YOUGHIOGHENY RIVER BASIN

ENVIRONMENTAL ASSESSMENT OF STREAM CONDITIONS

CHESAPEAKE BAY AND
WATERSHED PROGRAMS
MONITORING AND
NON-TIDAL ASSESSMENT

CBWP-MANTA- EA-00-3

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YOUGHIOGHENY BASIN

ENVIRONMENTAL ASSESSMENT OF STREAM CONDITIONS

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Report Completed
October 2000

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FOREWORD

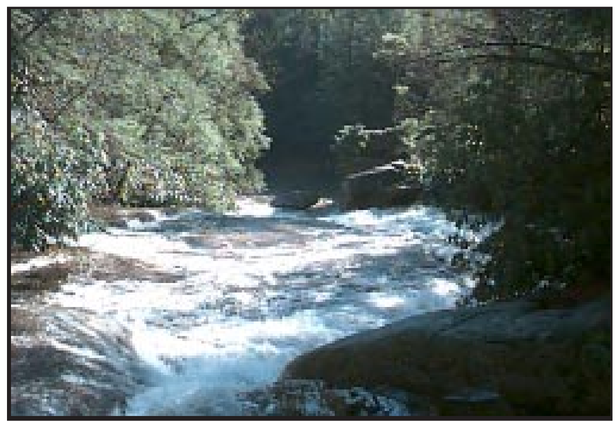
Much of this report is based on results of the Maryland Biological Stream Survey (MBSS), a program funded primarily by the Power Plant Research Program and the United States Environmental Protection Agency. The MBSS is administered by the Maryland Department of Natural Resources. Field data for the Youghiogheny River basin was primarily collected by the University of Maryland's Appalachian Laboratory (AL) under Contract Numbers CB95-005-002 and MA97-001-003 to MDNR. Analysis of water chemistry samples was also conducted by the (AL) under Contract numbers CB95-007-002 and MA97-003-003. Much of the initial data analysis for this report was conducted by Versar, Inc. under Contract Number PR-96-055-001\PRFP44 to DNR's Power Plant Assessment Division.

This report helps fulfill one of the outcomes in MDNR's Strategic Plan: Sustainable Populations of Living Resources and Healthy Ecosystems.

Mature hemlock forest at Swallow Falls State Park, Garrett Co., Maryland. Photo by Matt Kline

ACKNOWLEDGMENTS

We are grateful to Mick Burkett, Dave Neely, Doug Orr, Rod McLeod, Sandy Davis, Brent Murry, Molly Kline, Amy Gottesfeld, and Rachel Burke of the AL for long hours spend in the field. We are also grateful to Katie Kline of AL for long hours and weekends spent in the laboratory to ensure that holding times and quality control measures were met for water samples. We thank Janis Chaillou and the Versar landowner permission crew for long hours spent obtaining permission for sample sites. We would also like to thank Marty Hurd, Scott Stranko, for contributing to the document and providing Geographic Information Systems (GIS) support.



White water along Muddy Creek at Swallow Falls State Park, Garrett Co., Maryland. Photo by Matt Kline

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Photo by Matt Kline

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Maryland Biological Stream Survey

Executive Summary

This report describes existing aquatic resource conditions in first, second, and third-order streams in the Youghiogheny River basin in Maryland. The report also begins to assess water quality and habitat problems in the basin, as well as areas of high ecological value. This information may prove useful as specific strategies for restoring water quality in Maryland are developed and refined.

The primary source of information for this report is the Maryland Biological Stream Survey (MBSS) conducted by the Maryland Department of Natural Resources (MDNR) from 1994-1997 to characterize Maryland streams, including those within the Youghiogheny River basin. Although the primary focus of the MBSS is on acid deposition impacts, the survey can also be used for other purposes such as reporting on watershed conditions. The MBSS is a statewide survey of first, second, and third-order streams designed to characterize current biological and habitat conditions and provide a basis for assessing future trends. The probabilistic design used for the survey, in which all streams have a known probability of being sampled, allows for high quality estimates of stream characteristics and conditions. This approach is similar to taking a random sample of voters to determine who is likely to win an election.

FINDINGS

Water Quality

About 3% of the stream miles in the Youghiogheny River basin were very acidic (pH less than 5). Few fish species can persist in these waters. About 93% of the stream miles had pH values greater than 6, the level above which most biota thrive.

Most of the stream miles in the basin were well buffered. Only 6% of the stream miles had acid neutralizing capacity (ANC) less than 0 μeq/L. Hence few streams in the basin are permanently acidified. However, about 43% of the stream miles may be acidified during some part of the year (ANC between 50 and 200 μeq/L).

Only about 3% of the stream miles in the basin had summer dissolved oxygen levels lower than the state water quality criterion of 5 mg/L. This suggests that excessive loadings of oxygen-demanding organic chemicals to streams in the basin are only a minor influence on stream quality.

About 15% of the stream miles in the basin had elevated nitrogen levels (nitrogen greater than 1 mg/L). The primary source of nitrates appears to be acid deposition, but agriculture could also be a contributor.

Physical Habitat

About 60% of the stream miles in the basin had either Poor or Very Poor instream physical habitat. Physical habitat is a measure of the amount and diversity of stable materials such as boulders, logs, undercut banks and snags. Possible causes of degraded habitat include channelization, livestock trampling, and harvest of trees along stream banks.

Almost 13% of the stream miles in the basin had unstable stream banks, while nearly 70% of the stream miles had stable banks. Eroding stream banks can be a source of sediment and nutrients to downstream areas, including the Gulf of Mexico.

In general, riparian zones along streams in the basin were in Fair condition. About 50% of all stream miles had vegetated riparian zones greater than 50 meters wide, but about 26% of the stream miles contained no buffers. Forest was the dominant vegetation type in riparian zones and 66% of the stream miles were well shaded.

Fish

A total of 36 fish species representing 8 families were collected in the basin, including 7 species of gamefish: brook trout, brown trout, rainbow trout, chain pickerel, northern pike, largemouth bass, and smallmouth bass. Brook trout were the most abundant gamefish collected in the basin, estimated at over 100,000 individuals. This is about one third of all brook trout found in Maryland.

A total of about 2.4 million fish live in the Youghiogheny River basin. The most abundant fish species was mottled sculpin, a moderately pollution-tolerant species, estimated at nearly one million individuals.

Based on MDNR's Index of Biotic Integrity (IBI) for fish, 24% of the stream miles in the basin were in Good condition while 16% were in Very Poor condition. The remaining stream miles (60%) were assessed as either Fair or Poor.

Stonecat, a species of catfish, was the only species listed as rare in Maryland that was collected in the basin. Two other species, striped shiner and Johnny darter, were found in the Youghiogheny basin and nowhere else in Maryland.

Benthic Macroinvertebrates

Based on the MDNR's benthic macroinvertebrate IBI, about one-third (34%) of all stream miles in the basin were in Good condition, while only 9% and 4% of the stream miles were rated as Poor and Very Poor, respectively. The remaining stream miles (53%) were assessed as Fair.

Over half (188) of the 350 stream-dwelling benthic macroinvertebrate genera found in Maryland were collected in the Youghiogheny River basin. Dominant types were a non-biting midge, a mayfly, and a stonefly.

Reptiles and Amphibians

Reptiles and amphibians were present at 88% of the sites sampled in the basin. A total of 20 species of frogs, turtles, salamanders, and snakes were collected. Mountain dusky salamander was the most commonly collected species.

Summary

The major impacts to the streams in the basin include mine drainage, acid deposition, and reduced quality of physical habitat from historical logging and agriculture.

A Maryland DNR biologist measures out a sampling segment during the 1997 MBSS.

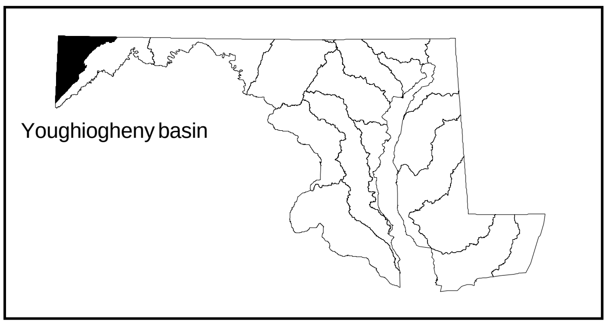
Maryland
Biological
Stream
Survey

Introduction

Chapter One 1

PURPOSE OF THIS REPORT

This report describes existing aquatic resource conditions in first, second, and third-order streams in the Youghiogheny River basin in Maryland. The report also begins to assess water quality and habitat problems in the basin, along with areas of high ecological value. We hope that this information will prove useful as specific strategies for restoring water quality in the basin are developed and refined.



The Youghiogheny basin, one of Maryland's 18 major river basins, is the western most basin in the state. It is the only basin in Maryland that drains to the Gulf of Mexico and not the Chesapeake Bay.

STREAM RESOURCES

The Youghiogheny River basin, one of Maryland's 18 major drainage basins, is the western most basin in the state. It is the only basin in Maryland that drains into the Gulf of Mexico and not the Chesapeake Bay.

The flowing waters of Maryland represent a vital lifeblood to its residents. In addition to providing a source of drinking water and water for agricultural and industrial uses, Maryland's streams and rivers provide recreational opportunities, attract tourists and support commercially important fish and shellfish. Forested riparian zones along streams and rivers contain some of the richest and most diverse plant and animal communities found anywhere in the state. They also temper the effects of heavy rainfall and storm water runoff, shade the stream channel, increase bank stability, and contribute leaf litter and woody debris—sources of food and habitat for stream biota. In many cases, the aesthetic attraction of streams and rivers has served as the primary catalyst for economic redevelopment.

Bear Creek, Garrett County, Maryland.

In spite of these values, Maryland's streams and rivers have been abused and neglected, often converted to flood routing systems or used as drains for unwanted wastes. Increasingly, Marylanders are realizing that our mistreatment of natural resources is neither economically nor environmentally sustainable. Efforts are being made to restore degraded stream systems and to protect healthy streams. In the end, the success of these efforts will be determined by how much we cherish these most valuable natural gifts.

INFORMATION SOURCES

The primary data source for this report is the Maryland Biological Stream Survey (MBSS) conducted by the MDNR. Although the primary focus of the MBSS is on acid deposition impacts, the survey can be used for other purposes such as drainage basin characterization. The MBSS is a statewide survey of first, second, and third-order streams designed to characterize current biological and habitat conditions and provide a basis for assessing future trends. The probabilistic design (all streams have a known probability of being sampled and sites are randomly selected for sampling) used for the survey allows unbiased estimates of stream characteristics and conditions. For example, the abundance of a given fish species in a basin can be validly estimated using the MBSS design. Because first, second, and third-order streams represent about 89% of the total stream miles in the Youghiogheny River basin, MBSS results should accurately represent overall stream quality in the basin. Examination of conditions in small streams also enables identification of specific problem areas where local protection, enhancement, and restoration efforts could be focused.

To provide some comparison of present and past conditions, historical information is presented where appropriate and available. In addition, information on land use, hydrology and other aspects of the basin are also represented so that observed conditions in streams can be placed in context of human activity.

Maryland Biological Stream Survey

Basin Description

Chapter Two 2

The following chapter uses existing information to provide a general overview of the Youghiogheny River basin, including ecological, recreational, and economical resources. The purpose of this general overview is to provide a context of interpreting the assessment of stream conditions found in Chapter 4.

HISTORY

It is believed that the first Native Americans lived in the basin for nearly 10,000 years before the first European settlers. One group known from the basin, the Monongahela Indians, lived in the basin between 900 and 1600. After the disappearance of the Monongahela Indians, Shawnee, Seneca, Delaware, and Erie Indians all spent some time in the basin. Europeans officially claimed the land of the basin through a 1744 treaty with the Iroquois Indians. Twenty-one year old George Washington made his first trip across the Youghiogheny River in 1753.

> ***How did the Youghiogheny River get its name?***
>
> The first known reference of the name of this basin is a caption on a 1737 map by William Mayo titled "Spring Heads of the Yok-yo-gane." Most historians agree that the name Youghiogheny comes from an Indian dialect and means "a stream flowing in a contrary direction," or "in a roundabout course." This is a fitting name for the river considering it's unusual north to northwest direction of flow (Palmer 1984).

The basin is the site of the first federally funded highway, the National or Cumberland Highway. The road was authorized by congress in 1806 and the section from Cumberland to the Youghiogheny River was completed in 1817. The National Highway, today's Alternate Route-40, became a main link between the eastern and the western frontier. During the late 1800s, lumber was the biggest industry in the basin. Coal mining became the dominant business in the early 1900s as the remaining forests were cleared out (Palmer 1984).

BASIN CHARACTERISTICS

The Youghiogheny River basin drains about 409 square miles of Garrett county in Maryland (MDNR 1996a). The headwaters of the river begin in Preston county, West Virginia and flows north for approximately 4 miles north to Maryland (Palmer 1984). The Youghiogheny River flows for about 43 miles through Maryland into the Youghiogheny Reservoir which extends seventeen miles into Pennsylvania. The river then flows for nearly 75 miles in a northwesterly direction toward Pittsburgh to its end at the confluence with the Monongahela River. It is in this section that the Casselman River (including water from the Maryland portion of the Casselman River) joins the Youghiogheny. The Monongahela joins the Ohio River, then the Mississippi River, and ultimately enters the Gulf of Mexico.

The basin lies within the Allegheny Plateau ecoregion, an area characterized by broad upland areas and ranges of mountains that extend in a generally northeast-southwest direction. Major tributaries to the Youghiogheny River in Maryland include the Casselman River, Little Youghiogheny River, Buffalo Run, Snowy Creek, Muddy Creek, Bear Creek and Cherry Creek. Elevations in the basin range from about 650 to nearly 3400 feet above sea level. The forests of the basin are dominated by stands of white oak, red oak, sugar maple, and tulip poplar. Hemlock and rhododendron are the typical woody vegetation in the riparian zones along streams in the basin. The high elevation of the basin affects the climate, providing wetter, cooler, and cloudier conditions then the rest of Maryland. The basin receives less than 2200 hours of sunshine on

Mill Run, a tributary to Youghiogheny River Lake.

average. In comparison, Annapolis receives as average of 2600 hours of sunshine per year. During an average year there are only 4 days when the temperatures climb to above 90°F. Average annual precipitation is 45.9 inches, and the long-term monthly average is 3.8 inches. May and June are typically the wettest months and November is usually the driest (Palmer 1984).

There are 374 miles of first, second, and third-order streams in the Maryland portion of the basin, based on a 1:125,000 scale U.S. Geological Survey map. For a description of stream order, see Chapter 3. The two largest lakes in the basin are Deep Creek Lake (3900 acres) and the Youghiogheny River Lake (593 acres in Maryland and nearly 3000 acres in Pennsylvania).

LANDUSE AND HUMAN POPULATION

Fifty-five percent of the acreage in the basin is characterized as forest. Over one third of the land in the basin (34%) is in agriculture and only 7% is classified as urban. Deep Creek Lake, the Youghiogheny Reservoir, and areas classified as wetlands make up the remaining 4% of the basin (Figures 1 and 2).

The Youghiogheny basin is mostly rural, with a population density of only 43 residents/sq. mile. Less than 1% of Maryland's population lives in the basin. Between 1990 and 2020, the population in the basin is expected to increase by 14% (MDNR 1997a).

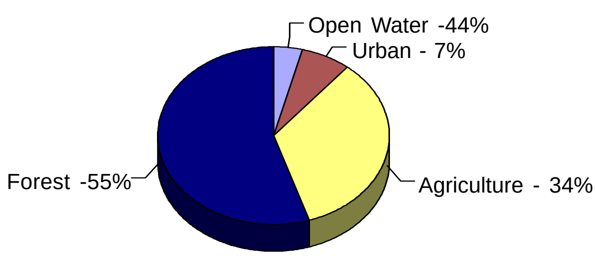


Figure 1. Percent landuse in the Youghiogheny basin (MOP 1994).

WATER QUALITY

Water quality in the basin varies from poor to excellent (MDNR 1996a), with most stream and river segments rated as good. Problems include high bacteria levels associated with raw sewage discharges and acid mine drainage from abandoned mines. Acid rain is also a problem in some parts of the basin due to naturally low buffering capacity.

The Maryland Department of the Environment (MDE) classifies all surface waters into 4 categories or "uses" (COMAR 1995). All waters of the state receive at least a Use I designation; that is, they are suitable for contact recreation, fishing, and protection of aquatic life and wildlife. This is the least protective use. Use II waters are suitable for shellfish harvesting, while uses III and IV are designated as natural and recreational trout waters, respectively. Special designations are given for waters protected for drinking water supplies.

Broadford Run and Piney Creek and all tributaries of each stream are protected for all Use I water uses. In addition, they are protected as public water supplies for the cities of Frostburg and Oakland. Several rivers and streams in the basin have more stringent protection than Use I. Use III waters include: the entire South Branch of the Casselman River and Piney Creek and all of its tributaries. The Youghiogheny River and all of its tributaries are protected as Use III plus protection for use as a public water supply. The only Use IV protected river in the basin is the Casselman River from the confluence of the North and South branches downstream to the Maryland-Pennsylvania line.

MDE has listed the following subwatersheds in the basin as impaired: Youghiogheny River, Little Youghiogheny River, Deep Creek, and the Casselman River. Nutrients, low pH, and suspended sediments are the primary stressors thought to be causing impairment in these subwatersheds. These pollutants originate from both non-point and natural sources.

What is Acid Rain?

Acid rain, or acid deposition, is a phenomenon that results from the burning of fossil fuels. The combustion of fossil fuels releases acid precursors such as carbon dioxide and nitrogen oxides into the atmosphere. These compounds combine with water and are oxidized to form nitric and sulfuric acids that can cause increases in rainfall acidity. Rainfall is considered to be acidic if its pH falls to less than 5.6. Acid precipitation can also be in the form of snow or fog. Annual average pH values for rain in the Allegheny Plateau is about 4.3 with measurements recorded as low as 2.8 (Baker et al. 1990).

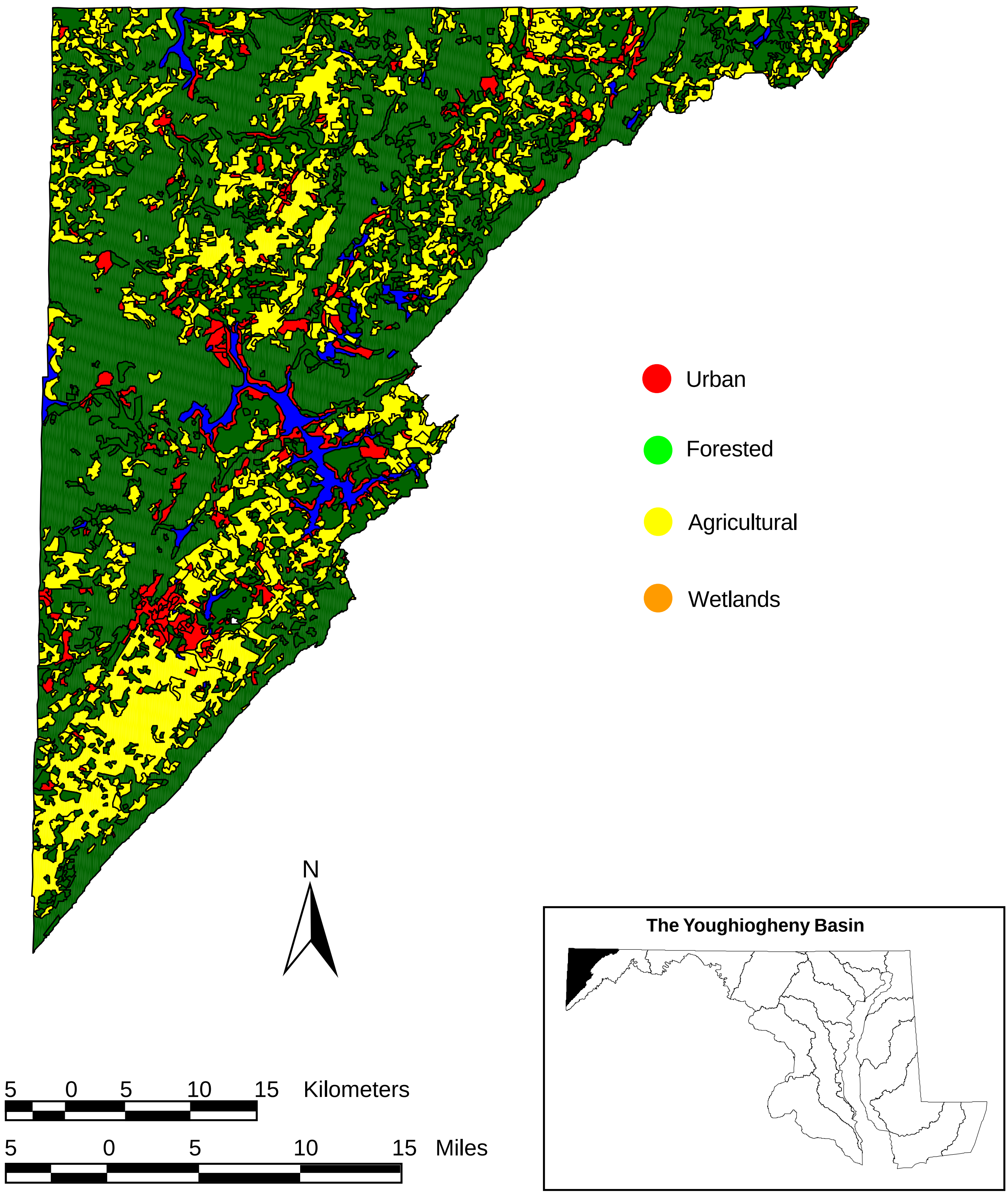


Figure 2. Landuse in the Youghiogheny basin (MOP 1995).

RESOURCE VALUES

Recreational and Ecological Resources

The Youghiogheny River basin has numerous publicly-owned lands that provide a broad range of recreational opportunities for residents and visitors. Recreational opportunities include canoeing, kayaking, hiking, boating, bicycling, camping, swimming, nature studies, skiing, hunting, snowmobiling, and fishing. There are over 26,000 acres of public land in the basin, including two state forests and four state parks. The oldest red oak in Maryland is living in the basin on Snaggy Mountain within the Garrett State Forest.

Swallow Falls State Park occupies 250 acres and is one of the most beautiful areas of Maryland. One of Maryland's last old growth forest is found in the park that features giant white pine and eastern hemlock that reach heights of over one hundred feet tall. A fifty-foot waterfall along muddy creek and ten miles of scenic hiking trails are other attractions of Swallow Falls State Park. Other state parks in the basin include Deep Creek Lake State Park, Herrington Manor State Park, and the Casselman River Bridge State Park.

Muddy Creek at Swallow Falls State Park.

Hunting is one of the main recreational attractions of the basin. Many citizens of Maryland and surrounding states head to the mountains of the basin in search of wild game. White-tailed deer, wild turkey, and ruffed grouse are abundant within the basin and there are thousands of acres of public land that are open to hunting.

Because of the extensive forests in the basin, few areas in Maryland have the quality and quantity of ecological resources that are found in the Youghiogheny basin. In addition to hunting and wildlife, outdoor enthusiasts can enjoy observing more than 100 species of birds that are known to nest in the basin (Robbins and Blom 1996). Bird watchers may enjoy seeing wild turkey, ruffed grouse, wood ducks, great blue herons, red-tailed hawks and other species.

There are an estimated 300 black bears in Maryland, many of which live in the Youghiogheny River basin. Shy and secretive black bears prefer the large expanses of forested land that are present throughout much of the basin. Other rarely seen animals that can be found in the basin are bobcats, fishers, coyotes, flying squirrels, and timber rattle snakes.

The Youghiogheny "A Wild River"

Twenty-one miles of the Youghiogheny River from Miller's Run to Friendsville were designated in 1976 as Maryland's first Wild River. North of Oakland, the river valley narrows, deepens, and becomes heavily forested. This section of the river is protected by the Forest and Park Service to preserve the wild and natural scenic, geologic, historic, ecological, recreational, fish, wildlife, and cultural resources. Many sites along the river are home to rare, threatened, or endangered plants and animals. The remote and rugged character of this section of river are partly responsible for the existence of at least eleven animal and fifteen plant species that are threatened or endangered on a statewide or national level. Most of the river lies within privately owned land but public access can be gained from Swallow Falls State Park or off of Sang Run Road.

Because of the river's remote character and outstanding white water, the river was designated as Maryland's first and only Wild River under the Wild and Scenic Rivers Program. There are about twenty Class IV and V rapids along the river, a challenge for even the most experienced of paddlers and rafters.

Extractable and Renewable Resources

Coal mining was an important industry in the basin as far back as the early 1900s. It is estimated that nearly 2100 acres of land at 91 sites and 182 stream miles have been disturbed by mining practices (MDNR 1973). Currently there are no working coal mine operations in the basin (MDE 1998). There are an estimated 287 million tons of coal reserves in the basin (MDNR 1975).

Timber resources in the basin are dominated by hardwoods including various oak species, black cherry, and tulip poplar.

Fishery Resources

Excellent recreational fishing opportunities are found in the Youghiogheny River, tributaries to the river, and in the lakes found in the basin. Deep Creek Lake and the Youghiogheny River Lake are popular fishing destinations for largemouth bass, yellow perch, black crappie, northern pike, chain pickerel, walleye, and a variety of panfish.

> ***Deep Creek Lake***
>
> Deep Creek Lake, the largest lake in Maryland, has many attractions to offer its visitors including skiing and snowboarding at the Wisp Resort, camping and swimming at Deep Creek State Park, and boating and fishing on the 3900 acres of the lake. Popular gamefish that can be caught from the lake include largemouth bass, smallmouth bass, northern pike, and a variety of panfish. Ice fishing is also a common form of recreation on the lake with yellow perch and walleye providing most of the action.

Many of the tributaries of the Youghiogheny River have abundant populations of native brook trout, and the mainstem Youghiogheny and Casselman Rivers are prime fly-fishing spots for brown and rainbow trout. In addition to the wild trout fishery, nearly 80,000 rainbow trout are stocked annually in 19 streams and lakes in the basin. A number of anglers fish for this species at Deep Creek Lake, Piney Reservoir, Bear Creek, Herrington Lake, Mill Run, Little Youghiogheny River, Youghiogheny River, and the Casselman River.

The basin has two special regulation trout fishing areas. The Casselman River from I-68 north to the state line is designated as a delayed harvest fishing area and angling is restricted to fly fishing and artificial lures. This section of the river is stocked with trophy sized rainbow and brown trout. Five miles of the mainstem Youghiogheny River from the Deep Creek Lake tail race is also designated as a fly-fishing and artificial lure catch and return trout fishing area.

> ***On the Fly...***
>
> Two organizations are working to preserve trout waters and promote fly fishing in Maryland. Trout Unlimited is a national organization that publishes Trout Magazine and conducts activities including habitat improvements, water quality monitoring, riparian reforestation, and bank stabilization. Free State Fly Fishers, established in 1974, promotes fly fishing in Maryland through education and conservation (ACB 1996).

CITIZEN INVOLVEMENT

During the last decade, an increasing number of concerned citizens have become involved in organizations and programs working to protect and restore Maryland's aquatic resources.

Trout Unlimited's Youghiogheny Chapter owns property along Bear Creek which provides access to fisherman and promotes the preservation of stream's riparian zone. The organization also sponsors annual stream clean up projects along the Casselman River and tributaries to the Youghiogheny River. Participation on a volunteer basis is encouraged and welcomed by the organization.

> To find out how to get involved in water quality monitoring and watershed issues in Youghiogheny River basin contact:
>
> **Trout Unlimited**
> 1) Youghiogheny Chapter
> PO Box 3026
> Swanton, MD 21561-0326
>
> 2) Nemocolin Chapter
> 29 N Front Street 2N FL
> Cumberland, MD 21502-2432
>
> **Free State Fly Fishers**
> PO Box 614
> Annapolis, MD 21401
>
> ...or check out the U.S. Environmental Protection Agency's website, Surf Your Watershed at http://www.epa.gov/surf/

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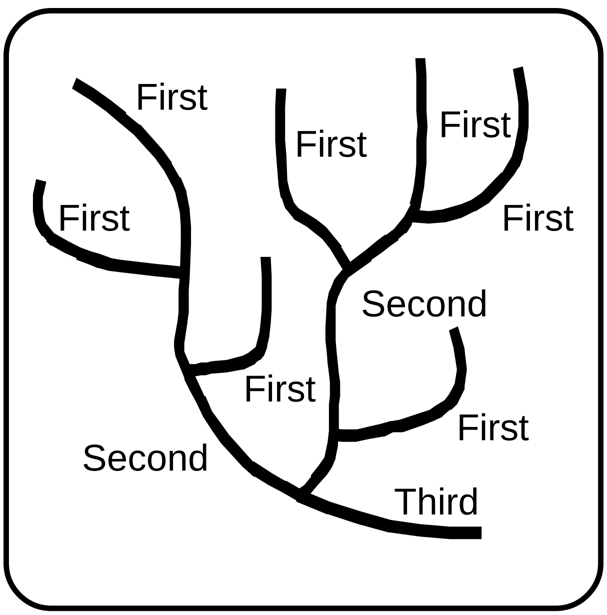
Maryland Biological Stream Survey

Chapter Three 3

This chapter briefly outlines the approach used by the MBSS to assess stream resources of the Youghiogheny River basin during 1995 and 1997. The sampling design used for this assessment differs from other stream surveys that have been conducted in Maryland. Randomly selected sampling sites on first, second, and third-order non-tidal streams (Strahler 1964) were chosen by computer rather than selected by the investigator. This approach allows estimates to be calculated for an array of ecological factors such as fish density and stream habitat condition. Non-randomly selected (supplemental) sites were also sampled in 1994, 1995, and 1997 to provide additional information on fish distributions. Figure 3 shows the quantitative and supplemental sites sampled in 1994, 1995, and 1997 in the basin as part of the MBSS.



STREAM ORDER

Stream order is a simple way to measure stream size. The smallest permanently flowing stream is termed first-order, and the union of two first-order streams creates a second-order stream. A third-order stream is formed where two-second order streams join. Stream order is directly related to watershed area.

After landowner permissions were obtained, sample sites were located with Global Positioning System (GPS) receivers, fish and benthic macroinvertebrates were collected, and physical habitat features were evaluated using methods patterned after EPA's Rapid Bioassessment Protocols (Plafkin et al. 1989). Reptiles, amphibians, and mussels were also surveyed on a presence/absence basis. Water quality was sampled using protocols previously established for acid rain studies in Maryland (MDNR 1988). Because the initial purpose of the MBSS was to assess the effect of acid rain on Maryland streams and rivers, other important water quality measures such as phosphorous and turbidity were not measured.

Because most stream sites in the Youghiogheny River basin were on private land, landowner permissions were sought for each randomly selected site. This procedure required contact with property owners, usually by phone. Overall, 76% of the landowners contacted in the basin gave DNR permission to have streams on their property sampled by the MBSS.

All catchments draining to MBSS sampling sites were delineated and land use (MOP 1994) was estimated for each. Throughout all sampling and data management activities, an extensive Quality Control program was employed. Additional technical information about the methods used to survey streams and survey results can be found in Appendices A through D of this report, in Roth et al. (1999), and in Kazyak (1996).

MBSS biologists prepare to sample a section of the Savage River.

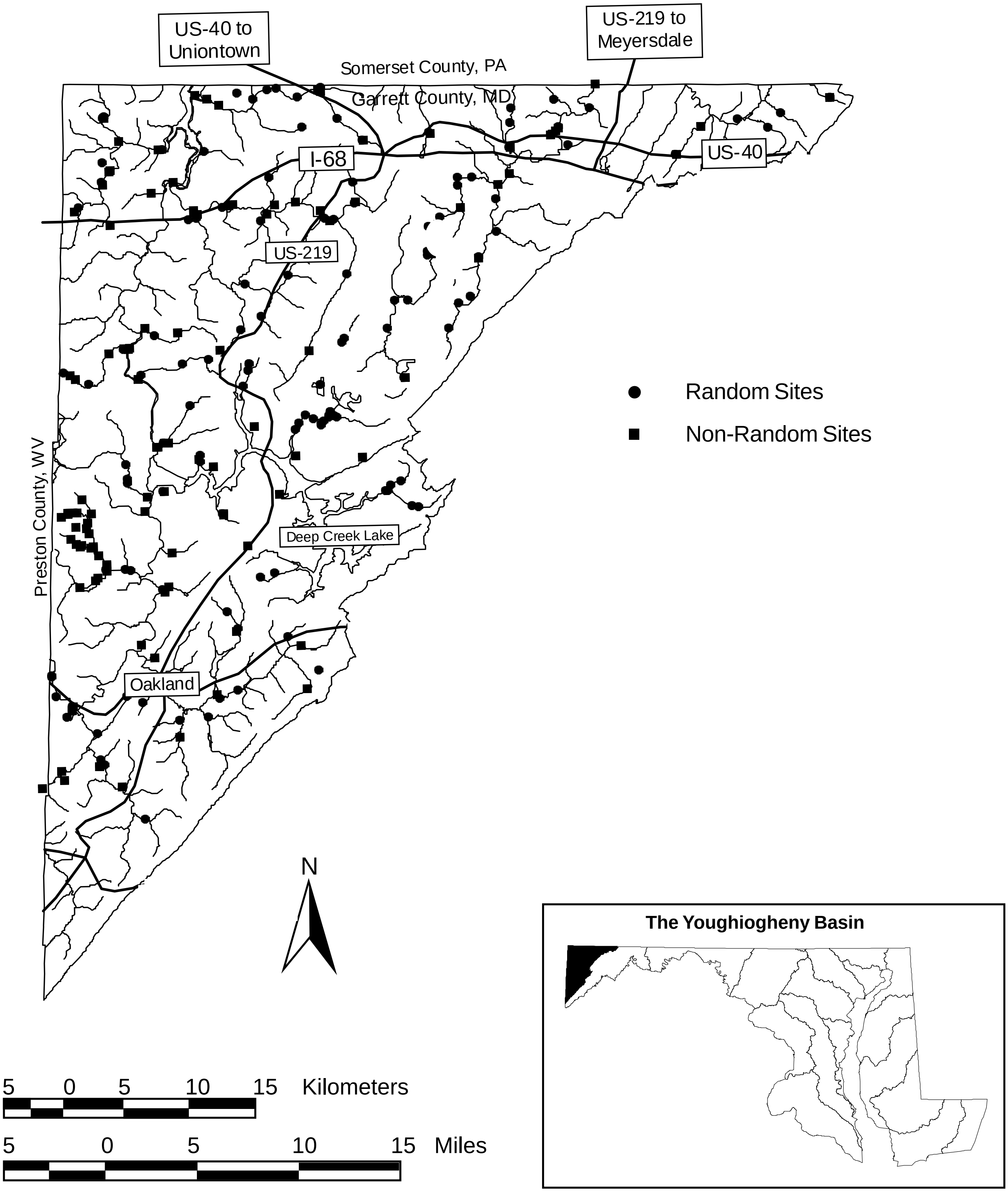


Figure 3. Location of 1994, 1995, and 1997 sites in the Youghiogheny basin. Major highways, population centers, and other features are shown for reference.

