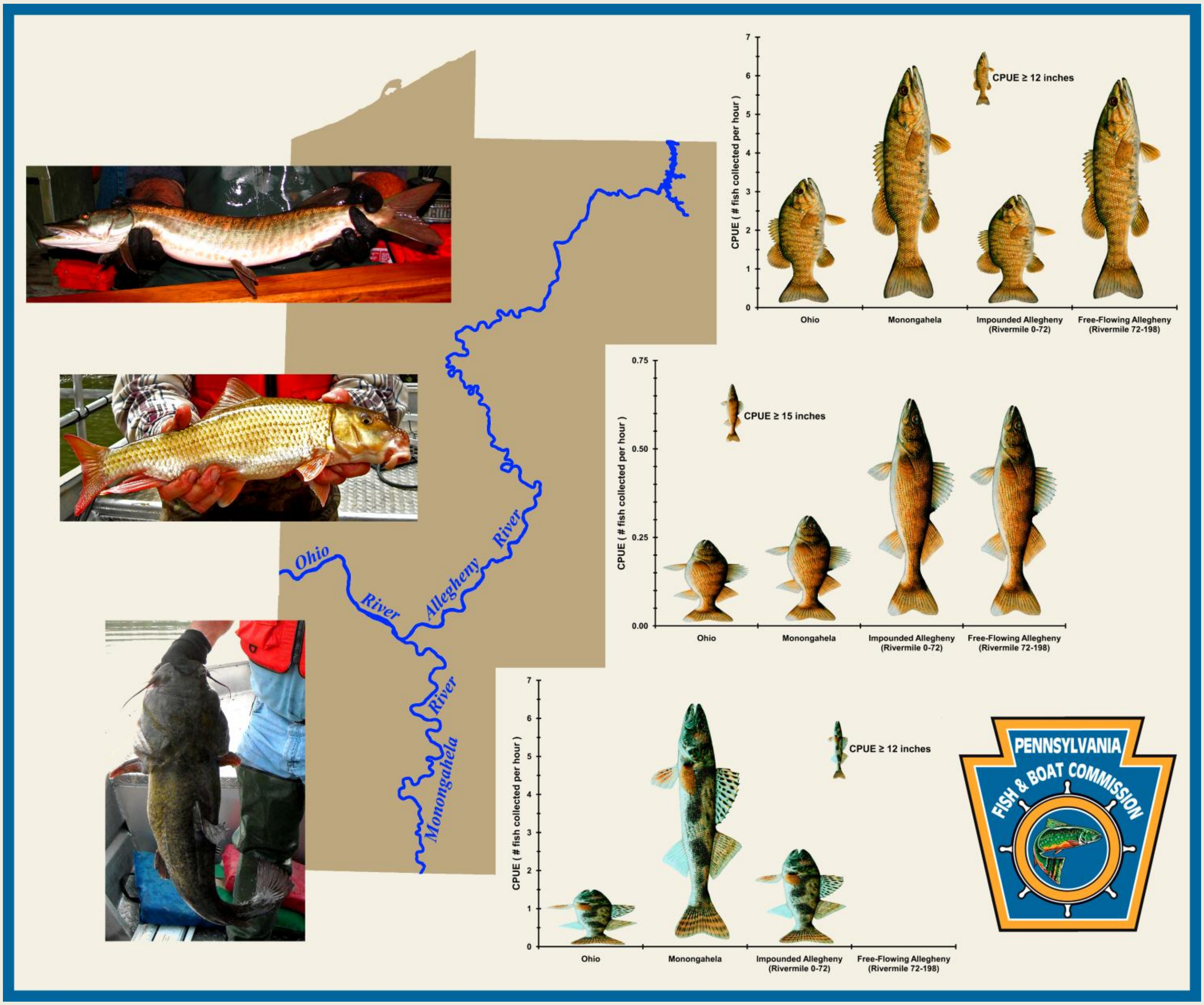
THREE RIVERS MANAGEMENT PLAN

A Strategy for Managing Fisheries Resources of the Allegheny, Monongahela, and Ohio Rivers



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ACKNOWLEDGEMENTS

The development of the *Three Rivers Management Plan* has been a joint undertaking of the Pennsylvania Fish and Boat Commission's Bureau of Fisheries, Fisheries Management Division (PFBC). This document was prepared by the PFBC's Three Rivers fisheries biologist Bob Ventorini. As with corresponding management plans prepared by PFBC's Susquehanna River fisheries biologist Geoff Smith and Delaware River fisheries biologist Daryl Pierce, the *Three Rivers Management Plan* was developed to function as a comprehensive approach to manage the fisheries resources of Pennsylvania's large rivers.

Several PFBC biologists shared responsibilities for enhancing the content and streamlining the format of this document. Area 8 (Somerset office) fisheries manager Rick Lorson, fisheries biologist Mike Depew, and fisheries biologist aide Matt Kinsey provided the preliminary critique, and Area 2 (Tionesta office) fisheries manager Al Woomer followed with insightful comments. Internal review was completed by division chief Dave Miko and bureau director Leroy Young.

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1. INTRODUCTION

1.1 Foreword

Collectively known as the "Three Rivers", the Allegheny River, Monongahela River, and Ohio River of western Pennsylvania possess a national reputation in terms of history, location, and an exceptional variety of fish species. Formed by the confluence of the Allegheny River and Monongahela River in Pittsburgh, the Ohio River is the second largest river system in the United States based on annual discharge, and its annual flow even exceeds that of the upper Mississippi River upstream of their confluence. The Ohio River drains a watershed area greater than 200,000 square miles, and includes portions of 15 states (Figure 1.1). In western Pennsylvania, the Three Rivers drain a watershed area of 15,600 square miles, second only in size to central Pennsylvania's Susquehanna River basin (22,000 square miles).

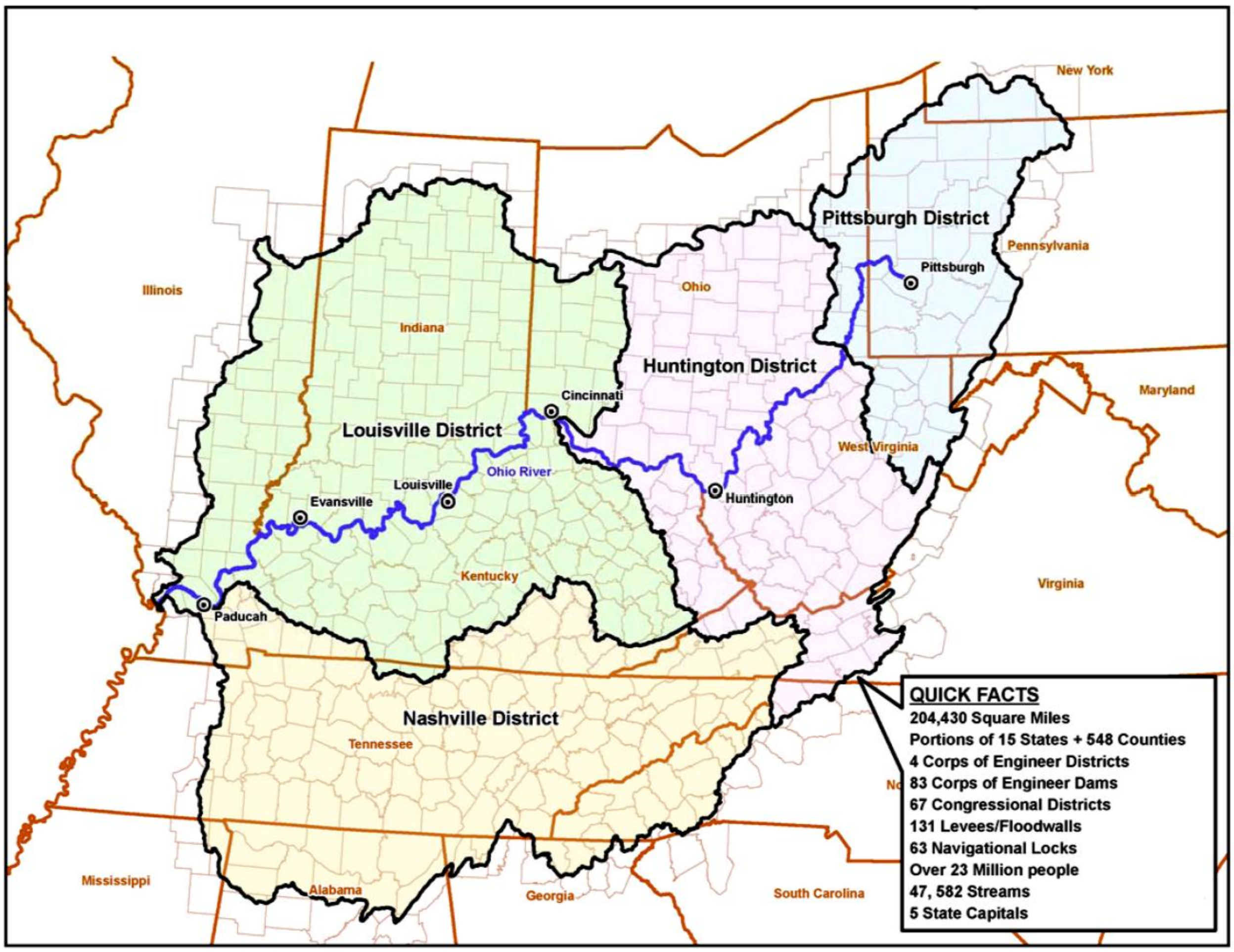

Figure 1.1. Ohio River basin (from USACE 2009).

The Three Rivers were one of the most vital in sustaining the emergence and development of the United States. The Ohio River served as the "Gateway to the West" by providing the most convenient transportation for westward-bound commodities, American Indians, and European settlers and explorers, including Captain Meriwether Lewis who departed Pittsburgh in 1803 with his locally-fabricated keelboat. The Three Rivers supported the birth and growth of great American industries, including coal, iron, steel, oil, salt, glass, and aluminum. With industrialization of the Pittsburgh region, the Monongahela River became the "Busiest Inland Waterway in the World" and helped "Win World War II." Rivers have long served industry by providing easily accessible navigation for the shipment of natural resources, but also as a convenient "sink" for decades of industrial and municipal wastes. By the early 1900s, the Three Rivers were experiencing widespread habitat devastation and water quality degradation. Through the 1970s, numerous fish kills were reported on the Allegheny River; however, none reported on the Monongahela River. The Monongahela's fisheries were nearly non-existent at that time, making a fish kill difficult to detect.

Concerted state and federal efforts in the 1970s eventually led to tremendous improvement in river water quality. Improved river water quality culminated in recoveries of fisheries, expressed as range expansions of native species, increases in fish population abundances, and a revival of angling opportunities within historically impacted river reaches. Documentation of the recovering fisheries can be found in an examination of navigation lockchamber fish survey findings. Initiated by the Ohio River Valley Water Sanitation Commission (ORSANCO) in 1957, 94 lockchamber surveys have been conducted on the Three Rivers.

Today, the Pennsylvania Fish and Boat Commission (PFBC) recognizes fisheries resources of the Three Rivers as diverse, coolwater and warmwater populations, characteristic of a recovering, large river ecosystem. In terms of diversity of native fish species of large river ecosystems, the Three Rivers are the richest in Pennsylvania (*i.e*., compared to the Susquehanna and Delaware Rivers; Table 1.1). Several nongame species are the Three Rivers are protected, emphasizing the importance for conservation.

Table 1.1. Summary of fish species collected from Pennsylvania's large rivers over the past 30 years.

River	Total # Fish Species	# Fish Hybrids	# Native Fish Species (% of total)	# Protected Fish Species*
Allegheny	100	3	93 (93%)	15 (7E, 4T, & 4C)
Ohio	89	3	81 (91%)	9 (5E & 4T)
Monongahela	76	3	68 (89%)	5 (3E,1T, & 1C)
Delaware	74	1	50 (68%)	7 (4E & 3C)
Susquehanna	67	2	45 (67%)	7 (4E & 3C)

*58 Pennsylvania Code Chapter 75 listings (E=Endangered, T=Threatened, and C=Candidate).

As an indicator of river recovery, several protected fish species have recently been removed from protected lists. Species removed by the PFBC include silver chub (previously PA-Endangered); smallmouth buffalo, longhead darter, channel darter, mooneye, and skipjack herring (previously PA-Threatened); and longnose gar, river redhorse, and brook silverside (previously PA-Candidate).

Sport fisheries resources of the Three Rivers have become markedly valuable. Pittsburgh and the Three Rivers hosted two major bass tournaments: the 2005 Bassmaster Classic, which generated $29 million in revenue for the City of Pittsburgh; and the 2009 Forrest L. Wood Cup, which produced $37 million in revenue and attracted visitors and professional anglers from around the United States. The most sought-after sport fish species of the Three Rivers are smallmouth bass, walleye, and sauger; and the Monongahela River maintains the most productive sauger fishery in Pennsylvania. In 2010, there were 85 fishing tournaments held on the Three Rivers, emphasizing the importance of its sport fisheries resources in terms of recreation as well as economic input to western Pennsylvania.

Historic impacts and present threats continue to hamper The Three Rivers. The lock and dam system that facilitates commercial river navigation impedes upstream movement for many fish species considered to be migratory. Commercial sand and gravel dredging in the Allegheny River and Ohio River has eliminated valuable instream habitats and further deepened the channels of these two systems. The threat of upstream range expansions of Asian carp within the Ohio River is the most likely pathway for invasions of this aquatic invasive species into Pennsylvania. The modified flows and elimination of instream and riparian habitats continues to impact the functioning of the Three Rivers as large river ecosystems. In June 2010, the Monongahela River was named number nine of the top ten *America's Most Endangered Rivers* by American Rivers primarily because of continuing threats from water pollution impacts from natural gas extraction activities in the Marcellus Shale.

1.2. Agency Responsibility and Mission

As the PFBC, we are responsible for supporting and coordinating planning obligations and overseeing management strategies for all aquatic species under our jurisdictional authority, including game and nongame fish species, mussels, and other aquatic organisms. Our mission is to protect, conserve, and enhance Pennsylvania's aquatic resources and to provide fishing and boating opportunities. Sanctioned authority to address our mission is defined under 58 Pennsylvania Code Chapter 57 as well as Pennsylvania Fish and Boat Code – Title 30 Pennsylvania Consolidated Statutes.

1.3. River Management Plan Approach

To better manage its river species, fisheries biologists from the PFBC's Bureau of Fisheries, Fisheries Management Division developed the *Three Rivers Management Plan (Management Plan)* to function as a comprehensive management approach for the fisheries resources of the Three Rivers.

During development of the *Management Plan*, existing information on the Three Rivers' fisheries resources, including scientific data, conservation efforts, and current and past fisheries management strategies, were compiled and evaluated. Data gaps were then identified and collaborative research opportunities were formulated. The *Management Plan* was prepared with the purpose of proposing and prioritizing management actions designed to address ongoing and identified needs and achieve realistic goals for stewardship of fisheries resources of the Three Rivers.

The *Management Plan* is also designed to serve as a tool for stakeholders of the Three Rivers to become more knowledgeable about issues affecting fisheries resources and to serve as a mechanism to stimulate involvement in stewardship. Stakeholders include government agencies, academic institutions, conservation groups, anglers and concerned citizens.

The *Management Plan's* proposed management actions deal with several issues affecting Three Rivers' fisheries including fish passage, water quality, fish health, commercial dredging, degraded habitats, and aquatic invasive species. The proposed management actions also promote stewardship of Three Rivers' resources including existing habitats, nongame fisheries, and sport fisheries. Several management actions proposed involve collaborative research initiatives with fisheries scientists from academic institutions and other state and federal agencies.

1.4. Sources of Information

In addition to PFBC data, information used to prepare the *Management Plan* was obtained from a variety of sources, including state, interstate, and federal agencies, academia, museums, conservation organizations, industry consultants, available scientific literature, and archival newspaper articles.

1.5. Public Process

Following internal PFBC review, the Draft *Management Plan* was completed and an *Executive Summary* was prepared. In February 2011, both documents were made available to the public on the PFBC Website (http://www.fishandboat.com/ThreeRiversPlan.htm). As a means to encourage public involvement and elicit comments on the Draft *Management Plan*, PFBC held a series of four public meetings with a formal presentation made followed by an open-forum format at strategic locations within the upper Ohio River basin (Monroeville, Franklin, Waynesburg, and Warrendale, Pennsylvania).

Following the meetings, the public was provided about a two-month window (February through April 2011) to submit written comments through the PFBC Website and also by email. All comments received during this timeframe were reviewed and considered, and the Final *Management Plan* (this document) was completed. Although any comments received after the April 2011 deadline were not evaluated for this Final *Management Plan*, they will be reviewed on an ongoing basis for inclusion in later iterations.

Comments may be submitted by mail, email, or telephone to:

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1.6 Public Comments Evaluation

Twenty-four citizens provided comments on the Draft *Management Plan* during the designated timeframe. Of these, 21 were concerned anglers, and four submitted comments about waters other than the Three Rivers. Nearly half (47%) of the remaining 17 requested our agency to consider a restoration program supported by stocking efforts for blue catfish (*Ictalurus furcatus*), a game fish species considered extirpated from the Three Rivers.

Blue catfish are becoming increasingly abundant within lower reaches of the Ohio River (Thomas *et al*. 2005). Since 2004, West Virginia Division of Natural Resources Wildlife Resources Section has annually stocked blue catfish fingerlings in the middle Ohio River to establish a sport fishery. The Allegheny and Monongahela Rivers were most likely the eastern fringe of blue catfish historical distribution. According to Cope (1883), blue catfish were sold in Pittsburgh fish markets, and found in the Monongahela River by Evermann and Bollman (1886); and reported in the Allegheny River by Bean (1892). Rafinesque (1820) collected them from the Ohio River.

1.7. Implementation

Implementation of the *Management Plan* will begin as indicated under Goal 2, Item B of the PFBC's *Strategic Plan* (http://www.fishandboat.com/stplan.pdf).

Although changes to this *Management Plan* can occur at any time, serving as a working document, it is expected that routine updates will take place every five years (next in 2016). However, the list of proposed management actions will be reviewed at least annually to measure progress toward stewardship goals.

2. JURISDICTIONS

Several federal and state resource agencies are responsible for the stewardship of the Three Rivers. Their jurisdictional authorities involve proposing, developing, and executing legislative actions and other measures that dictate stewardship and direct utilization of aquatic resources of the Three Rivers. In order for their stewardship to be effective, federal and state agencies must embrace cooperative planning and management with other governmental and nongovernmental partners. This section summarizes jurisdictions of federal and state partners who must work collectively for the long-term sustainability of aquatic resources of the Three Rivers.

2.1. Federal Jurisdictions

Allegheny National Forest

Thirty-seven miles of the upper Allegheny River are within the boundary of the 513,000-acre Allegheny National Forest (ANF). ANF is the only national forest in Pennsylvania and its lands are within four northwestern Pennsylvania counties (Warren, McKean, Forest, and Elk). Managed by the U.S. Forest Service (USFS), an agency under the U.S. Department of Agriculture, ANF is one of 15 national forests in the eastern United States and 155 nationwide. ANF was created in 1923 following Pennsylvania Legislature approval and President Calvin Coolidge's signed proclamation for federal purchase of available private lands.

National Wild and Scenic Rivers – Allegheny River

In 1986, the U.S. Congress passed the National Wild and Scenic Rivers Act, legislation designed to protect free-flowing rivers that possess outstandingly remarkable scenic, recreational, geological, biological, historical, cultural, or other notable attributes. The National Parks and Recreation Act passed in 1978 authorized the USFS at ANF to study 128 miles of the upper Allegheny River between East Brady and Kinzua Dam to determine if the river possessed sufficient values to meet eligibility for inclusion in the National Wild and Scenic Rivers System (NWSRS).

USFS conducted this study intermittently between 1980 and 1990 and concluded that 86.6 miles of the upper Allegheny River, divided among three reaches in Warren, Forest, and Venango Counties, met criteria for NWSRS designation (Table 2.1). In 1992, the three reaches were granted NWSRS status by Congress in recognition of the Allegheny River's value as one of the nation's outstanding free-flowing rivers. All three reaches received a Recreational River classification as they did not meet criteria for a Wild River or a Scenic River due to the relatively high degree of riparian development compared with other, more secluded rivers in NWSRS. Recreational River classification includes rivers and sections of rivers that are readily accessible by road or railroad, may have some development along their shorelines, and may have undergone some impoundment or diversion in the past.

In making the NWSRS designation, both scenic values and the rivers islands were considered to be outstandingly remarkable attributes. Between Emlenton and Franklin, the river is confined within a narrow, severely meandering valley with precipitous side slopes. From a regional perspective, this landscape is considered unique and outstandingly remarkable. Such a narrow river valley with its sharp bends and convincing spatial enclosure is uncommon for rivers of this size and length. Over 100 islands in the upper Allegheny River between Oil City and Kinzua Dam possess remarkable ecological, scenic, and recreational features. Seven of these islands comprise the Allegheny Islands Wilderness, the smallest federally-designated wilderness in the United States, and one of only two federal wilderness areas in Pennsylvania.

Table 2.1. National Wild and Scenic River reaches of the upper Allegheny River.

Downstream Extent	Upstream Extent	Rivermile (RM)	Length (miles)
Glade Bridge (Business US6) in Warren	Kinzua Dam	190.7-197.4	6.7
Alcorn Island near Oil City	Buckaloons Recreation Area (RDB)	133.6-181.2	47.6
Quaker State Refinery brownfield in Emlenton (LDB)	Sewage Treatment Plant in Franklin (LDB)	90.4-122.7	32.3

Allegheny Islands Wilderness

In 1984, Congress passed the Pennsylvania Wilderness Act which designated seven islands (unnamed island, Baker Island, King Island, Courson Island, Thompsons Island complex, and Crulls Island complex) located within the ANF between Tionesta (RM 153) and Buckaloons Recreation Area (RM 181) as part of the National Wilderness Preservation System. Designated as Allegheny Islands Wilderness, these islands are protected to sustain vestiges of exceptional and globally rare riverine bottomland forests dominated by silver maple (*Acer saccharinum*), American sycamore (*Platanus occidentalis*), shagbark hickory (*Carya ovata*), and green ash (*Fraxinus pennsylvanica*). The islands are also recognized nationally for their recreational value (Figure 2.1). Only 370 acres, Allegheny Islands Wilderness is the smallest component of the federal Wilderness System in the United States. USFS is the federal agency responsible for managing the three Allegheny River reaches designated under NWSRS and seven islands of Allegheny Islands Wilderness.

Figure 2.1. Canoeists maneuvering through the Allegheny Islands Wilderness (from Wilderness.net).

Ohio Rivers Islands National Wildlife Refuge

The Ohio River Islands National Wildlife Refuge (ORINWR) was established in 1990 under authority of the Fish and Wildlife Act of 1956 and was the first National Wildlife Refuge in West Virginia. Managed by the U.S. Fish and Wildlife Service (USFWS), an agency under the U.S. Department of Interior, ORINWR currently consists of all or part of 22 islands and three mainland tracts scattered along 362 miles of the upper Ohio River. Most of ORINWR's 3,300 acres of land and underwater habitat are located in West Virginia. Pennsylvania and Kentucky each possess two refuge islands. ORINWR in Pennsylvania, the upstream extent of the refuge, includes two islands, Georgetown Island (RM 37.6-37.8) and Phillis Island (RM 35.1-35.6) within Ohio River Section 4.

ORINWR protects, conserves, and restores habitat for wildlife native to floodplains of the Ohio River. In addition to the islands, over 100 embayments and wetlands contiguous with the mainland are within ORINWR's boundary. ORINWR's habitats sustain near natural assemblages of riverine flora and fauna. The distribution and complexity of bottomland and riparian habitats as well as deep and shallow instream habitats serve many species of fish and wildlife, including a high diversity of waterfowl, shore and wading birds, Neotropical migratory birds, furbearers, fish, mussels, and invertebrates. Deep and shallow instream habitats contiguous with ORINWR are major fish and mussel production areas. The often undisturbed island shorelines, especially the heads and back channels, are popular angling areas. Over 200 bird species (including 76 breeding species), 42 mollusk species, 15 species of reptiles and amphibians, 101 species of fish, 25 mammal species, and 500 species of plants have been identified within ORINWR.

Federally Listed Species

Two federally endangered mussel species (both listed in 1993), clubshell (*Pleurobema clava*) and northern riffleshell (*Epioblasma torulosa rangiana*), and three federal candidate mussel species, rayed bean (*Villosa fabalis*), rabbitsfoot (*Quadrula cylindrica cylindrica*), and sheepnose (*Plethobasus cyphyus*) occur in the middle and upper Allegheny River. Recent surveys by federal agencies (USFWS and USGS) as part of bridge replacement projects revealed that the upper Allegheny River supports the largest reproducing populations of clubshell and northern riffleshell in the world. Under the Endangered Species Act, USFWS has jurisdictional authority over federally listed mussel species of the Allegheny River.

Navigation

The U.S. Army Corps of Engineers (USACE) Pittsburgh District owns and operates 23 lock and dam structures to maintain commercial navigation on the Three Rivers. The Ohio River and Monongahela River and lower 72 miles of the Allegheny River are regularly maintained by USACE for commercial navigation. Under federal regulations, all Three Rivers are therefore classified as Navigable Waters of the United States. Navigable Waters are defined as “those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. A determination of navigability, once made, applies laterally over the entire surface of the waterbody, and is not extinguished by later actions or events which impede or destroy navigable capacity.” USACE has jurisdictional authority over waters classified as Navigable, and their jurisdiction extends shoreward to the mean high water mark. Navigable Waters of the United States, which are defined by the federal Rivers and Harbors Act, are often confused with Waters of the United States, which fall under the federal Clean Water Act. Waters of the United States include all Navigable Waters of the United States, all intermittent and perennial tributary streams, and all wetlands.

2.2. <u>Pennsylvania Jurisdictions</u>

Pennsylvania Fish and Boat Commission

The Pennsylvania Fish Commission (PFBC) was established in 1866 largely for the management, production, and restoration of declining American shad fisheries of the Susquehanna River. Over the years, its structure, mandates, and responsibilities have evolved and expanded, and today, PFBC operates as an independent state agency supported, in part, by user-based funding (*i.e*., fishing license and boating registration fees), federal grants (*e.g*., USFWS State Wildlife Grants), and royalties collected from commercial sand and gravel dredging operations ($0.42 per ton). It does not receive tax revenues or funding from the Pennsylvania General Fund. Under 58 Pennsylvania Code Chapter 57 and Pennsylvania Fish and Boat Code – Title 30 Pennsylvania Consolidated Statutes, PFBC has the jurisdictional authority to ensure the protection, propagation, and distribution of species classified as game fish, nongame fish, bait fish, fish bait, reptiles, amphibians, mussels, other aquatic invertebrates, and all aquatic organisms including plants.

PFBC is the only state agency with a specific focus on aquatic resources such as the Three Rivers and aquatic organisms that depend on the Three Rivers. PFBC functions in a unique and valuable role, serving as an advocate for protection and enhancement of the aquatic resources and recreational interests under its jurisdiction. PFBC's broad regulatory powers and duties are defined by the Pennsylvania General Assembly and the following statutory missions (under Fish and Boat Code, Act 1980-175, Title 30 Pennsylvania Consolidated Statues, Subchapter B):

- Encouragement, promotion, and development of fishery interests and regulations.
- Protection, management, preservation, propagation, and distribution of fish.
- Management of boating and operation of boats.
- Encouragement, management, promotion, and development of recreational boating interests and regulations.

