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# UPPER POTOMAC BASIN

## ENVIRONMENTAL ASSESSMENT OF STREAM CONDITIONS

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**December 2001**

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**Governor Parris N. Glendening**

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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 administered by the Maryland Department of Natural Resources. Field data for the Upper Potomac basin were collected by the Maryland Department of Natural Resources. Analyses of water chemistry samples were conducted by the University of Maryland's Appalachian Laboratory (AL) under Contract No. MA96-002-003. Much of the initial data analysis for this report was conducted by Versar, Inc. under Contract No. PR-96-055-001\PRFP44 to MDNR's Power Plant Assessment Division.

This report helps fulfill two outcomes in MDNR's Strategic Plan: 1) A Vital and Life Sustaining Chesapeake Bay and Its Tributaries, and 2) Sustainable Populations of Living Resources and Healthy Ecosystems.

On the cover:
Photo by Matt Kline

Munson Spring Branch, Washington Co., Maryland
Photo by Matt Kline

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**Maryland Biological Stream Survey**

# Executive Summary

This report describes existing aquatic resource conditions during 1995 in first, second, and third-order non-tidal streams in the Upper Potomac basin in Maryland. The report also begins to assess water quality and habitat problems in the basin, as well as defining areas of high ecological quality. This information may prove useful as watershed-specific strategies for restoring water quality in the Chesapeake Bay drainage are developed and refined.

The primary source of information for this report is the Maryland Biological Stream Survey (MBSS) conducted by Maryland Department of Natural Resources (MDNR) to characterize Maryland streams, including those within the Upper Potomac basin. Although the primary focus of the MBSS is on acid deposition impacts, the survey is also being used for other purposes such as reporting on watershed conditions. The MBSS is a statewide survey of first, second, and third-order non-tidal 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 and sites are selected randomly, allows for quantitative estimates of stream characteristics and conditions.

## FINDINGS

### Water Quality

About 5% of the Upper Potomac basin stream miles had dissolved oxygen levels lower than the state water quality criterion of 5 mg/L, with an additional 2% of stream miles below 3 mg/L. While runoff of oxygen-demanding materials does not appear to be a widespread problem in the basin, it could be contributing to poor dissolved oxygen levels in localized areas.

None of the stream miles had acid neutralizing capacity (ANC) less than 0 μeq/L, an indication that few streams are chronically acidified. However, about 40% of the basin's stream miles had ANC levels less than 200 μeq/L and are susceptible to episodic, storm-related acidification. The remainder of the stream miles had ANC levels greater than 200 μeq/L and are considered well-buffered and relatively immune to acid deposition impacts.

Acidity is not a widespread water quality problem in the Upper Potomac basin's first through third-order streams, although it could be a problem in localized areas. About 9% of the basin's streams had pH less than 6, the level below which significant adverse impacts on aquatic life are known to occur.

Elevated nitrogen levels (nitrate-nitrogen greater than 1 mg/L) occurred at 32% of the stream miles in the basin. The primary sources of nitrates appear to be agriculture, but urban runoff and acid deposition are also likely contributors.

### Physical Habitat

Almost two-thirds (59%) of the basin's stream miles were rated Poor to Very Poor for instream habitat. Some of the likely causes of degraded habitat include the loss of woody debris, channelization, sedimentation, and riparian zone deforestation.

Channel alteration is a problem in the Upper Potomac basin, with 33% of first through third-order streams having been altered. Channelization reduces the ability of streams to retain and process nutrients and provide diverse habitat for biota.

About 44% of stream banks in the basin were considered stable and about one-third were rated Poor to Very Poor. Eroding stream banks degrade available habitat and may be an important source of sediment and nutrients to Chesapeake Bay.

While 57% of the basin's stream miles had at least a 50 meter buffer zone, a surprisingly large percentage (33%) had no buffer zone on at least one side of the stream. These streams consequently have no protection against runoff and flood events.

**Fish**

A total of 49 fish species were collected in the Upper Potomac basin, including 7 game species: smallmouth bass, largemouth bass, chain pickerel, brook trout, cutthroat trout, rainbow trout, and brown trout.

About 4.6 million fish live in the basin's first through third-order streams. The most abundant species was blacknose dace, a pollution tolerant species, estimated at about 1.6 million individuals.

Based on MDNR's Index of Biotic Integrity (IBI) for fish, only 8% of the basin's streams are in Good condition, while 32% are in Poor to Very Poor condition. Of the remaining stream miles, 18% were rated as Fair, and 41% could not be assessed due to stream size limitations.

**Benthic Macroinvertebrates**

Based on MDNR's benthic macroinvertebrate IBI, about 41% of all first through third-order stream miles in the basin were assessed as Poor or Very Poor. About 16% were rated Good.

Approximately 350 genera of stream-dwelling macroinvertebrates are known to exist in Maryland, and 158 of these were found in the Upper Potomac basin. Dominant genera were non-biting midges and blackflies.

**Reptiles and Amphibians**

Reptiles and amphibians were present at 86% of the sites sampled in the basin. A total of 28 species of frogs, toads, turtles, salamanders, and snakes were collected.

**Freshwater Mussels**

No freshwater mussels were collected in the Upper Potomac basin.

**Summary**

The major impacts to non-tidal streams in the basin appear to be nitrogen enrichment from agriculture, reduced quality of physical habitat from historical logging and agriculture and insufficient riparian buffer zones. The most likely reasons for these impacts are from urban and agricultural land use.

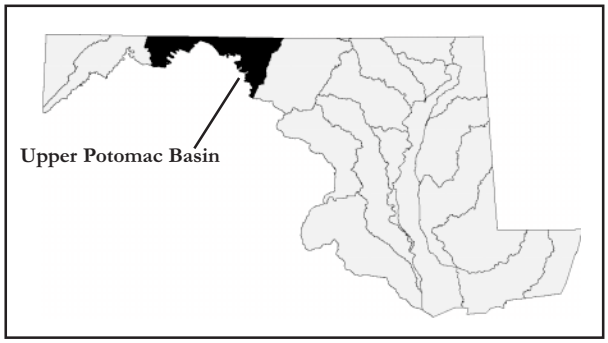
**Maryland Biological Stream Survey**

# Introduction

# Chapter One 1

### *PURPOSE OF THIS REPORT*

This report describes aquatic resource conditions in first, second, and third-order non-tidal streams in the Upper Potomac basin in Maryland during 1995. The report also begins to identify 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 Chesapeake Bay and its tributaries are developed and refined.




The Upper Potomac basin, one of Maryland's 18 major river basins, lies in the northwestern part of the state and includes parts of Allegany and Washington counties.

### *STREAM RESOURCES*

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 offer recreational opportunities, attract tourists, and support commercially and recreationally important fish and shellfish. Forested riparian zones contain some of the richest and most diverse plant and animal communities in the state. These areas help 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 a catalyst for economic development. Nearly all of the flowing waters in Maryland, including those within the Upper Potomac basin, drain to Chesapeake Bay — therefore the quality of these systems has a direct impact on the health of the Bay. As most Marylanders know, the Chesapeake Bay is one of Maryland's most important economic and natural resources.

Despite 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 underway to restore degraded systems and to protect those that are healthy. 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 1995 Maryland Biological Stream Survey (MBSS) conducted by the Maryland Department of Natural Resources (MDNR). 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) used for the survey allows unbiased estimates of stream characteristics and conditions. For example, the abundance of a given fish species in an entire basin can be validly estimated using the MBSS design. Because first, second, and third-order streams represent approximately 75% of the non-tidal stream miles in the Upper Potomac basin, MBSS results should accurately represent stream quality. Examination of conditions in small streams also helps to identify specific problem areas where local protection, enhancement, and restoration efforts should be focused.

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

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**Maryland Biological Stream Survey**

# Basin Description

# Chapter Two 2

This chapter uses existing information to provide an overview of the Upper Potomac basin, including ecological, recreational, and economic resources. This overview provides a context for interpreting the assessment of stream conditions found in Chapter 4.

### *HISTORY*

At the time the first European settlers entered the Upper Potomac basin, the area was inhabited and used as hunting grounds by both the Delaware and the Catawba Indian tribes. In 1732, land grants were made by Lord Baltimore to encourage settlement of the area, and the first major colony was established in 1739 (Williams 1968). However, until the end of the French and Indian War in 1763, the presence of Native Americans west of the Conococheague Creek limited European presence in the basin. A major influx of settlers ensued in the mid to late 1760s and by 1789 Washington and Allegany Counties were established.

By the 1800s, saw mills, grist mills, and wool mills were scattered along the banks of Antietam and Conococheague Creeks (Scharf 1968). Transportation was greatly enhanced in the basin during the first half of the nineteenth century. From 1812 to 1816, the National Road was extended into Washington County, and the Chesapeake and Ohio Canal was completed in 1850. The Cumberland Valley Railroad and Western Maryland Railroad were constructed in 1837 and 1852, respectively. As a result of these and other railroad projects, the innovations of the Industrial Revolution were introduced in the basin by the 1870s. By the turn of the century, the entire basin had been logged and, in turn, led to the establishment of major population centers such as Hagerstown, Boonsboro, Williamsport, Hancock, Clear Spring, and Smithsburg.

### *BASIN CHARACTERISTICS*

The Potomac River basin drains 14,670 square miles and includes parts of West Virginia, Virginia, Pennsylvania, and Maryland (ICPRB website). Originating in the Allegheny mountains of West Virginia, the mainstem of the Potomac River flows 383 miles before emptying into the Chesapeake Bay at Point Lookout. The Potomac River watershed is the fourth largest on the East Coast (ACB website), and covers five geological provinces: the Appalachian Plateau, Ridge and Valley, Blue Ridge, Piedmont, and Coastal Plain.

The Upper Potomac portion of the Potomac River watershed extends from the Town Creek watershed in central Allegany County to the Antietam Creek watershed, east of Hagerstown, in Washington County. A total of 669 miles of first, second, and third-order non-tidal streams make up the Upper Potomac basin; an additional 228 miles comprise forth-order and larger streams.

The Upper Potomac basin lies entirely within the Ridge and Valley physiographic province, the largest province within the Potomac River drainage. The Ridge and Valley is characterized in part by rich limestone formations that add large amounts of calcium to a number of streams. In particular, streams in the Great Valley sub-province, located between the Antietam and Conococheague Creeks, are highly influenced by the dense limestone underlayer.

Climate exerts a major influence on basin water quality, as it affects the water budget and precipitation chemistry. The quantity and chemical composition of water added through precipitation, coupled with the region's underlying geology dictate the chemical and biological features of the basin. The climate of the Upper Potomac basin is generally temperate with a mean annual air temperature of approximately 52°F (Walker 1971). July is typically the warmest month and January the coldest (USGS 1996). Annual precipitation averages between 35 and 40 inches per year, ranging from less than 30 inches some years to over 50 inches other years. This level of precipitation is the lowest of any basin in the state.

Several tree associations are found in the basin and include the ; Hemlock-Birch Association, Sycamore-Green Ash-Box Elder-Silver Maple Association, Chestnut Oak-Bear Oak Association, and the Sugar Maple-Basswood Association (Brush et al. 1977). Subcanopy species include Virginia creeper, poison ivy,

spicebrush, serviceberry, blueberry, and mountain laurel.

In the 1950s and 1960s, several government agencies advocated the planting of a non-native shrub called multiflora rose as a means to enhance wildlife habitat on farms and in backyards. Since then, this species has spread into every drainage basin in the state and it continues to spread today. As a result, this introduced species now constitutes a significant threat to efforts to restore lost native vegetation along streams. Multiflora rose is an opportunistic plant that colonizes cleared areas such as timber cuts and pastures, often so completely that virtually no other plants can compete with it. Because aquatic insects have adapted over thousands of years to feed on leaves fallen from native trees and shrubs, the takeover by multiflora rose is reducing the amount of food available for them. This, in turn, has very likely led to impacts on our native fish communities which depend upon insects to survive. An additional problem is that unlike mature trees whose root systems typically extend below the water level of a stream, the roots of multiflora rose do not protect the lower stream bank where erosion is most severe. Like many other introductions of non-native species, the introduction of multiflora rose has resulted in unforeseen negative consequences. Today, a great many riparian areas in the basin are virtually impenetrable because of the success of this noxious species.

Multiflora rose (*Rosa multiflora*)

### *LAND USE AND HUMAN POPULATION*

Most of the basin is comprised of forested (49%) and agricultural (40%) land (Figure 1). Urban land use (9%) accounts for most of the remaining area, along with small amounts of open water, wetlands, and barren land (MOP 1994). Agricultural and urban land use occur mainly in the eastern portion of the basin, while forests predominate in the western and central areas (Figure 2).

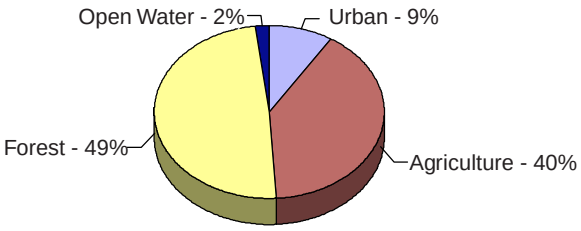



**Figure 1**. Percent land use in the Upper Potomac basin (1995).

According to 1995 census data, approximately 152,000 people live in the basin, with Hagerstown and Hancock being the most densely populated areas. Growth is moderate and the population is projected to increase seven percent to about 163,000 by 2020 (MDNR 1997).

### *WATER QUALITY*

According to previously published reports, water quality of the Upper Potomac basin generally ranges from fair to good, with most subwatersheds rated as good (MDNR 1996). Factors that contributed to diminished water quality included elevated bacteria and nutrient levels associated with agricultural and urban/suburban runoff, and elevated suspended solids resulting from agricultural runoff and erosion. Additionally, low levels of pesticide contamination have been detected in Antietam and Conococheague Creeks.

The Maryland Department of the Environment (MDE) classifies all surface waters in Maryland by their "designated use" (COMAR 1997). All waters of the state receive at least a Use I designation; that is, they are protected for contact recreation, fishing, and protection of aquatic life and wildlife. Use II waters are suitable for shellfish harvesting, while Uses III and IV are designated as natural and recreational trout waters, respectively. Additional designations are made for waters recognized for their function as drinking water supplies. In the Upper Potomac basin, waters

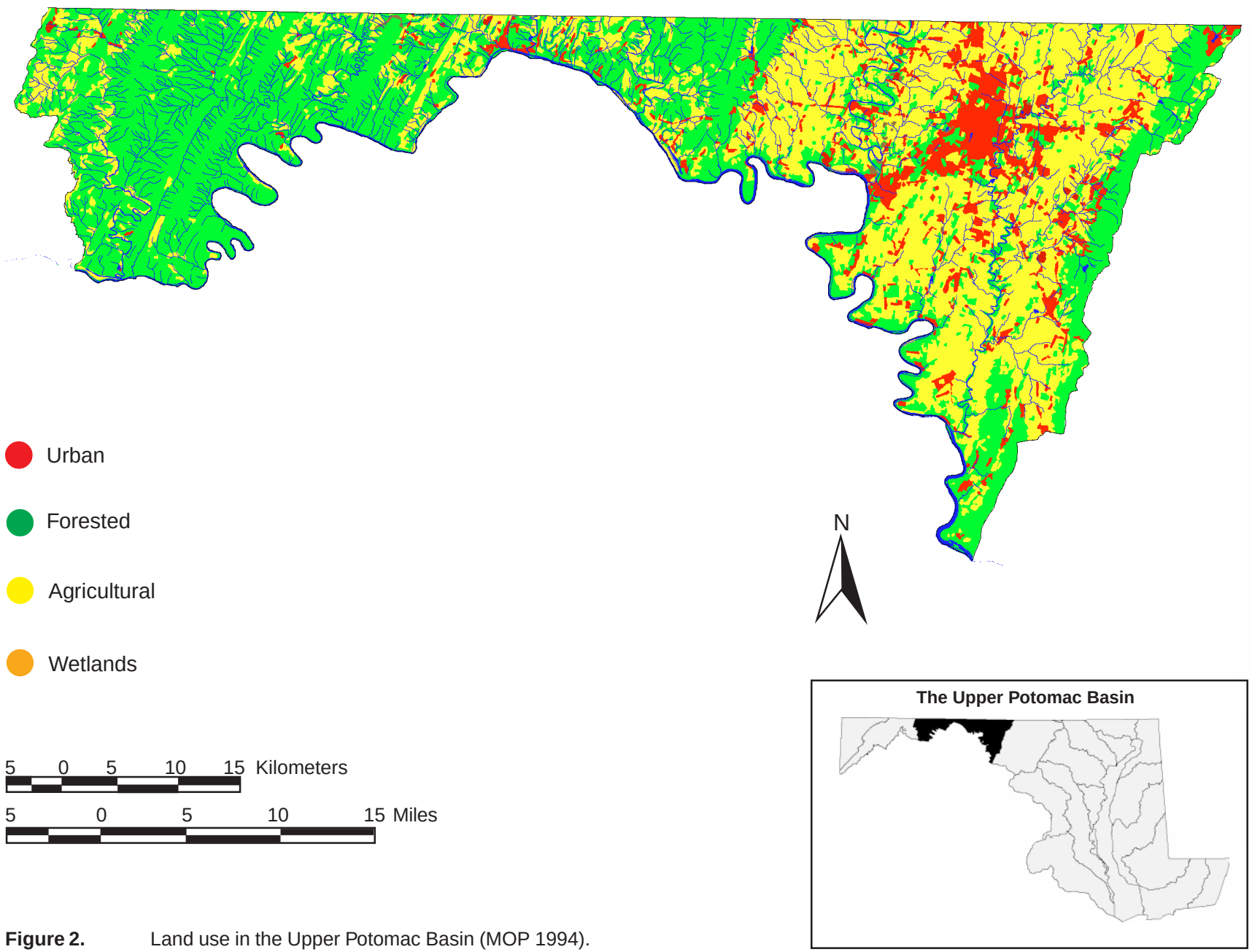



**Figure 2.** Land use in the Upper Potomac Basin (MOP 1994).

of the Town Creek and Conococheague Creek watersheds have been observed to have summer temperatures that exceeded use IV standards (MDNR 1996).

## RESOURCE VALUES

### Recreational Resources

The Upper Potomac basin offers many opportunities to participate in recreational activities. The Potomac River itself offers a variety of sportfishing, particularly for smallmouth bass and channel catfish. Within the basin, there are several wildlife management areas (WMA), including Warrior Mountain WMA, Woodmont-Sideling Hill WMA, and Indian Springs WMA. Green Ridge State Forest and Fort Frederick State Park are available for such recreational activities as hiking, biking, canoeing, camping, fishing, boating, hunting (turkey, grouse, and deer), picnicking, and cross-country skiing.

### Extractable Resources

Resources that are extractable and found in or around the Upper Potomac basin include natural gas, refractory clay, brick clay, building stone (limestone and sandstone), limestone, shale, and iron ore (Vokes 1968).

## CITIZEN INVOLVEMENT

Within the Upper Potomac basin, the Sideling Hill Creek Project involves both citizens and government agencies in the protection of Sideling Hill Creek, a tributary of the Potomac River. Partners include the Maryland chapter of the Nature Conservancy, Maryland's State Highway Administration, the Maryland Department of Natural Resources, and neighboring state governments. Landowners are also encouraged to participate. Another organization working within the basin is Friends of Beaver Creek, whose specific mission is to protect the water quality and aquifer of Beaver Creek. Volunteer activities include assisting in water quality monitoring.

In addition, there are several organizations that aim to protect the Potomac River and/or its tributaries on a regional scale, including the Maryland Save Our Streams Program, the Chesapeake Bay Program, Alliance for the Chesapeake Bay, Inc., Maryland Volunteer Water Quality Monitoring Association, Trout Unlimited, and the Potomac River Environmental Education Program. Further information on organizations concerned with aquatic resources in the Chesapeake Bay watershed may be available from the Chesapeake Bay Regional Information Service.

To find out how to get involved in water quality monitoring and watershed issues in the Upper Potomac basin, contact:

**The Nature Conservancy of Maryland**
Sideling Hill Creek Project
attn: Wayne Klockner
(301) 656-8673

**Friends of Beaver Creek**
9775 Beaver Creek Church Rd.
Hagerstown, MD 21740

**Maryland Save Our Streams**
258 Scotts Manor Dr.
Glen Burnie, MD 21061

**Trout Unlimited**
2916 Trellis Lane
Abingdon, MD 21009

**Ridge and Valley Streamkeepers**
attn: Donald Morris
798 Town Creek Road
Clearville, PA 15535

**Chesapeake Bay Regional Information Service**
(800) 662-2747

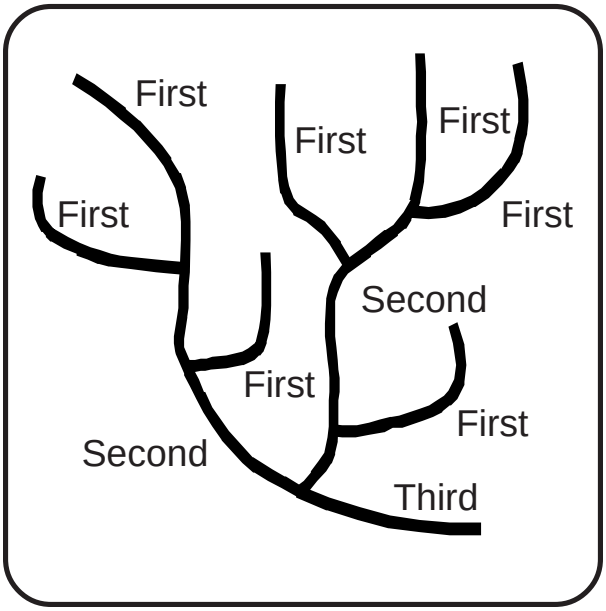
-also see the U.S. Environmental Protection Agency's website, Surf Your Watershed, at http://www.epa.gov/surf/

**Maryland Biological Stream Survey**

# Survey Design and Methods

# Chapter 3 Three

This chapter briefly outlines the approach used by the MBSS to assess stream resources of the Upper Potomac basin. 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 sites were also sampled to provide additional information on fish distributions. Figure 3 shows the location of random and non-random sites sampled during the 1995 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 then 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 Upper Potomac 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, 87% of the landowners contacted in the basin gave MDNR permission to have streams on their property sampled by the MBSS.

All catchments draining to the 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).

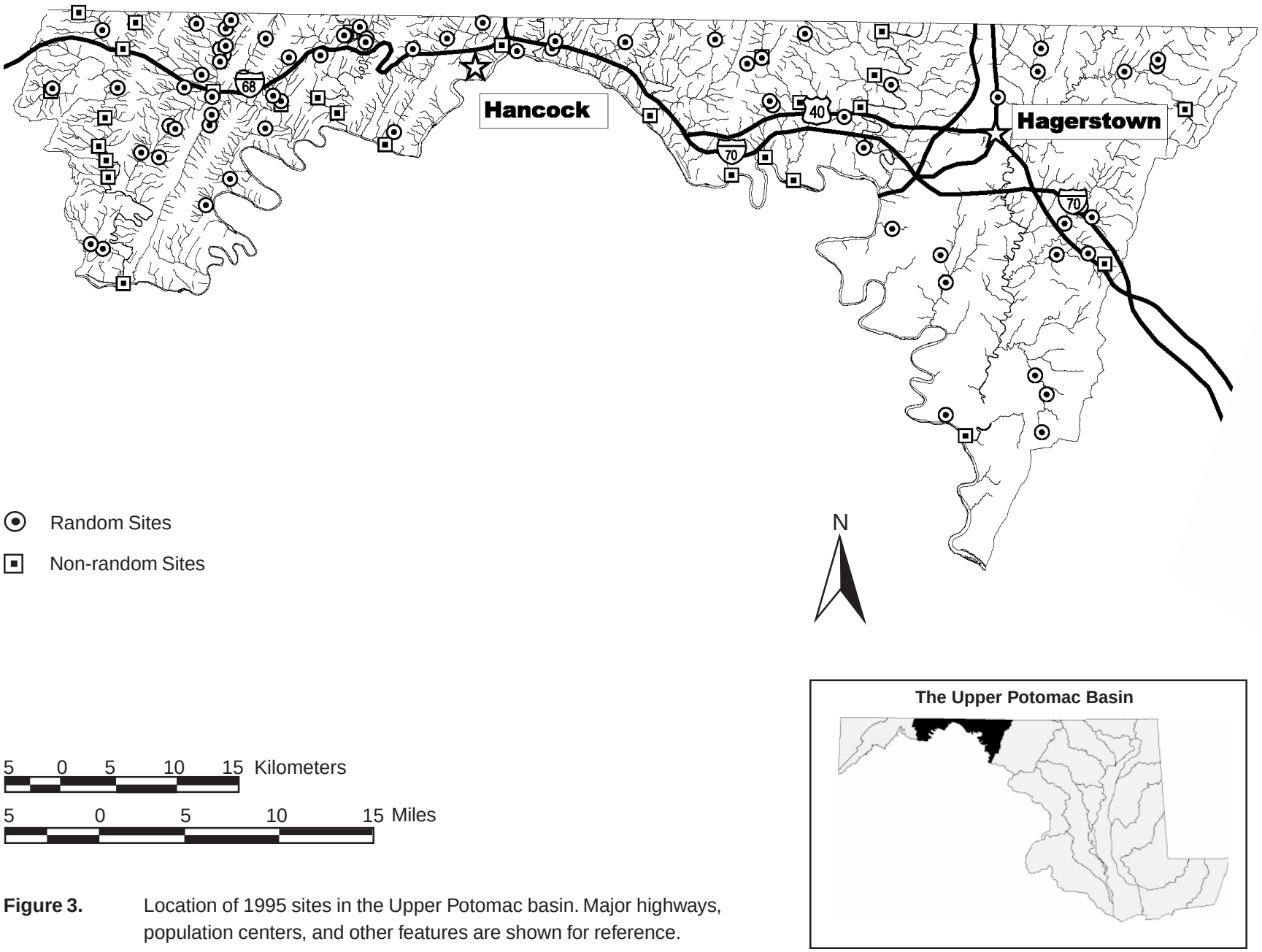



**Figure 3.** Location of 1995 sites in the Upper Potomac basin. Major highways, population centers, and other features are shown for reference.

**Maryland Biological Stream Survey**

# Current Status of Aquatic Resources

# Chapter Four 4

To describe the current status of non-tidal streams, this chapter uses 1995 MBSS data gathered from a total of 65 randomly selected (quantitative) sites in the Upper Potomac basin. All sites were sampled for water chemistry, physical habitat, fish and benthic macroinvertebrates. Where appropriate, data from non-random (qualitative) sites have been used to supplement fish and herpetofauna distributions. A map of these sites is shown in Figure 3, and a list of the streams sampled is presented in Appendix B.

## *GENERAL CHARACTERISTICS OF THE UPPER POTOMAC BASIN*

All sampling sites were located in the Ridge and Valley physiographic province, where streams tend to be moderately sloping with riffles to aerate the water. Of the sixty-five sites sampled in 1995, nineteen were first-order streams, thirty-one were second-order, and the remaining fifteen were third-order. Stream gradient ranged from 0.5% to 14.0%. Wetted width varied from 0 meters (for intermittent damp or dry sections of sampled streams) to 12 meters, with an average width of approximately 4 meters. Maximum depth averaged 0.19 meters and ranged from 0.10 to 0.63 meters.

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 5% of Upper Potomac basin stream miles had DO levels below the state water quality criterion of 5 mg/L (COMAR 1997), and 2% were found to be below 3 mg/L. This suggests that runoff of oxygen demanding materials in the basin does not result in widespread DO problems, but could be contributing to low DO in some areas. These areas warrant attention, since oxygen demanding materials in Upper Potomac streams flow to Chesapeake Bay, contributing to low dissolved oxygen there.

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 suggest that natural sources are contributing to overall acidity in a stream (Morgan 1995).

### *Nitrate and Dissolved Organic Carbon*

Thirty-two percent of the stream miles in the basin had nitrate concentrations greater than 1 mg/L, suggesting that excess nutrients are a relatively widespread environmental problem (Figure 4). Because these results represent spring baseflow conditions, and by inference groundwater concentrations, reductions in nitrate loading in the basin may not be apparent for years. A reduction in

point and non-point sources of nitrates to surface waters would only be recognized after groundwater sources are purged of their high concentrations.

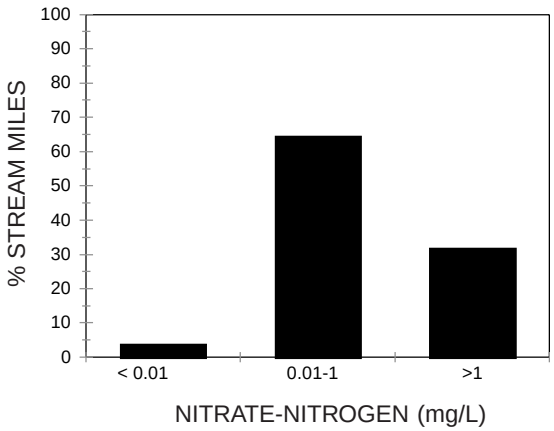



**Figure 4.** Nitrate-nitrogen concentration in non-tidal streams of the Upper Potomac basin (1995).

Approximately 96% of stream miles had DOC levels less than 5 mg/L; one percent of the remaining stream miles had concentrations between 5 and 10 mg/L, and three percent had concentrations greater than 10 mg/L. These data indicate that natural sources of acidity (i.e., wetlands) are not a dominant influence on stream water quality in the basin (Figure 5).

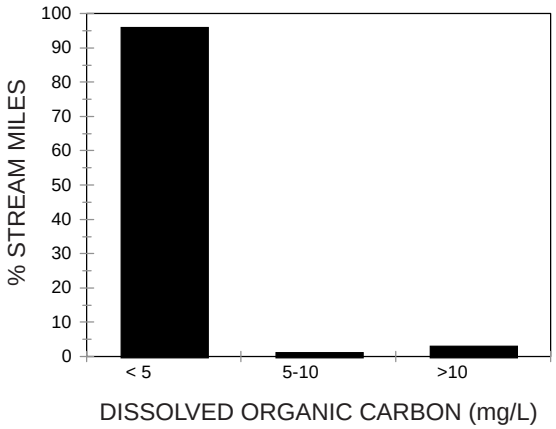



**Figure 5**. Dissolved organic carbon (DOC) in non-tidal streams of the Upper Potomac basin (1995).

### *pH and Buffering Capacity*

Significant adverse impacts on aquatic life are known to occur when pH values fall to 5.0, and below 4.5, faunal exclusion occurs (Allan 1995, Jefferies and Mills 1990). In 1995, most stream miles in the basin had pH values above 6, a level that is considered adequate for aquatic life. Less than 1% of stream miles in the Upper Potomac basin had pH levels below 5, and about 8% of the stream miles had pH values between 5 and 6.

