 4.101%
- 4.102% - 5.700%
- 5.701% - 8.480%
- 8.481% - 12.127%
- 12.128% - 18.907%

VACANT HOUSING UNITS BY BLOCK GROUP





Author: John Oduroe & Jonathan Kline

2.4 RENTED HOUSING UNITS BY WATERSHED

Map is based on U.S. census 2000 summary file 3 data. Percentages represent renter occupied proportion of total housing units in a watershed or blockgroup.

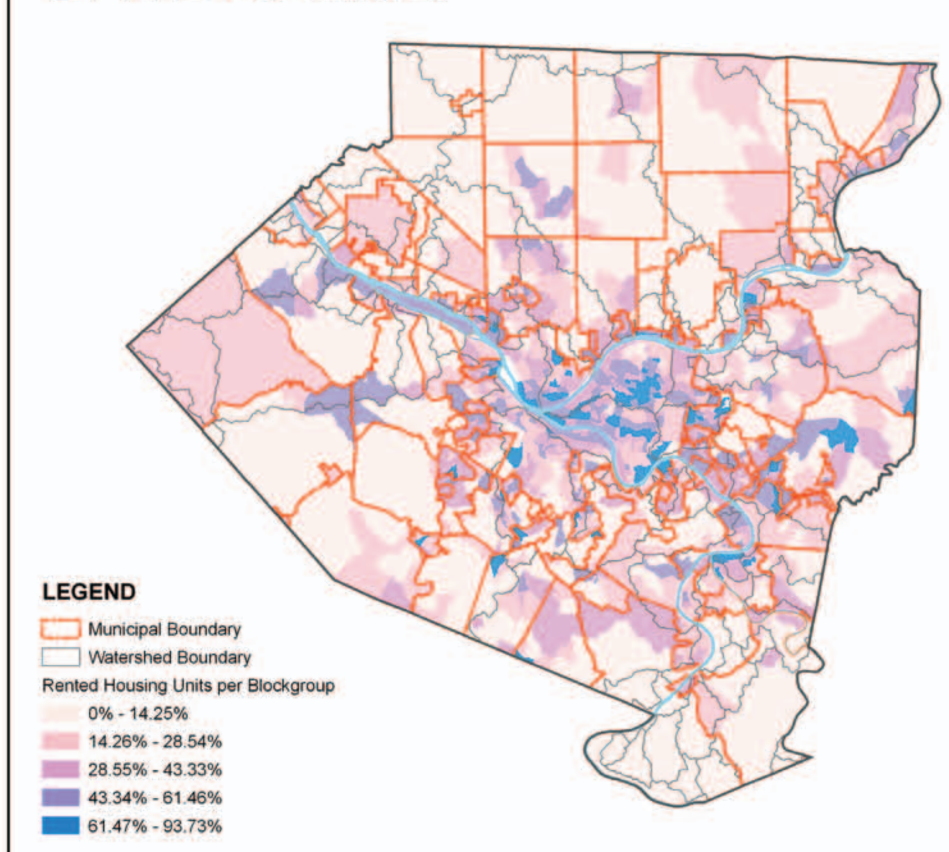
LEGEND

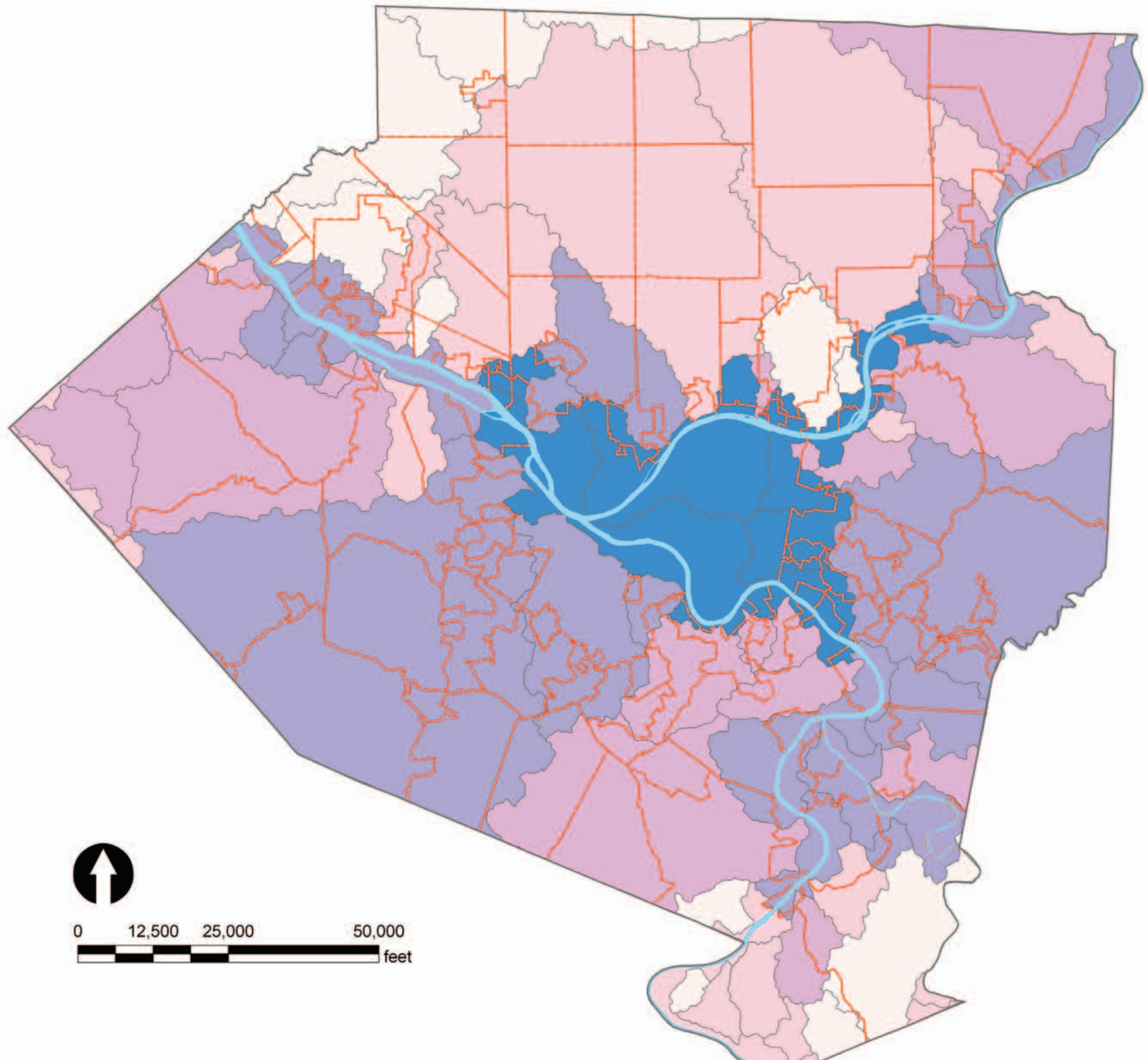
- Rivers
- Municipal Boundary
- Watershed Boundary

Percentage of Rented Housing units by Watershed

- 2.439% - 10.352%
- 10.353% - 17.122%
- 17.123% - 25.193%
- 25.194% - 37.844%
- 37.845% - 57.186%

RENTED HOUSING UNITS BY BLOCK GROUP





Author: John Oduroe & Jonathan Kline

2.5 OWNED HOUSING UNITS BY WATERSHED

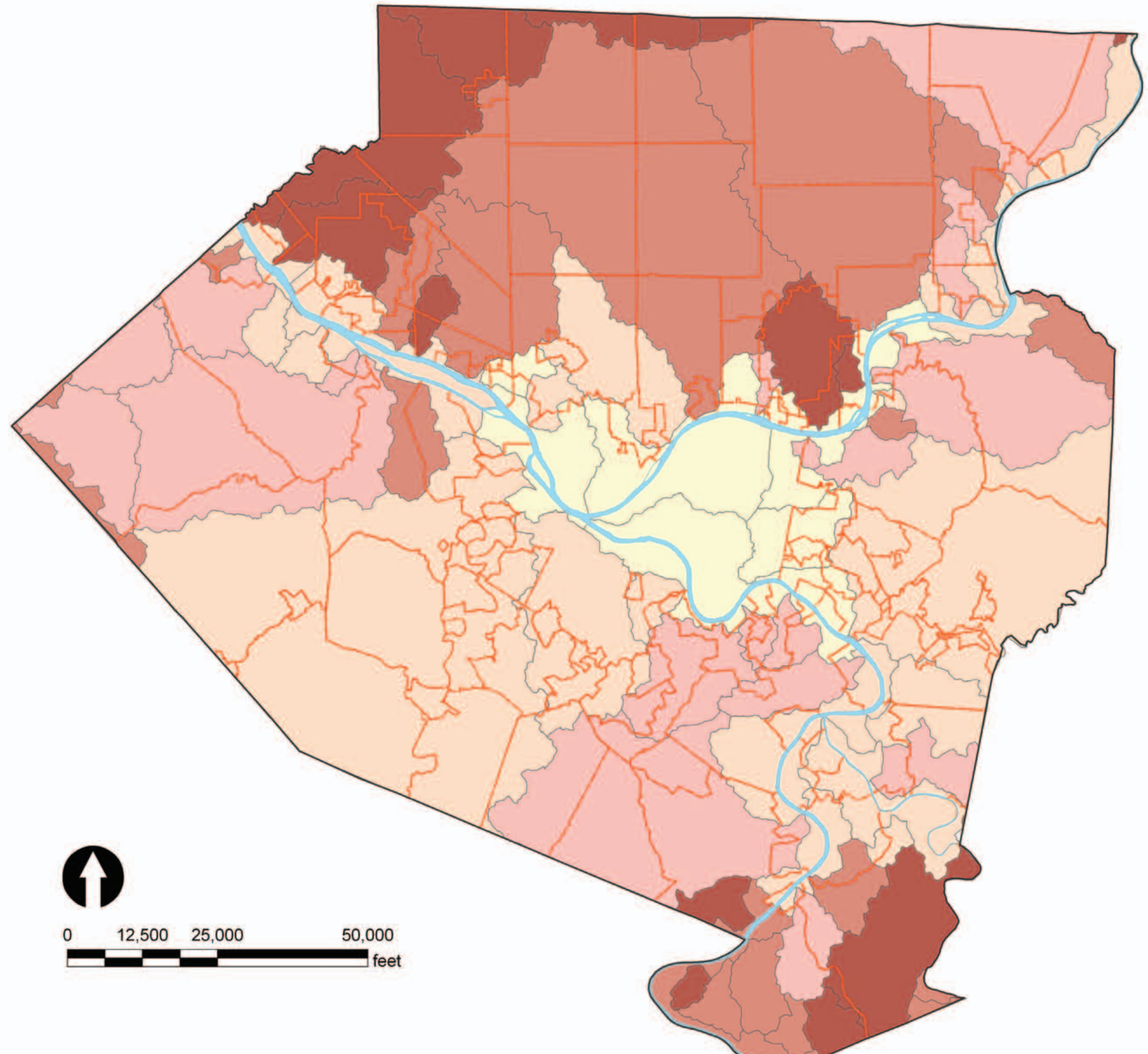
Map is based on U.S. census 2000 summary file 3 data. Percentages represent the proportion of owned housing units within a watershed or blockgroup