PFBC is responsible for water quality protection, habitat enhancement, management to protect naturally reproducing stocks, providing cultured fish for recreational angling, and angling regulations and law enforcement. Under PFBC Bureau of Fisheries are four Divisions: Fisheries Management (DFM), Environmental Services (DES), Fish Production (DFP), and Habitat Management (DHM). DFM is assigned with stewardship of fishes and management of fisheries resources. DES is responsible for the review and assessment of environmental impacts to aquatic resources and works closely with other agencies in regulation of non-fishery resources (*e.g.*, commercial sand and gravel dredging). DFP includes the state hatchery system responsible for rearing fish and stocking waters of Pennsylvania. DHM serves to identify issues and manage projects related to aquatic habitat improvement and restoration.

Stewardship of fishes and management of fisheries resources of the Three Rivers are shared by two management areas of DFM (Figure 2.2). DFM Area 2 in Tionesta serves the upper Allegheny River upstream of L/D 6 (RM 36.3) and DFM Area 8 in Somerset serves the lower Allegheny River downstream of L/D 6 as well as the entire Ohio River and Monongahela River. With the creation of DHM in 2006, there are two additional management areas for the Three Rivers, DHM Area 1 in Tionesta and DHM Area 4 in Somerset. For the Three Rivers, DHM jurisdictions are the same river reaches that the DFM areas serve (Figure 2.2).

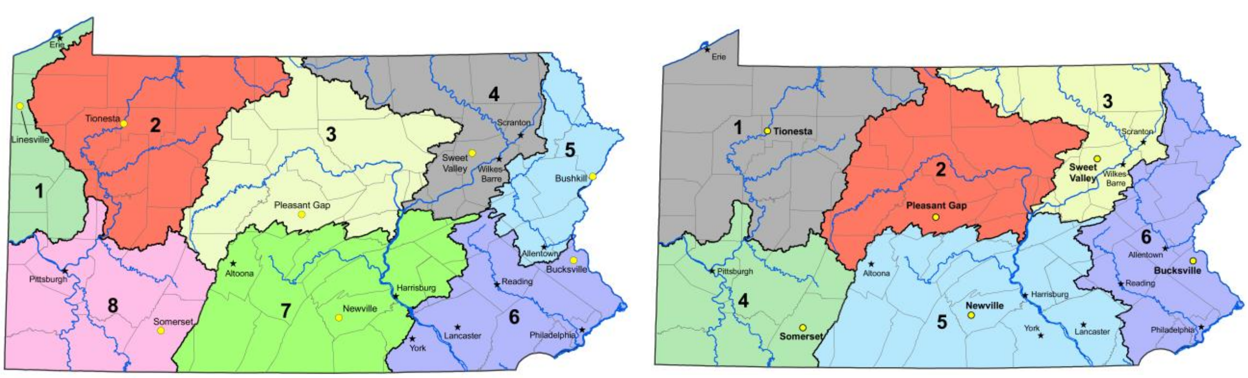

Figure 2.2. PFBC Fisheries Management Areas, left; and Habitat Management Areas, right (from PFBC).

Pennsylvania Game Commission
The Pennsylvania Game Commission (PGC) was created in 1895 to restore wildlife populations that were declining due to deforestation, pollution, and unregulated hunting and trapping. In the late Nineteenth Century, it was estimated that only 500 white-tailed deer remained in Pennsylvania (as opposed to the current population of about 1.5 million). Black bears and wild turkeys were nearly extinct as well. By regulating hunting and protecting wildlife habitats, PGC has restored or reintroduced populations of deer, turkey, bears, bobcats, river otters, wood ducks, geese, beavers, fishers, and elk. The first State Game Lands (SGL) was purchased in 1920, and now there are 287 SGLs. Like PFBC, PGC is an independent agency not supported by tax revenues or Pennsylvania's General Fund. PGC's financial support is from sales of hunting licenses, federal grants, and funds collected from sales of oil, gas, coal, and timber on SGLs. PGC has jurisdictional authority and is responsible for management of terrestrial wildlife, including many bird and mammal species that exploit or inhabit the Three Rivers. PGC's management involves monitoring wildlife populations, establishing laws and regulations, obtaining and improving habitat on SGLs, assessing public expectations, and educating the public on wildlife issues.

Pennsylvania Department of Conservation and Natural Resources
Established in 1995 when the former Department of Environmental Resources was split into two agencies, the Pennsylvania Department of Conservation and Natural Resources (PADCNR) is responsible for maintaining and preserving 117 state parks and 2.1 million acres of state forest land, providing information on the state's ecological and geologic resources, and establishing community conservation partnerships with grants and technical assistance to benefit rivers, trails, greenways, local parks and recreation, regional heritage parks, open space, and natural areas.

One of the state parks managed by PADCNR is Allegheny Islands State Park (Figure 2.3). The park is comprised of approximately 45 acres of alluvial islands of the lower Allegheny River, including the undeveloped, upstream head of Twelvemile Island (RM 13.5-13.6) and both lower (RM 13.7-14.4) and upper (RM 14.5-14.8) Fourteen Mile Island. Established in 1980, Allegheny Islands State Park remains undeveloped with no facilities and no plans for future development. The park is accessed only by water. Camping is allowed and they are open for visits by organized groups.

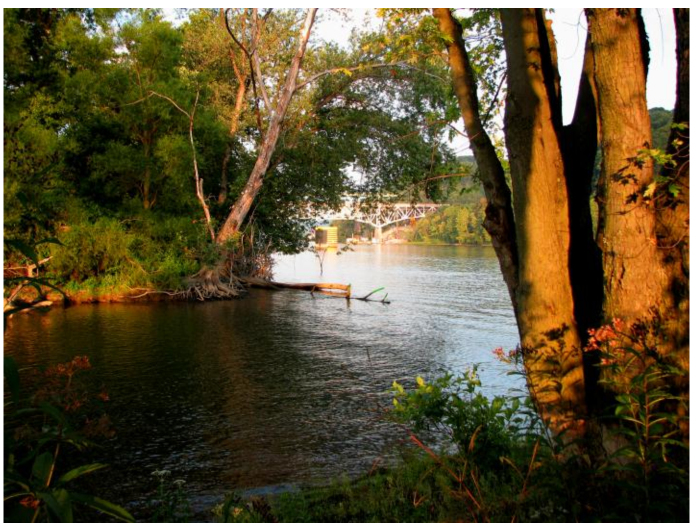

Figure 2.3. Downstream toe of Fourteen Mile Island at Allegheny Islands State Park (from Wikipedia).

Pennsylvania Department of Environmental Protection

Also established in 1995 when the Department of Environmental Resources was split, the Pennsylvania Department of Environmental Protection (PADEP) is responsible for protecting and preserving land, air, water, and energy resources through enforcement of Pennsylvania's environmental laws. PADEP also fosters community development, environmental education, and encourages public involvement in environmental policy. Regional PADEP offices within the upper Ohio River basin reside in Meadville (Northwest Regional Office) and Pittsburgh (Southwest Regional Office). District PADEP offices reside in Warren, Knox, New Castle, Beaver Falls, Ebensburg, Greensburg, Uniontown, and California. These offices are all involved with administering environmental permitting and enforcement programs, as well as implementing surface and ground water quality and biological assessment and monitoring programs. Most PADEP programs are designed to directly or indirectly protect the Three Rivers. In particular, PADEP is responsible for collecting and analyzing samples for routine monitoring of contaminants in fish tissue used to promulgate and update fish consumption advisories issued for the Three Rivers.

Since 2008, PADEP Southwest Regional Office in Pittsburgh has directed a comprehensive water quality monitoring investigation of the Monongahela River related to impacts from disposal of contaminated frac-flowback water from Marcellus Shale drilling sites. This office has also surveyed fish, mussel, and invertebrate assemblages of the Allegheny and Monongahela Rivers as well as collected water quality and sediment quality samples and evaluated riparian and instream habitats for the U.S. Environmental Protection Agency's (USEPA) Environmental Monitoring and Assessment Program for Great Rivers Ecosystems (EMAP-GRE). PADEP will provide PFBC information and results of Allegheny and Monongahela EMAP-GRE when the project is complete (in 2011).

2.3. <u>Adjacent States and Interstate Organizations</u>

New York, West Virginia, and Ohio

Adjacent states agencies are also responsible for stewardship of the Three Rivers. Their jurisdictional authority includes the upper Allegheny River in New York, managed by the New York Department of Environmental Conservation (NYDEC); the upper Monongahela River and upper Ohio River in West Virginia, managed by the West Virginia Division of Natural Resources (WVDNR); and the Ohio River in Ohio, managed by the Ohio Department of Natural Resources Division of Wildlife (ODNR).

Ohio River Fisheries Management Team

The Ohio River Fisheries Management Team (ORFMT) was organized in 1990 in response to the U.S. Supreme Court's ruling on ownership of the Ohio River. Pennsylvania has been a participant in ORFMT since 1991. The Memorandum of Understanding for Interstate Fisheries Management of the Ohio River (MOU) states that "U.S. Supreme Court settlements changed jurisdiction of the Ohio River from the exclusive jurisdiction of Kentucky to concurrent jurisdiction with the states of Ohio, Indiana, and Illinois beginning in 1985. The Ohio Decree was entered on April 15, 1985; the Indiana Decree was entered on November 4, 1985; and, the Illinois opinion was decided on May 28, 1991. Similar shared jurisdiction does not exist between the states of Ohio and West Virginia. West Virginia has current jurisdiction of the Ohio River along the Ohio-West Virginia border."

As a result of the MOU, Ohio's 451-mile southern border along the Ohio River is divided into a Western Management Unit (WMU) and an Eastern Management Unit (EMU) for the purposes of managing Ohio River's fisheries resources. WMU exists along the Kentucky-Ohio border, where Kentucky and Ohio have shared jurisdiction of the Ohio River since 1985. EMU exists along the West Virginia-Ohio border, where West Virginia owns the river and jurisdiction is not shared. Agreements between Kentucky and Ohio, and West Virginia and Ohio allow each state to honor the fishing licenses of the adjacent state on their common borders on the mainstem Ohio River, but access allowed in embayments and tributaries differs between WMU and EMU. While the authority and responsibility for the protection and management of the Ohio River fishery is vested in the individual states, it was recognized that fish are mobile with no regard for political boundaries and that there are numerous Ohio River fishery issues of common concern among the six bordering states (Illinois, Indiana, Kentucky, Ohio, West Virginia, and Pennsylvania). State fisheries agencies recognized that the effectiveness of long-term fisheries management by the individual states could be substantially enhanced through the collaborative pooling of resource information and management programs as possible. In the best interests of the fishery resources and the citizens of the six bordering states, ORFMT pursues cooperative interstate fisheries management of the Ohio River in the following ways:

- Develop shared fisheries management objectives.
- Coordinate regulatory responsibilities, conduct joint management programs, and facilitate technical information exchange among the states and with other governmental, public, and private interests.
- Designate and maintain at least one agency representative to serve on ORFMT.
- Convene ORFMT at least annually to discuss, plan, and report on cooperative fisheries management efforts.
- Recognize that the MOU shall neither obligate the parties to expenditure of funds nor in any way affect the legal authorities vested in the individual states.
- Retain the MOU until it is modified or terminated by those who signed this agreement.

The PFBC *Executive Director* signed the ORFMT MOU in 1995, but Pennsylvania did not regularly participate at that time. However, PFBC signed the Guiding Principles in March 2007 and became a full member of ORFMT. PFBC's Area 8 *Fisheries Manager* currently represents Pennsylvania on ORFMT and PFBC's *Three Rivers Fisheries Biologist* participates in the ORFMT Technical Committee.

ORSANCO

The Ohio River Valley Water Sanitation Commission (ORSANCO) was established in 1948 to control and abate pollution in the Ohio River basin. Headquartered in Cincinnati, ORSANCO is an interstate commission representing eight states and the federal government. Member states include Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia, and West Virginia. ORSANCO operates programs to improve water quality in the Ohio River and its tributaries, including setting waste water discharge standards; developing physical, chemical, and biological water quality criteria to protect desired uses; performing biological assessments; monitoring for chemical and physical properties of waterways; and conducting special surveys and studies. ORSANCO also coordinates emergency response activities for spills or accidental discharges to the river and promotes public participation in programs, such as the Ohio River Sweep and the RiverWatchers Volunteer Monitoring Program.

MICRA

Established in 1991, the Mississippi Interstate Cooperative Resource Association (MICRA) is an organization of 28 states (including Pennsylvania) and cooperating entities (USFWS, Tennessee Valley Authority, U.S. Bureau of Reclamation, USGS Biological Resources Division, Chickasaw Indian Nation, and Chippewa-Cree Indian Tribe) formed to improve conservation, development, management, and utilization of fisheries resources (both recreational and commercial) of interjurisdictional rivers of the Mississippi River basin through improved coordination and communication among the responsible management entities.

In the early 1990s, the USFWS petitioned that paddlefish (*Polyodon spathula*) be listed on the Federal List of Threatened and Endangered Wildlife. MICRA responded in 1994 and developed a strategic plan for management of paddlefish. A multi-state, multi-year effort was implemented to assess paddlefish stocks and document their habitat uses and movements among states and interjurisdictional rivers of the Mississippi River basin. Paddlefish, which were historically distributed throughout most of the major tributaries of the Mississippi River, including the Three Rivers in western Pennsylvania, were the first species considered by MICRA for interjurisdictional management given their extensive migratory behavior (paddlefish are known to travel hundreds of miles between state jurisdictions on a regular, sometimes weekly, basis) and commercial value.

Starting in 1995, cooperating states collected and tagged adult paddlefish and tagged hatchery-reared fish (including Pennsylvania) before release with coded wire tags carrying a MICRA numbering system. This protocol was designed so that recaptures could provide data on various stocks, movements, growth, mortality, harvest, and overall condition. By 1997, a total of 22 states (including Pennsylvania) were participating in this project, and over 6,000 wild, adult paddlefish as well as over one million hatchery-reared fingerlings were tagged and released. Tag returns are increasing each year, and preliminary information indicates that paddlefish are, as expected, highly migratory and likely more effectively managed interjurisdictionally rather than on a state-by-state basis.

2.4. Nongovernmental Organizations

Many watershed groups and local land conservancies are involved in protection and conservation of aquatic resources of the Three Rivers. For example, Allegheny Land Trust recently purchased Sycamore Island in the lower Allegheny and is preparing a management plan for the island and also owns land along the Ohio River. The oldest organization in western Pennsylvania in this category is probably the Western Pennsylvania Conservancy (WPC).

Established in 1932, WPC is a nonprofit organization dedicated to protecting the region’s exceptional natural places. Headquartered in Pittsburgh with regional offices in Blairsville and Ridgway, WPC has protected nearly 20,000 acres of islands, shorelines, and valleys along the Allegheny River. Most of the land has been conveyed to state and federal public land managers. WPC continues to hold 242 acres, including two islands and one floodplain forest. WPC also holds 11,305 acres of conservation and recreation easements, some in Venango County. Within the Allegheny River watershed, WPC has targeted 550 miles of major river and tributary ecosystems for conservation, along with 84 occurrences of globally imperiled plants, invertebrates, vertebrates, and aquatic communities; three biological diversity areas which have highly significant habitats, including island groups; and nine forest blocks that adjoin river riparian zones.

Funded by a USFWS State Wildlife Grant, WPC staff surveyed mussel assemblages in Allegheny River Pools 4, 5, 6, 7 and 8 as well as conducted bathymetric mapping of Allegheny River Pools 5, 6, 7, and 8. Using a GIS platform, WPC has prepared bathymetric profiles of Allegheny River reaches to reveal areas deepened by past commercial dredging operations.

3. BASIN OVERVIEW

3.1. Physiography and Ecoregions

The upper Ohio River basin of western Pennsylvania contains seven physiographic sections (Figure 3.1) within the Appalachian Plateaus Province (PADCNR 2010): Deep Valleys, High Plateau, Northwestern Glaciated Plateau, Pittsburgh Low Plateau, Allegheny Mountain, Allegheny Front, and Waynesburg Hills.

The Appalachian Plateau is generally characterized as a mostly unglaciated upland, dissected by many stream features in a dendritic drainage pattern, giving the appearance of a rugged topography, mountainous in parts, and containing broad ridges. Relief is generally greatest in the Allegheny Mountain Section where the valleys are wide with steep sides, and the uplands consist of broad, linear ridges. Relief is generally lowest in the Northwestern Glaciated Plateau where the valleys and uplands are smooth and eroded by glaciers. The Allegheny Mountain Section is characterized by an escarpment that rises abruptly to a maximum of 3,213 feet above mean sea level (MSL) at Mount Davis in Somerset County, the highest elevation in Pennsylvania.

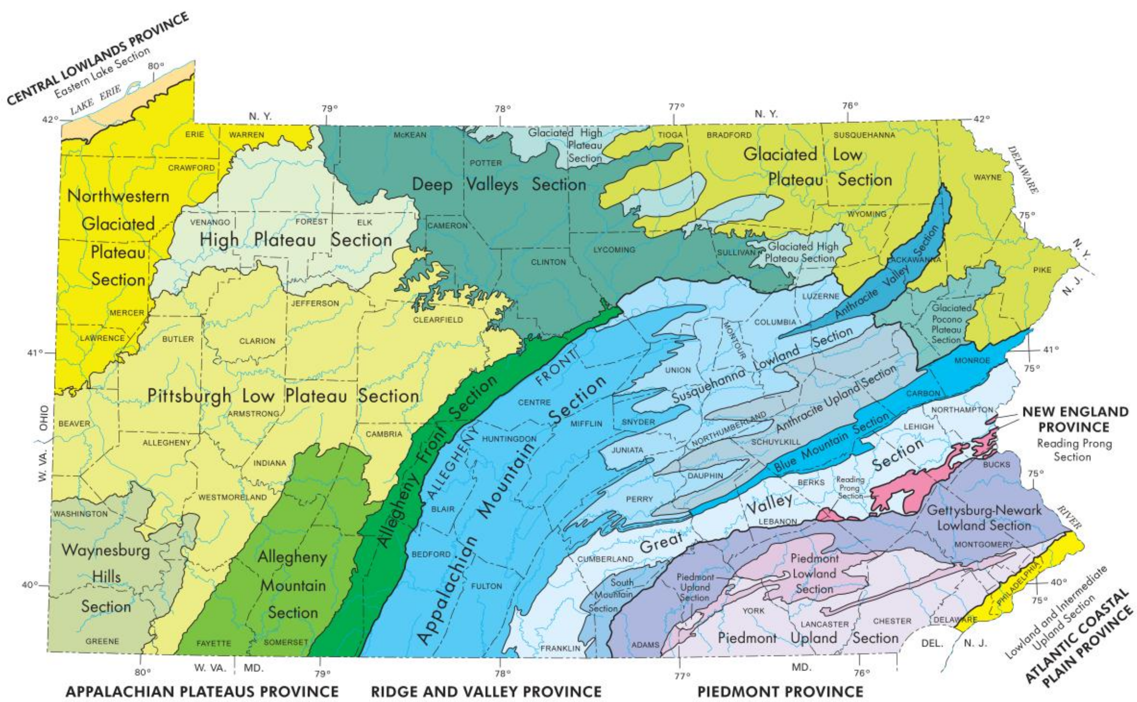

Figure 3.1. Physiographic Provinces of Pennsylvania (from PADCNR 2010).

The Pittsburgh Low Plateau contains the lowest elevation of the Appalachian Plateau in Pennsylvania, 664.5 feet above MSL (at normal "in pool" river stage), at the New Cumberland Pool of the Ohio River in Beaver County. Within the narrow valleys of the Three Rivers, gradients of 45 degrees are common, and some slopes are nearly vertical. The extreme dissection, high local relief, precipitous slopes, and narrow and discontinuous floodplains of the Appalachian Plateau have made river and stream valleys of the upper Ohio River basin prone to flood events.

The upper Ohio River basin includes four Level III and eight Level IV ecoregions, large contiguous land areas that delineate regions within which major ecosystem components, including the type, quality, and quantity of terrestrial flora and fauna, are generally similar and reoccur throughout the region in a relatively predictable pattern (Woods *et al.* 1999) (Table 3.1).

Table 3.1. Ecoregions of the upper Ohio River basin.

Level III	Level IV
Erie/Ontario Hills and Lake Plain	Mosquito Creek-Pymatuning Lowlands Low Lime Till Plain
North Central Appalachians	Unglaciated Allegheny High Plateau
Central Appalachians	Forested Hills and Mountains Uplands and Valleys of Mixed Land Use
Western Allegheny Plateau	Permian Hills Monongahela Transition Zone Pittsburgh Low Plateau

Ecoregions were originally designed to serve as a geographic framework for inventory, assessment, research, management, and monitoring of ecosystems and ecosystem components. Ecoregions have served during the development of state and federal biological criteria and water quality standards as well as the implementation of management goals for nonpoint source pollution.

3.2. Geology

Rocks of the Appalachian Plateau are almost entirely sedimentary, consisting of cyclic sequences of sandstone, shale, conglomerate, limestone, underclay, claystone, bituminous coal, and siltstone of Pennsylvanian, Mississippian, and Upper Devonian ages (Schultz 1999). These rocks have been fractured in many places by folding and faulting. Sedimentary strata of the Appalachian Plateau are relatively flat-lying with northeast- to southwest-trending folds. Structural relief decreases northwestward in a step-like fashion from the well-defined folds of the southeastern side of the Appalachian Plateau, where anticlines rise approximately 800 to 3,000 feet above adjacent synclines.

Coal

The bituminous coal fields of western Pennsylvania are almost entirely contained within the Appalachian Plateau (Schultz 1999). Coal has been mined extensively from the upper Ohio River basin for the past 250 years. In 1760, western Pennsylvania’s bituminous coal industry was born on Coal Hill (present-day Mount Washington) where the Pittsburgh Coal Seam outcropped along steep slopes (PHMC 2010). British troops excavated a makeshift drift mine on the hillside and transported Pittsburgh Coal across the Monongahela River by canoe to supply Fort Pitt with fuel.

Pittsburgh Coal was ideally suited for the production of metallurgical coke, used in blast furnaces at the myriad steel mills lining the Three Rivers, due to its high carbon (which fuels combustion) to impurities (sulfur, ash, and moisture, which impede combustion) ratio. Because of its availability, profusion (seams up to 14 feet thick), and remarkable proximity to industrial centers, Pittsburgh Coal eventually became the world’s single most valuable mineral deposit and was deep mined extensively using room-and-pillar methods throughout southwestern Pennsylvania during the late Nineteenth and early Twentieth Centuries (Figure 3.2). Coal mining and coking industries markedly declined during the latter half of the Twentieth Century.

Today, Pittsburgh Coal is largely mined from Washington and Greene Counties using longwall techniques and used primarily for electric power generation at coal-fired power plants.

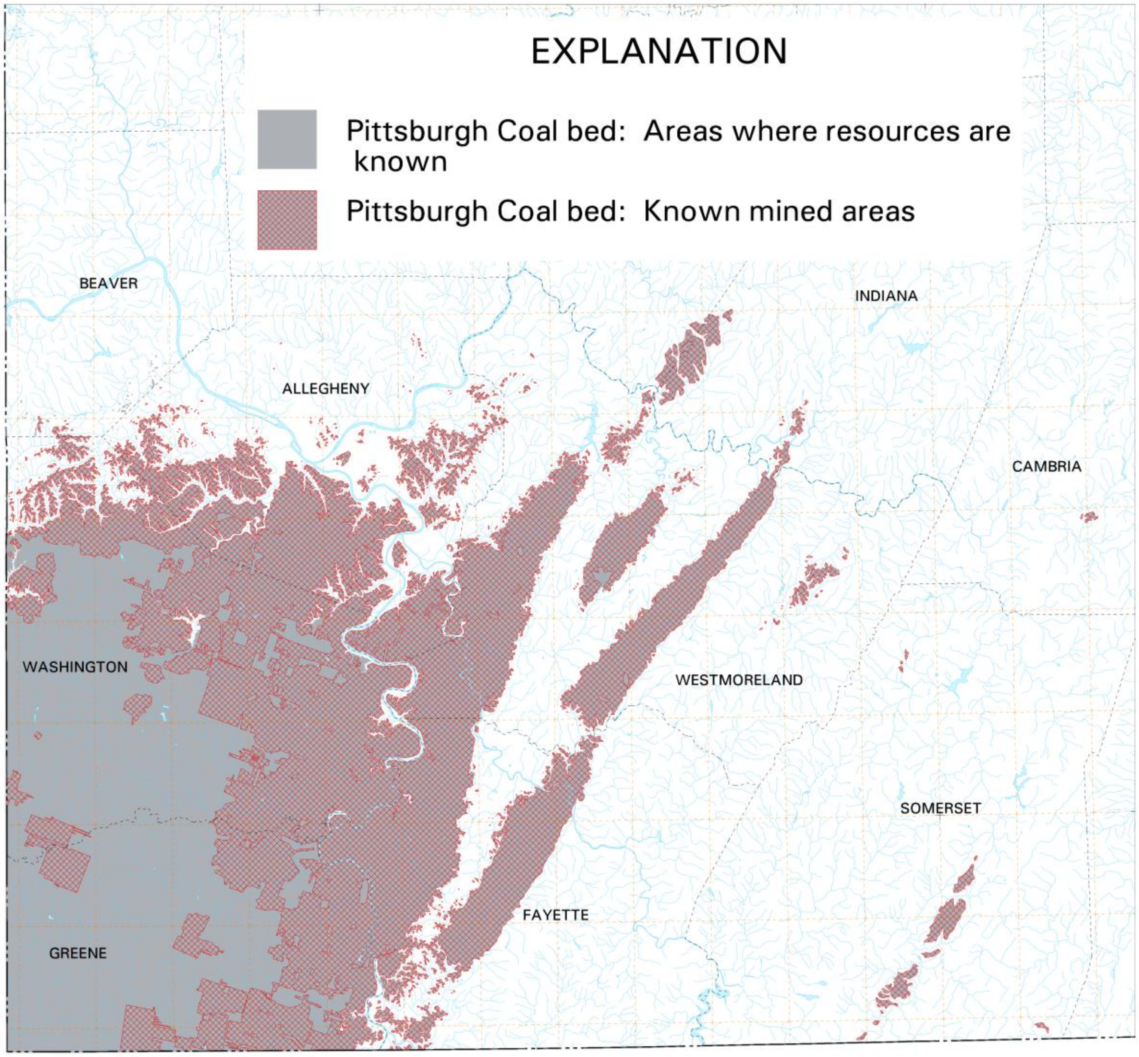

Figure 3.2. Mined areas of the Pittsburgh Coal Seam in southwestern Pennsylvania counties (from Tully 1997).

Other economically important strata of bituminous coal mined from western Pennsylvania include the Upper Freeport, Lower Freeport, Upper Kittanning, and Lower Kittanning seams (Schultz 1999). Production statistics on the majority of early bituminous operations were never recorded (*e.g.*, homestead mines producing house coal), and available historic records provide little or no detail on their extent. Despite the lack of early records, ten billion tons of bituminous coal have been mined from 21 counties in western Pennsylvania, which amounts to nearly one-fourth of all coal ever mined in the United States (PADEP 2010a).