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.

Consistent with pH results, first through third-order streams in the Upper Potomac basin were relatively well-buffered. Fifty-three percent of the basin's stream miles had ANC levels greater than 200 µeq/L, and are probably not susceptible to acid deposition impacts (Figure 6). The high percentage of well-buffered streams probably results from the fact that limestone is a large component of the local geology. Limestone is composed of calcium carbonate, an effective buffer that is commonly used in stomach antacids. However, another 40% had ANC between 50 and 200 µeq/L, a range that can be affected by unusually large additions of acid deposition. An additional 7% of stream miles in the basin had ANC less than 50 µeq/L; these streams are highly susceptible to acid additions during storms.

## *PHYSICAL HABITAT*

Many physical habitat characteristics of streams are

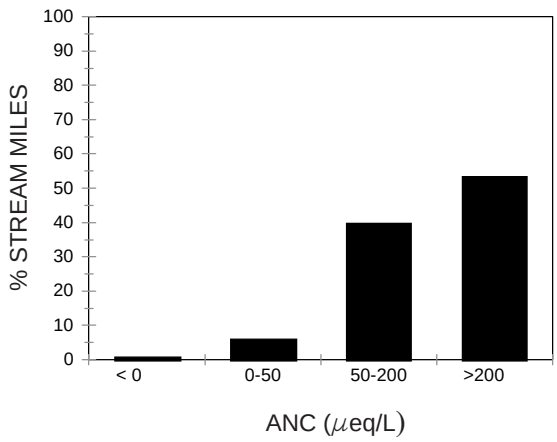



**Figure 6**. Acid neutralizing capacity (ANC) for non-tidal streams of the Upper Potomac basin (1995).

important determinants of ecosystem structure and function. Although a large number of habitat variables are measured by the MBSS, they can be grouped into four general categories: instream habitat, channel character, riparian zone, and aesthetics/remoteness. Most variables are classified as either 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 have the strongest influence on the abundance and diversity of biological communities. Important instream habitat characteristics include: 1) quality and composition of the stream bottom; 2) diversity of depths and flows; and 3) amount and quality of stable habitat for fish shelter and attachment sites for benthic macroinvertebrates.

About 59% of Upper Potomac stream miles were rated Poor to Very Poor for instream habitat, while only 16% were rated Good (Figure 7). Most instream habitat problems result from the removal or loss of woody debris from stream channels in agricultural or urban areas; little to no buffer between pastures, croplands, or urban lands and streams; increases in sediment loads, and the modification of stream channels, resulting in increased runoff to the stream. These impacts to instream habitat are common when lands are developed for agricultural or urban areas. However, the Upper Potomac basin is somewhat unique in that it receives low annual rainfall, so many of its streams tend to be small and often ephemeral. Therefore, these streams are considered to be naturally habitat-limited.

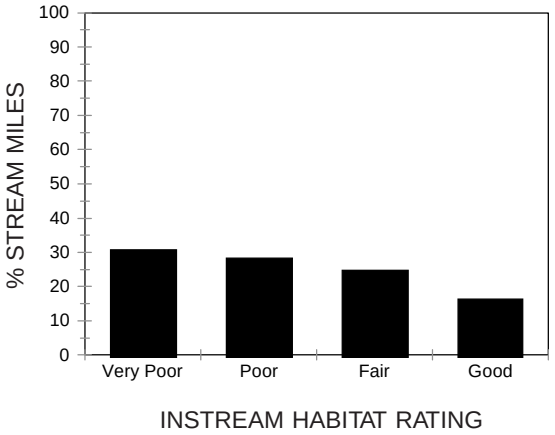



**Figure 7**. Instream habitat rating for non-tidal streams of the Upper Potomac basin (1995).

Added sediment loads tend to reduce the complexity and stability of the stream bottom, resulting in the loss of fish and macroinvertebrate habitat. Additionally, the burial, or "embedding" of stones by silt and sand in riffle areas also results in loss of habitat. Since many benthic macroinvertebrates such as mayflies and stoneflies use the spaces between rocks as living quarters, high sediment loads reduce the amount of habitat available to them, thereby reducing the diversity and abundance of benthos in streams. The Upper Potomac basin is affected by excess sedimentation, with a little over one-half (51%) of the stream miles rated Poor to Very Poor in terms of embeddedness, and with 39% rated Good.

Another impact to instream habitat quality is the reduction in the abundance of wood (i.e., logs, limbs, and rootwads) along stream banks and in stream channels compared to historical levels. Wood in streams enhances habitat quality for both fish and benthic macroinvertebrates by providing a diverse array of shelter, depths, and flow velocities. Woody debris also traps and retains leaves, a vital food supply for many benthic macroinvertebrates. By retaining organic

matter in and near the channel, the export of nutrients to the Chesapeake Bay is reduced.

A lack of woody debris and rootwads was clearly evident within the Upper Potomac basin. The basin has an average of 40 pieces of wood per stream mile, a relatively low number compared to the Middle Potomac basin at an average 57 pieces of wood per stream mile, and the Lower Potomac basin at 154. The low wood density of the Upper Potomac basin reflects that fact that 267 (or 40%) first through third-order stream miles are devoid of woody debris altogether. These streams consequently have limited diversity of physical habitat for stream inhabitants.

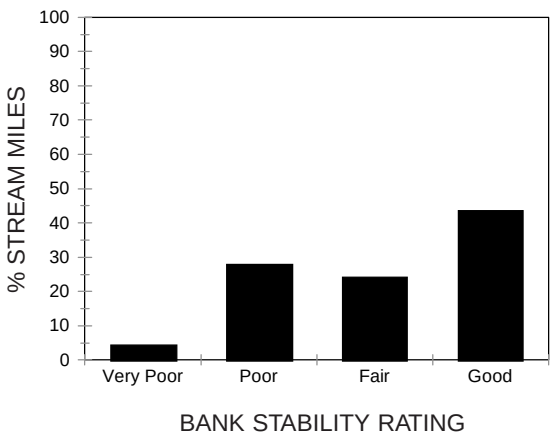



**Figure 8**. Bank stability rating for non-tidal streams of the Upper Potomac basin (1995).

### *Channel Characteristics*

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

One way that agriculture and urbanization affect stream habitat is by destabilizing the stream banks. Stream banks become destabilized by the flooding that occurs as a result of the developed land having been deforested. Signs of stream bank destabilization include highly eroded stream banks and the presence of silt or sand bars in slow moving areas. In the Upper Potomac basin, only a small percentage (4%) of stream miles were found to have highly unstable stream banks (Figure 8). However, over one-half (52%) of the stream banks were no better than Fair.

Stream channel disturbance is often the result of man-made modifications. Trees in the riparian zone are cut and streams channels straightened to allow for the efficient movement of water away from agricultural fields or housing developments. As a result, water velocity and stream bank erosion increase downstream of the impact. Heavily channelized streams are generally shallow, with little habitat for living resources, while downstream areas suffer from increased flooding and stream bank destabilization. Channelization also causes reduced retention and rapid transport of nutrients into Chesapeake Bay.

In the Upper Potomac basin, channel modification is clearly a problem, with altered conditions in 33% of first through third-order streams (Figure 9). As described above, the deleterious effects of channel alteration are likely affecting not only the areas within the basin, but also areas downstream.

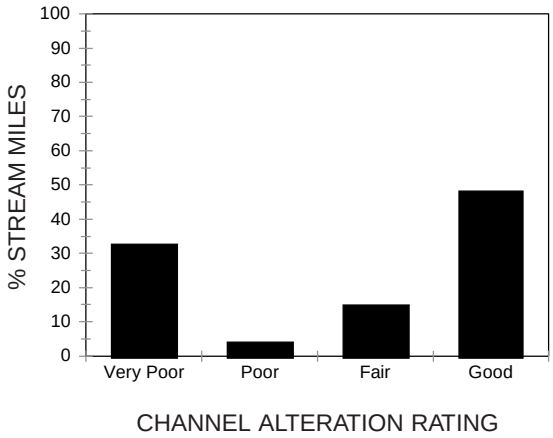



**Figure 9**. Channel alteration rating for non-tidal streams of the Upper Potomac basin (1995).

### *Riparian Zone*

Fifty-seven percent of the stream miles in Upper Potomac basin have at least a 50 meter wide, forested buffer zone, but an alarming 33% have no effective buffer zone on at least one side of the stream (Figure 10). These streams consequently have poor protection against runoff and flood events.

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.

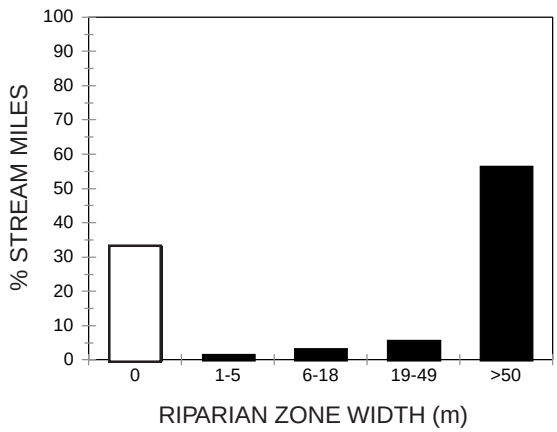



**Figure 10**. Riparian zone width in Upper Potomac basin streams (1995).

### *Aesthetics and Remoteness*

Most (63%) first through third-order stream miles in the basin were rated as Good based on the lack of human refuse at sites sampled. However, about 18% of the basin's stream miles were rated as Poor or Very Poor and contained excessive amounts of trash. Fifty percent of the stream miles were within one-quarter mile from the nearest road, with about one-half of those being located immediately adjacent to a road. The proximity of streams to roads and excessive human refuse both indicate human influences are prevalent near streams.

## *HABITAT QUALITY BASED ON A PHYSICAL HABITAT INDEX (PHI)*

In addition to evaluating habitat components individually, the MBSS has developed a provisional index that combines those aspects of physical habitat that have proven to be the best indicators of biological condition (Hall et al. 1999). Based on this index, nearly three-quarters (73%) of the basin's first through third-order stream miles were rated Poor to Very Poor, while only 8% were rated Good. A contributing factor to poor habitat may be the low rainfall that the basin receives, but the effects of land use practices are clearly evident.

**What is the worst stream pollution problem?**

When asked this question, many people will respond with one word..."trash". Although trash in and along streams is unsightly and undesirable, it is often not the primary cause of stream degradation. However, it may be a good indicator of upstream watershed conditions. The more people living or working in a watershed, the more likely trash will end up in the stream draining the watershed. Some groups conducting stream monitoring programs are developing indices based on the number of articles of trash (such as shopping carts) at a stream site. Quantifying stream characteristics such as trash will help us gauge our success in stormwater management, public education and even recycling.

## *FISHERY RESOURCES*

### *General Description*

A total of 49 fish species representing 10 families were collected in the Upper Potomac basin's first through third-order streams during 1995, and total abundance was estimated to be 4.6 million fish. Basin-wide population estimates for individual species ranged from 61 individuals for river chub to approximately 1.6 million for blacknose dace (Table 1). Blacknose dace, along with pearl dace, creek chub, mottled sculpin, and checkered sculpin, accounted for about 70 percent of the fish in the basin. The minnow family (Cyprinidae) was represented by the greatest number of species (20), followed by the sunfish family (Centrarchidae), with nine species. The remaining families were represented by four or fewer species.

### *Gamefish*

Seven species of gamefish were collected, including: smallmouth and largemouth bass, chain pickerel, and brook trout , cutthroat trout, rainbow trout, and brown trout. Smallmouth bass were the most abundant gamefish found, with chain pickerel and brown trout the second and third most numerous, respectively. Approximately 5000 smallmouth bass occur in streams of the basin (Table 1), but only about 1% of the

**Table 1.** Estimated total abundance and percent occurrence of fish species collected in the Upper Potomac basin in 1995 (first, second, and third-order non-tidal streams combined).

| Family | Common Name | (*Scientific Name*) | Percent Occurrence[1] | Population Estimate[2,3] | Standard Error |
|---|---|---|---|---|---|
| **Anguillidae** | | | | | |
| | American Eel | (*Anguilla rostrata*) | 11.6 | 112 | 105 |
| **Cyprinidae** | | | | | |
| | Central Stoneroller | (*Campostoma anomalum*) | 34.7 | 52,269 | 26,440 |
| | Goldfish | (*Carassius auratus*) | 1.1 | n/a[3] | n/a[3] |
| | Rosyside Dace | (*Clinostomus funduloides*) | 3.2 | 20,747 | 17,009 |
| | Spotfin Shiner | (*Cyprinella spiloptera*) | 16.8 | 8,527 | 5,175 |
| | Common Carp | (*Cyprinus carpio*) | 3.2 | 504 | 508 |
| | Cutlips Minnow | (*Exoglossum maxillingua*) | 10.5 | 1,160 | 637 |
| | Common Shiner | (*Luxilus cornutus*) | 20.0 | 4,867 | 2,768 |
| | Pearl Dace | (*Margariscus margarita*) | 12.6 | 579,313 | 313,764 |
| | River Chub | (*Nocomis micropogon*) | 13.7 | 61 | 61 |
| | Golden Shiner | (*Notemigonus crysoleucas*) | 1.1 | n/a[3] | n/a[3] |
| | Comely Shiner | (*Notropis amoenus*) | 1.1 | n/a[3] | n/a[3] |
| | Spottail Shiner | (*Notropis hudsonius*) | 7.4 | 1,578 | 1,642 |
| | Rosyface Shiner | (*Notropis rubellus*) | 12.6 | n/a[3] | n/a[3] |
| | Bluntnose Minnow | (*Pimephales notatus*) | 37.9 | 205,200 | 93,717 |
| | Fathead Minnow | (*Pimephales promelas*) | 2.1 | 4,203 | 7,663 |
| | Blacknose Dace | (*Rhinichthys atratulus*) | 65.3 | 1,599,558 | 405,829 |
| | Longnose Dace | (*Rhinichthys cataractae*) | 38.9 | 79,847 | 36,906 |
| | Creek Chub | (*Semotilus atromaculatus*) | 49.5 | 348,198 | 94,655 |
| | Fallfish | (*Semotilus corporalis*) | 14.7 | 2,182 | 1,664 |
| **Catostomidae** | | | | | |
| | White Sucker | (*Catostomus commersoni*) | 52.6 | 256,693 | 75,513 |
| | Creek Chubsucker | (*Erimyzon oblongus*) | 10.5 | 6,604 | 4,010 |
| | Northern Hogsucker | (*Hypentelium nigricans*) | 13.7 | 490 | 368 |
| | Golden Redhorse | (*Moxostoma erythrurum*) | 2.1 | n/a[3] | n/a[3] |
| **Esocidae** | | | | | |
| | Chain Pickerel | (*Esox niger*) | 10.5 | 4,069 | 2,088 |
| **Ictaluridae** | | | | | |
| | Yellow Bullhead | (*Ameiurus natalis*) | 16.8 | 785 | 447 |
| | Channel Catfish | (*Ictalurus punctatus*) | 1.1 | n/a[3] | n/a[3] |
| | Margined Madtom | (*Noturus insignis*) | 9.5 | n/a[3] | n/a[3] |
| **Salmonidae** | | | | | |
| | Cutthroat Trout | (*Oncorhynchus clarki*) | 1.1 | n/a[3] | n/a[3] |
| | Rainbow Trout | (*Oncorhynchus mykiss*) | 12.6 | 2,556 | 1,198 |
| | Brown Trout | (*Salmo trutta*) | 6.3 | 2,729 | 1,749 |
| | Brook Trout | (*Salvelinus fontinalis*) | 1.1 | n/a[3] | n/a[3] |
| **Fundulidae** | | | | | |
| | Banded Killifish | (*Fundulus diaphanus*) | 1.1 | n/a[3] | n/a[3] |
| **Cottidae** | | | | | |
| | Mottled Sculpin | (*Cottus bairdi*) | 20.0 | 335,386 | 129,732 |
| | Checkered Sculpin | (*Cottus sp. cf. cognatus*) | 11.6 | 507,794 | 1,274,820 |
| | Potomac Sculpin | (*Cottus girardi*) | 38.9 | 261,461 | 60,026 |
| **Centrarchidae** | | | | | |
| | Rock Bass | (*Ambloplites rupestris*) | 40.0 | 24,034 | 17,522 |
| | Redbreast Sunfish | (*Lepomis auritus*) | 16.8 | 6,437 | 5,947 |
| | Green Sunfish | (*Lepomis cyanellus*) | 30.5 | 4,568 | 1,680 |
| | Pumpkinseed | (*Lepomis gibbosus*) | 9.5 | 2,537 | 1,680 |
| | Bluegill | (*Lepomis macrochirus*) | 23.2 | 18,671 | 14,948 |
| | Longear Sunfish | (*Lepomis megalotis*) | 9.5 | n/a[3] | n/a[3] |
| | Smallmouth Bass | (*Micropterus dolomieu*) | 30.5 | 5,262 | 4,657 |
| | Largemouth Bass | (*Micropterus salmoides*) | 10.5 | 2,283 | 1,193 |
| | Black Crappie | (*Pomoxis nigromaculatus*) | 3.2 | 504 | 504 |
| **Percidae** | | | | | |
| | Greenside Darter | (*Etheostoma blennioides*) | 31.6 | 6,677 | 1,834 |
| | Rainbow Darter | (*Etheostoma caeruleum*) | 6.3 | n/a[3] | n/a[3] |
| | Fantail Darter | (*Etheostoma flabellare*) | 48.4 | 201,413 | 53,228 |
| | Tessellated Darter | (*Etheostoma olmstedi*) | 12.6 | n/a[3] | n/a[3] |

1 Percent of all random and nonrandom sites where each species was collected.
2 Total abundance (number per basin) adjusted for capture efficiency (Heimbuch et al. 1997).
3 Non-random site information was not used in calculating population estimates.

population was of legal size (12 inches or more). Likewise, less than 2% of the chain pickerel in the Upper Potomac basin were of legal size (14 inches or more). In contrast, over 52% of the brown trout and 97% of the rainbow trout were estimated to be of harvestable size (six inches or larger). No legal largemouth bass were collected, and the number and size of brook trout and cutthroat trout were not determined because they were only taken at qualitative sites.

***Rare and Uncommon Species***

None of the fish species collected are currently listed as threatened, rare, or endangered by either Maryland Department of Natural Resources or the U.S. Fish and Wildlife Service (MDNR 1997b). However, checkered sculpin (*Cottus* sp.) is being reviewed for potential inclusion on the Maryland Department of Natural Resources list. Although it is locally abundant in the basin, it is found only in a few western tributaries of the Potomac River, and is therefore considered rare. Similarly, pearl dace are common in the basin but not found elsewhere in the state.

Conversely, some species that are found elsewhere in the state in at least moderate abundance (and are therefore not listed as threatened, rare, or endangered,) are rare to the Upper Potomac basin, and may be isolated from other populations. These species include the comely shiner and the creek chubsucker. Less than 500 individuals of each were collected in 1995. Because of low abundance and probable geographic isolation, these species are at risk of local extinction. The loss of these species would reduce native biodiversity in the basin, an undesirable outcome.

***Introduced Species***

Species introduced to the Upper Potomac basin include common carp, goldfish, brown trout, rainbow trout, cutthroat trout, largemouth bass, and smallmouth bass. Carp and goldfish were brought to the East Coast from Asia, whereas brown trout were originally brought from Europe in the 1870s. Rainbow trout, cutthroat trout, largemouth bass, and smallmouth bass are all native to North America but have been transplanted outside their natural ranges. Exotic introductions generally have had an adverse impact on native biota by either competing with them for resources or by altering their habitats.

***Migratory Species***

There are three types of migratory fish in Maryland, anadromous, semi-anadromous, and catadromous. Anadromous species live as adults in estuarine or marine waters, moving into freshwater to spawn. Semi-anadromous species live as adults in estuarine or riverine waters, also moving into freshwater to spawn. However, semi-anadromous species migrate lesser distances. Conversely, catadromous American eels live as adults in freshwater, migrating to marine waters to spawn.

The only migratory fish capable of ascending Great Falls, a natural migration barrier upstream from Washington, DC is American eel. Consistent with our expectations, American eel was the only migratory species collected in the basin. The estimated basin-wide abundance for American eel was low, at about 100 individuals. While Great Falls acts as an impediment, there are at least eight dams that also restrict the distribution and abundance of eels.

***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 (F-IBI), only 8% of the Upper Potomac basin's first through third-order streams are in Good ecological condition, while 18% are Fair, 9% are Poor, and 23% are considered Very Poor. An additional 41% of the basin's first through third-order stream miles were not rated with the fish IBI. Some streams were not sampled for fish communities because they were dry at the time of sampling. Others were sampled but were not used to calculate IBI scores due to small watershed size (i.e., below 300 acres). In these cases, the streams were considered to be too small to adequately support a diverse assemblage of fish species, regardless of other factors. Sites assessed with the Fish IBI and their locations are shown in Figure 11.

### *BENTHIC MACROINVERTEBRATES*

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

Of the approximately 350 genera of stream-dwelling macroinvertebrates in Maryland, 158 were found in the Upper Potomac basin. The total number of taxa per site ranged from 6 to 30. Dominant taxa and their respective percent occurrences (among all sites) were *Parametriocnemus* (71%), *Prosimulium* (65%), *Neophylax* (64%), and *Ephemerella* (61%). A list of all benthic taxa collected in the basin is found in Appendix F.

MDNR's Benthic Index of Biotic Integrity (B-IBI) indicates that Upper Potomac streams are in better ecological health than is shown by the Fish IBI, rating 16% of the basin's first through third-order streams as Good, 42% as Fair, 30% as Poor, and 11% as Very Poor. Only 1% of first through third-order stream miles were not rated with the Benthic IBI. Sites assessed with the Benthic IBI and their locations are shown in Figure 12.

### *REPTILES AND AMPHIBIANS*

Reptile and amphibians were found at 86% of the sites sampled in 1995. Ten salamander, eight frog, five snake, three turtle, and two lizard species were observed (Table 2). The most commonly found species were northern two-lined salamanders, northern dusky salamanders, red salamanders, green frogs, and eastern box turtles.

### *FRESHWATER MUSSELS*

No freshwater mussels were collected in the Upper Potomac basin.

**Table 2.** List of herpetofauna observed in the Upper Potomac basin, 1995.

| | | Frequency of Occurrence |
|---|---|---|
| **Frog and Toads** | | |
| American toad | (*Bufo americanus*) | 7.7 |
| Bullfrog | (*Rana catesbeiana*) | 9.2 |
| Fowler's toad | (*Bufo woodhousii fowleri*) | 1.6 |
| Green frog | (*Rana clamitans melanota*) | 17.0 |
| Pickerel frog | (*Rana palustris*) | 6.2 |
| Wood frog | (*Rana sylvatica*) | 3.1 |
| **Turtles** | | |
| Common snapping turtle | (*Chelydra s. serpentina*) | 3.1 |
| Eastern box turtle | (*Terrapene c. carolina*) | 12.3 |
| Wood turtle | (*Clemmys insculpta*) | 1.5 |
| **Salamanders** | | |
| Eastern mud salamander | (*Pseudotriton montanus*) | 4.6 |
| Long tailed salamander | (*Eurycea longicauda*) | 6.2 |
| Marbled salamander | (*Ambystoma opacum*) | 1.5 |
| Northern dusky salamander | (*Desmognathus f. fuscus*) | 36.9 |
| Northern spring salamander | (*Gyrinophilus p. porphytiticus*) | 4.6 |
| Northern two-lined salamander | (*Eurycea bislineata*) | 47.7 |
| Red salamander | (*Pseudotriton ruber*) | 20.0 |
| Red spotted newt | (*Notopthalmus v. viridescens*) | 4.6 |
| Slimy salamander | (*Plethodon glutinosus*) | 3.1 |
| **Snakes** | | |
| Eastern smooth earth snake | (*Virginia v. valeriae*) | 1.5 |
| Eastern worm snake | (*Carphophis a. amoenus*) | 1.5 |
| Northern ringneck snake | (*Diadophis p. edwardsii*) | 3.1 |
| Northern water snake | (*Nerodia s. sipedon*) | 12.3 |
| Queen snake | (*Regina septemvittata*) | 1.5 |
| **Lizards** | | |
| Five-lined skink | (*Eumeces fasciatus*) | 1.5 |
| Northern fence lizard | (*Sceloporus u. hyacinthinus*) | 1.5 |

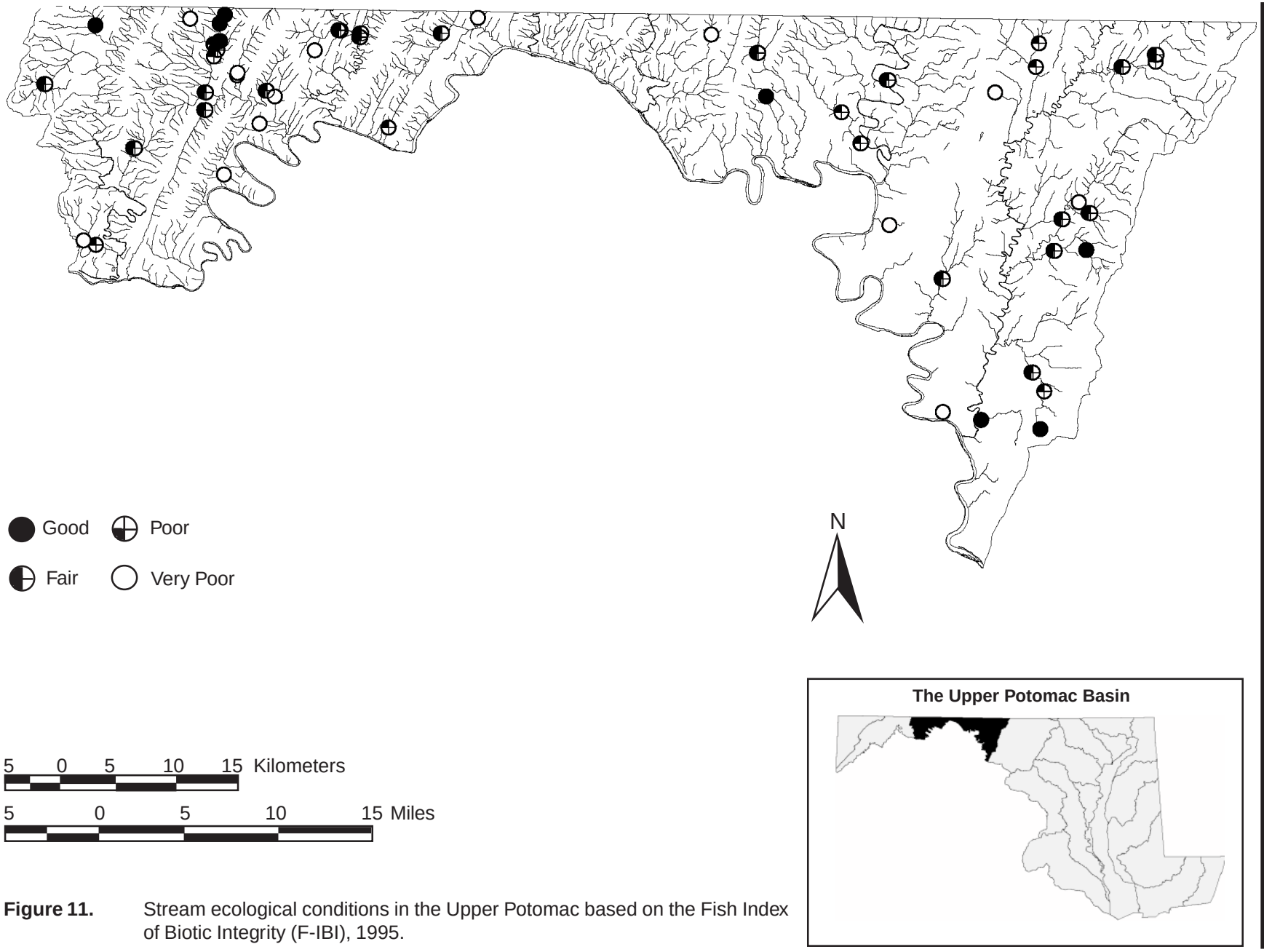



**Figure 11.** Stream ecological conditions in the Upper Potomac based on the Fish Index of Biotic Integrity (F-IBI), 1995.

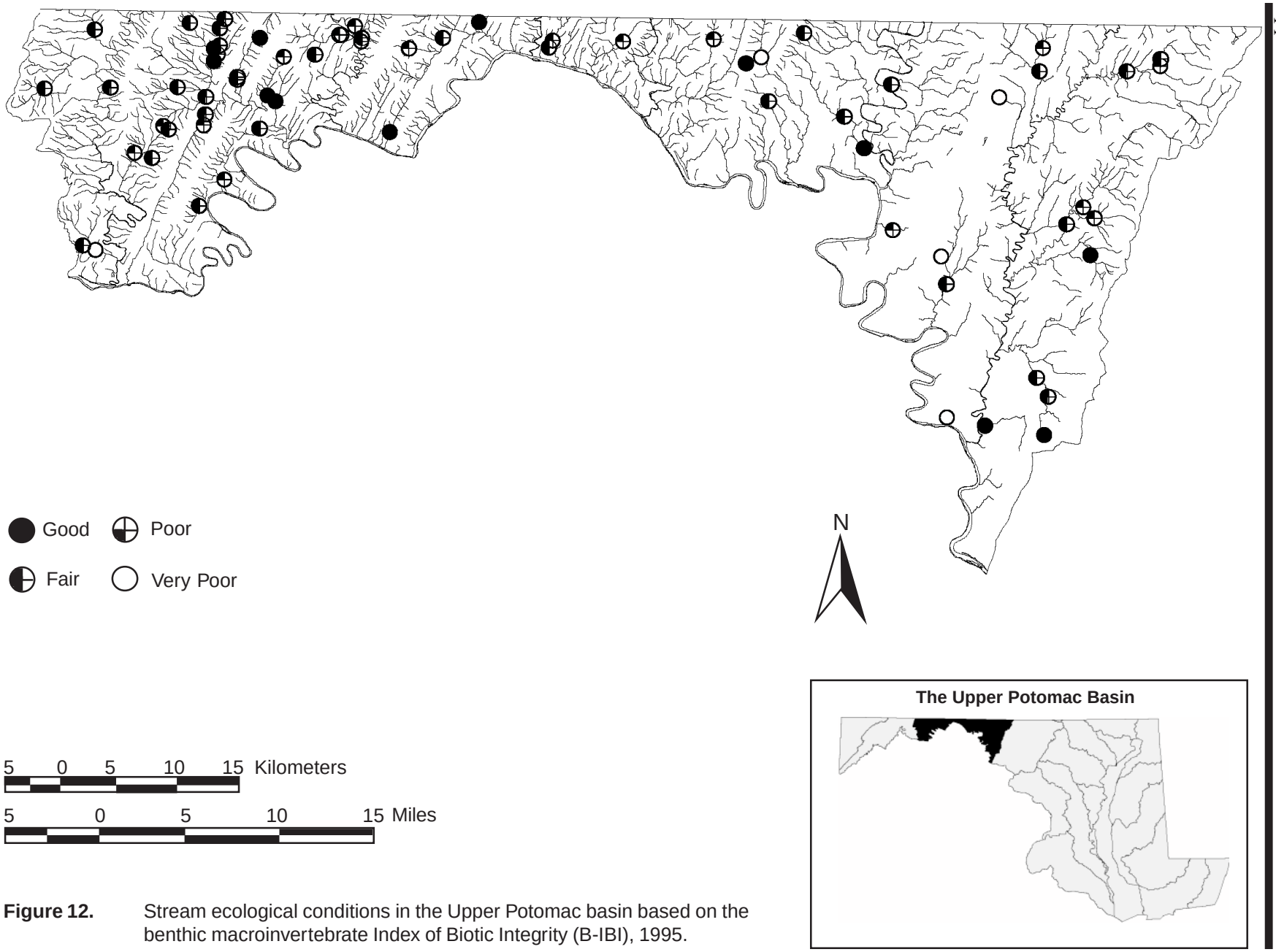



**Figure 12.** Stream ecological conditions in the Upper Potomac basin based on the benthic macroinvertebrate Index of Biotic Integrity (B-IBI), 1995.