Maryland Biological Stream Survey

Current Status of Aquatic Resources

Chapter 4

This chapter uses 1994, 1995 and 1997 Maryland Biological Stream Survey (MBSS) data from 111 randomly-selected sampling sites and 117 non-randomly selected (fish only) sampling sites in the Youghiogheny River Basin to describe the current status of wadeable streams. It is important to note that because most sites were selected randomly, portions (such as the uppermost reaches of the Youghiogheny River and small tributaries of the mainstem Youghiogheny River) of the basin may have few or no sites. During the next round (2000 to 2004) of the survey, MDNR will address gaps in data from the current round (1995-1997) and will target certain streams for sampling.

GENERAL CHARACTERISTICS OF YOUGHIOGHENY RIVER BASIN STREAMS

All sampling sites were within the Appalachian Plateau where streams tend to be of moderate to high gradient with riffles that aerate the water. Stream gradient ranged from 0.1% to 8%. A stream with a 10% gradient drops 10 meters in elevation for every 100 meters of stream channel length. Stream width varied from 1 meter (a stream you could easily jump across) to 20 meters (about as wide as a 4 lane highway).

> Dissolved oxygen (DO) is one of the most basic requirements of aquatic organisms, thus DO levels play an important role in shaping biological communities in streams. DO in streams may be low due to nutrient-rich runoff and groundwater inputs from urban and agricultural areas, oxygen demanding organic chemicals in point source discharges, or the breakdown of naturally-occurring organic material such as leaves. The State of Maryland has established a minimum surface water criterion of 5 milligrams per liter (mg/L, also known as parts per million) for DO. When DO is low (i.e., less than 5 mg/L), only those organisms adapted to low DO can persist. In the Ridge and Valley Province, streams typically have riffles, where water bubbles over rocks. Riffles help to keep DO levels high by aerating the water. During MBSS summer sampling, dissolved oxygen is measured only once during the day. In heavily impacted streams, DO may drop severely during the early morning hours because oxygen production from plants ceases at night while oxygen consumption by both plants and animals continues.

WATER QUALITY

Dissolved Oxygen

About 3% of the stream miles in the basin had dissolved oxygen levels below the state water quality criterion of 5 mg/L (COMAR 1995). This suggests that runoff of oxygen-demanding materials into the basin streams does not produce widespread DO-related problems in streams of the basin. However, these materials do contribute to the oxygen problems found in the Gulf of Mexico.

> Acidity is an important aspect of stream health. The balance between free hydrogen ions (which increase acidity) and negative ions (which decrease acidity) is measured as pH. The capacity of soil or water to absorb acids without changing the ion balance is known as its buffering capacity, measured as alkalinity or Acid Neutralizing Capacity (ANC). Streams with ANC less than 0 µeq/L are acidic and have no buffering capacity. Streams with baseflow ANC between 0 and 200 µeq/L are only moderately buffered and may periodically have low pH levels during rain or snowmelt events. Those streams with ANC greater than 200 µeq/L are well-buffered. Under acidic conditions, certain metals such as aluminum are dissolved into water and reach levels that can be lethal to aquatic organisms. Acidity in streams is affected by rain, snow, fog, and atmospheric dust, geology and soil characteristics, and organic matter.
>
> Acidification of streams can be either chronic (i.e., year-round) or episodic (seasonal or storm event-related), depending on the capacity of the stream to buffer acid inputs. Chronically acidified streams generally contain only those organisms highly tolerant of acid conditions. In contrast, streams which are only episodically acidified can and often do support less tolerant "invaders" from better buffered downstream areas during summer low flow periods.

pH and Buffering Capacity

Most (93%) of the stream miles of the basin had pH values greater than 6, indicating that acidity is not a chronic, widespread problem (Figure 4). Significant adverse impacts on aquatic life are known to occur for some species when pH values drop below 6, and for most species at pH less than 5. About 6% of the stream miles in the basin had ANC values less than 0 µeq/L, indicating that a low percentage of the streams were chronically acidified. About 49% of the stream miles had ANC values less than 200 µeq/L and thus may be susceptible to periodic acidification. Streams with ANC values greater than 200 µeq/L are considered well buffered.

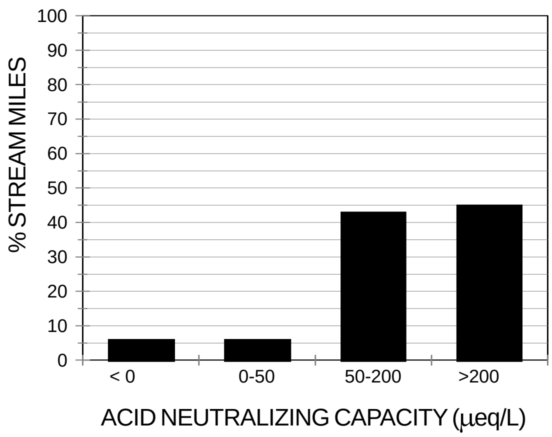


Figure 4. Acid neutralizing capacity (ANC) in wadeable streams of the Youghiogheny basin, 1995 and 1997.

Nitrates and Dissolved Organic Carbon

Two important indicators of the sources of acidity in Maryland streams are nitrate and dissolved organic carbon (DOC).

One important source of nitrates in Maryland streams is deposition from the atmosphere. However, leaching into groundwater and direct runoff of fertilizers and animal wastes used on agricultural lands, discharges from sewage treatment plants, and leaking of septic systems are more important sources of nitrates to streams. Stream nitrate concentrations greater than 1 mg/L are elevated compared to undisturbed streams (Morgan 1995).

The primary source of DOC in streams is leachate from decaying leaves and other plant material that are natural sources of organic matter found within the stream drainage network itself, especially wetlands. DOC concentrations greater than 10 mg/L indicate that organic acids contribute significantly to overall acidity, but DOC levels between 5 and 10 mg/L also indicate that natural sources are contributing to overall acidity in a stream (Morgan 1995).

About 15% of the stream miles in the basin had nitrate values greater than 1 mg/L, indicating that excess nutrients are a moderate problem (Figure 5). Because these results represent primarily spring baseflow conditions, and by inference groundwater concentrations, reductions in nitrate loading in the basin may not be apparent for many years to decades until groundwater sources are purged of their relatively high nitrogen levels, even if point and non-point sources of nitrates are reduced in surface waters.

All of the stream miles in the basin had DOC levels less than 5 mg/L, indicating that wetland areas are not a major influence on stream water quality in the basin.

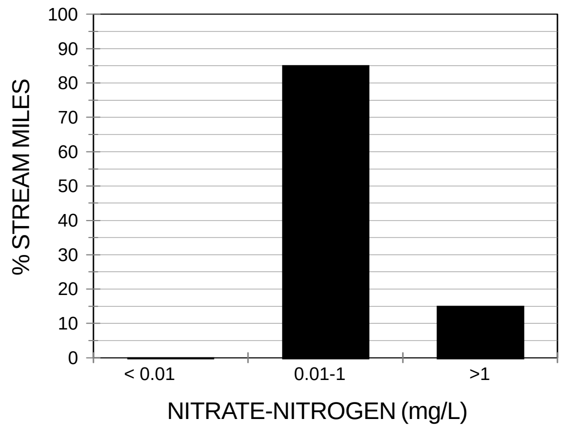


Figure 5. Nitrate concentrations in wadeable streams of the Youghiogheny basin, 1995 and 1997.

PHYSICAL HABITAT

Many physical habitat characteristics of streams are important determinants of ecosystem structure and function. Although a large number of physical habitat variables were measured by the MBSS, they can be grouped into four general categories: instream habitat, channel characteristics, riparian zone, and aesthetics/ remoteness. Most variables are classified (in order of decreasing habitat quality) as Good, Fair, Poor, or Very Poor. A description of selected MBSS physical habitat variables is included in Appendix D.

What is habitat?
The physical/chemical theater in which the ecological play takes place; it is a template for the biota, their interactions, and their evolution (ITFM 1995).

Instream Habitat

The complexity and stability of habitat in a stream typically has a strong relationship with abundance and diversity of biological communities that occur there.

Important instream habitat characteristics include: 1) quality and composition of the stream bottom; 2) diversity of depths and flows; 3) amount and quality of stable habitat for fish shelter; and 4) amount and quality of attachment sites for benthic macroinvertebrates.

Thirty-four percent of the stream miles in the basin were rated as Poor or Very Poor for instream habitat (Figure 6). Most instream habitat problems result from the removal of woody debris from stream channels, increased sedimentation, and modification of stream channels due to increased runoff. All three often occur when lands are developed for agricultural uses.

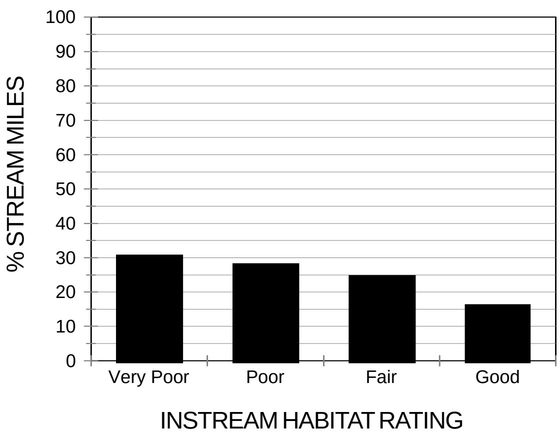


Figure 6. Instream habitat condition in wadeable streams of the Youghiogheny basin, 1995 and 1997.

Increased sediment loads tend to reduce the complexity and stability of the stream bottom, resulting in loss of habitat for fish. Another common occurrence is the coating or burial of stones in riffle areas. Since many benthic macroinvertebrates such as mayflies and stoneflies use the spaces between rocks as living quarters, high sediment loads reduce the amount of available habitat and reduce benthic macroinvertebrate diversity and abundance in streams. About 23% of the stream miles in the Youghiogheny River basin were rated as Poor or Very Poor based on embeddedness, while nearly 50% were rated as Good (Figure 7).

Another impact to instream habitat quality may be a reduction in the abundance of wood (i.e., large woody debris such as logs, limbs, and rootwads) along stream banks and in stream channels. Wood in streams may greatly enhance habitat quality for both fish and benthic

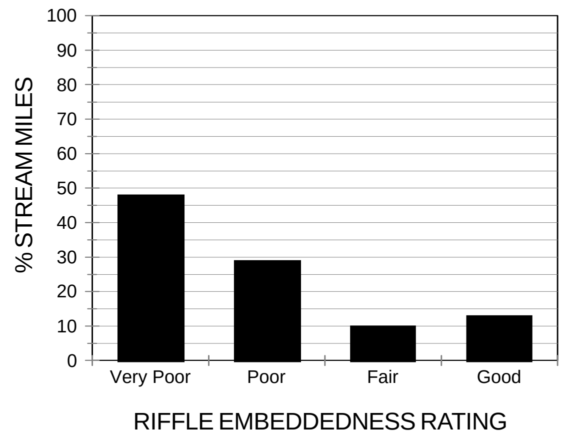


Figure 7. Riffle embeddedness ratings in wadeable streams of the Youghiogheny basin, 1995 and 1997.

macroinvertebrates by providing a diverse array of shelter, depths, and velocities. Woody debris also traps and retains leaves, a vital food supply for many benthic macroinvertebrates. Undisturbed streams in naturally-forested areas generally contain a great deal of woody material. While 74% of the sample streams contained at least one rootwad or woody debris, only 11% of the streams sampled contained more than 1 rootwad or woody debris per 30 feet of stream channel (Figure 8). As a measure of comparison, the shape and stability of 80% or more of stream channels with old growth forests is often determined by the amount and placement of wood (Maser and Sedell 1994).

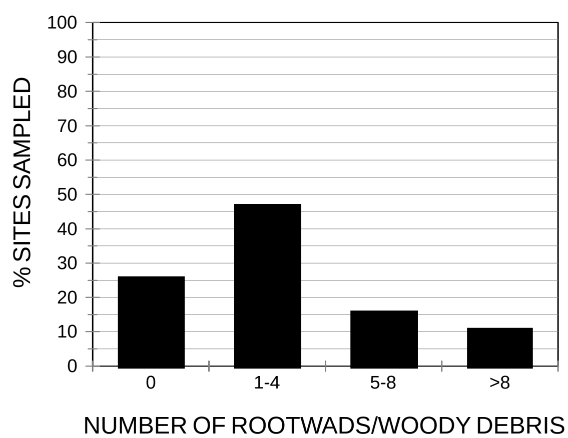


Figure 8. Percent of sites sampled in the Youghiogheny basin containing rootwads and woody debris, 1995 and 1997.

About 3% of all stream miles in the basin are artificially straightened and channelized. During channelization, trees in the riparian zone are often cut and woody debris is removed from the stream channel to allow for efficient movement of water away from agricultural fields and housing developments. As a result, heavily-channelized streams are generally shallow, with little habitat for living resources. Another cause of the reduced abundance of woody debris and rootwads in the basin is related to prevailing forestry practices. In today's managed forests, trees are rarely allowed to achieve senescence (old age and natural death). Thus, one of the vital and controlling elements of instream habitat (large dead trees and tree limbs) is largely prevented from entering the aquatic environment.

Channel Characteristics

Large-scale disturbance in the stream channel may result from watershed development or channel modification. Evidence of stream channel disturbance includes excessive bar formation, the presence of artificial structures (i.e., concrete armoring and rip-rap), channel dewatering for irrigation and other uses, and severe bank erosion.

As landscapes change through the development of land for agriculture and/or urbanization, stream channels can be destabilized, resulting in highly eroded banks and sand/silt bars in slow moving areas. Most of the stream banks in the Youghiogheny basin were stable (70%), while only 2% of the stream miles had banks that were classified as unstable (Figure 9).

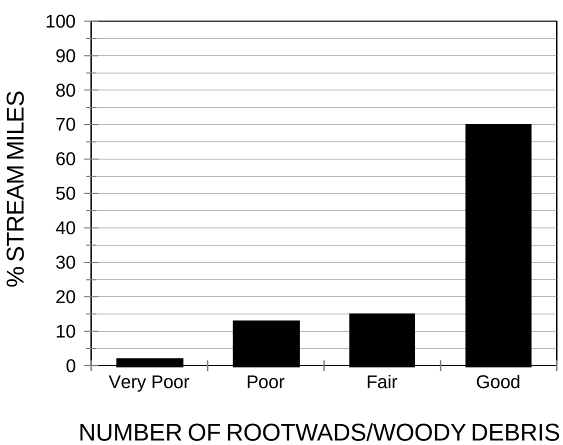


Figure 9. Bank condition in wadeable streams of the Youghiogheny basin, 1995 and 1997.

Riparian Zone

The riparian zones of the Youghiogheny River basin were in Fair condition. About one half (50%) of all stream miles had vegetated riparian zone widths greater than 50 meters (Figure 10). Riparian buffers consisted of forest in about 72% of all stream miles. Forested riparian zones provide habitat for corridor-dependent species, leaf litter, and woody debris to the stream channel. About 26% of the stream miles in the basin had no vegetated buffer and thus were not protected against runoff.

> Riparian zones are the areas alongside streams, rivers, and other water bodies. When these areas are vegetated, they play a vital role in structuring and maintaining physical habitat, energy flow, and aquatic community composition. Vegetated (trees, shrubs, and grasses) riparian zones act as buffers by decreasing runoff and preventing particulate pollutants from entering streams (Plafkin et al. 1989). Trees and shrubs also provide energy inputs to the stream in the form of leaf litter and woody debris, stabilize stream channels, supply overhead and instream cover for fishes and other aquatic life, and moderate stream water temperature.

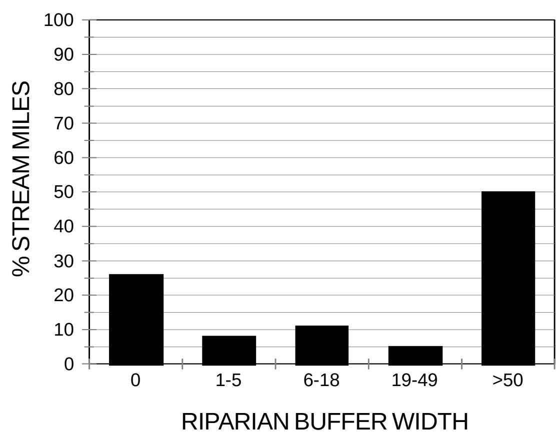


Figure 10. Riparian buffer width along wadeable streams of the Youghiogheny basin, 1995 and 1997.

The presence of trees in riparian zones is reflected in the amount of shading evident in the sampled streams. About 66% of all stream miles of the basin were well-shaded. Forest cover along streams greatly decreases exposure of the stream channel to direct sunlight and helps prevent warming of stream waters above their natural condition. Riparian forests also reduce the amount of nutrients that are exported from watersheds.

Aesthetics/Remoteness

Most stream miles in the basin were rated as either Fair (20%) or Good (65%) based on the amount of human refuse present (Figure 11). Nearly half (48%)

of the stream miles in the basin were rated as Good or Fair for remoteness. In contrast, nearly 30% of the stream miles were immediately adjacent to roads.

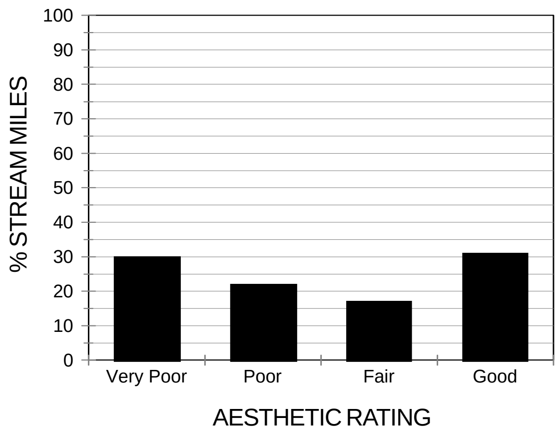


Figure 11. Aesthetic rating in wadeable streams of the Youghiogheny basin, 1995 and 1997.

FISHERY RESOURCES

General Description

A total of 36 fish species representing 8 families were collected in the Youghiogheny River basin in first, second, and third-order streams during 1994, 1995 and 1997 (Appendix E). Fish sampling was conducted at 111 random sites and at 117 non-random (presence/absence) sites. Fish were present at 84% of the random sites sampled. The total abundance of fish in first through third-order streams in the basin was about 2.5 million. Basin-wide estimates of population abundance for individual species ranged from less than 600 individuals for green sunfish, to over 900,000 for mottled sculpin (Table 1). The six most abundant species in the basin were mottled sculpin, blacknose dace, creek chub, brown bullhead, white sucker, and brook trout (Figure 12).

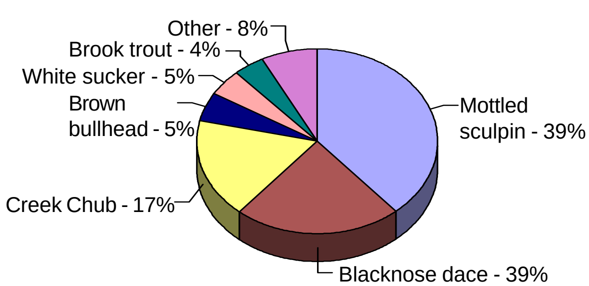


Figure 12. Percent abundance of the six most common fish species of the Youghiogheny basin, 1995 and 1997.

Consistent with the presence of mostly cool water habitat in the basin, the minnow family (Cyprinidae) had the greatest number of fish species (12) followed by the sunfish family (Centrarchidae) with 8 species. Twelve of the species that were collected are not native to the basin.

Gamefish

Seven species of gamefish were collected in the basin. Of these, brook trout and brown trout were the most abundant. Brook trout had an estimated density of 270 per stream mile and a total population estimate of about 100,000. Over 25% of the brook trout collected were of harvestable size (greater than 6 inches). Brown trout had an estimated density of 10 per stream mile and a total population of about 3600 individuals. Nearly 75% of the brown trout collected were of harvestable size. Largemouth bass and smallmouth bass were the next most abundant gamefish species collected, with estimated total abundances of about 3000 and 2000 individuals respectively. None of the largemouth bass and smallmouth bass collected were of legal size (12 inches or larger). The reason that only small largemouth bass and smallmouth bass were collected in streams of the Youghiogheny River basin may be that stream habitat in the basin is not well suited for residence by adults and that many of the largemouth collected were escapees from lakes and ponds in the basin.

Rainbow trout and chain pickerel were the least abundant gamefish collected, with estimated abundances of 800 and 700 respectively. Over 50% of the rainbow trout that were collected were of harvestable size.

The stonecat, *Noturus flavus*, is listed as highly rare by the Maryland DNR and is only found in the Casselman River

Rare and Uncommon Species

None of the fish species collected in the basin are presently listed as threatened, rare, or endangered by

Table 1. Estimated total abundance and percentage occurrence of fish species collected in the Youghiogheny basin in 1994, 1995, and 1997 (first through third-order streams combined) and a comparison of species collected at random versus non-random sites.

Family Common Name	(*Scientific Name*)	Sampling Occurrence2	Percentage Occurrence[3,4]	Population Estimate[4]	Standard Error
Cyprinidae					
Blacknose Dace	(R*hinichthys atratulus*)	B	60.53	544,142	136,480
Bluntnose Minnow	(*Pimephales notatus*)	B	9.65	29,834	23,758
Central Stoneroller	(*Campostoma anomalum*)	B	8.33	3,400	2,340
Common Carp	(*Cyprinus carpio*)	N	0.44		
Common Shiner	(*Luxilus cornutus*)	B	4.82	3,154	3,694
Creek Chub	(*Semotilus atromaculatus*)	B	59.21	423,599	99,167
Fathead Minnow	(*Pimephales promelas*)	B	4.39	1,806	1,499
Golden Shiner	(*Notemigonus crysoleucas*)	B	11.84	1,533	828
Longnose Dace	(*Rhinichthys cataractae*)	B	24.56	35,114	18,278
River Chub	(*Nocomis micropogon*)	B	18.86	7,340	2,781
Spotfin Shiner	(*Cyprinella spiloptera*)	N	0.44		
Striped Shiner	(*Luxilus chrysocephalus*)	B	7.89	5,922	3,209
Catostomidae					
Northern Hogsucker	(*Hypentelium nigricans*)	B	11.84	2,962	1,281
White Sucker	(*Catostomus commersoni*)	B	54.39	113,253	66,167
Ictaluridae					
Brown Bullhead	(*Ameirus nebulosus*)	B	12.72	122,860	100,014
Stonecat	(*Noturus flavus*)	N	1.32		
Yellow Bullhead	(*Ameiurus natalis*)	B	2.63	1,600	1,311
Salmonidae					
Brook Trout	(*Salvelinus fontinalis*)	B	29.82	101,033	26,822
Brown Trout	(*Salmo trutta*)	B	21.05	3,596	1,626
Rainbow Trout	(*Oncorhynchus mykiss*)	B	10.09	899	508
Cottidae					
Mottled Sculpin	(*Cottus bairdi*)	B	51.75	940,747	231,933
Centrarchidae					
Black Crappie	(*Pomoxis nigromaculatus*)	N	0.88		
Bluegill	(*Lepomis macrochirus*)	B	12.72	1,641	1,215
Green Sunfish	(*Lepomis cynellus*)	B	1.75	531	359
Largemouth Bass	(*Micropterus salmoides*)	B	10.96	2,693	1,526
Lepomis Hybrid		R	0.44		
Pumkinseed	(*Lepomis gibbosus*)	B	24.12	9,640	5,247
Rock Bass	(*Ambloplites rupestris*)	B	19.30	5,278	2,134
Smallmouth Bass	(*Micropterus dolomieu*)	B	12.72	1,856	2,470
White Crappie	(*Pomoxis annularis*)	N	0.44		
Percidae					
Greenside Darter	(*Etheostoma blenniodes*)	N	0.44		
Johnny Darter	(*Etheostoma nigrum*)	B	13.60	44,924	68,316
Tessellated Darter	(*Etheostoma olmstedi*)	N	0.88		
Yellow Perch	(*Perca flavescens*)	B	3.95	18,858	14,941
Esocidae					
Chain Pickerel	(*Esox niger*)	B	4.82		
Redfin Pickerel	(*Esox americanus*)	B	3.07	1,009	669
Northern Pike	(*Esox lucius*)	R	0.44		
Total Abundance for all Fish Species[2,3]			2,429,218	818,573	

[1] **R** indicates species was collected from only random sites, **N** indicates species was collected from only non-random sites and no population estimates could be calculated, and **B** indicates species was collected from random and non-random sites.

[2] % of all random and non-random sites where each species was collected.
[3] Total abundance (number per basin) adjusted for capture efficiency (Heimbuch, et al. 1997).

[4] Non-random site information was not used in calculating population estimates.

the U.S. Fish and Wildlife Service. Only one species, the stonecat (*Noturus flavus*), is listed by the Maryland DNR as highly rare and in need of conservation (MDNR 1997). The stonecat is only found in the 4th order reaches of the Casselman River.

STREAM QUALITY BASED ON AN INDEX OF BIOTIC INTEGRITY

MDNR recently developed an Index of Biotic Integrity (IBI) for non-tidal stream fish (Roth et al. 1997) and benthic macroinvertebrate (Stribling et al. 1998) communities that are effective tools for evaluating ecological conditions in streams. Using these IBIs, various characteristics of the fish and benthic community are compared to results from high quality reference streams and scored. The summary score is then used to assess ecological conditions of streams in the basin as Good, Fair, Poor, or Very Poor.

Based on MDNR's fish Index of Biotic Integrity (IBI), about 24% of the stream miles in the Youghiogheny River basin were in Good condition, about 24% of the stream miles were in Fair condition, about 10 % of the stream miles were categorized as Poor, and 16% of the stream miles were rated as Very Poor (Figure 13). About 26% of the stream miles could not be rated because fish communities are neither abundant nor diverse in very small, even relatively pristine streams.

Because MDNR's IBI rates streams with high abundance and high diversity more favorably than stream with fewer species and lower numbers of fish (such as the many coldwater trout streams in the Youghiogheny River basin), the current approach may underestimate the biotic integrity of the cold water streams of basin. Like some other states that are using IBIs to assess water quality and habitat condition in their water bodies (e.g., Ohio and Wisconsin), MDNR is working to develop and apply a separate IBI for fish communities in coldwater streams.

BENTHIC MACROINVERTEBRATES

Benthic macroinvertebrates, or more simply "benthos", are animals without backbones that are larger than 0.5 millimeter (the size of a pencil dot). These animals live on rocks, logs, sediment, debris, and aquatic plants during some period in their life. The benthos include crustaceans, such as crayfish; mollusks, such as clams and snails; aquatic worms; and the immature forms of aquatic insects such as stonefly and mayfly nymphs.

Of the approximately 350 genera of stream-dwelling benthic macroinvertebrates in Maryland, more than one-half (188) were found in the Youghiogheny River basin. Dominant genera, and their respective percentage occurrence (among all sites in the basin) were: *Parametriocnemus* (a non-biting midge; 81%), *Ephemerella* (a mayfly; 78%), *Amphinemura* (a stonefly; 71%), and *Leuctra* (a stonefly; 68%). Twenty-eight percent of the taxa collected were collected at only one site and 42% of the taxa were collected at only two sites. The total number of benthic genera per sample ranged from 8 to 37 among all sites in the basin. For comparison, the number of benthic genera in a good quality stream could exceed 100. A list of all benthic groups collected in the basin is found in Appendix F.

MDNR has developed a benthic macroinvertebrate Index of Biotic Integrity (IBI) for Maryland streams that is similar to the fish IBI described earlier. The benthic IBI includes 9 metrics that measure diversity, pollution sensitivity, feeding modes, and habit. Benthic IBI scores range from 1 (worst) to 5 (best). About one-third (34%) of all stream miles were rated as Good and over half of the stream miles were rated as Fair (53%). Nine percent of the stream miles were rated as Poor and only 4% of the stream miles were rated as Very Poor.

REPTILES AND AMPHIBIANS

Reptiles and amphibians were found at 88% of the random sites sampled in the Youghiogheny River basin in 1995 and 1997. Six frog, one turtle, ten salamander and three snake species were observed (Table 2; next page). Mountain dusky salamander, northern dusky salamander, green frog, and northern two-lined salamander were the most common species, occurring at 34%, 31%, 21%, and 15% of the sites, respectively.

Table 2. List of herpetofauna observed in the Youghiogheny basin, 1995 and 1997.

		Frequency of Occurrence
Frog and Toads		
American toad	(*Bufo americanus*)	3.6
Bullfrog	(*Rana catesbeiana*)	0.9
Green frog	(*Rana clamitans melanota*)	23.4
Northern spring peeper	(*Pseudacris crucifer crucifer*)	0.9
Pickerel frog	(*Rana palustris*)	4.5
Wood frog	(*Rana sylvatica*)	4.5
Turtles		
Common snapping turtle	(*Chelydra s. serpentina*)	1.8
Salamanders		
Long tailed salamander	(*Eurycea longicauda*)	2.7
Mountain dusky salamander	(*Desmognathus ochrophaeus*)	29.7
Northern dusky salamander	(*Desmognathus f. fuscus*)	35.1
Northern two-lined salamander	(*Eurycea bislineata*)	13.5
Red salamander	(*Pseudotriton ruber*)	20.0
Red spotted newt	(*Notopthalmus v. viridescens*)	4.5
Redback salamander	(*Plethodon cinereus*)	8.1
Seal salamander	(*Desmognathus monticola*)	9.0
Northern slimy salamander	(*Plethodon glutinosus*)	5.4
Northern spring salamander	(*Gyrinophilus p. porphytiticus*)	4.5
Snakes		
Eastern garter snake	(*Thamnophis s. sirtalis*)	2.7
Northern water snake	(*Nerodia s. sipedon*)	8.1
Smooth green snake	(*Opheodrys vernalis*)	0.9
Queen Snake	*(Regina septemvittata)*	0.9

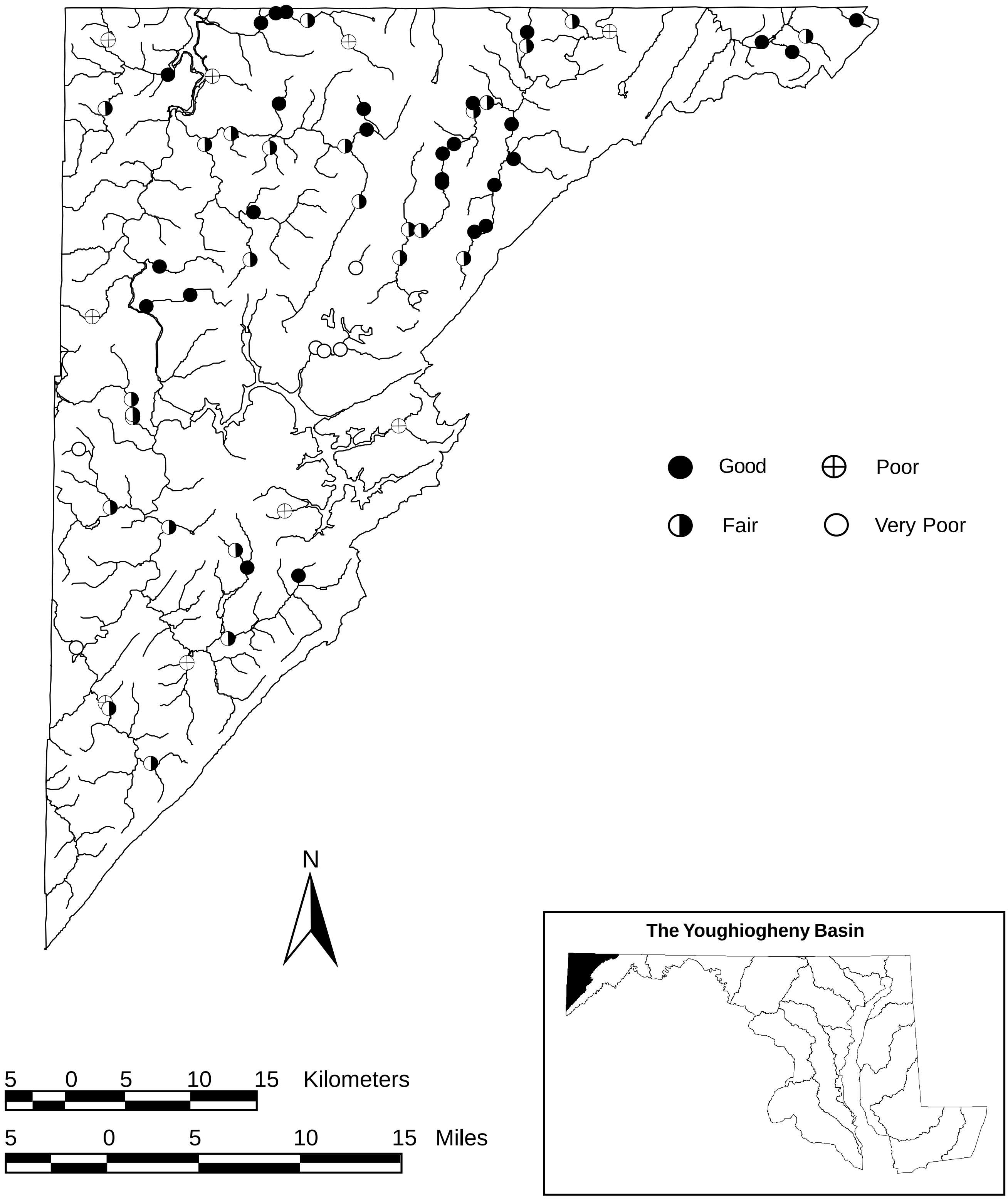


Figure 13. Stream ecological conditions in the Youghiogheny basin (1995 and 1997) based on the fish Index of Biotic Integrity (IBI). IBIs were calculated only for random sites, shown here.