The environmental legacy and aftermath of 250 years of coal mining includes 2,400 stream miles impacted by coal mine drainage in Pennsylvania from abandoned mining operations. Despite reclamation efforts, abandoned mine drainage continues to remain one of the single largest contributors of water pollution in Pennsylvania (PADEP 2010a).

Glacial Material

The northwestern region of the Appalachian Plateau was glaciated for several episodes. During glaciations, deposits of unconsolidated glaciofluvial material, including gravel, sand, silt, and clay, buried topographical depressions, filled stream and river valleys, and eroded and scoured topographical rises. Following glaciations, the resulting terrain was left with lower relief, smoother slopes, and characteristic glacial landform features such as tills and moraines (Schultz 1999).

As glacial ice bulldozed its way from present-day Canada into Pennsylvania, it pushed billions of tons of surface rocks and carried them along (Sevon *et al.* 1999). During this process, boulder-sized igneous and metamorphic rocks from the Canadian Shield were plucked (glacial plucking = loose rock material removed from bedrock, frozen onto the base of the glacier, and entrained into glacial ice moving downstream), crushed, rounded, and polished to gravel sizes by centuries of movement (Harper 1997). Much of the gravel was further worn down to sand. Softer sedimentary rocks were pulverized to sand, silt, and clay. As glacial ice melted, sand and gravel were liberated with meltwater. These actions carved new stream channels, flowed through existing channels, cut deeper into bedrock, and entrenched river channels. With each successive episode of glacial advances and retreats, the upper Allegheny River valley became increasingly loaded with massive deposits of glaciofluvial sand and gravel, a quantity of which washed downstream to the lower Allegheny River, upper Ohio River, and even lower Monongahela River (Bloyd 1974; Harper 1997).

Reaches of the Allegheny River flow over glacial outwash material (sand and gravel) as thick as 80 feet and the Ohio River over glacial outwash as thick as 100 feet (USACE 1981). Kussart (1938) reports a thickness of 130 feet for these rivers. Following the retreat of the Laurentide Ice Sheet during the last glacial episode approximately 10,000 years ago, river channels, riverbanks, areas contiguous with the Three Rivers, and accumulating glacial outwash were eventually covered with locally-derived, nonglacial river sediment (Figure 3.3).

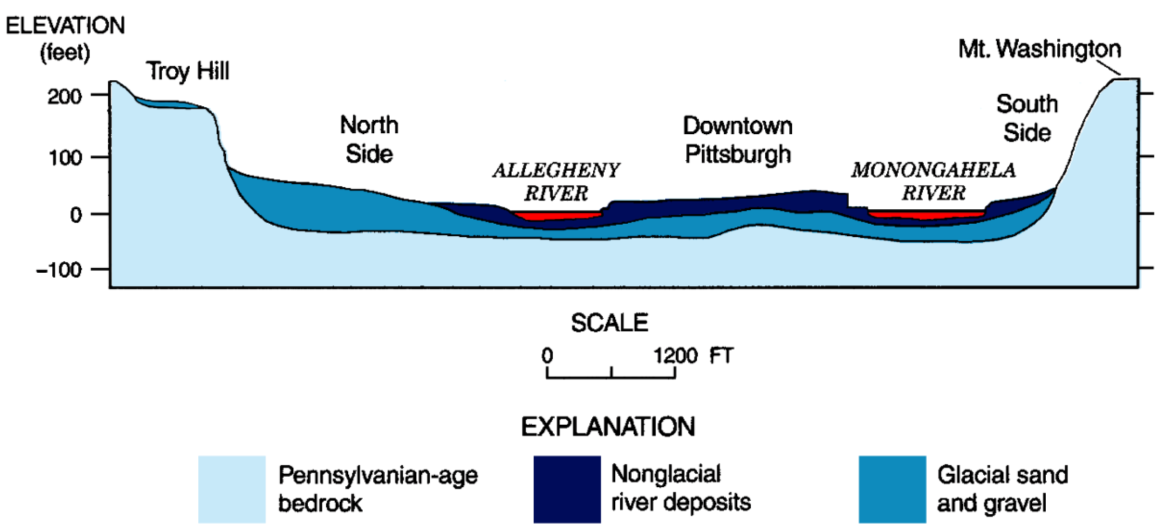

Figure 3.3. Geological cross section of the Three Rivers at Pittsburgh (from Harper 1997).

Throughout the early Nineteenth Century, round, glacially-derived cobble and gravel were frequently collected from the Allegheny and Ohio Rivers at times of low flow and used to pave streets and wharves (*e.g*., the Monongahela Wharf) of Pittsburgh and surrounding communities (Kussart 1938). By 1850, this material was in such short supply in Pittsburgh that mining cobble and gravel from further up the Allegheny and downriver from the Ohio and delivering it to Pittsburgh on horse-drawn flatboats became profitable. In the 1870s, steam-powered stern towboats equipped with clamshell dredges and barges were used to excavate the Allegheny River to meet increasing demands for paving stones.

High-quality glacially-derived sand from the Allegheny River was also in demand in the early Nineteenth Century. Produced from igneous rocks, Allegheny River sand possessed properties, including hard, sharp, clean, and high in silica content, that were desirable, if not optimal, for use in road and building construction as well as feeding the region's burgeoning glassmaking industry (Kussart 1938). Sand was excavated from exposed bars, shoals, and islands contiguous with river shorelines at times of low flow. Teams of horses drew wagons out onto the rivers or small wooden flats were pushed out, and sand was shoveled into them by hand. As the industry grew, larger flatboats were used, some horse-drawn. By 1852, the first steam-powered "sand digger" excavated sand from the bottom of the river and loaded it into flatboats. With the introduction of concrete in the 1870s, the demand for both sand and gravel increased, and commercial extraction of these materials became a growing industry along the Allegheny and Ohio Rivers.

Approximately 2.3 million tons of sand were excavated from the Allegheny and Ohio Rivers in 1909 by five Pittsburgh-based sand and gravel companies (Kussart, 1938). By 1921, this production had grown to more than four million tons of sand per year. Today, glacially-derived sand and gravel is still excavated from the Allegheny and Ohio Rivers by two companies. The production in 1990 was 4.1 million tons, but dropped to 1.7 million tons in 2008.

Sand and gravel dredged from the Allegheny and Ohio Rivers are especially suitable for road construction (USACE 2006). The sand meets the Pennsylvania Department of Transportation (PennDOT) specifications for Type A quality requirements (the highest rating) for fine aggregate, and the gravel meets not only the Type A quality requirements for coarse aggregate, but also receives the highest rating for skid resistance.

Since December 1985, PADEP implemented a moratorium on commercial sand and gravel dredging in Allegheny River Pool 6 due to the relative abundance and diversity of high-quality habitats as well as fish and mussels protected as species of conservation concern. Commercial dredging is also not currently allowed in Allegheny River Pools 2 and 9 as well as in the Ohio River Emsworth and Dashields Pools (USACE 2006); although authorized maintenance dredging to maintain navigation channels of these pools is recurrently performed by USACE. Commercial dredging has recently occurred in Allegheny River Pools 4, 5, 7, and 8 as well as in the Ohio River New Cumberland Pool.

Marcellus Formation

Marcellus Shale is a unit of Devonian-age sedimentary rock found throughout the Appalachian Plateau. Named for a distinctive outcrop located near the village of Marcellus, New York, Marcellus Shale contains a massive and largely untapped natural gas reserve, which has high economic potential (trillions of dollars) given its proximity to high-demand markets in the eastern United States. Using horizontal drilling and hydraulic fracturing techniques, numerous Marcellus Shale wells have been installed within the upper Ohio River basin for exploitation of natural gas.

With any resource extraction operation, there are environmental consequences. For Marcellus Shale drilling, most issues involve the transport, treatment, and disposal of contaminated frac-flowback water, a byproduct of hydraulic fracturing. In 2008, several wastewater treatment plants located along the Monongahela River were accepting frac-flowback water from multiple sources. Unable to completely treat this water, plant outflows caused a temporary spike in conductivity (readings as high as 1,200 µS/cm) and total dissolved solids (TDS readings as high as 900 mg/L) in the Monongahela River during October and November 2008.

3.3. Climate

The upper Ohio River basin maintains a temperate climate pattern with mean minimum temperature ranges from 9° Fahrenheit in the northern region of the basin to 19° Fahrenheit in the southern region and mean maximum temperature ranges from 75° Fahrenheit in the east to 84° Fahrenheit in the west. Average annual precipitation for the basin ranges from 34 to 53 inches per year. In general, northeastern areas of the basin receive less precipitation compared to southwestern areas. Precipitation generally varies from month to month. The northern part of the region receives the most precipitation in June while the southern part receives the most precipitation in July. Overall, the least monthly precipitation usually occurs in November.

3.4. Land Use

Early European settlers marveled at the extensive forests found throughout Penn's Woods, including the upper Ohio River basin. In the early 1700s, more than 80 percent of Pennsylvania's land was heavily forested with hemlock, pine, beech, chestnut, oak, maple, and other hardwood trees. By the mid-1800s, the needs of a growing nation had heavily impacted the state's natural resources with most of the trees cut to provide for rapid development.

Today, the dominant land use in the upper Ohio River basin is still forest cover, but the landscape is more fragmented and the variety of trees substantially altered (PADEP 2010b) (Figures 3.4 and 3.5). Most of the forest area is comprised of deciduous trees, containing some of the best black cherry stands in the world. Evergreen forests, once a major feature on the landscape, have been reduced to about eight percent. Although never a major industry in the area, agriculture, including both pasture and row crops, ranks second. About seven percent of the land is developed for residential and commercial uses. Most of the developed areas, and thus areas with more impervious surfaces, are concentrated in Allegheny County, communities situated along the Three Rivers (especially the Ohio River), and transportation corridors linking adjacent counties (*e.g.*, Beaver, Washington, and Westmoreland).

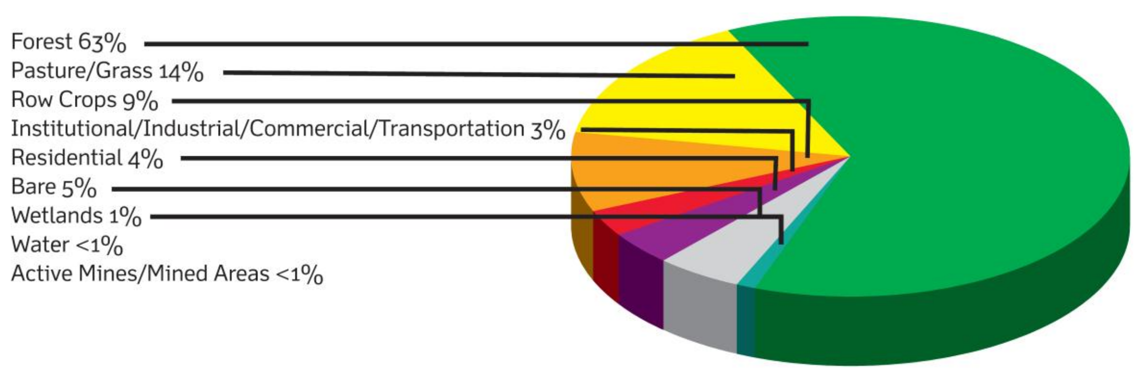

Figure 3.4. Land use in the upper Ohio River basin by percentage (from PADEP 2010b).

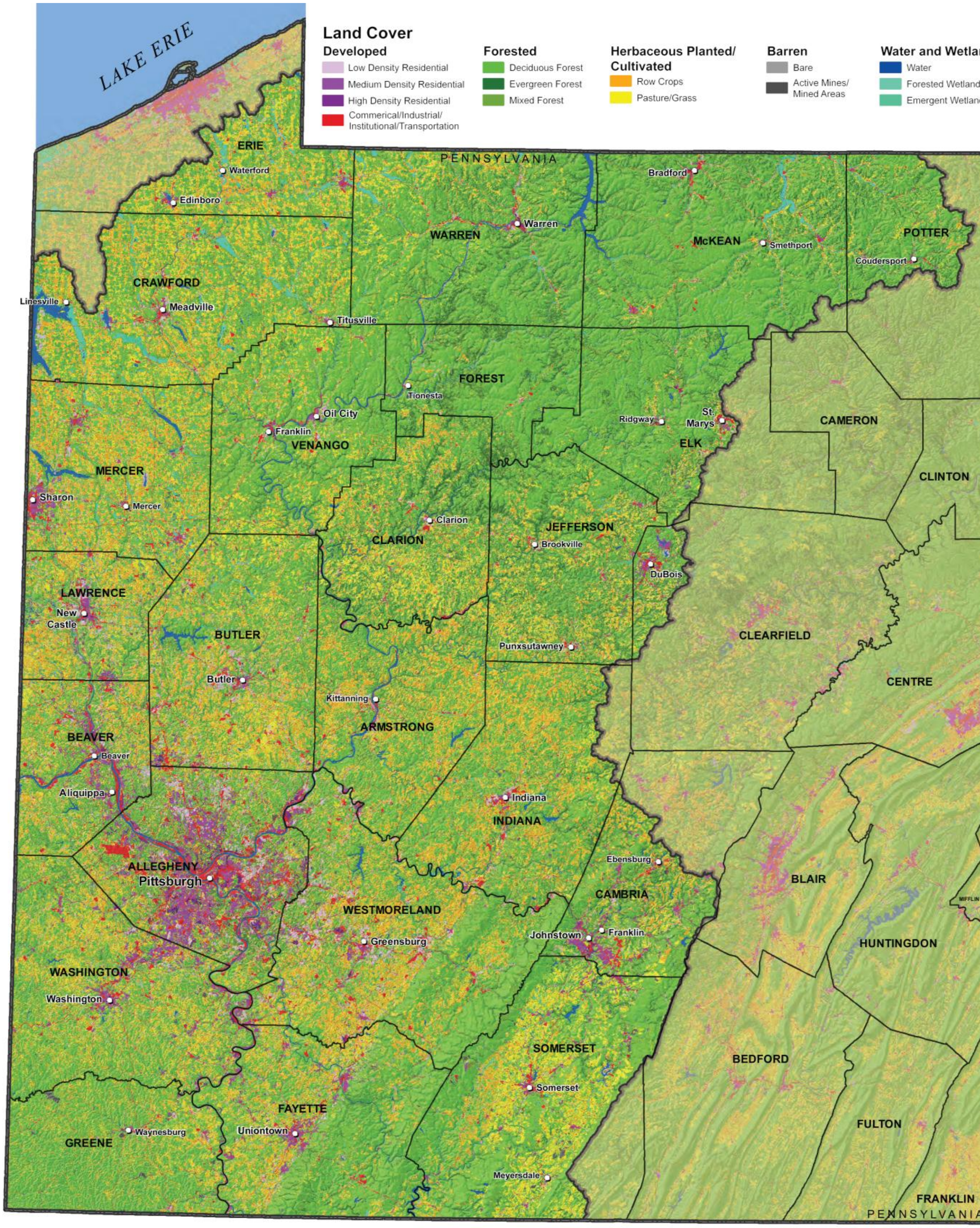

Figure 3.5. Map of land use in the upper Ohio River basin (from PADEP 2010b).

4. PHYSICAL FEATURES

4.1. Basin Area, Stream Magnitude, and Course

Several different methods are commonly used for determining physical features of rivers, including basin area and stream magnitude (*e.g.*, length, order, and gradient). Most of these methods vary considerably and data from different sources are usually not comparable. Some physical features can be determined directly from USGS 7.5-minute topographic maps, although accuracy may be questionable (*e.g.*, stream length). Rather than using hardcopy maps, more accurate data can be derived from contemporary mapping software, including Geographic Information System (GIS) platforms, however, discrepancies may still exist. For example, a detailed stream shapefile from PFBC's GIS portrays the Allegheny River as an eighth-order stream (using Strahler's 1957 method of stream-ordering). Meixler and Bain (1998) report the Allegheny as sixth-order, but most authors (*e.g.*, White *et al.* 2005) regard the Allegheny as seventh-order. Discrepancies in stream order determinations are most likely due to differences in levels of detail of first-order stream depictions. With this in mind, rather than provide the most accurate approximations available, the following sections summarize general physical features of the Three Rivers in the most meaningful context for this *Management Plan*.

Allegheny River

The Allegheny River drains a catchment area of approximately 11,700 square miles in Pennsylvania and New York (Table 4.1). The Allegheny begins as a first-order, high-gradient (defined by Rosgen (1994) as 4 percent to 10 percent slope) stream north of Pennsylvania Route 49 and west of the town of Raymond, Allegany Township, in north central Potter County, Pennsylvania. A roadside marker was erected in 1947 by the Pennsylvania Historical and Museum Commission (PHMC) in the vicinity of the Allegheny's source to commemorate its point of origin (Figure 4.1).

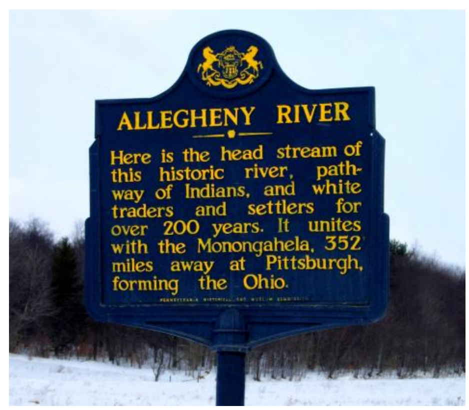

Figure 4.1. PHMC marker identifying the headwaters of the Allegheny River (PFBC Photograph).

From its headwaters, the Allegheny River flows in a westerly then northerly direction for approximately 55 miles through Potter and McKean Counties, and crosses the border into southern Cattaraugus County, New York. There it flows almost due west for another 48 miles, and then cuts south at the head of the massive Allegheny Reservoir (summer pool surface area approximately 12,080 acres and length approximately 24 miles) and back into Pennsylvania. After leaving the reservoir through Kinzua Dam, the river meanders to the southwest for 198 miles and along or through eight counties. During its course downstream of Kinzua Dam, approximately 126 miles of the Allegheny River remains free-flowing. Further downstream, 72 miles are impounded and regulated by eight fixed-crest, low-head, run-of-river navigation dams. When the Allegheny River finally reaches its confluence with the Monongahela River in Pittsburgh, Allegheny County, Pennsylvania, it is a low-gradient (defined by Rosgen (1994) as < 2 percent slope), seventh-order system (White *et al.* 2005) and classified by EPA as a large river (Flotemersch *et al*. 2006).

Table 4.1. Physical features and dimensions of the Three Rivers.

River	Total Length[1]	Length within Pennsylvania[2]	Total Basin Area[1]	Basin Area within Pennsylvania[2]	Strahler Stream Order[1]	EPA Typology[3]
Allegheny	325 mi	55 mi (Free-flowing above Allegheny Reservoir) 13 mi (Allegheny Reservoir) 126 mi (Free-flowing below Allegheny Reservoir) 72 mi (Dammed) 266 mi (Total)	11,700 mi^2	9,800 mi^2	7^{th}	Large River
Monongahela	128 mi	91 mi (Dammed)	7,400 mi^2	2,700 mi^2	7^{th}	Large River
Ohio	981 mi	40 mi (Dammed)	204,400 mi^2	3,100 mi^2	9^{th}	Great River

[1]White *et al*. (2005).
[2]PFBC's Agency Resource Database and GIS servers.
[3]Flotemersch *et al.* (2006).

Monongahela River
The Monongahela River drains a catchment area of approximately 7,400 square miles in West Virginia, Maryland, and Pennsylvania (Table 4.1). The Monongahela begins as a sixth-order, low-gradient system at the confluence of the West Fork River and Tygart Valley River in Fairmont, Marion County, West Virginia. During its northerly course downstream of Fairmont, through two counties in West Virginia and along or through five counties in Pennsylvania, the entire 128 miles of the river are impounded and regulated by nine run-of-river navigation dams. Two of these dams are fixed-crest / low-head (Grays Landing and Elizabeth in Pennsylvania) and seven are gated / high-lift (Opekiska, Hildebrand, and Morgantown in West Virginia and Point Marion, Maxwell, Charleroi, and Braddock in Pennsylvania). When the Monongahela finally reaches its confluence with the Allegheny in Pittsburgh, it is a low-gradient, seventh-order system (White *et al*. 2005) and also classified as a large river by EPA (Flotemersch *et al.* 2006).

Ohio River
The entire Ohio River drains a catchment area of approximately 204,400 square miles in 15 states (Table 4.1). The Ohio begins as a seventh-order, low-gradient system at the confluence of the Allegheny River and Monongahela River in Pittsburgh. It is the only river in North America with navigation miles numbered from its origin (RM 0 in Pittsburgh) rather than from its

mouth (RM 981 in Cairo, Illinois). During its westerly course downstream of Pittsburgh, the entire 981 miles of the Ohio River are impounded and regulated by 20 run-of-river navigation dams. Three of these dams are located in Pennsylvania (gated / high-lift dams Emsworth and Dashields in Allegheny County and Montgomery in Beaver County). When the Ohio River finally reaches its confluence with the upper Mississippi River in Cairo, it is a low-gradient, ninth-order system (White *et al.* 2005) and classified as a great river by EPA (Flotemersch *et al.* 2006).

Impacts of Glaciation

The glacial invasions of the Pleistocene Epoch, which began about 2.6 million years ago and ended approximately 10,000 years ago following the retreat of the Laurentide Ice Sheet during the Wisconsin Glacial Episode (Sevon *et al.* 1999), resulted in massive changes to both drainage patterns and orientations of the upper Ohio River basin (Harper 1997). Before the Pleistocene, drainage courses of the upper Ohio River basin were generally northwestward toward Canada rather than southwestward to the Mississippi Valley (Figure 4.2). The pre-Pleistocene Monongahela River was the predominant drainage feature of southwestern Pennsylvania, flowing north towards present-day Pittsburgh, following courses of the present-day Ohio River and Beaver River systems and eventually making its way into the Ancestral Erie Basin. At that time, the Ohio River was a tributary of the Monongahela, and the Allegheny River existed as three discrete and unrelated rivers: Lower Allegheny, Middle Allegheny, and Upper Allegheny. The three Alleghenys drained different regions and followed the courses of the present-day Clarion River and French Creek.

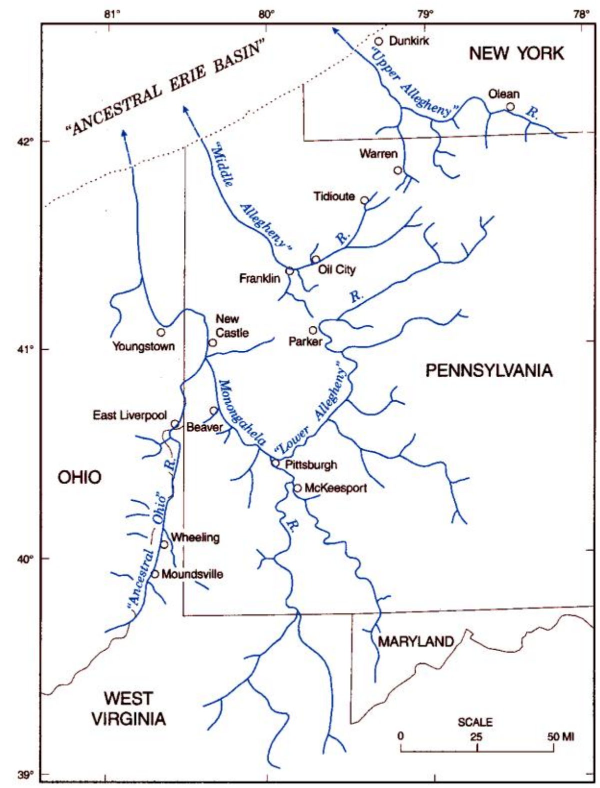

Figure 4.2. Drainage patterns and courses of the Three Rivers before the Pleistocene Epoch (from Harper 1997).

During the Pleistocene, glaciers advancing into northwestern Pennsylvania blocked the northwest-flowing rivers, causing ancestral lakes of varying extents to form along the edges of the ice sheet. Some lakes that formed, most notably Lake Monongahela, were enormous (White 1896). Eventually, these lakes filled with glacial meltwater and overflowed. Since water could not flow northward through the ice, it took a southerly route carving new courses through ridges; occupying channels formed by established streams; and reversing the ancient drainage patterns and orientations of the Monongahela, Middle Allegheny, and Upper Allegheny Rivers. After the Ohio River was re-routed to join the Mississippi River, the Monongahela and Allegheny became its tributaries. Having ancestral connections to both the northern Lake Erie/Saint Lawrence River system and present connections to the southern Mississippi River system was likely instrumental in shaping the biodiversity of today's upper Ohio River basin (Lachner 1956).

4.2. Channel Dimensions and Morphology

Allegheny River

At its headwaters in Potter County, the Allegheny River is less than one foot wide, while at normal "in-pool" river stage, it is approximately 950 feet wide where it meets the Monongahela River in Pittsburgh. The widest bank-to-bank extent on the Allegheny, 2,150 feet, is near Blawnox in the vicinity of Sycamore Island and Ninemile Island at RM 10.1.

Under a mandate from Congress, USACE's Pittsburgh District is responsible for maintaining a minimum 9-foot deep navigation channel created by the eight navigation dams along the lower Allegheny River from the confluence in Pittsburgh upstream to East Brady at RM 72. Navigation pools of the Allegheny are periodically deepened by USACE maintenance dredging as necessary to meet the minimum depth required for navigation. The same mandate is also in effect for navigation pools of the Monongahela River and Ohio River.

Above East Brady, the free-flowing Allegheny is considerably shallower than the dammed reach downstream, but is interspersed with occasional deep pools (> 25 feet) at historic commercial sand and gravel dredging locations near Franklin, Oil City, Tionesta, Starbrick, Mead Island, and Warren (Mayer 1972). Downstream of East Brady, the deepest locations in the river are dredge pits created by commercial sand and gravel extraction activities, and these pits are especially expansive in Pools 3, 4, 5, 7, and 8. The mean depth is 14 feet in undredged areas and 33 feet in dredged areas (USACE 2006a). Dredge pits up to 70 feet deep have been identified during recent bathymetric surveys of Pool 3 near Barking and Pool 5 near Johnetta.

From Pittsburgh upstream to East Brady, the lower Allegheny River maintains a high degree of sinuosity (defined by Rosgen (1996) as a ratio of channel length to valley length of 1.2 to 1.5 for slightly entrenched streams). Above East Brady, the river sustains a very high degree of sinuosity (defined by Rosgen (1996) as a ratio of channel length to valley length greater than 1.5 for slightly entrenched streams). For a large, unregulated river, this sinuosity is exemplified by the upper Allegheny's many well-defined meander bends, some having exceptional wavelength and amplitude (*e.g*., Brady's Bend at RM 66 to 71).

Along its course from Kinzua Dam to Pittsburgh, the unbraided, slightly entrenched river channel is confined within a relatively narrow, steep-walled, and moderately incised valley. Both 100-year and 500-year floodplains appear to be generally narrow and discontinuous due to the steep valley slopes that confine the river.

Monongahela River

During normal "in pool" river stage, the Monongahela River is approximately 750 feet wide at the Pennsylvania / West Virginia border and approximately 900 feet wide at its confluence with the Allegheny River in Pittsburgh. The widest bank-to-bank extent of the Monongahela River in Pennsylvania is 1,150 feet just upstream of the Braddock Locks and Dam (L/D) at RM 11.6, near the mouth of Turtle Creek.