**Maryland Biological Stream Survey**

# Summary of Stream Resource Conditions

**Chapter Five 5**

Information from the Maryland Biological Stream Survey has provided us with a snapshot of living resources, stream conditions, and major stressors to the aquatic habitat in the Upper Potomac basin. Like most Maryland watersheds, the Upper Potomac basin consists of a network of streams that range in quality from extremely degraded to relatively healthy.

MBSS' one-time measurements of water chemistry indicate that most streams in the basin have acceptable levels of water quality. However, 7% of streams violated the state water quality criterion for dissolved oxygen, and about 8% of streams had low buffering capacity and are highly susceptible to acid deposition impacts. Elevated nitrate-nitrogen levels were relatively common (~ 30% of stream miles), were strongly related to the proportion of land in agricultural use, and were concentrated in the eastern portion of the basin (Figures 13 and 14; next page). Urban runoff and point source inputs are major contributors of excess nitrate, however, agricultural fertilizers are probably the most important source of nitrate-nitrogen in streams in the basin. Because this condition represents both current and historical nutrient additions, it may be years to decades before the benefits of nutrient reduction efforts begin to be realized.

In addition to failing to meet some water quality standards (a result common to other surveys which only measure water chemistry), there is evidence of biological impairment in Upper Potomac basin streams. The MDNR's fish Index of Biotic Integrity classified 32% of the stream miles as Poor or Very Poor. The results of the benthic IBI were more dramatic, classifying 44% of the stream miles as Poor or Very Poor. Also, the majority of sites classified as Fair scored within the lower range of that category and are therefore susceptible to being degraded to Poor condition.

The discrepancy of the ratings between the IBIs may be attributed to several factors. First, the inherent variability associated with each index likely accounts for some of the disagreement. Second, it has been established that because of differences in trophic level,

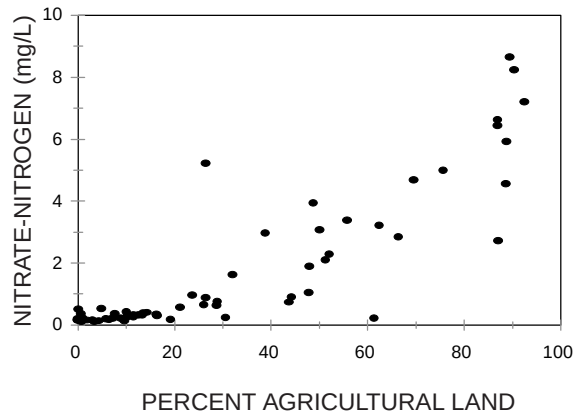



**Figure 13**. Effect of agricultural land use on stream nitrate-nitrogen concentrations.

life history patterns, and responses to environmental stressors, fish and benthic macroinvertebrates reflect different types of environmental perturbations. Fish generally respond to larger, landscape scale influences while the benthic macroinvertebrate community reflects water chemistry and instream habitat. Finally, nearly one-quarter of the stream miles could not be assessed by the fish IBI because of the minimum 300 acre watershed size criterion. The difference in the number of sites assessed by each IBI could affect the overall evaluation of the basin, particularly because these smaller first and second-order streams make up 70 percent of the streams in the basin.

Only 8% of the streams appear to be in Good condition based on the MDNR's Physical Habitat Index, with 73% of the stream miles in Poor or Very Poor condition. This degradation is largely the result of a lack of rootwads and woody debris in the stream channel from historical and ongoing logging practices; excess silt and unstable stream banks; modification of stream channels; and loss of functional riparian buffers. Large woody debris and rootwads function to reduce the erosive power of water. Without these natural structures bank instability intensifies, although in many cases marshes fill the functional niche of wood and rootwads. About 32% of all stream miles in the Upper Potomac basin have unstable or moderately unstable stream banks. Unstable bank conditions increase the amount of sediment that enters the

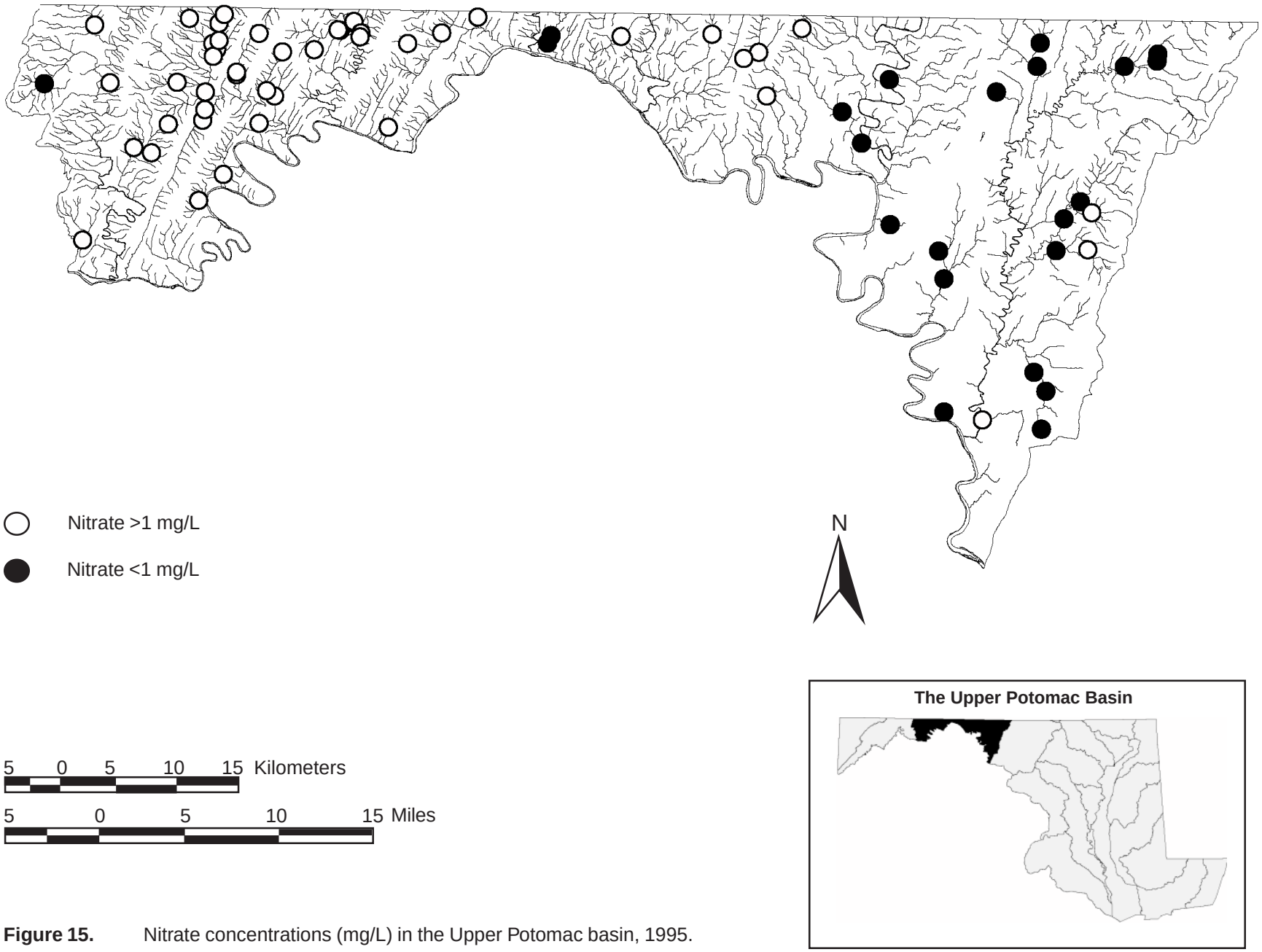



**Figure 15.** Nitrate concentrations (mg/L) in the Upper Potomac basin, 1995.

stream and, in turn, increases siltation, reducing habitat available for benthos and food supplies for fish. The problem of bank erosion is further compounded in streams that experience increased runoff due to land use changes that increase impervious surface or decrease the amount of stabilizing vegetation.

Nearly, 34% of the streams in the basin have no functional (vegetated) riparian buffer, thereby reducing the ecological integrity of the stream and threatening downstream areas. This lack of protective vegetation along streams is an obvious starting point in the restoration process because riparian buffers improve both water quality and physical habitat. In general, results of the MBSS suggest that physical habitat degradation is an important, widespread problem in the basin.

Although the total number of fish species collected (49) in the Upper Potomac was among the highest of any basin in the state, the mean number of species collected per sampling site was among the lowest (~4.5). Fourteen of the 49 species of fish collected are non-native and most, if not all, of these species were introduced by fisheries managers or anglers. From a recreational standpoint, some of these introductions have been beneficial, but ecological impacts, such as the reduction in distribution and abundance of native species, have occurred and will continue. Unfortunately, there is little historical information about fish community composition in the basin. Therefore, it is difficult to determine if the introduction of non-native fishes has influenced the distribution and abundance of native species. The MBSS results establish a useful benchmark of current fish species composition, distribution, and abundance that can be used to track future changes. Because of the recognized potential for detrimental effects, the Chesapeake Bay states have started a review process for proposed introductions of non-native species that should reduce the number of unwise introductions.

Seven species of gamefish were present in low numbers in the Upper Potomac basin's first through third-order streams. Only chain pickerel and brook trout are native to the basin; the rest have been introduced by fisheries managers. Only one-quarter of the basin's total number of gamefish were of harvestable size, but the streams of the basin may serve as nursery areas for larger waters such as the Potomac River.

Currently, the MDNR recognizes several watersheds in the basin as maintaining relatively unimpacted conditions (Figure 16). These systems have been designated as "reference" or "sentinel" watersheds because they support healthy biotic communities and meet the physical habitat, water chemistry, and land use criteria defined by Kazyak (1997). As a result, the MDNR is initiating biomonitoring and targeting restoration efforts in these areas. However, given the level and types of stream impacts noted in 1995 and the projected changes in land use, human population size, and water demands in the Upper Potomac basin, the biological communities and other ecological attributes of streams 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. However, it is important to note that BMPs may reduce, but do not eliminate, the often major ecological impacts of human disturbance.

This report clearly illustrates that valuable stream resources still exist in the basin. However, in many ways, the basin still suffers from mistakes of the past. The entire basin has been logged, including riparian zones. As a result, unstable stream channels are common, physical habitat is greatly reduced, and even forested streams now carry elevated sediment and nutrient loads. In addition, dams and other migration barriers contribute to the reduced use of habitat by American eel. In urbanized areas of the basin, such as Hagerstown, large volumes of water flush directly into streams during storms and baseflows are reduced to a trickle during dry periods. These extreme fluctuations in flow create conditions that only the hardiest of aquatic animals can tolerate. All of these problems can be lessened or eliminated over time, but we must work to restore conditions in the basin for future generations. At the same time, we need to make a concerted effort to protect and enhance the remaining high quality resources in the basin and elsewhere in Maryland. By learning to exist in a sustainable manner, we will be able to enjoy the natural resources of Maryland for generations to come.

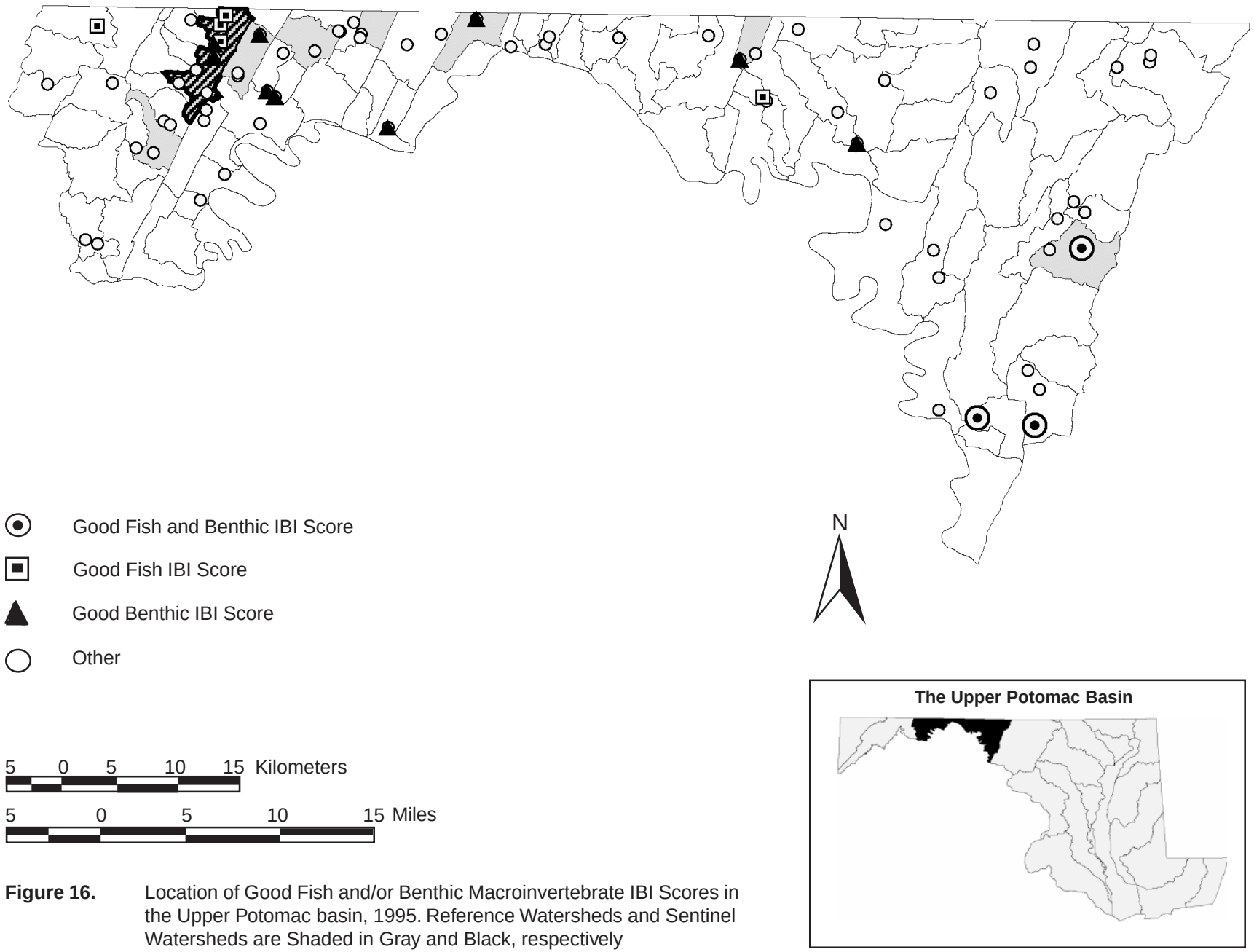



**Figure 16.** Location of Good Fish and/or Benthic Macroinvertebrate IBI Scores in the Upper Potomac basin, 1995. Reference Watersheds and Sentinel Watersheds are Shaded in Gray and Black, respectively

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# 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. Plans are to continue the MBSS and include 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, the MBSS sample sites for the Upper Potomac 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 to 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 UPPER POTOMAC BASIN IN 1995 AS PART OF 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 (UT).

| Stream Name | Order | Stream Name | Order |
|---|---|---|---|
| Bear Creek (2 sites) | 3 | Long Hollow | 2 |
| Beaver Creek (2 sites) | 2 | Maple Run | 2 |
| Black Rock Creek | 1 | UT Maple Run | 1 |
| Deep Run | 2 | Marsh Run (2 sites) | 2 |
| UT Deep Run | 1 | Marsh Run (1 site) | 2 |
| Ditch Run | 2 | Meadow Branch (2 sites) | 2 |
| Fifteenmile Creek (5 sites) | 3 | Murley Branch | 3 |
| UT Fifteenmile Creek (4 sites) | 2 | UT Potomac River (3 sites) | 1 |
| UT Fifteenmile Creek | 1 | UT Potomac River | 2 |
| Flat Run | 2 | Rabble Run | 2 |
| Flintstone Creek | 3 | UT Rockdale Run | 1 |
| Hamilton Run | 1 | Rush Run | 2 |
| Little Antietam Creek (2 sites) | 2 | Sawpit Run (2 sites) | 2 |
| Little Antietam Creek (1 site) | 3 | Sharmans Branch | 2 |
| UT Little Antietam Creek (2 sites) | 1 | UT Sideling Hill Creek (2 sites) | 1 |
| UT Little Antietam Creek | 2 | UT Sideling Hill Creek (2 sites) | 3 |
| Little Beaver Creek | 1 | UT St. James Run | 1 |
| UT Little Beaver Creek | 2 | Terrapin Run (2 sites) | 2 |
| Little Conococheague Creek | 2 | UT Terrapin Run | 1 |
| UT Little Conococheague Creek | 1 | Toms Run | 2 |
| Little Tonoloway Creek | 3 | UT Town Creek | 1 |
| UT Little Tonoloway Creek | 1 | White Sulphur Run (1 site) | 1 |
| UT Little Tonoloway Creek | 2 | White Sulphur Run (1 site) | 3 |

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**Appendix C:** Location (decimal degrees) and water quality data for MBSS sites in the Upper Potomac, 1995. 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 | $NO_3$ | $SO_4$ | DOC | ANC |
|---|---|---|---|---|---|---|---|---|---|
| Bear Creek | 39.7052 | 78.3170 | 20.0 | 9.1 | 7.25 | 0.89 | 15.05 | 2.0 | 180.07 |
| Bear Creek | 39.7024 | 78.3179 | 14.0 | 9.0 | 7.09 | 0.72 | 13.78 | 2.0 | 182.92 |
| Beaver Creek | 39.5753 | 77.6544 | 16.0 | 8.5 | 7.99 | 3.93 | 19.70 | 2.0 | 3301.25 |
| Beaver Creek | 39.5880 | 77.6391 | 18.9 | 9.1 | 8.06 | 1.04 | 9.53 | 2.0 | 1126.22 |
| Black Rock Creek | 39.5801 | 77.6285 | 17.1 | 9.0 | 6.77 | 0.25 | 5.46 | 2.0 | 49.37 |
| Deep Run | 39.6478 | 78.4626 | 17.0 | 3.4 | 6.70 | 0.16 | 14.91 | 2.0 | 94.23 |
| Ditch Run | 39.7050 | 78.1382 | 19.1 | 5.1 | 6.87 | 4.99 | 27.30 | 2.0 | 216.86 |
| Fifteenmile Creek | 39.6917 | 78.4523 | 22.0 | 9.3 | 6.89 | 0.29 | 10.27 | 2.0 | 177.81 |
| Fifteenmile Creek | 39.7107 | 78.4506 | 19.0 | 8.2 | 7.07 | 0.32 | 10.03 | 2.0 | 182.15 |
| Fifteenmile Creek | 39.6981 | 78.4503 | 17.9 | 7.7 | 7.12 | 0.32 | 10.09 | 5.0 | 181.48 |
| Fifteenmile Creek | 39.7172 | 78.4458 | 22.0 | 8.4 | 6.98 | 0.29 | 10.54 | 2.0 | 165.54 |
| Fifteenmile Creek | 39.6867 | 78.4557 | 22.5 | 7.4 | 6.91 | 0.26 | 10.34 | 2.0 | 172.95 |
| Flat Run | 39.6384 | 78.4116 | 15.5 | 3.8 | 6.77 | 0.12 | 14.36 | 2.0 | 144.01 |
| Flintstone Creek | 39.7081 | 78.5677 | 18.5 | 9.2 | 7.45 | 0.25 | 14.21 | 2.0 | 449.64 |
| Hamilton Run | 39.6673 | 77.7187 | 15.5 | 6.7 | 7.66 | 5.23 | 46.78 | 2.0 | 5736.67 |
| Little Antietam Creek | 39.4638 | 77.6814 | 19.5 | 9.2 | 8.14 | 2.28 | 14.44 | 2.0 | 1336.93 |
| Little Antietam Creek | 39.6866 | 77.5986 | 15.5 | 14.6 | 8.22 | 3.06 | 17.59 | 2.0 | 2657.96 |
| Little Antietam Creek | 39.4501 | 77.6703 | 24.0 | 9.3 | 7.61 | 2.11 | 13.37 | 2.0 | 1072.09 |
| Little Beaver Creek | 39.5525 | 77.6616 | 22.5 | 10.2 | 8.22 | 2.97 | 12.08 | 3.0 | 2966.92 |
| Little Conococheague Creek | 39.6946 | 77.9424 | 24.0 | 6.8 | 7.24 | 0.33 | 7.60 | 3.0 | 442.82 |
| Little Tonoloway Creek | 39.7061 | 78.2409 | 16.5 | 8.3 | 7.34 | 0.38 | 18.36 | 3.0 | 335.59 |
| Long Hollow | 39.6371 | 78.2899 | 20.0 | 7.4 | 7.14 | 0.20 | 23.28 | 3.0 | 337.24 |
| Maple Run | 39.6192 | 78.5287 | 24.8 | 1.7 | 6.33 | 0.14 | 10.60 | 2.0 | 93.73 |
| Marsh Run | 39.6862 | 77.6807 | 17.5 | 9.3 | 7.89 | 8.24 | 33.20 | 2.0 | 4723.34 |
| Marsh Run | 39.5313 | 77.7664 | 18.0 | 7.7 | 7.95 | 4.68 | 30.22 | 2.0 | 5334.01 |
| Marsh Run | 39.7033 | 77.6779 | 18.0 | 9.4 | 7.95 | 7.20 | 32.47 | 2.0 | 5715.83 |
| Meadow Brook | 39.6521 | 77.8634 | 23.0 | 8.4 | 7.82 | 4.56 | 13.37 | | 4477.51 |
| Meadow Brook | 39.6293 | 77.8451 | 27.0 | 9.4 | 8.04 | 6.44 | 22.41 | 2.0 | 4525.44 |
| Murley Branch | 39.6647 | 78.6138 | 14.5 | 9.0 | 8.08 | 1.63 | 26.36 | | 4286.44 |
| Rabble Run | 39.7075 | 77.9869 | 16.0 | 9.5 | 4.60 | 0.22 | 12.60 | 2.0 | -26.08 |
| Rush Run | 39.6757 | 77.8196 | 18.0 | 8.7 | 8.26 | 8.66 | 36.28 | 2.0 | 4851.26 |
| Sawpit Run | 39.5513 | 78.5753 | 18.5 | 7.9 | 6.69 | 0.14 | 21.55 | 2.0 | 291.05 |
| Sawpit Run | 39.5483 | 78.5638 | 16.0 | 8.4 | 7.30 | | 35.38 | 5.0 | 400.21 |
| Sharmans Run | 39.4289 | 77.7295 | 17.2 | 6.2 | 7.60 | 0.96 | 12.43 | 3.0 | 1484.52 |
| Terrapin Run | 39.6753 | 78.4331 | 16.0 | 8.2 | 6.94 | 0.17 | 14.62 | 2.0 | 183.60 |
| Terrapin Run | 39.6733 | 78.4334 | 17.0 | 7.6 | 6.98 | 0.19 | 14.88 | 3.0 | 175.46 |
| Toms Run | 39.6629 | 77.9347 | 20.0 | 8.8 | 8.21 | 0.18 | 6.46 | 2.0 | 2325.01 |
| UT Ditch Run | 39.6998 | 78.1414 | | | 6.12 | 0.20 | 17.20 | 2.0 | 33.65 |
| UT Ditch Run | 39.6400 | 78.4646 | 20.0 | 8.3 | 6.92 | 2.85 | 26.54 | 3.0 | 165.59 |
| UT Fifteenmile Creek | 39.7139 | 78.4786 | 20.0 | 6.4 | 6.49 | 0.12 | 11.02 | 2.0 | 92.90 |
| UT Fifteenmile Creek | 39.6957 | 78.4560 | 17.1 | 5.7 | 6.91 | 0.16 | 11.10 | 1.0 | 131.04 |
| UT Fifteenmile Creek | 39.6584 | 78.3974 | 18.0 | 9.2 | 6.84 | 0.58 | 15.44 | 2.0 | 138.19 |

**Appendix C:** Location (decimal degrees) and water quality data for MBSS sites in the Upper Potomac basin, 1995. 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 | $NO_3$ | $SO_4$ | DOC | ANC |
|---|---|---|---|---|---|---|---|---|---|
| UT Fifteenmile Creek | 39.6623 | 78.4050 | 16.0 | 7.6 | 7.20 | 0.23 | 16.78 | 2.0 | 240.62 |
| UT Fifteenmile Creek | 39.6905 | 78.3904 | 15.1 | 6.8 | 7.01 | 0.33 | 17.72 | 3.0 | 227.61 |
| UT Little Antietam Creek | 39.4225 | 77.6741 | 19.0 | 8.0 | 7.31 | 1.90 | 12.17 | 2.0 | 530.76 |
| UT Little Antietam Creek | 39.6905 | 77.5678 | 16.5 | 9.7 | 7.76 | 3.38 | 9.37 | 2.0 | 1976.40 |
| UT Little Antietam Creek | 39.6957 | 77.5671 | 24.0 | 12.0 | 8.62 | 3.22 | 13.64 | 2.0 | 3618.20 |
| UT Little Beaver Creek | 39.5532 | 77.6320 | 21.5 | 7.6 | 7.37 | 0.42 | 7.14 | 2.0 | 286.68 |
| Little Conococheague Creek | 39.6900 | 77.9565 | 18.5 | 8.2 | 7.23 | 0.53 | 11.60 | | 434.92 |
| UT Little Tonoloway Creek | 39.7178 | 78.2073 | 14.0 | 6.6 | 6.50 | 0.39 | 16.92 | 3.0 | 101.92 |
| UT Little Tonoloway Creek | 39.6980 | 78.2729 | 16.0 | 8.2 | 8.08 | 0.89 | 67.82 | 2.0 | 3384.35 |
| UT Maple Run | 39.6158 | 78.5121 | 19.5 | 6.8 | 6.99 | 0.14 | 11.99 | 2.0 | 231.11 |
| UT Piclic Run | 39.6673 | 78.4892 | | | 6.35 | 0.14 | 12.37 | 4.0 | 55.87 |
| UT Potomac River | 39.5815 | 78.4671 | 15.8 | 6.5 | 7.14 | 0.51 | 17.05 | 2.0 | 255.68 |
| UT Potomac River | 39.6009 | 78.4443 | 17.8 | 2.7 | 7.19 | 0.17 | 18.08 | 2.0 | 313.47 |
| UT Potomac River | 39.5702 | 77.8174 | 25.0 | 5.4 | 8.03 | 2.72 | 29.46 | 2.0 | 4007.08 |
| UT Potomac River | 39.4345 | 77.7654 | 19.2 | 9.0 | 8.12 | 6.63 | 25.91 | 2.0 | 5110.95 |
| UT Potomac River | 39.7051 | 78.0722 | | | 6.89 | 0.21 | 13.08 | 4.0 | 310.89 |
| UT Rockdale Run | 39.7124 | 77.9020 | 22.5 | 6.6 | 6.74 | 0.37 | 7.55 | 26.0 | 175.23 |
| UT Sideling Hill Creek | 39.7135 | 78.3238 | 18.5 | 7.6 | 6.56 | 0.65 | 11.52 | 2.0 | 92.49 |
| UT Sideling Hill Creek | 39.6925 | 78.3607 | 17.0 | 8.1 | 6.53 | 0.21 | 12.61 | 2.0 | 59.65 |
| UT Sideling Hill Creek | 39.7071 | 78.3367 | 19.0 | 5.6 | 7.28 | 0.64 | 15.39 | 2.0 | 430.90 |
| UT Sideling Hill Creek | 39.7072 | 78.3384 | 20.0 | 8.3 | 7.36 | 0.75 | 17.12 | 2.0 | 423.47 |
| UT St. James Run | 39.5514 | 77.7717 | 16.5 | 8.5 | 7.14 | 5.93 | 27.91 | 2.0 | 5814.56 |
| UT Terrapin Run | 39.7039 | 78.4127 | 16.0 | 8.4 | 6.60 | 0.35 | 11.41 | 2.0 | 74.56 |
| UT Town Creek | 39.6663 | 78.5522 | 15.0 | 4.8 | 6.95 | 0.11 | 15.28 | 2.0 | 131.40 |
| UT White Sulphur Run | 39.6367 | 78.4968 | 18.5 | 6.1 | 6.59 | 0.15 | 11.32 | 2.0 | 125.31 |
| White Sulphur Run | 39.6606 | 78.4625 | 21.0 | 11.2 | 6.92 | 0.16 | 11.59 | 2.0 | 118.03 |
| White Sulphur Run | 39.6392 | 78.5025 | | | 5.94 | | 8.78 | 1.0 | 73.24 |

# 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 Upper Potomac basin, 1995. See "Physical Habitat Conditions Measured By The MBSS" for details.