LEGEND

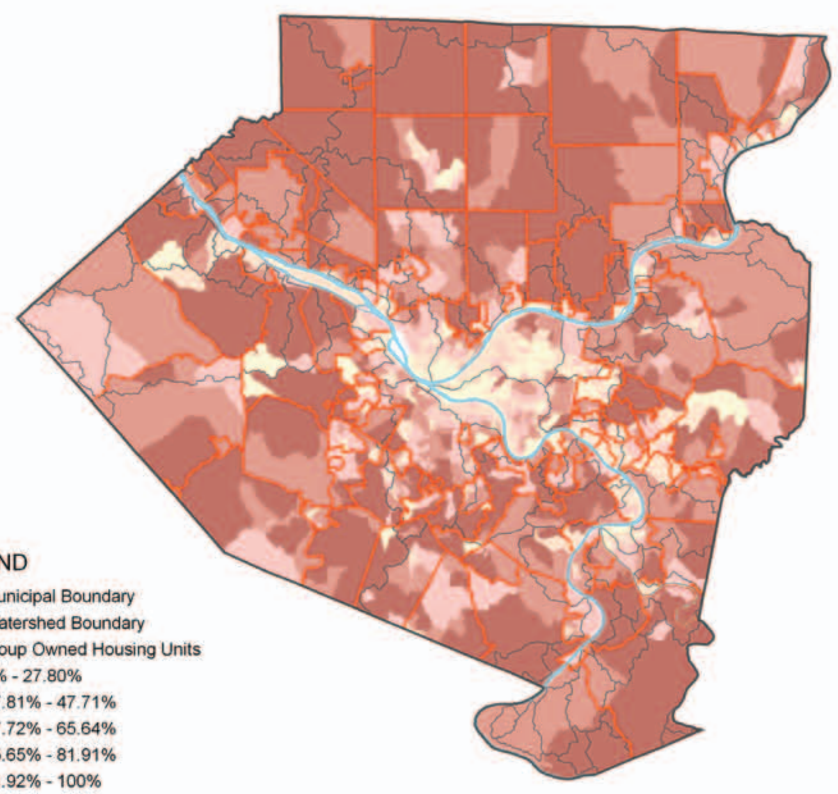
- Rivers
- Watershed Boundary
- Municipal Boundary

Owned Housing Units by Watershed

- 42.81% - 58.82%
- 58.83% - 73.94%
- 73.95% - 81.91%
- 81.92% - 88.90%
- 88.91% - 97.56%



OWNED HOUSING UNITS BY BLOCK GROUP



LEGEND

- Municipal Boundary
- Watershed Boundary

BlockGroup Owned Housing Units

- 0% - 27.80%
- 27.81% - 47.71%
- 47.72% - 65.64%
- 65.65% - 81.91%
- 81.92% - 100%

Author: John Oduroe & Jonathan Kline

Parks and Managed Open Space in the County

Parks and open spaces are an important element of any urban setting. New York, Washington and San Francisco are just a few of the major cities in the United States that have organized themselves around their public space and open space amenities. Our greatest public space amenity is our rivers. Yet parks and open space in the region have primarily developed on the plateaus and hills high above the river.

Map 2.6 Parks, Trails & Managed Open Space

Here we see the official map of managed open spaces provided by municipal, county and state government.

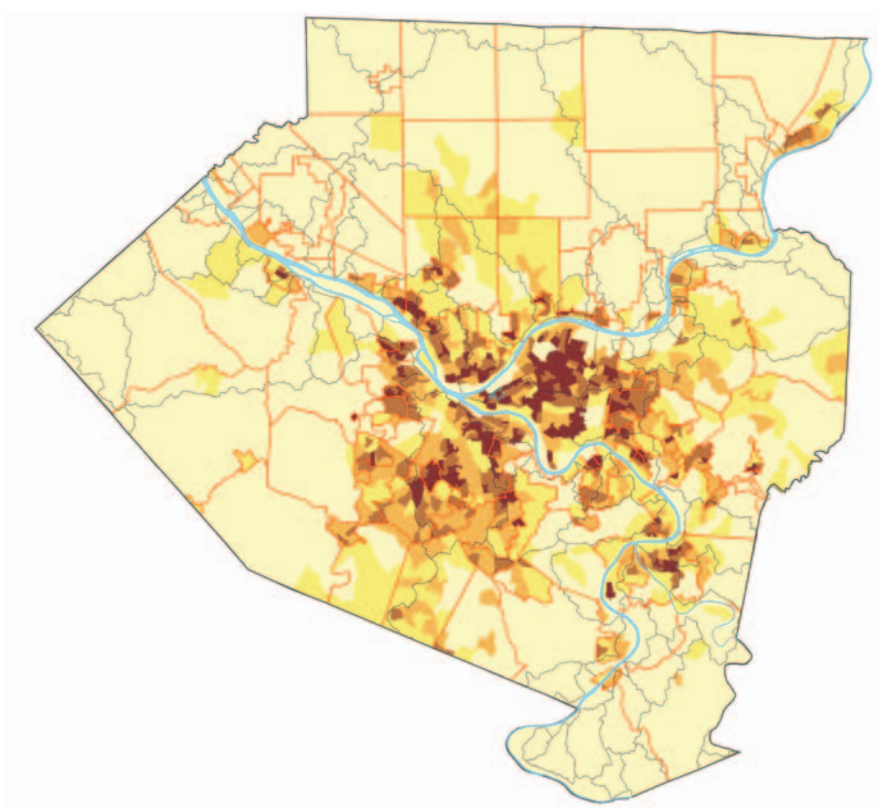


Figure II.4 Allegheny County population density in 2000 shown by census block group.

Map 2.7 Parks & Managed Open Space Per Capita

We begin to get a picture of human access to nature throughout the county by dividing the open space in each watershed by number of people living there. The river corridors have always been used for industrial development, and in this period of recovery not a single one of the long vacant properties has been turned into a dedicated public space. Would a new significant riverfront park in the Monongahela River Valley support the economic rebirth of that region? Good question, with no one working on the answer.

In places like Oakmont, along the Allegheny River, industrial development interests have seen fit to bury a significant remnant Plum Creek floodplain under six feet of rubble. One can only assume that the adjacent—empty—brownfield property simply did not supply enough available land to attract redevelopment.

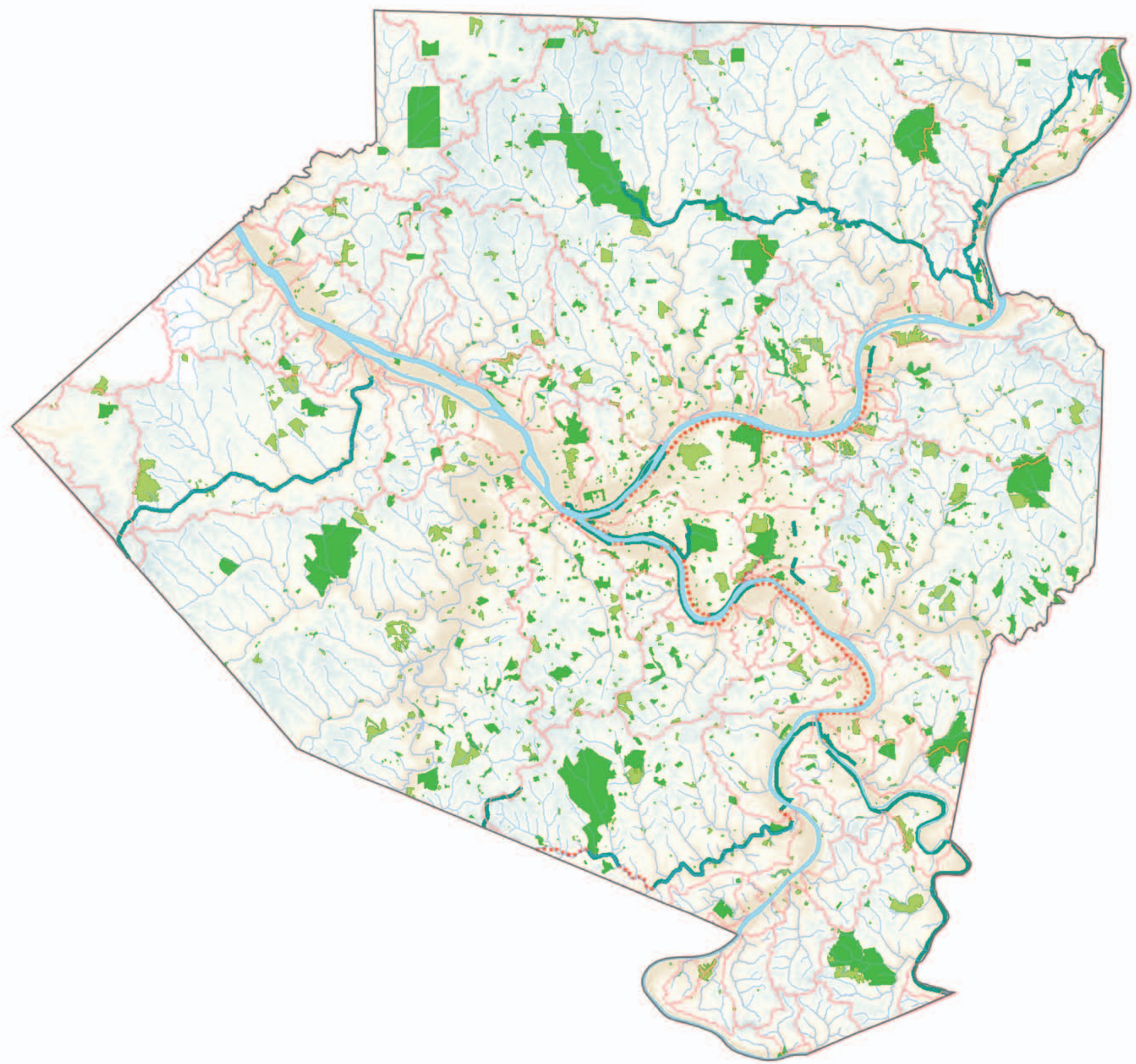
Managing open spaces, in many cases, is not an issue of limiting development, but instead an issue of land planning, of land use regulation and enforcement systems, and extremely powerful neo-industrial interests that are committed to complete autonomy in their development interests.

Following these maps, it is easy to see both the desire and amazing opportunities for regional waterfront parks on all three rivers. The following section will discuss the ecological potential of the region.

Figure II.5 A silver maple in Frick Park. (Photo 3R2N)

2.6 PARKS, TRAILS & MANAGED OPEN SPACE

Allegheny County contains a variety of parks large and small, across the county. Parks are owned and managed at municipal, county and state levels. The county also has a growing network of trails, most of which are conversions of rail beds along the rivers. In addition to public parks, the county has a variety of other managed open spaces such as athletic fields, cemeteries, golf courses, etc.



LEGEND

- River
- Stream
- Watershed Boundary
- Parks
- Managed Open Space

Trails

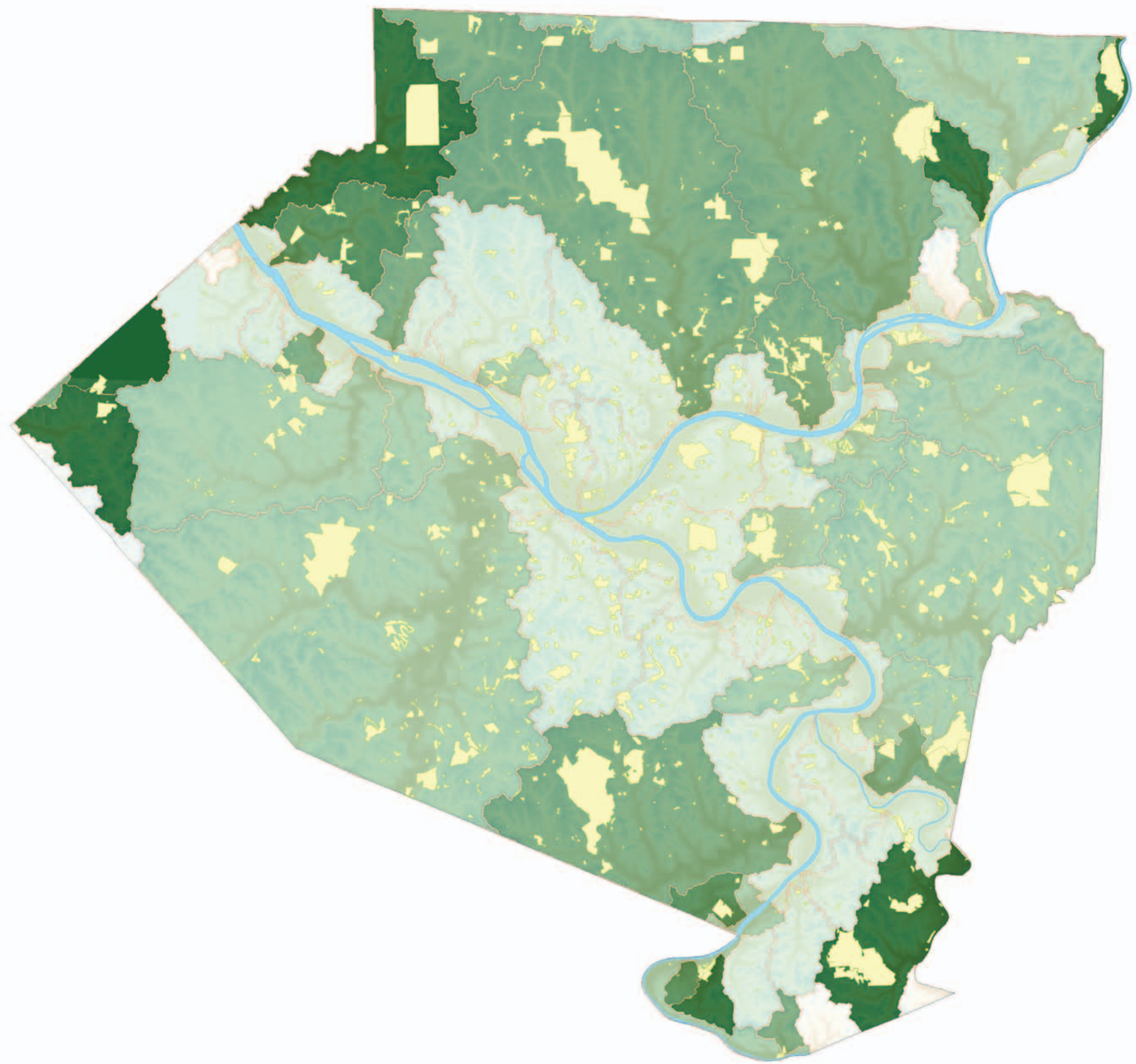
- Existing
- Proposed

0 12,500 25,000 50,000 Feet

Author: Lena Andrews, Jonathan Kline

2.7 PARKS & MANAGED OPEN SPACE PER CAPITA

For each watershed the total area of open space was calculated and divided by the total population of the watershed yielding acres of open space per capita for each watershed.