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Maryland Biological Stream Survey

Summary of Stream Resource Conditions

Chapter Five 5

Information from the Maryland Biological Stream Survey provides a snapshot of living resources, stream conditions, and major stressors to the aquatic habitat in the Youghiogheny River basin. MBSS' onetime measurements of dissolved oxygen, pH, and acid neutralizing capacity indicate acceptable levels of water quality. The only violations of state water quality standards that were observed were low dissolved oxygen levels at an estimated 3% of the stream miles of the basin. Although low pH does not appear to be a problem in the basin, about 62% of the stream miles of the basin were determined to be sensitive to acidification (ANC <200 μeq/L). Acidity in streams is affected by rain, snow, fog, atmospheric dust, geology and soil characteristics, and organic matter. One reason that there is a high percentage of acid sensitive streams in the basin is the inability of many of the rock types of the basin to absorb acids. Urbanization is not a major influence on water quality in the basin. Only 7% of the of the basin is classified as urban land use, while 55% of the basin is forested.

Although water quality in the basin appears to be good, about one-third of the stream miles had either Poor or Very Poor instream habitat condititons. Causes for degraded instream habitat include destruction of vegetated riparian corridors, channelization, excessive siltation, and groundwater withdrawal. About 26% of the stream miles in the basin were rated as having no functional riparian buffer, reducing the ecological integrity of the stream and threatening downstream areas as well. This lack of protective vegetation along streams is an obvious starting point in the restoration process, because fully-functioning riparian buffers improve water quality, physical habitat, and living resources.

Fish species richness was moderately high (36 species in 8 families) and seven species of gamefish were collected. Most of the fish species in streams of the Youghiogheny River basin are fairly pollution tolerant. Possible sources of such pollution are the modification of physical habitat and water quality through channelization and acid sources such as abandoned mine drainage and acid rain.

About one-third of the fish species observed in the basin, including brown trout, rainbow trout, pumpkinseed, yellow perch, and fathead minnow, are not native to the Youghiogheny River drainage, although they are naturalized in Maryland. Most, if not all, were introduced by fisheries managers or anglers. From a recreational aspect, some of these introductions have been beneficial, but ecological impacts (such as the reduction in native brook trout abundance throughout its range) have occurred and will continue. Unfortunately, there is little historical information about fish communities in basin streams. Therefore, it is difficult to determine how the introduction of non-native fishes has influenced the distribution and abundance of native fish species in the basin. The 1994, 1995 and 1997 MBSS results establish a useful benchmark of current fish species composition, distribution, and abundance that can be used to track future changes.

Based on the fish IBI, nearly half (48%) of the stream miles of the basin were rated as Good or Fair. Benthic macroinvertebrate community analyses suggest that there are more Good or Fair stream miles in the basin (87%) than indicated by the fish IBI. A possible reason for differences between the fish IBI and benthic IBI scores could be that fish and macroinvertebrates respond differently to different stressors.

The amount of rain and snow falling onto a watershed may be an important factor in shaping the biological community of a stream. Dry, low flow periods are considered stressful for stream life due to higher water temperatures and reduction in the amount of available habitat. Conversely, extremely heavy rainfall and high flows may result in large-scale changes in physical habitat, temporarily lethal water quality condition, mortality of bottom species because of crushing by moving rocks, and transport of aquatic animals to less favorable habitats.

Total rainfall in the Youghiogheny River basin was significantly higher than the yearly average in 1994 (21%), lower than the yearly average in 1995 (-13%), and slightly higher than the yearly average in 1997

(6.4%) (Figure 14). During the driest of the three years, 1995, eight months had below average rainfall. The period of March through July, 1995, had 35% less rainfall than the average for that time period. During the wettest of the three years, 1994, only 4 months had below average rainfall. The period of January through May, 1994 had 62% more rainfall than the average for that time period. Intensive wet or dry periods could have caused significant stress to the streams and biota in the basin. However, without long term data on rainfall, stream flow, and ecological conditions, it is difficult to determine relationships among these environmental factors and stream quality. When the MBSS is repeated in future years, more light will be shed on this important subject.

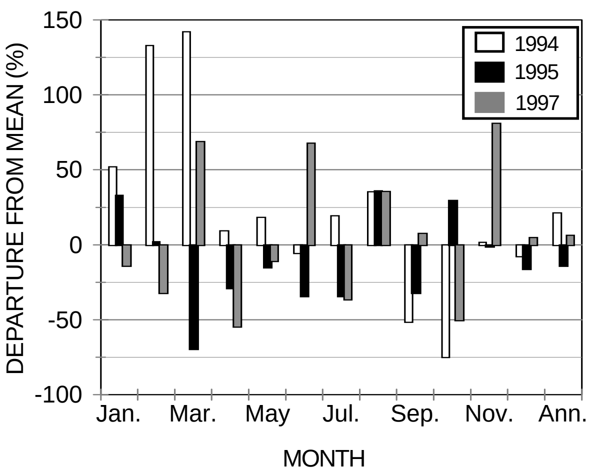

Figure 14. Monthly rainfall in the Youghiogheny basin (1994 1995 and 1997). Bars indicate the departure, expressed as a percentage, from the average monthly rainfall from 1960 through 1997.

Given the level and types of stream impacts noted in 1994, 1995 and 1997, and the projected changes in land use, human population size and water demands in the Youghiogheny River basin, the biological communities and other ecological attributes of stream in the basin will likely become more degraded in years to come. Comprehensive implementation of best management practices (BMPs), such as riparian zone protection and reforestation, may partially offset these impacts. It is important to note that BMPs may reduce, but do not eliminate, the ecological impacts of human disturbance.

This report clearly demonstrates that valuable stream resources still exist in the Youghiogheny River basin. However, in many ways, the basin still suffers from mistakes of the past. With the exception of a 37 acre grove of eastern hemlock in Swallow Falls State Park, the entire basin has been logged, including riparian zones. As a result, unstable stream channels are present, physical habitat is degraded, and even forested streams carry elevated sediment loads. These problems can be lessened or eliminated, but great cost and many decades may be involved. Over time, we must work to restore conditions in the Youghiogheny River basin for future generations. At the same time, however, we also need to make a concerted effort to protect and enhance the remaining high quality resources in the basin and elsewhere in Maryland. Only in this way can we learn to exist in a sustainable manner.

LITERATURE CITED

ACB. (Alliance for the Chesapeake Bay) 1996. Watershed Directory; 1996 Edition. A guide to citizen, river, and watershed organizations working in the Chesapeake Bay watershed. Towson, Maryland.

COMAR. 1995. Code of Maryland Regulations. Maryland Department of the Environment. Baltimore, Maryland..

Heimbuch, D.G., H.T. Wilson, S.B. Weisburg, J.H. Volstad, and P.F. Kazyak. 1997. Estimating fish abundance in stream surveys by using double-pass removal sampling. Transactions of the American Fisheries Society 126:795-803.

ITFM. 1995. The strategy for improving water-quality monitoring in the United States. Final report of the Intergovernmental Task Force on Monitoring Water Quality. Intergovernmental Task Force on Monitoring Water Quality. Reston, Virginia.

Jenkins, R. and N. Burkhead. 1994. Freshwater fishes of Virginia. American Fisheries Society. Bethesda, Maryland.

Kazyak, P.K. 1996. Maryland biological stream survey sampling manual. Maryland Department of Natural Resources. Monitoring and Non-Tidal Assessment Division. Annapolis, Maryland.

Maser, C. and J.R. Sedell. 1994. From the forest to the sea: the ecology of wood in streams, rivers, estuaries, and oceans. St. Lucie Press. Delray Beach, Florida.

MDE. 1998. Seventy-fifth annual report of the Maryland Bureau of Mines. Water Management Administration, Bureau of Mines, Maryland Department of the Environment. Frostburg, Maryland.

MDNR. 1973. Bureau of Mines Reclamation Program. Water Resources Administration. Frostburg, Maryland.

MDNR. 1976. Coal reserves in Maryland: Potential for future development. Maryland Geological Survey, Maryland Department of Natural Resources.

MDNR. 1996. Maryland Department of Natural Resources. Maryland Water Quality Inventory: 1993-1995. Resource Assessment Service. Annapolis, Maryland.

MDNR. 1997a. Watershed economic and environmental database. Maryland Department of Natural Resources. Chesapeake and Coastal Watershed Service. Annapolis, Maryland.

MDNR. 1997b. Rare, threatened, and endangered animals of Maryland. Wildlife and Heritage Division. Annapolis, Maryland.

MOP. 1995. 1995 Land use report. Maryland Office of Planning. Baltimore, Maryland.

MSP. 1969. Maryland Department of State Planning. Manual of Coordinates. Publication No. 155. Baltimore, Maryland.

Rankin, E. 1989. The Qualitative Habitat Evaluation Index (QHEI): rationale, methods, and application. Division of Water Quality Planning and Assessment. Ohio Environmental Protection Agency. Columbus, Ohio.

Robbins, C.S. and E.A.T. Blom. 1996. Atlas of the breeding birds of Maryland and the District of Columbia. University of Pittsburgh Press, Pittsburgh, Pennsylvania.

Rohde, F., R. Arndt, D. Linquist, and J. Parnell. 1994. Freshwater fishes of the Carolinas, Virginia, Maryland, and Delaware. University of Carolina Press. Chapell Hill, North Carolina.

Palmer, T. 1984. Youghiogheny: Appalachian River. Pittsburgh University Press, Pittsburgh, Pennsylvania.

Plafkin, J., M. Barbour, K. Porter, S. Gross, and R. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers; benthic macroinvertebrates and fish (EPA/444/4-89-001). US Environmental Protection Agency. Washington, D.C.

Platts, W.S., W. Megahan, and G. Minshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. General Technical Report: INT-138. Intermountain Research Station, Forest Service, U.S. Department of Agriculture. Ogden, Utah.

Strahler, A. 1964. Quantitative geomorphology of drainage basins and channel networks: Section 4-2 in Handbook of applied hydrology (ed. Ven te Chow). McGraw-Hill. New York, New York.

Volstad, J., M. Southerland, S. Weisburg, H. Wilson, D. Heimbuch, and J. Seibel. 1995. Maryland biological stream survey: 1994 demonstration project. Versar, Inc. Columbia, Maryland.

SYNOPSIS OF MBSS DESIGN AND SAMPLING METHODS

The MBSS is intended to provide unbiased estimates of the condition of streams and rivers of Maryland on a local (e.g., drainage basin or county) as well as a statewide scale. To date, the MBSS has focused on wadeable, headwater streams. The survey is based on a probabilistic stream sampling approach where random selections are made from all sections of streams in the state which can physically be sampled. The approach supports statistically-valid population estimation of variables of interest (e.g., largemouth bass densities, miles of streams with degraded physical habitat, etc.). When repeated, the MBSS will also provide a basis for assessing future changes in ecological condition of flowing waters of the state. The MBSS is now a part of MDNR's long-term monitoring strategy and includes 4th order streams in the sampling design.

The study area for the MBSS includes each of the 18 major drainage basins of the state, and a total of three years was required to sample all 18 basins. For logistical reasons, the state was divided into three geographic regions (east, west, and central) with five to seven basins in each region. Each basin was sampled at least once during the three year cycle, and one basin in each region was sampled twice so that data collected in different years could be combined into a single statewide estimate for each of the variables of interest.

The sampling frame for the MBSS was constructed by overlaying basin boundaries on a map of all blueline stream reaches in the state as digitized on a U.S. Geological Survey 1:250,000 scale map. Sampling within basins was restricted to non-tidal, first, second and third-order (Strahler 1964) stream reaches, excluding unwadeable or otherwise unsampleable areas. An additional restriction was that only public land or privately-owned sites where landowner permissions was obtained were sampled.

During 1995 and 1997, the MBSS sample sites for the Youghioheny basin were selected from a comprehensive list of headwater stream reaches. To provide adequate information about each size of stream, an approximately equal number of first, second and third-order streams were sampled during spring and summer, with the number of sites in a basin being proportional to the number of stream miles in the entire state.

Benthic macroinvertebrates and water quality samples were collected during the spring index period from March through early May, while fish, herpetofauna, *in situ* stream chemistry and physical habitat sampling were conducted during the low flow period in the summer, from June through September.

In the spring, water samples were collected and analyzed for pH, acid-neutralizing capacity (ANC), sulfate (SO_4), nitrate (NO_3), conductivity, and dissolved organic carbon (DOC) in the laboratory. These variables primarily characterize the sensitivity of the streams to acid deposition and other anthropogenic stressors to a lesser extent. Benthic macroinvertebrates collected in the spring were identified to family and genus level in the laboratory.

Habitat assessments were conducted in the summer using metrics largely patterned after EPA's Rapid Bioassessment Protocols and Ohio EPA's Qualitative Habitat Evaluation Index (QHEI) described by Rankin (1989), Plafkin *et al.* (1989), and Platts *et al.* (1983) in the designated 75 m length of the stream segments; riparian habitat measurements were based on the surrounding area within 50 m of the stream. Other qualitative measurements included (1) aesthetic value, based on evidence of human refuse; (2) remoteness, based on the absence of detectable human activity and difficulty in accessing the segment; (3) land use, based on the surrounding area immediately visible from the segment; (4) general stream character, based on the shape, substrate, and vegetation of the segment; and (5) bank erosion, based on the kind and extent of erosion present. Quantitative measurements at each segment included flow, depth, wetted width, and stream gradient.

Fish and herpetofauna were sampled during the summer index period using quantitative, double-pass electrofishing of the 75 m stream segments. Blocking nets were placed at each end of the segment, and one or more direct-current, backpack electrofishing units were used to sample the entire segment. All fish captured during each electrofishing pass were identified, counted, weighed in aggregate, and up to 100 individuals of each species were examined for external anomalies such as lesions and tumors. All gamefish captured were also measured for length. Any amphibians, reptiles, freshwater molluscs, submerged aquatic vegetation either in or near the stream segment were collected and identified.

For all phases of the MBSS, there was a ongoing, documented program of quality assurance/quality control (QA/QC). The QA/QC program used by the MBSS allows for generation of data with known confidence.

STREAMS SAMPLED IN THE YOUGHIOGHENY BASIN IN 1994, 1995, AND 1997 AS PARTOF THE MARYLAND BIOLOGICAL STREAM SURVEY (MBSS) - QUANTITATIVE SAMPLES ONLY -

As described in Chapter 3 and Appendix B, MBSS sampling sites were selected randomly from 1:250,000 scale maps. Many very small streams were selected, some with names and some without. Stream names were acquired for the MBSS database from several map sources. Those streams with no names are called unnamed tributaries (Un. Trib.).

Stream Name	Stream Name
Bear Creek (5 sites)	Little Laurel Run (1 site)
Bear Creek Un. Trib. (1 site)	Little Youghiogheny River (2 sites)
Big Shade Run (3 sites)	L. Youghiogheny River Un. Trib. (2 sites)
Black Run (1 site)	Mill Run (5 sites)
Broadford Run (2 sites)	Mill Run Un. Trib. (1 site)
Buffalo Run (3 sites)	Millers Run (1 site)
Buffalo Run Un. Trib. (1 site)	Muddy Creek (3 sites)
Bull Glade Run (1 site)	North Branch of the Casselman River (10 sites)
Casselman Un. Trib. (3 sites)	North Glade Run (6 sites)
Cherry Creek - Trib. to Deep Creek (12 sites)	Piney Creek (2 sites)
Cherry Creek - Trib. to Youghiogheny River south of Oakland (3 sites)	Piney Creek Un. Trib. (1 site)
Cove RunSUn. Trib. to Mill Run (1 site)	Puzzley Run (1 site)
Deep Creek (1 site)	Rocklick Creek (1 site)
Deep Creek Lake Un. Trib. (4 sites)	Salt Block Run (3 sites)
Fikes Run (1 site)	Snowy Creek (3 sites)
Getz Run (1 site)	South Branch of Bear Creek (4 sites)
Ginseng Run (3 sites)	S. Branch of Bear Creek Un. Trib. (1 site)
Glade Run (2 sites)	South Branch of the Casselman River (5 sites)
Herrington Creek (3 sites)	Trout Run (1 site)
Hoyes Run (1 site)	White Meadow Run (2 sites)
Little Bear Creek (2 sites)	Youghiogheny River Lake Un. Trib. (1 site)
	Youghiogheny River Un. Trib. (1 site)

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Appendix C: Location (in decimal degrees) and water quality data for MBSS sites in the Youghiogheny basin: 1994, 1995 and 1997. Temperature and Dissolved Oxygen (DO) were measured in the summer while all other parameters were measured during the spring. Units of measure for temperature are degrees Celcius. DO, nitrate nitrogen (NO_3), sulfate (SO_4), and dissolved organic carbon (DOC) are presented in mg/L, and acid neutralizing capacity (ANC) is measured as μeq/L.

Stream Name	Latitude	Longitude	Temp.	DO	pH	ANC	NO_3	SO_4	DOC
Bear Creek	39.656000	79.367000	19.5	8.3	7.13	171.6	0.986	10.922	0.9
Bear Creek	39.621600	79.281531	17.5	8.1	7.00	157.5	0.587	8.529	2.0
Bear Creek	39.650261	79.290589	15.8	7.4	6.96	160.7	0.647	9.589	1.0
Bear Creek	39.650731	79.296631	16.9	7.4	6.99	161.0	0.741	8.802	2.0
Bear Creek Un. Trib.	39.649000	79.341000	12.5	9.0	6.24	279.2	1.739	16.197	1.0
Bear Creek Un. Trib.	39.669619	79.277981	19.0	6.8	7.14	278.4	0.592	13.186	1.0
Bid Shade Run	39.709261	79.169200	17.9	7.1	7.01	232.4	0.461	26.159	0.0
Big Shade Run	39.702100	79.170100	20.0	6.9	6.97	197.2	0.423	34.615	0.0
Black Run	39.411531	79.299839	17.0	4.5	6.80	144.4	0.230	9.263	2.0
Blandy Run	39.699600	78.993111	20.0	5.9	7.10	262.2	0.678	11.158	1.0
Broadford Run	39.433000	79.355000	19.5	7.6	6.82	163.6	0.693	8.975	1.7
Buffalo Run	39.687000	79.409000	16.8	8.3	7.33	242.5	0.613	18.869	1.3
Buffalo Run	39.669311	79.450239	18.5	8.2	7.39	354.3	0.456	22.977	2.0
Buffalo Run Un. Trib.	39.656000	79.466000	17.0	7.3	7.25	239.2	0.398	9.194	1.2
Bull Glade Run	39.494000	79.467000	13.9	9.0	4.77	-25.2	0.274	8.040	1.0
Casselman River Un. Trib.	39.710000	79.114997	16.6	7.8	7.49	284.0	0.674	17.673	1.3
Cherry Creek	39.538469	79.316231	15.9	8.0	4.85	-8.7	0.090	25.671	3.0
Cherry Creek	39.547000	79.310000	16.3	8.1	5.92	25.4	0.248	42.145	2.3
Cherry Creek	39.545000	79.304000	16.5	6.5	5.98	37.2	0.226	42.562	2.5
Cherry Creek	39.584811	79.284839	17.0	3.9	4.75	-28.2	0.126	37.797	2.0
Cherry Creek	39.587000	79.283000	18.0	5.4	5.03	-6.3	0.196	27.163	3.0
Cherry Creek	39.562831	79.299000	19.0	1.8	4.75	-28.2	0.126	37.797	2.0
Cherry Creek	39.360311	79.445961	19.0	7.5	7.05	375.2	0.708	8.411	3.0
Cherry Creek	39.363161	79.448211	17.0	7.3	7.06	389.1	0.715	8.395	3.0
Cherry Creek	39.704000	79.449000	25.5	7.0	6.85	195.6	0.593	15.777	1.4
Cherry Creek	39.543200	79.296950	20.8	5.8	5.26	2.6	0.095	32.101	3.0
Cherry Creek	39.545850	79.293450	20.1	5.6	5.79	43.5	0.141	52.477	3.0
Cherry Creek Un. Trib.	39.331981	79.418119	16.0	7.9	7.12	245.4	0.551	7.924	2.0
Cherry Creek Un. Trib.	39.546181	79.289700	24.8	5.7	4.22	-63.3	0.000	8.298	3.0
Cherry Creek Un. Trib.	39.545681	79.288089	23.0	5.2	4.22	-63.3	0.000	8.298	3.0
Cove Run	39.699000	79.313000	14.3	8.1	6.82	138.0	4.913	9.576	0.9
Crab Grass Run	39.714000	79.140000	23.0	9.1	7.69	647.1	3.471	16.481	2.1
Deep Creek Lake Un. Trib.	39.462631	79.330150	17.8	6.5	6.92	276.5	0.663	8.684	5.0
Deep Creek Lake Un. Trib.	39.460789	79.340011	16.5	7.5	6.97	302.7	0.779	12.231	4.0
Fikes Run	39.672000	79.334997	13.0	8.6	7.16	156.3	0.603	8.320	0.7
Getz Run	39.707111	78.983669	19.1	8.2	7.12	177.0	1.979	10.051	2.0
Ginseng Run	39.576000	79.376000	19.9	7.0	6.97	158.9	0.714	10.837	0.9
Ginseng Run	39.573000	79.393000	17.1	8.0	6.58	76.2	0.859	9.661	1.0
Ginseng Run	39.567000	79.423000	17.0	8.0	7.69	501.5	1.076	11.508	1.0
Herrington Creek	39.464119	79.431919	21.0	5.8	6.07	47.7	0.188	8.092	2.0
Herrington Creek	39.463811	79.428550	20.0	6.5	6.05	17.3	0.187	7.902	2.0
Herrington Creek	39.463781	79.445681	24.5	6.4	5.85	13.1	0.252	9.822	2.0
Kings Run	39.441739	79.362511	26.0	8.8	6.85	334.9	0.749	15.673	6.0

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Stream Name	Latitude	Longitude	Temp.	DO	pH	ANC	NO_3	SO_4	DOC
Little Bear Creek	39.659000	79.276000	14.9	9.1	6.93	85.8	0.810	8.159	0.6
Little Laurel Run	39.644250	79.178631	27.5	6.4	6.86	109.4	0.269	11.140	2.0
Little Youghiogheny River	39.396319	79.367219	16.5	6.9	7.40	356.4	0.378	13.141	2.0
Little Youghiogheny R. Un. Trib.	39.393000	79.420000	15.2	8.5	6.79	165.4	1.297	9.500	1.3
Little Youghiogheny R. Un. Trib.	39.385989	79.375069	17.0	7.2	7.14	320.0	1.139	12.857	1.0
Little Youghiogheny R. Un. Trib.	39.429000	79.321000	21.2	7.2	7.06	274.2	0.554	11.134	1.2
Mill Run	39.719311	79.330231	16.4	7.7	7.19	171.7	0.681	12.072	1.0
Mill Run	39.719000	79.337000	15.0	9.3	7.13	168.1	0.751	11.163	0.8
Mill Run	39.714961	79.315981	16.6	8.5	7.22	178.5	0.634	11.797	1.0
Mill Run	39.714000	79.347000	14.9	8.9	7.13	171.4	0.688	13.600	0.9
Mill Run	39.703781	79.288500	26.5	6.9	6.96	161.9	0.570	15.887	1.0
Mill Run Un. Trib.	39.716711	79.357489	22.0	7.1	7.34	464.8	0.606	12.000	2.0
Millers Run	39.453831	79.407000	18.9	7.0	7.10	222.3	0.334	8.496	4.0
Muddy Creek	39.509997	79.431000	18.0	8.2	6.54	42.9	0.369	8.238	1.9
Muddy Creek	39.520000	79.433000	23.0	7.1	6.48	46.6	0.375	8.179	2.1
Muddy Creek	39.512000	79.431000	18.0	8.2	6.51	45.4	0.356	8.163	2.2
N. Branch Casselman River	39.669000	79.206000	17.0	8.6	6.74	65.0	0.431	16.920	1.4
N. Branch Casselman River	39.647000	79.226000	17.0	8.6	6.73	73.2	0.464	14.791	1.7
N. Branch Casselman River	39.632000	79.226000	16.0	7.7	6.70	68.7	0.474	15.709	1.7
N. Branch Casselman River	39.634000	79.226000	16.0	7.1	6.57	69.3	0.477	15.182	1.7
N. Branch Casselman River	39.651461	79.218161	19.5	7.9	6.97	114.1	0.331	21.980	1.0
N. Branch Casselman River	39.592850	79.253939	16.0	6.1	6.49	110.9	0.262	22.783	3.0
N. Branch Casselman River	39.608000	79.249000	21.2	8.0	6.72	83.8	0.446	17.766	2.1
N. Branch Casselman River	39.607181	79.240039	19.0	6.5	6.59	51.5	0.275	22.844	2.0
N. Branch Casselman River	39.672739	79.196369	18.0	7.4	6.76	85.7	0.291	2.503	1.0
N. Branch Casselman River	39.673000	79.206000	17.0	8.6	6.71	60.5	0.437	17.094	1.5
North Glade Run	39.511811	79.243881	25.0	6.9	6.45	93.6	0.924	9.637	2.0
North Glade Run	39.509469	79.250811	16.2	8.2	6.45	93.6	0.924	9.637	2.0
North Glade Run	39.506500	79.254631	19.2	7.3	6.83	158.0	0.672	10.482	2.0
North Glade Run	39.506450	79.252889	18.9	7.1	6.53	131.8	0.834	9.058	3.0
North Glade Run	39.506481	79.256369	18.0	6.1	6.53	131.8	0.834	9.058	3.0
North Glade Run	39.498061	79.231669	21.0	6.6	6.17	73.4	1.147	6.798	2.0
North Glade Run	39.498581	79.235919	19.9	6.6	6.17	73.4	1.147	6.798	2.0
Piney Creek	39.704000	79.013000	23.3	7.3	7.14	172.8	1.081	10.029	2.3
Rocklick Creek	39.591539	79.353639	20.0	7.2	7.54	279.8	0.452	14.984	2.0
Salt Block Run	39.562000	79.458000	19.0	6.4	6.93	216.7	0.406	9.163	1.3
Salt Block Run	39.581019	79.434611	19.3	7.9	6.86	65.0	0.272	8.242	0.0
Snowy Creek	39.540889	79.299000	15.0	7.8	4.13	-85.4	0.050	8.376	3.0
Snowy Creek	39.542131	79.298639	15.0	6.7	4.13	-85.4	0.050	8.376	3.0
Snowy Creek	39.396819	79.478739	19.0	7.2	6.48	96.7	0.441	17.468	1.0
Snowy Creek	39.390131	79.467989	21.3	7.4	6.48	96.7	0.441	17.468	1.0
Snowy Creek	39.391489	79.468000	22.8	9.1	7.15	290.1	0.519	27.589	2.0
South Branch Bear Creek	39.651000	79.385000	19.0	7.2	7.28	280.4	1.351	12.485	1.1

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Stream Name	Latitude	Longitude	Temp.	DO	pH	ANC	NO_3	SO_4	DOC
South Branch Bear Creek	39.616000	79.351000	13.0	9.5	7.34	301.8	1.503	13.053	1.4
South Branch Bear Creek	39.620819	79.322111	17.0	8.8	7.51	546.0	1.967	17.552	2.0
S. Branch Casselman River	39.606000	79.204000	13.0	9.2	7.05	173.1	0.742	30.207	1.5
S. Branch Casselman River	39.609997	79.196000	12.0	9.0	7.00	149.6	0.682	27.910	1.3
S. Branch Casselman River	39.631000	79.191000	18.5	7.6	7.19	182.7	0.636	21.155	1.2
S. Branch Casselman River	39.593000	79.211000	17.0	8.0	6.26	181.2	0.685	43.436	1.4
S. Branch Casselman River	39.661689	79.179700	23.8	7.2	7.11	276.8	0.454	25.423	1.0
Trout Run	39.384000	79.394000	21.9	8.6	7.07	267.1	1.521	10.236	1.8
Youghiogheny Res.Un. Trib..	39.686000	79.379000	17.0	8.9	6.45	44.4	0.390	14.699	0.8
Youghiogheny R. Un. Trib.	39.570189	79.348719	13.6	8.3	5.08	-7.6	0.179	6.775	1.0
Youghiogheny R. Un. Trib.	39.561269	79.352019	15.5	8.3	4.94	-10.4	0.280	6.058	1.0
Youghiogheny R. Un. Trib.	39.525039	79.381481	12.2	6.7	4.44	-36.8	0.122	9.679	1.0
Youghiogheny R. Un. Trib.	39.588000	79.414000	18.5	8.4	7.62	764.3	2.032	13.042	1.2
Youghiogheny R. Un. Trib.	39.575350	79.347111	15.5	5.8	4.94	-12.4	0.142	7.150	1.0
Youghiogheny R. Un. Trib.	39.576031	79.347119	15.5	5.8	4.94	-12.4	0.142	7.150	1.0

PHYSICAL HABITAT CONDITIONS MEASURED BY THE MBSS

- All variables rated on a scale of 0 (poor) to 20 (optimal) unless otherwise noted. -

I. SUBSTRATE AND INSTREAM COVER

Instream Habitat is rated according to the perceived value of habitat to the fish community. Higher scores are assigned to sites with a variety of habitat types and particle sizes. In addition, higher scores are assigned to sites with a high degree of uneven substrate, including logs and rootwads. In streams where substrate types are favorable but flows are so low that fish are essentially precluded from using the habitat, low scores are assigned. If none of the habitat within a segment is useable by fish, a score of zero is assigned.

Epifaunal Substrate is rated based on the amount and variety of hard, stable substrates usable by benthic macroinvertebrates. Because they inhibit colonization, flocculent materials or fine sediments surrounding otherwise good substrates are assigned low scores. Scores are also reduced when substrates are less stable.

Velocity/Depth Diversity is rated based on the variety of velocity/depth regimes present at a site (slow-shallow, slow-deep, fast-shallow, and fast-deep). As with embeddedness, this metric varies by stream gradient.

Pool/Glide/Eddy Quality is rated based on the variety and spatial complexity of slow or still water habitat within the sample segment. In high-gradient streams, functionally important slow water habitat may exist in the form of larger eddies. Within a category, higher scores are assigned to segments which have undercut banks, woody debris or other types of cover for fish.

Riffle/Run Quality is based on the depth, complexity, and functional importance of riffle/run habitat in the segment, with highest scores assigned to segments dominated by deeper riffle/run areas, stable substrates, and a variety of current velocities.

Embeddedness is a percentage of surface area of larger particles that is surrounded by fine sediments on the stream bottom. In low gradient streams, embeddedness may be high even in relatively unimpaired watersheds.

II. CHANNEL CHARACTER

Channel Alteration is a measure of large-scale changes in the shape of the stream channel. Channel alteration includes: concrete channels, artificial embankments, obvious straightening of the natural channel, rip-rap, or other structures, as well as recent bar development. Ratings for this metric are based on the presence of artificial structures as well as the existence, extent, and coarseness of point bars, side bars, and mid-channel bars which indicate the degree of flow fluctuations and substrate stability. Evidence of channelization may sometimes be seen in the form of berms which parallel the stream channel.

Bank Stability is rated based on the presence/absence of riparian vegetation and other stabilizing bank materials such as boulders and rootwads, and frequency/size of erosional areas. Sites with steep slopes are not penalized if banks are composed solely of stable materials.

Channel Flow Status is the percentage of the stream channel that has water, with subtractions made for exposed substrates and dewatered areas.

III. RIPARIAN CORRIDOR

Shading is rated based on estimates of the degree and duration of shading at a site during summer, including any effects of shading caused by land forms.

Riparian Buffer is rated according to the size and type of the vegetated riparian buffer zone at the site. Cultivated fields for agriculture which have bare soil to any extent are not considered as riparian buffers. At sites where the buffer width is variable or direct delivery of storm runoff or sediment to the stream is evident or highly likely, the narrowest representative buffer width in the segment (e.g., 0 if parking lot runoff enters directly to the stream) is measured and recorded even though some of the stream segment may have a well developed riparian buffer.

IV. AESTHETICS/REMOTENESS

Aesthetics are rated according to the visual appeal of the site and presence/absence of human refuse, with highest scores assigned to stream segments with no human refuse and visually outstanding character.

Remoteness is rated based on the absence of detectable human activity and difficulty in accessing the segment.

Appendix D: Location and physical habitat data for MBSS sites in the Youghiogheny Basin: 1994, 1995, and 1997. See "Physical Habitat Conditions Measured By The MBSS" for details.

Stream Name	Instream Habitat	Epifaunal Substrate	Velocity/ Depth	Pool Quality	Riffle Quality	Channel Alteration	Bank Stability
Bear Creek	20	18	16	16	18	18	17
Bear Creek	17	16	10	16	16	10	16
Bear Creek	17	19	14	16	18	10	17
Bear Creek	17	18	16	15	18	17	16
Bear Creek Un. Trib.	10	9	8	8	7	17	16
Bear Creek Un. Trib.	16	13	9	12	6	5	15
Big Shade Run	15	9	9	16	4	8	17
Big Shade Run	17	17	8	10	15	10	17
Black Run	2	3	6	2	6	5	15
Blandy Run	17	15	14	19	15	15	15
Broadford Run	10	6	6	7	8	5	16
Buffalo Run	16	18	10	10	15	18	19
Buffalo Run	17	16	15	17	17	10	16
Buffalo Run Un. Trib.	6	7	7	7	4	16	20
Bull Glade Run	10	10	8	7	15	17	19
Casselman River Un. Trib.	10	12	7	7	6	16	16
Cherry Creek	16	3	12	16	2	16	19
Cherry Creek	13	3	9	12	0	5	16
Cherry Creek	16	5	14	15	12	5	17
Cherry Creek	10	5	8	14	0	5	14
Cherry Creek	17	9	13	17	15	8	8
Cherry Creek	17	5	15	18	15	4	5
Cherry Creek	17	11	10	16	5	4	12
Cherry Creek	17	18	12	12	15	19	18
Cherry Creek	5	1	13	18	9	19	1
Cherry Creek	2	1	6	17	0	16	15
Cherry Creek	5	2	3	17	0	5	16
Cherry Creek Un. Trib.	10	5	9	11	5	5	5
Cherry Creek Un. Trib.	10	5	13	16	6	16	11
Cherry Creek Un. Trib.	10	5	6	16	6	19	11
Cove Run	8	11	6	8	6	15	18
Crab Grass Run	11	5	7	7	6	5	6
Deep Creek Lake Un. Trib.	5	1	6	4	2	5	15
Deep Creek Lake Un. Trib.	11	1	6	3	3	2	10
Fikes Run	11	16	9	8	11	16	18
Getz Run	12	15	9	10	10	5	18
Ginseng Run	6	5	5	5	3	8	19
Ginseng Run	9	10	7	7	8	19	18
Ginseng Run	10	7	10	7	7	9	18
Herrington Creek	16	5	11	16	6	5	16
Herrington Creek	16	5	6	16	2	5	15
Herrington Creek	14	5	11	16	7	3	15
Kings Run	6	2	6	10	8	4	10
Little Bear Creek	15	18	12	15	14	19	18
Little Laurel Run	12	5	9	10	12	16	17

Appendix D: Location and physical habitat data for MBSS sites in the Youghiogheny Basin: 1994, 1995, and 1997. See "Physical Habitat Conditions Measured By The MBSS" for details.