| Stream Name | Latitude | Longitude | Instream Habitat | Epifaunal Substrate | Velocity/ Depth | Pool Quality |
|---|---|---|---|---|---|---|
| Bear Creek | 39.7052 | 78.3170 | 15 | 5 | 8 | 10 |
| Bear Creek | 39.7024 | 78.3179 | 17 | 19 | 17 | 16 |
| Beaver Creek | 39.5753 | 77.6544 | 18 | 4 | 15 | 19 |
| Beaver Creek | 39.5880 | 77.6391 | 5 | 2 | 14 | 18 |
| Black Rock Creek | 39.5801 | 77.6285 | 10 | 3 | 11 | 11 |
| Deep Run | 39.6478 | 78.4626 | 8 | 13 | 11 | 13 |
| Ditch Run | 39.7050 | 78.1382 | 1 | 1 | 2 | 1 |
| Fifteenmile Creek | 39.6917 | 78.4523 | 13 | 11 | 11 | 16 |
| Fifteenmile Creek | 39.7107 | 78.4506 | 15 | 17 | 17 | 13 |
| Fifteenmile Creek | 39.6981 | 78.4503 | 13 | 14 | 12 | 12 |
| Fifteenmile Creek | 39.7172 | 78.4458 | 8 | 5 | 12 | 11 |
| Fifteenmile Creek | 39.6867 | 78.4557 | 13 | 8 | 8 | 18 |
| Flat Run | 39.6384 | 78.4116 | 7 | 5 | 3 | 7 |
| Flintstone Creek | 39.7081 | 78.5677 | 15 | 13 | 12 | 10 |
| Hamilton Run | 39.6673 | 77.7187 | 5 | 3 | 6 | 6 |
| Little Antietam Creek | 39.4638 | 77.6814 | 18 | 5 | 15 | 18 |
| Little Antietam Creek | 39.6866 | 77.5986 | 18 | 11 | 16 | 17 |
| Little Antietam Creek | 39.4501 | 77.6703 | 11 | 3 | 8 | 10 |
| Little Beaver Creek | 39.5525 | 77.6616 | 16 | 5 | 16 | 17 |
| Little Conococheague Creek | 39.6946 | 77.9424 | 16 | 4 | 12 | 6 |
| Little Tonoloway Creek | 39.7061 | 78.2409 | 5 | 5 | 7 | 16 |
| Long Hollow | 39.6371 | 78.2899 | 12 | 7 | 12 | 13 |
| Maple Run | 39.6192 | 78.5287 | 1 | 1 | 2 | 1 |
| Marsh Run | 39.6862 | 77.6807 | 17 | 11 | 18 | 18 |
| Marsh Run | 39.5313 | 77.7664 | 17 | 11 | 16 | 19 |
| Marsh Run | 39.7033 | 77.6779 | 8 | 1 | 9 | 16 |
| Meadow Brook | 39.6521 | 77.8634 | 16 | 5 | 14 | 17 |
| Meadow Brook | 39.6293 | 77.8451 | 13 | 2 | 8 | 11 |
| Murley Branch | 39.6647 | 78.6138 | 15 | 16 | 9 | 10 |
| Rabble Run | 39.7075 | 77.9869 | 19 | 20 | 17 | 15 |
| Rush Run | 39.6757 | 77.8196 | 16 | 16 | 15 | 16 |
| Sawpit Run | 39.5513 | 78.5753 | 5 | 2 | 6 | 10 |
| Sawpit Run | 39.5483 | 78.5638 | 16 | 5 | 16 | 16 |
| Sharmans Run | 39.4289 | 77.7295 | 17 | 4 | 15 | 16 |
| Terrapin Run | 39.6753 | 78.4331 | 6 | 11 | 8 | 8 |
| Terrapin Run | 39.6733 | 78.4334 | 8 | 11 | 7 | 14 |
| Toms Run | 39.6629 | 77.9347 | 16 | 5 | 12 | 14 |
| UT Ditch Run | 39.6998 | 78.1414 | 11 | 5 | 8 | 10 |
| UT Fifteenmile Creek | 39.7139 | 78.4786 | 6 | 12 | 4 | 2 |
| UT Fifteenmile Creek | 39.6957 | 78.4560 | 6 | 11 | 7 | 3 |
| UT Fifteenmile Creek | 39.6584 | 78.3974 | 16 | 15 | 11 | 11 |
| UT Fifteenmile Creek | 39.6623 | 78.4050 | 4 | 5 | 6 | 6 |
| UT Fifteenmile Creek | 39.6905 | 78.3904 | 5 | 5 | 6 | 3 |
| UT Little Antietam Creek | 39.4225 | 77.6741 | 10 | 1 | 6 | 5 |
| UT Little Antietam Creek | 39.6905 | 77.5678 | 16 | 12 | 7 | 10 |

**Appendix D:** Location and physical habitat data for MBSS sites in the Upper Potomac basin, 1995. See "Physical Habitat Conditions Measured By The MBSS" for details.

| Stream Name | Latitude | Longitude | Instream Habitat | Epifaunal Substrate | Velocity/ Depth | Pool Quality |
|---|---|---|---|---|---|---|
| UT Little Antietam Creek | 39.6957 | 77.5671 | 5 | 3 | 11 | 16 |
| UT Little Beaver Creek | 39.5532 | 77.6320 | 16 | 15 | 12 | 13 |
| UT Little Conococheague Creek | 39.6900 | 77.9565 | 17 | 17 | 9 | 11 |
| UT Little Tonoloway Creek | 39.7178 | 78.2073 | 11 | 5 | 6 | 12 |
| UT Little Tonoloway Creek | 39.6980 | 78.2729 | 3 | 2 | 3 | 5 |
| UT Maple Run | 39.6158 | 78.5121 | 15 | 15 | 8 | 10 |
| UT Potomac River | 39.5815 | 78.4671 | 10 | 5 | 6 | 4 |
| UT Potomac River | 39.6009 | 78.4443 | 2 | 1 | 2 | 1 |
| UT Potomac River | 39.5702 | 77.8174 | 1 | 1 | 6 | 3 |
| UT Potomac River | 39.4345 | 77.7654 | 13 | 1 | 9 | 16 |
| UT Rockdale Run | 39.7124 | 77.9020 | 7 | 5 | 8 | 16 |
| UT Sideling Hill Creek | 39.7135 | 78.3238 | 10 | 12 | 6 | 8 |
| UT Sideling Hill Creek | 39.6925 | 78.3607 | 13 | 16 | 9 | 10 |
| UT Sideling Hill Creek | 39.7071 | 78.3367 | 12 | 10 | 12 | 9 |
| UT Sideling Hill Creek | 39.7072 | 78.3384 | 10 | 5 | 6 | 8 |
| UT St. James Run | 39.5514 | 77.7717 | 1 | 0 | 2 | 16 |
| UT Terrapin Run | 39.7039 | 78.4127 | 11 | 5 | 6 | 6 |
| UT Town Creek | 39.6663 | 78.5522 | 1 | 1 | 2 | 1 |
| UT White Sulphur Run | 39.6367 | 78.4968 | 6 | 11 | 6 | 3 |
| White Sulphur Run | 39.6606 | 78.4625 | 16 | 5 | 12 | 16 |

**Appendix D:** Location and physical habitat data for MBSS sites in the Upper Potomac basin, 1995. See "Physical Habitat Conditions Measured By The MBSS" for details.

| Stream Name | Latitude | Longitude | Riffle Quality | Channel Alteration | Bank Stability | Percent Embeddedness | Channel Flow (%) |
|---|---|---|---|---|---|---|---|
| Bear Creek | 39.7052 | 78.3170 | 13 | 16 | 16 | 0 | 95 |
| Bear Creek | 39.7024 | 78.3179 | 15 | 17 | 16 | 30 | 75 |
| Beaver Creek | 39.5753 | 77.6544 | 0 | 3 | 10 | 100 | 100 |
| Beaver Creek | 39.5880 | 77.6391 | 0 | 3 | 16 | 65 | 95 |
| Black Rock Creek | 39.5801 | 77.6285 | 16 | 3 | 10 | 25 | 100 |
| Deep Run | 39.6478 | 78.4626 | 6 | 12 | 17 | 30 | 45 |
| Ditch Run | 39.7050 | 78.1382 | 2 | 2 | 6 | 100 | 60 |
| Fifteenmile Creek | 39.6917 | 78.4523 | 16 | 14 | 15 | 40 | 75 |
| Fifteenmile Creek | 39.7107 | 78.4506 | 19 | 16 | 6 | 10 | 100 |
| Fifteenmile Creek | 39.6981 | 78.4503 | 17 | 18 | 18 | 10 | 99 |
| Fifteenmile Creek | 39.7172 | 78.4458 | 14 | 16 | 13 | 100 | 100 |
| Fifteenmile Creek | 39.6867 | 78.4557 | 0 | 10 | 15 | 100 | 90 |
| Flat Run | 39.6384 | 78.4116 | 6 | 19 | 17 | 0 | 40 |
| Flintstone Creek | 39.7081 | 78.5677 | 19 | 16 | 18 | 0 | 95 |
| Hamilton Run | 39.6673 | 77.7187 | 11 | 5 | 5 | 100 | 90 |
| Little Antietam Creek | 39.4638 | 77.6814 | 15 | 5 | 11 | 40 | 96 |
| Little Antietam Creek | 39.6866 | 77.5986 | 16 | 11 | 6 | 45 | 97 |
| Little Antietam Creek | 39.4501 | 77.6703 | 12 | 5 | 10 | 25 | 96 |
| Little Beaver Creek | 39.5525 | 77.6616 | 16 | 16 | 14 | 60 | 100 |
| Little Conococheague Creek | 39.6946 | 77.9424 | 14 | 15 | 16 | 30 | 95 |
| Little Tonoloway Creek | 39.7061 | 78.2409 | 11 | 12 | 6 | 25 | 80 |
| Long Hollow | 39.6371 | 78.2899 | 12 | 17 | 16 | 30 | 80 |
| Maple Run | 39.6192 | 78.5287 | 0 | 11 | 5 | 90 | 2 |
| Marsh Run | 39.6862 | 77.6807 | 20 | 2 | 16 | 100 | 100 |
| Marsh Run | 39.5313 | 77.7664 | 16 | 2 | 12 | 100 | 100 |
| Marsh Run | 39.7033 | 77.6779 | 15 | 1 | 7 | 30 | 100 |
| Meadow Brook | 39.6521 | 77.8634 | 16 | 11 | 15 | 100 | 85 |
| Meadow Brook | 39.6293 | 77.8451 | 16 | 16 | 10 | 100 | 97 |
| Murley Branch | 39.6647 | 78.6138 | 16 | 11 | 11 | 20 | 90 |
| Rabble Run | 39.7075 | 77.9869 | 20 | 20 | 20 | 10 | 100 |
| Rush Run | 39.6757 | 77.8196 | 16 | 5 | 11 | 50 | 90 |
| Sawpit Run | 39.5513 | 78.5753 | 11 | 20 | 19 | 100 | 100 |
| Sawpit Run | 39.5483 | 78.5638 | 15 | 18 | 16 | 100 | 100 |
| Sharmans Run | 39.4289 | 77.7295 | 14 | 11 | 8 | 50 | 90 |
| Terrapin Run | 39.6753 | 78.4331 | 7 | 16 | 16 | 40 | 40 |
| Terrapin Run | 39.6733 | 78.4334 | 7 | 16 | 15 | 100 | 45 |
| Toms Run | 39.6629 | 77.9347 | 15 | 11 | 16 | 60 | 95 |
| UT Ditch Run | 39.6998 | 78.1414 | 8 | 15 | 14 | 100 | 70 |
| UT Fifteenmile Creek | 39.7139 | 78.4786 | 3 | 18 | 15 | 100 | 15 |
| UT Fifteenmile Creek | 39.6957 | 78.4560 | 7 | 17 | 12 | 25 | 30 |
| UT Fifteenmile Creek | 39.6584 | 78.3974 | 13 | 19 | 19 | 100 | 90 |
| UT Fifteenmile Creek | 39.6623 | 78.4050 | 6 | 15 | 18 | 20 | 40 |
| UT Fifteenmile Creek | 39.6905 | 78.3904 | 6 | 17 | 13 | 40 | 40 |
| UT Little Antietam Creek | 39.4225 | 77.6741 | 10 | 5 | 6 | 75 | 85 |
| UT Little Antietam Creek | 39.6905 | 77.5678 | 15 | 16 | 18 | 30 | 100 |

**Appendix D:** Location and physical habitat data for MBSS sites in the Upper Potomac basin, 1995. See "Physical Habitat Conditions Measured By The MBSS" for details.

| Stream Name | Latitude | Longitude | Riffle Quality | Channel Alteration | Bank Stability | Percent Embeddedness | Channel Flow (%) |
|---|---|---|---|---|---|---|---|
| UT Little Antietam Creek | 39.6957 | 77.5671 | 16 | 4 | 17 | 50 | 100 |
| UT Little Beaver Creek | 39.5532 | 77.6320 | 10 | 16 | 15 | 50 | 50 |
| UT Little Conococheague Creek | 39.6900 | 77.9565 | 15 | 16 | 16 | 30 | 93 |
| UT Little Tonoloway Creek | 39.7178 | 78.2073 | 7 | 16 | 13 | 50 | 60 |
| UT Little Tonoloway Creek | 39.6980 | 78.2729 | 6 | 17 | 8 | 15 | 40 |
| UT Maple Run | 39.6158 | 78.5121 | 11 | 16 | 13 | 100 | 80 |
| UT Potomac River | 39.5815 | 78.4671 | 6 | 18 | 18 | 100 | 45 |
| UT Potomac River | 39.6009 | 78.4443 | 0 | 17 | 16 | 50 | 2 |
| UT Potomac River | 39.5702 | 77.8174 | 3 | 1 | 6 | 100 | 70 |
| UT Potomac River | 39.4345 | 77.7654 | 10 | 3 | 17 | 100 | 70 |
| UT Rockdale Run | 39.7124 | 77.9020 | 11 | 10 | 10 | 40 | 80 |
| UT Sideling Hill Creek | 39.7135 | 78.3238 | 10 | 18 | 16 | 10 | 50 |
| UT Sideling Hill Creek | 39.6925 | 78.3607 | 14 | 15 | 15 | 15 | 70 |
| UT Sideling Hill Creek | 39.7071 | 78.3367 | 10 | 12 | 17 | 15 | 75 |
| UT Sideling Hill Creek | 39.7072 | 78.3384 | 16 | 5 | 17 | 25 | 85 |
| UT St. James Run | 39.5514 | 77.7717 | 0 | 1 | 8 | 100 | 100 |
| UT Terrapin Run | 39.7039 | 78.4127 | 8 | 18 | 16 | 70 | 90 |
| UT Town Creek | 39.6663 | 78.5522 | 1 | 20 | 18 | 100 | 10 |
| UT White Sulphur Run | 39.6367 | 78.4968 | 6 | 19 | 17 | 20 | 35 |
| White Sulphur Run | 39.6606 | 78.4625 | 6 | 16 | 13 | 20 | 50 |

**Appendix D:** Location and physical habitat data for MBSS sites in the Upper Potomac basin, 1995. See "Physical Habitat Conditions Measured By The MBSS" for details.

| Stream Name | Latitude | Longitude | Percent Shading | Riparian Width (m) | Aesthetic Rating | Maximum Depth (cm) | Percent Gradient |
|---|---|---|---|---|---|---|---|
| Bear Creek | 39.7052 | 78.3170 | 80 | 50 | 17 | 36 | 0.8 |
| Bear Creek | 39.7024 | 78.3179 | 70 | 8 | 16 | 104 | 2.3 |
| Beaver Creek | 39.5753 | 77.6544 | 50 | 50 | 8 | 120 | 0.9 |
| Beaver Creek | 39.5880 | 77.6391 | 65 | 0 | 19 | 86 | 0.5 |
| Black Rock Creek | 39.5801 | 77.6285 | 13 | 0 | 16 | 50 | 0.5 |
| Deep Run | 39.6478 | 78.4626 | 90 | 50 | 15 | 56 | 2.0 |
| Ditch Run | 39.7050 | 78.1382 | 85 | 50 | 14 | 7 | 8.0 |
| Fifteenmile Creek | 39.6917 | 78.4523 | 30 | 50 | 17 | 65 | 1.0 |
| Fifteenmile Creek | 39.7107 | 78.4506 | 60 | 50 | 11 | 76 | 1.5 |
| Fifteenmile Creek | 39.6981 | 78.4503 | 90 | 50 | 16 | 70 | 1.5 |
| Fifteenmile Creek | 39.7172 | 78.4458 | 65 | 13 | 6 | 54 | 1.5 |
| Fifteenmile Creek | 39.6867 | 78.4557 | 30 | 0 | 15 | 83 | 1.0 |
| Flat Run | 39.6384 | 78.4116 | 95 | 50 | 19 | 32 | 2.3 |
| Flintstone Creek | 39.7081 | 78.5677 | 50 | 0 | 15 | 50 | 1.5 |
| Hamilton Run | 39.6673 | 77.7187 | 80 | 0 | 1 | 38 | 1.0 |
| Little Antietam Creek | 39.4638 | 77.6814 | 60 | 0 | 17 | 84 | 1.0 |
| Little Antietam Creek | 39.6866 | 77.5986 | 20 | 22 | 16 | 120 | 1.0 |
| Little Antietam Creek | 39.4501 | 77.6703 | 40 | 0 | 15 | 44 | 1.0 |
| Little Beaver Creek | 39.5525 | 77.6616 | 15 | 0 | 16 | 64 | 2.1 |
| Little Conococheague Creek | 39.6946 | 77.9424 | 87 | 50 | 15 | 54 | 2.0 |
| Little Tonoloway Creek | 39.7061 | 78.2409 | 90 | 0 | 11 | 28 | 0.9 |
| Long Hollow | 39.6371 | 78.2899 | 90 | 7 | 18 | 70 | 1.9 |
| Maple Run | 39.6192 | 78.5287 | 90 | 50 | 20 | 20 | 2.0 |
| Marsh Run | 39.6862 | 77.6807 | 60 | 50 | 8 | 81 | 0.8 |
| Marsh Run | 39.5313 | 77.7664 | 80 | 1 | 16 | 92 | 2.2 |
| Marsh Run | 39.7033 | 77.6779 | 98 | 7 | 13 | 38 | 0.5 |
| Meadow Brook | 39.6521 | 77.8634 | 97 | 0 | 11 | 66 | 1.0 |
| Meadow Brook | 39.6293 | 77.8451 | 20 | 0 | 11 | 46 | 0.9 |
| Murley Branch | 39.6647 | 78.6138 | 60 | 1 | 12 | 42 | 1.6 |
| Rabble Run | 39.7075 | 77.9869 | 90 | 50 | 20 | 86 | 6.0 |
| Rush Run | 39.6757 | 77.8196 | 80 | 0 | 14 | 54 | 0.8 |
| Sawpit Run | 39.5513 | 78.5753 | 55 | 50 | 15 | 40 | 0.5 |
| Sawpit Run | 39.5483 | 78.5638 | 25 | 28 | 19 | 70 | 1.0 |
| Sharmans Run | 39.4289 | 77.7295 | 90 | 13 | 15 | 44 | 2.0 |
| Terrapin Run | 39.6753 | 78.4331 | 93 | 50 | 19 | 38 | 3.0 |
| Terrapin Run | 39.6733 | 78.4334 | 97 | 50 | 19 | 36 | 3.5 |
| Toms Run | 39.6629 | 77.9347 | 60 | 0 | 8 | 54 | 2.0 |
| UT Ditch Run | 39.6998 | 78.1414 | 80 | 50 | 17 | 32 | 5.0 |
| UT Fifteenmile Creek | 39.7139 | 78.4786 | 50 | 0 | 20 | 8 | 2.0 |
| UT Fifteenmile Creek | 39.6957 | 78.4560 | 90 | 50 | 20 | 19 | 2.5 |
| UT Fifteenmile Creek | 39.6584 | 78.3974 | 95 | 0 | 18 | 58 | 8.3 |
| UT Fifteenmile Creek | 39.6623 | 78.4050 | 97 | 50 | 19 | 20 | 2.0 |
| UT Fifteenmile Creek | 39.6905 | 78.3904 | 96 | 50 | 19 | 14 | 4.2 |
| UT Little Antietam Creek | 39.4225 | 77.6741 | 95 | 0 | 11 | 16 | 1.3 |
| UT Little Antietam Creek | 39.6905 | 77.5678 | 70 | 0 | 18 | 28 | 1.3 |

**Appendix D:** Location and physical habitat data for MBSS sites in the Upper Potomac basin, 1995. See "Physical Habitat Conditions Measured By The MBSS" for details.

| Stream Name | Latitude | Longitude | Percent Shading | Riparian Width (m) | Aesthetic Rating | Maximum Depth (cm) | Percent Gradient |
|---|---|---|---|---|---|---|---|
| UT Little Antietam Creek | 39.6957 | 77.5671 | 10 | 0 | 18 | 52 | 1.0 |
| UT Little Beaver Creek | 39.5532 | 77.6320 | 95 | 50 | 15 | 62 | 2.7 |
| UT Little Conococheague Creek | 39.6900 | 77.9565 | 90 | 50 | 15 | 26 | 0.5 |
| UT Little Tonoloway Creek | 39.7178 | 78.2073 | 90 | 29 | 19 | 28 | 1.5 |
| UT Little Tonoloway Creek | 39.6980 | 78.2729 | 90 | 50 | 19 | 20 | 5.1 |
| UT Maple Run | 39.6158 | 78.5121 | 90 | 50 | 19 | 29 | 5.0 |
| UT Potomac River | 39.5815 | 78.4671 | 95 | 50 | 20 | 19 | 14.0 |
| UT Potomac River | 39.6009 | 78.4443 | 85 | 2 | 15 | 9 | 4.0 |
| UT Potomac River | 39.5702 | 77.8174 | 5 | 0 | 16 | 12 | 2.0 |
| UT Potomac River | 39.4345 | 77.7654 | 80 | 50 | 6 | 30 | 1.5 |
| UT Rockdale Run | 39.7124 | 77.9020 | 80 | 50 | 16 | 30 | 2.5 |
| UT Sideling Hill Creek | 39.7135 | 78.3238 | 75 | 50 | 19 | 16 | 4.4 |
| UT Sideling Hill Creek | 39.6925 | 78.3607 | 95 | 50 | 19 | 30 | 3.9 |
| UT Sideling Hill Creek | 39.7071 | 78.3367 | 65 | 0 | 9 | 60 | 2.0 |
| UT Sideling Hill Creek | 39.7072 | 78.3384 | 20 | 0 | 8 | 24 | 1.5 |
| UT St. James Run | 39.5514 | 77.7717 | 10 | 0 | 9 | 36 | 0.5 |
| UT Terrapin Run | 39.7039 | 78.4127 | 75 | 50 | 19 | 12 | 4.5 |
| UT Town Creek | 39.6663 | 78.5522 | 90 | 30 | 0 | 12 | 8.5 |
| UT White Sulphur Run | 39.6367 | 78.4968 | 95 | 50 | 19 | 20 | 1.8 |
| White Sulphur Run | 39.6606 | 78.4625 | 70 | 0 | 19 | 46 | 1.0 |

# ECOLOGY AND DISTRIBUTION OF FISH SPECIES COLLECTED IN THE UPPER POTOMAC BASIN

The species descriptions (Jenkins and Burkhead 1994, Rohde et al. 1994) and distribution maps which follow (Figure E5-E53) include those fish species collected during both random and non-random sampling in the Upper Potomac basin as part of the 1995 MBSS.

| *Common Name* | *Family* | *Tolerance* | *Feeding Group* | *Page* | *Interesting Facts* |
|---|---|---|---|---|---|
| American eel | Eel | Tolerant | Generalist | E-5 | Although most of their life is spent in fresh water streams (up to 20 years or more), adults become silver in color and journey to the Sargasso sea to spawn (catadromous). |
| Chain pickerel | Pike | Moderate | Top Predator | E-6 | This ambush predator feeds almost exclusively on other fish. |
| Blacknose dace | Minnow | Tolerant | Omnivore | E-7 | 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-8 | As the name implies, this species is characterized by an extremely blunt snout. |
| Central stoneroller | Minnow | Moderate | Algivore | E-9 | Because of its long intestine (up to 8 times its body length), this species is efficient at digesting detritus and algae. |
| Comely shiner | Minnow | Moderate | Invertivore | E-10 | This species is considered uncommon in Maryland. |
| Common shiner | Minnow | Moderate | Omnivore | E-11 | This species often becomes more abundant when cold water streams become stressed by high temperatures. |
| Common carp | Minnow | Tolerant | Omnivore | E-12 | This minnow is tolerant of many environmental conditions and can survive in highly degraded habitat. |
| 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. |
| Cutlips minnow | Minnow | Moderate | Invertivore | E-14 | This species is named for the presence of a bony lower jaw bordered on each side by a soft oval lobe. |
| Fallfish | Minnow | Moderate | Generalist | E-15 | The male fallfish may build a large nest of gravel over 3 feet high to protect its mates eggs. |

| Common Name | Family | Tolerance | Feeding Group | Page | Interesting Facts |
|---|---|---|---|---|---|
| Fathead minnow | Minnow | Tolerant | Omnivore | E-16 | As a result of bait-bucket introductions, this minnow is widely distributed throughout the eastern United States. |
| Golden shiner | Minnow | Tolerant | Omnivore | E-17 | This species is a favorite food of largemouth bass. It has been transported throughout the United States as a result of bucket introductions. |
| Goldfish | Minnow | Tolerant | Omnivore | E-18 | This well known Asian fish was the first exotic fish species introduced to North America. Unfortunately, many new introductions still occur from tropical fish hobbyists. |
| Longnose dace | Minnow | Moderate | Omnivore | E-19 | Its streamlined body shape and large fins allow this minnow to move around easily and remain stationary in fast currents. |
| Pearl dace | Minnow | Moderate | Invertivore | E-20 | During mating season the pearl dace produces sounds when courting. In Maryland, they are only found in in the Upper and Middle Potomac basins. |
| River chub | Minnow | Moderate | Omnivore | E-21 | During the breeding season, the male develops tubercles on its head and vigorously defends its nest from other males and egg-foraging predators. |
| Rosyface shiner | Minnow | Moderate | Invertivore | E-22 | This species is an opportunistic feeder and preys on a variety of drifting and attached organisms. |
| Rosyside dace | Minnow | Intolerant | Invertivore | E-23 | This minnow is considered to be sensitive to heavy siltation. |
| Spotfin shiner | Minnow | Moderate | Invertivore | E-24 | This species occurs in generally 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. |
| Spottail shiner | Minnow | Moderate | Omnivore | E-25 | This species is found in a wide range of habitats, including tidal freshwater areas where it can be highly abundant. |
| Creek chubsucker | Sucker | Moderate | Invertivore | E-26 | This species lacks a lateral line and therefore is easily distinguished from other suckers in Maryland. |
| Golden Redhorse | Sucker | Moderate | Omnivore | E-27 | The breeding behavior of males of this species is very aggressive. The males often engage in three fish shoving matches, where one male butts another sideways toward a third, who returns the hammering. |
| Northern hogsucker | Sucker | Intolerant | Invertivore | E-28 | 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. |

| Common Name | Family | Tolerance | Feeding Group | Page | Interesting Facts |
|---|---|---|---|---|---|
| White sucker | Sucker | Tolerant | Omnivore | E-29 | 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. |
| Channel catfish | Catfish | Moderate | Omnivore | E-30 | This is probably the most familiar and popular catfish in North America. In addition to its popularity with anglers, it a prized food fish that is widely raised in hatcheries. It is common in the Potomac River mainstem. |
| Margined madtom | Catfish | Moderate | Invertivore | E-31 | This highly nocturnal species requires hiding places to thrive. The spines of margined madtoms are venomous and can cause considerable pain if handled incorrectly. |
| Yellow bullhead | Catfish | Tolerant | Omnivore | E-32 | 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-33 | 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-34 | This European species was widely introduced prior to 1900 and has contributed to the widespread decline of brook trout in the eastern United States. Because of its wariness, this trout presents a great challenge to fishermen. |
| Cutthroat trout | Trout | Moderate | Top Predator | E-35 | This native of the United States was recently introduced to Maryland for sportfishing. |
| Rainbow trout | Trout | Moderate | Top Predator | E-36 | Although ranked among the top five sought after gamefish in North America, hatchery-reared fish are not considered desirable by many fishing purists. |
| Banded killifish | Killifish | Moderate | Invertivore | E-37 | As a result of its hardy nature and general abundance this species is often used as live bait. |
| Checkered sculpin | Sculpin | Moderate | Insectivore | E-38 | Unique to the Potomac River basin, this fish was recently recognized as a distinct species from the slimy sculpin. |
| Mottled sculpin | Sculpin | Moderate | Insectivore | E-39 | This species is primarily an insectivore and does the majority of its feeding nocturnally. |
| Potomac sculpin | Sculpin | Moderate | Insectivore | E-40 | This sculpin is found only in the Potomac River basin. |
| Black crappie | Sunfish | Moderate | Generalist | E-41 | Found in swamps, ponds, lakes, and slack water of low to moderate-gradient streams and rivers, this species prefers aquatic vegetation, fallen trees, stumps, and other structure. |

| Common Name | Family | Tolerance | Feeding Group | Page | Interesting Facts |
|---|---|---|---|---|---|
| Bluegill | Sunfish | Tolerant | Invertivore | E-42 | 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-43 | This species is intolerant of low pH, but tolerant of many other types of stress. |
| Largemouth bass | Sunfish | Moderate | Top Predator | E-44 | This species is considered the most popular gamefish in the United States and has been known to reach weights of over 20 pounds. |
| Longear sunfish | Sunfish | Moderate | Invertivore | E-45 | This introduced species common in the mainstem of the Potomac River. It gets its name from its large earflap which is black with a pale margin. |
| Pumpkinseed | Sunfish | Moderate | Invertivore | E-46 | This sunfish is tolerant of darkly-stained acidic waters and is a regular visitor to brackish waters. |
| Redbreast sunfish | Sunfish | Moderate | Generalist | E-47 | Often found with smallmouth bass and other “cool water” species, this sunfish has been collected in water warmer than 100° F. |
| Rock bass | Sunfish | Moderate | Generalist | E-48 | 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-49 | One reason for this species’ popularity as a gamefish is its aggressive nature and frequent aerial acrobatics when hooked on light tackle. |
| Fantail darter | Perch | Moderate | Insectivore | E-50 | Aided by its small, cone shaped mouth, this insect eater commonly forages in crevices and under rocks. |
| Greenside darter | Perch | Moderate | Insectivore | E-51 | Of the genus *Etheostoma*, the greenside darter is the largest species |
| Rainbow darter | Perch | Moderate | Insectivore | E-52 | This species is named for its bright red, blue, and green coloration during spawning season. |
| Tessellated darter | Perch | Moderate | Invertivore | E-53 | The male tessellated darter has a curious behavior of frequently caring for nests containing eggs that it did not fertilize. |

● **Species PRESENT at site**

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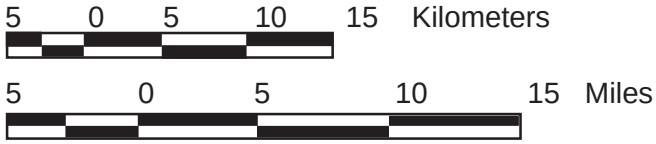


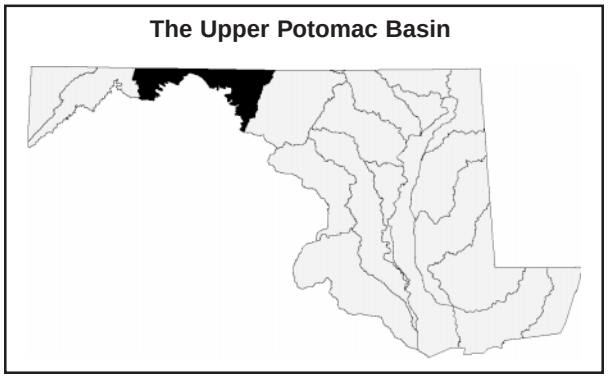


Distribution American eel in the Upper Potomac basin, 1995.