LEGEND

River

Parks & Manged Open Spaces

Acres of Open Space per capita by Watershed

0.000 - 0.015 acres/person

0.016 - 0.040 acres/person

0.041 - 0.101 acres/person

0.102 - 0.209 acres/person

0.210 - 0.432 acres/person

0 13,000 26,000 52,000 Feet

Author: Lena Andres and Jonathan Kline

III. Woodland Watershed Analysis

Woodland Watershed Analysis in Allegheny County

Allegheny County is rich in natural resources. Settlement of the region was founded on the intensive extraction and use of the many resources found here. As the population of Pittsburgh and the surrounding area grew, land was cleared for industrial, commercial and residential development. The human use and abuse over the last several centuries of the county's ecosystems and resources have altered them forever; but the natural communities of the county are now in a state of growth and recovery (Western Pennsylvania Conservancy 1994).

According to the Terrestrial Ecoregions of North America, Allegheny County is located in Appalachian Mixed Mesophytic Forest, which "harbor the most diverse temperate forests in North America." The Appalachian Mixed Mesophytic Forest Ecoregions has been identified as globally outstanding and requires immediate protection and restoration (Ricketts et al. 1999). Southwestern Pennsylvania is also considered a "hot spot" or area of immediate conservation or concern for a number of neotropical migratory bird species (Rosenberg and Wells 2004).

The vegetation found in county is quite diverse because of the region's topography and varied geology. While the county contains many natural communities, this analysis is focused on the forested or woodland areas of the county. The forests of Allegheny County have been characterized by a number of sources (See Table *3.1*).

An overview of some of the above mentioned these classifications and their respective descriptions of the county are discussed in the Allegheny County Natural Heritage Inventory. The Natural Heritage Inventory uses the classification of natural communities defined by Smith (1983) and is summarized here.

Characterization of Forest in Allegheny County	Source
Mixed Mesophytic Forest Region	Braun 1950*
White Oak Association - upland areas Sugar Maple-Beech Climax Associations – floodplains & lower slopes	Jennings 1927*
Oak – Tulip Tree Forest Region	Lull 1968*
Mesic Central Forest Northern – Hardwood Conifer Forest Dry – Mesic Acid Forest Floodplain Forest	Smith 1983*
Appalachian Oak Forest	Utech 1989

*Summarized from Allegheny County Natural Heritage Inventory

Table 3.1 Characterization of Forest in Allegheny County

Figure III.1 Sycamore Island on the Allegheny River (Photo 3R2N)

Four forest communities were identified in the county using Smith's classification. The Mesic Central Forest community is generally found on slopes and uplands. Dominant species in this community include sugar maple, white oak, red oak, hickories, American beech, American basswood and white ash. Northern-Hardwood Conifer Forest is commonly located on cool, moist slopes dominated with species of hemlock, maple and birch. Dry - Mesic Acidic Forest is on uplands and south facing slopes, in the presence of dry acidic soils with oaks and hickories dominating. The last forest community identified was Floodplain Forest. This community is located at the bottomlands along rivers and streams where species such as eastern sycamore, silver maple, cottonwood, box elder and black willow are commonly found (Western Pennsylvania Conservancy 1994).

Methodology

The hydrology of the area has defined the county's current landscape of valleys and steep hillsides. The complex drainage pattern of the county has driven development and settlement patterns. Many of the woodland areas that exist in the county are located in areas where development is not possible. The Woodland Watershed Analysis presented here is a watershed level analysis[1]. The watershed level allows us to evaluate woodland patches and potential associations among woodland patches and streams at a scale relative to the county's complex local drainage patterns.

The data used is this analysis is from Allegheny County. In 1992 Allegheny County mapped the woodland areas in their jurisdiction to the detailed scale of 1:2400. This data does not provide information related to species composition or potential habitat quality. It does provide an opportunity to take a comprehensive look at the size, shape and location of woodland patches in Allegheny County. Given the limitations of the available data, the purpose of the Woodland Watershed Rating Analysis is to characterize and rate the county's woodland areas by watersheds based on landscape metrics and proximity of these woodland patches to streams and to each other.

A Total Woodland Watershed rating for each watershed was calculated based on the cumulative score of three values: a woodland area score, a stream analysis score, and a landscape metric score. These scores attempt to quantify the following:

[1] It should be noted that the data used in this analysis are limited to the extent of county boundary. Therefore in some cases the analysis does not provide a full evaluation of the entire watershed.

Figure III.2 Inside a woodland patch near the Monongahela River (Photo 3R2N)

- Size and amount of total woodland and interior woodland areas
- Mean shape of the patches in the watershed and isolation based on their mean patch proximity
- Contiguousness of woodlands along the streams and percentage of woodland areas near streams

Woodland and Interior Patches

Interior forest habitat is critical in maintaining populations of many organisms by providing stable, valuable sources of food and cover. The forest edge differs from the forest interior in its microclimate, vegetation and species present. The more edge a forest patch has the less likely an interior species will be found within it and more likely wildlife generalist will be present. Wildlife generalists have broader niche requirements than specialist species. Edge is increased as patches become more fragmented. Increasing edge habitat may alter community dynamics in several ways including:

- Altering species movement patterns (facilitating movement or limiting it)
- Increasing edge related mortality (e.g. change in microclimate from interior to edge may affect the survival of seedlings)
- Changing competition interactions (e.g. edge generalist out competing interior specialist in high quality habitat that is located near the edge; as edge area increases the amount of competition between these species increases) (Fagan, Cantrell and Cosner 1999)

In general, as habitat area increases so does species richness. While the reasons for this are likely caused by many factors, a simple explanation is that as habitat area increases so does the diversity of resources and microhabitats (Meffe et al. 1997). The largest woodland patches in the county generally contain more interior habitat and less edge proportionally, and are more likely to support a more diverse range of species than smaller patches.

For this analysis, interior or core forest was defined as the forest area approximately 100 meters from the edge of forest patch (Moyer 2003). Based on this definition of interior forest, less than half the forests of Pennsylvania are considered interior forest; most are privately owned and occur in small blocks (Moyer 2003). Woodland patches were classified into two size classes: 250 acres and larger, and less than 250 acres. These categories were based on avian studies and serve to define a category of large woodland patches. Studies have shown that the number of individuals and diversity of neotropical migrants dramatically drops in forest patches smaller than 250 acres or approximately 100 hectares. (Robbins et al. 1989 and Askins 2000).

Map 3.1 Woodland & Interior Patches

Map 3.1 displays woodland, interior patches and their respective watersheds. The percentages of woodland area per watershed, interior forest and woodland areas that are 250 acres and above were calculated for each watershed. Each of these three calculations was multiplied by 100 to standardize them to whole numbers. These three values were summed for each watershed for a Total Woodland Area value. See Appendix A for each watershed's scores. Watersheds with patches 250 acres and above, interior forest and large amount of wooded areas relative to the size of the watershed were valued higher than watershed with little interior forest, small woodland patches and fragmented or little woodland areas.

The watersheds on the edge of the county contain woodland patches that are larger and appear to be less fragmented than those watersheds in the center of the county. The center of the county is the most urban area of the county, and includes the City of Pittsburgh. Few watersheds contained patches 250 acres and above. Along the first order drainages of the Ohio, Allegheny and Monongahela Rivers the scores were low, which again is not surprising considering the urban and industrial development patterns for the region and the location of the City of Pittsburgh. The Youghiogheny scored higher than the three major rivers in the county.

On average watersheds within Allegheny County contain 39% woodland areas, 6% woodland patches of 250 acres or more and 13% interior forest. Whitaker Run scored the lowest for this section of the analysis, while the following watersheds scored as the top 10 watersheds: Days Run, Thorn Run, Toms Run, Perry Mill Run, Pucketa Creek, Big Sewickley Creek, Little Sewickley Creek, Boston Hollow, Crawford Run, Flaugherty Run and Bulls Run.

3.1 WOODLAND & INTERIOR PATCHES

All county woodlands rated by size shown with areas of interior forest.

Author: Kostoula Vallianos

Figure III.3 A Beaver dam along Fallen Timber Run (Photo 3R2N)

Stream Analysis

Stream function and structure is directly affected by the land use and condition of the surrounding watershed (Snyder et al. 2003). Sediment, bacteria, nutrients and metals are the leading pollutants identified by the USEPA (2000) as threatening our waterways. One of the major sources of these pollutants is urban runoff via storm sewers. Snyder et al. (2003) found that urban land uses were more disruptive to biological integrity of streams than other land uses, with the effect being even more significant in catchments with steeper slopes than catchments with less of a gradient.

Riparian areas are an interface between terrestrial and aquatic systems. The plant communities found in the riparian zone have been shown to provide many ecological functions including improving water quality. Specifically, riparian plant communities improve stream bank stabilization, reduce sedimentation, remove chemicals, moderate the temperature of the waterway and reduce particulate matter (National Council for Air and Stream Improvement 2000, Gregory et al. 1991). Riparian vegetation also provides habitat for a large variety of plant and animal species, and contributes organic matter for a number of species. These communities have also been documented to be habitat components that promote faunal movement, gene flow, and serve as habitats for animals either outright or during disturbance in adjacent habitats (Fischer and Fischenich 2000; Gregory et al. 1991). Not surprisingly, continuous riparian buffers and corridors are more effective for water quality improvements, moderating stream temperatures and wild life movement than fragmented wider ones (Weller, Jordan and Correll 1989).

Map 3.2 Riparian Woodland Patches and Map 3.3 Riparian Woodland Contiguity

Maps 3.2 and 3.3 illustrate woodland patches that are near riparian areas and woodland contained within 100 meters of the streams. The purpose of these maps is to begin to quantify how spatially connected woodland areas are to streams in the county. These specific questions were examined:

- Are the woodland patches located near the rivers and streams?
- Are the woodland areas contiguous along the rivers and streams?
- How much woodland of each watershed is located near the rivers and streams?

For both maps, the woodland and interior patches were defined in the same manner as described in for Map 3.1. In addition, each existing stream was buffered by 100 meters, a minimum width recommended for neotropical migrants and area sensitive avian species (Fischer and Fischenich 2000). The 100 meters buffer is sufficient to cover the 100-year FEMA floodplain and some upland area. This buffer is not recommended for streams in Allegheny County, but merely serves as a way to evaluate the amount and contiguousness of woodland near the streams.