Unlike the Allegheny and Ohio Rivers, the Monongahela River has not been subjected to commercial extraction activities for glacial sand and gravel aggregate, which was not deposited in this basin. Although mean depth figures for the Monongahela River could not be obtained, recent observations suggest a mean depth of about 20 feet, which likely changes year-to-year as in all dynamic large river ecosystems.

Along its course, the Monongahela River maintains a high degree of sinuosity, exemplified by a number of meander bends having a range of amplitudes and wavelengths for a large, regulated river. The unbraided, slightly entrenched river channel is confined in a relatively narrow, steep-walled, and moderately incised valley. Both 100-year and 500-year floodplains appear to be generally narrow and discontinuous due to the steep slopes of the river valley.

Ohio River

During normal "in pool" river stage, the Ohio River is approximately 2,150 feet wide where it starts in Pittsburgh and approximately 1,250 feet wide at the Pennsylvania border with Ohio. The widest bank-to-bank extent on the Ohio within Pennsylvania, 3,850 feet, is near Emsworth in the vicinity of Neville Island at RM 5.7.

Like the Allegheny, the deepest locations on the Ohio River are dredge pits created by commercial sand and gravel extraction activities. These dredge pits are expansive in the Dashields, Montgomery, and New Cumberland Pools. The mean depth of the Ohio River is 14 feet in undredged areas and 33 feet in dredged areas (USACE 2006a). Dredge pits up to 60 feet deep have been identified during recent bathymetric surveys of the New Cumberland pool downstream of Phillis Island.

From Pittsburgh downstream to Cairo, the Ohio River maintains a high degree of sinuosity, exemplified by several sweeping meander bends having a range of amplitudes and wavelengths for a great, regulated river. Within Pennsylvania, the unbraided, slightly entrenched river channel is confined within a relatively narrow, steep-walled, and moderately incised valley. Both 100-year and 500-year floodplains appear to be generally narrow and discontinuous, restricted by the steep slopes of the river valley.

5. HYDROLOGY

5.1. Hydrologic Regime

Groundwater

Groundwater impacts the hydrologic regime of the Three Rivers from two aquifers (USACE 1975a, 1975b, 1980, 1981):

1. The primary and most productive source of available groundwater is contained by relatively shallow, unconsolidated glaciofluvial sand and gravel contiguous with valleys of the Ohio River, Allegheny River, and lower Monongahela River. This unconfined aquifer often has been erroneously called the "Fourth River" or "Underground River" by the media because it provides a source of water for the fountain at Point State Park in Pittsburgh. Having remarkable porosity and permeability, the aquifer is easily replenished by infiltration from precipitation and contributions from tributary streams (Fleeger 1999). The rivers also recharge the aquifer during periods of high flows. An estimated 4.5 billion gallons of water are stored in the glaciofluvial aquifer of the Ohio River (USACE 2006b). Due to the shallow depth of this aquifer, it is especially vulnerable to pollution.
2. The secondary source of available groundwater is contained within relatively deep, consolidated bedrock located beneath the glaciofluvial deposits contiguous with valleys of the Ohio River, Allegheny River, and Monongahela River. This confined bedrock aquifer is generally comprised of sandstone and shale that possess sufficient permeability to allow the passage of water (Fleeger 1999).

Groundwater contribution to river discharge (*i.e*., base flow) within the upper Ohio River basin remains relatively constant throughout the year (USACE 1981).

River Discharge

In the upper Ohio River basin, seasonal variations in precipitation have been reported to produce even more variable rates of overland runoff (USACE 1975a, 1975b, 1980, 1981). Of the 22 major subbasins within the entire Ohio River basin, the Allegheny River basin and Monongahela River basin ranked first and second, respectively, in both amounts of annual runoff (average annual runoff of 23.2 inches and 23.1 inches, respectively) and percentages of annual precipitation that results as runoff (58 percent and 60 percent, respectively; USACE 1966). Periods of relatively high river discharge typically occur from November through April when soils are saturated or frozen and most conducive for runoff. However, overall river discharge for the Three Rivers shows little seasonal, interannual, or decadal patterns.

Extreme landform dissection, high local relief, precipitous slopes of river valleys, narrow discontinuous floodplains, confined river channels, climate and precipitation patterns, and relatively high rates of runoff have all contributed to the propensity of flood events for the Three Rivers. Flood events of winter/early spring are typically the result of prolonged moderate rainfall over large areas, usually accompanied by snowmelt. Summer/early fall flood events generally result from torrential rainfall of great intensity and short duration over small areas. Flood events can and have occurred on the Three Rivers throughout different times of the year.

Over the past 250 years, there have been many major flood events of the Three Rivers, some of which have been notably destructive, such as the infamous Saint Patrick's Day Flood of 1936. This event was considered by some meteorologists to be the worst natural disaster in western Pennsylvania history, a 500-year event. The Three Rivers rose 21 feet above flood stage, inundating the Point and most of downtown Pittsburgh (Figure 5.1). This event provoked Congress to finally pass the Flood Control Act of 1936, signed into law by President Franklin D. Roosevelt in June of that year.

Figure 5.1. Pittsburgh and the confluence of the Three Rivers during the Saint Patrick's Day Flood of 1936 (from Heinz History Center Library & Archives).

The record maximum peak discharge recorded at the USGS gauging station on the Ohio River at Sewickley, Allegheny County (Dashields Pool), was 574,000 cubic feet per second (cfs) on March 18, 1936, and the lowest daily mean discharge recorded was only 2,100 cfs on September 4, 1957 (USGS 2008). The annual mean discharge for this location based on daily records from 1934 to 2008 is 33,640 cfs, which approximates the mean of 39,790 cfs for 2008.

The maximum peak discharge recorded at the USGS gauging station on the Allegheny River at Kittanning, Armstrong County (Pool 7), was 269,000 cfs on March 26, 1913, and the lowest daily mean discharge recorded was only 570 cfs from September 15-17, 1913 (USGS 2008). The annual mean discharge for this location based on daily records from 1904 to 2008 is 15,970 cfs, which approximates the mean of 18,210 cfs for 2008.

For an upstream comparison, the maximum peak discharge recorded at the USGS gauging station at West Hickory, Forest County, was 101,000 cfs on March 8, 1956, and the lowest daily mean discharge recorded was only 272 cfs on October 15, 1963 (USGS 2008). The annual mean discharge for this location based on records from 1941 to 2008 is 6,708 cfs, which approximates the mean of 7,429 cfs for 2008.

At the USGS gauging station on the Monongahela River at Elizabeth, Allegheny County (Elizabeth Pool), the maximum peak discharge recorded was 178,000 cfs on November 6, 1985, and the lowest daily mean discharge recorded was only 206 cfs on June 29, 1936 (USGS 2008). The annual mean discharge for this location based on records 1934 to 2008 is 9,262 cfs, which approximates the mean of 11,280 cfs for 2008 of 11,280.

Flow duration curves and high flow statistics (*e.g.*, 5% exceedances – river flows that have been exceeded only five percent of all days of the flow record) for the Three Rivers were evaluated for this *Management Plan*. The iteration of high flow frequencies of the Three Rivers reflects the excessive number of flood events that have occurred over the years, as well as the inherent variability of river discharge data. Low flow statistics (*e.g.*, $7Q_{10}$ – average minimum river flows expected for seven consecutive days once every ten years) for the Three Rivers were also evaluated. Although the Monongahela River's $7Q_{10}$ values are considerably lower than the Allegheny's, all values predictably increase downstream (Table 5.1).

Table 5.1. Low flow statistics ($7Q_{10}$) for selected locations on the Three Rivers (USGS 2010b).

River	Location	County	RM	$7Q_{10}$ (cfs)
Ohio	McKee's Rocks Bridge (Pittsburgh)	Allegheny	3.3	3,090
	Shippingport Bridge	Beaver	34.7	3,650
Monongahela	Fort Pitt Bridge (Pittsburgh)	Allegheny	0.2	1,210
	Clairton-Glassport Bridge	Allegheny	19.3	501
	Belle Vernon Bridge	Fayette	43.3	482
	Masontown Bridge	Fayette	79.2	476
Allegheny	Fort Duquesne Bridge (Pittsburgh)	Allegheny	0.3	1,430
	Donald R. Lobaugh Bridge (Freeport)	Armstrong	28.2	1,370
	Kittanning Citizens Bridge	Armstrong	45.1	1,020
	Sergeant Carl F. Curran II Memorial Bridge (East Brady)	Clarion	69.5	967
	Veterans Memorial Bridge (Oil City)	Venango	131.3	940
	Tionesta Bridge	Forest	152.0	797
	West Hickory Bridge	Forest	158.2	784
	Tidioute Bridge	Warren	166.6	767
	National Forge Bridge (Warren)	Warren	187.6	671

Material Transport and Bedload

Rivers transport sediment in the form of "suspended load" (fine-grained clay- and/or silt-sized particles suspended in the water column) and "bedload" (coarse-grained sand-, gravel-, cobble-, and/or boulder-sized material that roll or bounce along the riverbed) (Gupta 2007). As river velocity decreases, it reaches a point when the force of the water is not great enough to keep sediments suspended and finer particles begin to be deposited (*i.e.,* sedimentation). Sediment loads carried by the Three Rivers represent the sum of all erosive processes occurring within the upper Ohio River basin, mostly contributions from tributary streams rather than mainstem bed and bank erosion (USACE 1981). With the industrialization of western Pennsylvania, coal fines and steel mill slag became a substantial component of fluvial sediment (as bedload) of the Three Rivers, especially for the lower Monongahela River and the upper Ohio River. The impacts of coal fines and steel mill slag on fisheries resources of the Three Rivers has not been investigated.

The Three Rivers provide a substantial system for transporting sediment from the Appalachian Plateau of western Pennsylvania to the Mississippi River by means of the Ohio River. Run-of-river navigation dams as well as flood control dams and their impoundments have altered processes by which the Three Rivers naturally transport and store their sediment loads. Navigation dams impound water that would naturally flow away and partition the Three Rivers into large, flat reaches that inundate what little floodplains exist, which otherwise would flood only seasonally or intermittently.

Navigation dams reduce the natural velocity immediately upriver from their locations, trapping sediments that would otherwise flow downstream. Fine-grained fluvial sediments are known to adsorb and carry nutrients (*e.g.*, mostly phosphorus, and to a small degree, nitrogen), contaminants (*e.g.,* polychlorinated biphenyls (PCBs) and heavy metals), and allochthonous organic carbon (Meade 1995). Sediment retention by dams can have downstream (*e.g.*, nutrient depletions) and upstream (*e.g.,* nutrient loadings, oxygen demand, accumulation of contaminants as “legacy sediments”) consequences.

A tenfold increase in suspended sediment loads has occurred in the Ohio River over the last several hundred years, most likely as a result of increases in rowcrop agriculture and deforestation in the basin (Meade 1995, Meade & Moody 2010). During the same timeframe, suspended sediment loads in the Mississippi River actually decreased by one-half, attributable to construction of large dams and impoundments on the Missouri and Arkansas Rivers that retain sediment loads and hinder sediment transport. The degrees of sediment load and transport within the Allegheny River and Monongahela River as well as degrees of sediment retention by dams remain unknown.

Nearly all maintenance dredging on the Three Rivers occurs at locations downstream of navigation dams, especially at the downstream approaches of lock chambers rather than upstream of dams where sediments most likely accumulate (USACE 1975a, 1975b, 1980). Impacts of maintenance dredging (*e.g.,* increased turbidity, downstream siltation, liberation of sediment-bound legacy contaminants, destruction of riverine habitats) on the Three Rivers as well as land disposal of dredge material has not been reported.

Major Tributaries

As a riverine ecosystem, the Three Rivers depend upon discharge, sediment transport, and inputs of allochthonous organic carbon (as coarse particulate organic matter, fine particulate organic matter, and dissolved organic carbon), nutrients, and inorganic constituents (*e.g*., carbonate alkalinity, essential ions, and dissolved elements) from all of their tributary streams in the 32 major subbasins (Figure 5.2).

Major tributaries entering the upper Allegheny River from glaciated landscapes to the west, including Brokenstraw Creek and the celebrated French Creek, are generally very diverse in terms of maintaining warmwater fish and mussel assemblages and are relatively well-buffered. Major tributaries entering the upper Allegheny River from densely forested, unglaciated landscapes to the east, including Tionesta Creek and the Clarion River, are not as diverse or buffered as their western counterparts. Some of these eastern tributaries sustain coldwater fisheries to varying degrees (put-and-take, put-grow-take fingerlings, and natural reproduction). Many major tributary streams entering the middle and lower Allegheny River from the east, including Redbank Creek, Mahoning Creek, Cowanshannock Creek, Crooked Creek, and the Kiskiminetas River, have experienced negative impacts from a long history of coal mining and inputs from abandoned coal mines. Many of these impacted eastern tributaries have recovered, or are still recovering, to varying degrees and now support warmwater assemblages.

Major tributary streams entering the Monongahela River have also experienced negative impacts from a legacy of coal mining, and continue to receive inputs from abandoned coal mines today. These streams span the range of recovery, from nearly recovered (*e.g.*, Youghiogheny River) to remaining impacted (*e.g.*, Turtle Creek). Some Monongahela River tributaries continue to be disturbed by modern industries, such as longwall mining and Marcellus Shale drilling, including Dunkard Creek and Tenmile Creek. Major tributary streams of the upper Ohio River include Chartiers Creek (one of the most disturbed streams in the basin from numerous perturbations), Raccoon Creek (a recovering stream), and the Beaver River system.

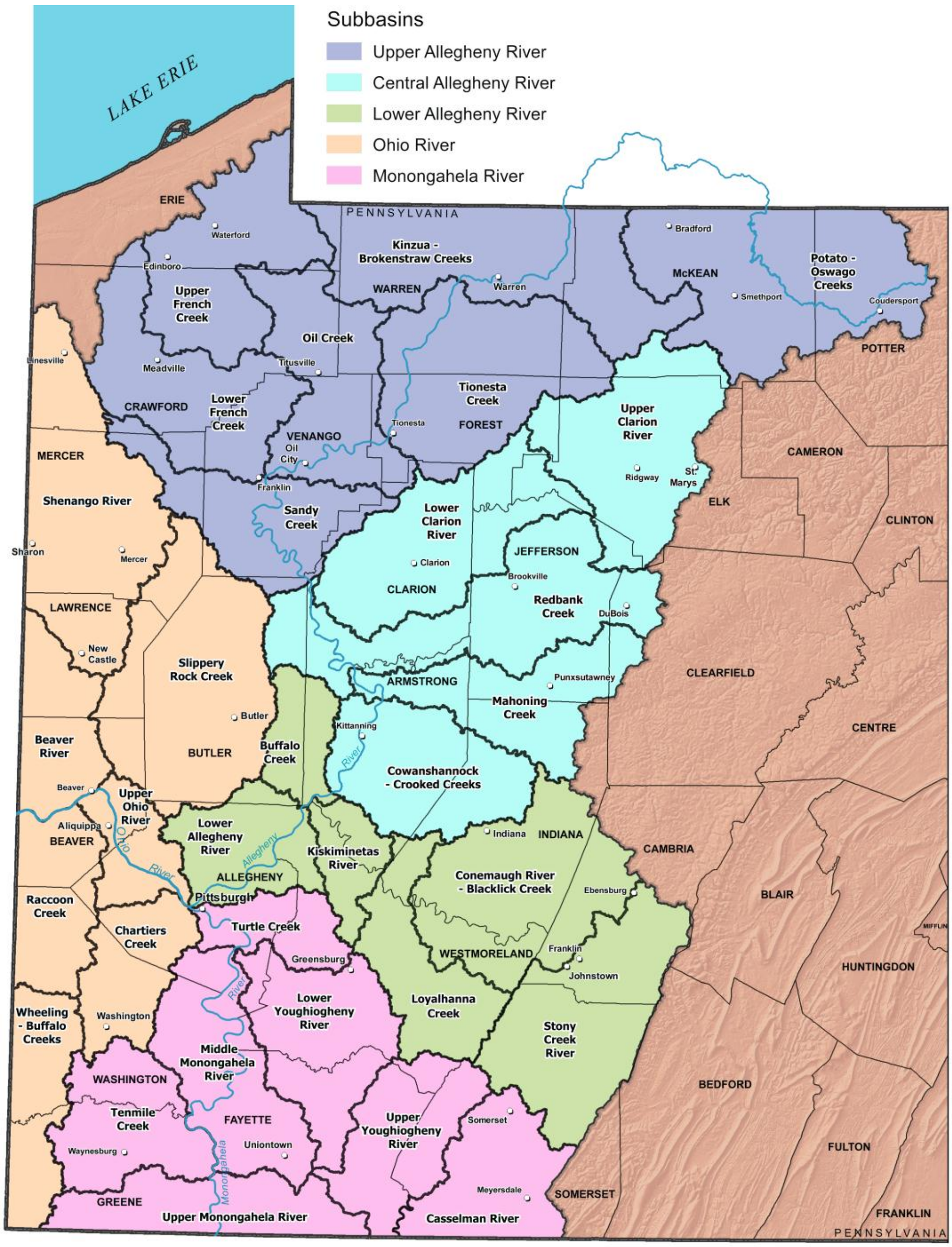

Figure 5.2. Major tributary stream subbasins of the upper Ohio River basin (from PADEP 2010b).

5.2. Flow Modifications

Navigation Dams

In the Nineteenth Century, navigation on the Three Rivers was challenging, if not dangerous. In addition to seasonally fluctuating river depths, floods, and ice, steamboat operators were relentlessly confronted by shallow sand and gravel bars, boulders, large woody debris, river currents, rapids, chutes, and eddies. Skilled steamboat operators could easily navigate the Three Rivers in depths as low as about three feet (Johnson 1974); however, this depth was usually not available during times of low flow, typically July through October, when only the shallowest draft boats could navigate. During low flow months, teams of horses were often required to pull boats through shallow river reaches. Businesses and manufacturing industries that relied on river transport were unable to operate without sufficient river flow and temporarily closed, laying-off employees, until river levels returned to navigable stages. Steamboat operators came to rely on two rises: the fall rise in November and December and the spring rise in March and April (Johnson 1974). During these periods, the Three Rivers became awash in boats transporting commodities to upriver and downriver markets.

Overall discord of steamboat operators distressed over river conditions coupled with increasing demands for river-transported commerce finally led to intervention by local and state governments. In 1819, a joint commission of representatives from Virginia, Kentucky, Ohio, and Pennsylvania assembled in Pittsburgh to plan for navigation improvements on the Ohio River, given its interstate position. Unfortunately, state and local governments backed by private companies found that they lacked the financial resources or the jurisdiction to undertake such a massive project. The United States Congress intervened and appropriated $5,000 to a joint commission for a survey of the Ohio River, which was used to map 102 obstructions between Pittsburgh and Louisville (Frost and Mitsch 1989). The 1820 appropriation marked the beginning of federal water resources programs in the United States. In 1821, Pennsylvania appropriated an additional $15,000 for this work, but other states did not parlay, so these funds were expended on only the upper Ohio River.

In 1824, Congress passed the General Survey Act, which gave USACE continuing authority to conduct navigational studies. This was followed by the first Rivers and Harbors Act of 1827, which authorized federal removal of river obstructions and improvement of harbors in the United States (Frost and Mitsch 1989). The initial appropriation for the Ohio River was $30,000, to be used for snag removal and channel deepening. This was the first of a series of 12 annual federal appropriations, averaging about $50,000 per year, which were expended to improve the Ohio River (Johnson 1974). During the initial phases of federal participation, snag boats of multifarious and peculiar designs operated by USACE were worked extensively on major rivers of the United States. Nicknamed "Uncle Sam's Tooth Pullers," these vessels were used to extract entire trees and large woody debris (Figure 5.3). Snag removal was accompanied by sandbar dredging, which was found to be a more effective technique of improving navigation on major rivers.

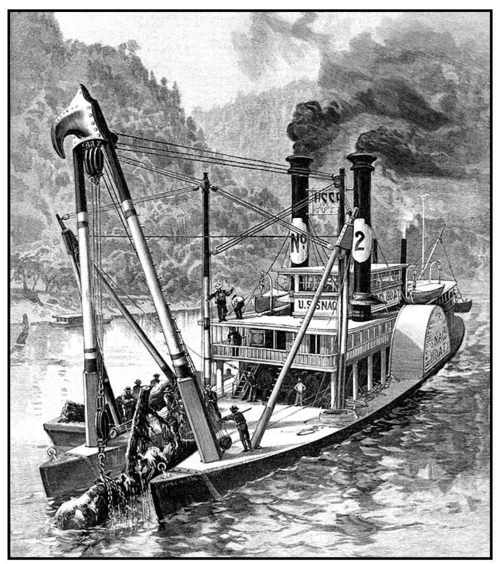

Figure 5.3. USACE *Snag Boat Number 2* removing large woody debris from the Monongahela River (from *Harper's Weekly*, November 2, 1889).

In the years following the Rivers and Harbors Act of 1827, numerous hazards (and fish habitat) were removed from the Three Rivers using snag boats. Volumes of sand, gravel, cobble, and boulders were also excavated during dredging operations. The Three Rivers became easier to navigate, but the problem of low water prevailed during low flow months. Because the Ohio River was interstate water, it was relatively easy for Congress to pass bills and appropriate funds for its improvement, but this was not the case for the Monongahela and Allegheny Rivers. Unable to solicit federal funding, the Pennsylvania Assembly decided to underwrite improvements for the much busier Monongahela River and authorized the formation of the Monongahela Navigation Company (MNC) in 1836. In its first year, MNC proposed seven locks and dams to extend navigation pools from Pittsburgh to the Pennsylvania border with West Virginia (Moxley 2001). MNC was incorporated in 1837 and started operations in 1838.

MNC completed construction of L/D 1 at RM 2 in Pittsburgh in 1841 (Figure 5.4) and L/D 2 at RM 11.7 at “Braddock’s Upper Ripple” (most likely a shallow gravel/cobble riffle) just upstream of the confluence with Turtle Creek (Moxley 2001). Both structures featured a single lock chamber constructed of hand-cut stone and timber with wooden gates that were operated manually and fixed crest dams constructed of stone-filled timber cribs. Due to increasing river traffic, MNC added a second and much larger lock chamber at each of the two structures in 1848 and 1854, respectively.

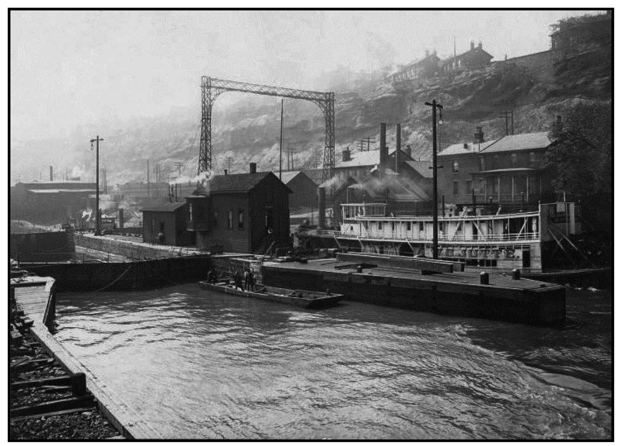

Figure 5.4. Monongahela River L/D 1 in Pittsburgh featuring dual lock chambers (from Heinz History Center Library & Archives).

In 1844, MNC completed L/D 3 at Elizabeth (RM 23.8) and L/D 4 at North Charleroi (RM 40.9). Before it was officially incorporated in 1885, North Charleroi was known as Lock 4. In 1856, MNC completed L/D 5 at Denbo (RM 58.8) and L/D 6 at Rices Landing (RM 68.2). Finally, L/D 7 was completed in 1883 near the confluence of Jacobs Creek upstream of Grays Landing (RM 82.8).

Under the Rivers and Harbors Act of 1875, Congress appropriated funds for the first federally-constructed lock and dam on the Ohio River, L/D 1, at Davis Island (RM 4.7) in Pittsburgh (USACE 2006b). Completed in 1885, the Davis Island project created the “Pittsburgh Harbor.” This project employed a single lock chamber (Figure 5.5), much larger than the ones constructed by MNC, and the largest in the world at that time. The Davis Island project also consisted of what would soon become a very familiar site along the Ohio River, a moveable wicket dam. With 305 wickets spanning a total of 1,223 feet, L/D 1 on the Ohio River as the longest dam in the world at that time.

Wicket dams consisted of wooden bulkheads hinged on the river bottom that could be lowered with a maneuver boat when flow was high or lifted when flow was low to create an upstream navigation pool (Figure 5.6). When lowered at high flow, wicket dams allowed boat traffic to maneuver over the lowered wickets, eliminating the need to navigate through the time-consuming lock chamber.

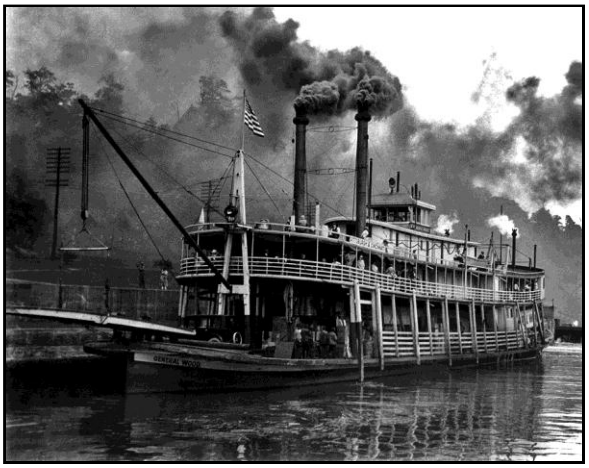

Figure 5.5. The *General Wood* locking through Ohio River L/D 1 at Davis Island, Pittsburgh in 1921 (from Public Library of Cincinnati and Hamilton County).

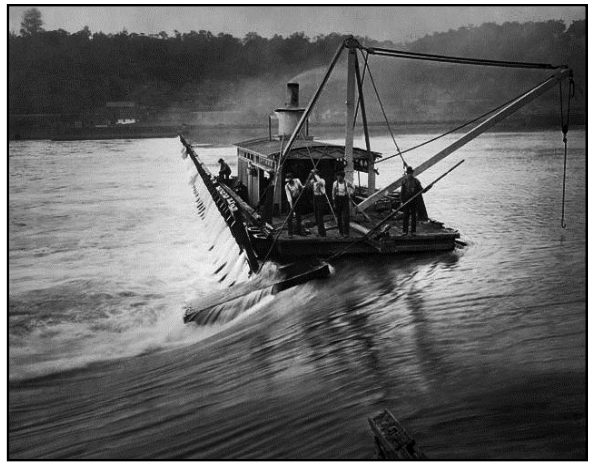

Figure 5.6. Lowering wickets at Ohio River L/D 1 at Davis Island, Pittsburgh in 1904 (from Heinz History center Library & Archives).

Congress granted the first federal funding for Allegheny River improvement in 1878 with an appropriation of $10,000 to survey the river for hazards. In 1885, they approved construction of L/D 1, a wicket dam near 22nd Street in Pittsburgh (RM 1.7) at "Garrison's Ripple" downstream of Herrs Island (erroneously called Herrs Island Lock and Dam, even though it was constructed 0.4 miles downstream of the island) (Figure 5.7). Construction of L/D 1 was completed in 1903. Allegheny River L/D 2 at Aspinwall upstream of Sixmile Island (RM 6.9) and L/D 3 at Springdale (RM 16.5) were completed in 1908.