Stream Name	Instream Habitat	Epifaunal Substrate	Velocity/ Depth	Pool Quality	Riffle Quality	Channel Alteration	Bank Stability
Little Youghiogheny River	15	4	9	17	4	5	15
Little Youghiogheny R. Un. Trib.	10	9	7	11	11	17	6
Little Youghiogheny R. Un. Trib.	8	6	7	6	8	5	17
Little Youghiogheny R. Un. Trib.	17	12	10	16	15	14	17
Mill Run	18	18	12	16	16	20	17
Mill Run	15	18	8	11	15	10	18
Mill Run	17	16	18	17	17	16	18
Mill Run	17	16	15	20	17	17	18
Mill Run	14	11	7	16	6	15	15
Mill Run Un. Trib.	12	3	7	6	4	5	17
Millers Run	17	10	10	17	17	18	17
Muddy Creek	17	16	12	13	16	19	18
Muddy Creek	17	15	10	15	16	18	18
Muddy Creek	16	16	12	15	13	19	18
N. Branch Casselman River	17	15	13	15	16	18	18
N. Branch Casselman River	16	14	10	13	12	15	17
N. Branch Casselman River	16	11	14	18	13	5	17
N. Branch Casselman River	16	12	13	15	15	5	14
N. Branch Casselman River	15	7	12	16	10	5	17
N. Branch Casselman River	16	10	14	14	8	17	18
N. Branch Casselman River	19	19	17	18	19	16	17
N. Branch Casselman River	17	3	10	16	1	8	13
N. Branch Casselman River	16	16	10	15	18	18	19
N. Branch Casselman River	18	19	10	17	19	17	18
North Glade Run	5	3	5	17	0	2	10
North Glade Run	3	3	3	16	8	20	2
North Glade Run	11	5	11	16	8	18	7
North Glade Run	12	5	7	11	7	5	9
North Glade Run	15	5	4	18	0	20	2
North Glade Run	6	5	6	6	6	16	15
North Glade Run	1	1	6	11	6	2	2
Piney Creek	15	11	7	8	5	6	19
Rocklick Creek	16	6	8	12	10	12	16
Salt Block Run	11	6	10	12	7	5	18
Salt Block Run	20	18	16	15	19	18	19
Snowy Creek	13	8	10	11	16	16	15
Snowy Creek	18	14	6	16	6	19	19
Snowy Creek	16	5	13	17	6	19	19
Snowy Creek	16	13	18	17	16	8	8
Snowy Creek	17	5	12	19	16	8	6
South Branch Bear Creek	17	16	12	15	14	19	17
South Branch Bear Creek	16	15	11	12	15	18	15
South Branch Bear Creek	6	2	7	16	5	4	15
S. Branch Casselman River	15	13	9	11	13	17	18
S. Branch Casselman River	16	17	14	16	15	17	16

Appendix D: Location and physical habitat data for MBSS sites in the Youghiogheny Basin: 1994, 1995, and 1997. See "Physical Habitat Conditions Measured By The MBSS" for details.

Stream Name	Instream Habitat	Epifaunal Substrate	Velocity/ Depth	Pool Quality	Riffle Quality	Channel Alteration	Bank Stability
S. Branch Casselman River	14	10	10	14	11	16	19
S. Branch Casselman River	14	14	9	10	12	18	17
S. Branch Casselman River	18	11	15	18	10	5	5
Trout Run	16	7	10	15	12	5	8
Youghiogheny Res. Un. Trib.	12	17	8	8	11	18	19
Youghiogheny River Un. Trib.	13	7	11	15	15	18	19
Youghiogheny River Un. Trib.	11	11	6	8	8	7	16
Youghiogheny River Un. Trib.	16	15	7	7	10	2	16
Youghiogheny River Un. Trib.	5	5	2	2	1	18	16
Youghiogheny River Un. Trib.	2	5	6	1	1	5	17
Youghiogheny River Un. Trib.	2	4	6	1	1	5	16

Appendix D: Location and physical habitat data for MBSS sites in the Youghiogheny Basin: 1994, 1995, and 1997. See "Physical Habitat Conditions Measured By The MBSS" for details.

Stream Name	Percent Embeddedness	Channel Flow (%)	Percent Shading	Riparian Width (m)	Aesthetic Rating	Max. Depth (cm)	Percent Gradient
Bear Creek	15	70	85	50	19	96	1.0
Bear Creek	35	90	50	50	19	37	3.0
Bear Creek	25	75	80	6	16	56	1.3
Bear Creek	20	70	40	31	16	54	1.5
Bear Creek Un. Trib.	10	45	98	50	20	34	2.5
Bear Creek Un. Trib.	45	35	80	50	17	29	2.4
Bid Shade Run	35	50	60	50	18	43	2.0
Big Shade Run	100	55	95	50	12	20	3.0
Black Run	40	35	95	5	15	15	2.0
Blandy Run	20	90	90	50	20	114	1.0
Broadford Run	25	85	98	3	16	26	0.7
Buffalo Run	20	50	75	50	18	37	1.0
Buffalo Run	40	85	75	50	10	81	3.0
Buffalo Run Un. Trib.	20	10	97	50	17	24	7.0
Bull Glade Run	35	80	98	50	20	34	3.0
Casselman River Un. Trib.	20	50	98	50	19	22	5.0
Cherry Creek	75	90	95	19	5	50	4.5
Cherry Creek	45	95	10	50	15	73	0.2
Cherry Creek	50	100	55	0	13	72	0.2
Cherry Creek	100	100	70	0	12	54	0.1
Cherry Creek	30	98	15	50	16	68	0.5
Cherry Creek	40	100	35	0	16	68	0.5
Cherry Creek	100	100	70	50	18	86	0.5
Cherry Creek	10	70	97	13	17	64	0.8
Cherry Creek	100	97	90	0	16	50	1.0
Cherry Creek	100	98	8	0	17	92	0.3
Cherry Creek	100	97	40	50	20	105	0.2
Cherry Creek Un. Trib.	100	95	80	0	16	49	1.0
Cherry Creek Un. Trib.	100	95	10	50	19	95	0.3
Cherry Creek Un. Trib.	100	97	25	0	16	34	0.3
Cove Run	20	50	95	12	15	48	1.5
Crab Gras Run	35	75	60	0	9	20	1.0
Deep Creek Lake Un. Trib.	65	85	98	0	16	19	0.5
Deep Creek Lake Un. Trib.	60	60	90	4	16	10	1.5
Fikes Run	15	75	75	50	20	38	2.5
Getz Run	10	80	98	9	20	46	1.5
Ginseng Run	25	40	80	0	16	15	1.5
Ginseng Run	0	50	95	5	16	20	3.0
Ginseng Run	35	70	70	0	15	40	1.5
Herrington Creek	50	40	90	50	18	50	0.8
Herrington Creek	50	70	85	50	10	24	0.5
Herrington Creek	100	80	45	0	13	60	0.9
Kings Run	65	90	80	0	6	15	1.0
Little Bear Creek	15	50	95	50	18	67	1.5
Little Laurel Run	35	80	15	0	16	28	2.1

Appendix D: Location and physical habitat data for MBSS sites in the Youghiogheny Basin: 1994, 1995, and 1997. See "Physical Habitat Conditions Measured By The MBSS" for details.

Stream Name	Percent Embeddedness	Channel Flow (%)	Percent Shading	Riparian Width (m)	Aesthetic Rating	Max. Depth (cm)	Percent Gradient
Little Youghiogheny River	40	98	97	19	12	78	0.5
Little Youghiogheny R. Un. Trib.	25	100	95	0	12	26	2.5
Little Youghiogheny R. Un. Trib.	20	85	95	20	6	22	1.0
Little Youghiogheny R. Un. Trib.	35	90	90	8	13	34	1.2
Mill Run	15	70	95	50	20	68	5.5
Mill Run	15	75	85	0	17	51	3.0
Mill Run	25	80	95	50	19	71	5.6
Mill Run	20	80	92	50	16	126	5.2
Mill Run	40	92	50	50	18	47	0.7
Mill Run Un. Trib.	100	40	95	0	14	24	8.0
Millers Run	100	100	80	50	16	43	2.0
Muddy Creek	35	95	65	50	20	54	0.8
Muddy Creek	40	90	75	50	19	34	0.5
Muddy Creek	40	99	40	50	20	74	0.7
N. Branch Casselman River	20	80	60	50	20	69	1.0
N. Branch Casselman River	20	50	50	50	19	49	1.0
N. Branch Casselman River	30	100	45	50	15	63	0.1
N. Branch Casselman River	35	95	65	50	16	77	0.5
N. Branch Casselman River	35	100	45	50	16	106	0.7
N. Branch Casselman River	25	85	60	50	19	112	0.3
N. Branch Casselman River	20	95	40	50	16	99	1.5
N. Branch Casselman River	55	97	35	0	16	58	0.9
N. Branch Casselman River	25	75	70	50	17	38	1.4
N. Branch Casselman River	20	90	80	33	18	48	1.0
North Glade Run	70	97	30	50	16	48	0.0
North Glade Run	100	100	5	0	16	34	0.8
North Glade Run	65	87	50	6	16	56	1.5
North Glade Run	55	85	70	24	17	38	0.5
North Glade Run	75	100	20	50	17	88	0.8
North Glade Run	20	60	80	30	16	44	1.0
North Glade Run	100	20	20	0	11	20	1.0
Piney Creek	10	90	40	50	9	28	0.5
Rocklick Creek	100	80	50	0	5	41	3.0
Salt Block Run	100	100	15	50	19	55	0.5
Salt Block Run	5	95	98	50	19	68	6.0
Snowy Creek	35	80	50	0	6	34	1.5
Snowy Creek	65	90	99	50	20	32	2.0
Snowy Creek	100	100	60	50	20	50	0.5
Snowy Creek	30	97	50	20	2	76	0.5
Snowy Creek	60	87	50	0	3	89	0.4
South Branch Bear Creek	15	75	90	15	18	64	2.4
South Branch Bear Creek	10	75	90	50	20	69	1.5
South Branch Bear Creek	65	90	75	50	6	26	2.5
S. Branch Casselman River	25	70	95	50	19	41	1.7
S. Branch Casselman River	25	50	90	50	20	99	1.7

Appendix D: Location and physical habitat data for MBSS sites in the Youghiogheny Basin: 1994, 1995, and 1997. See "Physical Habitat Conditions Measured By The MBSS" for details.

Stream Name	Percent Embeddedness	Channel Flow (%)	Percent Shading	Riparian Width (m)	Aesthetic Rating	Max. Depth (cm)	Percent Gradient
S. Branch Casselman River	20	75	50	3	16	46	0.5
S. Branch Casselman River	20	80	35	18	18	34	1.2
S. Branch Casselman River	25	98	15	50	5	75	0.8
Trout Run	35	100	40	0	8	48	1.0
Youghiogheny Res. Un. Trib.	15	65	95	50	19	30	7.0
Youghiogheny River Un. Trib.	0	75	90	50	20	50	2.5
Youghiogheny River Un. Trib.	50	75	97	50	20	18	0.3
Youghiogheny River Un. Trib.	70	60	97	8	16	20	4.0
Youghiogheny River Un. Trib.	70	30	95	50	20	8	13.0
Youghiogheny River Un. Trib.	50	10	95	50	20	12	5.0
Youghiogheny River Un. Trib.	55	10	93	50	20	5	8.0

ECOLOGY AND DISTRIBUTION OF FISH SPECIES COLLECTED IN THE YOUGHIOGHENY BASIN

The species descriptions (Jenkins and Burkhead 1994, Rohde et al. 1994) and distributional maps which follow (Figure E5-E40) include those fish species collected during both random and non-random sampling in the Youghiogheny basin as part of the 1994, 1995, and 1996 MBSS.

Common Name	*Family*	*Tolerance*	*Feeding Group*	*Map*	*Interesting Facts*
Chain pickerel	Pike	Moderate	Top Predator	E-5	This ambush predator feeds almost exclusively on other fish.
Northern Pike	Pike	Moderate	Top Predator	E-6	The voracious predator can grow to over 3 feet in length and can weigh over 40 pounds.
Redfin pickerel	Pike	Moderate	Top Predator	E-7	This member of the pike family is able to survive in small streams and ditches with extremely low dissolved oxygen.
Blacknose dace	Minnow	Tolerant	Omnivore	E-8	This species is tolerant of a wide range of environmental conditions and pollutants. It is the most abundant stream fish in Maryland.
Bluntnose minnow	Minnow	Tolerant	Omnivore	E-9	As the name implies, this species is characterized by an extremely blunt snout.
Central stoneroller	Minnow	Moderate	Algivore	E-10	Because of its long intestine (up to 8 times its body length), this species is incredibly efficient at digesting detritus and algae.
Common carp	Minnow	Moderate	Omnivore	E-11	This minnow is tolerant of many environmental conditions and can survive in highly degraded habitat.
Common shiner	Minnow	Moderate	Omnivore	E-12	This species often becomes more abundant when cold water streams become stressed by high temperatures.
Creek chub	Minnow	Tolerant	Generalist	E-13	Like other minnow species, this minnow doesn't have teeth around the jaw. However, it is quite capable of taking large prey items and readily strikes at lures intended for trout.
Fathead minnow	Minnow	Tolerant	Omnivore	E-14	As a result of bait-bucket introductions, this minnow is widely distributed throughout the eastern United States.
Golden shiner	Minnow	Tolerant	Omnivore	E-15	This species is a favorite food of largemouth bass. It has been transported throughout the United States as a result of bait-bucket introductions.

Common Name	Family	Tolerance	Feeding Group	Map	Interesting Facts
Longnose dace	Minnow	Moderate	Omnivore	E-16	Its streamlined body and large fins allow this minnow to move around easily and remain stationary in fast currents.
River chub	Minnow	Moderate	Omnivore	E-17	During the breeding season, the male develops tubercles on its head and vigorously defends its nest from other males and egg-foraging predators.
Spotfin shiner	Minnow	Moderate	Invertivore	E-18	This species occurs in clear streams of moderate gradient and in the shallows of reservoirs and lakes. It is a warmwater species known to form small schools that are occasionally mixed with other minnows.
Striped shiner	Minnow	Moderate	Omnivore	E-19	This species is native to only the Youghiogheny River basin in Maryland and is very similar to the common shiner.
Northern hogsucker	Sucker	Intolerant	Invertivore	E-20	Considered an aggressive feeder, this species has been known to overturn stones and gravel in search of food. Because of its coloration, large schools often go unnoticed.
White sucker	Sucker	Tolerant	Omnivore	E-21	Large white suckers have been reported to reach 17 years of age and lengths of over 23 inches. This is the most widely distributed sucker species in Maryland.
Brown bullhead	Catfish	Tolerant	Omnivore	E-22	Although considered native to Maryland, this species has been widely introduced throughout the United Statesto provide fishing opportunities.
Stonecat	Catfish	Intolerant	Invertivore	E-23	Stonecats are native to and only found in the Youghiogheny River basin in Maryland. The Casselman River near Grantsville holds the only known population of this species.
Yellow bullhead	Catfish	Tolerant	Omnivore	E-24	Although bullheads are considered bottom feeders, when given the opportunity they are quite capable of catching and eating fish such as minnows and sunfish.
Brook trout	Trout	Intolerant	Generalist	E-25	Commonly found in cold headwater streams, this species is the only trout native to Maryland, and only about 300,000 individuals remain.
Brown trout	Trout	Moderate	Top Predator	E-26	This European species was widely introduced prior to 1900 and has contributed to the widespread decline of brook trout in the eastern United States.
Rainbow trout	Trout	Moderate	Top Predator	E-27	Although ranked among the top five sought after gamefish in North America, hatchery-reared fish are not considered desirable by many fishing purists.

Common Name	Family	Tolerance	Feeding Group	Map	Interesting Facts
Mottled sculpin	Sculpin	Moderate	Insectivore	E-28	This species is primarily an insectivore and does the majority of its feeding nocturnally. It is the second most abundant stream fish in Maryland.
Black crappie	Sunfish	Moderate	Generalist	E-29	This species has been widely introduced throughout North America and is a very popular panfish.
Bluegill	Sunfish	Tolerant	Invertivore	E-30	This species has been widely introduced throughout the United States, and has flourished as a result of its tolerance to a variety of conditions.
Green sunfish	Sunfish	Tolerant	Generalist	E-31	This species is intolerant of low pH, but tolerant of many other types of stress. The lowest pH where this sunfish was collected in the basin was 7.1.
Largemouth bass	Sunfish	Moderate	Top Predator	E-32	This species is considered the most popular gamefish in the United States and has been known to reach weights of over 10 pounds in Maryland.
Pumpkinseed	Sunfish	Moderate	Invertivore	E-33	This sunfish is tolerant of darkly-stained acidic waters and is a regular visitor to brackish waters.
Rock bass	Sunfish	Moderate	Generalist	E-34	This big-mouthed sunfish is an ambush predator that feeds on a wide variety of minnows and aquatic insects.
Smallmouth bass	Sunfish	Moderate	Top Predator	E-35	One reason for this species' popularity as a gamefish is its aggressive nature and frequent aerial acrobatics when hooked on light tackle.
White crappie	Sunfish	Moderate	Generalist	E-36	This species is a close relative of the black crappie, a species that is very popular with anglers. Distinguishing between the two species can be very difficult.
Johnny darter	Perch	Moderate	Invertivore	E-37	Johnny darters are a close relative of tessellated darter which are very common throughout Maryland. Johnny darters are found only in the Youghiogheny basin, while tessellated darters are in almost every other basin in Maryland.
Greenside darter	Perch	Moderate	Insectivore	E-38	Of the genus *Etheostoma*, the greenside darter is the largest species.
Tessellated darter	Perch	Moderate	Invertivore	E-39	The male tessellated darter has a curious behavior of frequently caring for nest containing eggs that it did not fertilize. This species is not native to the Youghiogheny basin.
Yellow perch	Perch	Moderate	Generalist	E-40	Yellow perch have been extensively introduced outside of their native range because they are easy to catch and tasty.

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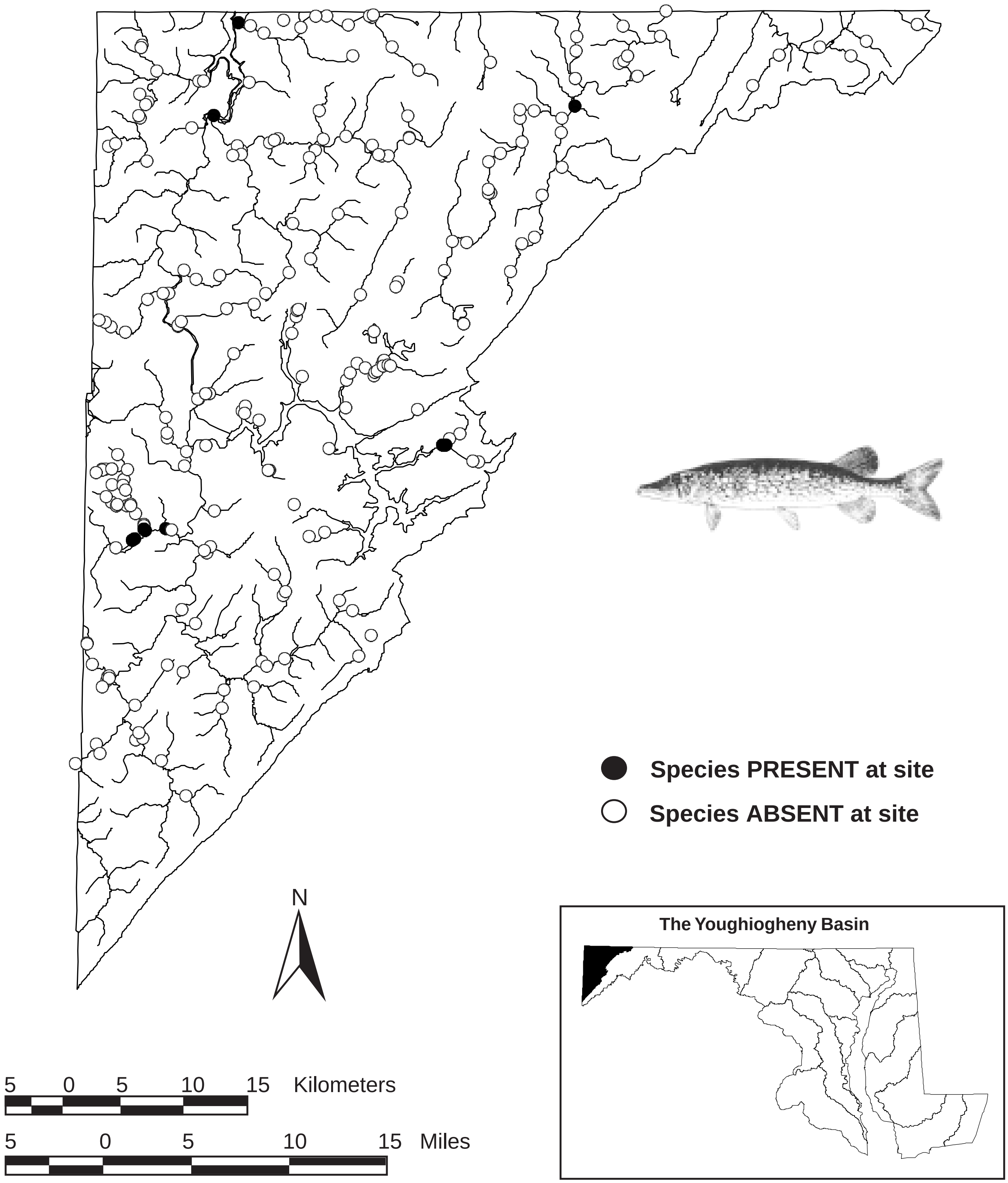
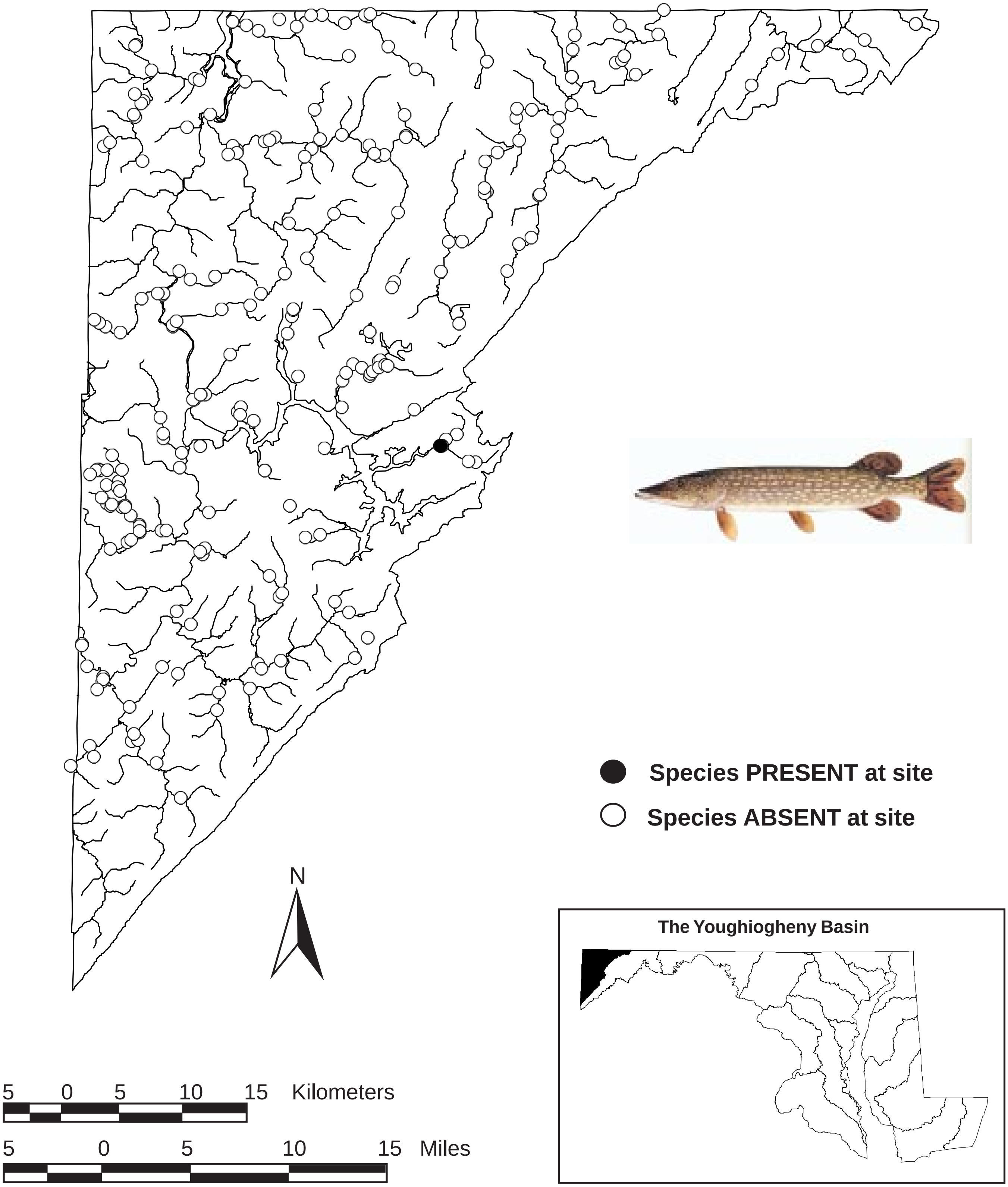
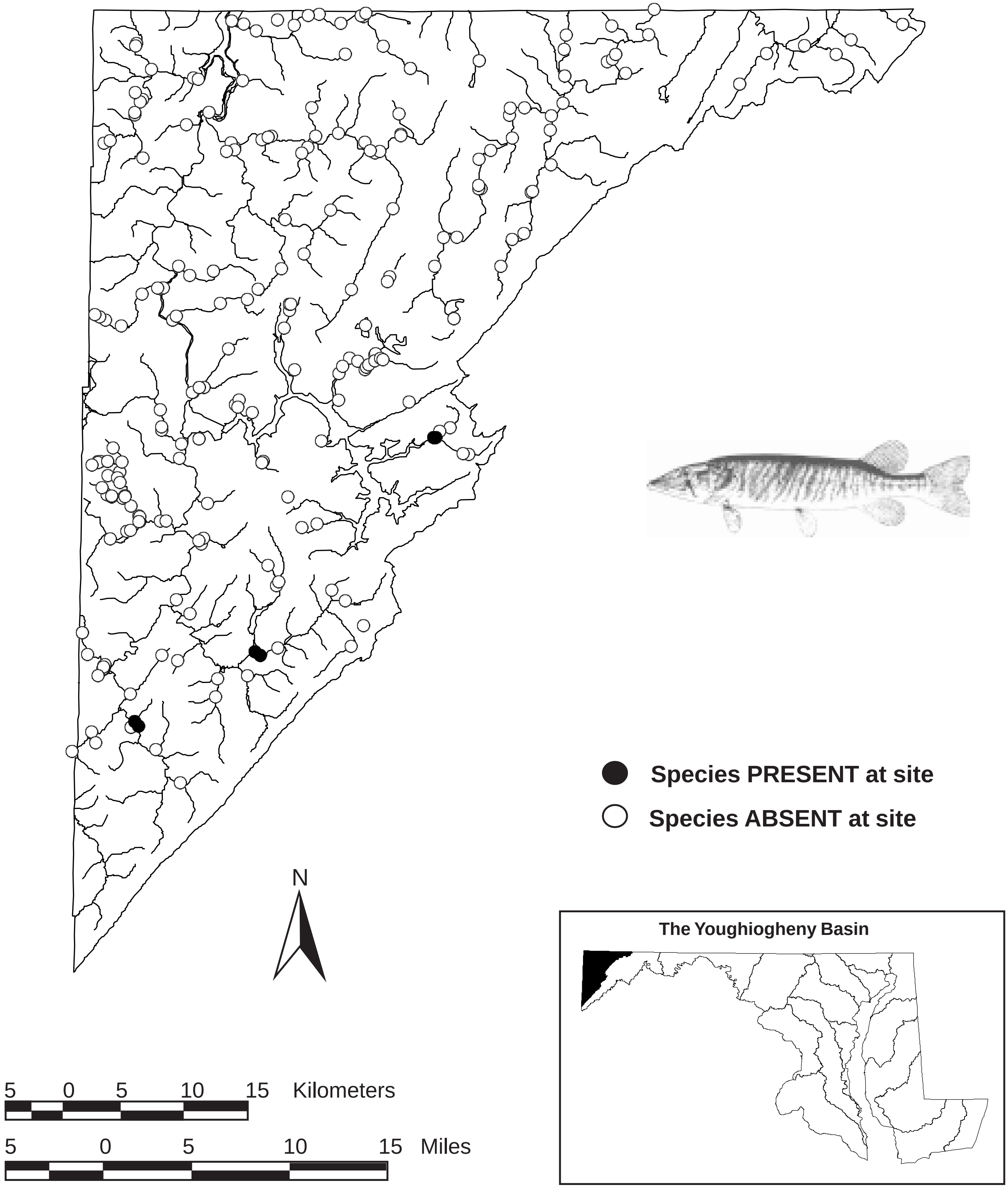


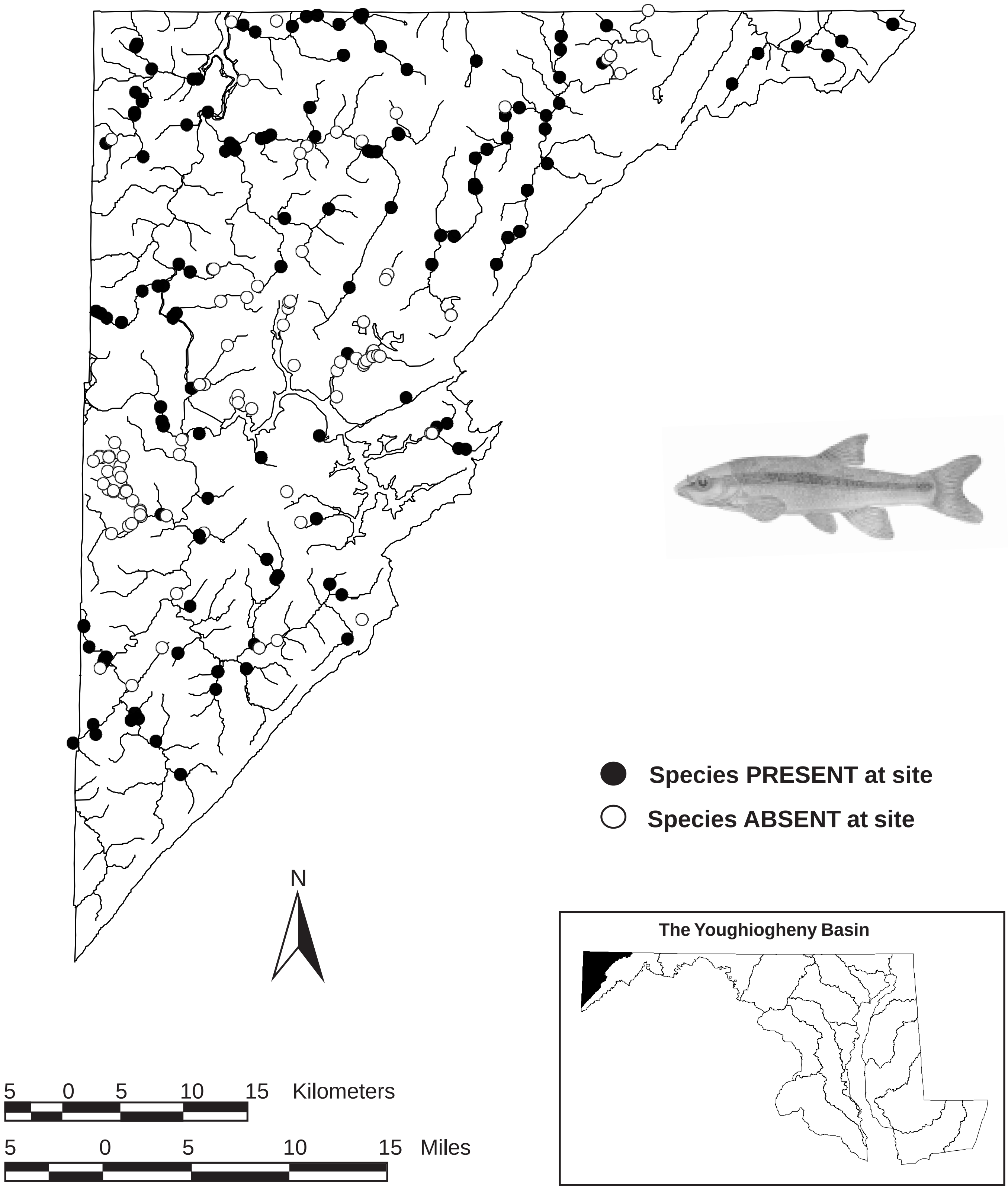
Chain pickerel distribution in the Youghiogheny basin, 1994, 1995 and 1997.