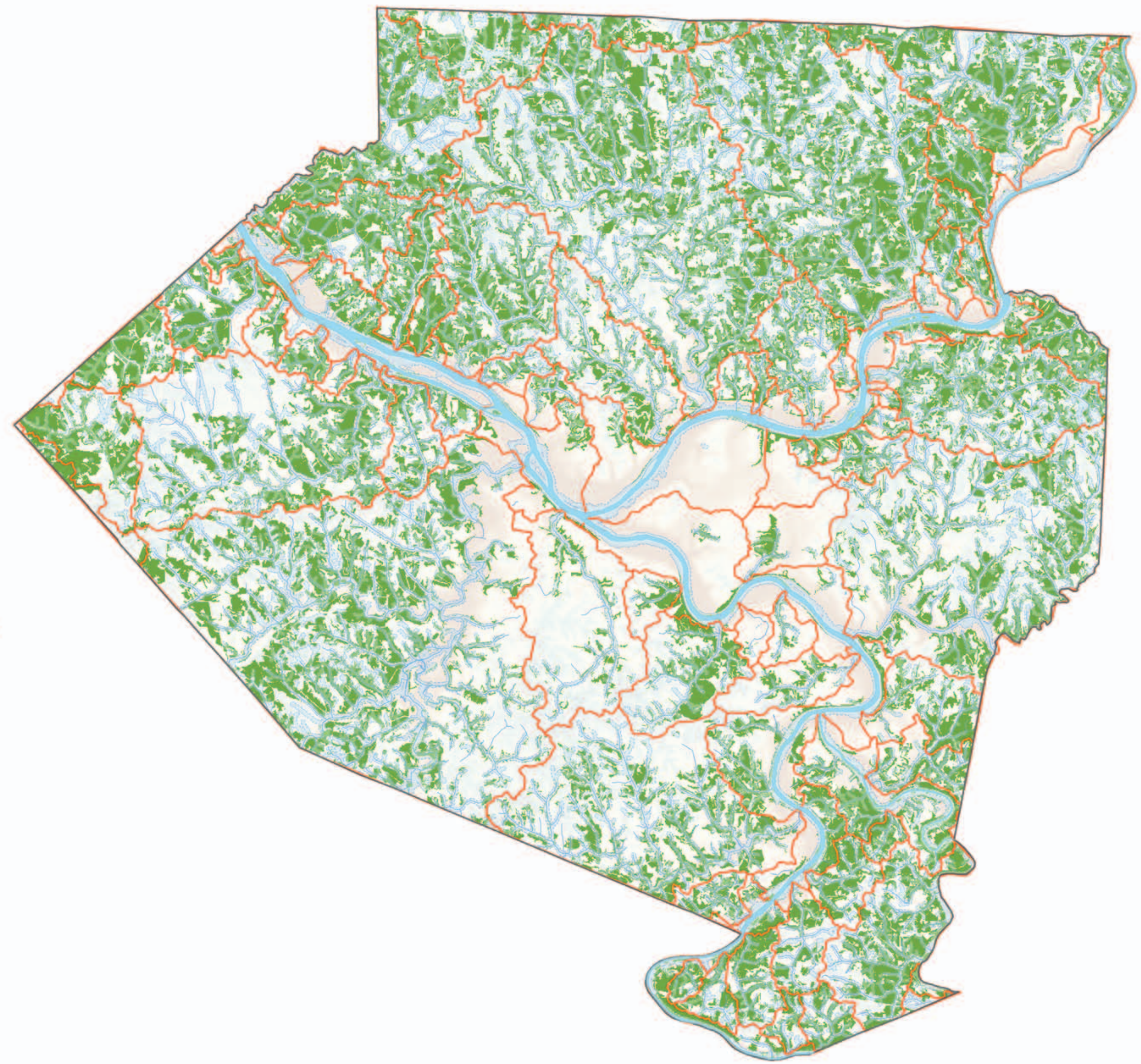
For each watershed, the percentage of woodland that occurs within 100 meters of a stream and the percentage of riparian buffer that contained woodland was calculated. The percentages were each multiplied by 100 to normalize them to whole numbers. Scores for each watershed can be found in Appendix B. The scores were then summed together to provide a total Stream Analysis Score.

Figure III.4 A woodland patch in the Monongahela Valley.

Along the edges of the county, and in watersheds north of the Allegheny and Ohio Rivers, the stream areas are much more wooded than in and around the City of Pittsburgh or south of the Monongahela River (southern suburbs). The original drainage pattern has been altered dramatically in and around the City of Pittsburgh. Most streams in the city limits are underground or contained with culverts (Pinkham 2002). On average 86% of the woodland areas in Allegheny County are within 100 meters of streams and 46% of the 100 meter stream buffer contains woodlands. Within Shades Run watershed, 93% of the stream buffer contained woodlands and 89% of the woodlands in this watershed were near streams. West Run scored the lowest for woodlands near the streams and also had a low score for woodlands within 100 meters of streams. As expected, the major rivers all had low scores for this analysis. The industrial development of the region was focused near the rivers. In addition, the river valleys of the county are some of the flattest areas of the region and were likely developed first.

3.2 RIPARIAN WOODLAND PATCHES

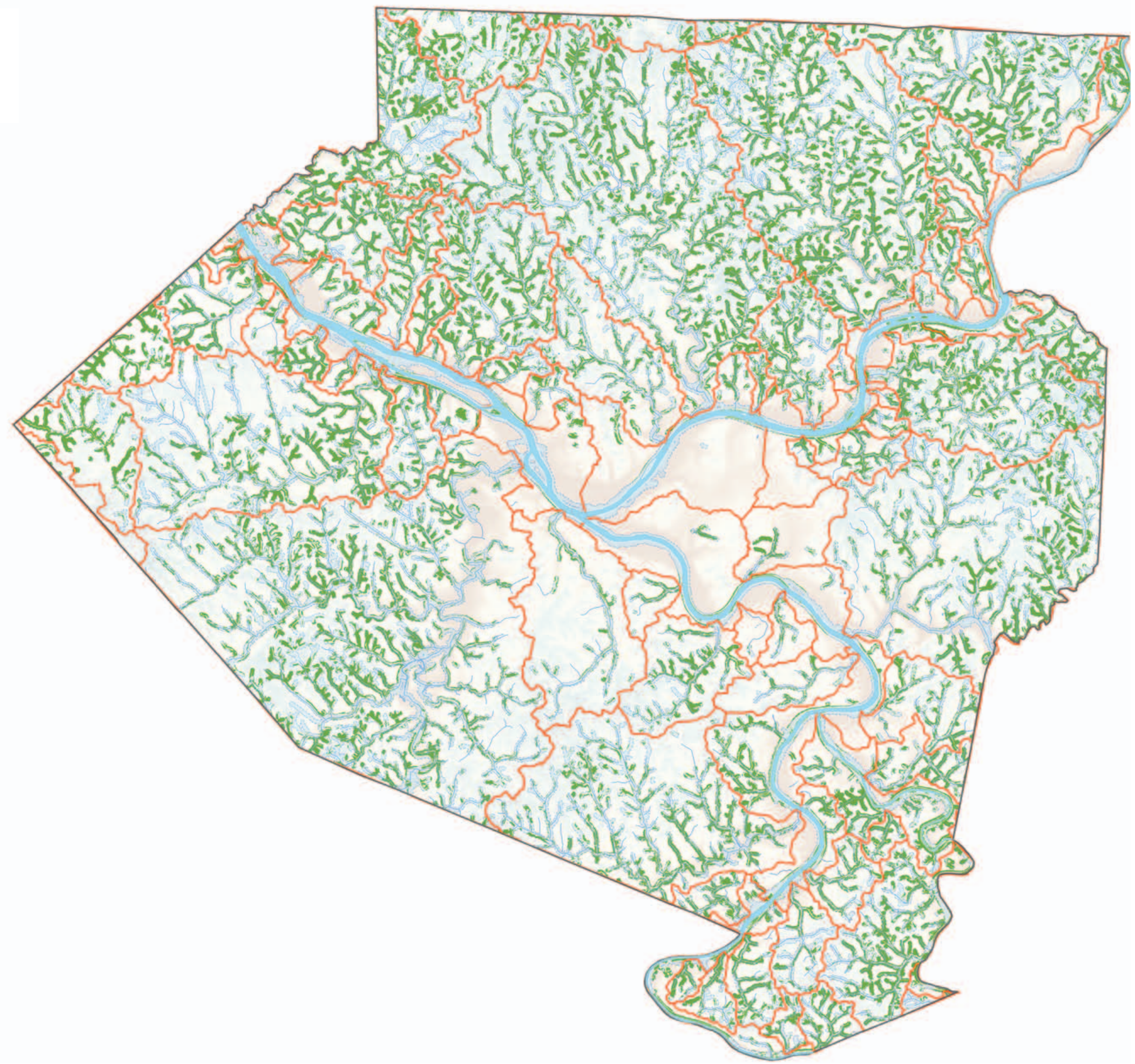
A 330 foot (100 meter) buffer was created around all streams and rivers in the county. Shown are all woodland patches which touch these riparian buffers.



Author: Kostoula Vallianos

3.3 RIPARIAN WOODLAND CONTIGUITY

All woodlands within the 330 foot (100 meter) stream buffer corridors.



LEGEND

- River
- Stream
- Riparian Corridor - 330 ft buffer of rivers and streams
- Watershed Boundary
- Woodlands within Riparian Corridors

0 12,500 25,000 50,000 feet

Author: Kostoula Valianos

Landscape Metrics

"Landscape metrics are algorithms that quantify specific spatial characteristics of patches, classes of patches, or entire landscape mosaics" (McGarigal et al. 2004). These metrics can either evaluate the composition or spatial configuration of the data. While there are a great number or landscape metrics that can be calculated, this analysis used two metrics that evaluate the spatial configuration of woodland patches: Mean Shape Index and Mean Nearest Neighbor.

As a landscape becomes more fragmented and patches are sliced into smaller patches, many times, the shape of the individual habitat patches become more complex. Complex and linear shapes tend to consist of more edge and less interior habitat. Simple shapes, such as circles and squares contain the least amount of edge proportionally and the most interior habitat (Turner et al. 2003, Meffe et al. 1997). As described earlier, the forest edge differs from forest interior in its microclimate, vegetation, and species present. As the amount of edge increases, specialized interior species decrease in numbers while the populations of wildlife generalist increases.

Isolation of habitats patches is also a detrimental effect of habitat fragmentation. As patches become smaller, species may be required to use adjacent patches or patches in close proximity to acquire all the resources needed to survive. If a habitat patch is isolated from other similar habitat, the species that depend on that habitat may not be able to acquire the resources they need. Furthermore, if a catastrophic event occurs destroying that "habitat island," the species might not be able to disperse to other suitable habitat, ultimately leading to the death or decline of that population (Meffe et al. 1997).

Mean Shape Index (MSI) is a measure of patch complexity. This metric is calculated by finding the sum of each patch perimeter divided by the square root of the patch area and divided by the number of patches in a given landscape or region (in this case watershed). A value of 1 or near one indicates a simple shape such a square or circle. This type of shape contains less edge than a complex shape. The higher the value, the more complex the average patch shape is.

Mean Nearest Neighbor (MNN) analysis was used to measure patch isolation in each watershed. This metric is calculated by measuring the shortest nearest neighbor distance of each individual patches to similar patches (in this case woodland) and taking an average of these distances. Woodland patches in watersheds with low MNN distances are less isolated relative to woodland patches with large distances.

Calculations

Patch Analyst, an ArcView program extension, was used to calculate both these metrics (Rempel, R.S. and A. P. Carr. 2003). The values for these metrics were scores slightly different than the others already presented. Because the value calculated by these metrics do not take into account the size or number of the patches in each watershed, the scores from this section of the analysis were reduced so they would not skew the final score. All the previous calculations were based on a high value of 100. The high value possible for each of these two metrics is 25. The MNN score was calculated by comparing the MNN for each watershed to the shortest MNN distance calculated in the county and multiplying by 25. The scores for MSI were defined as the following: score of 1-1.5 = 25; 1.5 –2.0 = 13; 2.0 or > = 0. The scores for MSI and MNN were then summed for a Total Landscape Metric score. A map was not generated for this section of the analysis. Refer to Map 3.1, which shows the shape and location of the county's woodland patches.

All the watersheds scored MSI values greater than 1.5, which indicates that the patch shapes are quite complex. Twelve watersheds had MSI values greater than 2.0. The shortest MNN distance was 45 meters (Wylie Run) and the longest was 136 meters (Shouse Run). On average the MNN distance was 83 meters. Scores for each watershed can be found in Appendix C.