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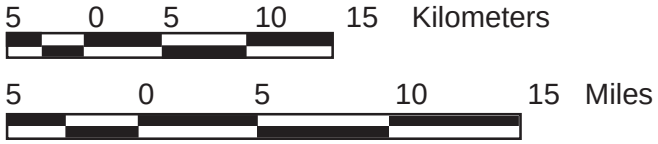
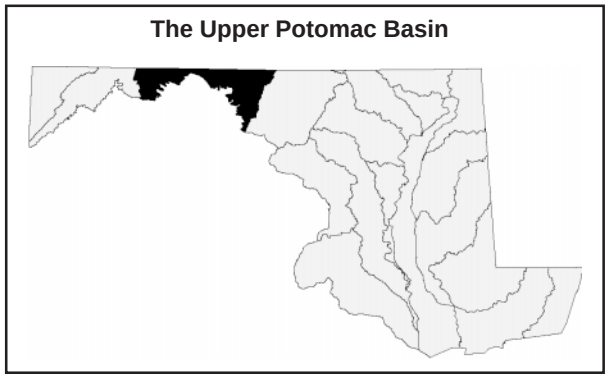
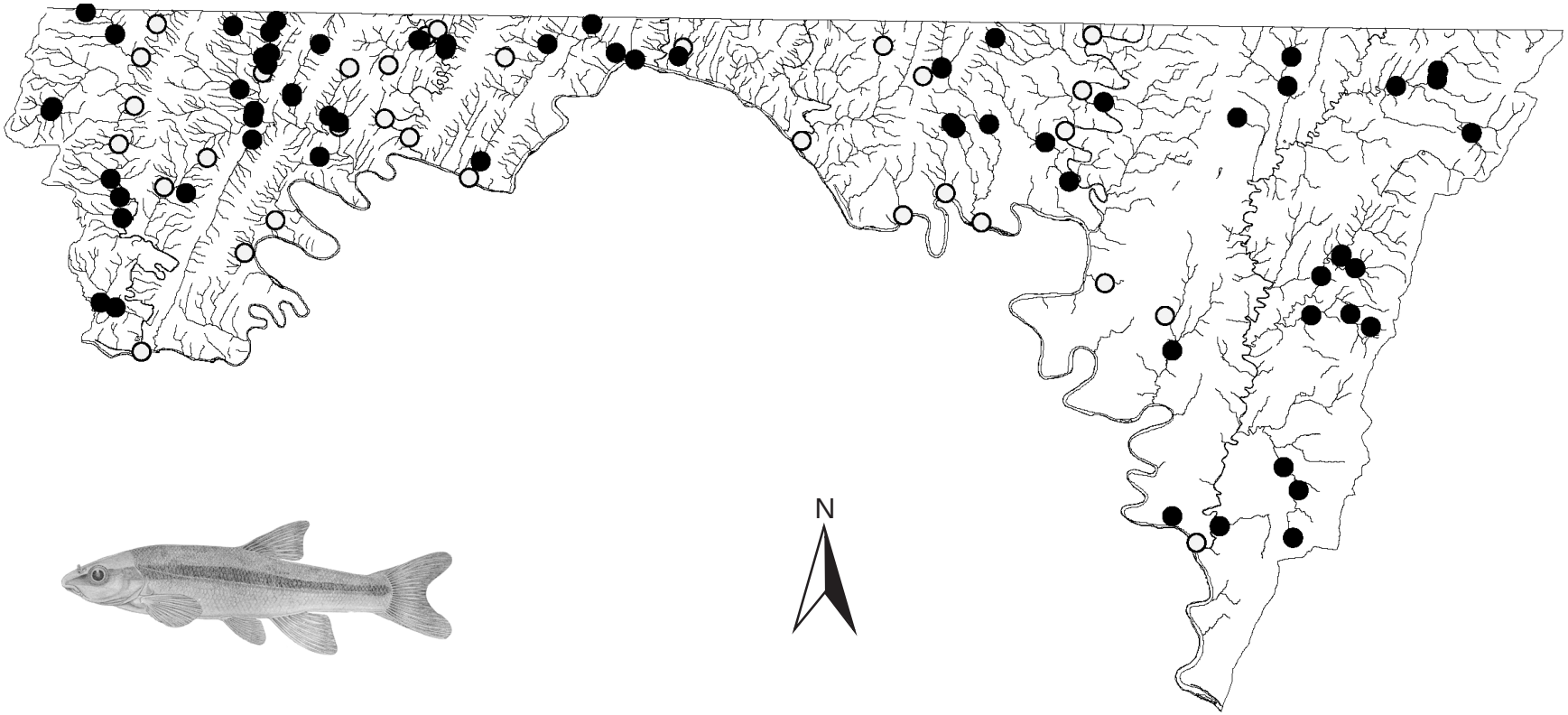



Distribution chain pickerel in the Upper Potomac basin, 1995.



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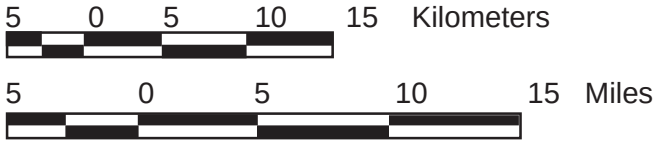


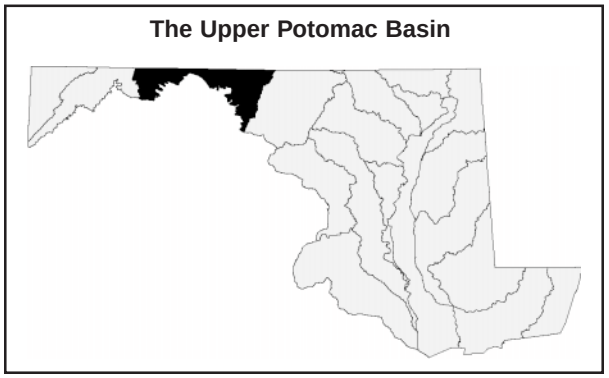


Distribution blacknose dace in the Upper Potomac basin, 1995.

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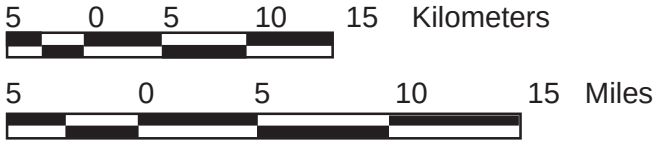


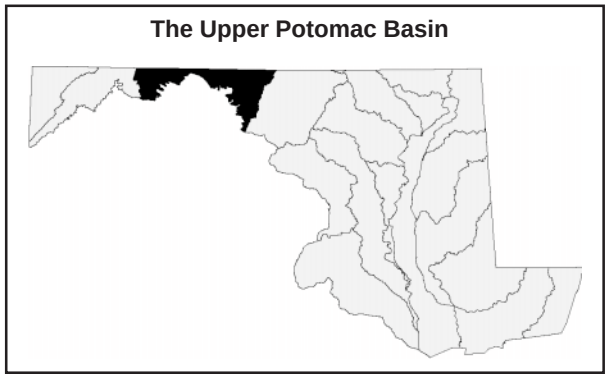


Distribution bluntnose minnow in the Upper Potomac basin, 1995.

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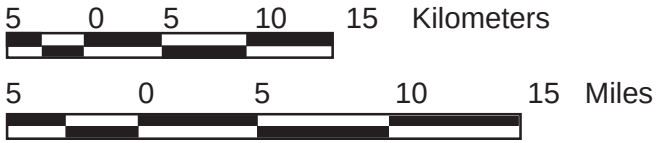


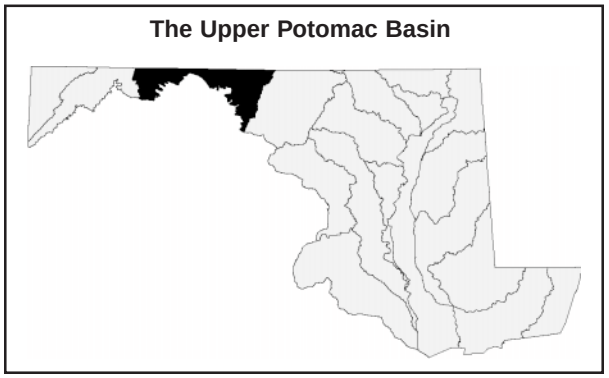


Distribution central stoneroller in the Upper Potomac basin, 1995.

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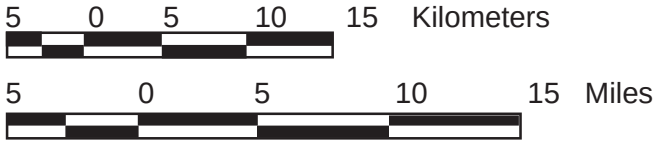
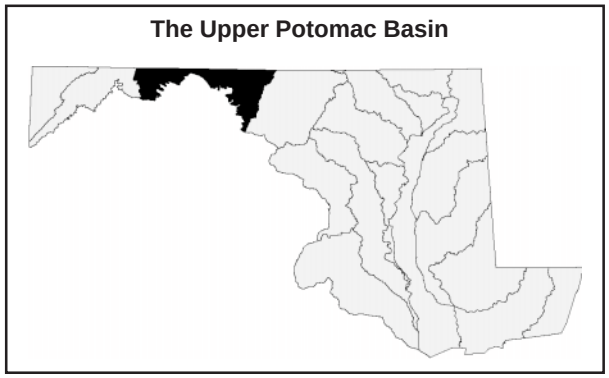
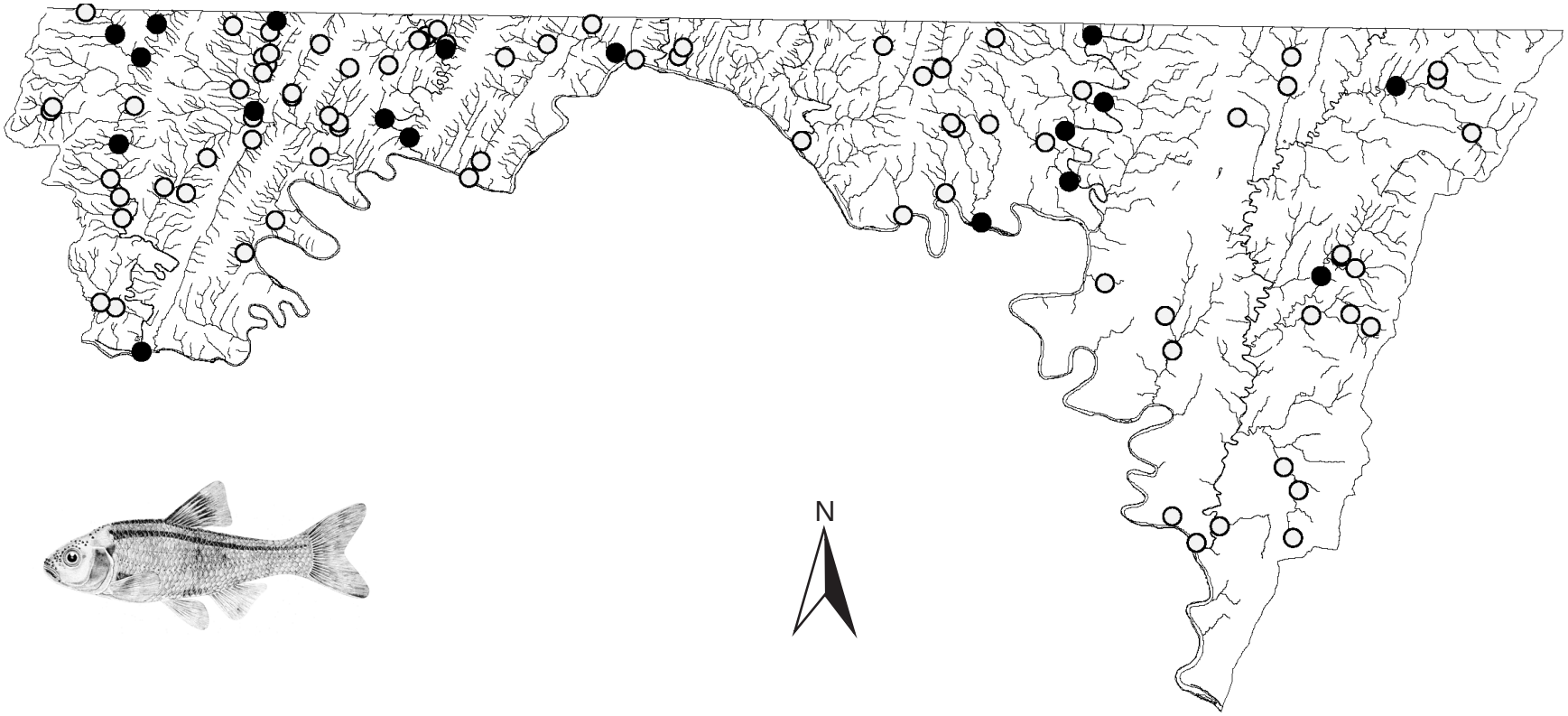



Distribution comely shiner in the Upper Potomac basin, 1995.



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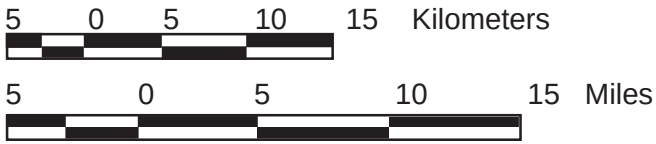
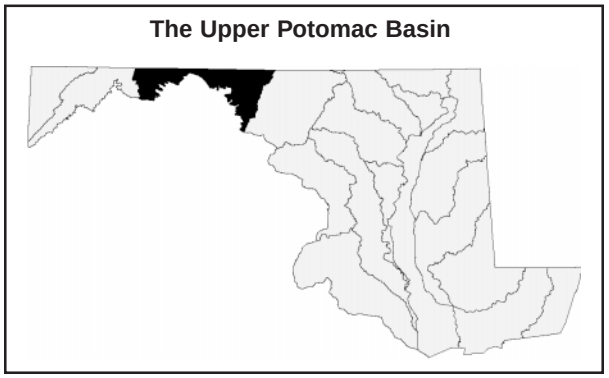
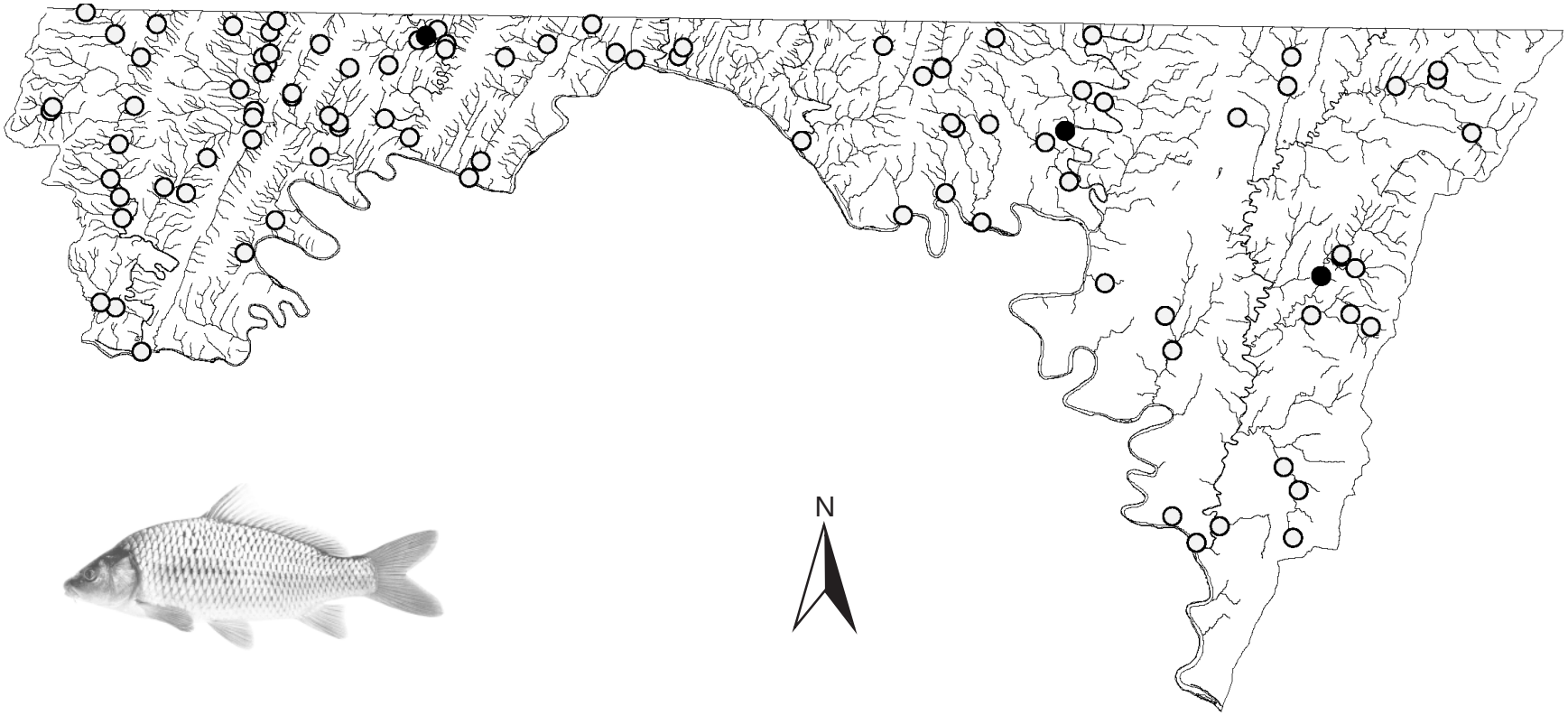



Distribution common shiner in the Upper Potomac basin, 1995.



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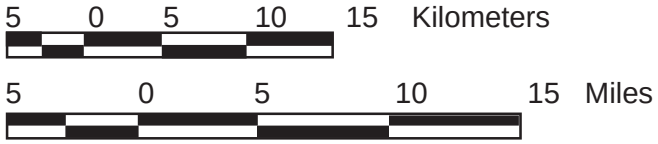
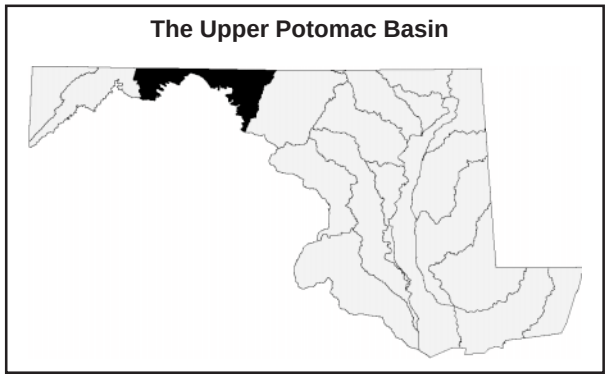
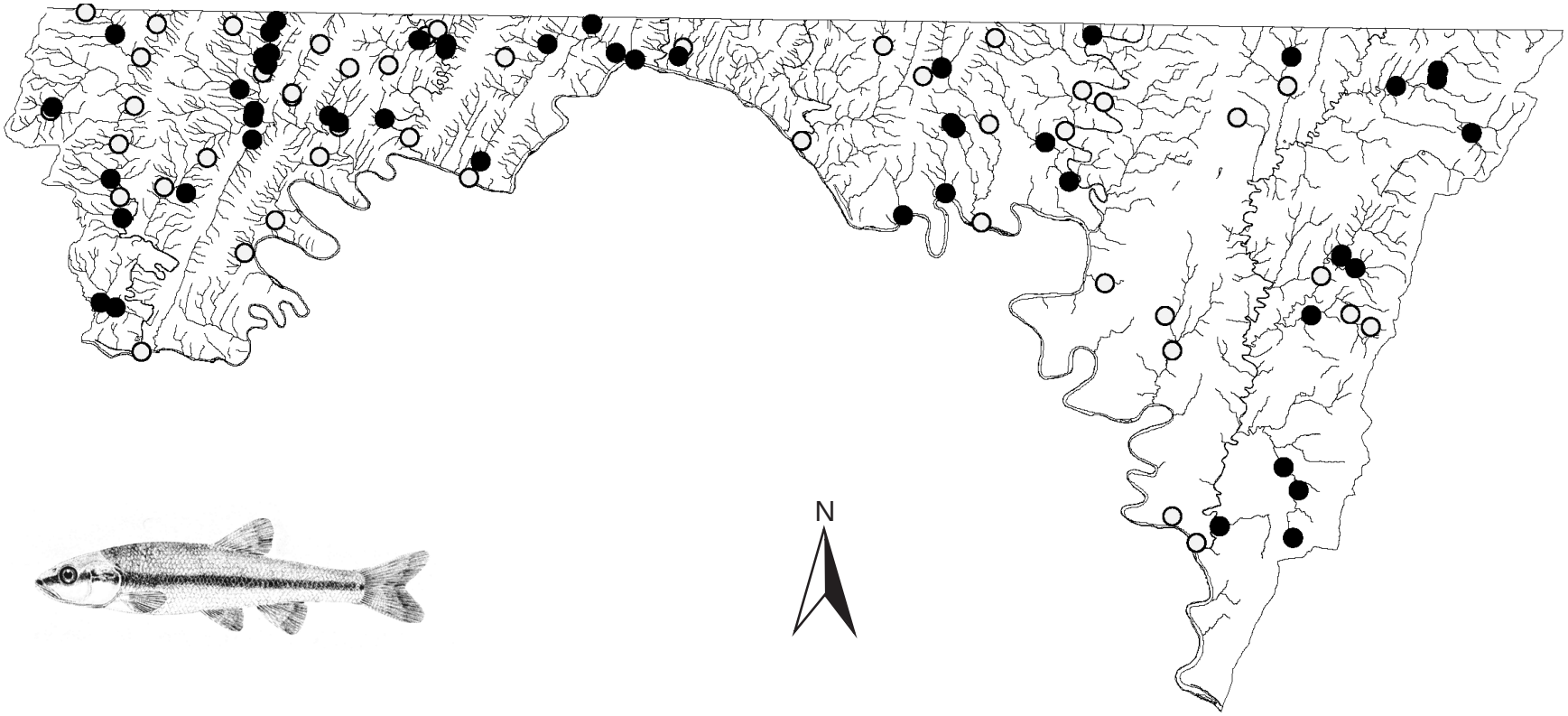



Distribution common carp in the Upper Potomac basin, 1995.



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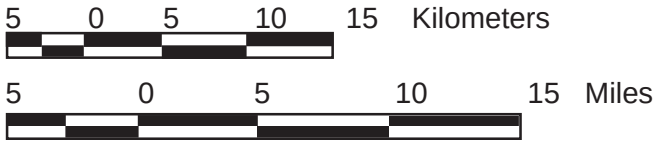


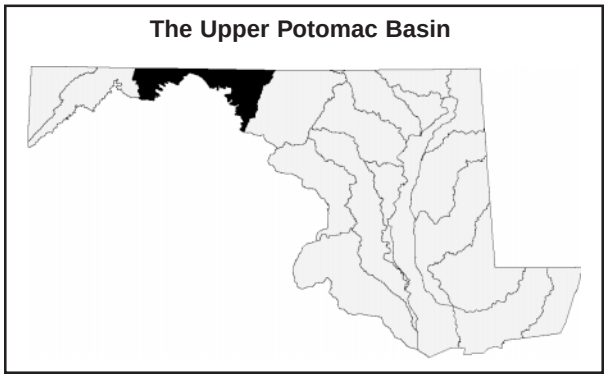


Distribution creek chub in the Upper Potomac basin, 1995.

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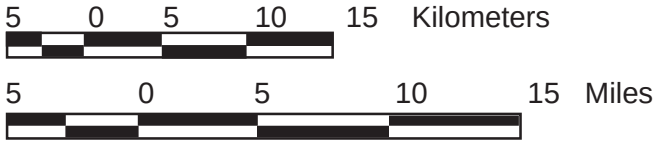


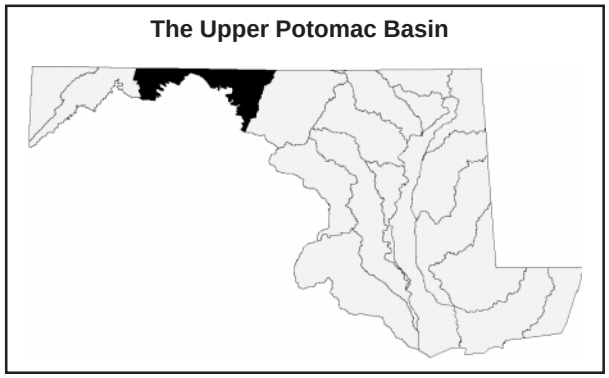


Distribution cutlips minnow in the Upper Potomac basin, 1995.

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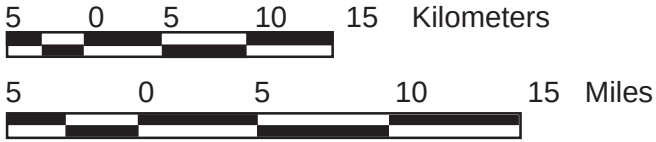


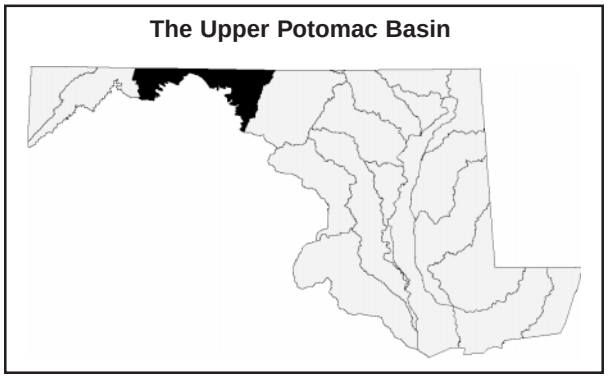


Distribution fallfish in the Upper Potomac basin, 1995.

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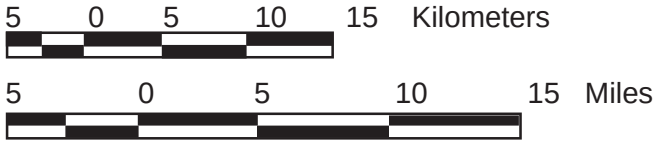
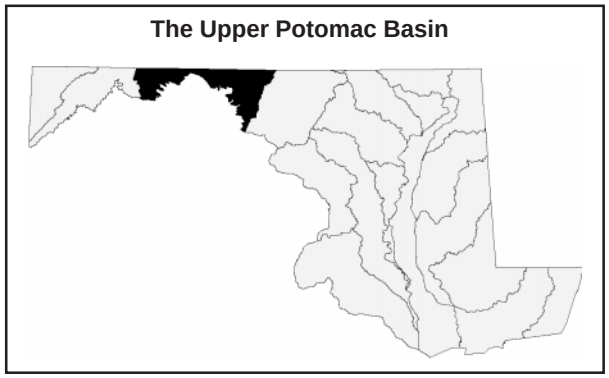
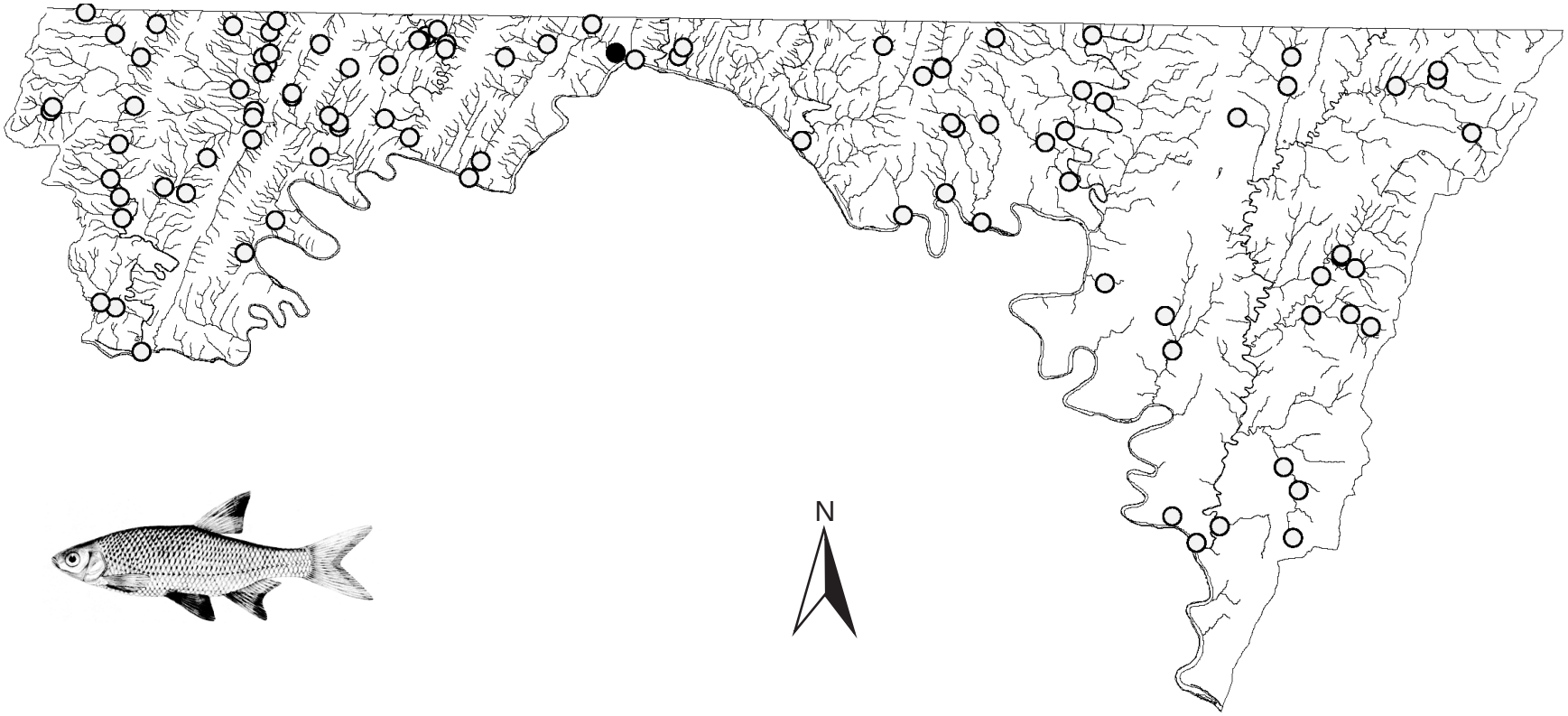



Distribution fathead minnow in the Upper Potomac basin, 1995.