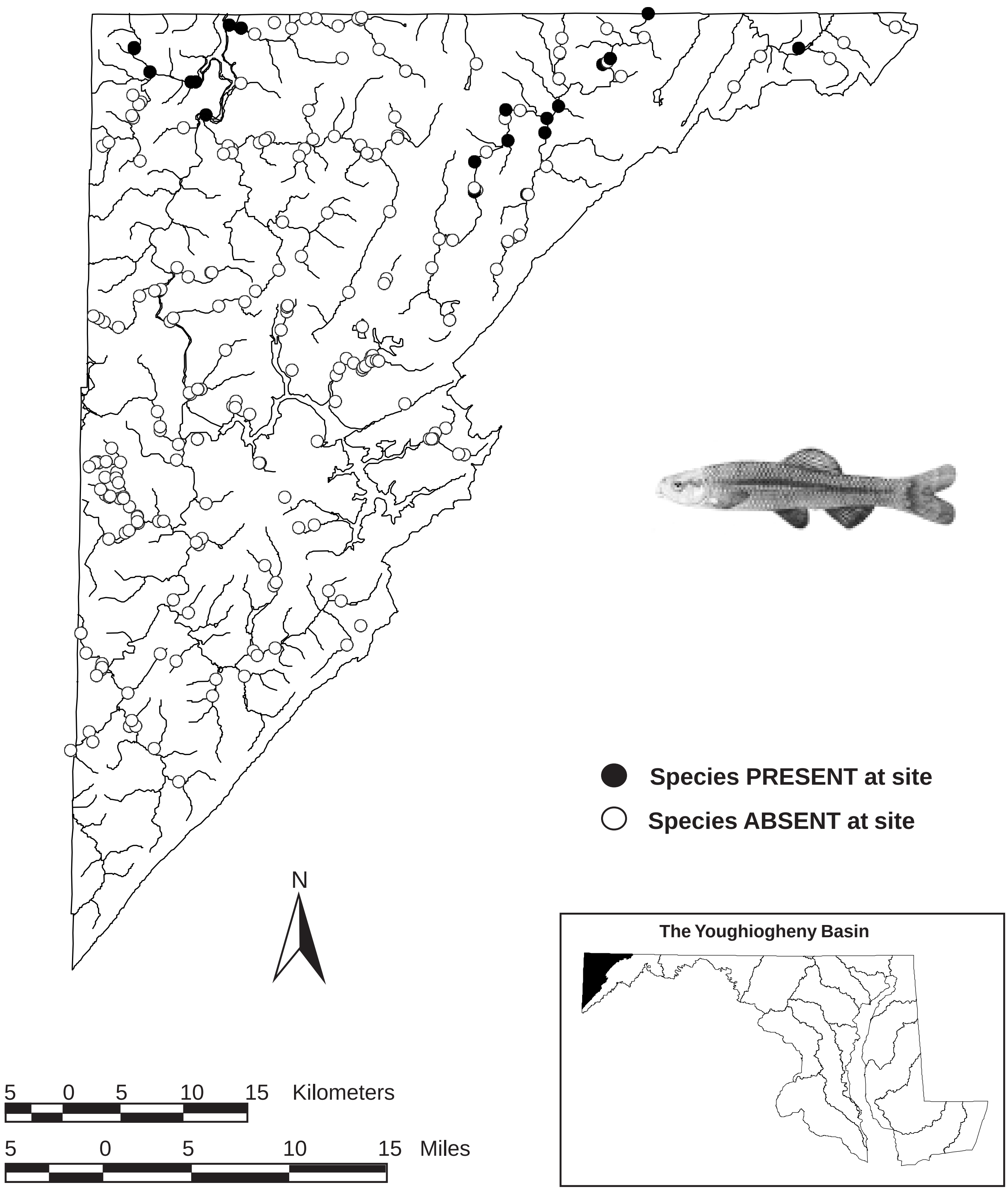
Northern pike distribution in the Youghiogheny basin, 1994, 1995 and 1997.



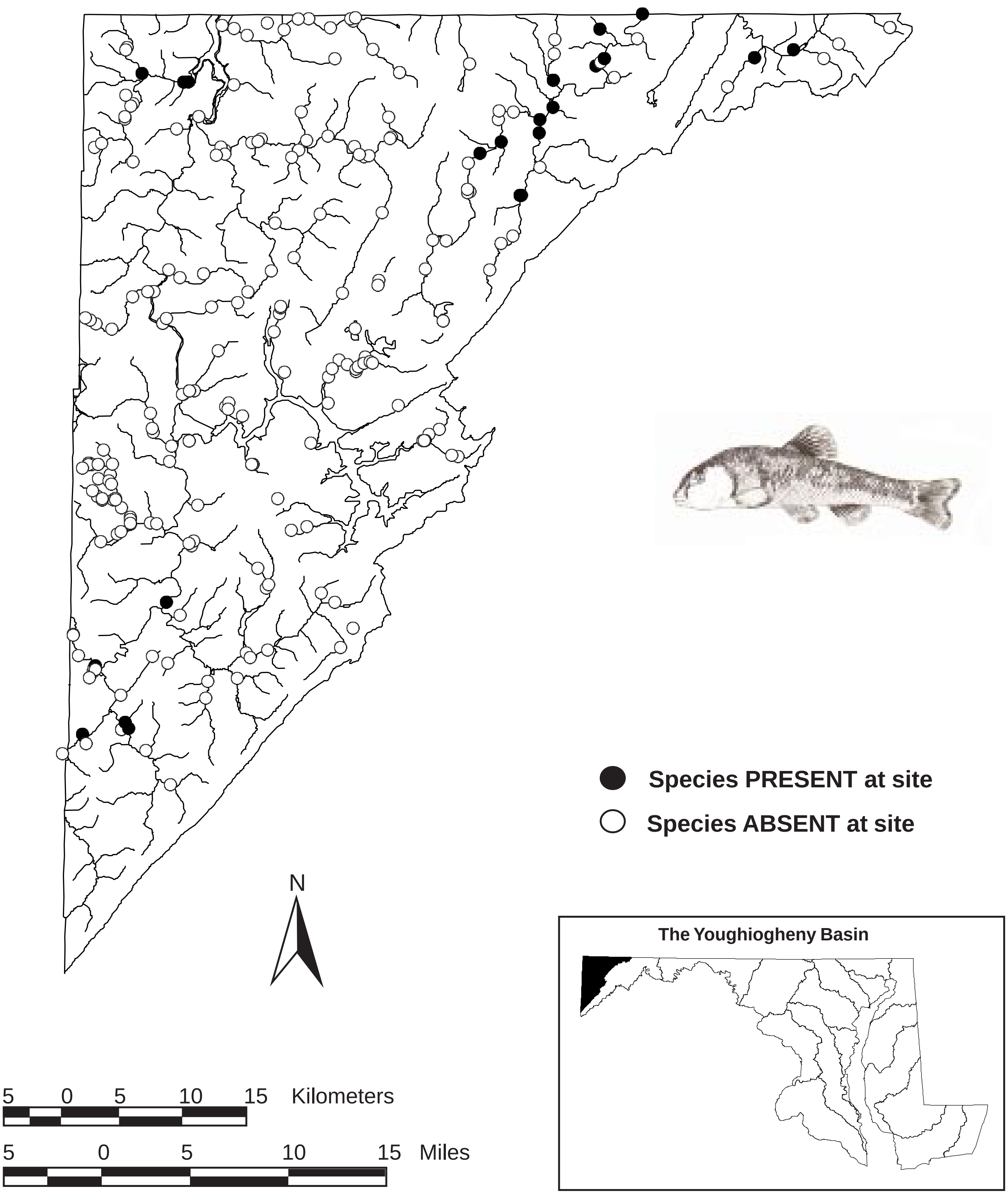
Redfin pickerel distribution in the Youghiogheny basin, 1994, 1995 and 1997.



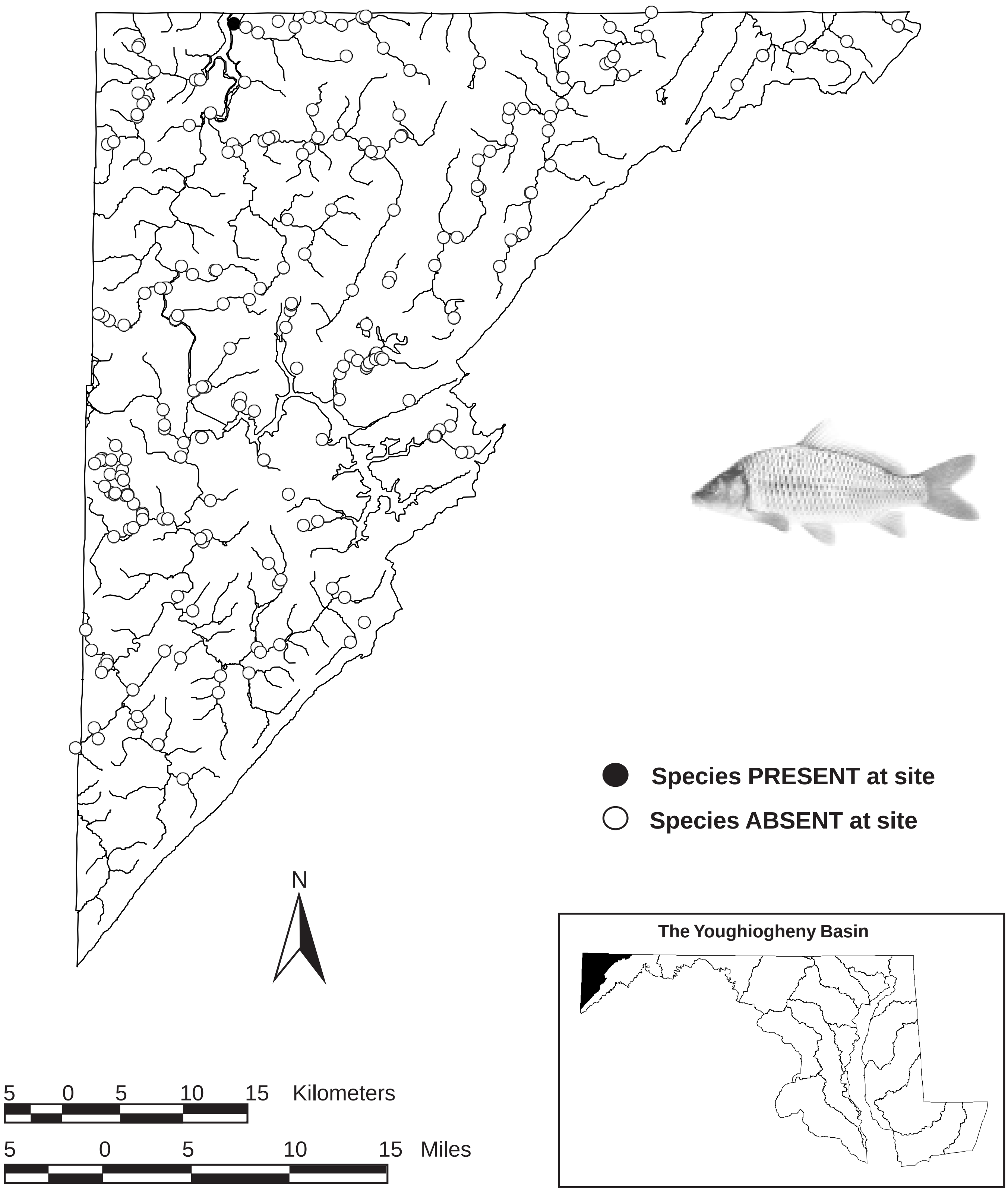
Blacknose dace distribution in the Youghiogheny basin, 1994, 1995 and 1997.



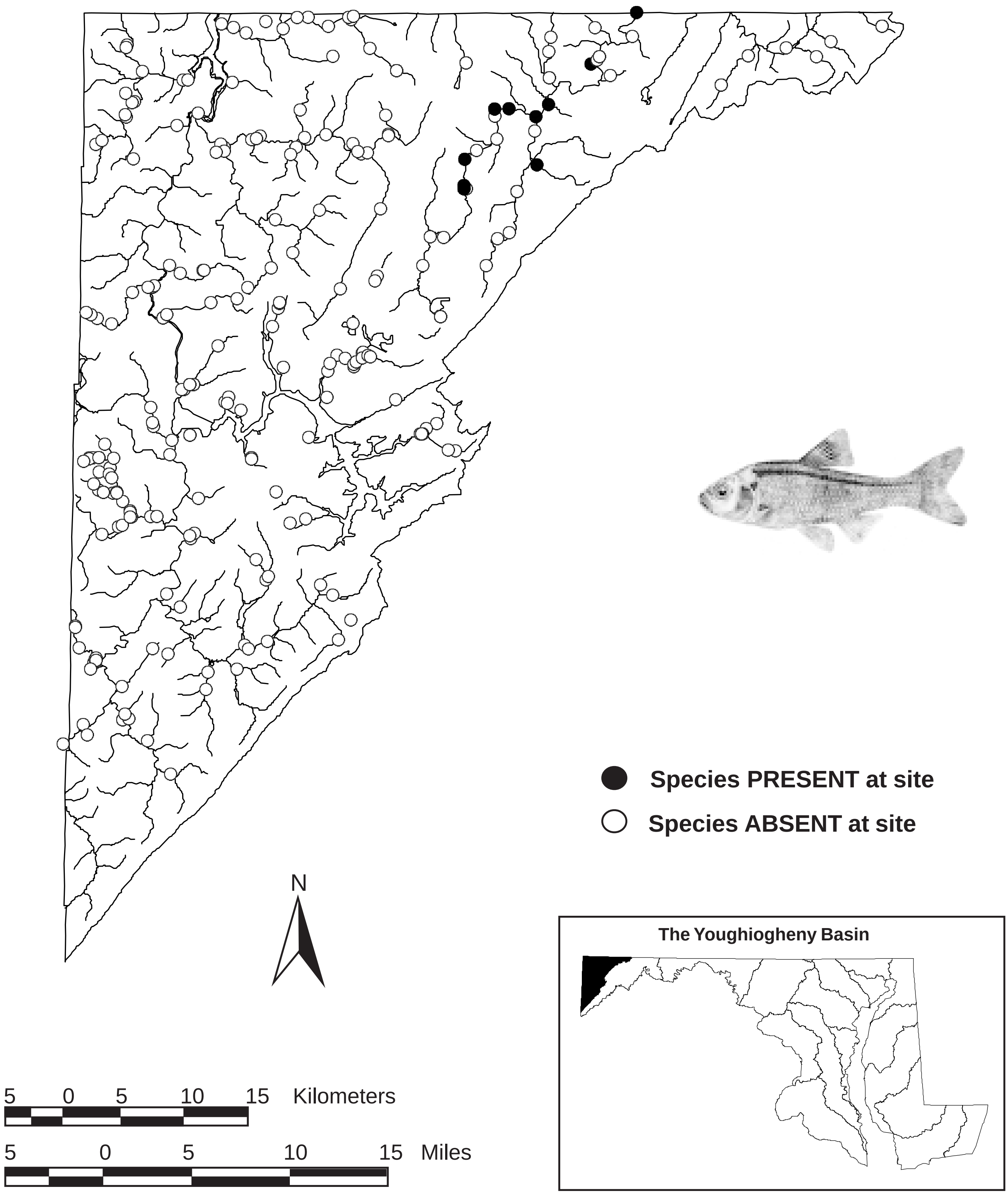
Bluntnose minnow distribution in the Youghiogheny basin, 1994, 1995 and 1997.



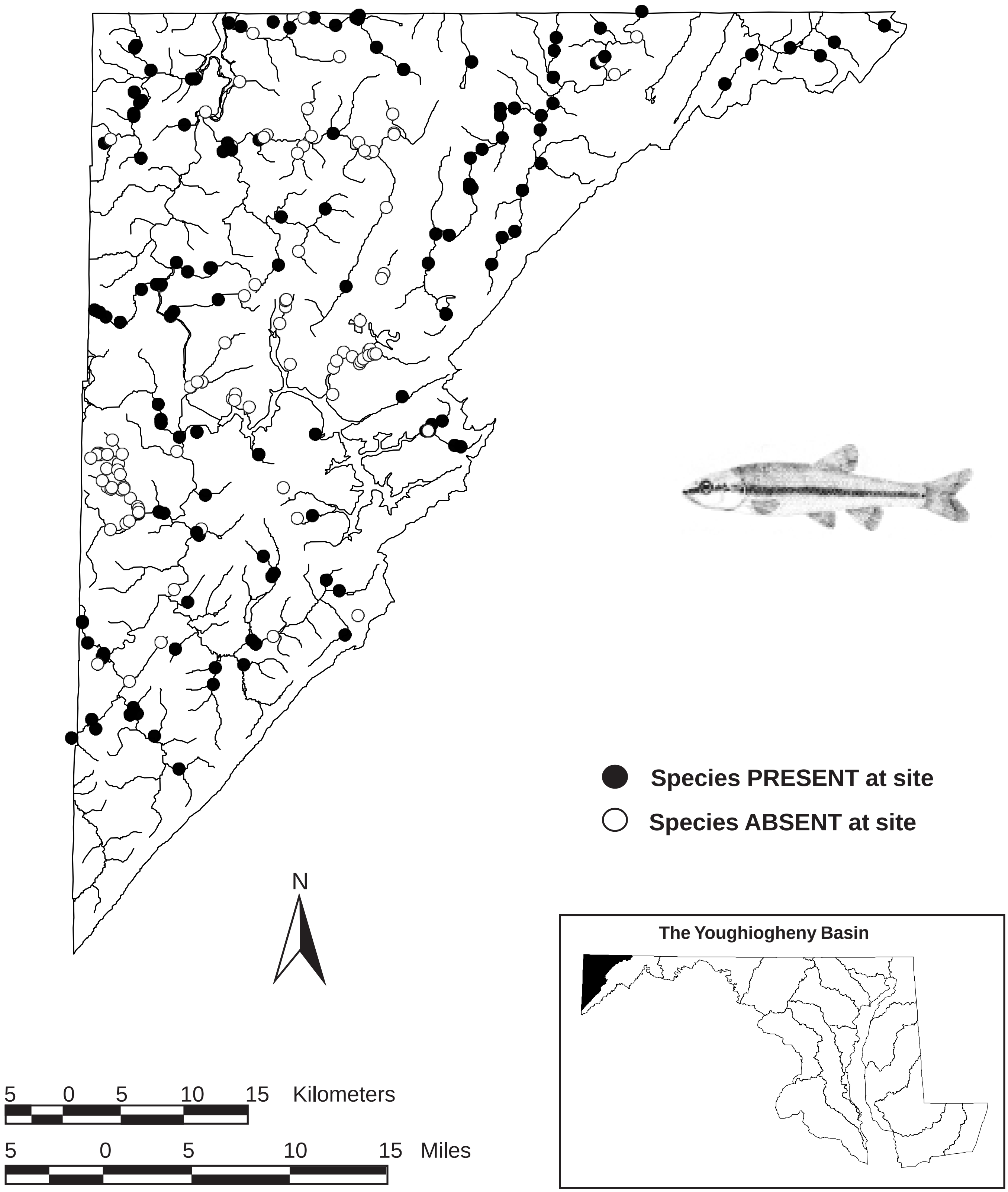
Central stoneroller distribution in the Youghiogheny basin, 1994, 1995 and 1997.



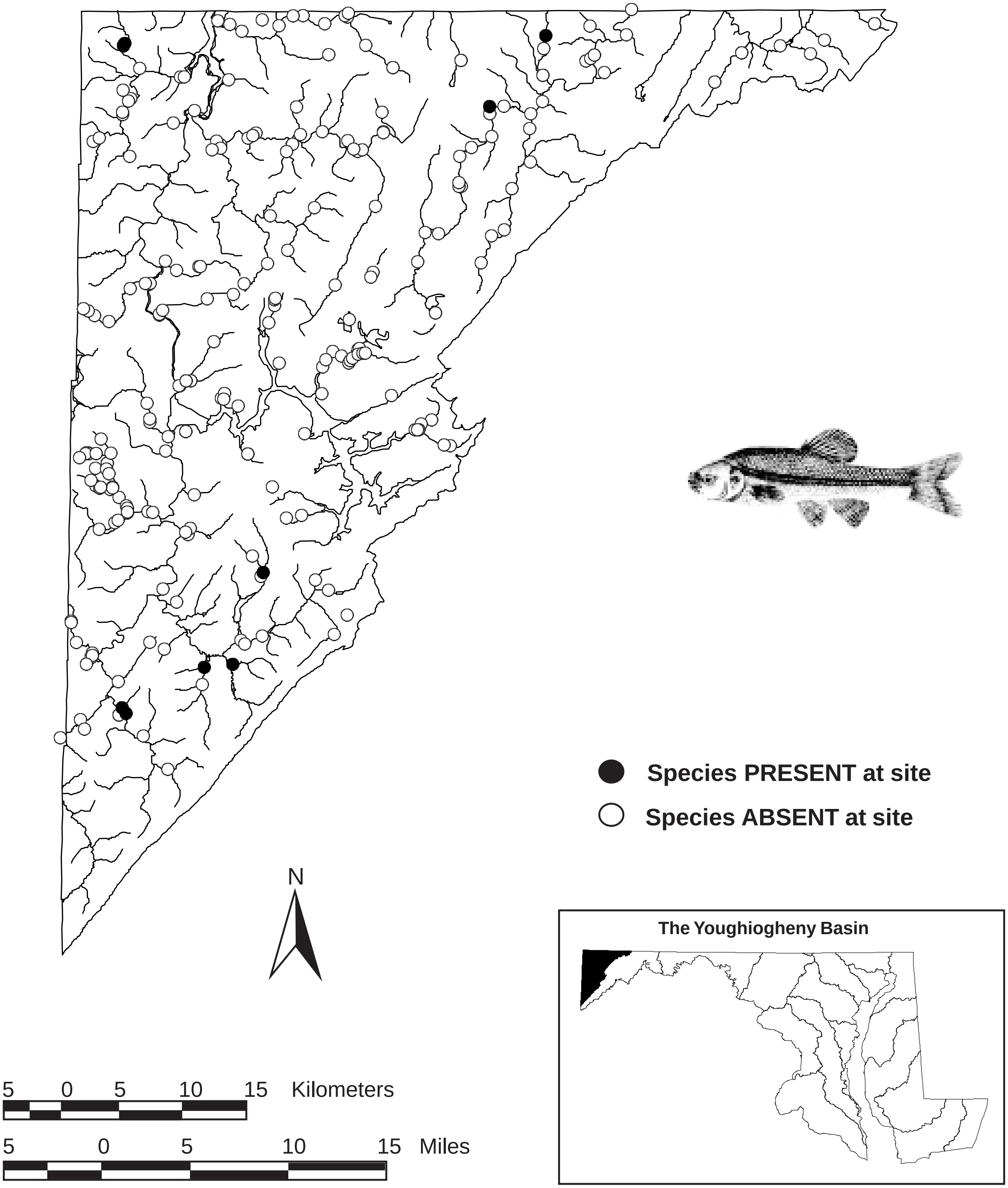
Common carp distribution in the Youghiogheny basin, 1994, 1995 and 1997.



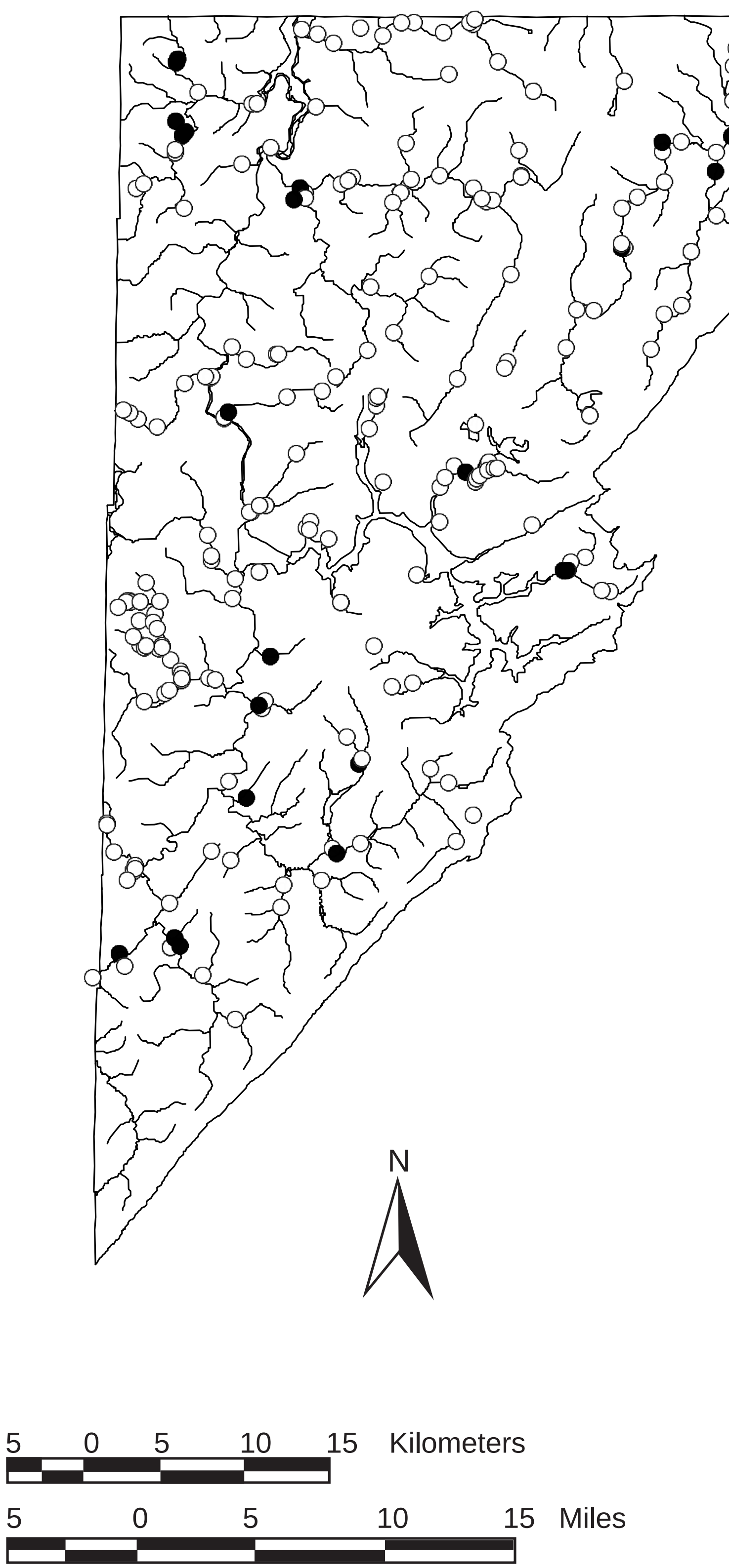
Common shiner distribution in the Youghiogheny basin, 1994, 1995 and 1997.

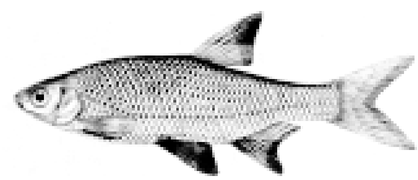


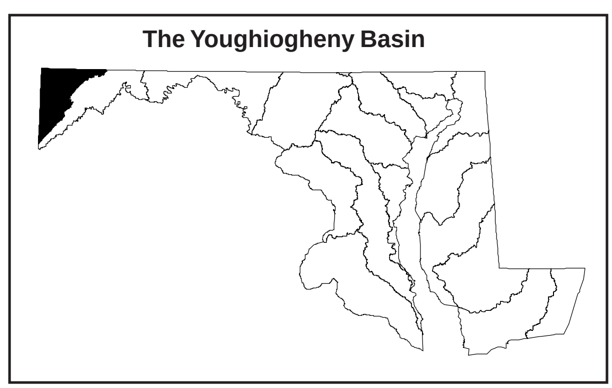
Creek chub distribution in the Youghiogheny basin, 1994, 1995 and 1997.



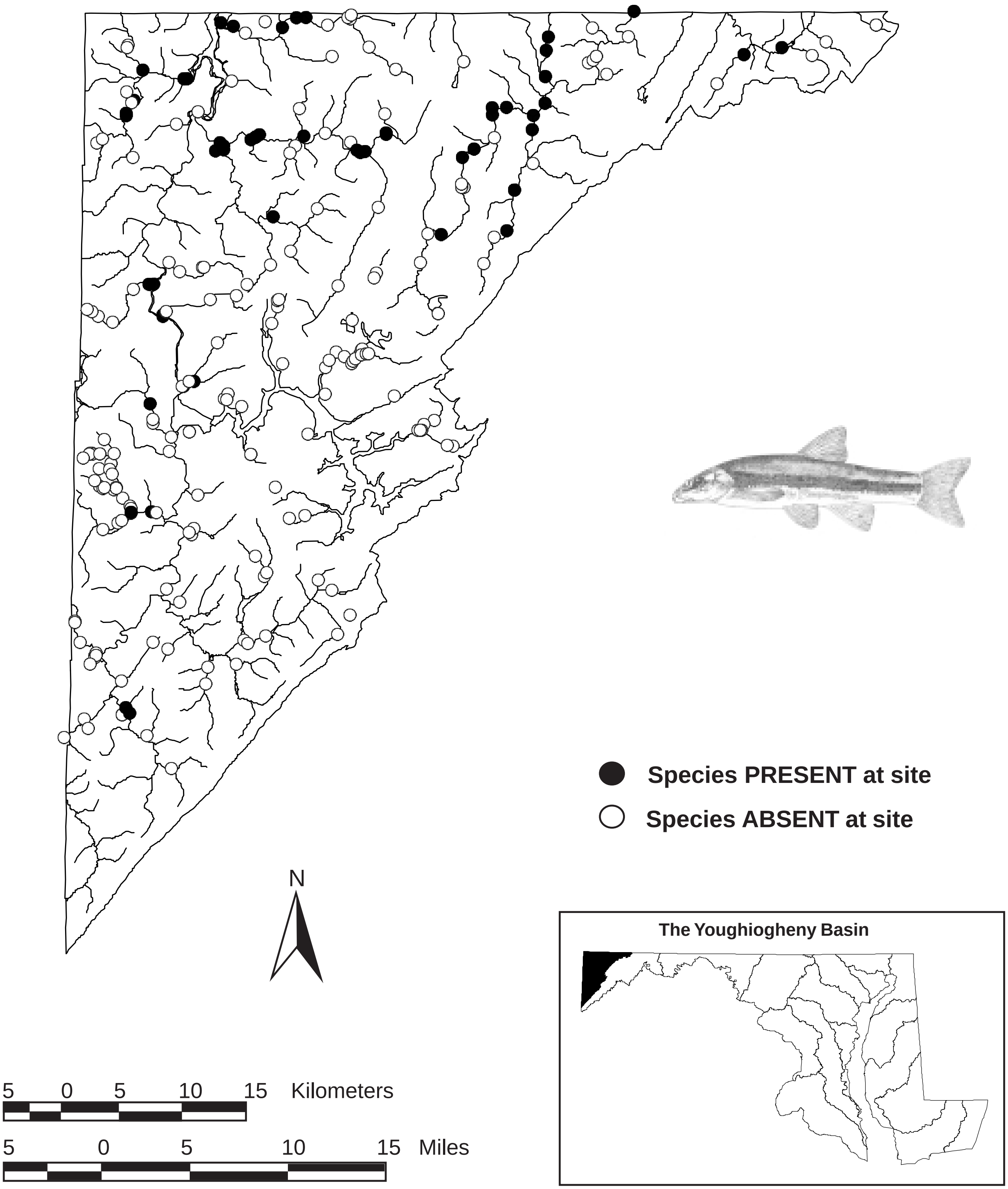
Fathead minnow distribution in the Youghiogheny basin, 1994, 1995 and 1997.