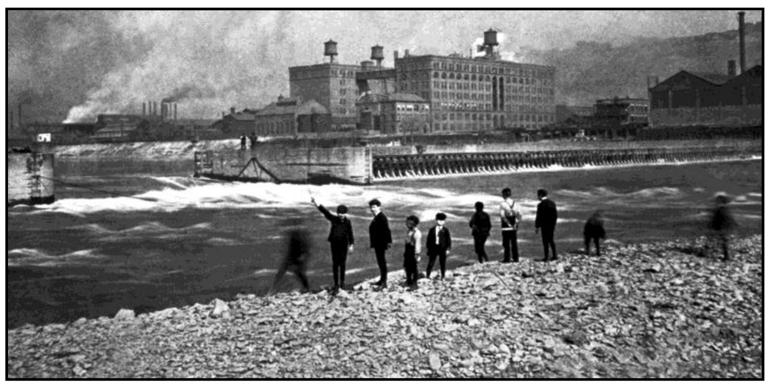

Figure 5.7. Allegheny River L/D 1 in Pittsburgh (from USACE 2010).

In order to recover its capital investment, and to make their venture profitable, the privatized MNC collected tolls from steamboat operators locking through L/D 1 through L/D 7 on the Monongahela River (Moxley 2001). Following the passage of the Rivers and Harbors Act of 1884, which prohibited tolls, fees, or operating charges of any kind collected on public navigational works owned by the United States, steamboat operators and coal companies lobbied Congress to purchase MNC's assets to allow toll-free navigation on the river (Moxley 2001). MNC resisted, and after several legal battles and lengthy condemnation proceedings, the Supreme Court ruled in 1897 that the United States had the authority to acquire all of MNC's properties for $3.8 million. With the river under federal jurisdiction, USACE extended toll-free navigation on the Monongahela River, and by 1904, completed construction of L/D 8 through L/D 15 to the headwaters at Fairmont, West Virginia.

By the turn of the Twentieth Century, the newer barges running the Ohio River were deeper draft, about 9 feet, than the older boats. Again, Congress intervened, and the Rivers and Harbors Act of 1910 authorized a 9-foot navigation channel project involving construction of additional moveable wicket dams and lock chambers for the entire Ohio River (USACE 2006b). By 1929, 51 wicket dams and lock chambers were installed from L/D 1 at Pittsburgh downstream to L/D 53 near Mound City, Illinois.

Wicket dams were successful in deepening the navigation channel of the Ohio River, but the navigation pools they created were not permanent. Congress passed the Rivers and harbors Act of 1918, which appropriated funds for construction of permanent structures to make navigation even more convenient on the Ohio River, which would ultimately result in improved conditions for industrial development along the Three Rivers (USACE 2006b). The first permanent structure constructed on the Ohio River was the Emsworth L/D at RM 6.2 in Pittsburgh.

The Emsworth L/D was completed in 1922 and eventually replaced three older structures upstream: original L/D 1 on the Ohio River (removed in 1922); original L/D 1 on the Allegheny River (removed in 1938); and original L/D 1 on the Monongahela River (removed in 1938) (Moxley 2001). The original L/Dam 2 on the Ohio River was removed in 1922. The Dashields L/D was completed downstream of Emsworth in 1929, replacing the original L/D 3 that was removed that year (Moxley 2001). In 1936, the Montgomery L/D was completed downstream of Dashields, replacing the original L/Ds 4, 5, and 6 that were removed that year (USACE 2006b).

Throughout the early part of the Twentieth Century, the ten original lock and dam structures on the Allegheny and Monongahela Rivers were systematically replaced. For example, by 1906, L/D 2 on Monongahela River was removed and reconstructed downstream, this time below the confluence of Turtle Creek. Additional structures were also constructed on the Allegheny River, extending navigation from Pittsburgh upstream to East Brady. Today, there are three locks and dams on the Ohio River in Pennsylvania (Figures 5.8, 5.11), eight on the Allegheny River (Figures 5.9, 5.12), and six on the Monongahela River within Pennsylvania (Figures 5.10, 5.13) (Table 5.2).

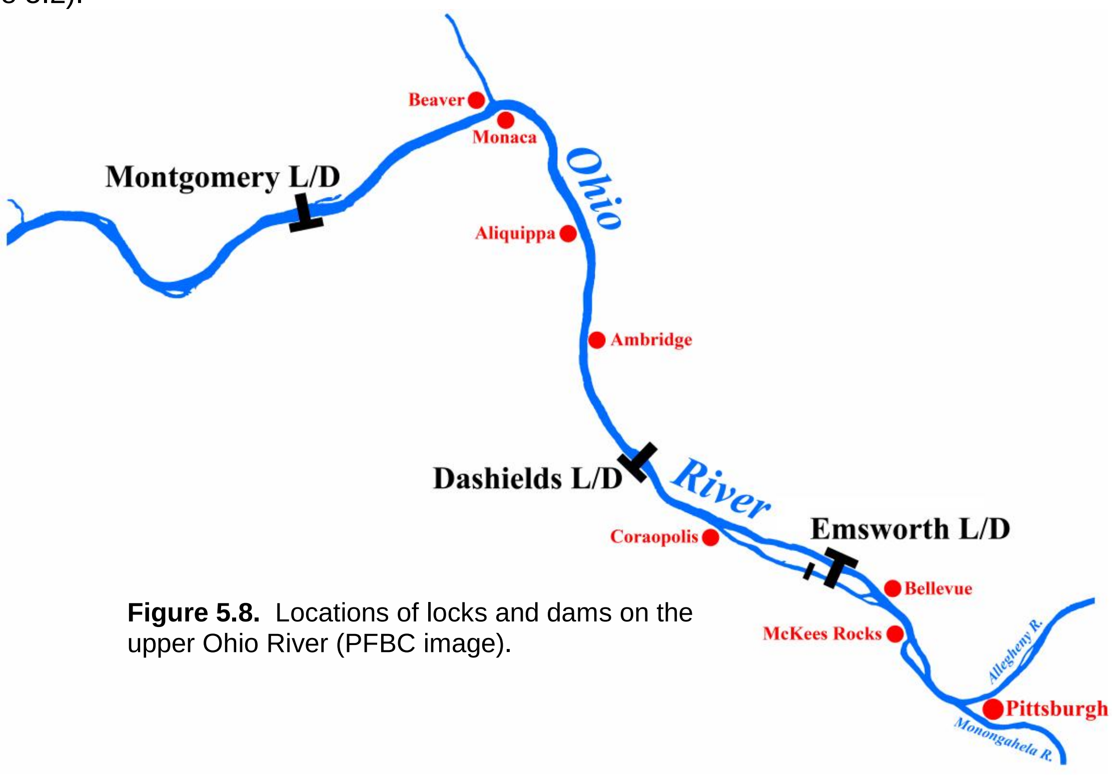

Figure 5.8. Locations of locks and dams on the upper Ohio River (PFBC image).

Maps Not to Same Scale.

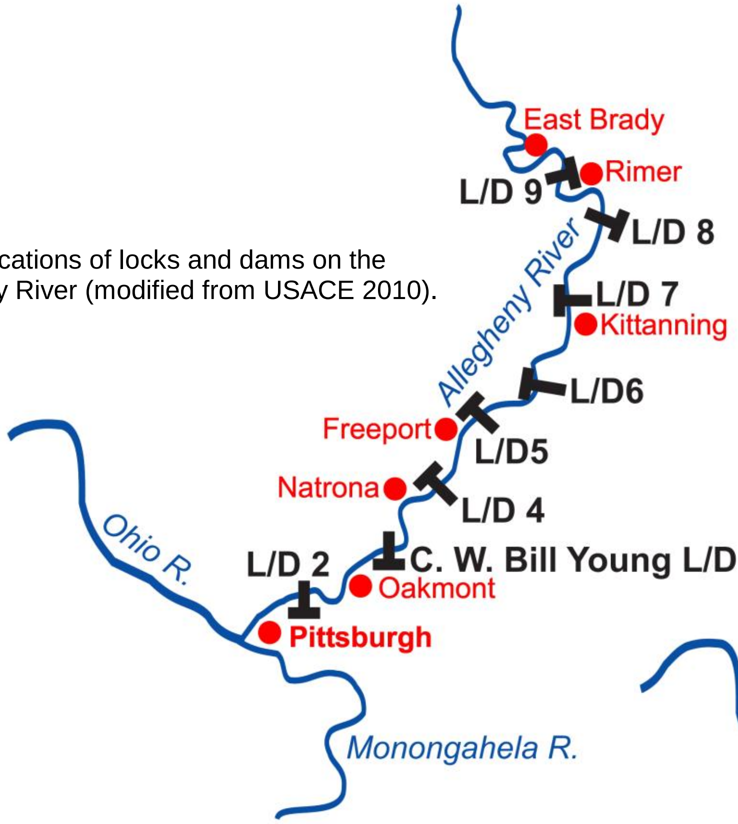

Figure 5.9. Locations of locks and dams on the lower Allegheny River (modified from USACE 2010).

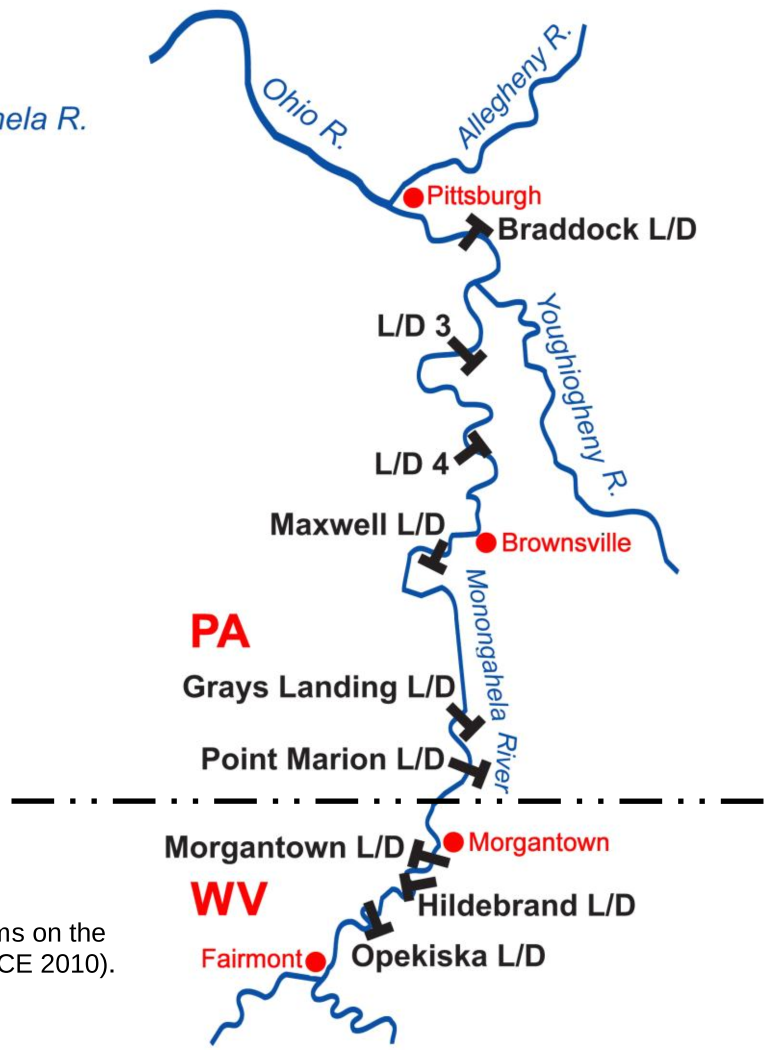

Figure 5.10. Locations of locks and dams on the Monongahela River (modified from USACE 2010).

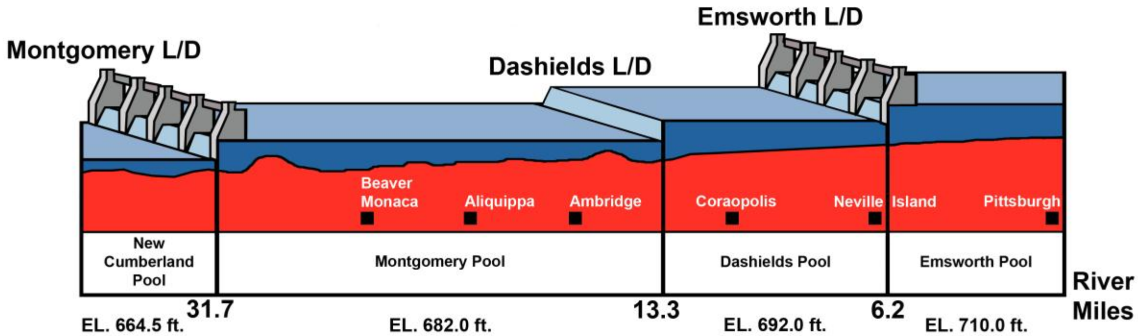

Figure 5.11. Generalized profile of locks and dams on the upper Ohio River, depicting navigation pool elevations and downstream distances from Pittsburgh (modified from USACE 2010).

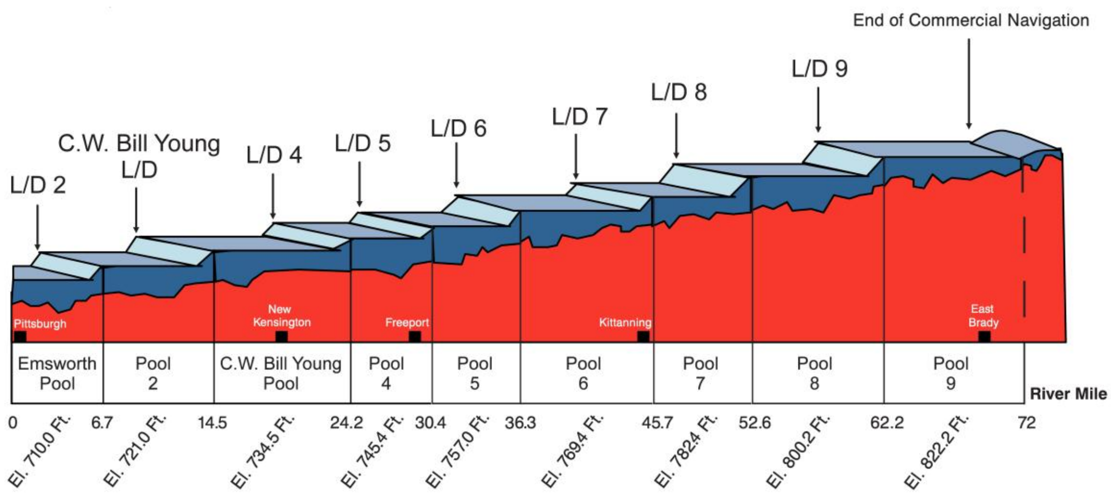

Figure 5.12. Generalized profile of locks and dams on the lower Allegheny River, depicting navigation pool elevations and upstream distances from Pittsburgh (modified from USACE 2010).

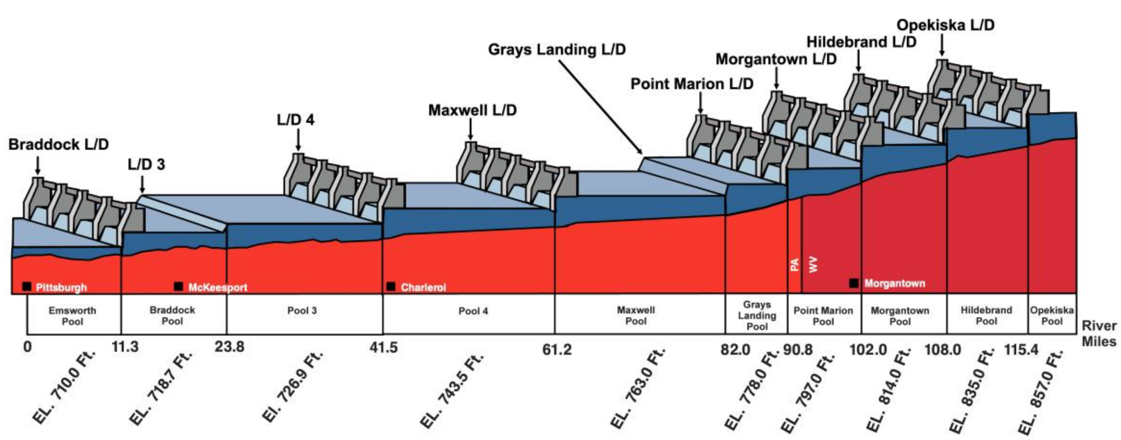

Figure 5.13. Generalized profile of locks and dams on the Monongahela River, depicting navigation pool elevations and upstream distances from Pittsburgh (modified from USACE 2010).

Table 5.2. Locks and dams on the Three Rivers.

River	Lock(s) and Dam	# Lock Chambers	RM	Upper Pool Elevation (feet above MSL)	Crest Configuration	Placed in Operation
Ohio	Emsworth	2	Main channel dam-6.2 Back channel dam-6.8	710.0	2 gated dams	1922
	Dashields	2	13.3	692.0	fixed crest dam	1929
	Montgomery	2	31.7	682.0	gated dam	1936
Monongahela	Braddock	2	11.3	718.7	gated dam	1906
	L/D 3 (Elizabeth)	2	23.8	726.9	fixed crest dam	1907
	L/D 4 (Charleroi)	2	41.5	743.5	gated dam	1932
	Maxwell	2	61.2	763.0	gated dam	1965
	Grays Landing	1	82.0	778.0	fixed crest dam	1995
	Point Marion	1	90.8	797.0	gated dam	1926
Allegheny	L/D 2	1	6.7	721.0	fixed crest dam	1934
	C.W. Bill Young (L/D 3)	1	14.5	734.5	fixed crest dam	1934
	L/D 4	1	24.2	745.4	fixed crest dam	1927
	L/D 5*	1	30.4	757.0	fixed crest dam	1927
	L/D 6*	1	36.3	769.4	fixed crest dam	1928
	L/D 7	1	45.7	782.4	fixed crest dam	1930
	L/D 8*	1	52.6	800.2	fixed crest dam	1931
	L/D 9*	1	62.2	822.2	fixed crest dam	1938

*Retrofitted with hydroelectric facility.

Four locks and dams on the Allegheny River were later retrofitted with run-of-river hydroelectric plants (Figure 5.14). These facilities were constructed at L/D 5 (9.5 megawatt, placed in operation 1989), L/D 6 (9.5 megawatt, placed in operation 1989), L/D 8 (14 megawatt, placed in operation 1990), and L/D 9 (18 megawatt, placed in operation 1990). Levels of fish mortality (from mechanical injury; pressure affects, including cavitation and decompression; swim bladder rupture; and shear damage) resulting from passage through hydraulic turbines at hydroelectric facilities can be substantial. Adverse affects caused by rack impingement, entrainment, and turbine operations were reported to be relatively low at the hydroelectric facilities on the middle Allegheny River (ERC 1996; Sigma Consultants 1993).

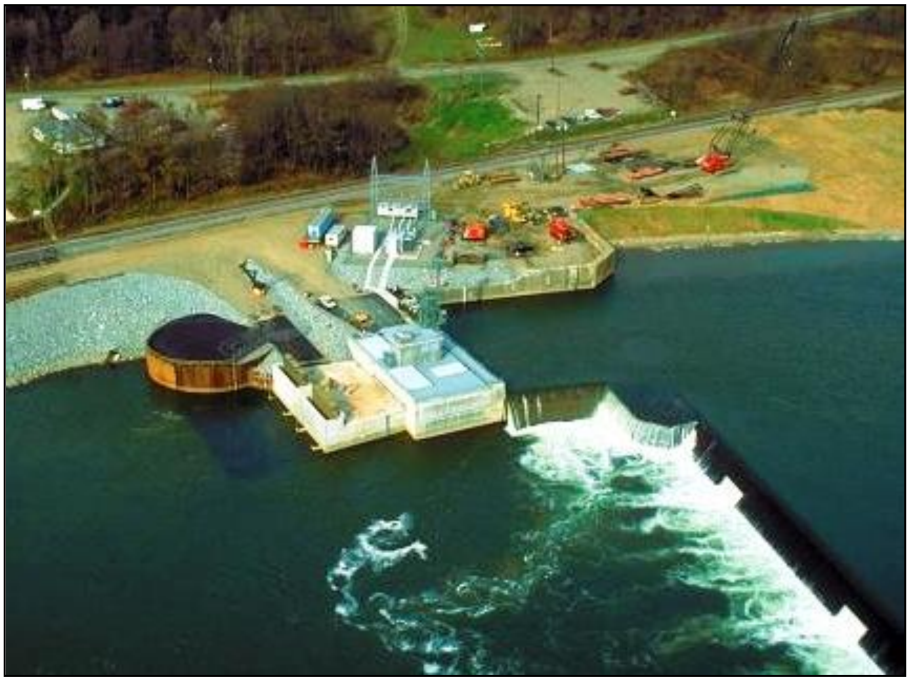

Figure 5.14. Hydroelectric facility at L/D 8 on the Allegheny River (from Port of Pittsburgh Commission).

Fish Passage

Many of the Three Rivers' native fish species are classified, at this time, as migratory (Wilcox *et al*. 2004). Migratory species such as walleye (DePhilip *et al.* 2005), sauger (Jaeger *et al.* 2005), channel catfish (Pellet *et al.* 1998), smallmouth bass (Beam 1990), and redhorses (Reid *et al.* 2008*)* have been observed traveling hundreds of miles in large river systems, typically upstream, or sometimes even entering tributary streams during seasonal migrations to spawning, foraging, or overwintering habitats. Obstruction of migratory routes by dams and the conversion of free-flowing rivers into reservoirs have been attributed to the decline of riverine fishes by several authors (*e.g.,* Santucci *et al.* 2005). However, in the interest of management implications for PFBC's jurisdictional species of the Three Rivers, the impacts of navigation locks and dams on fish migrations has yet to be investigated specifically.

With the decline of heavy industry along the Three Rivers over the past 30 years or so, commercial lockages have also substantially decreased, especially for locks of the middle Allegheny River (Locks 5-9). For example, Allegheny River Lock 9 has not passed any commercial cargo over the last seven years (Port of Pittsburgh Commission 2010), and is now only open on the weekends and holidays (USACE 2010) to accommodate recreational boaters. Likewise, Allegheny River Locks 6, 7, and 8 have limited hours of operation, and are now closed Tuesday through Thursday (USACE 2010).

Since closed lockchambers are a barrier to migrating fish, PFBC requested USACE to conduct annual assisted fish lockages (*i.e*., lockages conducted without boats intended to move fish) at Allegheny River Locks 5, 6, 7, 8, and 9. These lockages were initiated in the early 1980s to accommodate fish movement during the spring spawning season and to improve reproductive success for species classified as migratory. Fish passage by means of lockages, commercial, recreational, or assisted, have been found by several authors to be a low-cost alternative (compared to construction of fish passage structures) for facilitating upstream migration of river fish. Allegheny River fish lockages are generally conducted March through May, using river water temperature of 40° Fahrenheit as a trigger. The benefits of conducting assisted lockages for resident migratory fish of the middle Allegheny River have not yet been documented.

Emsworth, Dashields, and Montgomery locks and dams (EDM) are the oldest navigation structures on the entire Ohio River. Due to their proximity to industrial centers of Pittsburgh, EDM moves a great deal of barge traffic. Because the lock structures of EDM have limited barge capacity and have developed structural integrity issues, USACE initiated the *Upper Ohio River Navigation Study*. The purpose of this study is to examine lock modernization alternatives for EDM and work toward ecosystem restoration on the upper Ohio River, which may provide an opportunity to include fish passage at EDM.

In anticipation of lock modernization at EDM, USACE formed the Upper Ohio Interagency Working Group, and PFBC has actively participated in this group. The working group is providing advice to USACE to assist them in determining the best way to fulfill the purpose of the *Upper Ohio River Navigation Study*. Because of their expertise with fish passage, the USFWS Carterville National Fish and Wildlife Conservation Office in Illinois (Carterville NFWCO) was recruited to evaluate the feasibility of creating fish passage opportunities as part of lock modernization projects at EDM.

In conjunction with the working group, Carterville NFWCO has evaluated a number of alternatives for fish passage at EDM and also facilitated a meeting to develop goals and objectives for fish passage, discuss project constraints, and identify realistic alternatives, including natural and technical fishways as well as non-structural measures such as fish lockages. Carterville NFWCO worked with group members to develop a list of species that will be used to evaluate various fish passage alternatives. A second meeting in September 2009 with fisheries experts continued the evaluation process based on a given alternative’s potential effectiveness in providing passage opportunities. Conceptual designs for fish passage alternatives as well as technical designs for selected alternatives were developed.

The *Draft Upper Ohio Navigation Study Fish Passage Feasibility Study Report* was submitted to USACE in October 2009. The draft report includes discussion of viable alternatives for EDM, technical fishway designs, and preliminary recommendations. Carterville NWFCO will continue to work with USACE, PFBC, and other members of the working group to finalize the *Upper Ohio River Fish Passage Feasibility Study.* As part of the ecosystem restoration component of the study, PFBC has also assisted biologists from the USACE’s Nashville District during boat reconnaissance of potential habitat restoration sites on the upper Ohio River.

Flow Pattern

Naturally flowing rivers obviously flow in a downhill direction from the source to the mouth. Depending upon degree of sinuosity, one-dimensional flow patterns can be linear for straight or braided channels, or curvilinear for meandering channels (Gupta 2007). In a meandering channel, a low flow thalweg typically approaches the outside of a meander bend. During high or flood flows, the thalweg pulls away from the outside bend due to higher flow velocities and tractive forces (*i.e*., pulling forces or “stream power”) (USACE 1981).

Lock and dams cause alterations in the three-dimensional, often complex, flow patterns of rivers. At the tailwaters of a dam, where the river is more stream-like, water circulation patterns, including turbulent hydraulics located directly below the dam (*e.g*., backwash, boil line, and outwash) or eddies located adjacent to shorelines or behind obstructions, provide an important environmental condition of fish habitat for some species. Downstream of lock and dam structures, especially near the approaches of heads of dams, the river becomes more lake-like, and flow patterns are generally uniform across the channel, more so at fixed- crest structures than gated structures or those retrofitted with hydroelectric facilities where the river is constricted to pass through one or more gates.

The Three Rivers remain a greatly altered ecosystem, impounded for navigation purposes since 1841 when L/Ds 1 and 2 were constructed on the Monongahela. The altered hydrology has noticeably impacted ecological functions and values as well as the biological integrity of riverine and contiguous riparian habitats. Riverine habitats, including numerous islands, shallow sand and gravel bars, cobble riffles, and channel wetlands have been forever lost and replaced by deepwater habitats. Impoundment of the Three Rivers and resultant elevated water tables have also impacted contiguous riparian habitats, including loss of what little floodplains existed, backchannels, and alteration of native floodplain plant communities.

Navigation dams were only designed to maintain the nine-foot navigation channel; they are not designed for flood control purposes and have little effect on high water. On the other hand, flood control dams and their impoundments constructed on tributaries of the Three Rivers as well as the upper Allegheny River (*i.e*., Kinzua Dam) were designed first and foremost for flood control purposes.