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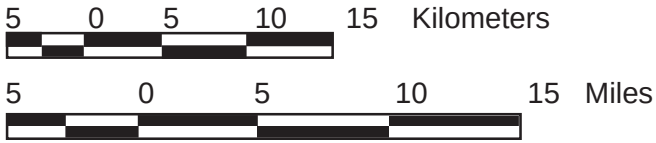


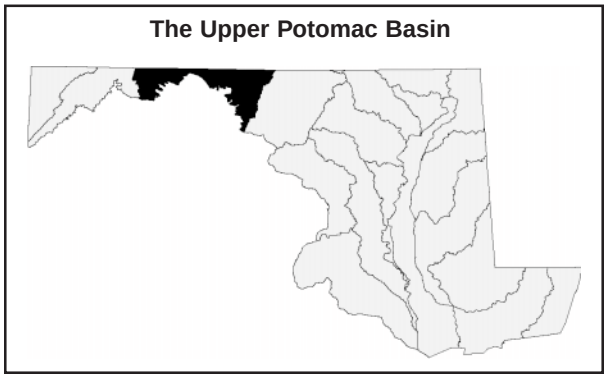


Distribution golden shiner in the Upper Potomac basin, 1995.

● **Species PRESENT at site**

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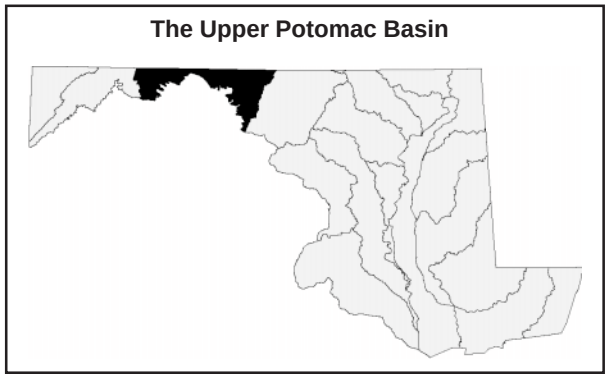


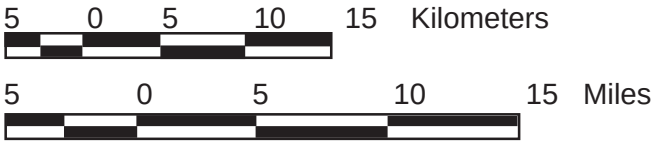


Distribution goldfish in the Upper Potomac basin, 1995.

● **Species PRESENT at site**

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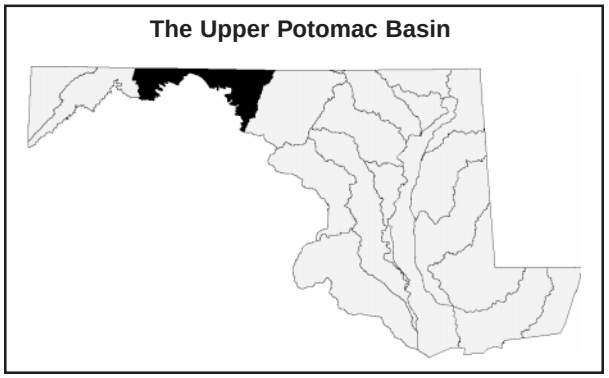


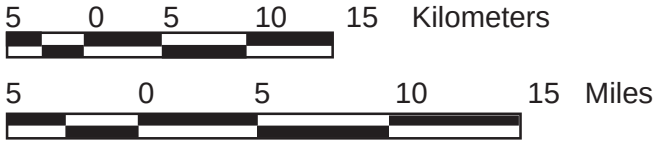

5 0 5 10 15 Kilometers

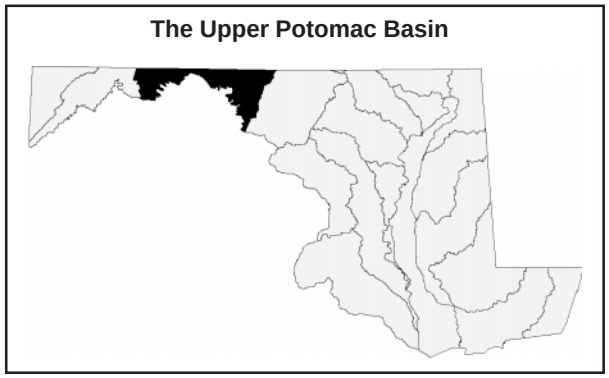
5 0 5 10 15 Miles

Distribution longnose dace in the Upper Potomac basin, 1995.

● **Species PRESENT at site**

○ **Species ABSENT at site**

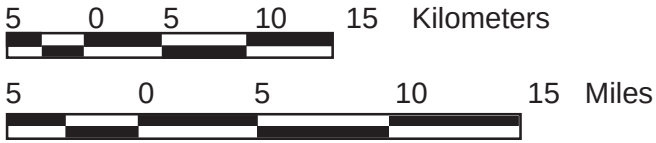


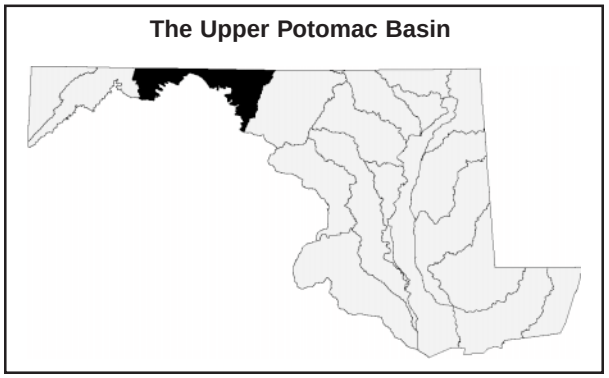




Distribution pearl dace in the Upper Potomac basin, 1995.

● **Species PRESENT at site**

○ **Species ABSENT at site**




Distribution river chub in the Upper Potomac basin, 1995.

● **Species PRESENT at site**

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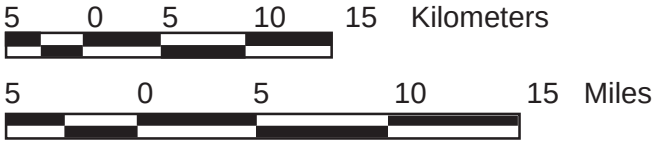
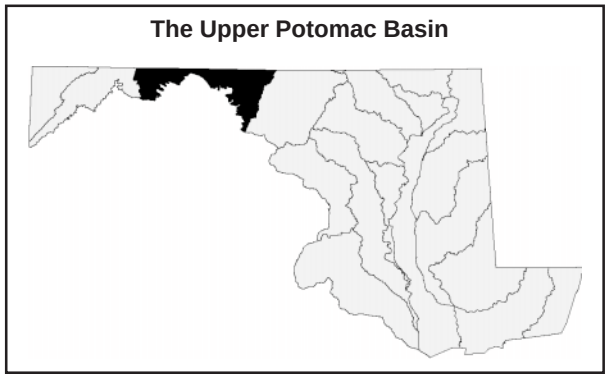
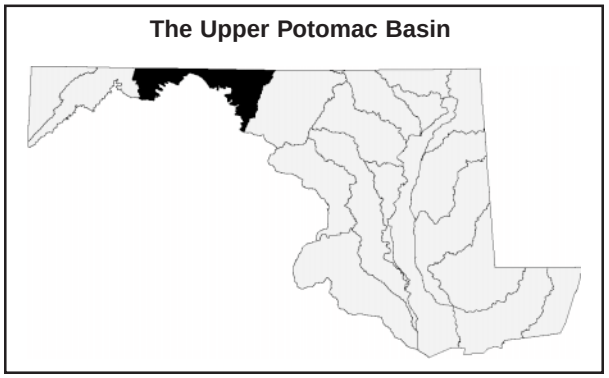



Distribution rosyface shiner in the Upper Potomac basin, 1995.

● **Species PRESENT at site**

○ **Species ABSENT at site**



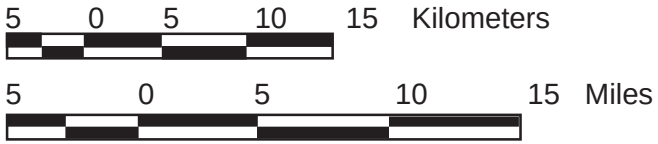

5 0 5 10 15 Kilometers

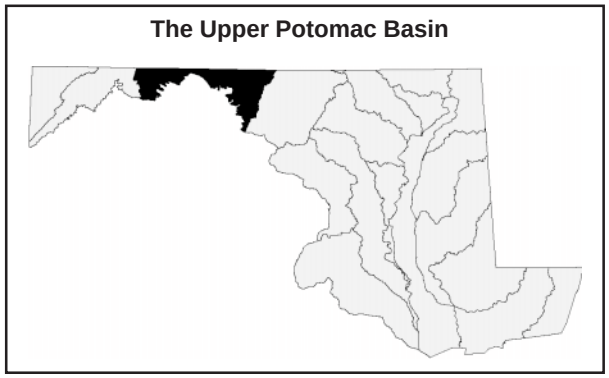
5 0 5 10 15 Miles

Distribution rosyside dace in the Upper Potomac basin, 1995.

● **Species PRESENT at site**

○ **Species ABSENT at site**

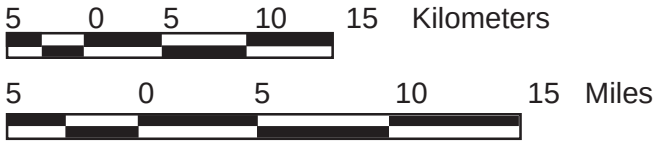


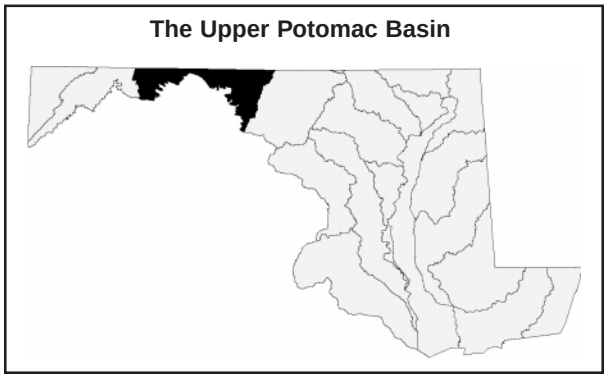




Distribution spotfin shiner in the Upper Potomac basin, 1995.

● **Species PRESENT at site**

○ **Species ABSENT at site**

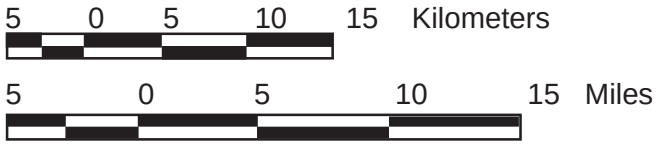


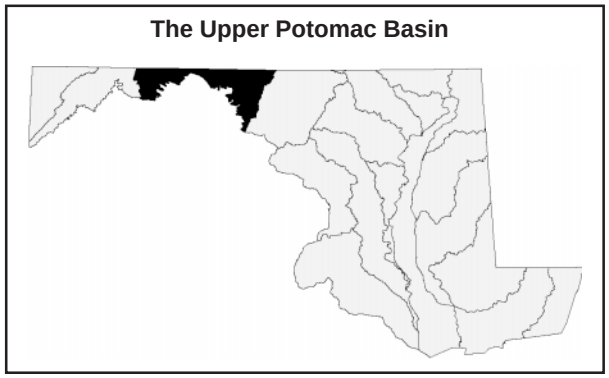




Distribution spottail shiner in the Upper Potomac basin, 1995.

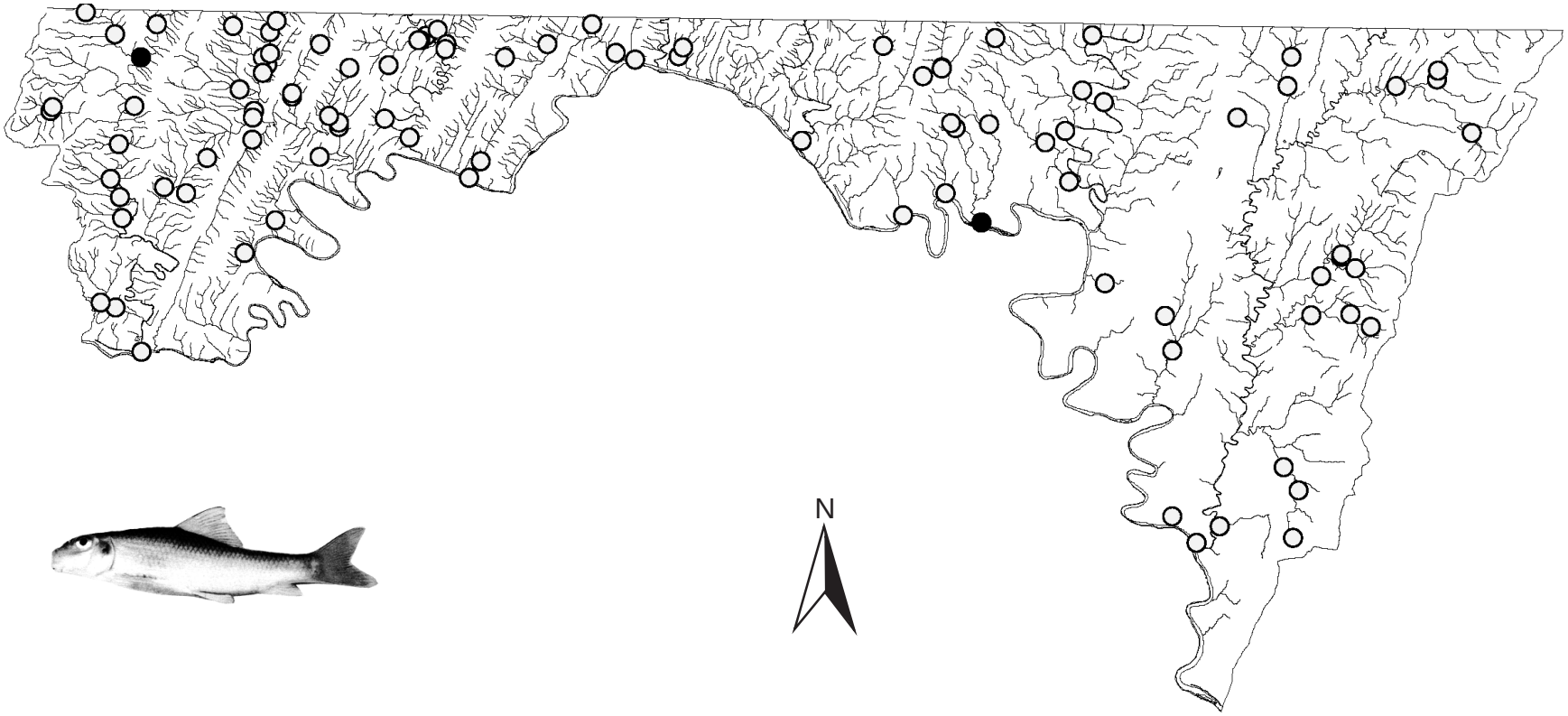
● **Species PRESENT at site**

○ **Species ABSENT at site**



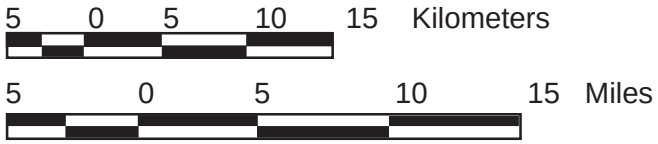

Distribution creek chubsucker in the Upper Potomac basin, 1995.

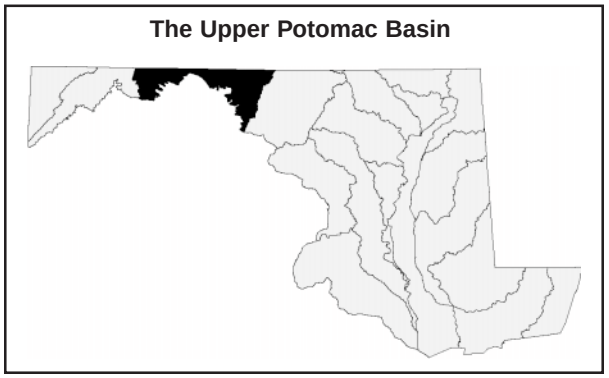





● **Species PRESENT at site**

○ **Species ABSENT at site**

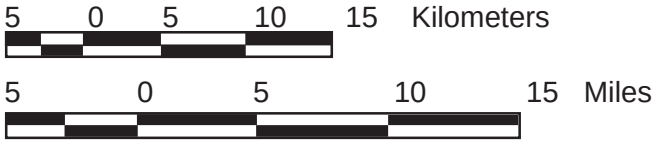


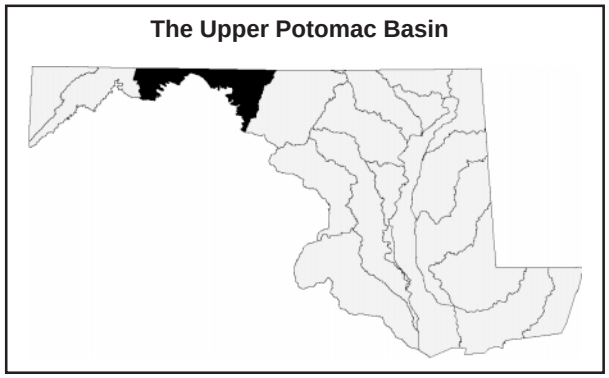




Distribution golden redhorse in the Upper Potomac basin, 1995.

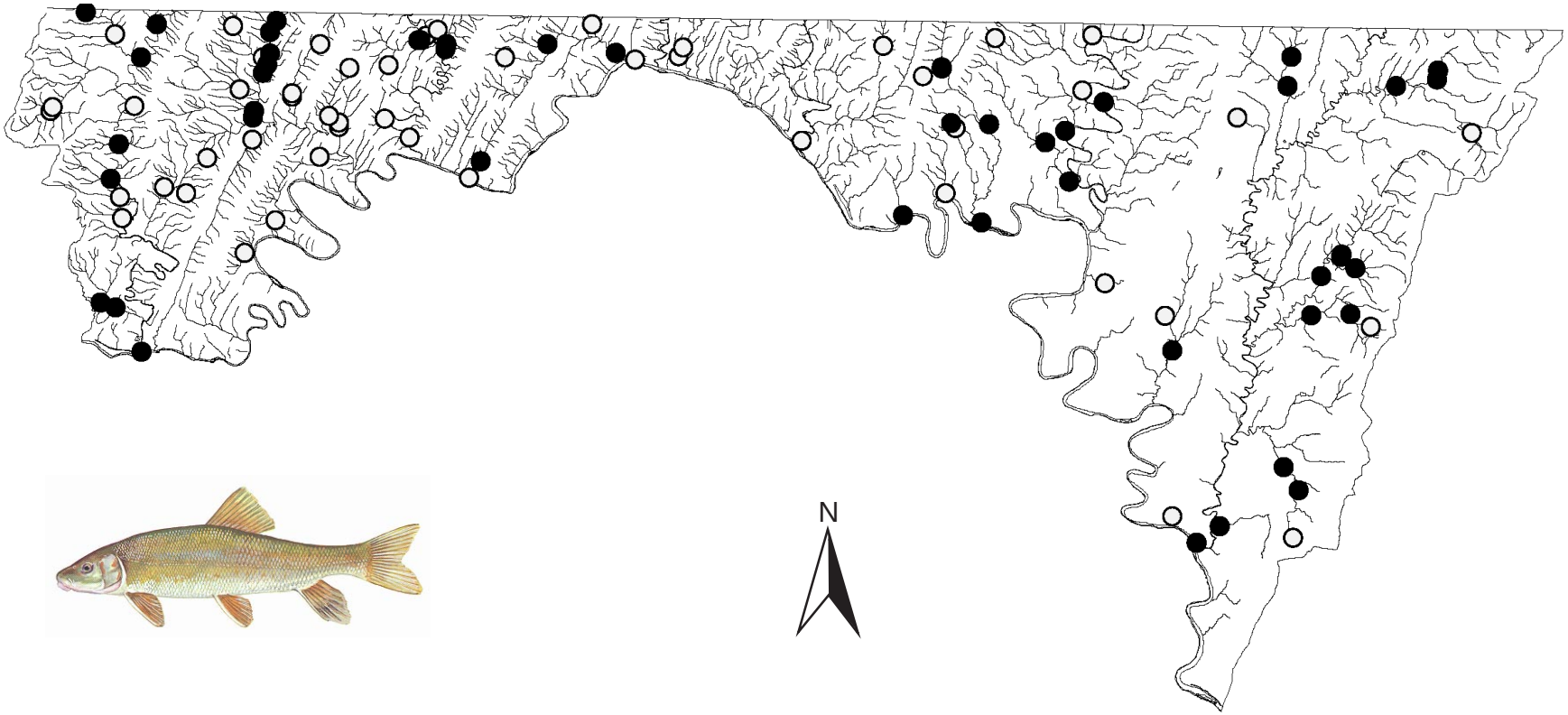
● **Species PRESENT at site**

○ **Species ABSENT at site**



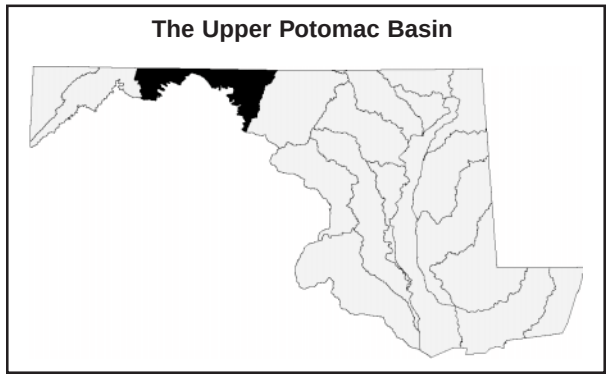

Distribution Northern hogsucker in the Upper Potomac basin, 1995.






● **Species PRESENT at site**

○ **Species ABSENT at site**



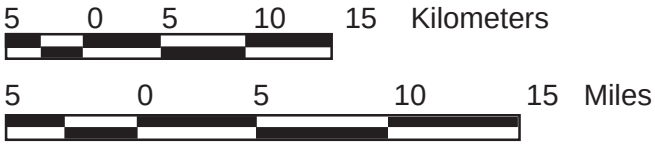

5 0 5 10 15 Kilometers

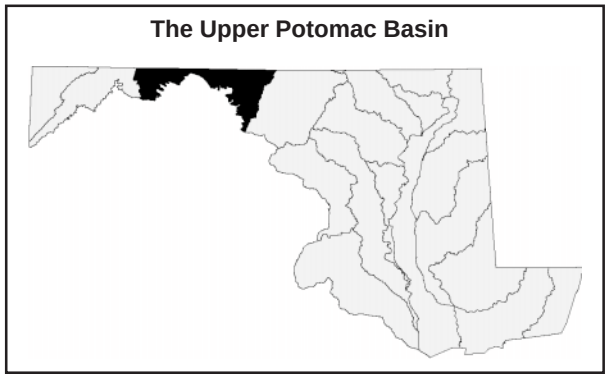
5 0 5 10 15 Miles

Distribution white sucker in the Upper Potomac basin, 1995.

● **Species PRESENT at site**

○ **Species ABSENT at site**

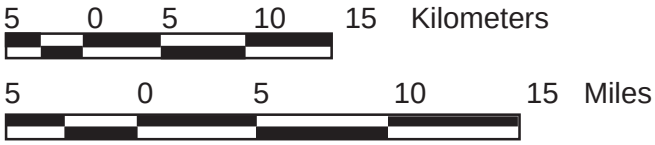


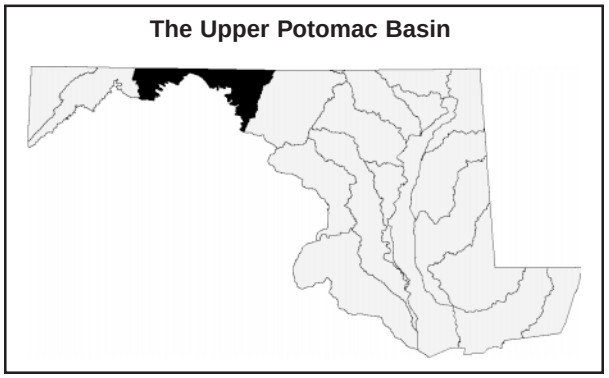




Distribution channel catfish in the Upper Potomac basin, 1995.

● **Species PRESENT at site**

○ **Species ABSENT at site**

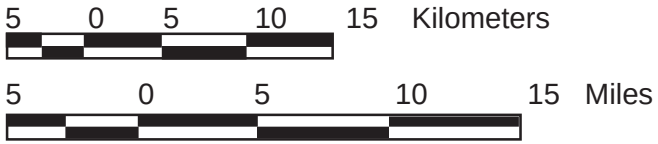


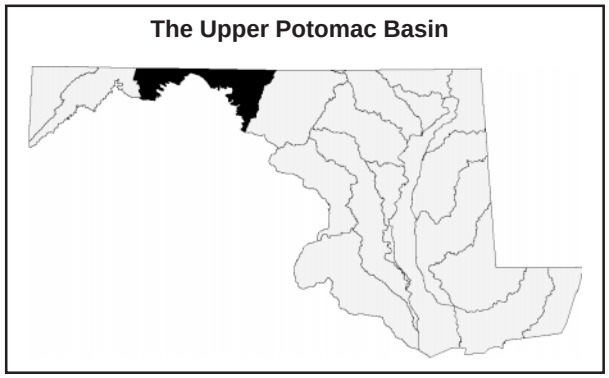




Distribution margined madtom in the Upper Potomac basin, 1995.

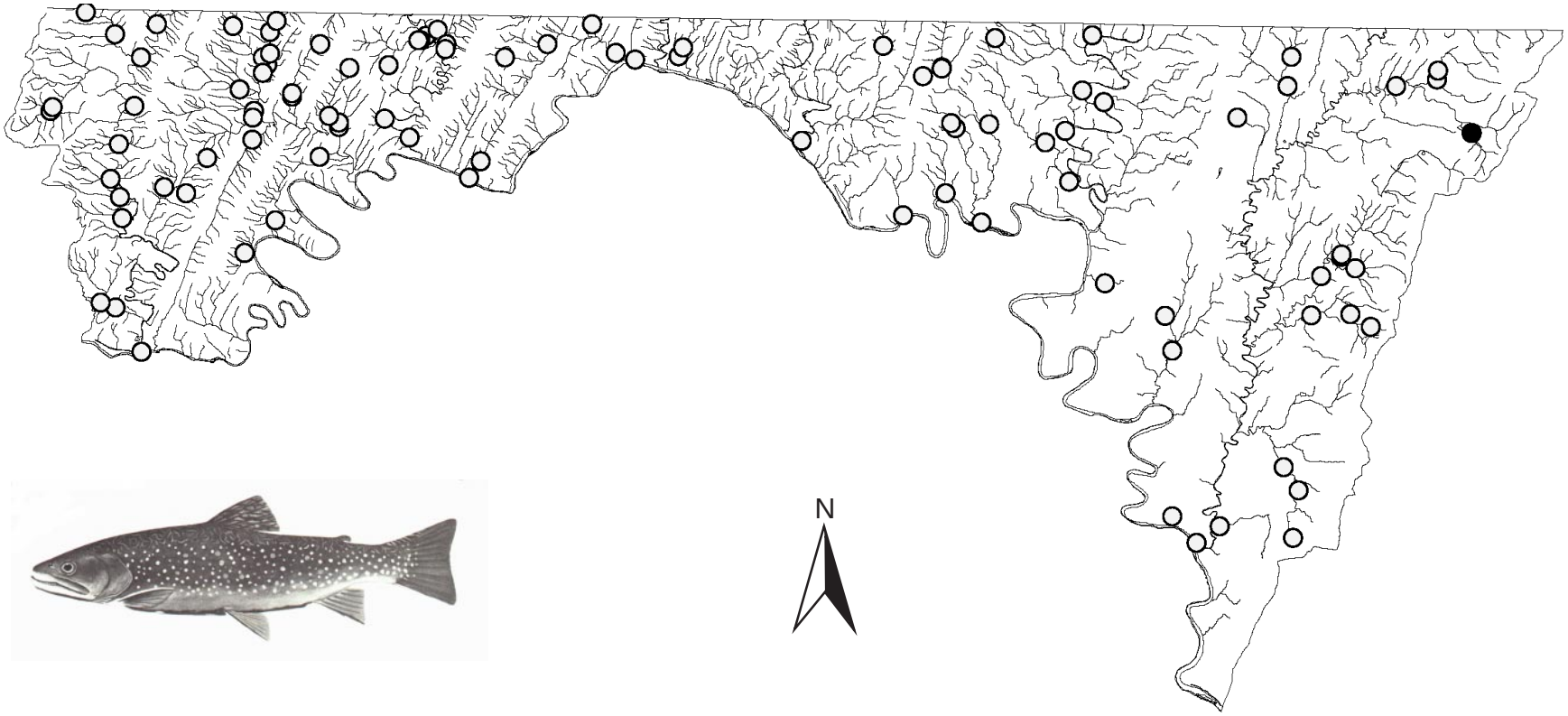
● **Species PRESENT at site**

○ **Species ABSENT at site**



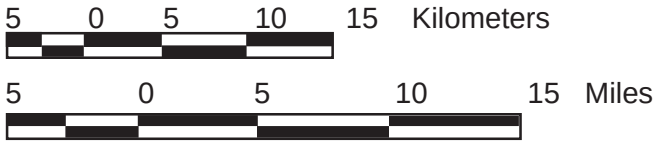

Distribution yellow bullhead in the Upper Potomac basin, 1995.