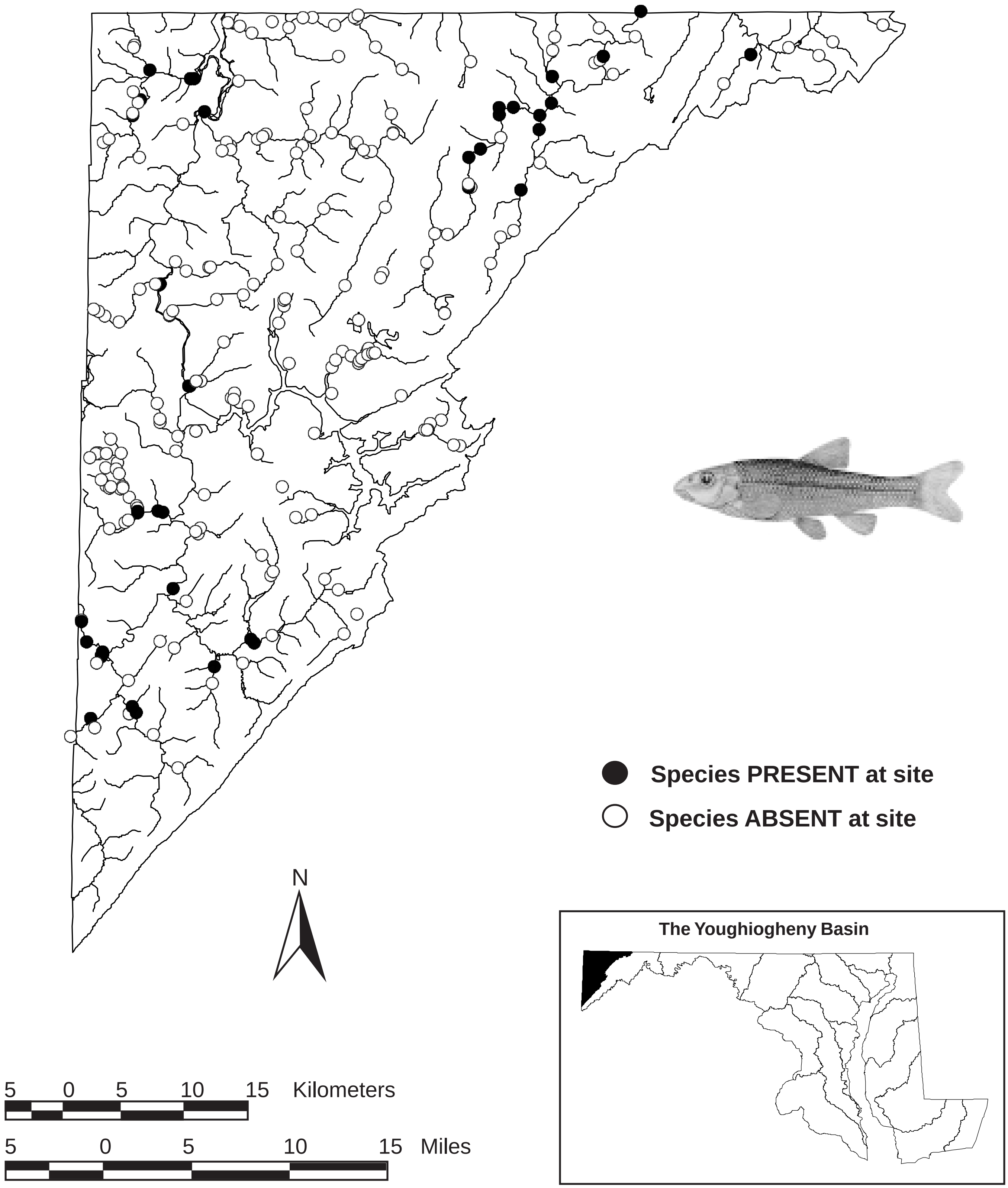




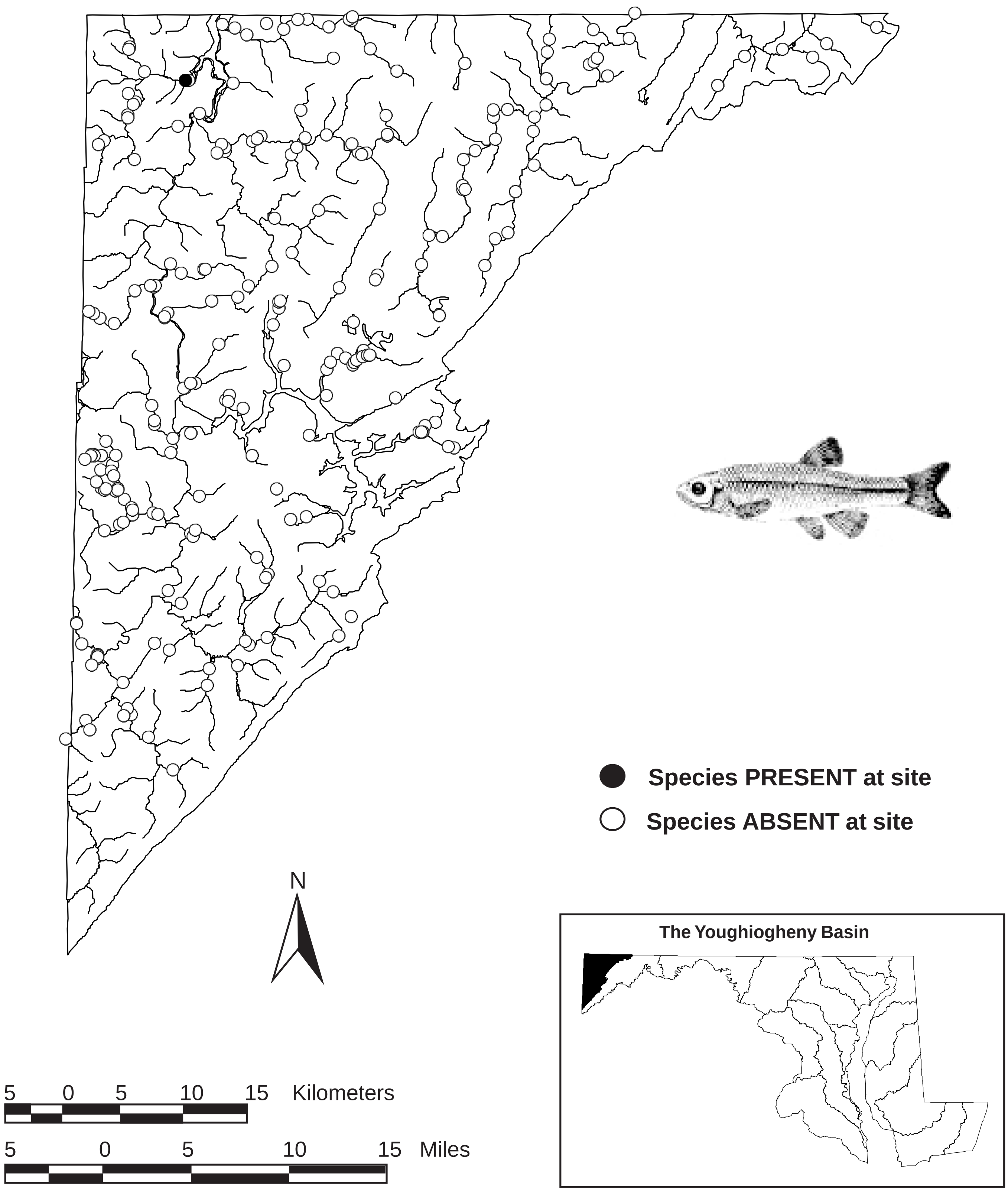
Golden shiner distribution in the Youghiogheny basin, 1994, 1995 and 1997.



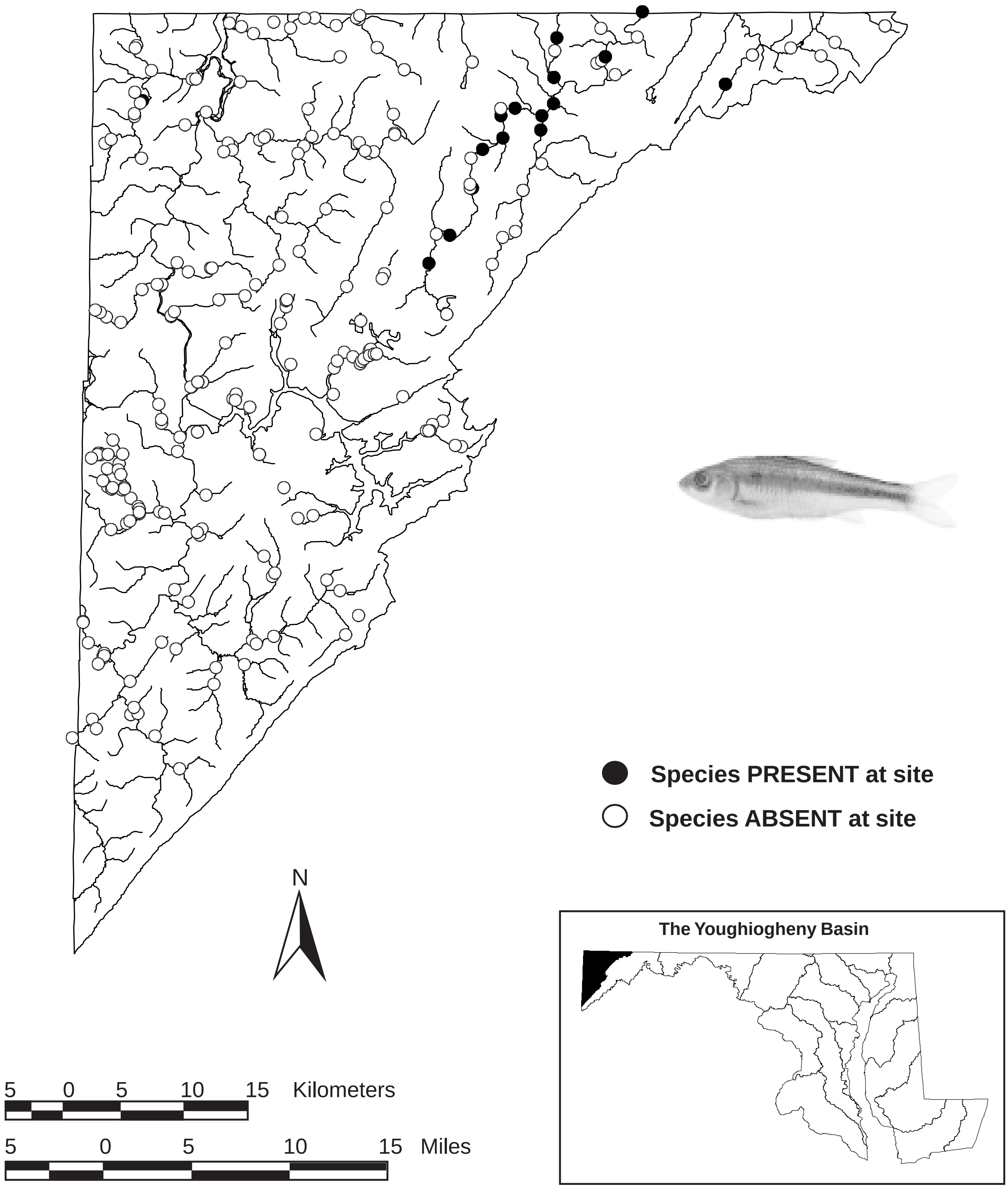
Longnose dace distribution in the Youghiogheny basin, 1994, 1995 and 1997.



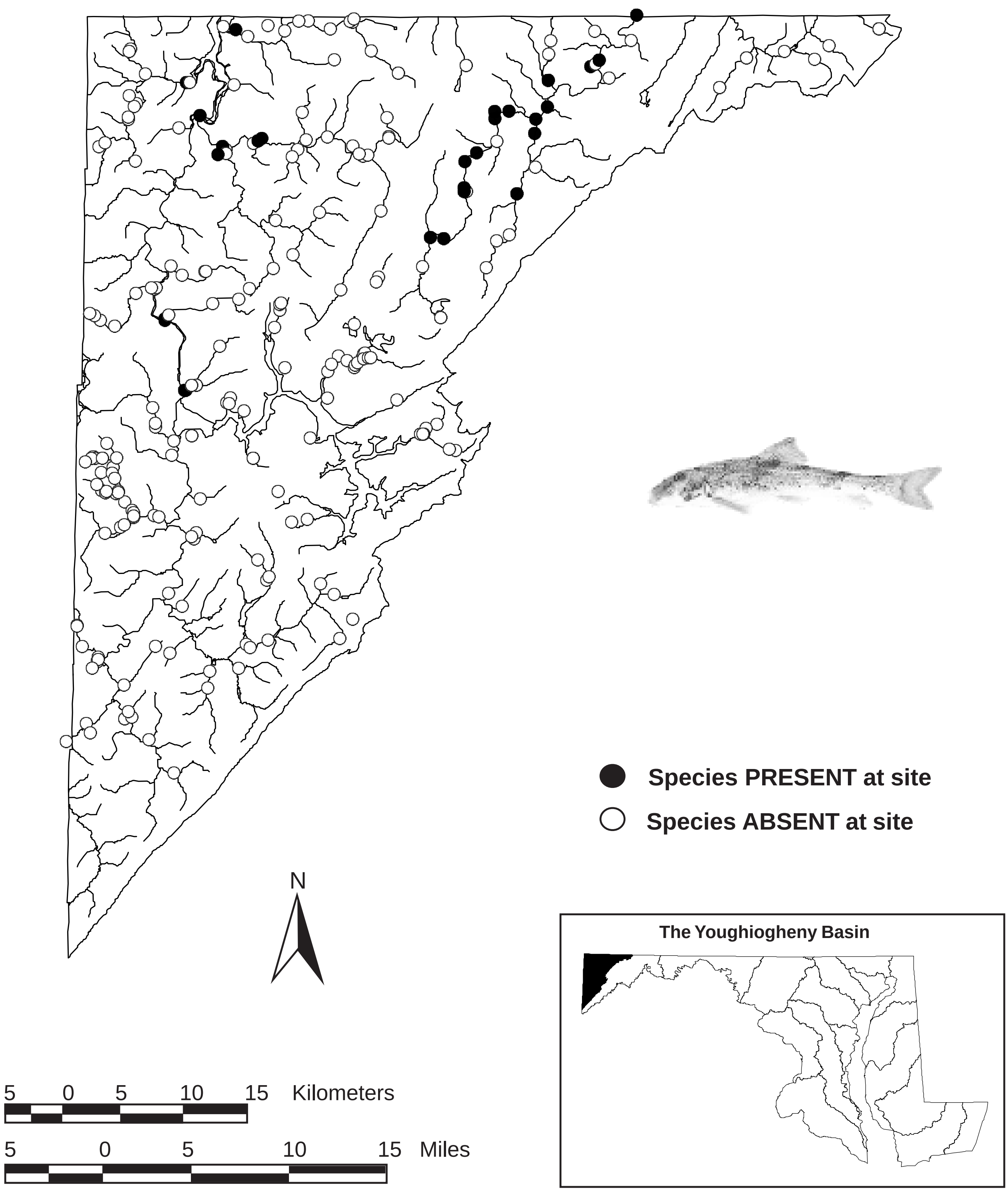
River chub distribution in the Youghiogheny basin, 1994, 1995 and 1997.



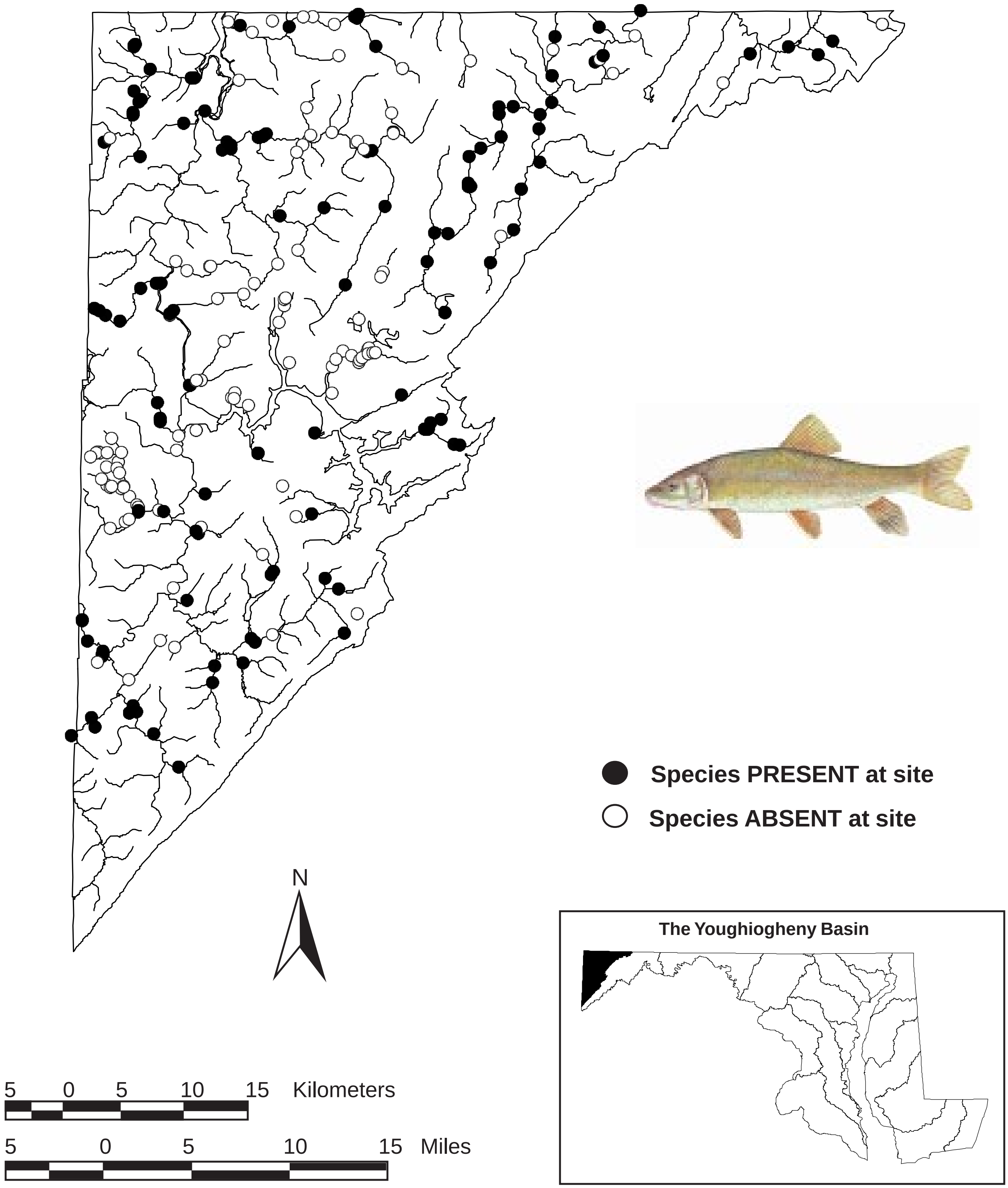
Spotfin shiner distribution in the Youghiogheny basin, 1994, 1995 and 1997.



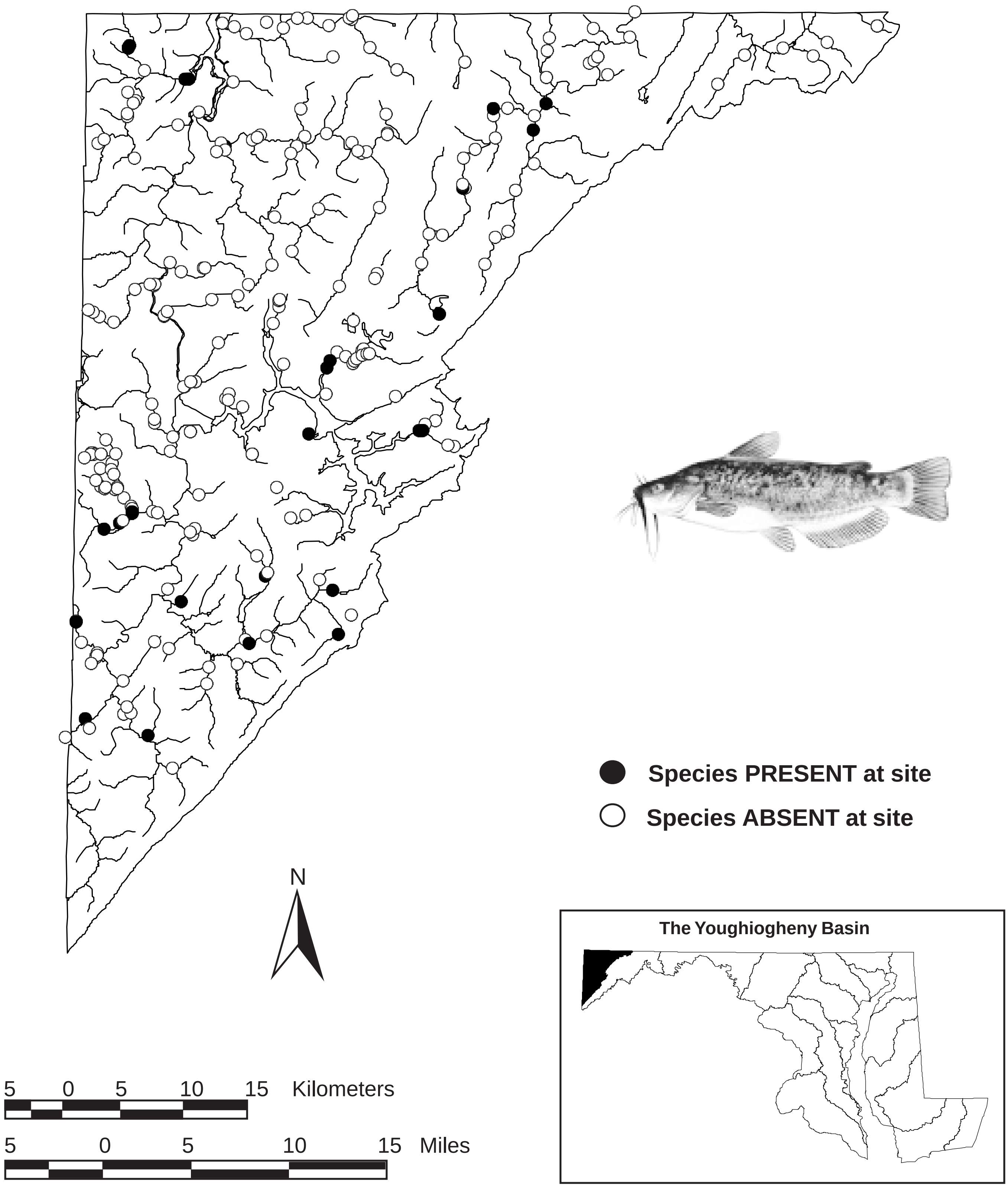
Striped shiner distribution in the Youghiogheny basin, 1994, 1995 and 1997.



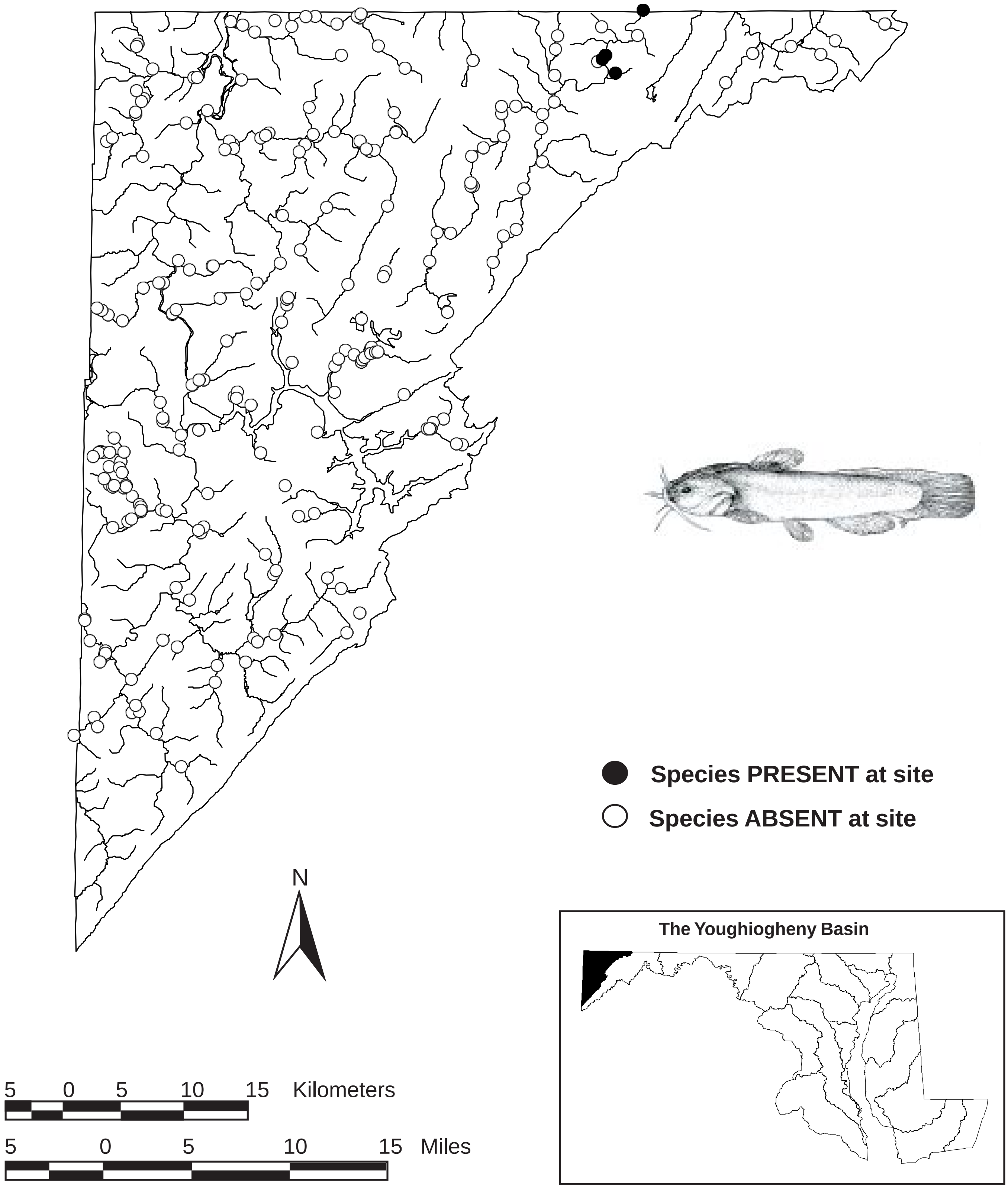
Northern hogsucker distribution in the Youghiogheny basin, 1994, 1995 and 1997.



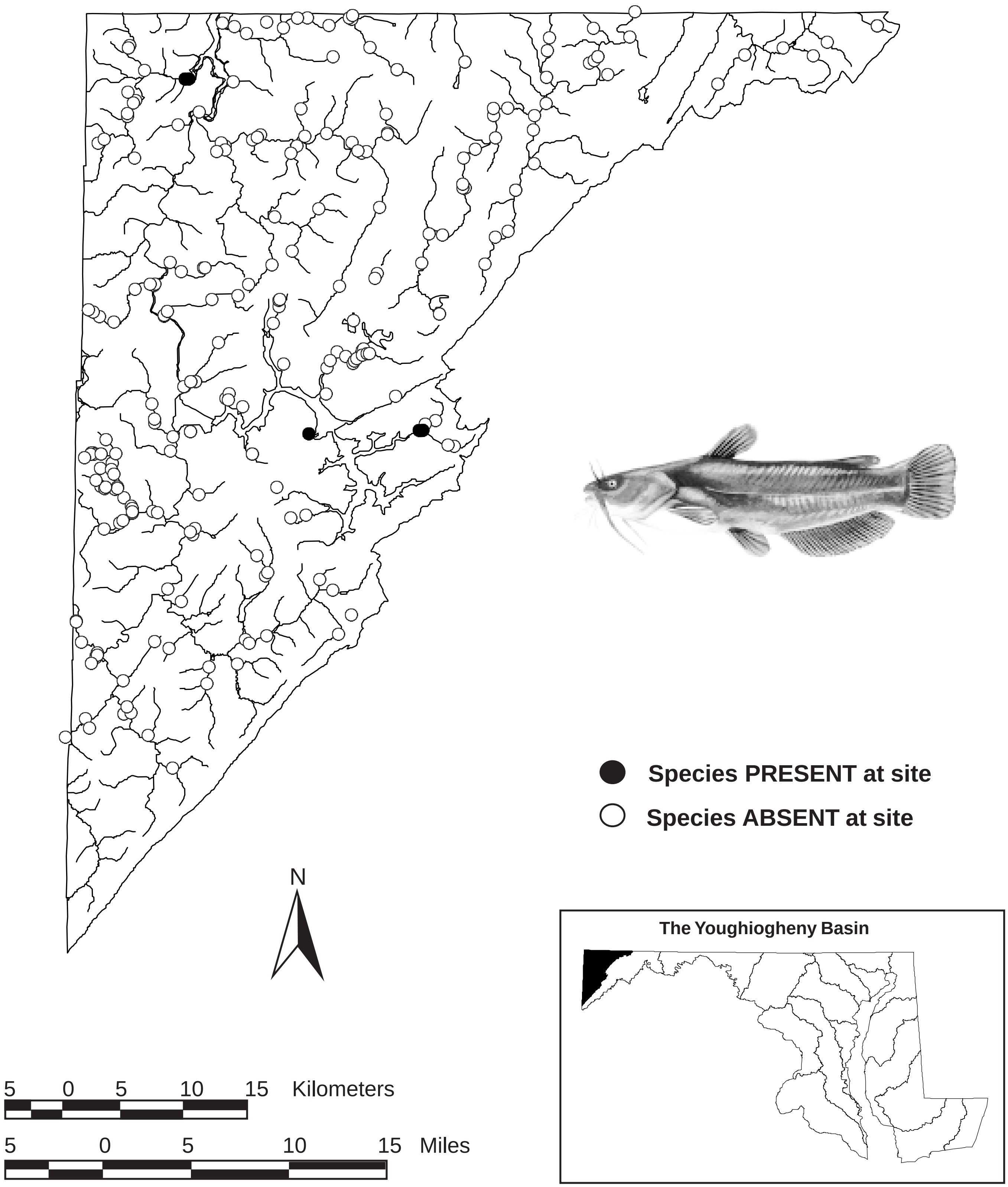
White sucker distribution in the Youghiogheny basin, 1994, 1995 and 1997.



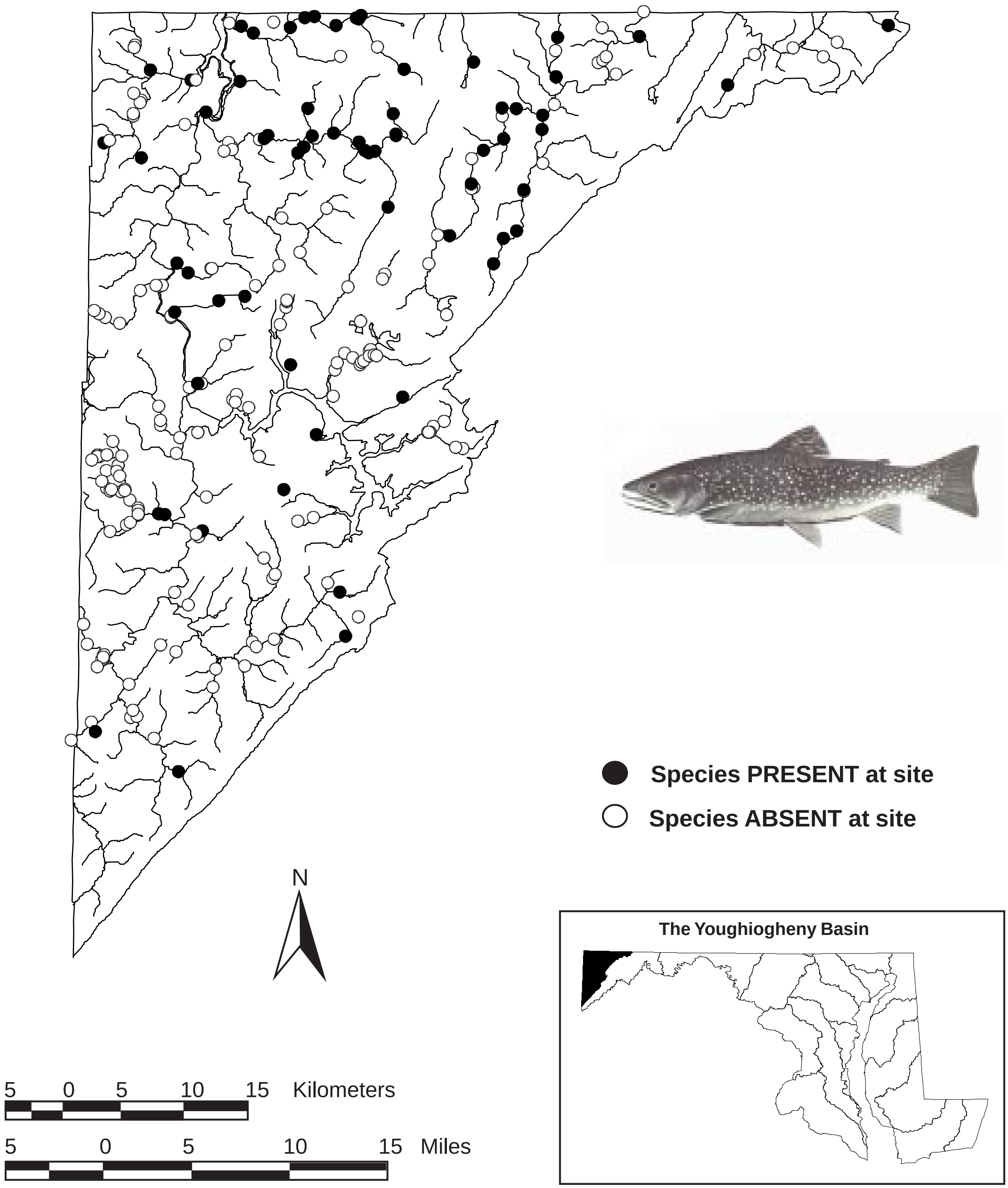
Brown bullhead distribution in the Youghiogheny basin, 1994, 1995 and 1997.



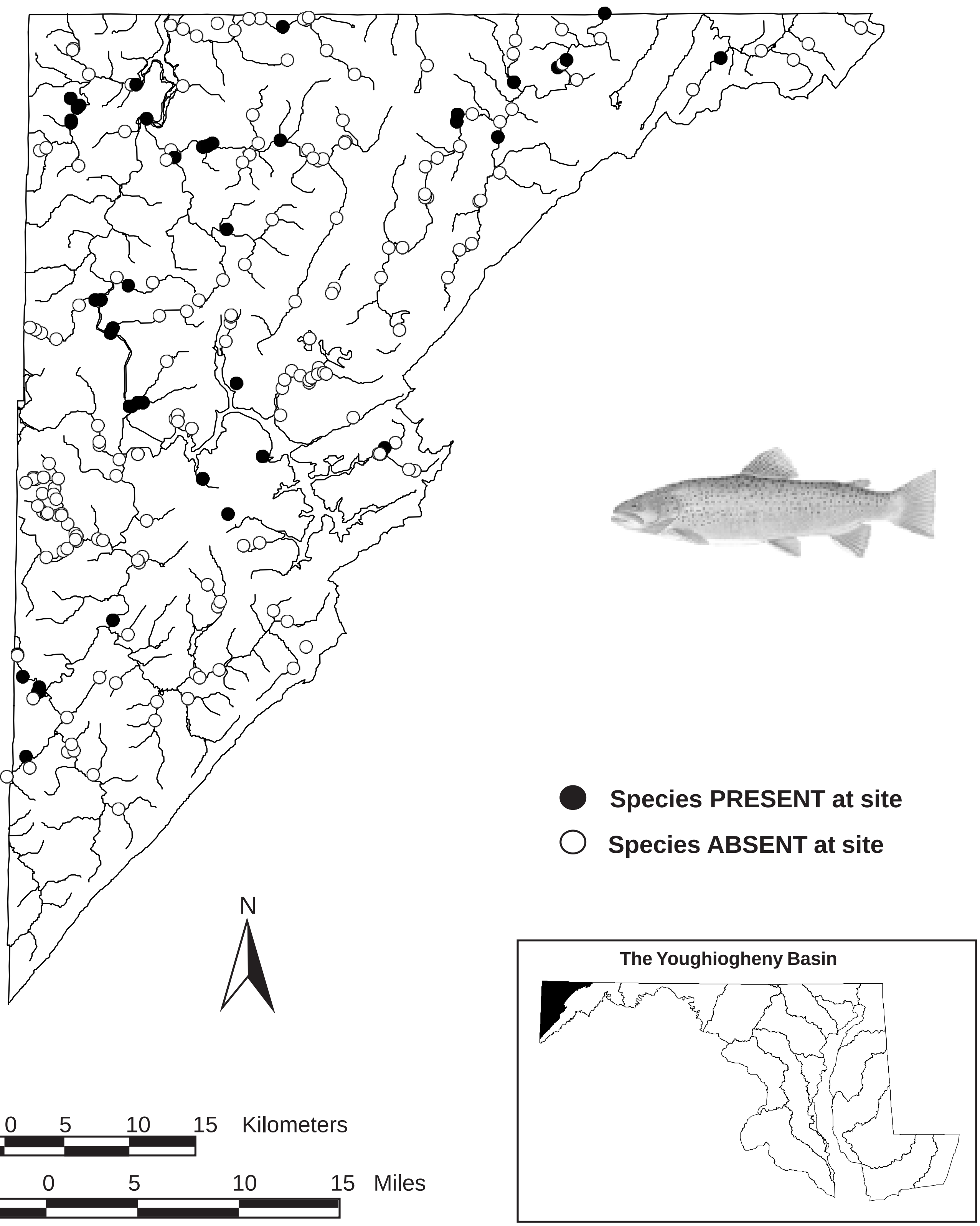
Stonecat distribution in the Youghiogheny basin, 1994, 1995 and 1997.