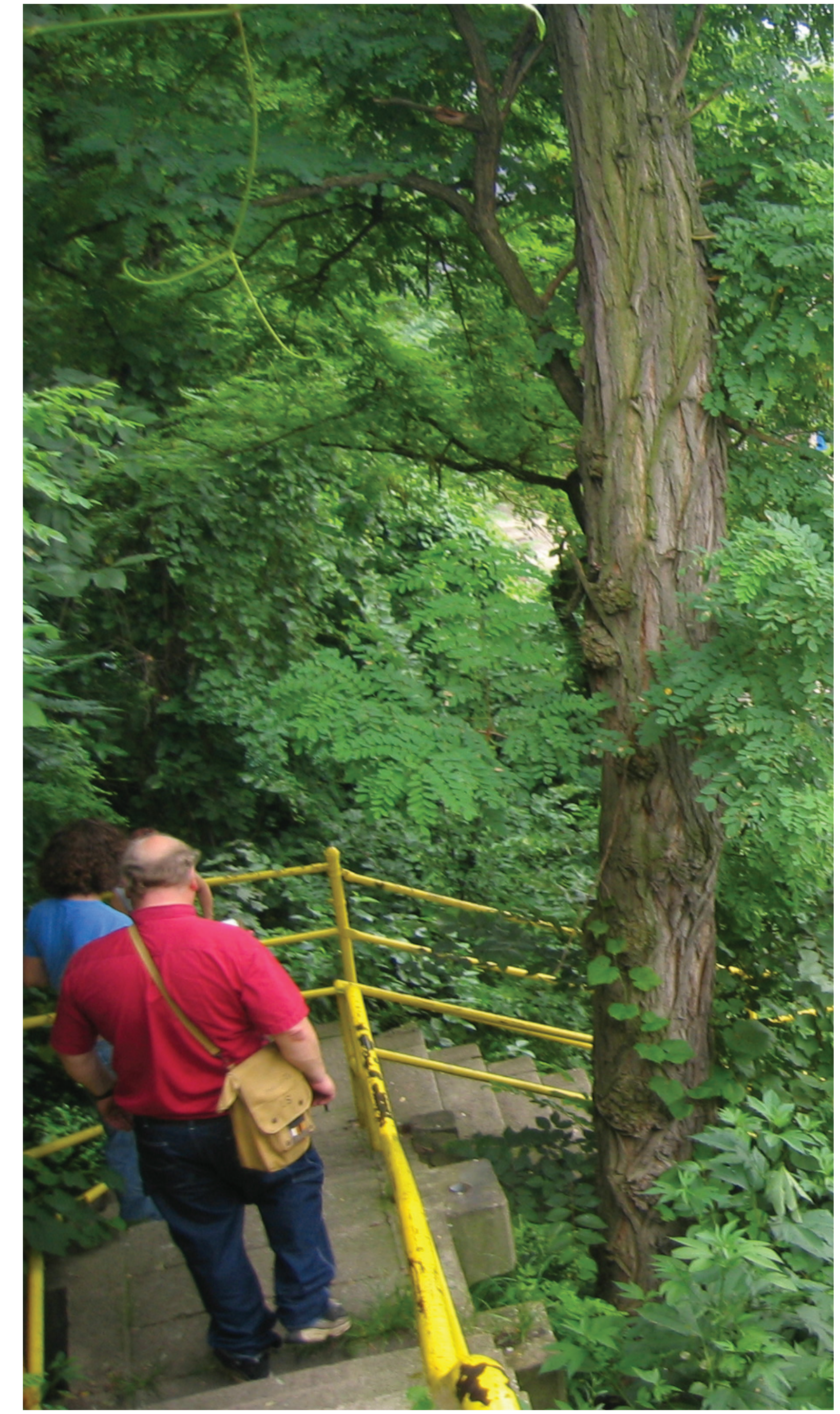


Figure III.5 A city staircase through a forest patch in the Hill District (Photo 3R2N)

Map 3.4 Watershed Woodland Evaluation

The scores from the Total Woodland Area, Stream and Landscape Metric analysis were summed to provide a Total Woodland Watershed Rating Score. Each watershed was rated on a scale of 1-5 (1 being low or the worst score and 5 being high or the best score). These scores are only relative to watersheds found in the county and only provide an initial comparison of woodlands in the county. Map 3.4 shows the scores each watershed received. Table 3.2 at right, summarizes all the calculations used in the Total Watershed Woodland Rating Score. Final values for all watersheds can be found in Appendix D.

Figure III.6 Woodland in the Squaw Run Watershed

Summary of Woodland Watershed Rating Analysis

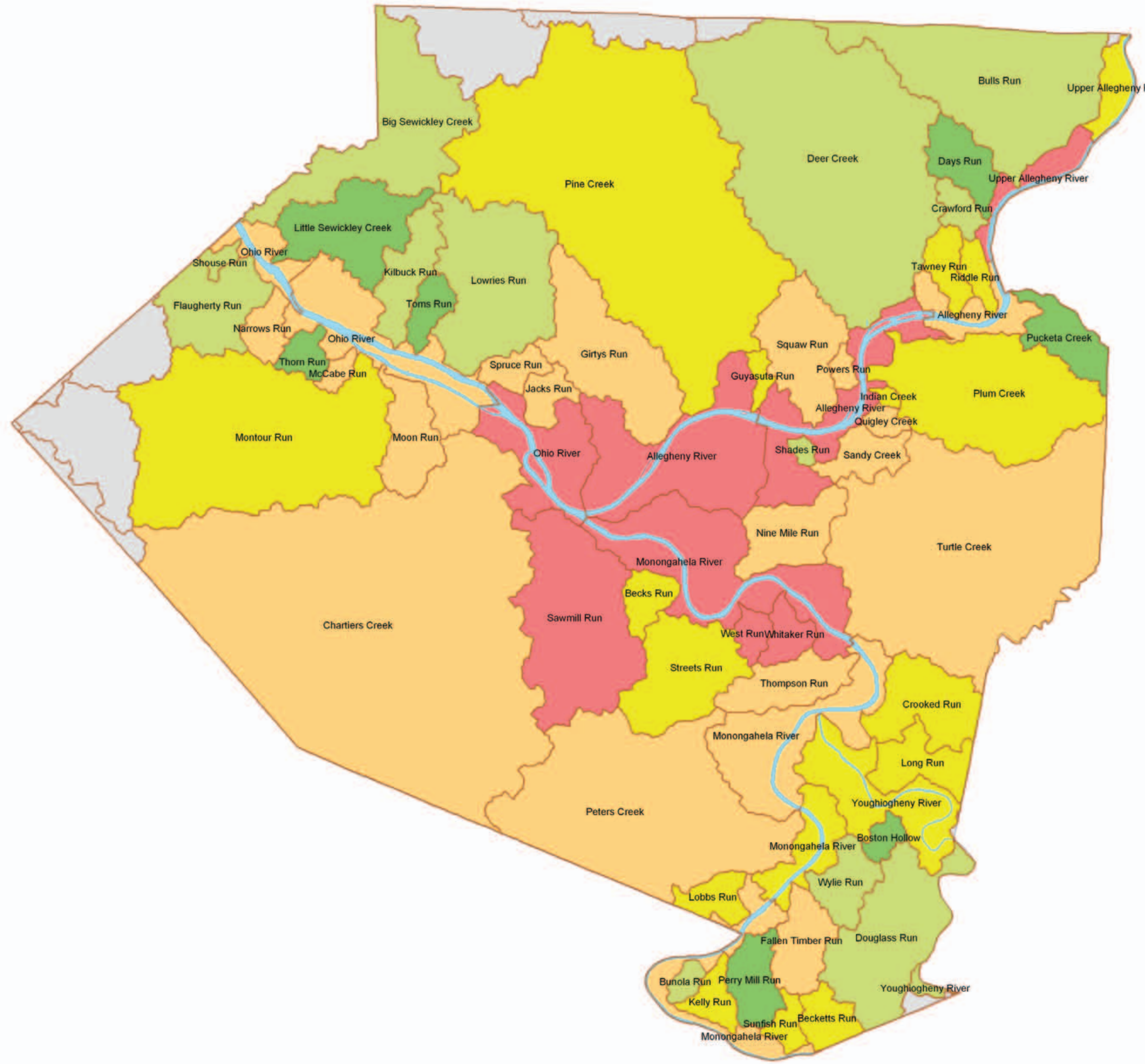
Watershed Values

Question	GIS Analysis Process	Value
1. Woodland Analysis		
• How much woodland is in each watershed?	• Area of forest over 250 acres/total area of watershed	%*100
	• Total forest in watershed/total area of watershed	%*100
	• Total interior forest/total area of watershed	%*100
Final value for forest analysis	• Total value for forest	Sum of the above
2. Landscape Metrics		
• Mean Nearest Neighbor (MNN)	• Measure of isolation-average of nearest neighbor distance of individual patch (edge to edge)	(Smallest MNN/X)*25
• Mean Shape Index (MSI)	• Measure of patch shape complexity-MSI = 1 when patches are circular - sum of each patch perimeter divided by the square root of patch area	1-1.5 = 25; 1.5-2 = 13; 2 < X = 0
Final value	• Total for patch metrics	
3. Stream Analysis		
• How much of the riparian buffer contains woodlands?	• Vegetated forest within stream buffer/ area total stream buffer	%*100
• How much of the total woodland in a given watershed are part of the stream corridor?	• Woodland areas within stream corridor/total woodland for watershed	%*100
Final value for stream analysis	• Total for stream analysis	

Table 3.2 Summary of Woodland Watershed Rating Analysis.

3.4 WATERSHED WOODLAND EVALUATION

Total Watershed value is based upon total woodlands within the watershed, classified by size and tested in relation to the riparian corridor. A higher value indicates a healthier watershed.



LEGEND

- River
- Watershed Boundary

Watershed Woodland Ranking

- 5 - Good
- 4
- 3
- 2
- 1 - Bad
- Excluded Partial Watershed

0 13,000 26,000 52,000 feet

Authors: Kostoula Vallianos & Jonathan Kline

Conclusions on Watershed and Woodlands

As we have said earlier, intact healthy ecosytems provide a range of important services that are valuable and highly desirable for urban and suburban communities. The highly intact watersheds, Little Sewickley Creek, Toms Run and Thorn Run on the Ohio River; Pucketa Creek on the Allegheny River; and Boston Hollow and Perry Mill Run on the Monongahela are important areas to be considered for preservation and conservation. These are important pockets of post-industrial nature, successful ecosystems if you will, that deserve some ground study and analysis. The process of land use change demands monitoring for value, regulation analysis and finally realistic enforcement strategies that protect these natural systems. The fundamental question is, what land use management controls exist in these multi-municipal watersheds and are they doing the job of protecting ecosystems services?

The other areas worth some signification consideration would be the watersheds marked in yellow. There are some very large watersheds, such as Montour Run, Pine Run, Plum Creek and Streets Run that are relatively isolated, but somewhat intact. There are land use decisions going on in these watersheds today that will either decimate or retain ecosystem services. These are, in many ways, the key indicator watersheds of our region. Water quality and quantity changes here indicate shifts in urban land use characteristics that we need to pay attention to. Monitoring provides us with an understanding of the values that might drive our restoration goals. But the final decision to restore remains challenging and with little public funding, programming or policy in place to support such an agenda.

We can also see bands of yellow along the upper Allegheny, and Monongahlea Rivers that look like significant restoration opportunities. With a little effort and planing, the Monongahela River Corridor has what is likely to be the best potential for large scale restoration projects. With U.S. Army Corps of Engineers work on the dams and the planned Mon Fayette Highway, it would seem to be very, very likely that some significant ecological restoration money could be found along with some land banking support, shifting the Monongahela River Valley from a post-industrial liability to an urban ecological opportunity. All it takes is a shift in policy and investment strategies, changes that can often be initiated on the ground in local communities amongst activist networks of interested citizens working with non profit entities.

Figure III.7 Pine Creek Watershed (Photo 3R2N)

IV. Other Measures of Watershed Health

Impervious Surfaces

The more developed an area is the more impervious surfaces there are. Impervious surfaces increase the amount of runoff that enters streams and waterways and ultimately increase the amount of pollutants and sediments that enter those systems. In addition, the increased runoff can cause flooding and increase erosion.