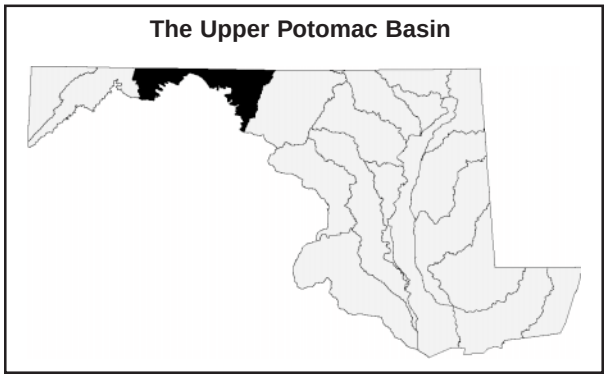





● **Species PRESENT at site**

○ **Species ABSENT at site**

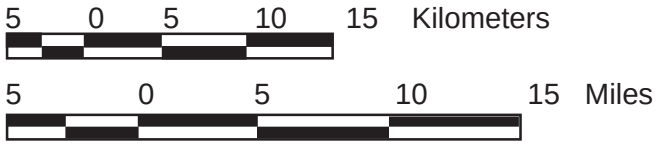


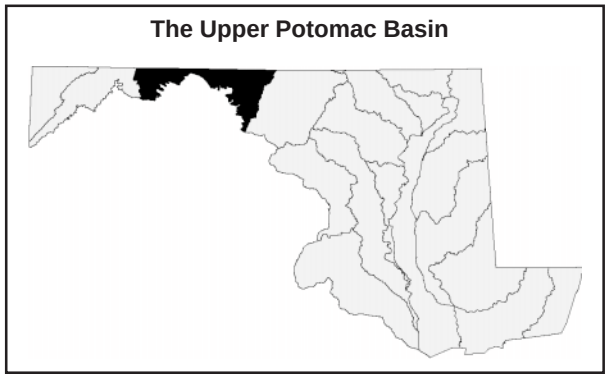




Distribution brook trout in the Upper Potomac basin, 1995.

● **Species PRESENT at site**

○ **Species ABSENT at site**

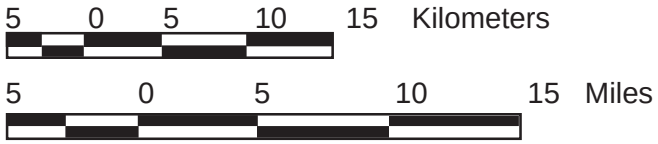


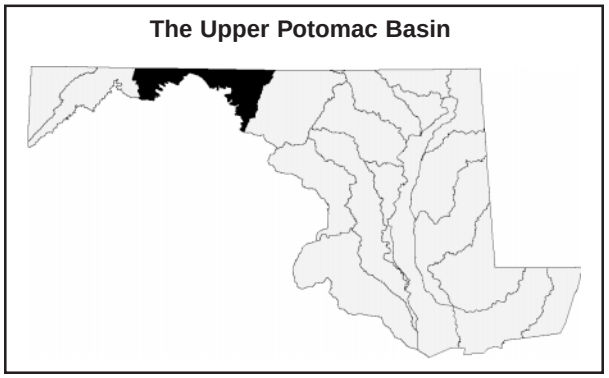




Distribution brown trout in the Upper Potomac basin, 1995.

● **Species PRESENT at site**

○ **Species ABSENT at site**

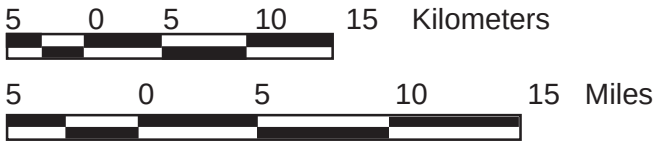


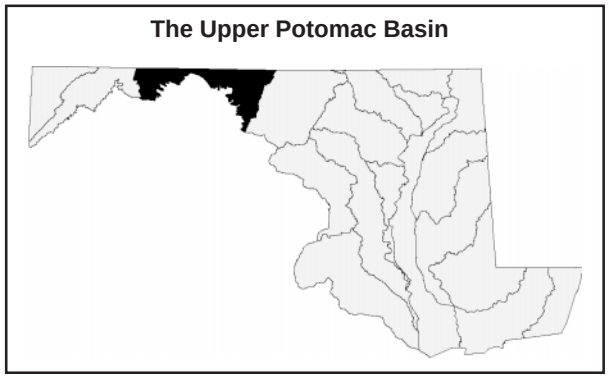




Distribution cutthroat trout in the Upper Potomac basin, 1995.

● **Species PRESENT at site**

○ **Species ABSENT at site**

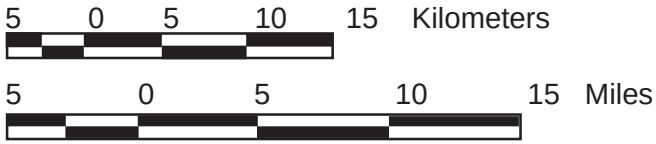


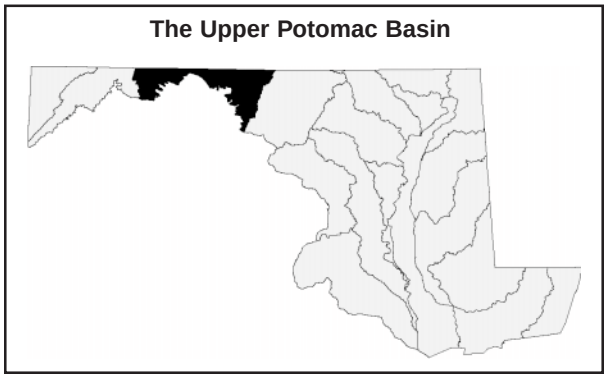




Distribution rainbow trout in the Upper Potomac basin, 1995.

● **Species PRESENT at site**

○ **Species ABSENT at site**

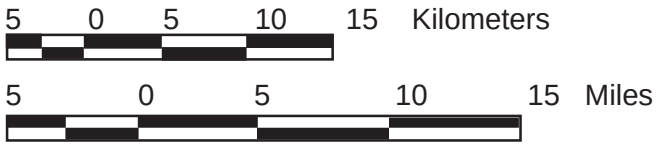


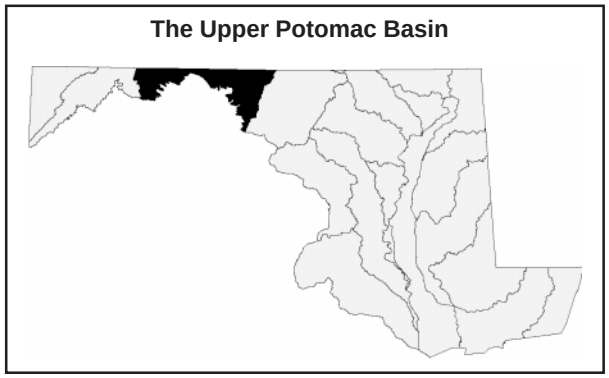




Distribution banded killifish in the Upper Potomac basin, 1995.

● **Species PRESENT at site**

○ **Species ABSENT at site**

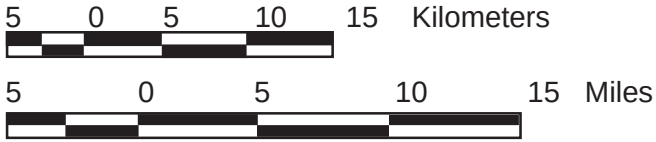


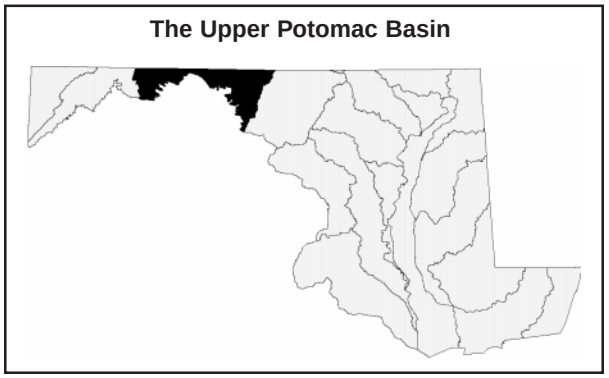




Distribution checkered sculpin in the Upper Potomac basin, 1995.

● **Species PRESENT at site**

○ **Species ABSENT at site**

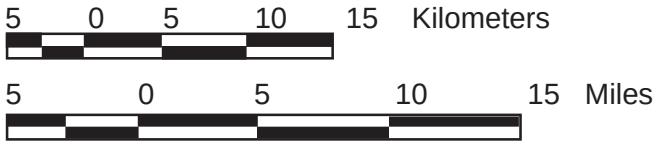


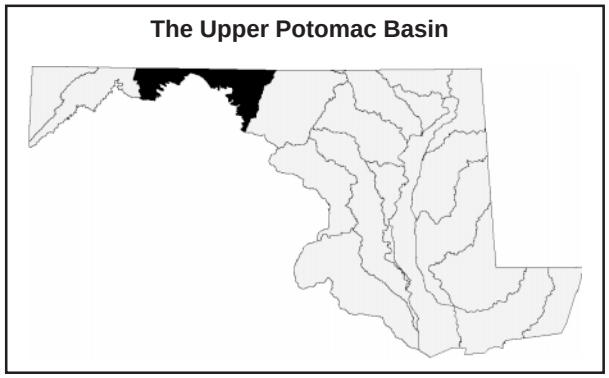




Distribution mottled sculpin in the Upper Potomac basin, 1995.

● **Species PRESENT at site**

○ **Species ABSENT at site**

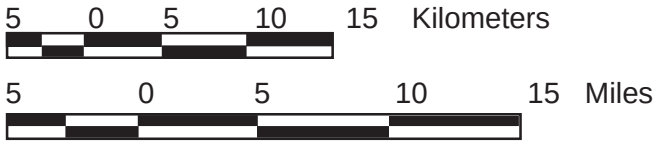


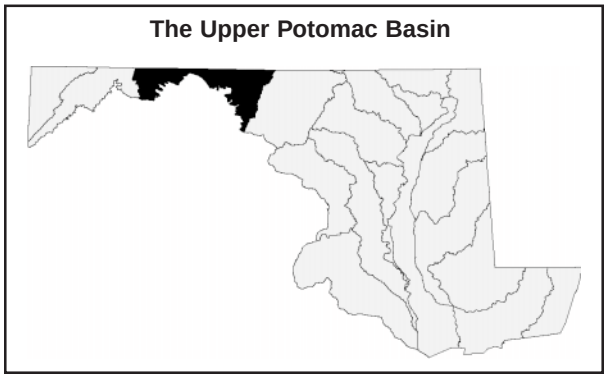




Distribution Potomac sculpin in the Upper Potomac basin, 1995.

● **Species PRESENT at site**

○ **Species ABSENT at site**

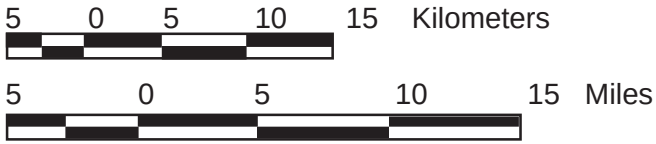


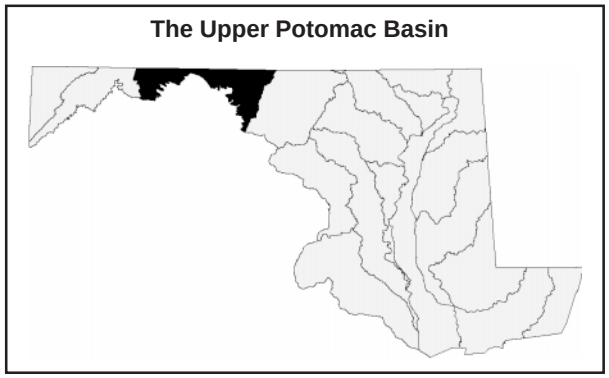




Distribution black crappie in the Upper Potomac basin, 1995.

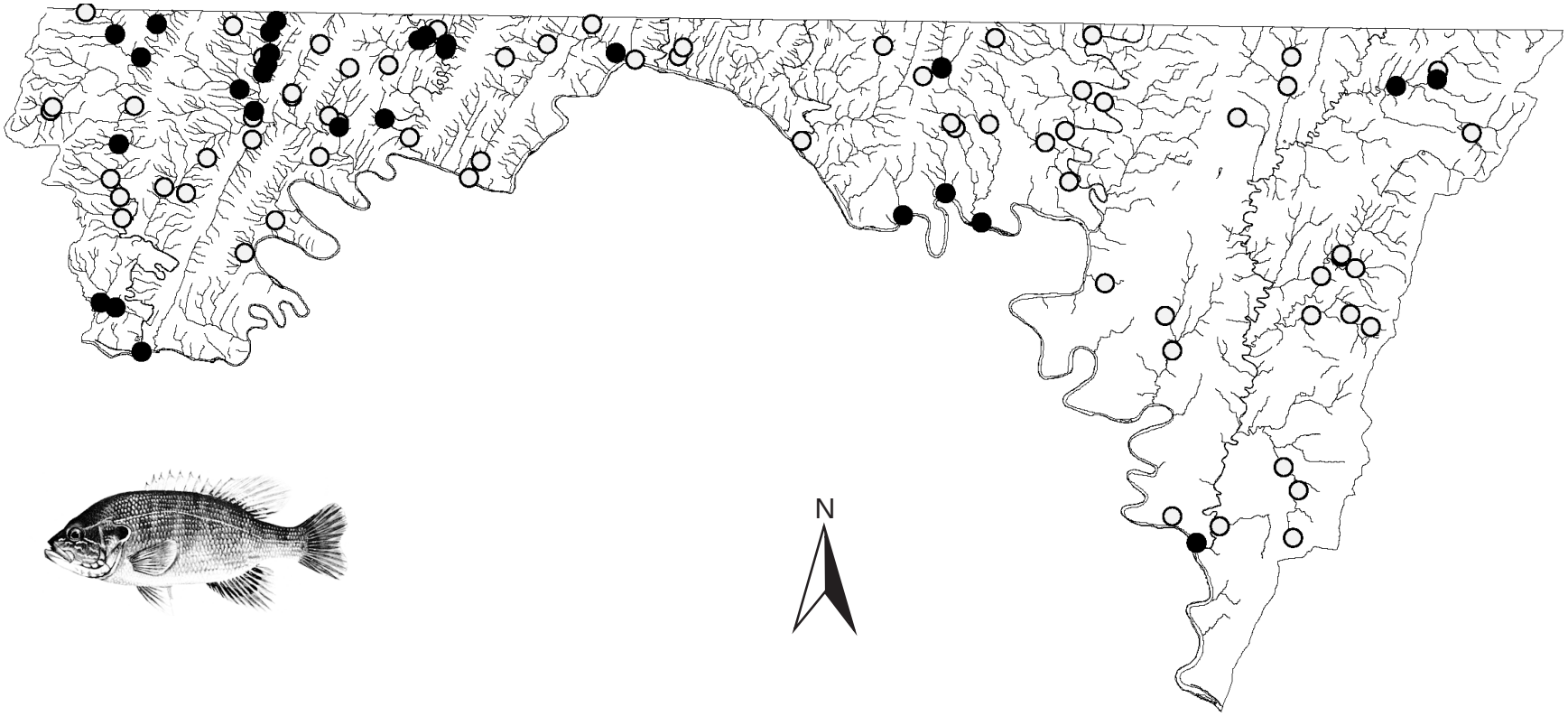
● **Species PRESENT at site**

○ **Species ABSENT at site**



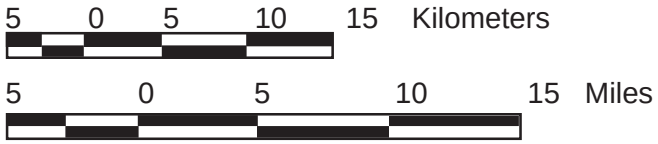

Distribution bluegill in the Upper Potomac basin, 1995.

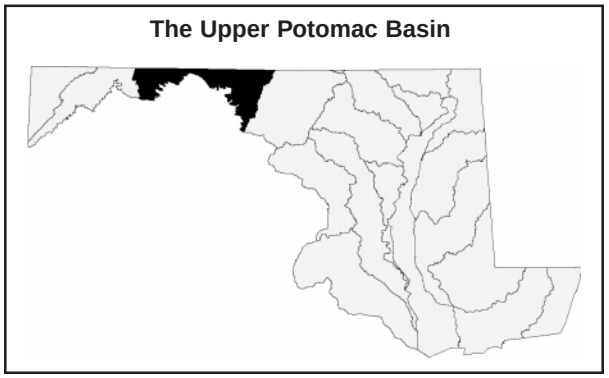





● **Species PRESENT at site**

○ **Species ABSENT at site**

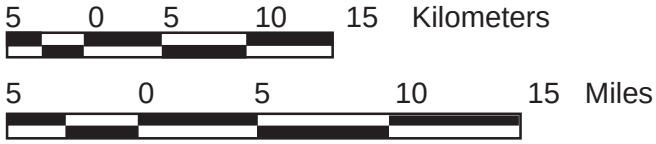


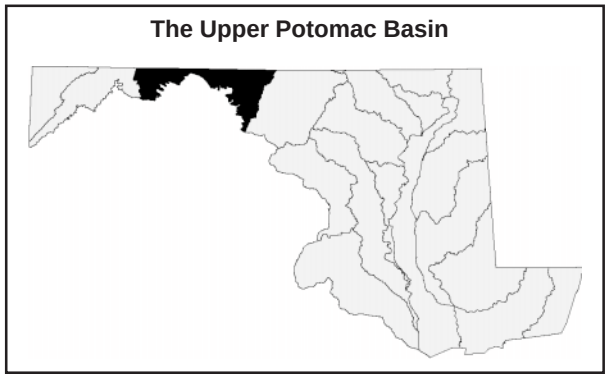




Distribution green sunfish in the Upper Potomac basin, 1995.

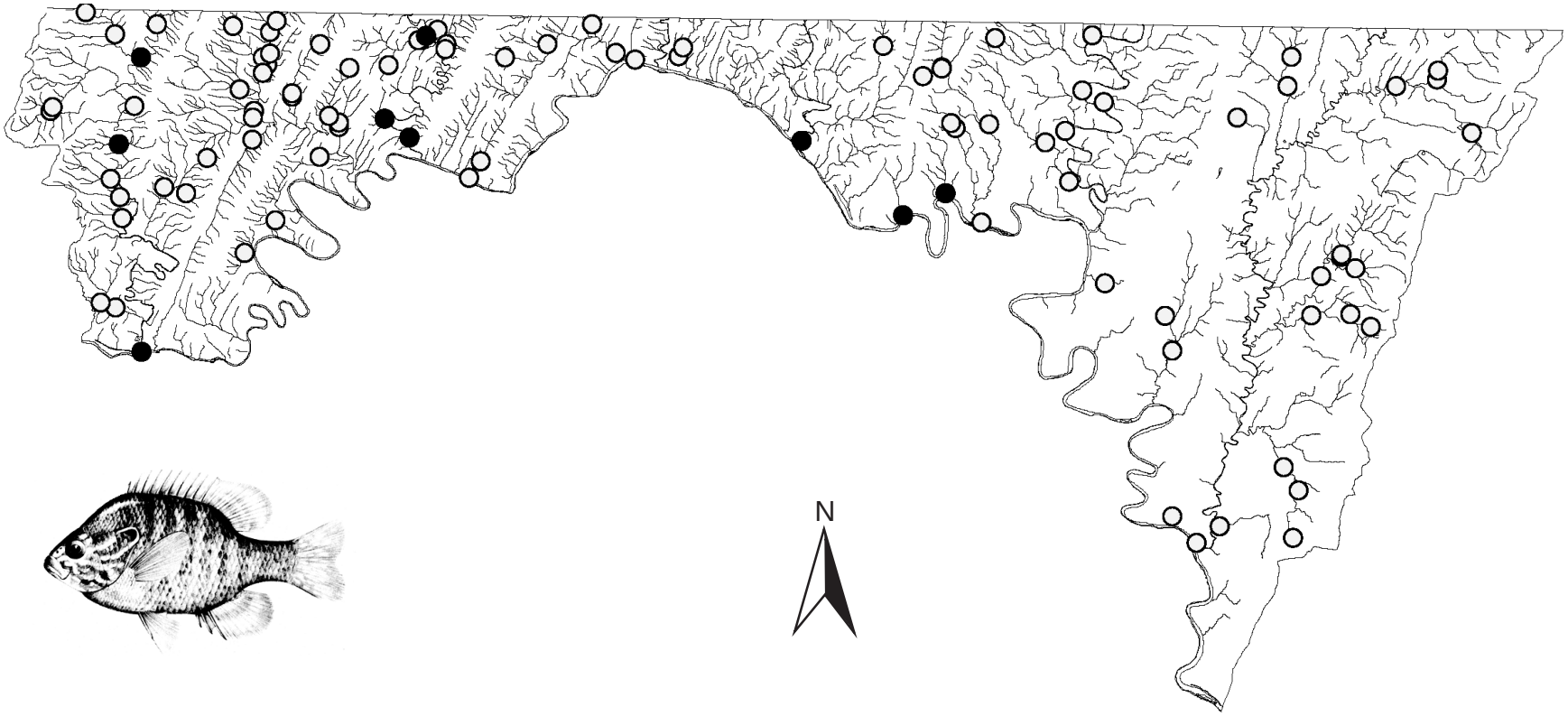
● **Species PRESENT at site**

○ **Species ABSENT at site**



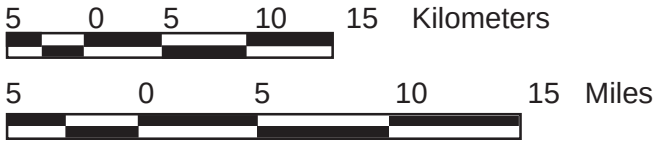

Distribution largemouth bass in the Upper Potomac basin, 1995.

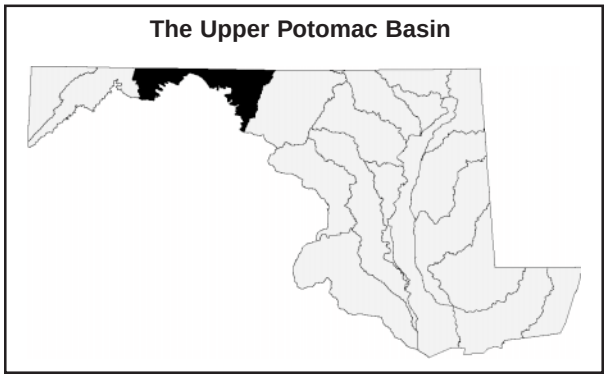





● **Species PRESENT at site**

○ **Species ABSENT at site**

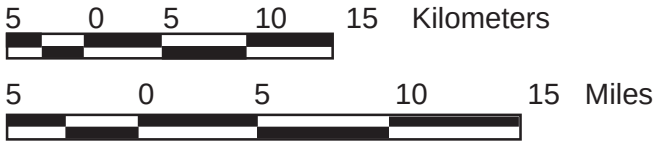


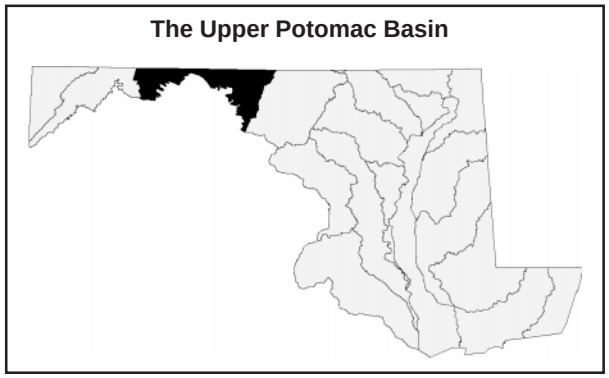




Distribution longear sunfish in the Upper Potomac basin, 1995.

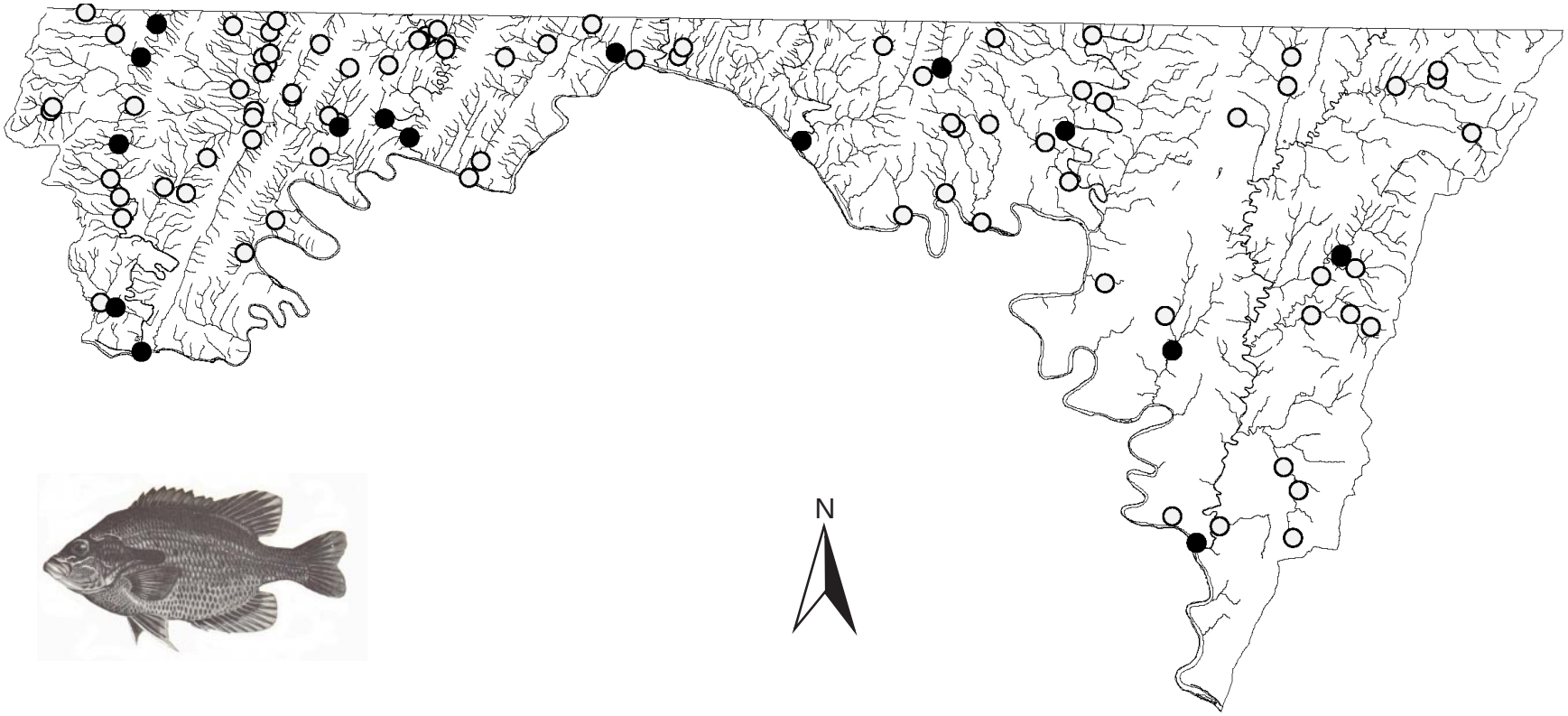
● **Species PRESENT at site**

○ **Species ABSENT at site**



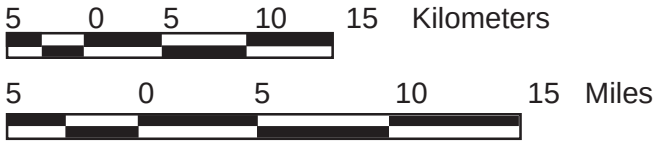

Distribution pumpkinseed in the Upper Potomac basin, 1995.

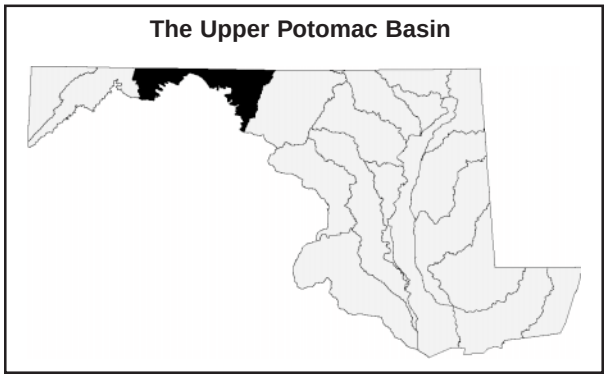





● **Species PRESENT at site**

○ **Species ABSENT at site**

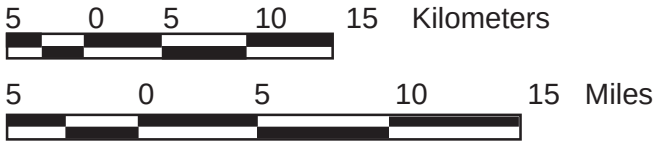


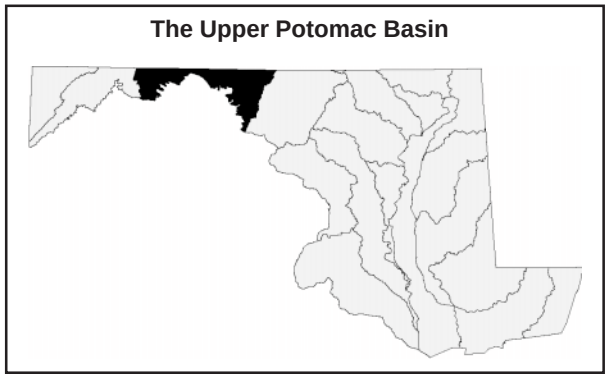




Distribution redbreast sunfish in the Upper Potomac basin, 1995.