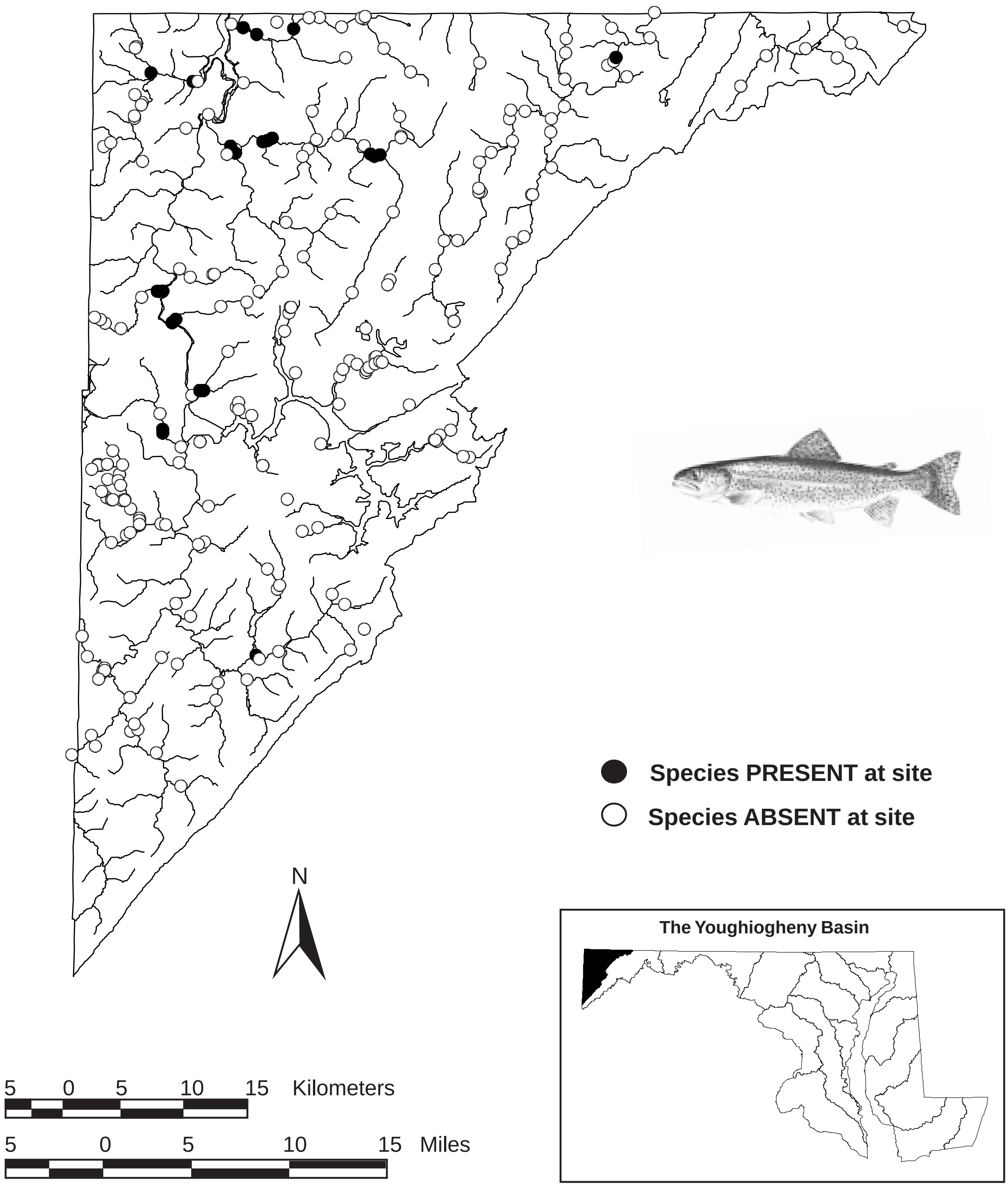
Yellow bullhead distribution in the Youghiogheny basin, 1994, 1995 and 1997.



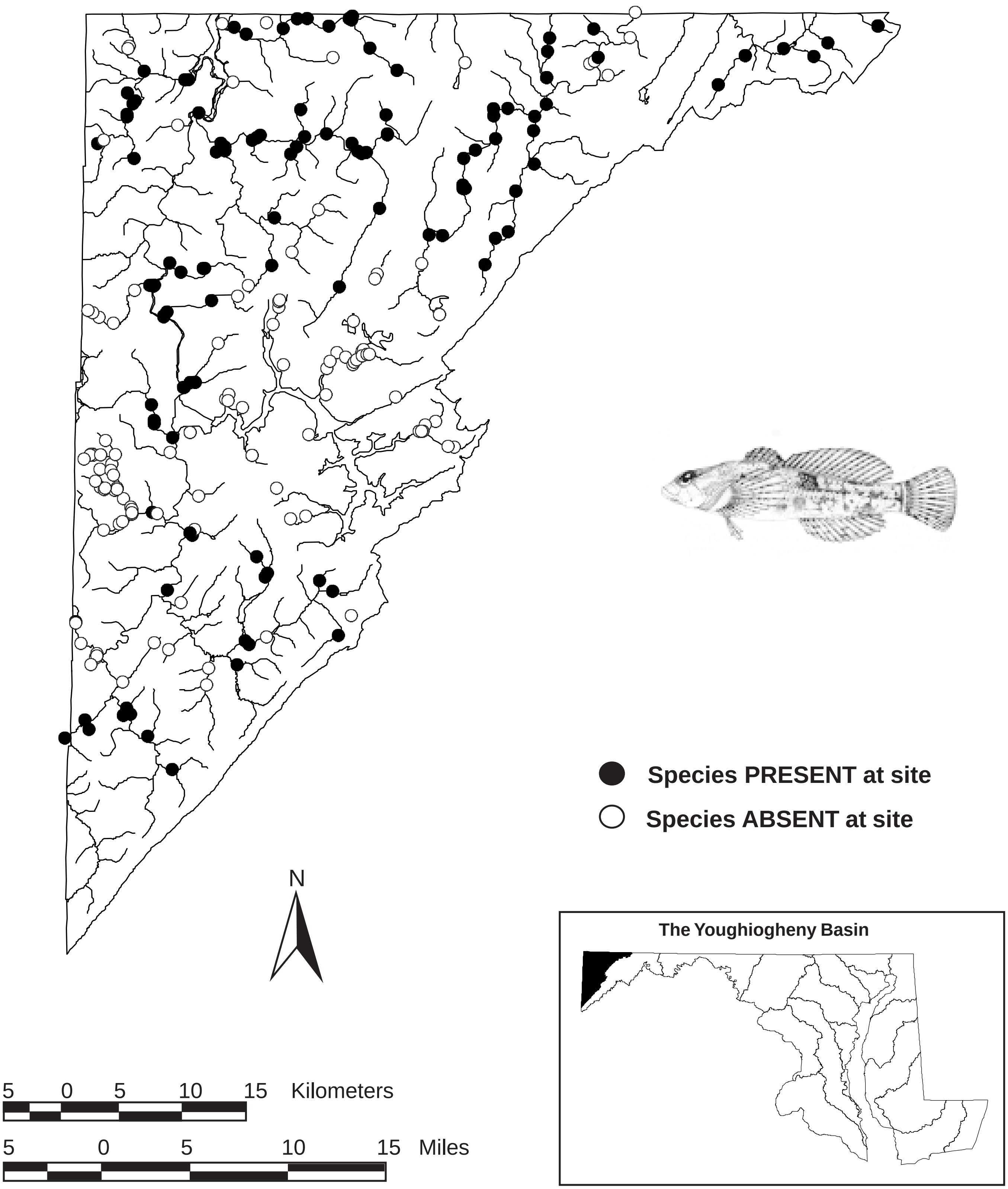
Brook trout distribution in the Youghiogheny basin, 1994, 1995 and 1997.



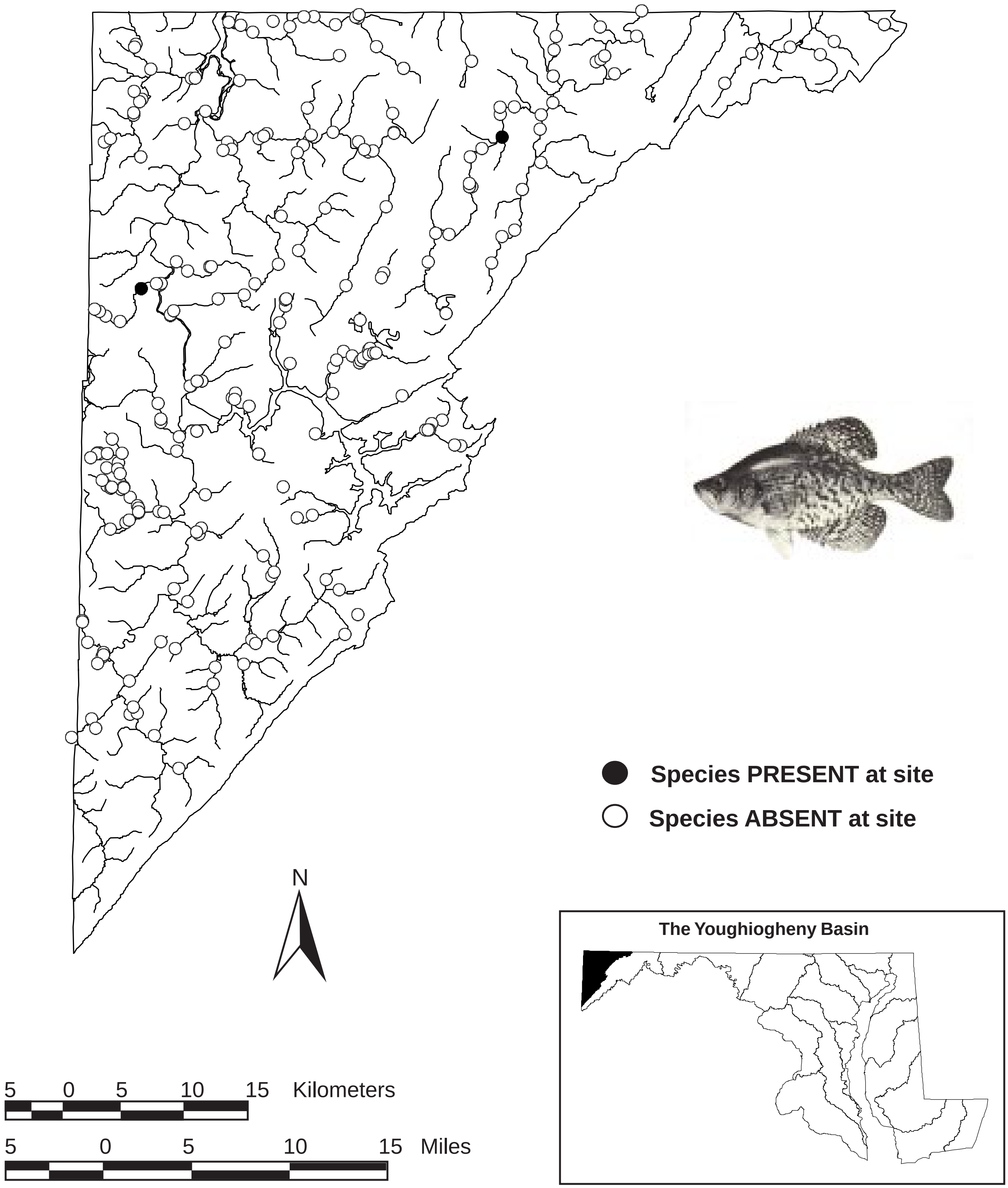
Brown trout distribution in the Youghiogheny basin, 1994, 1995 and 1997.



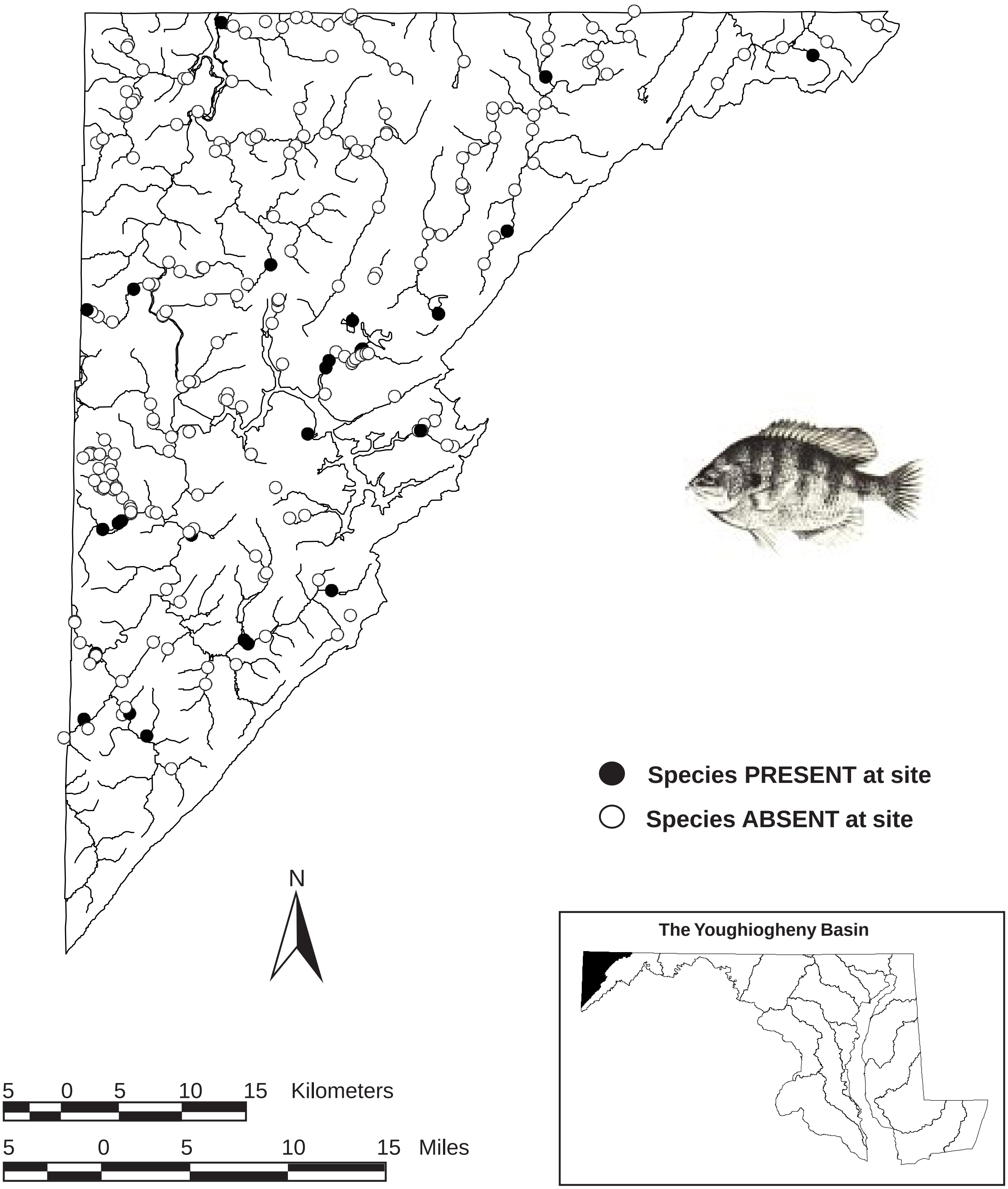
Rainbow trout distribution in the Youghiogheny basin, 1994, 1995 and 1997.



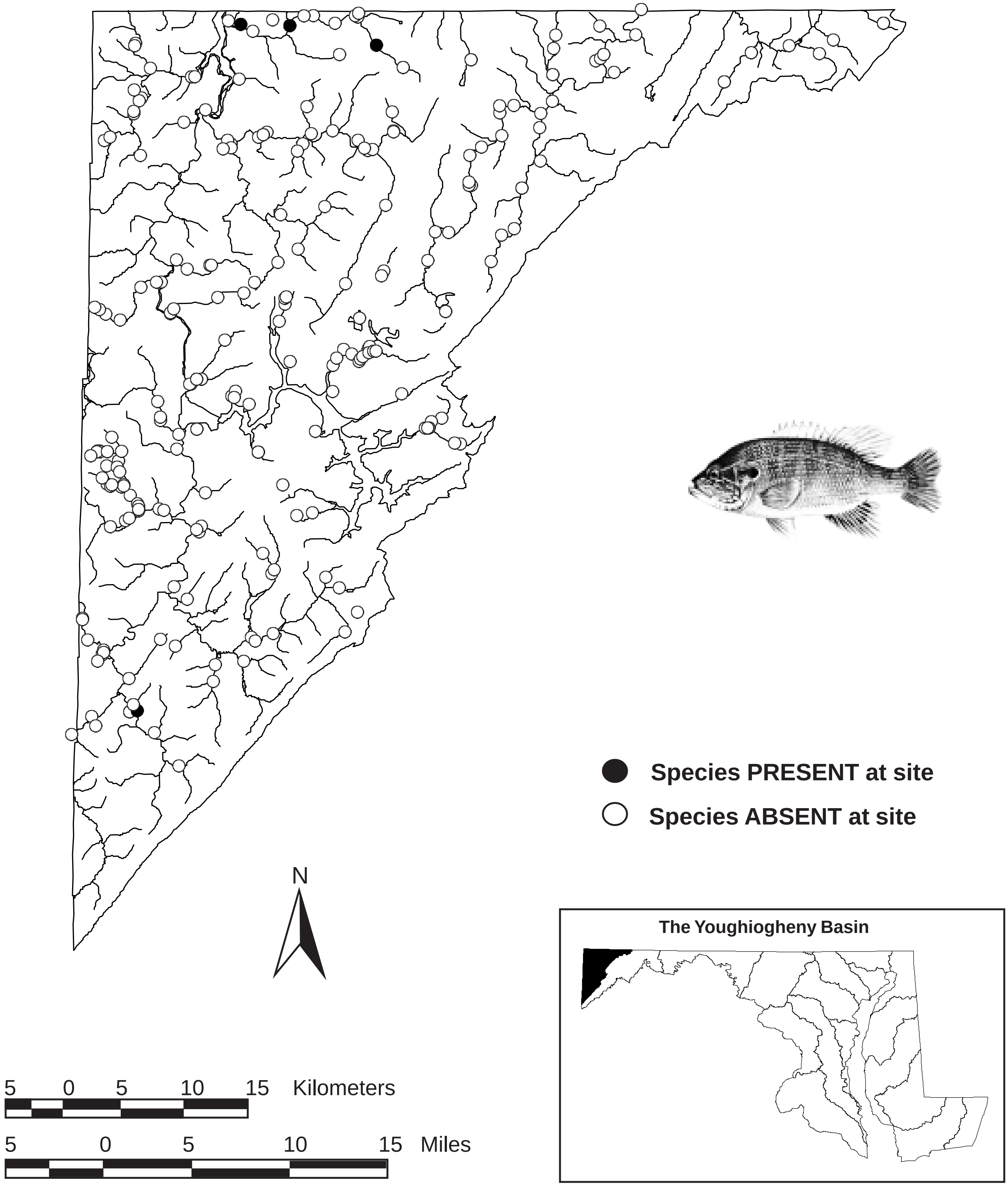
Mottled sculpin distribution in the Youghiogheny basin, 1994, 1995 and 1997.



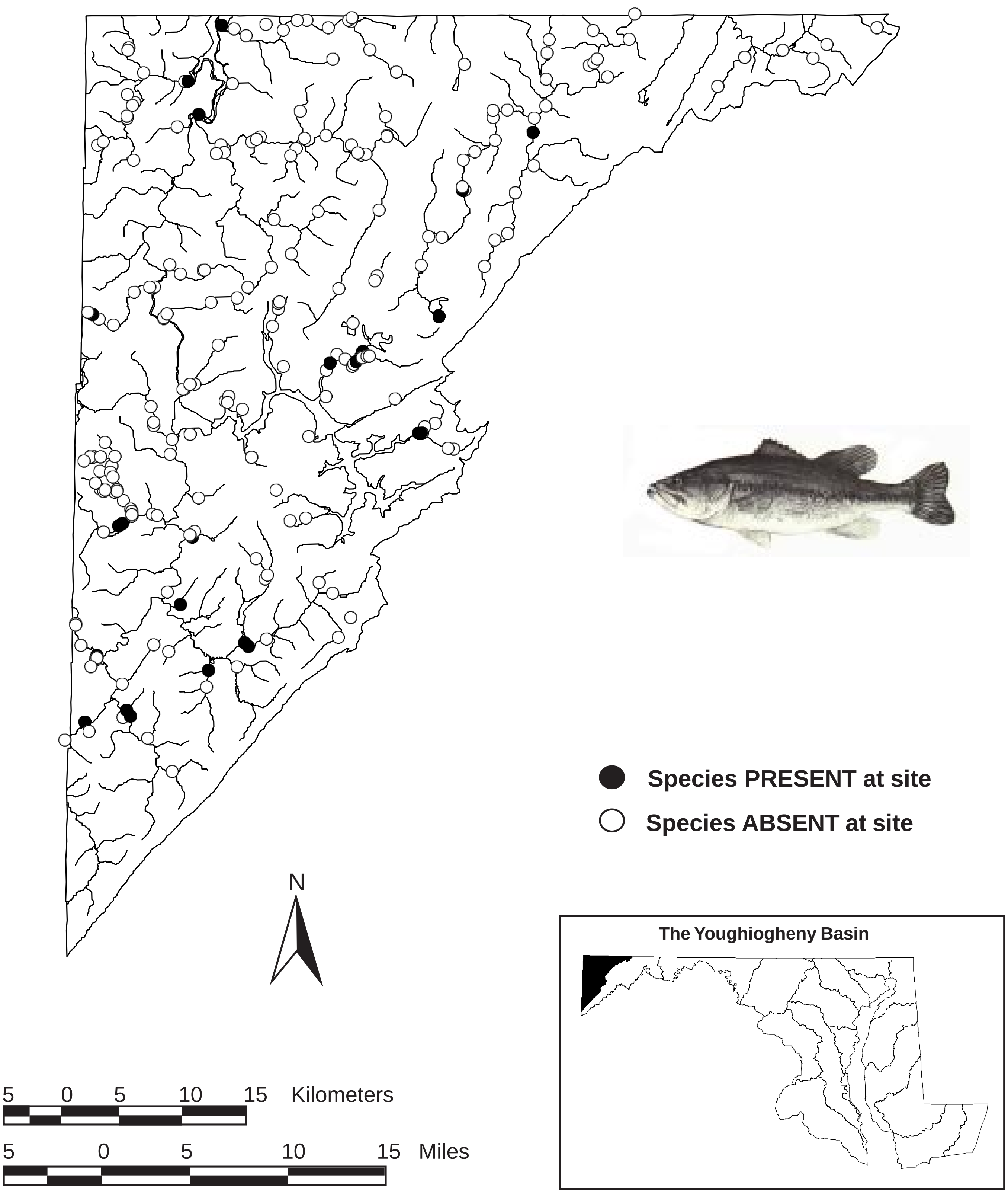
Black crappie distribution in the Youghiogheny basin, 1994, 1995 and 1997.



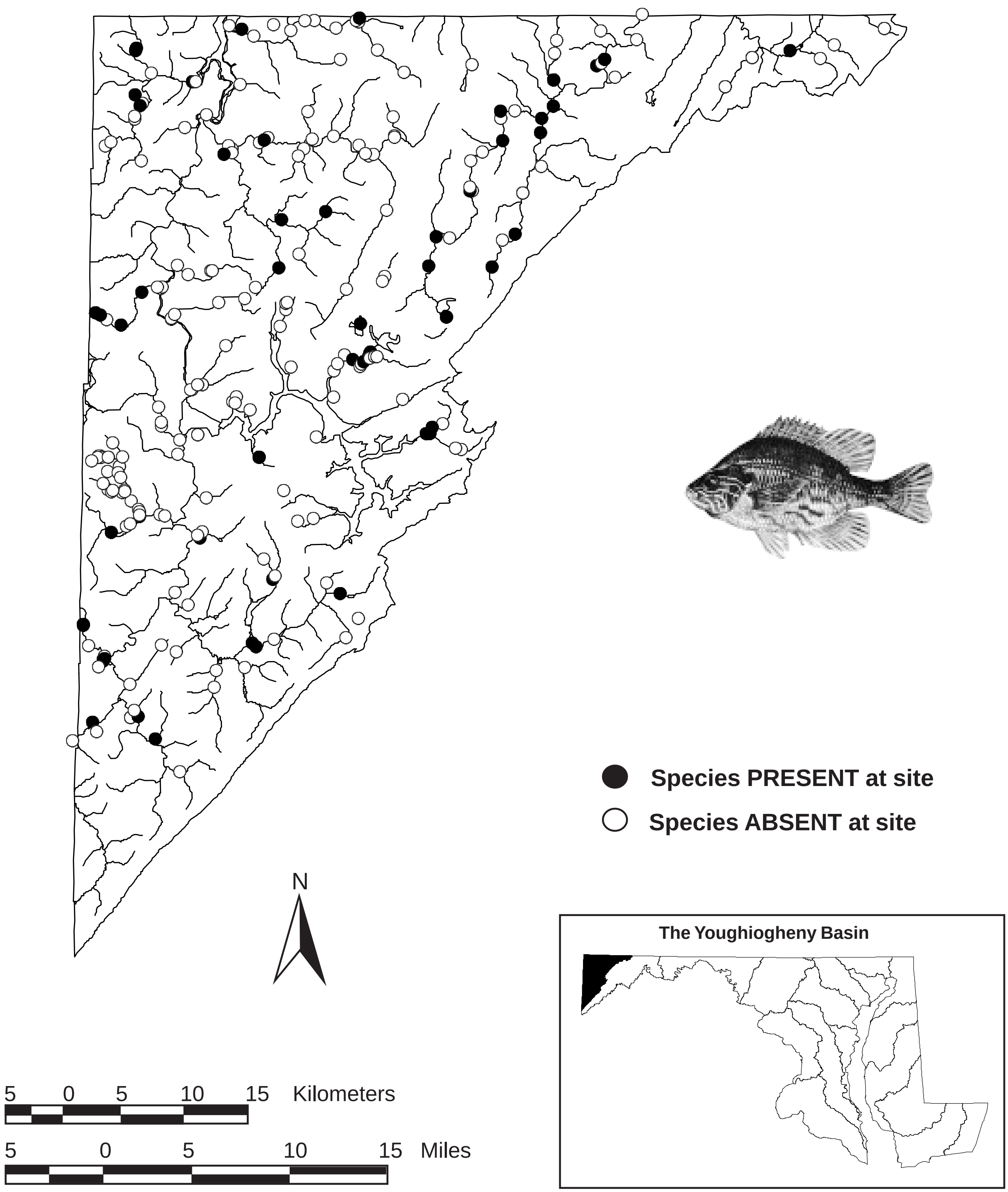
Bluegill distribution in the Youghiogheny basin, 1994, 1995 and 1997.



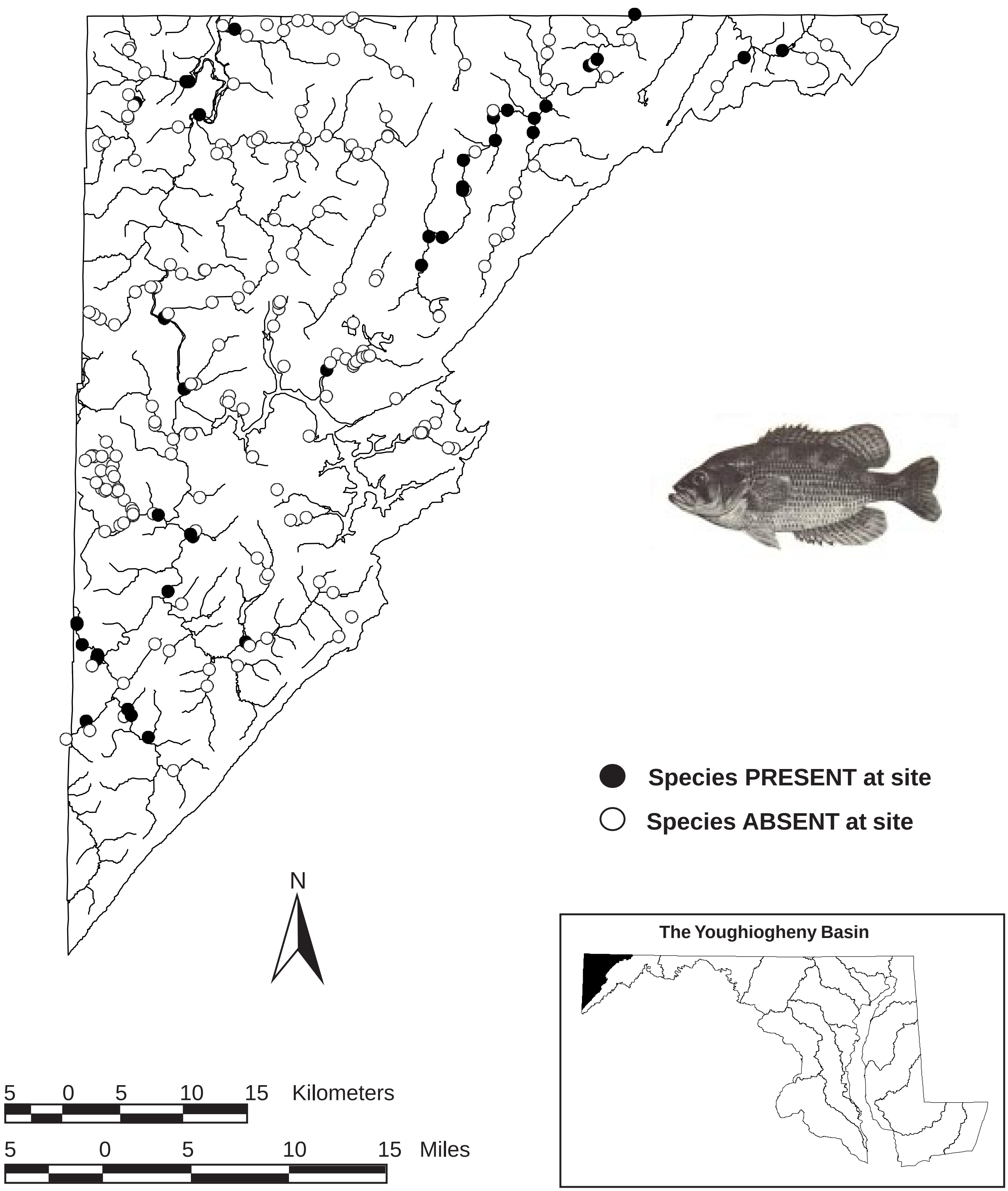
Green sunfish distribution in the Youghiogheny basin, 1994, 1995 and 1997.



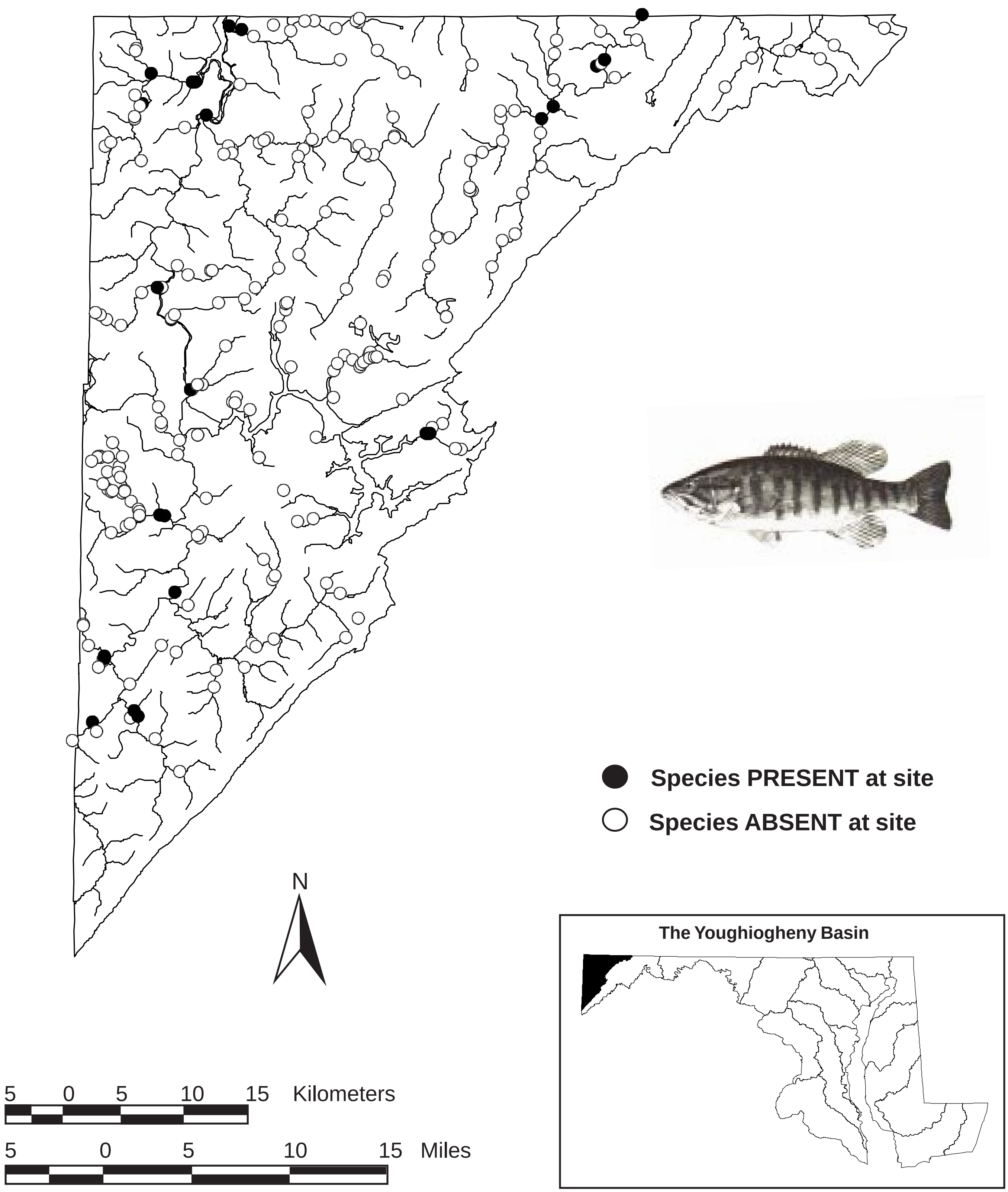
Largemouth bass distribution in the Youghiogheny basin, 1994, 1995 and 1997.