Map 4.1 Watershed Imperviousness

The percentage of impervious surface found in each watershed was calculated and mapped in Map 4.1. This calculation is valuable because it is a reflection on how urban or developed a particular watershed is. The county land use data was used to calculate this information. Total area of imperviousness was compared to the total area of the watershed.

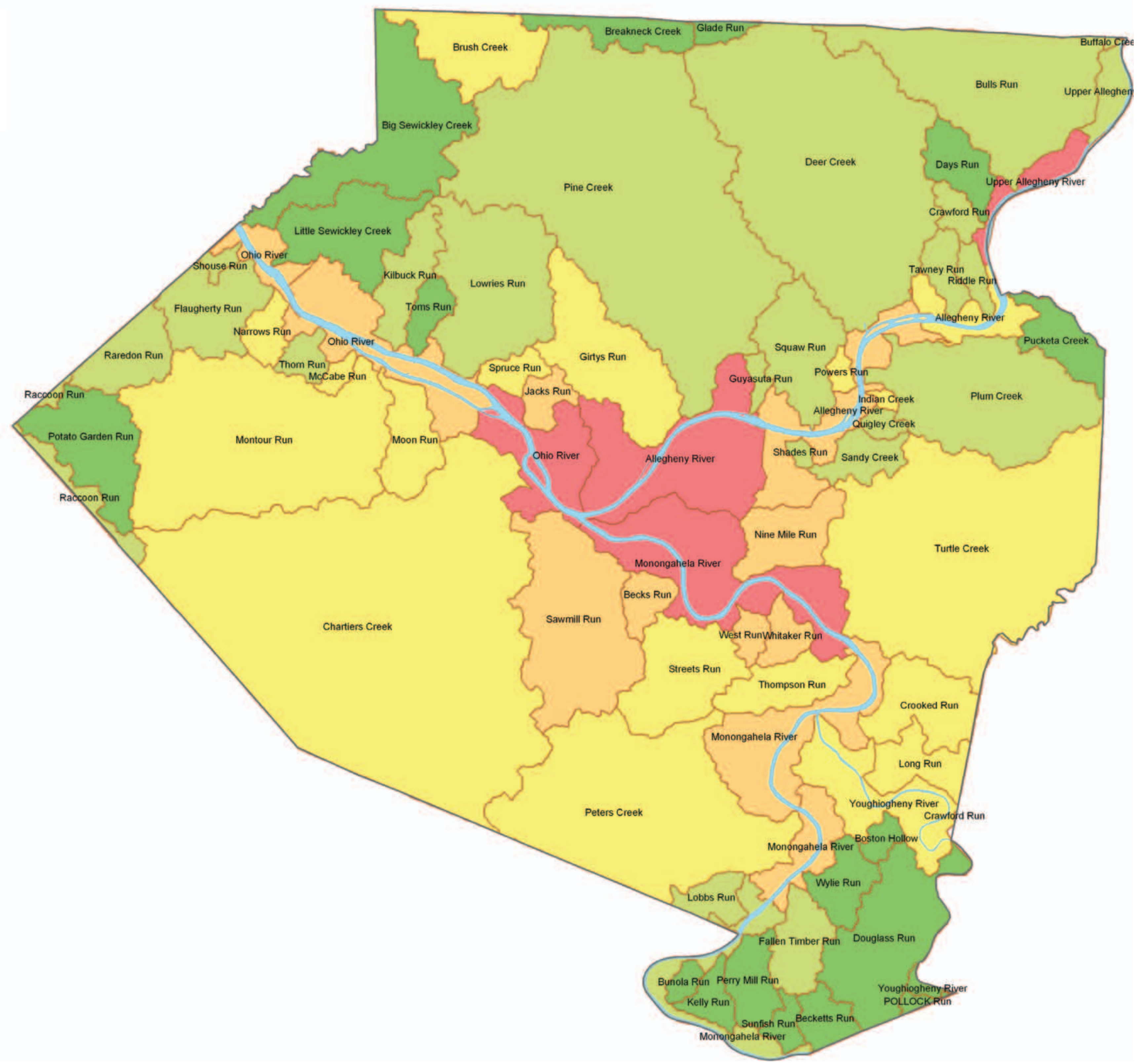
The highest percentages of impervious surfaces are concentrated around the City of Pittsburgh, which again is the most urban area found in the county. The lowest levels of impervious surfaces were found in southern portion of the county, in watersheds between the Monongahela and Youghiogheny Rivers, and also in Little Sewickley Creek, Big Sewickley Creek, Toms Run, Days Run and Pucketa Creek. The average percentage of impervious surfaces found in the county was 7%. The highest percentages of imperviousness in the county were calculated to be between 23-25%. Scores for each watershed can be found in Appendix A.

Figure IV.1 Impervious surfaces near the Ohio River (Photo 3R2N)

Figure IV.2 Stream Valley of the old Four Mile Run (culverted) in Panther Hollow (Photo 3R2N)

4.1 WATERSHED IMPERVIOUSNESS

Imperviousness is based upon county wide land-use data. Each land-use is assigned a value and the land-uses within a watershed are averaged. Watershed Imperviousness represents the average percent imperviousness for the entire watershed.



Percentage of Impervious Surface Area

- 0.6% - 2.8%
- 2.9% - 6.7%
- 6.8% - 11.8%
- 11.9% - 19.4%
- 19.5% - 27.1%
- Watershed Boundary

0 12,500 25,000 50,000 feet

Author: Lena Andrews & Jonathan Kline

Stream Condition Field Studies: Macroinvertebrate and Fish

Between 2001 and 2003, 3 Rivers 2nd Nature commissioned a 3-phased study evaluating the condition of streams in the county. One measure used in this study was a sampling of macroinvertebrates. All samples were collected near the mouths of streams of tributary to the Allegheny, Monongahela and Ohio Rivers. The analyses were conducted following protocol developed by the U.S. Environmental Protection Agency, as refined by the Ohio Environmental Protection Agency (OEPA), for stream quality Rapid Biological Assessments (RBAs), with appropriate modifications and adjustments to local conditions (Koryak and Stafford 2004).

Benthic macroinvertebrate communities are highly responsive indices of water quality, in addition to having an intrinsic value and importance as food for fish and other forms of aquatic life and often non-aquatic life. Streams that are non-degraded are highly diverse in the types of invertebrate communities they support and would include many different organisms, including pollutant intolerant species. Degraded streams in contrast would contain only a small number of pollutant tolerant species (Koryak and Stafford 2004).

Forty-seven streams were also evaluated for stream condition based on fish sampling. An Index of Biotic Integrity (IBI) score was developed for these streams. The IBI score was calculated from data collected by electrofishing. Twelve metrics were applied to this score.

They include:
- Total number of species
- Number of Darter/Sculpin Species
- Number of Sunfish species
- Number of Sucker species
- Number of Minnow species
- Number of Intolerant species
- Number of tolerant species
- Percent omnivores/generalists
- Percent insectivorous species
- Percent top carnivores/piscivores
- Number of individuals/300 meters
- Percent abundance of Blacknose Dace

Calculations and Maps

Condition scores were developed from the invertebrate data to evaluate the water quality and biological condition of each of the 72 streams sampled. Condition scores greater than 80% indicate that a stream is nonimpaired, 60-79 % slightly impaired, 40-59 % moderately impaired, and less than 39 % severely impaired. All except one of the Allegheny County stream stations examined were impaired to various degrees; 19.4 % slightly impaired, 41.7 % moderately impaired, and 37.5 % severely impaired. Map 4.2 illustrates the findings of the macroinvertebrate study (Koryak and Stafford 2004). This study also prioritized streams for preservation/protection and restoration. Pine Creek, Riddle Run, Toms Run and Tawney Run were identified respectively in order of highest priority for preservation/protection. Sixteen streams were identified for restoration. Lowries Run, Montours Run, Streets Run, Becketts Run, and Bunola Run were identified as the top five priorities for restoration.

The IBI scoring found nine streams had good scores, seven had fair scores, and eight had poor scores, and 23 had very poor scores. While this information indicates that numerous small streams in Allegheny County are still experiencing severe stresses, nonetheless, the results generally exceeded expectations of the researchers (Koryak and Stafford 2004). Map 4.3 shows the IBI scores calculated in the county.

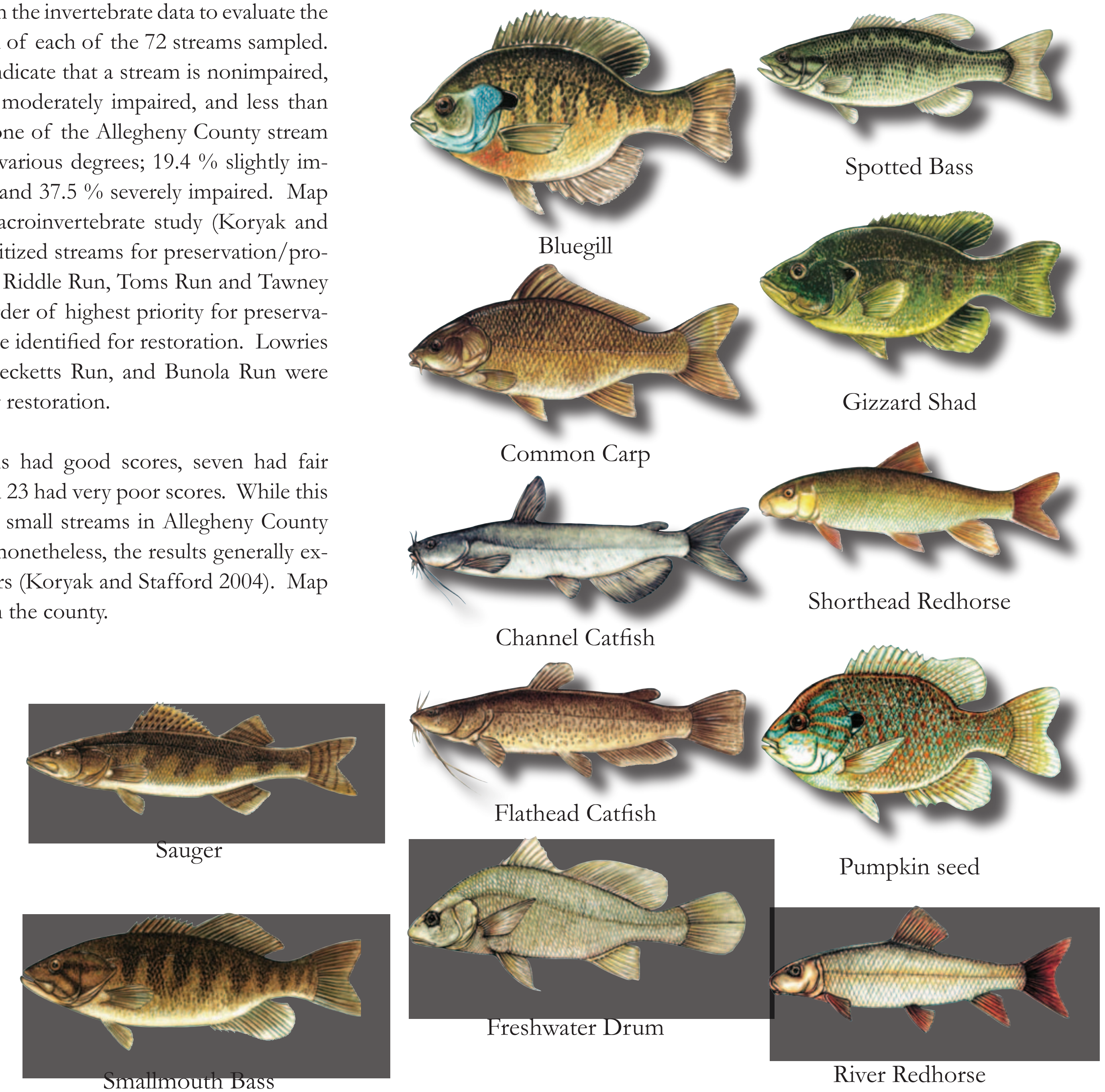
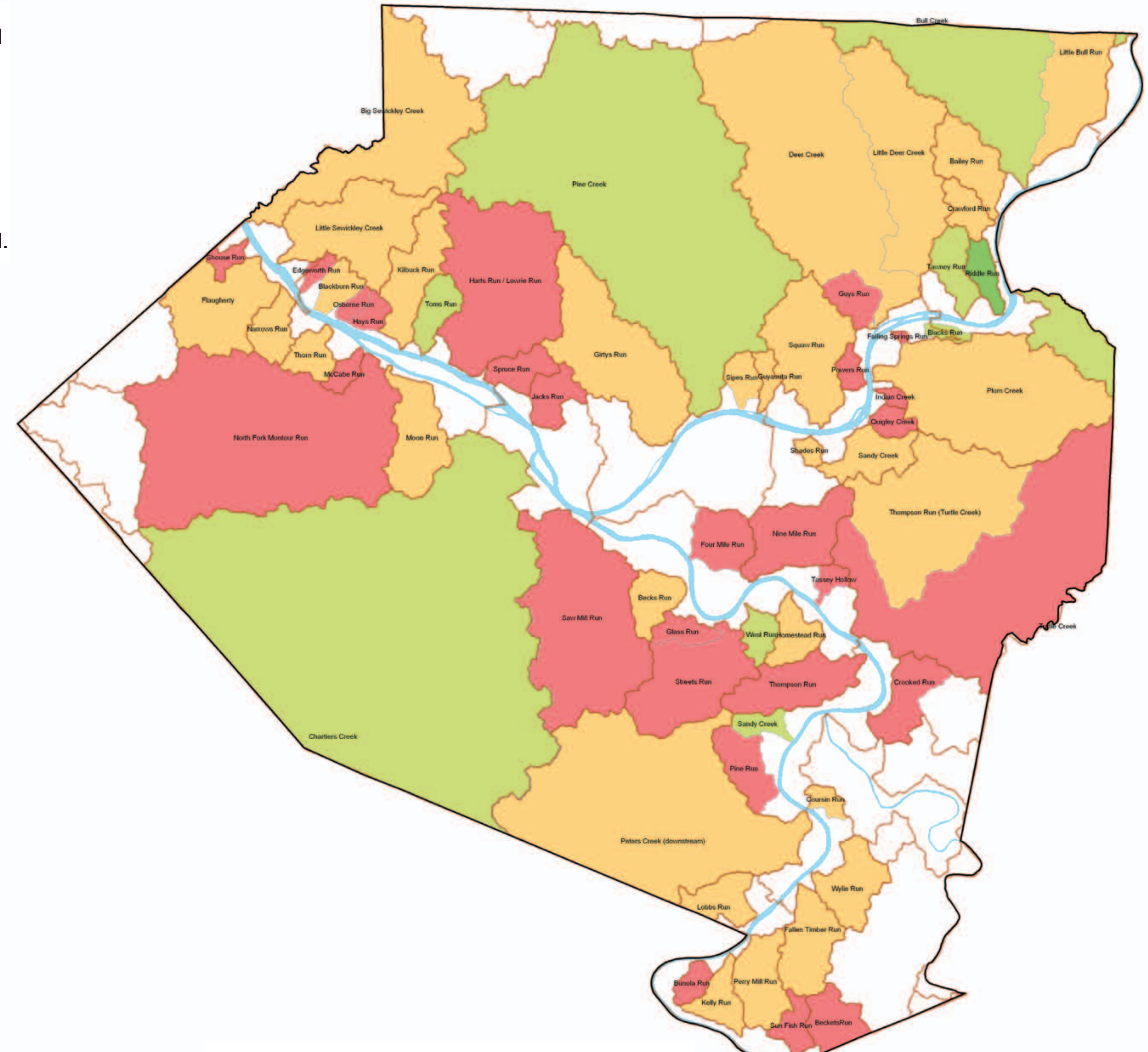