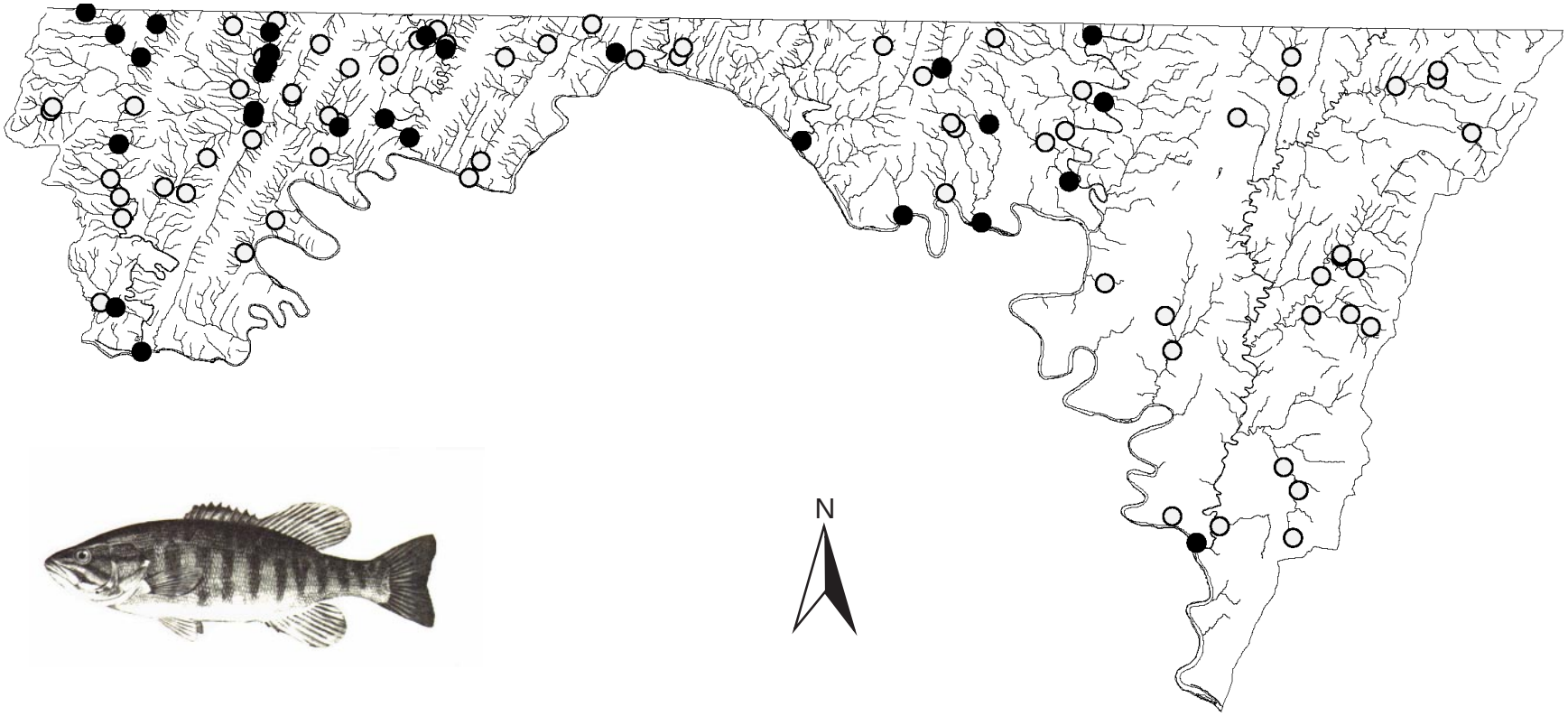
● **Species PRESENT at site**

○ **Species ABSENT at site**



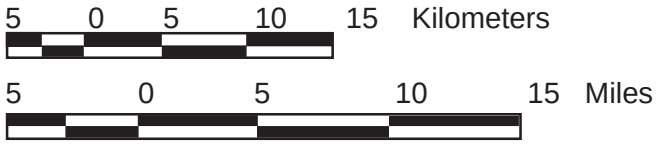

Distribution rock bass in the Upper Potomac basin, 1995.

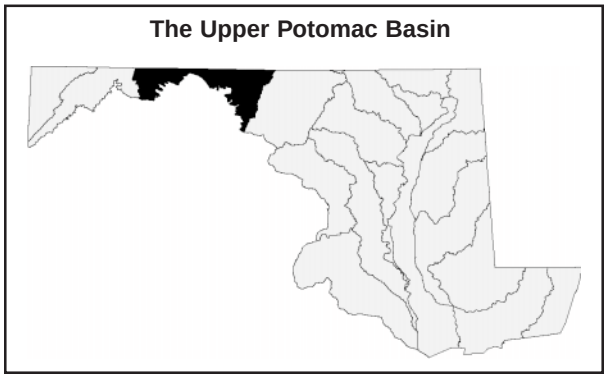





● **Species PRESENT at site**

○ **Species ABSENT at site**

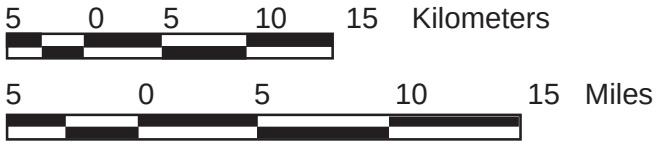


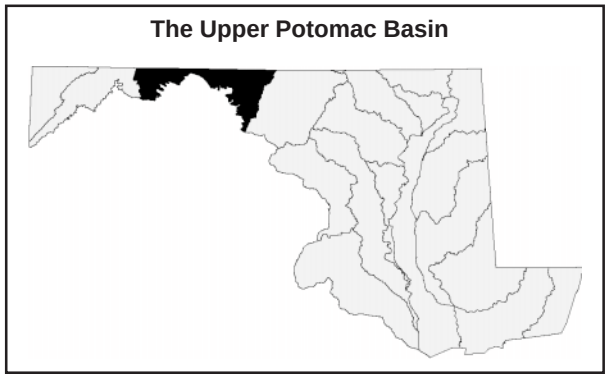




Distribution smallmouth bass in the Upper Potomac basin, 1995.

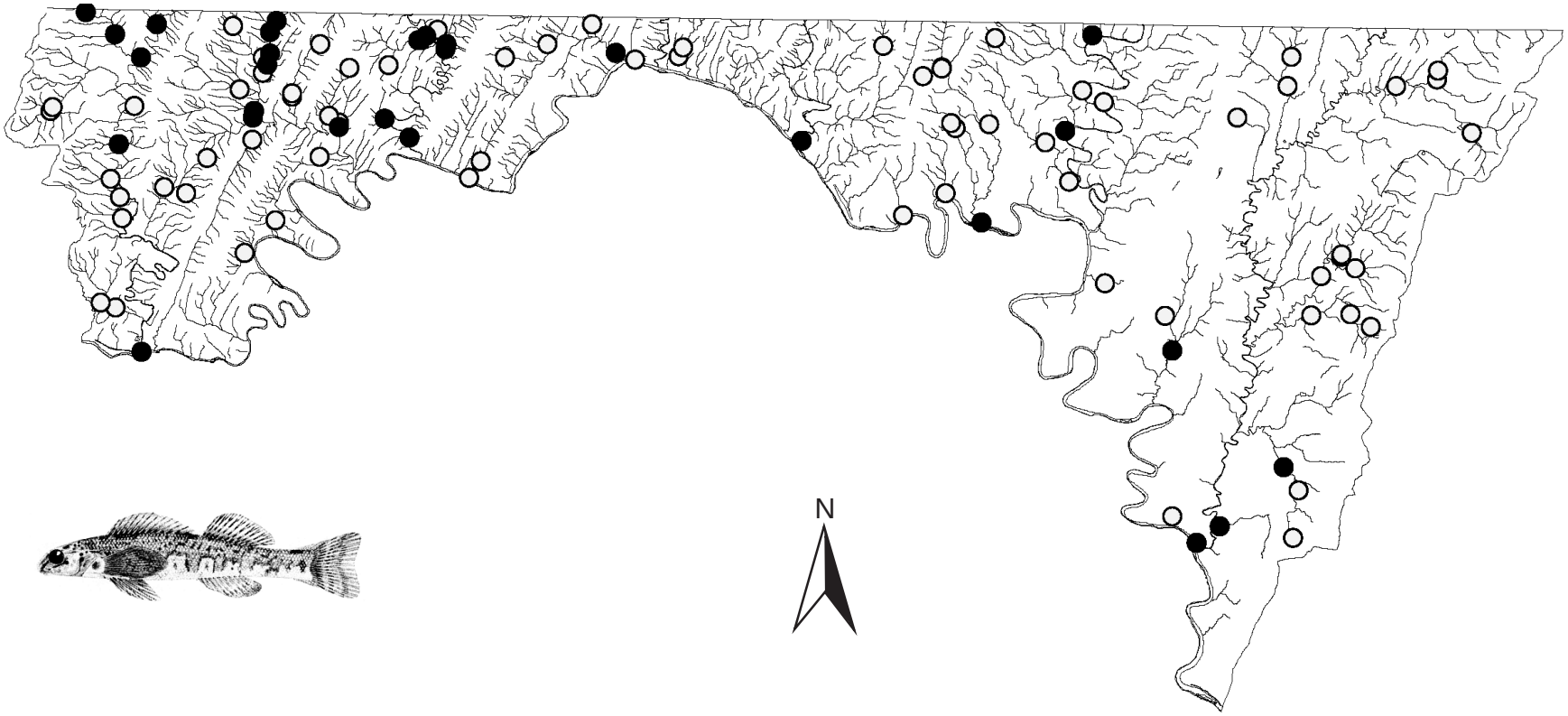
● **Species PRESENT at site**

○ **Species ABSENT at site**



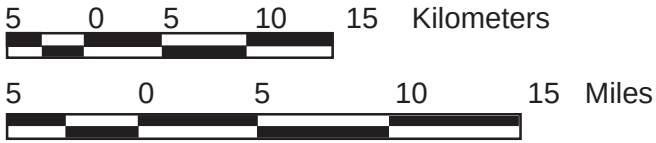

Distribution fantail darter in the Upper Potomac basin, 1995.

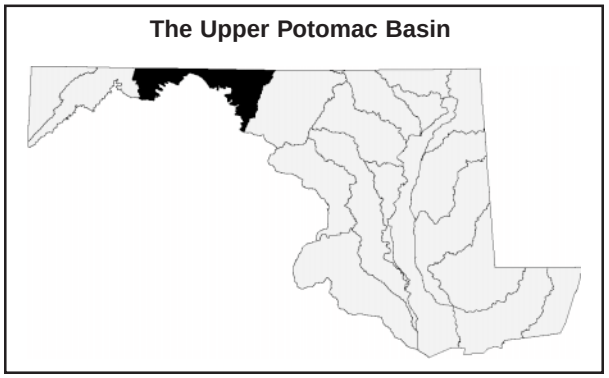





● **Species PRESENT at site**

○ **Species ABSENT at site**

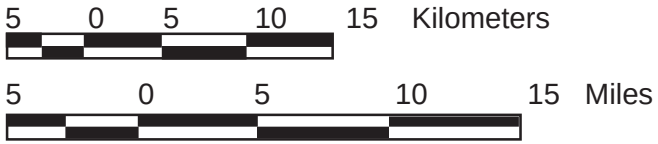


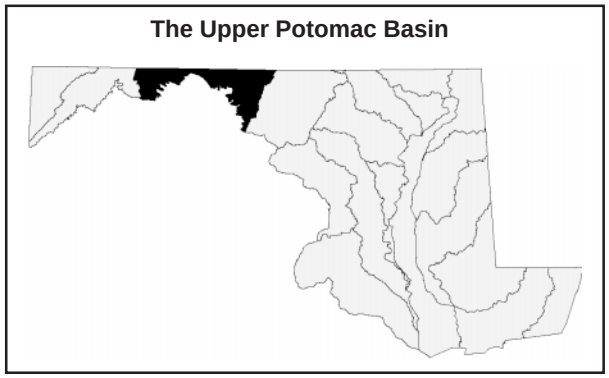




Distribution greenside darter in the Upper Potomac basin, 1995.

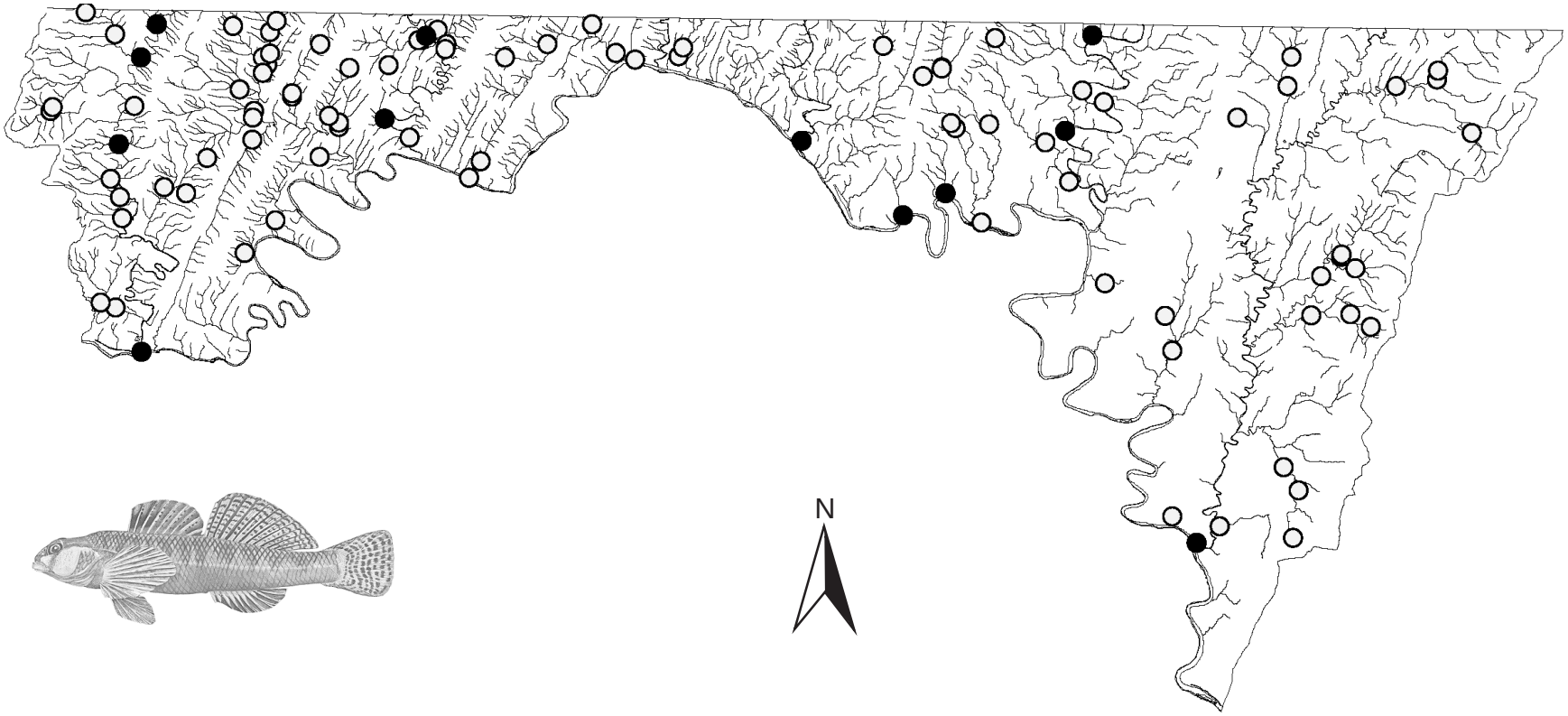
● **Species PRESENT at site**

○ **Species ABSENT at site**



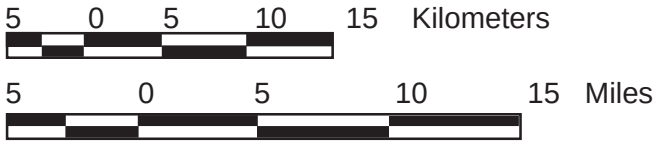

Distribution rainbow darter in the Upper Potomac basin, 1995.

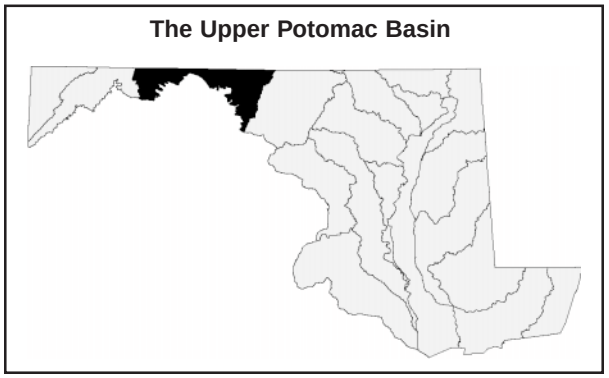





● **Species PRESENT at site**

○ **Species ABSENT at site**




Distribution tessellated darter in the Upper Potomac basin, 1995.

**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 1995 MBSS sites in the Upper Potomac 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. |
|---|---|---|---|---|---|---|---|
| Turbellaria | Tricladida | Planariidae | *Cura* | | | sp | 4.35 |
| | | | *Dugesia* | 7 | Predator | sp | 2.90 |
| Oligochaeta | Lumbriculida | Lumbriculidae | | 10 | Collector | bu | 17.39 |
| | Tubificida | Naididae | | 10 | Collector | bu | 5.80 |
| | | Tubificidae | *Limnodrilus* | 10 | Collector | cn | 1.45 |
| Gastropoda | Basommatophora | Lymnaeidae | *Fossaria* | 8 | Scraper | cb | 1.45 |
| | | Physidae | *Physella* | 8 | Scraper | cb | 7.25 |
| | | Planorbidae | *Gyraulus* | 8 | Scraper | cb | 1.45 |
| | | | *Leptoxis* | | Scraper | cb | 1.45 |
| Pelecypoda | Veneroida | Corbiculidae | *Corbicula* | 6 | Filterer | bu | 1.45 |
| | | Sphaeriidae | *Pisidium* | 8 | Filterer | bu | 1.45 |
| Malacostraca | Amphipoda | Crangonyctidae | *Crangonyx* | 4 | Collector | sp | 15.94 |
| | | Gammaridae | *Gammarus* | 6 | Shredder | sp | 13.04 |
| | Decapoda | Cambaridae | *Cambarus* | 6 | Collector | sp | 2.90 |
| | | | *Orconectes* | 6 | Shredder | sp | 1.45 |
| | Isopoda | Asellidae | *Caecidotea* | 8 | Collector | sp | 28.99 |
| | | | *Lirceus* | 8 | Collector | sp | 8.70 |
| Insecta | Ephemeroptera | Ameletidae | *Ameletus* | 0 | Collector | sw, cb | 44.93 |
| | | Baetidae | *Acentrella* | 4 | Collector | sw, cn | 5.80 |
| | | | *Acerpenna* | 4 | Collector | sw, cn | 13.04 |
| | | | *Baetis* | 6 | Collector | sw, cb, cn | 13.04 |
| | | | *Diphetor* | | Collector | sw, cn | 5.80 |
| | | Caenidae | *Caenis* | 7 | Collector | sp | 2.90 |
| | | | *Ephemerella* | 2 | Collector | cn, sw | 60.87 |
| | | | *Eurylophella* | 4 | Scraper | cn, sp | 11.59 |
| | | | *Serratella* | 2 | Collector | cn | 4.35 |
| | | Ephemeridae | *Ephemera* | 3 | Collector | bu | 4.35 |
| | | Heptageniidae | *Cinygmula* | | Scraper | cn | 5.80 |
| | | | *Epeorus* | 0 | Scraper | cn | 40.58 |
| | | | *Heptagenia* | 4 | Scraper | cn, sw | 2.90 |
| | | | *Leucrocuta* | 1 | Scraper | cn | 5.80 |
| | | | *Nixe* | 2 | Scraper | cn | 1.45 |
| | | | *Stenacron* | 4 | Collector | cn | 5.80 |
| | | | *Stenonema* | 4 | Scraper | cn | 27.54 |
| | | Isonychiidae | *Isonychia* | 2 | Filterer | sw, cn | 5.80 |
| Insecta | Odonata | Leptophlebiidae | *Paraleptophlebia* | 2 | Collector | sw, cn, sp | 27.54 |
| | | Coenagrionidae | *Argia* | 8 | Predator | cn, cb, sp | 1.45 |
| | | Gomphidae | *Lanthus* | 6 | Predator | bu | 1.45 |
| | | | *Stylogomphus* | | Predator | bu | 4.35 |
| Insecta | Plecoptera | Capniidae | *Allocapnia* | 3 | Shredder | cn | 8.70 |
| | | | *Sweltsa* | | Predator | cn | 31.88 |
| | | Leuctridae | *Leuctra* | 0 | Shredder | cn | 33.33 |
| | | Nemouridae | *Amphinemura* | 3 | Shredder | sp, cn | 47.83 |
| | | | *Nemoura* | 1 | Shredder | sp, cn | 1.45 |

| Class | Order | Family | Genus | TV | FFG | Habit | % Occ. |
|---|---|---|---|---|---|---|---|
| Insecta | Plecoptera | Nemouridae | *Ostrocerca* | | Shredder | sp, cn | 33.33 |
| | | | *Prostoia* | | Shredder | sp, cn | 17.39 |
| | | Peltoperlidae | *Tallaperla* | | Shredder | cn, sp | 1.45 |
| | | Perlidae | *Acroneuria* | 0 | Predator | cn | 10.14 |
| | | | *Eccoptura* | | Predator | cn | 2.90 |
| | | Perlodidae | *Clioperla* | 1 | Predator | cn | 8.70 |
| | | | *Isoperla* | 2 | Predator | cn, sp | 18.84 |
| | | Pteronarcyidae | *Pteronarcys* | 2 | Shredder | cn, sp | 1.45 |
| | | Taeniopterygidae | *Oemopteryx* | | Shredder | sp, cn | 17.39 |
| | | | *Strophopteryx* | | Shredder | sp, cn | 2.90 |
| Insecta | Megaloptera | Corydalidae | *Nigronia* | 0 | Predator | cn, cb | 13.04 |
| | | Sialidae | *Sialis* | 4 | Predator | bu, cb, cn | 2.90 |
| Insecta | Trichoptera | Glossosomatidae | *Glossosoma* | 0 | Scraper | cn | 2.90 |
| | | Hydropsychidae | *Cheumatopsyche* | 5 | Filterer | cn | 42.03 |
| | | | *Diplectrona* | 2 | Filterer | cn | 10.14 |
| | | | *Homoplectra* | | Filterer | cn | 1.45 |
| | | | *Hydropsyche* | 6 | Filterer | cn | 28.99 |
| | | | *Ochrotrichia* | 4 | Scraper | cn | 1.45 |
| | | Lepidostomatidae | *Lepidostoma* | 3 | Shredder | cb, sp, cn | 8.70 |
| | | Limnephilidae | *Hydatophylax* | 2 | Shredder | sp, cb | 2.90 |
| | | | *Ironoquia* | 3 | Shredder | sp | 7.25 |
| | | | *Limnephilus* | 3 | Shredder | cb, sp, cn | 1.45 |
| | | | *Pycnopsyche* | 4 | Shredder | sp, cb, cn | 2.90 |
| | | Philopotamidae | *Chimarra* | 4 | Filterer | cn | 18.84 |
| | | | *Dolophilodes* | 0 | Filterer | cn | 18.84 |
| | | | *Wormaldia* | | Filterer | cn | 5.80 |
| | | | *Polycentropus* | 5 | Filterer | cn | 7.25 |
| | | Psychomyiidae | *Lype* | 2 | Scraper | cn | 1.45 |
| | | | *Psychomyia* | 2 | Collector | cn | 1.45 |
| | | Rhyacophilidae | *Rhyacophila* | 1 | Predator | cn | 40.58 |
| | | Uenoidae | *Neophylax* | 3 | Scraper | cn | 63.77 |
| Insecta | Coleoptera | Dytiscidae | *Agabus* | 5 | Predator | sw, dv | 1.45 |
| | | | *Cybister* | 5 | Predator | sw, dv | 1.45 |
| | | Elmidae | *Ancyronyx* | 2 | Scraper | cn, sp | 1.45 |
| | | | *Dubiraphia* | 6 | Scraper | cn, cb | 1.45 |
| | | | *Macronychus* | 4 | Scraper | cn | 1.45 |
| | | | *Optioservus* | 4 | Scraper | cn | 34.78 |
| | | | *Oulimnius* | 2 | Scraper | cn | 7.25 |
| | | | *Stenelmis* | 6 | Scraper | cn | 14.49 |
| | | Psephenidae | *Ectopria* | 5 | Scraper | cn | 4.35 |
| | | | *Psephenus* | 4 | Scraper | cn | 5.80 |
| | | Ptilodactylidae | *Anchytarsus* | 4 | Shredder | cn | 2.90 |
| Insecta | Diptera | Athericidae | *Atherix* | 2 | Predator | sp, bu | 1.45 |
| | | Ceratopogonidae | *Bezzia* | 6 | Predator | bu | 1.45 |
| | | | *Ceratopogon* | 6 | Predator | sp, bu | 10.14 |
| | | | *Culicoides* | 10 | Predator | bu | 1.45 |
| | | | *Probezzia* | 6 | Predator | bu | 11.59 |
| | | Chaoboridae | *Chaoborus* | | Predator | sp, sw | 1.45 |
| | | Chironomidae | *Brillia* | 5 | Shredder | bu, sp | 7.25 |

| Class | Order | Family | Genus | TV | FFG | Habit | % Occ. |
|---|---|---|---|---|---|---|---|
| Insecta | Diptera | Chironomidae | *Cardiocladius* | 6 | Predator | bu, cn | 1.45 |
| | | | *Chironomus* | 10 | Collector | bu | 4.35 |
| | | | *Cladotanytarsus* | 7 | Filterer | | 1.45 |
| | | | *Clinotanypus* | 8 | Predator | bu | 1.45 |
| | | | *Conchapelopia* | 6 | Predator | sp | 31.88 |
| | | | *Corynoneura* | 7 | Collector | sp | 18.84 |
| | | | *Cricotopus* | 7 | Shredder | cn, bu | 10.14 |
| | | | *Cricotopus/ Orthocladius* | | Shredder | | 7.39 |
| | | | *Cryptochironomus* | 8 | Predator | sp, bu | 1.45 |
| | | | *Diamesinae* | | | | 1.45 |
| | | | *Diamesa* | 5 | Collector | sp | 5.80 |
| | | | *Dicrotendipes* | 10 | Collector | bu | 2.90 |
| | | | *Diplocladius* | 7 | Collector | sp | 1.45 |
| | | | *Endochironomus* | 10 | Shredder | cn | 1.45 |
| | | | *Eukiefferiella* | 8 | Collector | sp | 46.38 |
| | | | *Heleniella* | | Predator | sp | 10.14 |
| | | | *Heterotrissocladius* | | Collector | sp, bu | 5.80 |
| | | | *Krenopelopia* | | Predator | sp | 1.45 |
| | | | *Larsia* | 6 | Predator | sp | 2.90 |
| | | | *Micropsectra* | 7 | Collector | cb, sp | 52.17 |
| | | | *Microtendipes* | 6 | Filterer | cn | 20.29 |
| | | | *Nanocladius* | 3 | Collector | sp | 1.45 |
| | | | *Orthocladiinae A* | | | | 1.45 |
| | | | *Orthocladius* | 6 | Collector | sp, bu | 21.74 |
| | | | *Pagastia* | 1 | Collector | | 4.35 |
| | | | *Parachaetocladius* | 2 | Collector | sp | 1.45 |
| | | | *Parametriocnemus* | 5 | Collector | sp | 1.01 |
| | | | *Paratanytarsus* | 6 | Collector | sp | 2.90 |
| | | | *Pentaneura* | 6 | Predator | sp | 2.90 |
| | | | *Phaenopsectra* | 7 | Collector | cn | 1.45 |
| | | | *Polypedilum* | 6 | Shredder | cb, cn | 21.74 |
| | | | *Potthastia* | 2 | Collector | sp | 1.45 |
| | | | *Procladius* | 9 | Predator | sp | 2.90 |
| | | | *Prodiamesa* | 3 | Collector | bu, sp | 1.45 |
| | | | *Pseudorthocladius* | 0 | Collector | sp | 1.45 |
| | | | *Rheocricotopus* | 6 | Collector | sp | 5.80 |
| | | | *Rheotanytarsus* | 6 | Filterer | cn | 10.14 |
| | | | *Stempellinella* | 4 | Collector | cb, sp, cn | 2.90 |
| | | | *Stictochironomus* | 9 | Collector | bu | 4.35 |
| | | | *Sublettea* | | Collector | | 1.45 |
| | | | *Sympotthastia* | 2 | Collector | sp | 4.35 |
| | | | *Tanytarsus* | 6 | Filterer | cb, cn | 17.39 |
| | | | *Thienemanniella* | 6 | Collector | sp | 21.74 |
| | | | *Thienemannimyia* | | Predator | sp | 13.04 |
| | | | *Tvetenia* | 5 | Collector | sp | 18.84 |
| | | | *Unniella* | | Collector | | 1.45 |
| | | | *Zavrelimyia* | 8 | Predator | sp | 4.35 |
| | | Empididae | *Chelifera* | | Predator | sp, bu | 5.80 |

| Class | Order | Family | Genus | TV | FFG | Habit | % Occ |
|---|---|---|---|---|---|---|---|
| Insecta | Diptera | Empididae | *Clinocera* | | Predator | cn | 7.25 |
| | | | *Hemerodromia* | 6 | Predator | sp, bu | 7.25 |
| | | Simuliidae | *Prosimulium* | 7 | Filterer | cn | 65.22 |
| | | | *Simulium* | 7 | Filterer | cn | 21.74 |
| | | | *Stegopterna* | 7 | Filterer | cn | 39.13 |
| | | Stratiomyidae | *Stratiomys* | | Collector | sp, bu | 1.45 |
| | | Tabanidae | *Chrysops* | 7 | Predator | sp, bu | 1.45 |
| | | | *Tabanus* | 5 | Predator | sp, bu | 5.80 |
| | | Tipulidae | | | Predator | bu, sp | 1.45 |
| | | | *Antocha* | 5 | Collector | cn | 18.84 |
| | | | *Dicranota* | 4 | Predator | sp, bu | 5.80 |
| | | | *Hexatoma* | 4 | Predator | bu, sp | 23.19 |
| | | | *Limnophila* | 4 | Predator | bu | 2.90 |
| | | | *Limonia* | 6 | Shredder | bu, sp | 1.45 |
| | | | *Ormosia* | | Collector | bu | 2.90 |
| | | | *Pseudolimnophila* | 2 | Predator | bu | 7.25 |
| | | | *Tipula* | 4 | Shredder | bu | 17.39 |