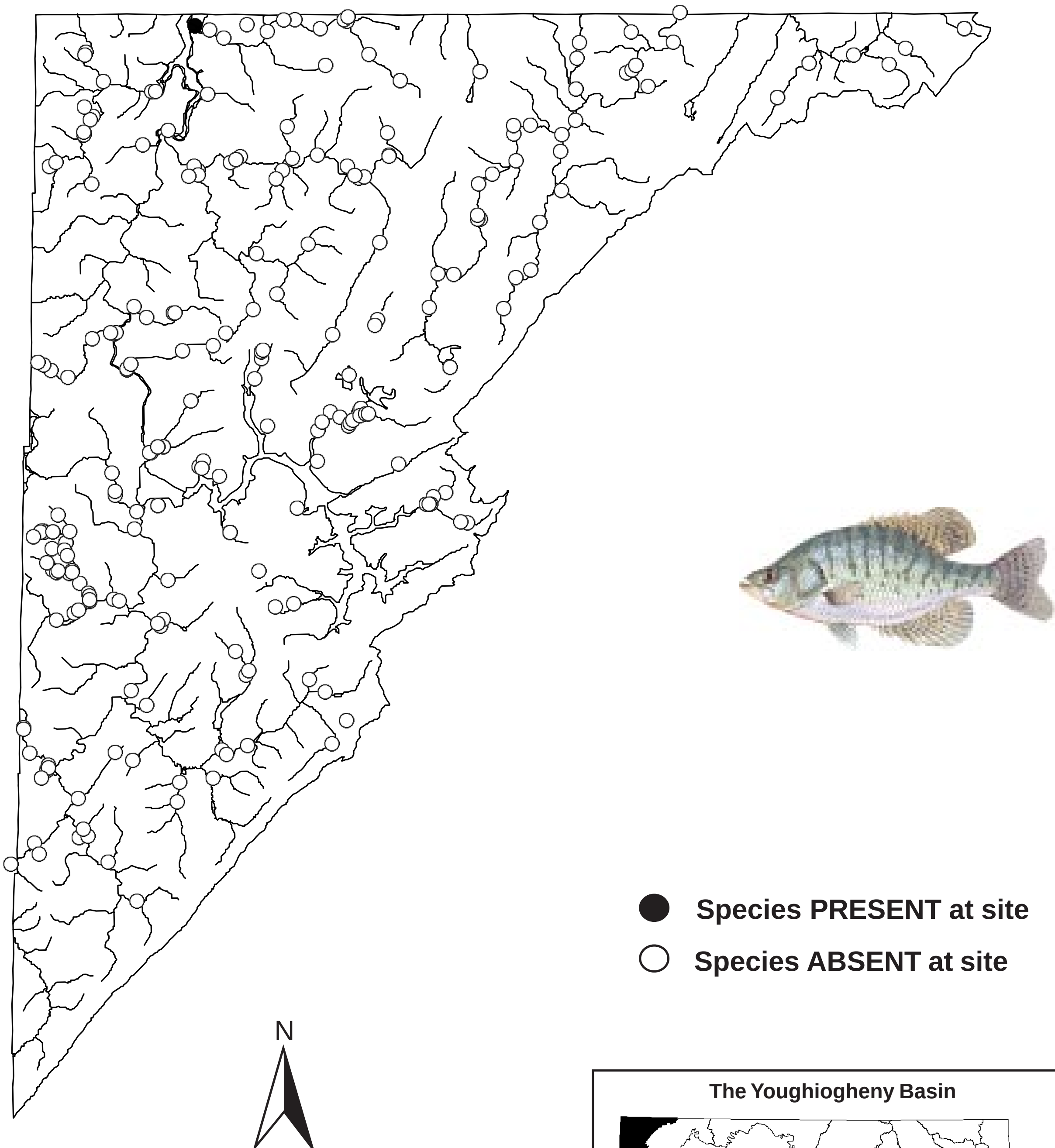
Pumpkinseed distribution in the Youghiogheny basin, 1994, 1995 and 1997.



Rock bass distribution in the Youghiogheny basin, 1994, 1995 and 1997.

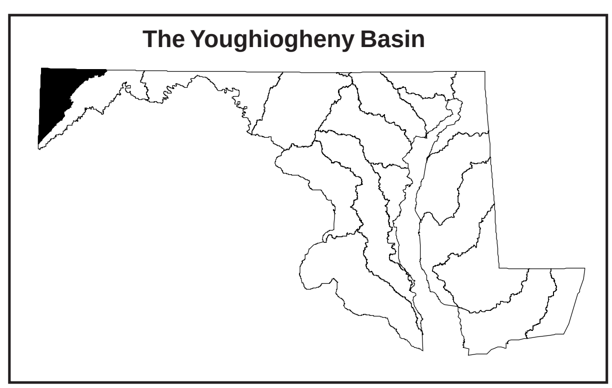


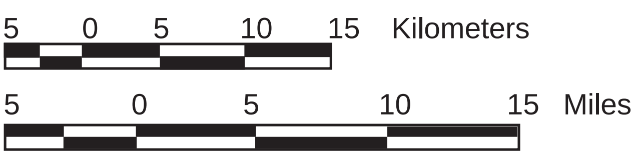
Smallmouth bass distribution in the Youghiogheny basin, 1994, 1995 and 1997.



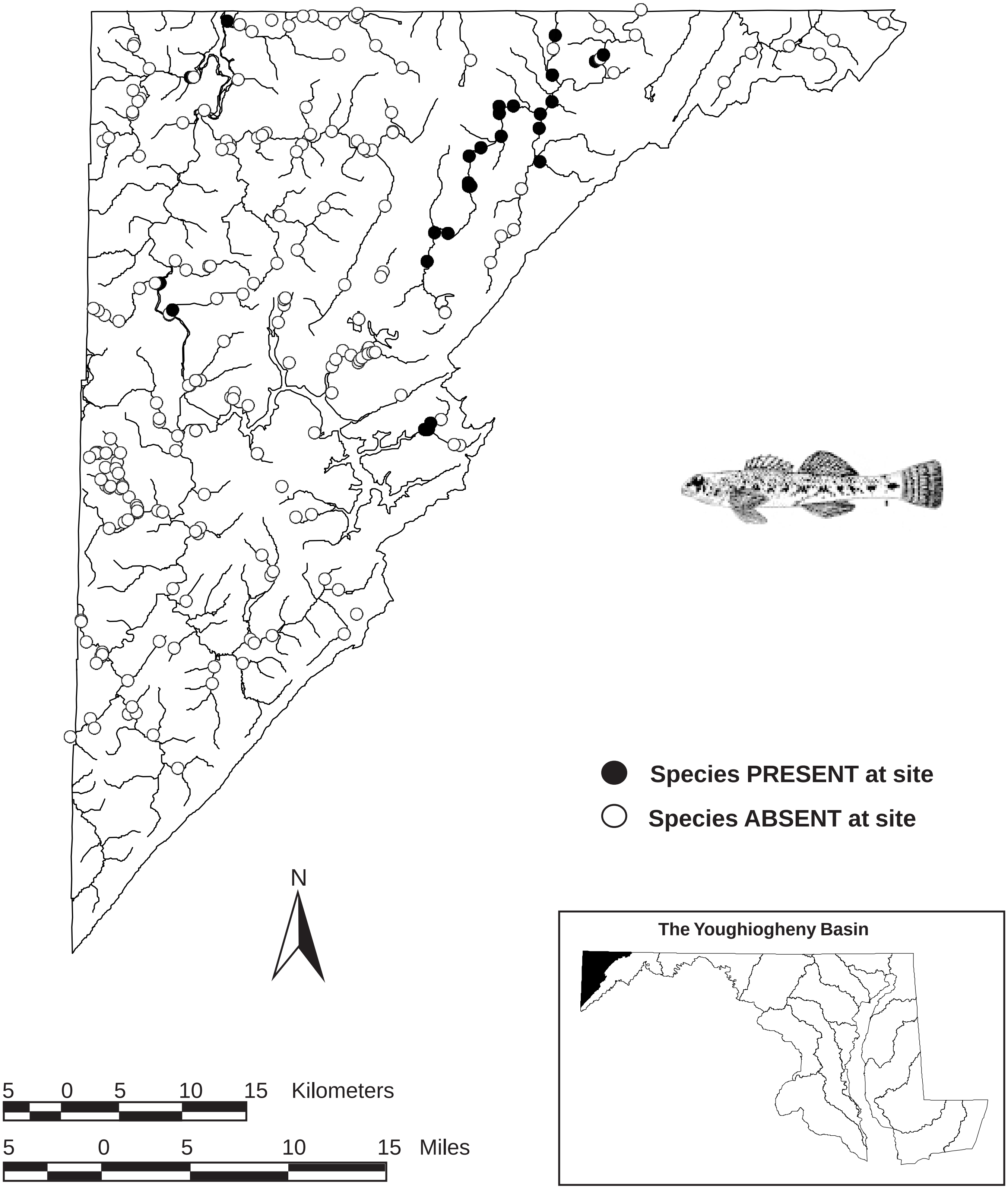
Species PRESENT at site

Species ABSENT at site

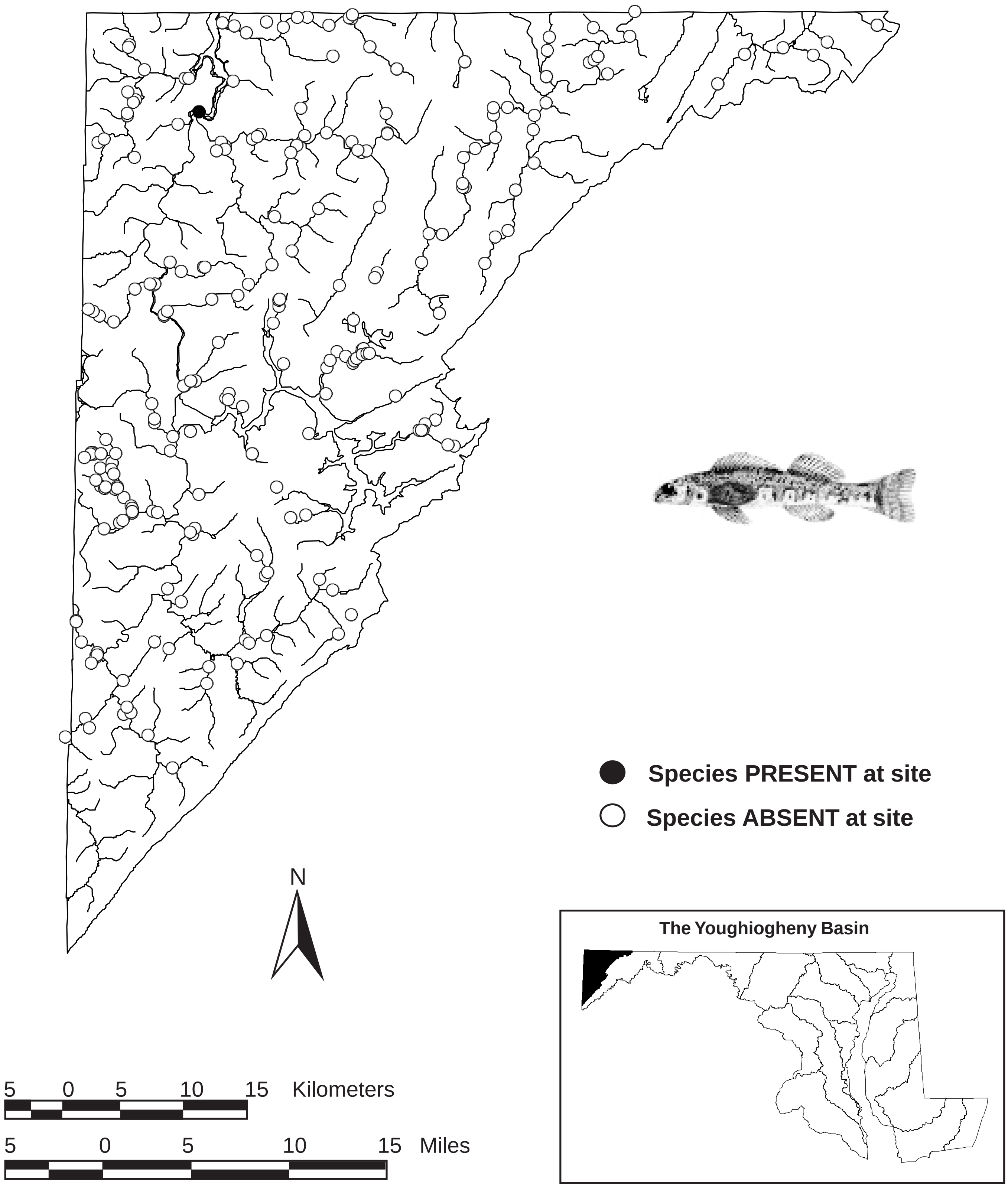




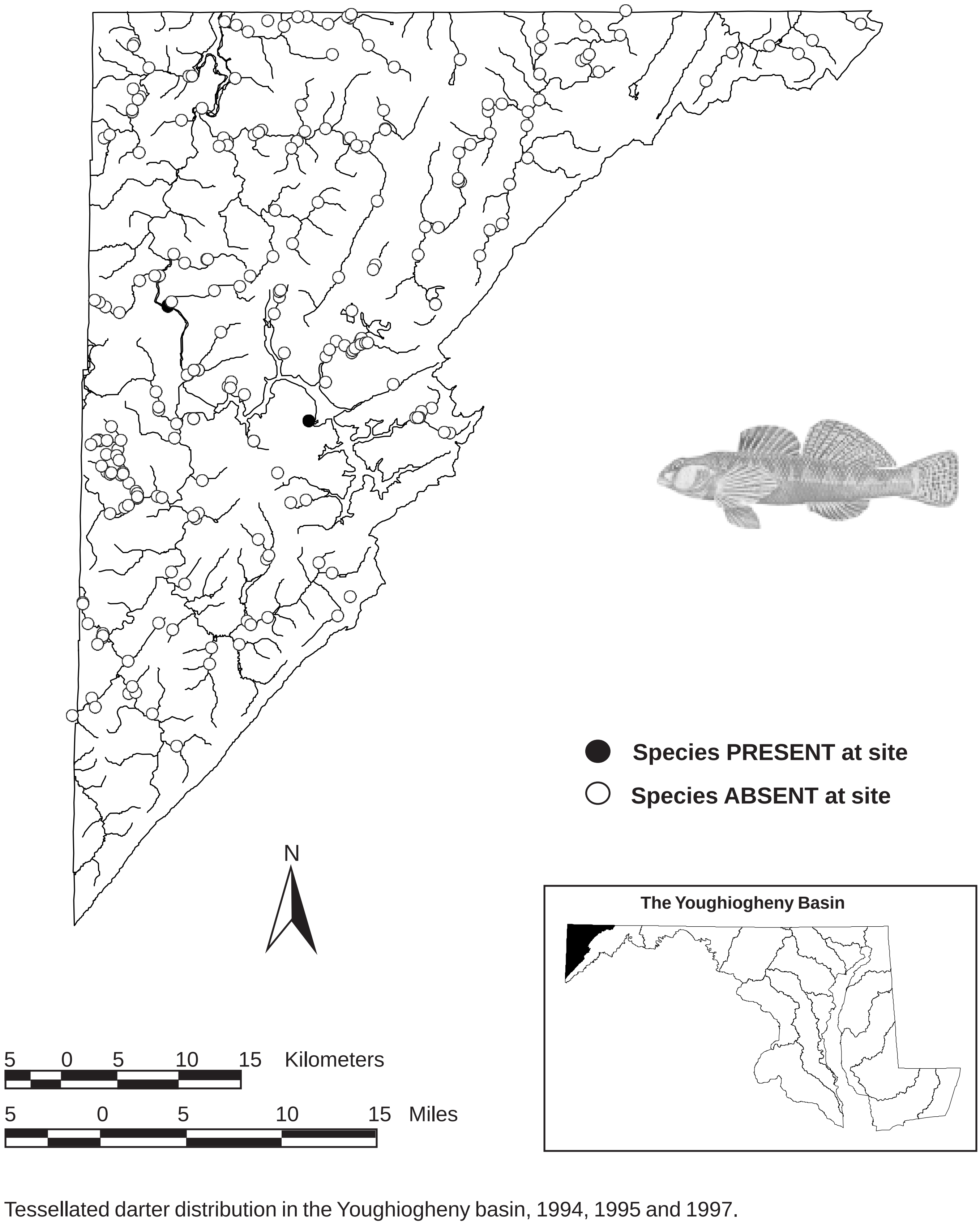
White crappie distribution in the Youghiogheny basin, 1994, 1995 and 1997.



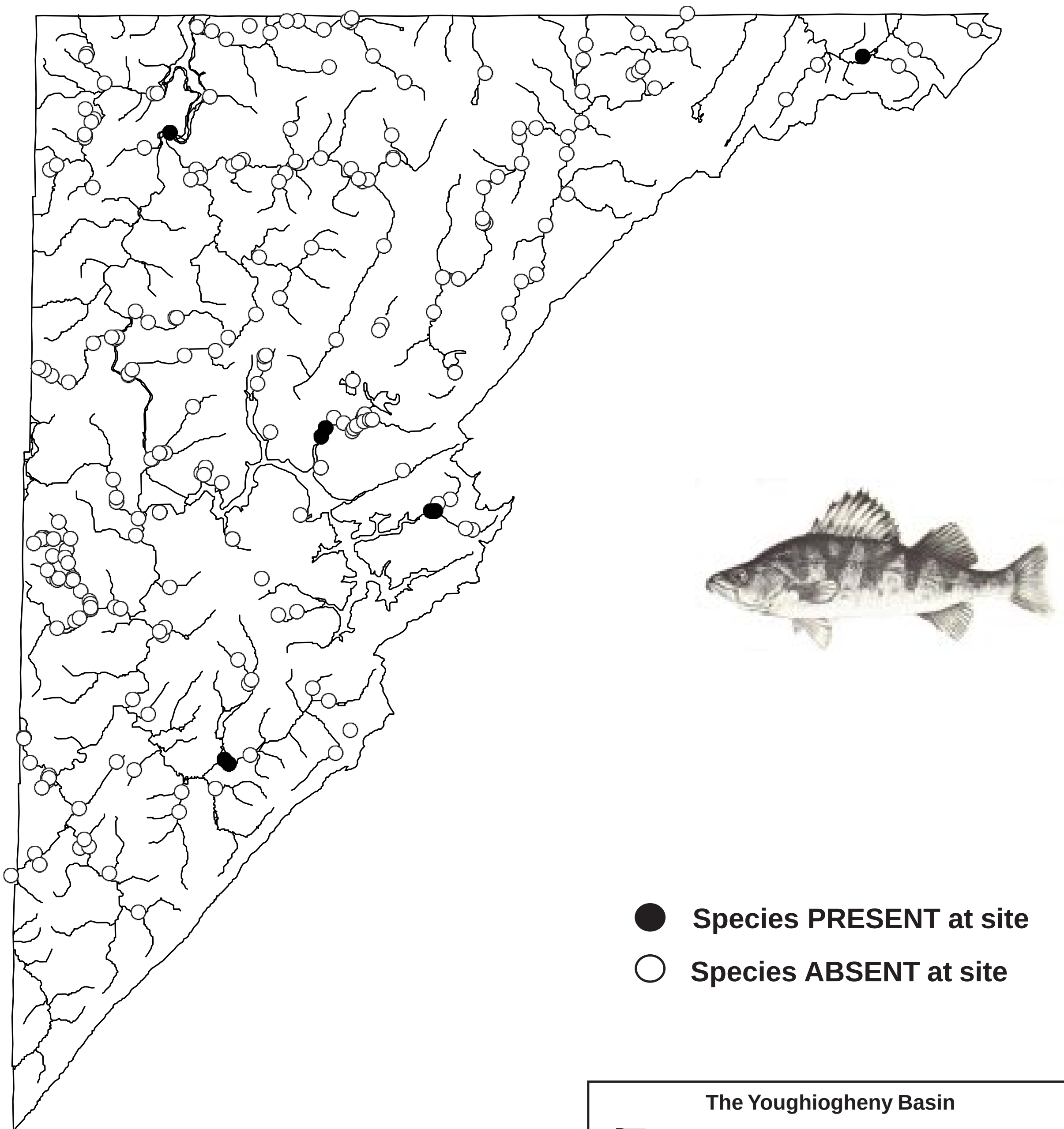
Johnny darter distribution in the Youghiogheny basin, 1994, 1995 and 1997.



Greenside darter distribution in the Youghiogheny basin, 1994, 1995 and 1997.

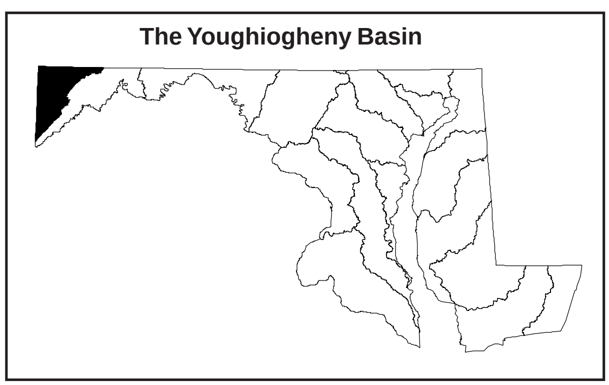


Tessellated darter distribution in the Youghiogheny basin, 1994, 1995 and 1997.



● Species PRESENT at site

○ Species ABSENT at site



5 0 5 10 15 Kilometers

5 0 5 10 15 Miles

Yellow perch distribution in the Youghiogheny basin, 1994, 1995 and 1997.

Appendix F. Benthic macroinvertebrate taxa with designated tolerance value (TV 10 = most tolerant, 0 = least tolerant), functional feeding groups (FFG), habit, and percent occurrence (% Occ.) for the 1994, 1995, and 1997 MBSS sites in the Youghiogheny basin. Abbreviations of habits are as follows: bu - burrower, cn - clinger, sp - spawler, cb - climber, sw -swimmer, dv - diver, sk - skater (modified from Stribling et al. 1998)

Class	*Order*	*Family*	*Genus*	*TV*	*FFG*	*Habit*	*% Occ.*
Enopla	Hoplonemertea	Tetrastemmatidae	*Prostoma*		Predator		1
Turbellaria	Tricladida	Planariidae	*Cura*			sp	1
			Dugesia	7	Predator	sp	2
Oligochaeta	Lumbriclida	Lumbriculidae	*(unidentified)*	10	Collector	bu	18
	Tubificida	Enchytraeidae	*(unidentified)*	10	Collector	bu	2
		Naididae	*(unidentified)*	10	Collector	bu	17
		Tubificidae	*(unidentified)*	10	Collector	bu	7
Gastropoda	Basommatophora	Ancylidae	*Ferrissia*	7	Scraper	cb	1
		Physidae	*Physella*	8	Scraper	cb	1
Pelecypoda	Veneroida	Sphaeriidae	*(unidentified)*		Filterer	bu	3
			Pisidium	8	Filterer	bu	5
			Sphaerium	8	Filterer	bu	1
Malacostraca	Amphipoda	Crangonyctidae	*Crangonyx*	4	Collector	sp	2
		Gammaridae	*Gammarus*	6	Shredder	sp	3
		Hyalellidae	*Hyalella*	6	Shredder	sp	3
	Decapoda	Cambaridae	*Cambarus*	6	Collector	sp	7
			Orconectes	6	Shredder	sp	1
	Isopoda	(unidentified)	*(unidentified)*	8	Collector		1
		Asellidae	*Caecidotea*	8	Collector	sp	10
Insecta	Collembola	(unidentified)	*(unidentified)*				1
	Ephemeroptera	Ameletidae	*Ameletus*	0	Collector	sw, cb	6
		Baetidae	*(unidentified)*		Collector	sw, cn	16
			Baetis	6	Collector	sw, cb, cn	28
			Centroptilum	2	Collector	sw, cn	4
			Diphetor		Collector	sw, cn	2
		Ephemerellidae	*Ephemerella*	2	Collector	cn, sw	70
			Eurylophella	4	Scraper	cn, sp	14
			Serratella	2	Collector	cn	14
		Ephemeridae	*Ephemera*	3	Collector	bu	6
		Heptageniidae	*(unidentified)*		Scraper	cn	2
			Cinygmula		Scraper	cn	16
			Epeorus	0	Scraper	cn	36
			Heptagenia	4	Scraper	cn, sw	3
			Stenacron	4	Collector	cn	17
			Stenonema	4	Scraper	cn	46
		Isonychiidae	*Isonychia*	2	Filterer	sw, cn	2
		Leptophlebiidae	*(unidentified)*		Collector	sw, cn	5
			Leptophlebia	4	Collector	sw, cn, sp	4
			Paraleptophlebia	2	Collector	sw, cn, sp	43
	Odonata	Aeshnidae	*Boyeria*	2	Predator	cb, sp	4
		Coenagrionidae	*Argia*	8	Predator	cn, cb, sp	1
		Gomphidae	*(unidentified)*		Predator	bu	4
			Lanthus	6	Predator	bu	2
		Libellulidae	*Leucorrhinia*		Predator	cb	1
	Plecoptera	Capniidae	*Allocapnia*	3	Shredder	cn	1

Class	Order	Family	Genus	TV	FFG	Habit	% Occ.
Insecta	Plecoptera	Capniidae	*Paracapnia*	1	Shredder		1
		Chloroperlidae	*(unidentified)*		Predator	cn	18
			Alloperla		Predator	cn	1
			Haploperla		Predator	cn	12
			Sweltsa		Predator	cn	6
		Leuctridae	*(unidentified)*		Shredder	sp, cn	4
			Leuctra	0	Shredder	cn	62
			Paraleuctra		Shredder	sp, cn	1
		Nemouridae	*(unidentified)*		Shredder	sp, cn	6
			Amphinemura	3	Shredder	sp, cn	64
			Ostrocerca		Shredder	sp, cn	1
		Peltoperlidae	*(unidentified)*		Shredder	cn, sp	2
			Peltoperla		Shredder	cn, sp	6
			Tallaperla		Shredder	cn, sp	16
		Perlidae	*(unidentified)*		Predator	cn	6
			Acroneuria	0	Predator	cn	23
			Paragnetina	1	Predator	cn	2
			Phasganophora		Predator	cn	5
		Perlodidae	*(unidentified)*		Predator	cn	21
			Clioperla	1	Predator	cn	4
			Cultus		Predator	cn	1
			Diploperla		Predator	cn	10
			Isoperla	2	Predator	cn, sp	28
			Malirekus		Predator	cn	4
		Pteronarcyidae	*Pteronarcys*	2	Shredder	cn, sp	14
		Taeniopterygidae	*Oemopteryx*		Shredder	sp, cn	1
	Megaloptera	Corydalidae	*Nigronia*	0	Predator	cn, cb	20
		Sialidae	*Sialis*	4	Predator	bu, cb, cn	4
	Trichoptera	Brachycentridae	*(unidentified)*	1	Filterer		1
			Micrasema	2	Shredder	cn, sp	4
		Dipseudopsidae	*Phylocentropus*	5	Collector	bu	13
		Glossosomatidae	*Glossosoma*	0	Scraper	cn	2
		Hydropsychidae	*Cheumatopsyche*	5	Filterer	cn	40
			Diplectrona	2	Filterer	cn	33
			Hydropsyche	6	Filterer	cn	48
			Parapsyche	1	Filterer	cn	1
		Lepidostomatidae	*Lepidostoma*	3	Shredder	cb, sp, cn	12
		Leptoceridae	*(unidentified)*	4	Collector		1
			Nectopsyche	3	Shredder	cb, sw	1
			Oecetis	8	Predator	cn, sp, cb	1
		Limnephilidae	*(unidentified)*		Shredder	cb, sp, cn	2
			Goera		Scraper	cn	1
			Hydatophylax	2	Shredder	sp, cb	1
			Limnephilus	3	Shredder	cb, sp, cn	1
			Platycentropus	4	Shredder	cb	1
			Pycnopsyche	4	Shredder	sp, cb, cn	7
		Odontoceridae	*Psilotreta*	0	Scraper	sp	4
		Philopotamidae	*Chimarra*	4	Filterer	cn	12
			Dolophilodes	0	Filterer	cn	12

Class	Order	Family	Genus	TV	FFG	Habit	% Occ.
Insecta	Trichoptera	Philopotamidae	*Wormaldia*		Filterer	cn	3
		Phryganeidae	*Ptilostomis*	5	Shredder	cb	2
		Polycentropodidae	*(unidentified)*			cn	1
			Neureclipsis	7	Filterer	cn	1
			Nyctiophylax	5	Filterer	cn	1
			Polycentropus	5	Filterer	cn	13
		Psychomyiidae	*Lype*	2	Scraper	cn	5
			Psychomyia	2	Collector	cn	3
		Rhyacophilidae	*Rhyacophila*	1	Predator	cn	40
		Uenoidae	*Neophylax*	3	Scraper	cn	9
	Coleoptera	Dryopidae	*Helichus*	5	Scraper	cn	1
		Dytiscidae	*(unidentified)*	5	Predator	sw, dv	1
			Hydroporus	5	Predator	sw, cb	2
		Elmidae	*Dubiraphia*	6	Scraper	cn, cb	13
			Optioservus	4	Scraper	cn	22
			Oulimnius	2	Scraper	cn	25
			Promoresia	2	Scraper	cn	9
			Stenelmis	6	Scraper	cn	6
		Hydrophilidae	*Hydrochus*		Shredder	cb	1
		Psephenidae	*Ectopria*	5	Scraper	cn	4
			Psephenus	4	Scraper	cn	1
		Ptilodactylidae	*Anchytarsus*	4	Shredder	cn	3
		Scirtidae	*Cyphon*	7	Scraper	cb	1
	Diptera	(unidentified)	*(unidentified)*				2
		Athericidae	*Atherix*	2	Predator	sp, bu	3
		Blephariceridae	*Blepharicera*		Scraper	cn	7
		Ceratopogonidae	*Bezzia*	6	Predator	bu	10
			Ceratopogon	6	Predator	sp, bu	4
			Probezzia	6	Predator	bu	15
			Sphaeromias		Predator	bu	2
		Chironomidae	*Ablabesmyia*	8	Predator	sp	3
			Brillia	5	Shredder	bu, sp	10
			Cardiocladius	6	Predator	bu, cn	1
			Chironomini	6			1
			Chironomus	10	Collector	bu	1
			Conchapelopia	6	Predator	sp	33
			Corynoneura	7	Collector	sp	12
			Cricotopus	7	Shredder	cn, bu	10
			Cricotopus/ Orthocladius		Shredder		17
			Cryptochironomus	8	Predator	sp, bu	3
			Diamesa	5	Collector	sp	9
			Dicrotendipes	10	Collector	bu	3
			Diplocladius	7	Collector	sp	2
			Eukiefferiella	8	Collector	sp	46
			Heleniella		Predator	sp	3
			Heterotrissocladius		Collector	sp, bu	6
			Hydrobaenus	8	Scraper	sp	2
			Krenopelopia		Predator	sp	2

Class	Order	Family	Genus	TV	FFG	Habit	% Occ.
Insecta	Dipera	Chironomidae	*Labrundinia*	7	Predator	sp	2
			Larsia	6	Predator	sp	2
			Lopescladius		Collector	sp	1
			Micropsectra	7	Collector	cb, sp	33
			Microtendipes	6	Filterer	cn	14
			Nanocladius	3	Collector	sp	4
			Natarsia	8	Predator	sp	2
			Orthocladius	6	Collector	sp, bu	17
			Pagastia	1	Collector		5
			Paracladopelma	7	Collector	sp	1
			Parametriocnemus	5	Collector	sp	73
			Paraphaenocladius	4	Collector	sp	1
			Paratanytarsus	6	Collector	sp	7
			Paratendipes	8	Collector	bu	1
			Phaenopsectra	7	Collector	cn	1
			Polypedilum	6	Shredder	cb, cn	28
			Potthastia	2	Collector	sp	2
			Procladius	9	Predator	sp	2
			Psectrocladius	8	Shredder	sp, bu	2
			Pseudorthocladius	0	Collector	sp	1
			Rheocricotopus	6	Collector	sp	10
			Rheopelopia	4	Predator	sp	1
			Rheotanytarsus	6	Filterer	cn	1
			Stempellinella	4	Collector	cb, sp, cn	17
			Stenochironomus	5	Shredder	bu	1
			Stictochironomus	9	Collector	bu	2
			Sublettea		Collector		2
			Tanytarsus	6	Filterer	cb, cn	21
			Thienemanniella	6	Collector	sp	22
			Thienemannimyia		Predator	sp	17
			Tribelos	5	Collector	bu	1
			Trissopelopia		Predator	sp	9
			Tvetenia	5	Collector	sp	14
			Xylotopus	2	Shredder	bu	1
			Zavrelimyia	8	Predator	sp	3
		Dixidae	*Dixa*	4	Predator	sw, cb	1
		Empididae	*(unidentified)*		Predator	sp, bu	2
			Chelifera		Predator	sp, bu	16
			Clinocera		Predator	cn	5
			Hemerodromia	6	Predator	sp, bu	15
		Simuliidae	*(unidentified)*	7	Filterer	cn	1
			Prosimulium	7	Filterer	cn	44
			Simulium	7	Filterer	cn	12
		Tabanidae	*Chrysops*	7	Predator	sp, bu	4
			Tabanus	5	Predator	sp, bu	4
		Tipulidae	*(unidentified)*		Predator	bu, sp	1
			Antocha	5	Collector	cn	18
			Dicranota	4	Predator	sp, bu	46
			Hexatoma	4	Predator	bu, sp	21

Class	***Order***	***Family***	***Genus***	***TV***	***FFG***	***Habit***	***% Occ.***
Insecta	Dipera	Tipulidae	*Limnophila*	4	Predator	bu	1
			Molophilus			bu	1
			Ormosia		Collector	bu	5
			Pilaria	7	Predator	bu	1
			Pseudolimnophila	2	Predator	bu	11
			Tipula	4	Shredder	bu	16

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