Flood Control Dams

USACE Pittsburgh District operates and maintains 16 flood control projects (*i.e*., dams and impoundments) within the upper Ohio River basin (Table 5.3). These 16 projects are multipurpose, but were primarily constructed for retention of excess upstream runoff following precipitation events and subsequent controlled releases, both of which are designed to prevent or reduce downstream flooding. Additional benefits include downstream low flow augmentation to meet water quality objectives (*e.g*., pollution dilution, temperature control to sustain coldwater fisheries) and recreational objectives (*e.g*., flow modification to accommodate whitewater activities) as well as hydroelectric power generation. These 16 projects have collectively mitigated downstream flood stages in Pittsburgh, including preventing 7.7 feet more water in September 2004, 9.7 feet in January 1996, and 12.1 feet in June 1972, which otherwise would have eclipsed the March 1936 record by 1.9 feet (USACE 2010). Overall, these projects have prevented flood damages in excess of $8.8 billion.

In particular, Kinzua Dam (one of the largest dams constructed east of the Mississippi River) and the massive Allegheny Reservoir have had considerable upstream and downstream impacts on the Allegheny River ecosystem. Allegheny Reservoir's large volume of available storage is committed for low flow augmentation to improve downstream uses such as recreation, registered water withdrawals (*e.g*., consumptive uses such as public water supply and non-consumptive uses such as cooling water), and navigation for commercial traffic on both the Allegheny and upper Ohio Rivers. The available storage is also accessible for contingency operations to control downstream ice jamming as well as flushing or moving downstream contaminants during spill emergencies. A large (110 acres, 73 feet deep) upper reservoir was constructed for hydroelectric power generation at the 435-megawatt Seneca Pumped Storage Generating Station facility (USACE 2010) (Figure 5.15).

Table 5.3. Flood control projects within the upper Ohio River basin.

River Basin	Flood Control Project	Impounded Water	Maximum Pool (acres)	Normal Pool (acres)	Placed in Operation
Upper Ohio	Mosquito Creek Lake	Mosquito Creek, Ohio	8,900	7,850	1944
	Michael J. Kirwin Dam and Reservoir	West Branch Mahoning River, Ohio	3,240	2,650	1965
	Berlin Lake	Mahoning River, Ohio	5,500	3,590	1943
	Shenango River Lake	Shenango River, Pennsylvania	11,090	3,560	1965
Monongahela	Tygart Lake	Tygart River, West Virginia	3,440	1,750	1938
	Stonewall Jackson Lake	West Fork River, West Virginia	6,820	800	1990
	Youghiogheny River Lake	Youghiogheny River, Pennsylvania and Maryland	3,566	2,840	1943
Allegheny	Kinzua Dam/Allegheny Reservoir	Allegheny River, Pennsylvania and New York	21,180	12,080	1965
	Union City Dam and Reservoir	French Creek, Pennsylvania	2,290	Dry bed reservoir	1971
	Woodcock Creek Lake	Woodcock Creek, Pennsylvania	775	333	1973
	East Branch Clarion River Lake	East Branch Clarion River, Pennsylvania	1,370	1,160	1952
	Tionesta Lake	Tionesta Creek, Pennsylvania	2,770	480	1940
	Mahoning Creek Lake	Mahoning Creek, Pennsylvania	2,370	280	1941
	Crooked Creek Lake	Crooked Creek, Pennsylvania	1,940	350	1940
	Conemaugh River Lake	Conemaugh River, Pennsylvania	6,820	800	1952
	Loyalhanna Lake	Loyalhanna Creek, Pennsylvania	3,280	400	1951

Fall and winter drawdowns at Allegheny Reservoir can result in substantial and recurrent fish kills affiliated with bottom sluice outflows of Kinzua Dam (Smith and Anderson 1984). Allegheny Reservoir's metalimnetic and hypolimnetic outflow from six bottom release sluices (123 feet deep below summer pool elevation) of Kinzua Dam is substantially colder than ambient Allegheny River water temperature (Dortch 1981). As a result, a coldwater tailwater fishery is sustained throughout the year. In 1988, PFBC implemented a successful annual fingerling trout stocking program for both brown trout and rainbow trout on Allegheny River Section 7 (confluence of Conewango Creek upstream to Kinzua Dam). Paddlefish stocked in Allegheny Reservoir by the New York State Department of Environmental Conservation are often found (both live and dead specimens) in the Allegheny River downstream of Kinzua Dam.

Figure 5.15. Kinzua Dam, Allegheny Reservoirs (upper and lower), Seneca Pumped Storage Generating Station, and Allegheny River (from USACE 2010).

5.3. <u>Water Quality</u>

The most tangible legacy of the Three Rivers might very well be issues related to water quality. Through two hundred years of floods, flow modifications, habitat alterations, channel excavations, fish kills, decline and loss of species, and loss of human life, the demand and need for clean water has been paramount. Up until the 1970s, the convenience of using the Three Rivers as a sink for decades of municipal and industrial wastes trumped requirements for potable water in western Pennsylvania. During the Twentieth Century, sewage-contaminated drinking water from the Three Rivers resulted in Pittsburgh having the highest typhoid fever death rate in the United States (Tarr 2004). The Monongahela River was devoid of fish and was too acidic for people to swim in, even dissolving steel gates at some of its lock and dam structures. Fish kills on the Allegheny River made national news. The odor emanating from the Ohio River was objectionable, if not harmful (Tarr 2004).

Through concerted efforts from many parties, water quality of the Three Rivers vastly improved by the end of the Twentieth Century. Advances such as implementation of municipal wastewater treatment plants (in particular, Allegheny County Sanitary Authority's, (ALCOSAN) interceptor sewer system and primary treatment plant became fully operative in 1959), enactment of state and federal water pollution control legislation (*e.g.,* Pennsylvania Clean Streams Law of 1937; Federal Water Pollution Control Act of 1948, its 1972 Water Quality Amendments, and 35 additional amendments through 2000; and Federal Surface Mining Control and Reclamation Act of 1977), collapse of heavy industries such as steel (ten major steel mills closed operations in the 1980s (Muller 2006), and the establishment and implementation of water quality programs by the Ohio River Valley Water Sanitation Commission (ORSANCO) in 1948 were all instrumental in the ongoing recovery of water quality of the Three Rivers.

Even with the tremendous improvements in river water quality, the Three Rivers have occasionally endured catastrophic pollution events, including the infamous January 2, 1988 spill from Ashland Petroleum Company, where 23,810 barrels of Number 2 diesel fuel discharged from a collapsed 40-year-old aboveground storage tank into the Elizabeth Pool of the Monongahela River. As the spill moved downriver, water intake supplies became contaminated, resulting in the disruption of water services to riverside communities in Pennsylvania, Ohio, and West Virginia. On March 30, 1990, Buckeye Pipe Line Company's “Line 703”, a 10-inch-diameter pipeline, ruptured from overstress due to a landslide, resulting in the release of 1,790 barrels of TransMix (a mixture of petroleum products gasoline, kerosene, and Number 2 diesel fuel) into tributary Knapp Run, and then the Allegheny River at rivermile 32.0 (Pool 5). The product release resulted in extensive ground and surface water pollution and interrupted the use of the Allegheny River as a water supply for several communities. The aftermath of both the Ashland and Buckeye spill events included millions of dollars spent for clean-up and remediation, fines and penalties, settlement of claims for damages and compensatory payments, and interrupted water supplies.

Today, several state and federal agencies, including the PADEP Southwest Regional Office, USACE Pittsburgh District, EPA Region 3 Freshwater Biology Team, USGS Pennsylvania Water Science Center Pittsburgh Office, and ORSANCO conduct comprehensive water quality monitoring programs (*e.g*. Clean Water Act Sections 305(b) and 303(d)) on the Three Rivers and provide data for use by other organizations.

Chapter 93 Designations

Under *Pennsylvania's Water Quality Standards*, the Ohio River, Allegheny River (from Kinzua Dam to the confluence in Pittsburgh), and Monongahela River all are assigned an aquatic life use designation of *Warm Water Fishes* (WWF), defined as “maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat.” As a use designation, aquatic life use categories are designed to target ecosystem health rather than human health and use. Water quality impairments compromise diversity and abundance of aquatic life and the Commonwealth of Pennsylvania has placed intrinsic value on the protection of aquatic life. This protection has an indirect affect on human health through recreation and fish consumption. Pennsylvania uses aquatic life use data (*i.e*., habitat and biological indicators) to evaluate the capacity of its jurisdictional waters to “maintain and/or propagate fish species and additional flora and fauna that are indigenous” to the diverse aquatic habitats of Pennsylvania.

The Three Rivers are not designated as special protection waters (*i.e*., *High Quality Waters* or *Exceptional Value Waters*) and, therefore, are not subject to strict antidegradation requirements. Under Chapter 93, the Ohio River, Monongahela River, and Allegheny River from the confluence of the Clarion River downstream to Pittsburgh are assigned a *Navigation* (N) designation, defined as “use of the water for the commercial transfer and transport of persons, animals, and goods.” The Ohio River is also subject to ORSANCO's *Pollution Control Standards for Discharges to the Ohio River*, only if their water quality standards are more stringent than specific numeric water quality criteria in Chapter 93.

Total Maximum Daily Loads

Under Section 303(d) of the Federal Clean Water Act, total maximum daily loads (TMDLs) have been developed for the Three Rivers by PADEP's Bureau of Watershed Management (Table 5.4). TMDLs are designed to depict a watershed budget for pollutants, representing the total amount of pollutants that can be assimilated by a waterbody without causing water quality standards to be exceeded. The overall goal of a TMDL is to achieve the "fishable-swimmable" goal of the Federal Clean Water Act. Unfortunately, these goals are not being met in the Three Rivers, primarily due to established fish consumption advisories resulting from contamination from PCBs and chlordane. The specific goal of a TMDL is to outline a plan to achieve water quality standards (*i.e*., when concentrations of PCBs and chlordane in the river water column must be equal to, or less than, Pennsylvania's water quality criteria) in the river reaches specified.

Table 5.4. TMDL development for the Three Rivers (from PADEP 2010c).

River (Year Established)	Parameter	Estimated Water Column Concentration*	PA Chapter 16 Water Quality Criteria	Fish Species Used to Calculate TMDL	River Reach
Ohio (2001)	PCBs	0.04577 µg/L	0.00004 µg/L	Walleye	Entire reach within Pennsylvania
				White Bass	
				Freshwater drum	
				Common carp	
				Channel catfish	
	Chlordane	0.01830 µg/L	0.0005 µg/L	Common carp	
				Channel catfish	
Allegheny (2001)	PCBs	0.02433 µg/L	0.00004 µg/L	Smallmouth bass	Confluence in Pittsburgh upstream to L/D 3
				Spotted bass	
				Common carp	
				Channel catfish	
	Chlordane	0.02128 µg/L	0.0005 µg/L	Common carp	
Monongahela (2001)	PCBs	0.01433 µg/L	0.00004 µg/L	Common carp	Grays Landing L/D upstream to Point Marion L/D
	Chlordane	0.01177 µg/L	0.0005 µg/L	White bass	

*Determined from dividing average fish tissue concentration by appropriate EPA bioconcentration factors.

Combined Sewer Overflows

Throughout the late Nineteenth and early Twentieth Centuries, growing communities along the Three Rivers hastily constructed combined sewer systems as part of the developing infrastructure. These systems were originally designed to convey both untreated municipal wastewater (domestic, sewage, and industrial) and stormwater through the same pipe and discharge it directly to the Three Rivers, based on the reasoning that stormwater helped flush sewage away, and one large pipe accommodating both wastewater and stormwater was more economical than installing separate pipes (3 Rivers Wet Weather 2010).

The Three Rivers eventually became so polluted with untreated sewage that it was essential to construct a wastewater treatment plant (the largest in the Pittsburgh area) that not only reduced levels of river pollution, but also facilitated disease reduction and health improvements for the Pittsburgh area. ALCOSAN's primary treatment facility went online in 1959 and featured a 95-mile interceptor sewer system engineered to tie into pipes from the older combined sewer systems to the primary treatment facility located on the Ohio River (RM 2.9 on the right descending bank (RDB) in the vicinity of Brunot Island).

Today, most of the antiquated combined systems are still in use and due to financial constraints, they have not been upgraded to comply with modern standards of separate pipes for sewer and stormwater. During even modest wet weather events (as little as 0.1 inch), stormwater mixes with wastewater in the combined pipes, which overloads the system and downstream treatment facilities. To prevent untreated wastewater from backing up into businesses and homes, combined sewer overflow (CSO) structures were installed to discharge the untreated stormwater / wastewater mix directly into a receiving waterbody (Figure 5.16). Over the past 100 years, the Three Rivers have been the primary receiving waterbodies for nearly all of western Pennsylvania's CSOs.

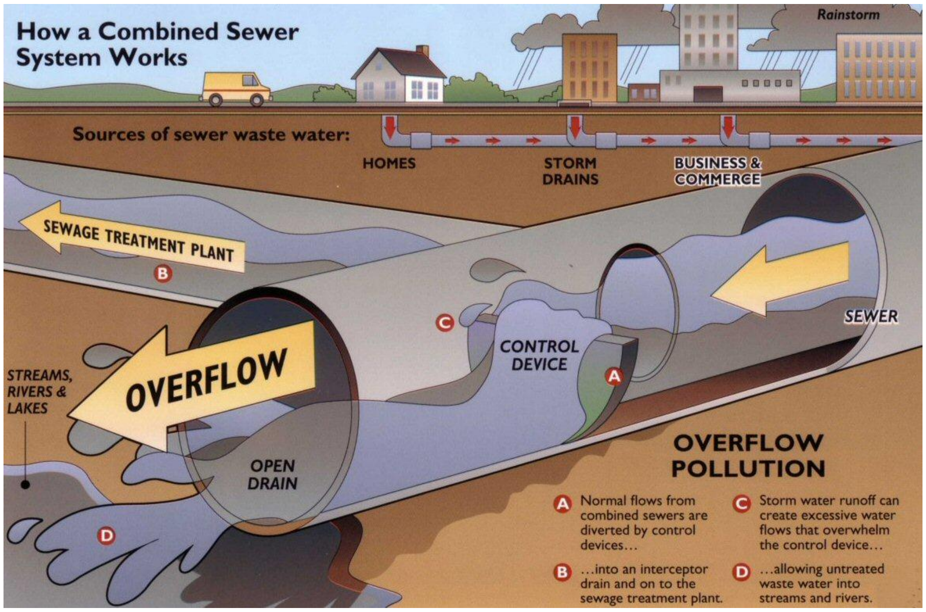

Figure 5.16. Schematic of a combined sewer system (from 3 Rivers Wet Weather).

Pennsylvania has the highest number of CSO outlets in the United States. Half of these are located in southwestern Pennsylvania, which would place this region fifth in the state ranking. One-quarter of the CSO outlets occur in Allegheny County alone (Table 5.5).

Table 5.5. Top five states with the most CSO structures (Regional Water Management Task Force 2010).

State	# CSOs
Pennsylvania Southwestern Pennsylvania Allegheny County	1,631 763 413
Ohio	1,378
New York	1,032
Indiana	876
Illinois	742

In addition to CSOs, sanitary sewer overflows (SSOs), where untreated wastewater is unintentionally discharged through overflowing manholes from municipal sanitary sewers running too full, also discharge directly to the Three Rivers (Table 5.6). ALCOSAN has authority over the majority of overflow structures that discharge directly to the Three Rivers, all in Allegheny County. ALCOSAN is also responsible for additional overflow structures that discharge to tributary streams very near their confluences with the Three Rivers, including Ohio River tributaries Chartiers Creek (41 CSOs, 18 SSOs) and Saw Mill Run (24 CSOs, five SSOs), and Monongahela River tributary Turtle Creek (20 CSOs, 11 SSOs) (ALCOSAN 2007).

Table 5.6. CSO and SSO structures that discharge directly to the Three Rivers (ALCOSAN 2007; PADEP 2010d).

River	Permittee	# CSOs	# SSOs
Ohio	ALCOSAN	32	12
	Other Municipal Authorities	45	0
Lower Allegheny	ALCOSAN	78	3
	Other Municipal Authorities	70	0
Upper Allegheny	Municipal authorities in Franklin, Oil City, Titusville, and Warren	29	0
Monongahela	ALCOSAN	62	0
	Other Municipal Authorities	140	0

The Three Rivers serve as the primary source of drinking water for about 90 percent of the population of Allegheny County. Discharges from CSO and SSO structures present risks to both human health and river ecosystem health since they discharge a toxic mixture of residential, commercial, and industrial wastewater as well as pollution carried by stormwater. Pollutants typically include raw sewage, nutrients, heavy metals, pesticides, herbicides, organic compounds (volatile and semi-volatile), oil, grease, pathogenic protozoans, bacteria, viruses, and "emerging contaminants." The Regional Water Management Task Force estimates that fixing the sewer problems in the eleven counties of southwestern Pennsylvania might cost upwards of $10 billion. In September 2000, ALCOSAN received a draft Consent Decree from USEPA, which finally entered into effect in January 2008. USEPA's federal ruling holds ALCOSAN responsible for evaluating, monitoring, modeling, repairing, and assuring compliance to control or eliminate wet weather (CSO and SSO) discharges within their service area. Under the Consent Decree, ALCOSAN and affiliated municipal authorities have 20 years to complete this undertaking.

Emerging Contaminants

Emerging contaminants are defined as any synthetic or naturally occurring chemical or microorganism that is not typically monitored in the environment, but has the potential to enter the environment and cause known or suspected adverse ecological or human health affects (USGS 2010a). In some cases, releases of emerging chemical or microbial contaminants to the environment likely have occurred for a long time, but may not have been recognized until new detection methods were developed. In other cases, synthesis of new chemicals or changes in use and disposal of existing chemicals can create new sources of emerging contaminants.

Exposure to low levels of a class of emerging contaminants known as endocrine disrupting compounds (EDCs) modulates, mimics, or interferes with normal hormonal activity in animals. Examples of EDCs include synthetic hormones, certain pesticides, some pharmaceuticals, detergent degradation products (nonylphenol), and a growing list of many other compounds. An expanding research area examining the effects of EDCs on animals is intersex fish, or fish with characteristics of both male and female sexes. Intersex in fishes that are normally gonochoristic (after sex is determined, it does not change during an individual's lifetime) is used as an indicator of exposure to EDCs. In addition to intersex, exposure to EDCs can also interfere with brain and nervous system development, growth and function of reproductive system, and response to stressors in the environment. Endocrine disruption may also impart deleterious population level impacts (Blazer *et al*. 2007).

EDCs have been documented in fish collected from several rivers and streams across the United States, including intersex smallmouth bass in the South Branch Potomac River and Shenandoah River in Virginia (Blazer *et al*. 2007). The primary sources of these estrogenic compounds are believed to be CSOs and SSOs that discharge to the rivers. PFBC is assisting with fish collection efforts to support ongoing studies of EDCs by the USGS Leetown Science Center Fish Health Branch.

5.4. Proposed Management Actions

For this Section of the *Management Plan*, PFBC first developed each proposed Management Action in consideration of Stewardship Goal 5.1, and then prioritized these actions into one of three levels with expectation of commencing within the following timeframes:

1 (Red) = Proposed Management Action initiated within two years.
2 (Yellow) = Proposed Management Action initiated within three years.
3 (Green) = Proposed Management Action initiated within five years.

Stewardship Goal 5.1. Evaluate the impacts of human activities, such as navigation dams, emerging contaminants, and other threats on fish species and fish habitats of the Three Rivers, to assist in conservation and restoration efforts.

Stewardship Goal 5.1 – Proposed Management Actions		Priority
5.1.1	Depending upon the results of the Asian Carp Risk Assessment (see proposed Management Action 8.1.1), continue to request that the U.S. Army Corps of Engineers (USACE) Pittsburgh District conduct annual assisted fish passage lockages throughout the spring spawning season at Allegheny River Locks and Dams 5 through 9 and finalize a Memorandum of Agreement for these lockages.	**1**
5.1.2	Continue to serve on the Upper Ohio Interagency Working Group and provide recommendations to the USACE with input on fish passage structures and habitat enhancement mitigation projects proposed at the Emsworth, Dashields, and Montgomery Locks and Dams on the upper Ohio River.	
5.1.3	Continue to assist scientists from the U.S. Geological Survey Leetown Science Center during research investigations of fish health and levels of intersex within the Three Rivers.	
5.1.4	Assist biologists from the Pennsylvania Department of Environmental Protection (PADEP) with fish collection activities on the Three Rivers for Pennsylvania's Fish Consumption Advisory Program.	
5.1.5	Prepare a grant proposal to fund a study to determine fish passage through lock structures of the Three Rivers.	**3**
5.1.6	Investigate the potential of redesignation of the free-flowing upper Allegheny River (rivermile 72 at East Brady upstream to rivermile 198 at Kinzua Dam) from Warm Water Fishes (WWF) to High Quality – Warm Water Fishes (HQ-WWF).	

6. Commercial Dredging

6.1. Legacy of Exploitation

Exploitation of the Allegheny and Ohio River's glacially-derived coarse substrates began in the early Nineteenth Century. Thousands of tons of cobble were mined and used as paving stones. Millions of tons of sand were dredged and used in road and building construction and for glassmaking. In 1909, approximately 2.3 million tons of sand were excavated from the Allegheny and Ohio Rivers by five sand and gravel companies (Kussart 1938). By 1921, this production had grown to more than four million tons of sand per year. Today, glacially-derived sand and gravel is still excavated from the Allegheny and Ohio Rivers by two companies, the only two rivers in Pennsylvania where this is allowed. Production in 1990 was 4.1 million tons, but dropped to 1.7 million tons in 2008.

Based on these figures, a conservative estimate is that at least 400 million tons of sand and gravel have been commercially excavated from these two rivers. This figure does not account for material that was extracted before 1909 (commercial or otherwise), material that was extracted from the upper Allegheny River (four companies operating in Franklin, Oil City, Tionesta, and Warren between 1928 and 1972), or material dredged for navigation improvements, including annual maintenance dredging conducted by USACE. Adding these activities, the amount of sand and gravel dredged likely exceeds half a billion tons!

6.2. Channel Deepening

With any resource extraction operation, there are environmental consequences. Upstream of East Brady, the free-flowing Allegheny River is interspersed with occasional deep pools, 25 feet deep in some locations, at historic commercial dredging locations near Franklin, Oil City, Tionesta, Starbrick, Mead Island, and Warren (Mayer 1972). Dredged pools in Warren are nearly 40 feet deep (Mayer 1972). Downstream of East Brady, the deepest locations in the Allegheny River are dredge pits created by commercial sand and gravel extraction activities, which are especially expansive in Pools 3, 4, 5, 7, and 8 (Figures 6.1 and 6.2).

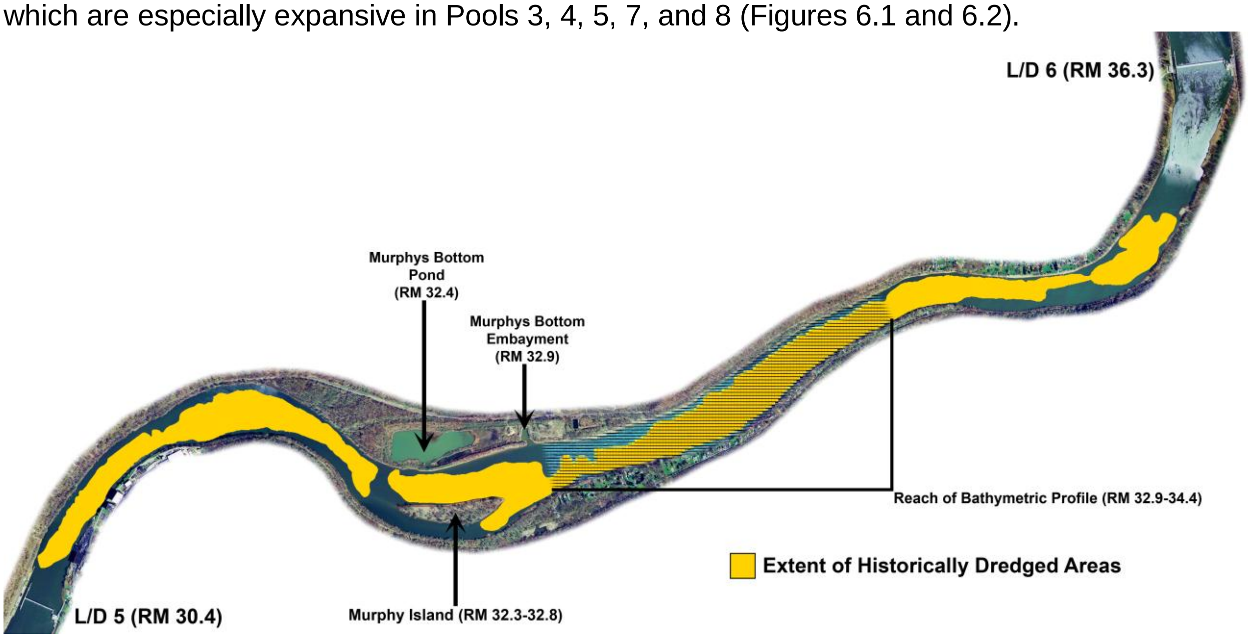

Figure 6.1. Dredged Allegheny River Pool 5. Yellow polygons depict historically dredged areas. Cross-hatched area delineates river reach of the bathymetric profile shown in Figure 6.3 (photograph from PASDA 2010; dredged areas from USACE 2006).

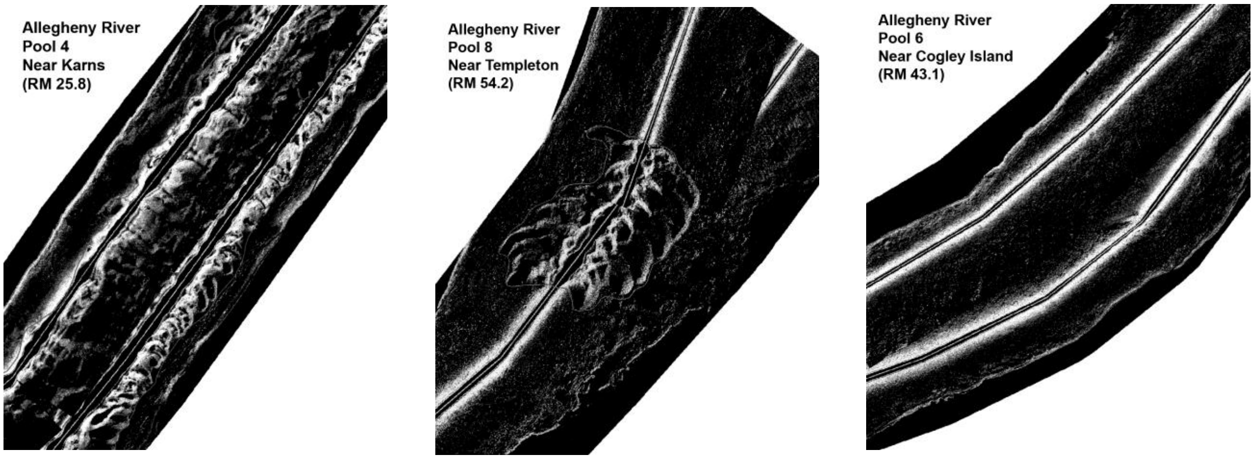

Figure 6.2. Side-scan sonar images of extensively dredged reaches of Allegheny River Pool 4 (left); Allegheny River Pool 8 dredge pit with scoop marks from clamshell dredge (center); and for comparison, an undredged reach of Allegheny River Pool 6 (right) (sonar images from USACE 2006).

Exceptionally deep dredge pits (nearly 70 feet) have been identified during recent bathymetric surveys of Allegheny River Pool 5 (Figure 6.3). Ohio River dredge pits are expansive in the Dashields, Montgomery, and New Cumberland Pools. Dredge pits nearly 60 feet deep have been identified during recent bathymetric surveys of the New Cumberland pool downstream of Phillis Island.