Figure IV.3 Fish Species Composition of the Ohio River (The Point to Emsworth Dam) Images Courtesy of the Pennsylvania Fish and Boat Commission

4.2 STREAM CONDITION: INVERTEBRATE HEALTH

Seventy-two streams were evaluated for stream condition based on benthic macroinvertebrate community sampling conducted by 3R2N between 2001 and 2003. Condition scores were developed from the invertebrate data to evaluate the water quality and biological condition of each of the 72 streams sampled. Condition scores greater than 80% indicate that a stream is nonimpaired, 60-79% slightly impaired, 40-59% moderately impaired, and less than 39% severely impaired. All except one of the Allegheny County Stream stations examined were impaired to various degrees; 19.4% slightly impaired, 41.7% moderately impaired, and 37.5% severely impaired.



LEGEND

- River
- Watershed Boundaries

Invertebrate Condition Score

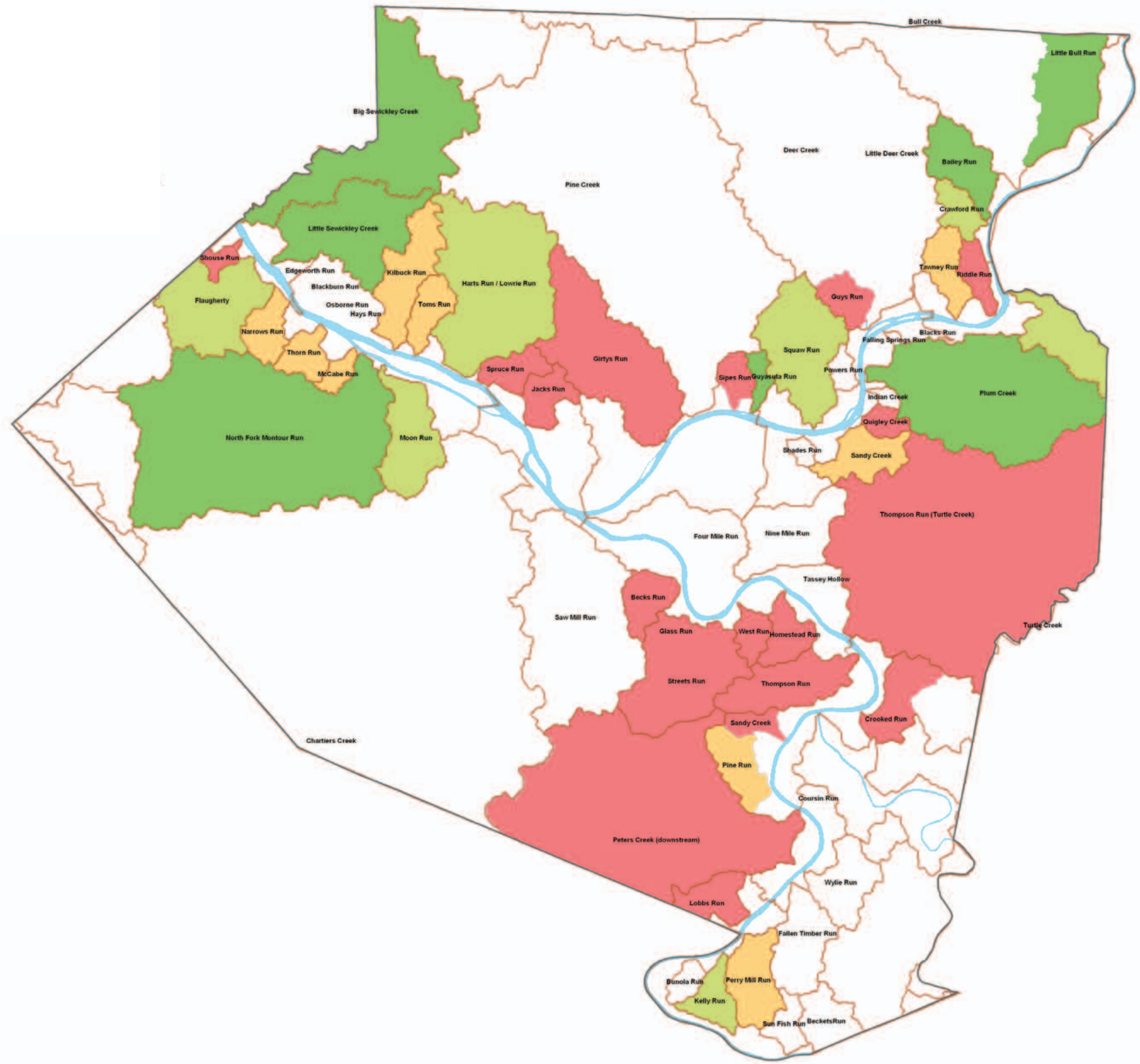
- 81 - 100 Non-Impaired
- 61 - 80 Slightly Impaired
- 41 - 60 Moderately Impaired
- 0 - 40 Severely Impaired

0 12,500 25,000 50,000 Feet

Author: Jonathan Kline, Lena Andrews & John Oduroe

4.3 STREAM CONDITION: INDEX OF BIOTIC INTEGRITY

Forty-seven streams were evaluated for stream condition based on fish sampling conducted by 3R2N between 2001 and 2003. An Index of Biotic Integrity (IBI) score was developed for these streams. The IBI score was calculated from data collected by electrofishing. Twelve metrics were applied to this score. They include: Total number of species, Number of Darter/Sculpin species, Number of Sunfish species, Number of Sucker species, Number of Minnow species, Number of intolerant species, Number of tolerant species, Percent omnivores/generalists, Percent insectivorous species, Percent top carnivores/piscivores, Number of individuals/300 meters, and Percent abundance of Blacknose Dace.



LEGEND

River

Watershed Boundaries

Index of Biotic Integrity (Based on Fish Studies)

Good

Fair

Poor

Very Poor

0 12,500 25,000 50,000 feet

Author: Jonathan Kline, Lena Andrews & John Oduroe

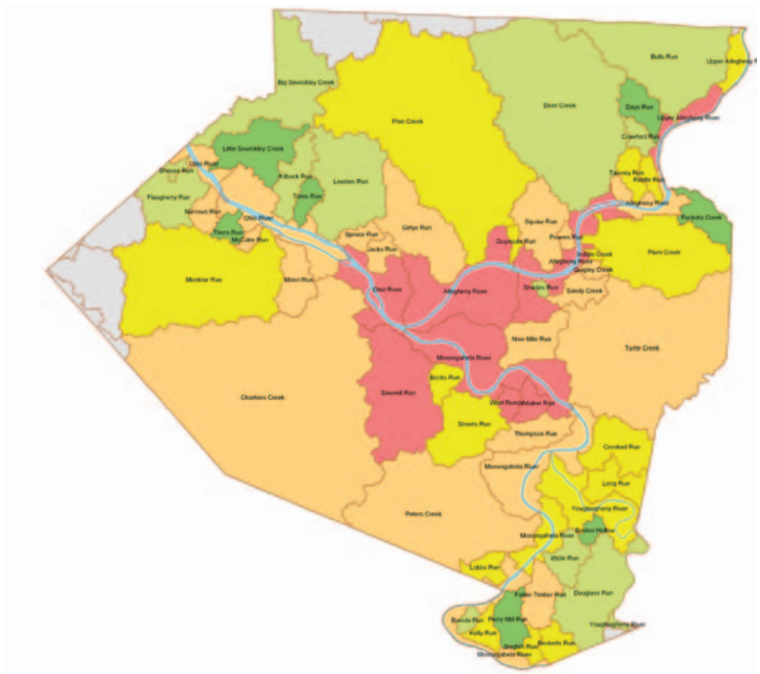


Figure IV.4 Watershed Woodland Evaluation.

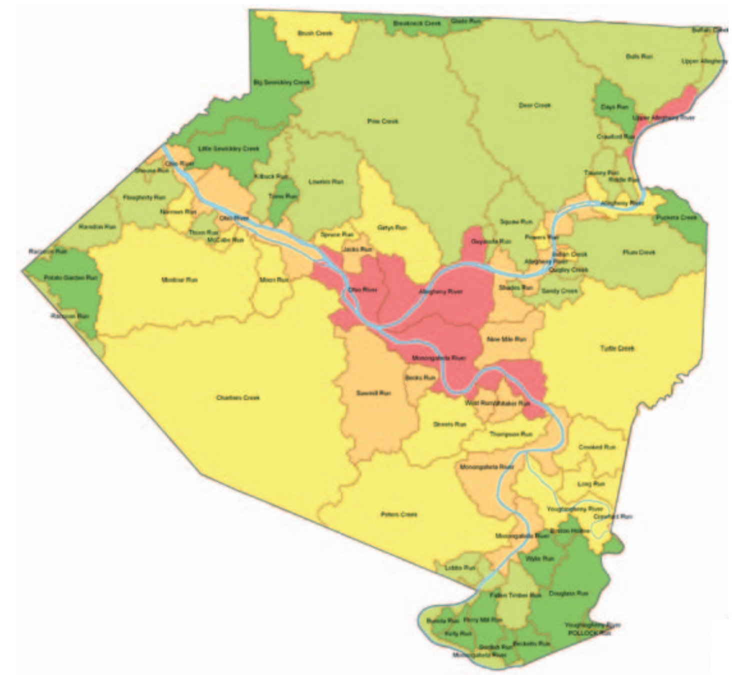


Figure IV.5 Watershed Imperviousness.

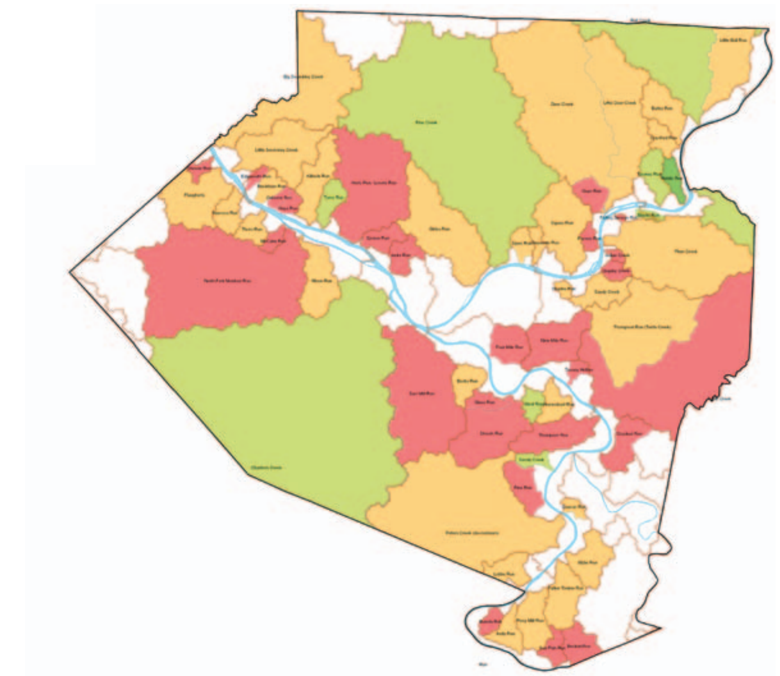


Figure IV.6 Stream Condition - Invertebrate Health.

Average Ecological Watershed Rating

An average rating was calculated for each watershed by using the scores from the Woodland Watershed Analysis, Impervious Surfaces and Macroinvertebrate Stream Condition data. Because the IBI data set is significantly less complete than the Watershed Woodland Rating, Impervious Surfaces and Macroinvertebrate data, it was not included in the calculation of Average Ecological Watershed Rating. Though it does provide greater insight to the condition of the streams in county for the watersheds that were included.

Each data set was broken into four or five categories (on a 1 to 5 scale with 5 being best) and was averaged for each watershed. From the Woodland Watershed rating, the Total Value was used. The scores from this data set were already broken into five categories as illustrated on Map 3.4. The impervious surface scores were reversed so that a watershed with low percentage of impervious surfaces is considered best.(i.e. 0 –2.3% = 5; 2.4-6.7% = 4; 6.8-11.8% = 3; 11.9-19.4% =2; >19.4 =1). The Macroinvertebrate analysis was broken into 4 categories: Non-impaired, Slightly impaired, Moderately Impaired and Severely Impaired.

Generally, the watershed ratings in each data set was fairly consistent across the three data sets. Watersheds with low Woodland Watershed ratings tended to have low Macroinvertebrate Stream Condition Scores and high percentage of impervious surfaces. In contrast, watersheds that had high Woodland Watershed Scores also tended to have low percentage of impervious surface and high Macroinvertebrate scores.

The Average Ecological Score provides an initial evaluation of the county's watersheds and should serve as guidance for future field studies and data collecting. Interested parties and municipalities can also use the information provided in this document as a starting point or tool in prioritizing and in evaluating:

- Conservation projects
- Restoration projects
- The acquisition of open space, conservation easements or parks

Because this analysis is largely based on spatial data, critical next steps should include collecting specific data related to woodland composition, detailed flora and fauna surveys, and ground-truthing areas of interest.

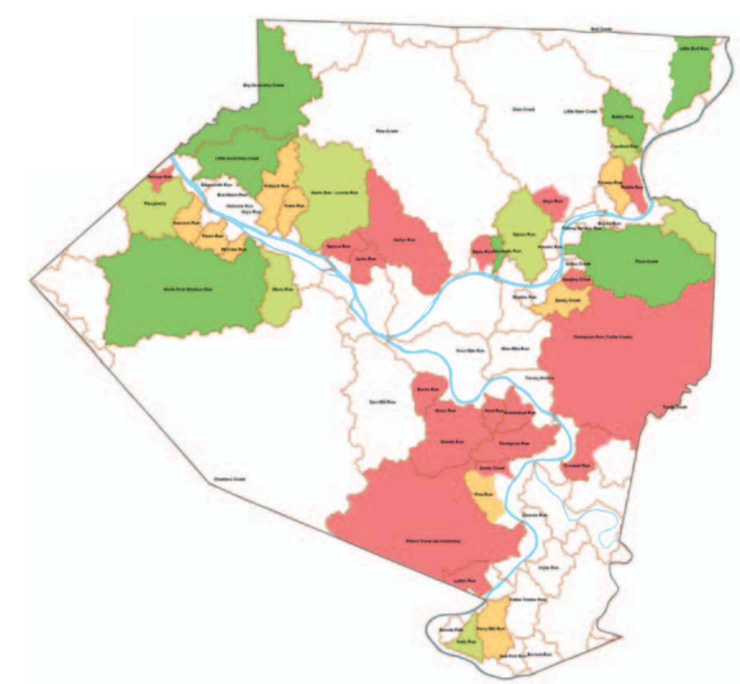


Figure IV.7 Stream Condition - Index of Biotic Integrity.

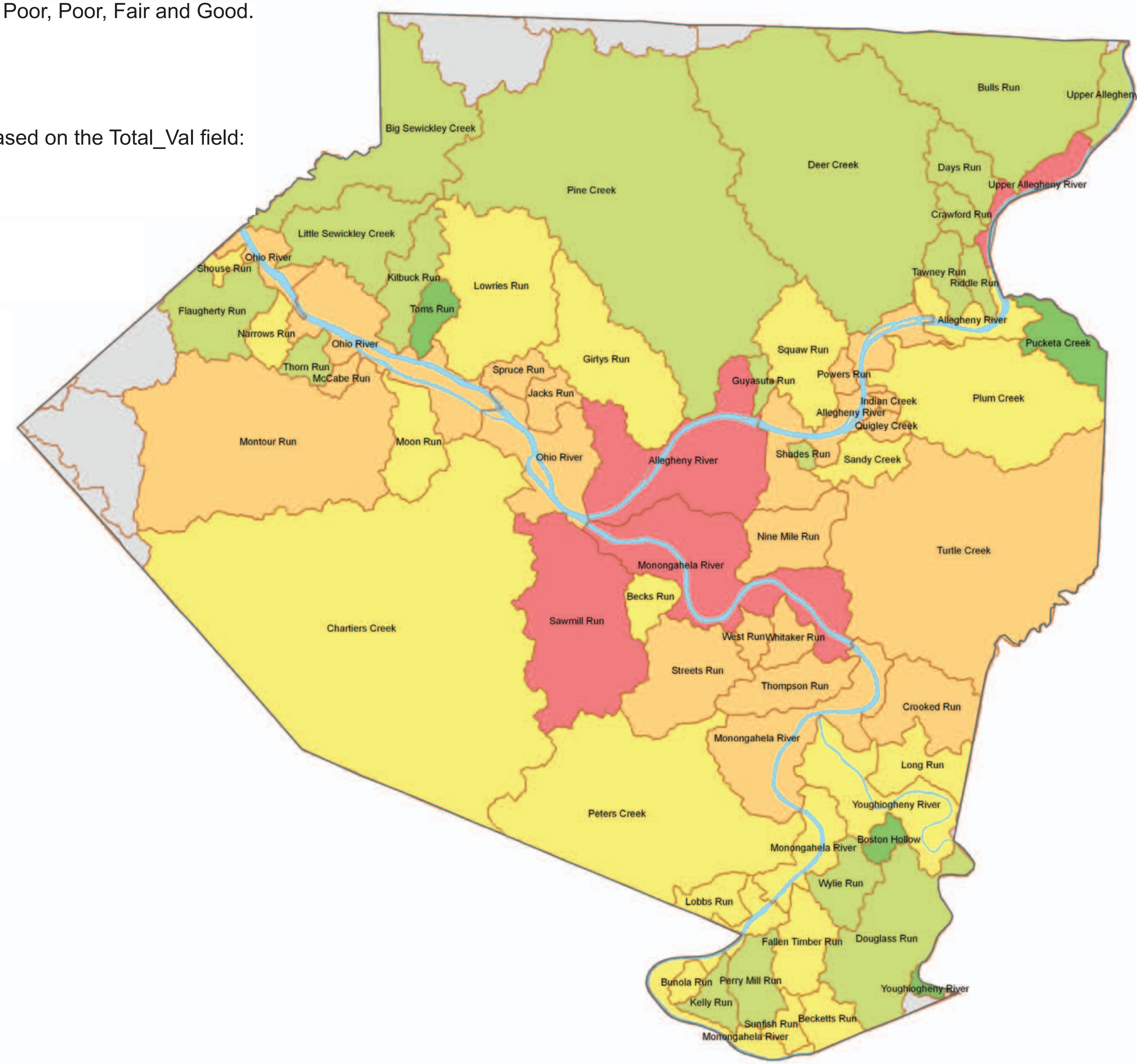
4.4 AVERAGE ECOLOGICAL WATERSHED RATING

The Invertebrate Health rating was broken into four categories: Very Poor, Poor, Fair and Good. These were ranked on a 5 point scale.

Very Poor = 1.25, Poor = 2.5, Fair = 3.75, Good = 5

The Woodland Health rating was also broken into four categories, based on the Total_Val field:

0-136 = 1, 137-201 = 2, 202-242 = 3, 243-289 = 4, >289 = 5



LEGEND

River

Watershed Boundary

Watershed Health (Averaged Rating)

5 - Good

4

3

2

1- Bad

Excluded Partial Watershed

0 12,500 25,000 50,000 Feet

Author: Lena Andrews, Kostoula Vallianos & Jonathan Kline

Conclusions on Watershed Health

Looking at Map 4.4, we see a synthesis based on a mix of terrestrial and aquatic conditions. From the terrestrial point of view, we have forest cover and impervious surfaces; two structural conditions that can indicate whether or not the hydrology of the region is intact, diminished or destroyed. From the aquatic point of view, invertebrate health (bottom dwelling insects) and the index of biotic integrity (diversity of fish species) tell us about the actual life that occurs in the streams. If the structure is good, the life should follow unless there are extenuating circumstances as we will see below.

Much of this report is designed to set up a tension in the reader's mind between green natural infrastructure and the significant expenditures required when the decision is made to go to grey engineered infrastructure systems. In the first case, we can think about rain and the health it brings to the landscape, in the second case, we think about stormwater. One is opportunity, the other constraint. One is to be enjoyed, the other to be managed for minimum impact to daily life. From an ecological perspective, the steep forested hillsides and stream valleys that make Allegheny County a challenging place to build on allow us to retain a fairly intact forest cover. Forest cover, when coupled with low impervious surfaces, makes for fairly intact hydrological regimes and healthy stream characteristics. These are the forms that support life. If you are living in a watershed with a healthy diversity of natural organisms, you can assume that you also have a very good chance of a long term healthy life, living in that place.

Despite changing land use characteristics, the drainages to the north shore of the Allegheny and the eastern shore of the Ohio still look quite good; forest cover and structurally complex larger watersheds allow for more niches for organisms to survive. The other areas that show promise are found along the Monongahela River valley, with the best opportunities on the eastern shores of that river. It is forest cover and the lack of impervious surfaces that make these opportunities stand out. The biological organisms are not as successful in this region partially because of the steep first and second order stream conditions. This geometry is typical of smaller watersheds and in the Monongahela valley they are often coupled with acid mine drainage discharges that limit the life in these streams. But the terrestrial indicators tell us there is strong potential for a significant recovery along the Monongahela River valley.

Figure IV.8 The Monongahela River (Photo 3R2N)