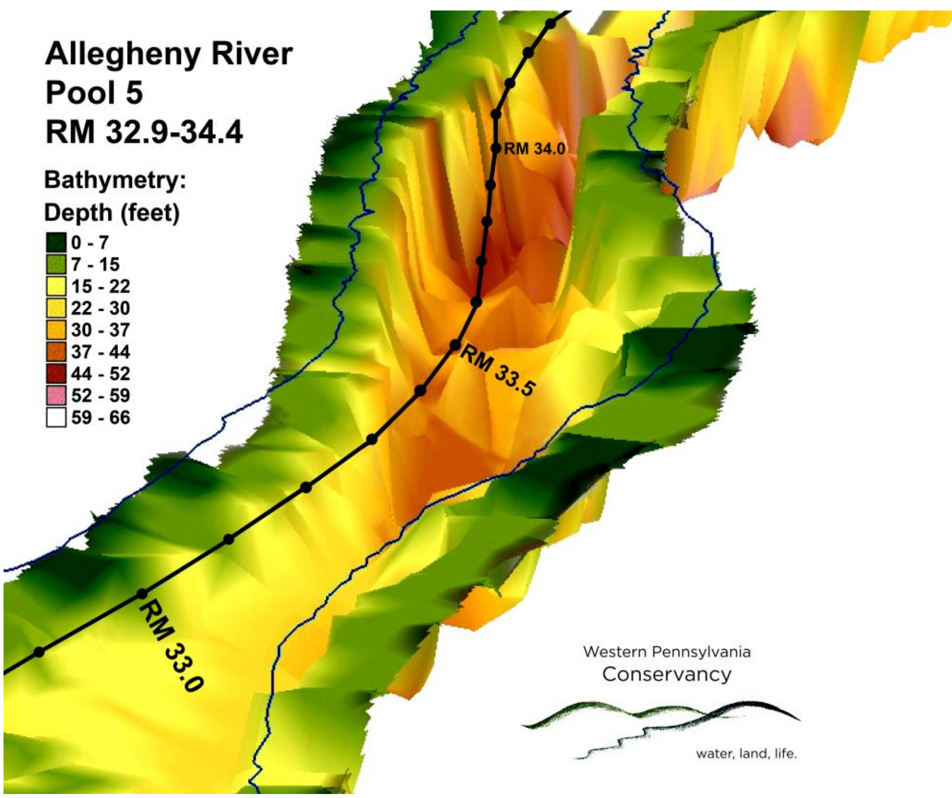

Figure 6.3. Allegheny River Pool 5 bathymetric profile depicting dredged reach characterized by sheer vertical walls and exceptional depth (prepared by WPC).

6.3. Ecological Impact Assessments

Investigations to determine impacts of commercial dredging operations on biological components (*e.g.*, fish and mussel assemblages) of the Allegheny and Ohio Rivers are limited. The first serious studies occurred in 1971-1972 on behalf of Tionesta Sand and Gravel, Inc.'s (TSG) application to renew environmental permits for continued dredging of the Allegheny River. From 1953 to 1972, TSG mined sand and gravel from the Allegheny near the confluence of Tionesta Creek (Figure 6.4).

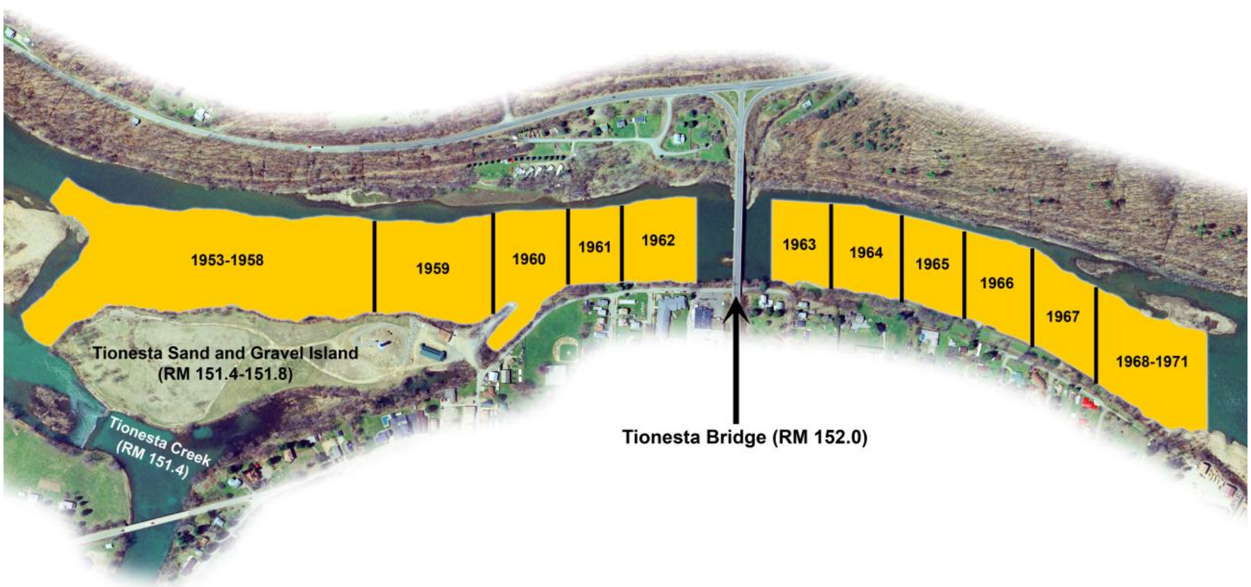

Figure 6.4. Dredged Allegheny River at Tionesta. Yellow polygons depict TSG's historically dredged areas by year (photograph from PASDA 2010; dredged areas from Bardarik *et al*. 1972).

In support of its 1973 permit application, TSG's consultant conducted an *ad-hoc* upstream-control, downstream-impact assessment investigation (Bardarik *et al.* 1972). Evaluations and comparisons were made of fisheries (October 1971), invertebrates (Surber and petite Ponar samples collected August and October 1971), and water and sediment quality data collected from undredged riffle habitats located immediately upstream (US) and downstream (DS) of dredged areas (Tionesta) as well as undredged (West Hickory) and dredged (Tionesta) pool habitats. Results of water and sediment quality parameters and invertebrate survey data were inconclusive from this industry study. However, results of fisheries data (collected by electrofishing, gill net sets, beach seine hauls, and otter trawl hauls) are intriguing (Table 6.1).

Table 6.1. 1972 Allegheny River fish abundance data at Tionesta (Bardarik *et al.* 1972).

Species	Pollution Tolerance[1]	Habitat Disturbance Tolerance[2]	West Hickory Natural Pool	Tionesta Dredged Pool	Riffle Upstream of Dredge	Riffle Downstream of Dredge
Cyprinidae (minnows)						
Common carp	Tolerant	Tolerant	3	7		
Central stoneroller	Intermediate	Moderately intolerant	117	14	34	12
Creek chub	Tolerant	Tolerant		1		
River chub	Intolerant	Intermediate	45		24	6
Blacknose dace	Tolerant	Tolerant			1	5
Tonguetied minnow	Intolerant	Intermediate	1	1	1	
Streamline chub	Intolerant	Intolerant	28	3	35	3
Bigeye shiner	Intolerant	Intolerant	7			
Common shiner	Intermediate	Intermediate	185	98	250	1
Silver shiner	Intolerant	Intermediate	1	1	1	
Rosyface shiner	Intolerant	Intolerant	34	19	29	
Mimic shiner	Intolerant	Moderately intolerant	35	2	4	
Bluntnose minnow	Tolerant	Tolerant	31	9	10	1
Catostomidae (suckers)						
Quillback	Intermediate	Moderately tolerant	1	21	3	
White sucker	Tolerant	Tolerant	4	24		
Northern hog sucker	Moderately intolerant	Intolerant	64	26	13	4
Silver redhorse	Moderately intolerant	Intermediate	11	125		1
Black redhorse	Intolerant	Moderately intolerant	25	111	11	
Smallmouth redhorse	Intolerant	Intolerant	8			
Ictaluridae (bullhead catfishes)						
Yellow bullhead	Tolerant	Moderately tolerant		26		
Brown bullhead	Tolerant	Moderately intolerant		19	1	
Stonecat	Intolerant	Intolerant	9		1	3
Esocidae (pikes)						
Northern pike	Intermediate	Moderately intolerant		4		
Muskellunge	Intermediate	Intermediate	1			
Percopsidae (trout-perches)						
Trout-perch	Intermediate	Intermediate	1	3		
Centrarchidae (sunfishes)						
White crappie	Intermediate	Intermediate		28		
Black crappie	Intermediate	Intermediate		92		
Rock bass	Intermediate	Intolerant	34	32	1	
Bluegill	Moderately tolerant	Intermediate		288	3	
Pumpkinseed	Moderately tolerant	Intermediate		83		
Smallmouth bass	Intolerant	Intolerant	9	17	7	
Largemouth bass	Intermediate	Intermediate		24		
Percidae (perches)						
Greenside darter	Intolerant	Intolerant	47	7	122	8
Rainbow darter	Moderately intolerant	Intolerant	6	3	52	2
Bluebreast darter	Intolerant	Intolerant			2	19
Johnny darter	Intermediate	Intolerant	7	1	5	
Orangethroat darter[3]	Intermediate	Moderately intolerant				1
Tippecanoe darter	Intolerant	Intolerant				1
Variegate darter	Intolerant	Intolerant	42		71	38
Banded darter	Intolerant	Intolerant	13		59	83
Longhead darter	Intolerant	Intolerant	3	4		
Blackside darter	Intermediate	Intolerant	2	12		
Logperch	Intolerant	Moderately intolerant	5	9	5	
Yellow perch	Intermediate	Moderately intolerant		8		
# Individuals			779	1,122	745	188
# Species			30	33	25	16
# Species *Intolerant* of Pollution (% abundance)			18 (50%)	12 (29%)	15 (52%)	10 (88%)
# Species *Intolerant* of Habitat Disturbance (% abundance)			19 (64%)	17 (26%)	17 (61%)	11 (93%)
# Species *Tolerant* of Pollution (% abundance)			3 (5%)	8 (41%)	4 (2%)	2 (3%)
# Species *Tolerant* of Habitat Disturbance (% abundance)			4 (5%)	6 (8%)	3 (2%)	2 (3%)
Shannon-Weaver Diversity Index[4]			3.83	3.82	3.23	2.65

[1]Pollution tolerance designations from Thomas *et al*. 2005 and Ohio EPA 2008.

[2]Habitat disturbance tolerances from USEPA 2010a and Grabarkiewicz and Davis 2008.
[3]Orangethroat darter (*Etheostoma spectabile*) occurrences have never been reported for Allegheny River or Pennsylvania (Cooper 1983). Most likely was a misidentified gilt darter (*Percina evides*), which, unlike the orangethroat darter, is intolerant of pollution and habitat disturbances.
[4]From first-order diversity formula presented on *Java Components for Mathematics* Website (Eck and Ryan 2010).

TSG's report suggested that dredging operations were not impacting fish assemblages of the Allegheny River and that dredged pools provided better habitat for game fish species. A review of these data does reveal that more game fish and panfish species (*e.g*., white and black crappie, bluegill, and largemouth bass), and greater abundances of these species were collected from the dredged pool compared to the natural pool. Similar to the report's conclusion, comparing conventional assemblage metrics suggests little difference in the dredged pool versus the natural pool in terms of species richness (30 and 33, respectively) and diversity (Shannon-Weaver Diversity Index values of 3.83 and 3.82, respectively, which are in the range of good diversity).

Since this study was conducted, fisheries biologists have improved the methods for evaluating fisheries, especially the use of fish assemblage data to depict biological integrity. Many underutilized species historically classified as "rough fish," especially Catostomids (*e.g.*, sucker species such as redhorses), are now regarded as sensitive indicators of stream health. In the 1970s, fish were often categorized according to economic value and angler appeal: game fish, panfish, forage fish, and rough fish. Today's fisheries biologists with improved knowledge of lotic ecology classify fish species according to trophic levels, reproductive guilds, and tolerances to pollution and physical habitat disturbances.

Our 2010 re-evaluation of these 1970s fisheries data suggests that dredging at Tionesta was having an impact on Allegheny River's fish assemblages to some degree. The natural pool supported more species sensitive to pollution and habitat disturbance and fewer species tolerant of these perturbations than the dredged pool (*e.g.*, smallmouth redhorse, stonecat, and variegate darter) as well as higher relative abundances of sensitive species and lower relative abundances of tolerant species. The upstream riffle also was more productive than the downstream riffle in terms of fish species richness, species diversity, and number of sensitive species. In addition to the occurrence of orangethroat darter (which is thought not to occur in Pennsylvania), the relatively high numbers of black redhorse collected and no golden redhorse reported is suspect, given the nearly identical physical similarities of these two species.

A parallel investigation of the Tionesta dredged pool was conducted by PFBC in 1972-1973 (Lee 1973). Like the study done for TSG, the PFBC study included invertebrate samples (Surber sampler, kick net, and Coleman pots) and measured water quality parameters. Fish were surveyed in July, October, and November 1972 and June and July 1973 using electrofishing gear at the Tionesta dredged pool and an undredged pool located upstream of Tionesta at Dawson Eddy (Table 6.2). These findings were much more convincing than results of the TSG study. The natural pool at Dawson Eddy maintained a more diverse and productive ichthyofauna characterized by a greater number and abundance of sensitive species than the dredged pool at Tionesta. Unlike the earlier findings, higher diversity and abundances of game fish species (northern pike, walleye, and largemouth bass) were collected from the natural pool compared to the dredged pool.

Table 6.2. 1973 Allegheny River fish abundance data at Tionesta (Lee 1973).

Species	Pollution Tolerance[1]	Habitat Disturbance Tolerance[2]	Dawson Eddy Natural Pool	Tionesta Dredged Pool
Cyprinidae (minnows)				
Common carp	Tolerant	Tolerant	37	64
Golden shiner	Tolerant	Tolerant	1	
River chub	Intolerant	Intermediate	2	
Streamline chub	Intolerant	Intolerant	10	
Common shiner	Intermediate	Intermediate	8	3
Silver shiner	Intolerant	Intermediate	7	10
Rosyface shiner	Intolerant	Intolerant	6	4
Mimic shiner	Intolerant	Moderately intolerant	1	
Bluntnose minnow	Tolerant	Tolerant	2	
Catostomidae (suckers)				
Quillback	Intermediate	Moderately tolerant		7
Northern hog sucker	Moderately intolerant	Intolerant	14	
Silver redhorse	Moderately intolerant	Intermediate	9	59
Golden redhorse	Moderately intolerant	Moderately intolerant	145	77
Black redhorse	Intolerant	Moderately intolerant	1	
Smallmouth redhorse	Intolerant	Intolerant	13	1
River redhorse	Intolerant	Moderately intolerant	3	
Ictaluridae (bullhead catfishes)				
Yellow bullhead	Tolerant	Moderately tolerant	1	
Brown bullhead	Tolerant	Moderately intolerant	3	3
Stonecat	Intolerant	Intolerant	1	
Esocidae (pikes)				
Northern pike	Intermediate	Moderately intolerant	9	1
Muskellunge	Intermediate	Intermediate	1	3
Centrarchidae (sunfishes)				
White crappie	Intermediate	Intermediate	1	
Black crappie	Intermediate	Intermediate	3	2
Rock bass	Intermediate	Intolerant	10	2
Bluegill	Moderately Tolerant	Intermediate	9	1
Pumpkinseed	Moderately Tolerant	Intermediate	4	2
Smallmouth bass	Intolerant	Intolerant	16	9
Largemouth bass	Intermediate	Intermediate	5	
Percidae (perches)				
Greenside darter	Intolerant	Intolerant	6	
Johnny darter	Intermediate	Intolerant	1	
Longhead darter	Intolerant	Intolerant	12	
Blackside darter	Intermediate	Intolerant	3	
Logperch	Intolerant	Moderately intolerant	15	3
Yellow perch	Intermediate	Moderately intolerant	3	17
Walleye	Intermediate	Moderately Intolerant	1	
		# Individuals	363	268
		# Species	34	18
		# Species *Intolerant* of Pollution (% abundance)	16 (72%)	7 (61%)
		# Species *Intolerant* of Habitat Disturbance (% abundance)	20 (75%)	9 (44%)
		# Species *Tolerant* of Pollution (% abundance)	7 (16%)	4 (26%)
		# Species *Tolerant* of Habitat Disturbance (% abundance)	4 (11%)	2 (26%)
		Shannon-Weaver Diversity Index[3]	3.61	2.85

[1]Pollution tolerance designations from Thomas *et al*. 2005 and Ohio EPA 2008.
[2]Habitat disturbance tolerances from USEPA 2010a and Grabarkiewicz and Davis 2008.
[3]From first-order diversity formula presented on *Java Components for Mathematics* Website (Eck and Ryan 2010).

TSG's 1973 permit renewal application to continue dredging operations on the Allegheny River at Tionesta was denied by USACE, mostly as a result of the PFBC study and grassroots efforts of the Allegheny River Protection Association, Allegheny River Conservation Association, and the Tionesta Cottage Association. By 1975, dredging operations at Franklin, Oil City, and Warren also terminated when their environmental permits expired. The last operation to leave the upper Allegheny River was at Mead Island. The termination of the dredging industry of the upper Allegheny River was a pivotal milestone that saved much of the natural character, instream habitats, islands, and glacially-derived coarse substrates of the free-flowing reach, which is recognized as a national treasure today.

A 1980 Environmental Impact Statement (EIS) prepared by USACE Pittsburgh District stated that "dredging appears to have no significant impact on fish in the Allegheny River." Having doubts about this statement, PFBC decided to conduct an impact assessment similar to the 1973 study, this time on the lower Allegheny River (Lee *et al.* 1992). Fish assemblages were surveyed in 1990-1991 using electrofishing gear, gill nets, and beach seines at Allegheny River Pool 5, a profoundly dredged pool, and at marginally dredged Pool 6 for comparison (Table 6.3). PADEP implemented a moratorium in 1985 on dredging in Allegheny River Pool 6 due to the relative abundance and diversity of high-quality habitats as well as fish and mussels protected as species of conservation concern.

Results of the Pool 5-Pool 6 comparison were not as striking as the PFBC Tionesta study, but still demonstrated dredging impacts. Pools 5 and 6 had similar diversity index values as well as numbers and abundances of sensitive fish species. Although Pool 6's diversity index was impacted by the large number (2,795) of bluntnose minnows collected, both more species and a greater abundance of game fish were observed in Pool 6 than Pool 5.

These three investigations suggest that commercial dredging has impacted fisheries of the Allegheny River. In conducting future impact ecological assessments of commercial dredging, factors to consider include:

- Deepening of the Allegheny River by dams is likely a confounding variable to the extent that determining impacts from dredging may be more difficult for these reaches of river.
- A before-after study would be more robust than upstream-downstream or impact-control study, but pre-impact data do not exist for the Allegheny River.
- Single-event surveys are not representative of existing conditions, and long-term monitoring should be conducted.
- Presence/absence of indicator species, especially those with patchy distributions (*e.g.*, mussels in navigation pools) may not reflect the true impacts of dredging.
- Studies of consequences to ecological functioning of large rivers, such as alterations to sediment transport, allochthonous carbon processing, and river continuum and flood pulse succession, may reveal the true impacts of commercial dredging.

Table 6.3. 1990-1991 Allegheny River fish abundance data at Pool 5 and Pool 6 (Lee *et al.* 1992).

Species	Pollution Tolerance[1]	Habitat Disturbance Tolerance[2]	Allegheny River Pool 6	Allegheny River Pool 5
Clupeidae (herrings & shads)				
Gizzard shad	Intermediate	Intermediate	9	
Cyprinidae (minnows)				
Common carp	Tolerant	Tolerant	7	4
Central stoneroller	Intermediate	Moderately intolerant	4	1
Streamline chub	Intolerant	Intolerant	8	12
Spotfin shiner	Intermediate	Intolerant	220	125
Spottail shiner	Moderately tolerant	Intermediate	1	
Striped shiner	Intermediate	Moderately intolerant	2	
Emerald shiner	Intermediate	Moderately tolerant	30	776
Silver shiner	Intolerant	Intermediate	1	
Rosyface shiner	Intolerant	Intolerant	496	2
Mimic shiner	Intolerant	Moderately intolerant		14
Sand shiner	Moderately intolerant	Moderately intolerant	360	27
Bluntnose minnow	Tolerant	Tolerant	2,795	18
Catostomidae (suckers)				
Quillback	Intermediate	Moderately tolerant	23	10
Smallmouth buffalo	Intermediate	Moderately tolerant		1
Northern hog sucker	Moderately intolerant	Intolerant	58	3
Silver redhorse	Moderately intolerant	Intermediate	34	10
Golden redhorse	Moderately intolerant	Moderately intolerant	415	96
Smallmouth redhorse	Intolerant	Intolerant	10	9
River redhorse	Intolerant	Moderately intolerant	31	1
White sucker	Tolerant	Tolerant	35	
Ictaluridae (bullhead catfishes)				
Channel catfish	Intermediate	Moderately tolerant	6	13
Esocidae (pikes)				
Northern pike	Intermediate	Moderately intolerant	1	
Muskellunge	Intermediate	Intermediate	2	2
Percopsidae (trout-perches)				
Trout-perch	Intermediate	Intermediate	23	
Atherinopsidae (New World silversides)				
Brook silverside	Intolerant	Intermediate	7	
Centrarchidae (sunfishes)				
White crappie	Intermediate	Intermediate	3	
Black crappie	Intermediate	Intermediate	1	1
Rock bass	Intermediate	Intolerant	73	51
Bluegill	Moderately tolerant	Intermediate	14	3
Pumpkinseed	Moderately tolerant	Intermediate	1	
Smallmouth bass	Intolerant	Intolerant	178	97
Spotted bass	Intermediate	Intermediate	1	
Largemouth bass	Intermediate	Intermediate	3	
Percidae (perches)				
Greenside darter	Intolerant	Intolerant	4	2
Johnny darter	Intermediate	Intolerant	139	2
Rainbow darter	Moderately intolerant	Intolerant	1	3
Longhead darter	Intolerant	Intolerant		1
Blackside darter	Intermediate	Intolerant	5	
Logperch	Intolerant	Moderately intolerant	33	1
Sauger	Intermediate	Moderately intolerant	7	19
Walleye	Intermediate	Moderately intolerant	98	41
		# Individuals	5,139	1,345
		# Species	39	29
		# Species *Intolerant* of Pollution (% abundance)	14 (32%)	14 (21%)
		# Species *Intolerant* of Habitat Disturbance (% abundance)	20 (42%)	19 (38%)
		# Species *Tolerant* of Pollution (% abundance)	6 (56%)	3 (2%)
		# Species *Tolerant* of Habitat Disturbance (% abundance)	6 (56%)	6 (61%)
		Shannon-Weaver Diversity Index[3]	2.62	2.47

[1]Pollution tolerance designations from Thomas *et al*. 2005 and Ohio EPA 2008.
[2]Habitat disturbance tolerances from USEPA 2010a and Grabarkiewicz and Davis 2008.
[3]From first-order diversity formula presented on *Java Components for Mathematics* Website (Eck and Ryan 2010).

6.4. Environmental Permitting Restrictions

In addition to the moratorium in Allegheny River Pool 6, dredging is also currently not allowed in Allegheny River Pool 2 and Pool 9 as well as in Ohio River Emsworth Pool and Dashields Pool (USACE 2006). Commercial dredging activities are authorized under Section 404 of the federal Clean Water Act (permits administered by USACE) and Chapter 105 of the Pennsylvania Code (permits administered by PADEP). Dredging companies are now required to conduct pre-dredging surveys for fish using benthic trawling gear as well as for mussels during transect dives (ORVET 2004 protocol).

Commercial dredging of the Three Rivers is not permitted:

- Within 500 feet of any bridge, pier, or abutment.
- Within 1,000 feet upstream, downstream, or laterally of any public water supply intake.
- Within 1,000 feet of the upstream or downstream face of any dam or lock.
- Within 300 feet of any pipeline, submarine cable, commercial or industrial dock, or public launching area.
- Within 150 feet of the 6-foot river depth contours, as measured at normal pool water elevation, and in depths less than 9 feet outside of the navigation channel.
- Closer to the 6-foot river depth contour than twice the dredging depth.
- On the back channel side of any island.
- Within 1,000 feet upstream and 500 feet downstream of any island, except for Phillis Island and Georgetown Island where the offsets are 1,500 feet upstream and 1,000 feet downstream. For Phillis Island and Georgetown Island, the restricted area is measured from the point where the normal pool meets the islands upstream and downstream and extends perpendicular from this point to the 150-foot offset from the 6-foot river depth.
- Buffer areas (1,500 feet upstream and 500 feet downstream) at RM 58.30 and RM 58.85 in Allegheny River Pool 8, due to known presence of federally listed mussel species.
- Within 1000 feet of any public water supply well(s).
- Within the navigation channel unless specifically authorized by USACE. An approval to dredge LDB or RDB authorizes the permittee to dredge from the geographical center line of the river extending shoreward and is subject to the other terms and conditions.
- Within five feet of the bedrock of the river bottom and a minimum of five feet of sand and gravel armoring must be left over the river bottom bedrock.

6.5. Proposed Management Actions

For this Section of the *Management Plan*, PFBC first developed each proposed Management Action in consideration of Stewardship Goal 6.1, and then prioritized these actions into one of three levels with expectation of commencing within the following timeframes:

1 (Red) = Proposed Management Action initiated within two years.
2 (Yellow) = Proposed Management Action initiated within three years.
3 (Green) = Proposed Management Action initiated within five years.

Stewardship Goal 6.1. Evaluate the impacts of past commercial dredging activities on fish species and fish habitats of the Allegheny River and Ohio River to assist in conservation and restoration efforts.

Stewardship Goal 6.1 – Proposed Management Actions		Priority
6.1.1	Form collaborative research partnerships with other resource agencies (e.g., PADEP, ORSANCO) and prepare a grant proposal to fund a study that reevaluates the impacts of past commercial dredging activities on fisheries and/or ecological functioning at historic dredge sites of the upper Allegheny River (Franklin, Oil City, Tionesta, and Warren) and lower Allegheny River (Pool 3 through Pool 9).	**2**

7. Habitats

Over the years, the Three Rivers have maintained a variety of instream and riparian habitats. Due to human alterations within river channels, including dredging and construction of dams, habitats of the Three Rivers, especially those of the Ohio, Monongahela, and lower Allegheny Rivers, have lost much of their complexity. Impoundments and resulting elevated water levels have impacted ecological functions and values as well as the biological integrity of riverine habitats. Instream habitats, including islands, shallow sand and gravel bars, cobble riffles, and channel wetlands, have been lost and replaced by deepwater habitats. Riparian habitats have also been impacted, including loss of what little floodplains and back channels existed.

7.1. Instream Macrohabitats

Instream habitats of the Three Rivers can be classified into four general macrohabitat categories: (1) riffles, (2) runs, (3) natural pools of the free-flowing upper Allegheny River upstream of East Brady (RM 72-198), and (4) navigation pools of the lower Allegheny River, Ohio River, and Monongahela River.

The Cowardin classification system (Cowardin *et al.* 1979), adopted by the U.S. Fish and Wildlife Service for their National Wetland Inventory (NWI), is the standard classification system for mapped wetlands and deepwater habitats across the United States. The Cowardin system separates wetlands and deepwater habitats first into systems, and then further separates systems into subsystems, classes, and then hydrologic regimes. According to NWI maps, all reaches of the Three Rivers are classified as R2UBH (USFWS 2010); or:

- R = Riverine – This system includes all wetlands and deepwater habitats that exist within natural and artificial channels and contain either periodically or continuously flowing water.
- 2 = Lower Perennial – This subsystem typically has a low gradient and a slow water velocity. Substrates in this subsystem are mainly made up of sand and mud, and floodplains are typically well developed.
- UB = Unconsolidated Bottom – This class has a muddy or silty substrate with at least 25 percent cover.
- H = Permanently Flooded – This hydrologic regime holds water throughout the year in all years.

Macrohabitats of the Upper Allegheny River

In the free-flowing upper Allegheny River, natural pools predominate and are interspersed by occasional sequences of riffles and runs (Figure 7.1). The complexity of riffle-run habitats depends on river discharge (*i.e.* high flows result in fewer riffles/more runs; low flows result in more riffles/fewer runs). In general, riffle-run habitats of the upper Allegheny River are comprised of firmly packed glaciofluvial sand and aggregates of gravel and cobble strewn with occasional boulders. Having higher water velocities than natural pools, riffle-run habitats generally maintain higher dissolved oxygen concentrations and lower rates of sedimentation.

Figure 7.1. Pool-riffle-run sequence at confluence of Oil Creek and Allegheny River, Venango County (RM 131.9). This reach of river has historically maintained a riffle-run, tagged "Oil City Rapids" (Class II) by local whitewater enthusiasts. Arrow depicts direction of flow (modified aerial photograph from PASDA 2010).

Riffle-run habitats are essential components of ecological functions of the upper Allegheny River, including food chain production (*e.g*., invertebrate standing crop, fish forage base). Riffle-run habitats also provide spawning, nesting, and foraging sites for many riverine fish species. Several darter species are habitat specialists and spend most of their lives in riffle-runs (Stauffer *et al*. 1996). Most mussel species of the upper Allegheny River require environmental conditions that riffle-run habitats provide in order to survive (*e.g*. federally endangered clubshell and northern riffleshell). Many leaf-shredding and particle-collecting invertebrates (*e.g*. mayfly and caddisfly larvae) that contribute to downstream metabolization and assimilation of allochthonous organic carbon (deciduous leaf litter → coarse particulate organic matter (CPOM) → fine particulate organic matter (FPOM) → dissolved organic carbon (DOC)] require coarse substrates and high water velocities of riffle-run habitats (Vannote *et al*. 1980)

Natural pools also contribute to ecological functioning of the upper Allegheny River, but not to the same degree as riffles and runs. Natural pool habitats of the upper Allegheny River are also generally comprised of firmly packed glaciofluvial sand and aggregates of gravel and cobble strewn with occasional boulders. Having lower water velocities than riffle-run habitats, sedimentation of varying degrees occurs within natural pools, which can blanket coarse substrates with fine-grained alluvium. These lower water velocities also support growth of phytoplankton and submergent macrophytes, allowing for primary production functioning. Many fish species of the upper Allegheny, including species of game fish, require natural pool habitats. Large woody debris (LWD), boulders, and macrophytes of natural pools provide escape cover for prey, ambush cover for predators, refugia for resting, and sanctuaries for rearing many riverine fish species.

Navigation Pool Macrohabitats of the Three Rivers

Instream habitats of the lower Allegheny River downstream of East Brady (RM 72) and for the entire Ohio and Monongahela Rivers have been altered by navigation dams. Pool habitats created by dams are considerably deeper and have less complexity than instream habitats of the free-flowing Allegheny River. When the impounded Three Rivers are at normal "in pool" stage, their predominant deepwater habitats generally have low water velocities. Compared to habitats of the upper Allegheny River, habitats of the impounded Three Rivers are more lake-like, and low water velocity flow patterns are generally uniform across the deep main navigation channel and shallow back channels. These low water velocities can amplify substantially during flood events.

Substrate quality and fish and mussel habitat of navigation pools of the Three Rivers have depreciated immeasurably over the past 200 years. Boulders, cobble, and large woody debris were removed and excavated to improve navigation. Glaciofluvial sand and gravel of the Allegheny and Ohio Rivers has been dredged to sizeable depths (40 to 70 feet). Maintenance dredging by USACE to maintain the minimum 9-foot navigation channels continues to disturb and deepen river bottoms. River substrates are now dominated by firmly-packed silt. Remnant glaciofluvial sand/gravel/cobble now exist primarily along shorelines and islands. Coal fines and steel mill slag are a substantial component of river substrates, especially for the lower Monongahela River and upper Ohio River. Legacy sediments of the Three Rivers that accumulate in low water velocity reaches (*e.g*., behind dams) have been found to be contaminated with heavy metals, PCBs, and pesticides (USACE 1975a, 1975b, and 1981).

Boulder- and cobble-sized rock riprap placed to protect river shorelines and manmade structures, such as bridges and dams, can greatly improve instream habitats, providing fish escape cover for prey, ambush cover for predators, and refugia for resting. Bulkhead structures, including walls of corrugated metal sheet piling, wood railroad ties, concrete blocks, buried barges, limestone-filled Gabion baskets, and corrugated metal mooring cells, line extensive reaches of industrialized shorelines. Many of these structures are abandoned and exist as a reminder of the history of heavy industry along the Three Rivers. Like riprap, bulkhead structures may also increase the complexity of river habitat. Bulkhead structures with high vertical walls can disconnect a river from its floodplain, which further impacts ecological functions and biological integrity of instream and riparian habitats (Junk *et al*. 1989).

Water velocities are visibly higher at the tailwaters of navigation dams (for about 1.5 miles downstream), where the rivers are more stream-like (Figure 7.2). Here, water circulation patterns, including turbulent hydraulics directly below dams and eddies adjacent to shorelines or behind obstructions, provide an important environmental condition of fish habitat for many species, especially walleye and sauger. Deep scour plunge pools excavated by backwash at the spillway of gates or aprons of fixed-crest dams followed downstream by shallow gravel/cobble bars where scour material is deposited by outwash enhances the complexity of tailwater habitat. Predominant macrohabitats of a large river navigation pool include dam tailwaters, main channel, and back channel (Figure 7.3).

Figure 7.2. Monongahela River L/D 4 at Charleroi (RM 41.5). Even with only the middle tainter gate open, water velocity downstream of the dam is appreciably higher than upstream (from USACE 2010).

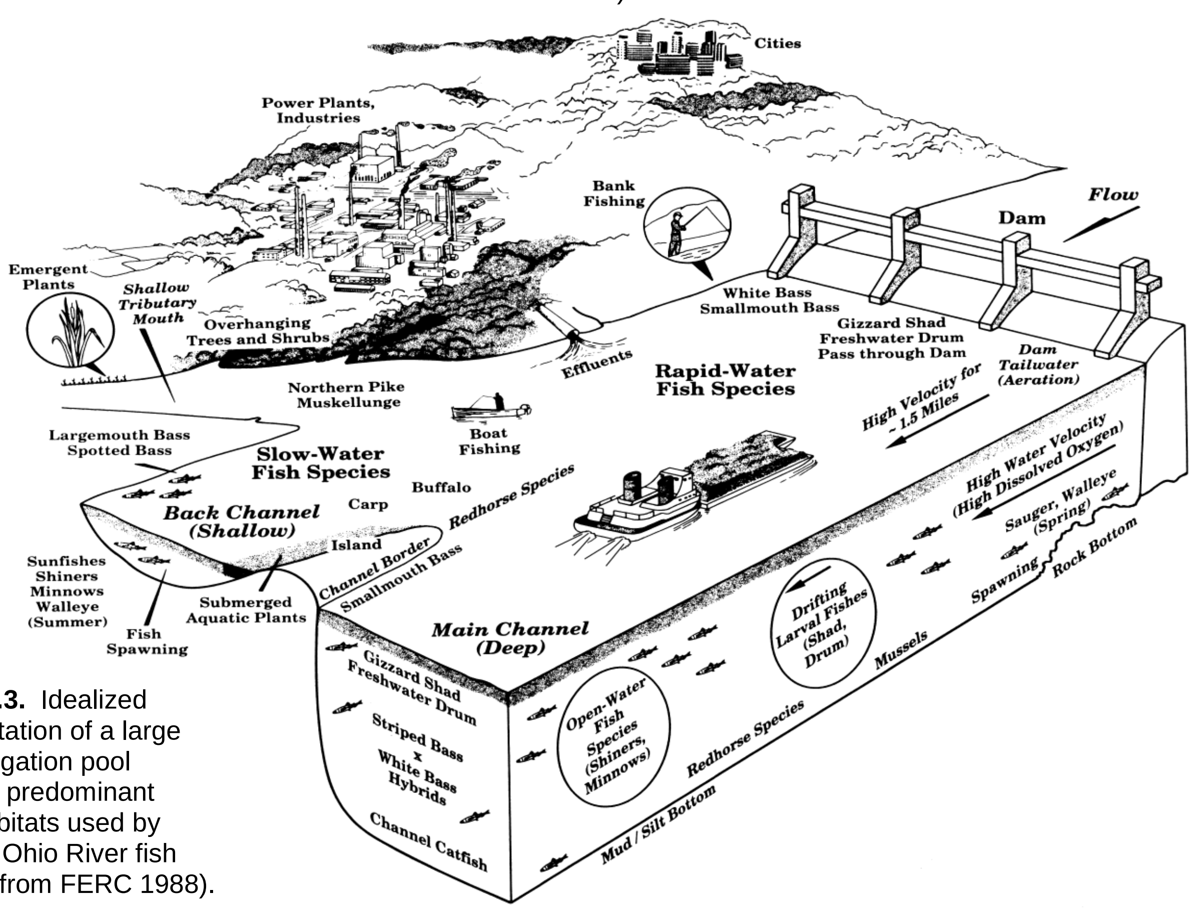

Figure 7.3. Idealized representation of a large river navigation pool depicting predominant macrohabitats used by common Ohio River fish species (from FERC 1988).

7.2. Shallow Water Habitats

Shallow water habitats of the Three Rivers include areas contiguous with river shorelines and islands as well as mouths of tributary streams and embayments. Below is a summary of relatively large (> second-order) tributary streams to the Three Rivers and locations (RM) of their confluences (Table 7.1). Relative widths at the tributary mouth and presence of exposed alluvial fans were determined from 2004 U.S. Department of Agriculture National Agriculture Imagery Program (NAIP) one-meter resolution color infrared (CIR) aerial photographs. Exposed alluvial fans are important shallow water habitats as they are typically comprised of sand-, gravel-, and even cobble-sized tributary stream bedload, which provides fish spawning, nesting, and foraging locations as well as colonization areas for invertebrates (Figure 7.4). Shallow water habitats of tributary mouths could also serve fish as escape areas for prey, ambush areas for predators, refugia for resting, and sanctuaries for rearing.

Table 7.1. Relatively large tributary streams of the Three Rivers.

River	Tributary Stream	Confluence RM	Stream Width at Mouth Category[1]	Confluence Side[2]	Exposed Alluvial Fan
Ohio	Pennsylvania-Ohio Border = RM 40.0				
	Little Beaver Creek	40.5	Large	RDB	No
	Raccoon Creek	29.6	Large	LDB	No
	Beaver River	25.5	Very Large	RDB	No
	Big Sewickley Creek	15.4	Small	RDB	Yes
	Little Sewickley Creek	13.6	Small	RDB	Yes
	Montour Run	9.4	Small	LDB	Yes
	Chartiers Creek	2.7	Medium	LDB	No
Allegheny	Pine Creek	4.7	Small	RDB	Yes
	Plum Creek	10.8	Large (braided channel)	LDB	Yes
	Deer Creek	13.2	Medium	RDB	Yes
	Pucketa Creek	18.0	Medium	LDB	Yes
	Bull Creek	21.6	Medium	RDB	No
	Buffalo Creek	28.6	Medium	RDB	No
	Kiskiminetas River	30.1	Very Large	LDB	No
	Crooked Creek	40.2	Large	LDB	No
	Cowanshannock Creek	48.6	Medium	LDB	No
	Pine Creek	50.7	Medium	LDB	No
	Mahoning Creek	55.6	Large	LDB	No
	Redbank Creek	64.0	Large	LDB	No
	Sugar Creek	69.6	Small	RDB	Yes
	Bear Creek	82.2	Medium	RDB	Yes
	Clarion River	84.6	Very Large	LDB	No
	Scrubgrass Creek	106.9	Medium	RDB	Yes
	Sandy Creek	114.1	Medium	RDB	Yes
	East Sandy Creek	118.4	Medium	LDB	No
	French Creek	123.9	Large	RDB	No
	Oil Creek	131.9	Large	RDB	Yes
	Pithole Creek	140.9	Medium	RDB	No

	Hemlock Creek	144.6	Medium	LDB	Yes
	Tionesta Creek	151.4	Large	LDB	No
	West Hickory Creek	157.2	Small	RDB	Yes
	East Hickory Creek	158.9	Medium	LDB	Yes
	Tidioute Creek	166.7	Small	RDB	Yes
	Brokenstraw Creek	181.2	Very Large (braided channel)	RDB	Yes
	Conewango Creek	188.9	Large	RDB	No
	Kinzua Dam = RM 197.4				
Monongahela	Streets Run	6.0	Small	LDB	Yes
	Ninemile Run	7.5	Small	RDB	Yes
	Turtle Creek	11.5	Medium	RDB	No
	Youghiogheny River	15.5	Very Large	RDB	No
	Peters Creek	19.9	Small	LDB	No
	Mingo Creek	29.7	Small	LDB	Yes
	Pigeon Creek	32.3	Medium	LDB	No
	Pike Run	51.3	Medium	LDB	No
	Redstone Creek	55.0	Medium	RDB	No
	Dunlap Creek	56.1	Small	RDB	No
	Tenmile Creek	65.7	Large	LDB	No
	Pumpkin Run	68.4	Medium	LDB	No
	Muddy Run	72.9	Medium	LDB	No
	Whitely Creek	80.2	Medium	LDB	No
	Georges Creek	84.9	Medium	RDB	No
	Dunkard Creek	87.2	Medium	LDB	No
	Cheat River	89.6	Very Large	RDB	No
	Pennsylvania-West Virginia Border = RM 91.3				

[1]Small < 100 ft; Medium = 100-200 ft; Large = 200-400 ft; Very Large > 400ft.
[2]RDB = Right Descending Bank; LDB = Left Descending Bank.

Figure 7.4. Confluence of Pine Creek and Allegheny River (RM 4.7) in Allegheny County. Pine Creek contributes a great deal of alluvial bedload to the Allegheny, most likely a result of Earth disturbance activities, impervious surfaces, and flashy hydrology of the contributing Pine Creek watershed, which drains several rapidly-developing northern suburbs of Pittsburgh. Arrow depicts direction of flow (modified aerial photograph from PASDA 2010).

Embayments, although few, also provide important habitat (Table 7.2). Possessing generally lower water velocities than the main river channel, embayments maintain important shallow water habitats for fish, reptiles, amphibians, and birds; and provide areas for spawning, nesting, and foraging as well as escape areas for prey, ambush areas for predators, refugia for resting, and sanctuaries for rearing. PFBC historically surveyed the River Forest Embayment of the

Allegheny River in search of paddlefish and found it home to several large Esocids (muskies and tiger muskies). Montgomery Slough on the Ohio River is a natural feature (Figure 7.5), while all embayments of the Allegheny River were excavated by industry, primarily commercial sand and gravel dredging, as fleeting areas for barges (Figure 7.6). Embayment surface areas and relative levels of riparian development were determined from 2004 NAIP CIR aerial photographs.

Table 7.2. Embayments of the Three Rivers.

River	Embayment	Confluence RM	Area (acres)	Confluence Side[1]	Riparian Development
Ohio	Montgomery Slough	31.6	22	RDB	Low
Allegheny	Chapel Harbor Embayment	8.6	3	RDB	High
	Harmar Mine Embayment	12.9	7	RDB	High
	River Forest Embayment	27.8	15	LDB	Medium
	Freeport Terminals Embayment	29.6	2	RDB	High
	(Lower) Murphys Bottom Pond[2]	32.4	21	RDB	Low
	(Upper) Murphys Bottom Embayment	32.9	1	RDB	Low
	Tarrtown Embayment	48.3	18	RDB	Medium

[1]RDB = Right Descending Bank; LDB = Left Descending Bank.
[2]No current surface connection to river; Duquesne University (2010) has proposed to enhance this connection.

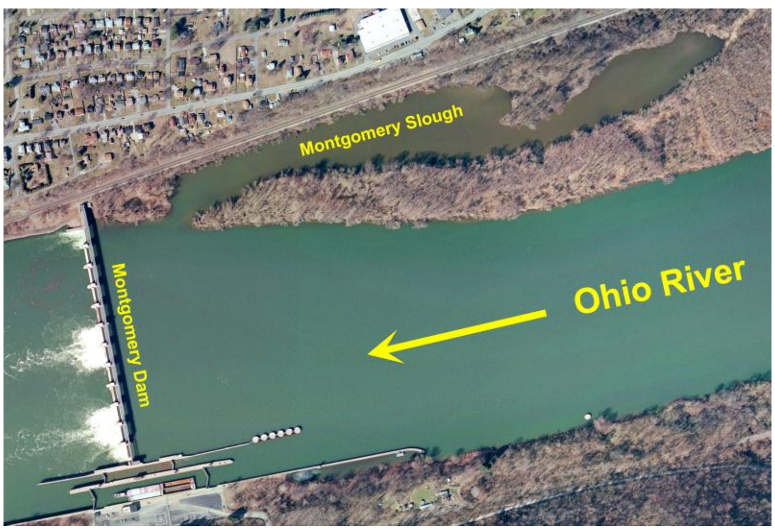

Figure 7.5. Montgomery Slough (RM 31.6) and Ohio River confluence in Beaver County. Arrow depicts direction of flow (modified aerial photograph from PASDA 2010).

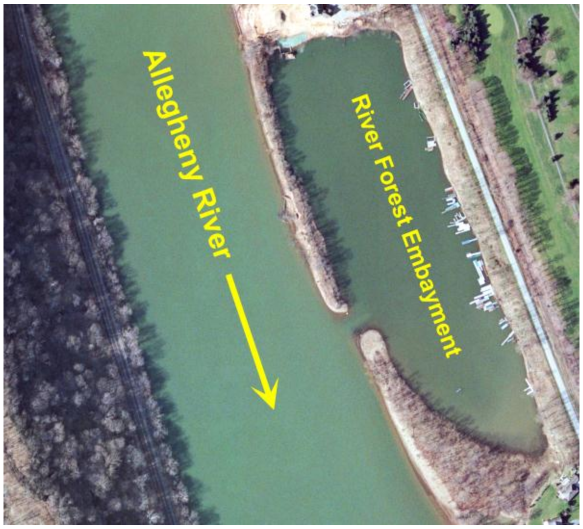

Figure 7.6. River Forest embayment (RM 27.8) and Allegheny River confluence in Westmoreland County. A fixed-site located immediately upstream of the embayment confluence is surveyed annually by PFBC for young-of-the-year smallmouth bass. Arrow depicts direction of flow (modified aerial photograph from PASDA 2010).

7.3. <u>Islands</u>

Possessing both terrestrial and aquatic features, islands maintain some of the most valuable instream and riparian habitats of the Allegheny and Ohio Rivers. Shallow water habitats contiguous with island shorelines provide fish spawning, nesting, and foraging locations as well as colonization areas for mussels and invertebrates. Depending on their shapes, islands generally maintain large, rounded, sand/cobble/gravel shallows at their upstream heads and narrow, pointed, silty shallows at their downstream toes (FERC 1980). Since water velocity is generally lower at island toes than heads, toes serve as depositional areas for fine-grained alluvial substrates and organic material. As a result, island toes typically help to maintain expansive beds of submergent and emergent macrophytes, especially water willow (*Justicia americana*) (Figure 7.7) as well as submergent and emergent large woody debris from felled trees (Figure 7.8). With relatively lower water velocities than deeper main channels, shallow island back channels provide fish escape areas for prey, ambush areas for predators, refugia for resting, and sanctuaries for rearing. The diversity of river depths, current patterns, substrates, and riparian forest cover adds value to islands as riverine habitats, making them suitable to maintain high abundance and diversity of fish, mussels, and other aquatic life.

Figure 7.7. Toe of Allegheny River's Sycamore Island (RM 9.9-10.3) and its riverine habitats, including mature silver maple floodplain forest, attenuating black willows, and emergent and submergent macrophytes – water willow and smartweeds (PFBC photograph).

Figure 7.8. Toe of Ohio River's Georgetown Island (RM 37.6-37.8) and its riverine habitats, including large woody debris and shallow sand and gravel bars. The island has lost much of its area due to commercial sand and gravel dredging. Note the large stand of Japanese knotweed and the island's steep eroding banks (PFBC photograph).

Numerous islands of the lower Allegheny River and upper Ohio River were eliminated during navigation channel improvements and excavation of aggregates during the Eighteenth and Nineteenth Centuries, including Garrison Island (also known as Wainwright Island, where George Washington and Christopher Gist were stranded in 1753), Puckerty Island, and Bull Creek Island of the Allegheny and Low Island, Killbuck Island (also known as Smokey Island), Deer Island, Deadman Island, Crow Island, Hog Island, and Montgomery Island of the Ohio (Babbitt 1855; Cramer 1824). Maps of early Pittsburgh from the early 1800s depict a large "sand bar dry at low water" in the middle of the Monongahela River (ca. RM 0.2-1.0) (Bernhard 1826).

Islands of the Three Rivers and their locations within the river channels (toe – head RM for Allegheny and head – toe RM for Ohio) are summarized below (Table 7.3). Approximate surface areas (to the nearest five acres) and relative levels of development were determined from 2004 NAIP CIR aerial photographs. Islands are primarily comprised of glaciofluvial aggregate base material and locally-derived nonglacial alluvial sediment deposited over base material. The unglaciated Monongahela River does not maintain any natural islands, although a very small manmade island exists just downstream of Point Marion L/D.

The upper Ohio River contains five islands totalling approximately 1,200 acres. The lower Allegheny River (RM 0-72) maintains 14 islands totaling approximately 290 acres. In contrast, the upper Allegheny River (RM 72-198) has more than 150 islands (some exist as complexes comprised of more than two separate land masses while others persist as mosaics of landforms) totaling approximately 1,840 acres.

Some islands of the Three Rivers have undergone various degrees of commercial, industrial, and residential development, including Neville Island and Brunot Island in the Ohio River, and Herrs Island (Figure 7.9) and Mead Island (Figure 7.10) in the Allegheny River. Most islands remain undeveloped, including Georgetown Island and Phillis Island in the Ohio River, which are part of the Ohio River Islands National Wildlife Refuge (ORINWR). Many islands of the Allegheny River are protected, including Sycamore Island (purchased by Allegheny Land Trust) (Figure 7.11), islands of PADCNR's Allegheny Islands State Park (upstream end of Twelvemile Island and upper and lower Fourteen Mile Islands), and islands of the U.S. Forest Service's Allegheny Islands Wilderness (unnamed island, Baker Island, King Island, Courson Island, Thompsons Island complex, and Crulls Island complex).

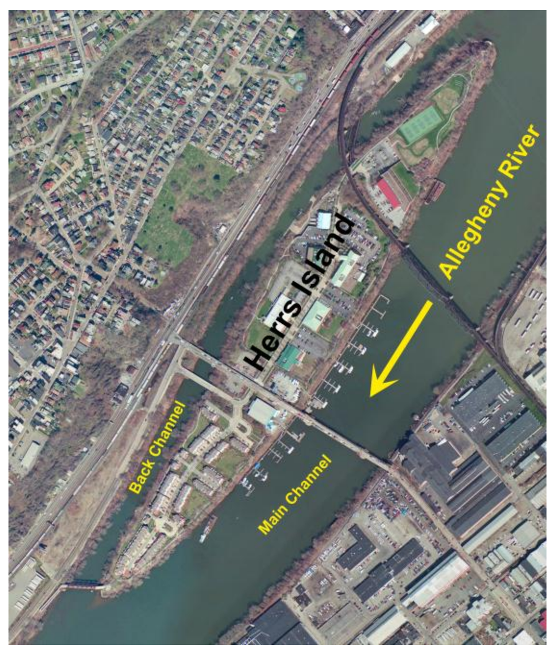

Figure 7.9. Allegheny River's Herrs Island (RM 2.2-3.0) is one of the most heavily developed islands of the Three Rivers. Decades of contamination were remediated to create upscale housing, modern office buildings, and a marina (modified aerial photograph from PASDA 2010).

Table 7.3. Islands of the Three Rivers.

River	Island	RM	Approximate Area (acres)	Navigation Channel[1]	Develop-ment
Ohio	Pennsylvania-Ohio Border = RM 40.0				
	Georgetown Island	37.6-37.8	5	Left	None
	Phillis Island	35.1-35.6	20	Right	None
	Neville Island	4.9-10.0	980	Right	High
	Davis Island	4.5-5.1	40	Right	Medium
	Brunot Island	1.7-2.8	150	Left & right	Medium
Allegheny	Herrs Island	2.2-3.0	50	Left	High
	Sixmile Island	6.2-6.4	5	Left	Low
	Ninemile Island	9.9-10.2	5	Right	Low
	Sycamore Island	9.8-10.3	15	Left	Low
	Twelvemile Island	12.7-13.6	50	Left	Medium
	(Lower) Fourteen Mile Island (complex)	13.7-14.4	35	Left	None
	(Upper) Fourteen Mile Island	14.5-14.8	10	Left	None
	Jacks Island (complex)	24.3-25.9	35	Right	Low
	Unnamed island (at tailwaters L/D 5)	30.2	< 5	Right	None
	Murphy Island	32.3-32.8	15	Right	None
	Nicholson Island	36.7-37.3	20	Right	None
	Ross Island	39.5-40.1	20	Right	None
	Cogley Island (complex)	42.5-43.4	30	Left	None
	Unnamed island (at tailwaters L/D 7)	45.5-45.6	< 5	Right	None
	Bald Eagle Island	76.3-76.5	10	n/a	None
	Black Fox Island	77.2-77.5	15	n/a	None
	Unnamed island (at Parker)	82.6-82.7	5	n/a	None
	Clarion Island (complex)	83.6-85.1	60	n/a	None
	14 unnamed islands	95.8-111.5	80	n/a	None
	Whitherup Island	112.1-112.5	20	n/a	None
	22 unnamed islands	113.3-123.8	75	n/a	None
	Hoge Island	123.9-124.6	45	n/a	Low
	4 unnamed islands	125.8-133.1	25	n/a	None
	Alcorn Island	133.6-134.0	15	n/a	None
	19 unnamed islands	136.6-147.4	135	n/a	None
	Holeman Island	147.3-148.1	60	n/a	High
	17 unnamed islands	149.2-154.0	135	n/a	None
	"Tionesta Sand and Gravel Island"	151.4-151.8	25	n/a	High
	Baker Island	154.0-154.9	80	n/a	None
	King Island	156.2-156.9	40	n/a	None
	Hemlock Island (complex)	158.7-160.4	85	n/a	None
	9 unnamed islands	161.2-163.9	95	n/a	None
	Siggias Island	163.7-164.3	30	n/a	None
	6 unnamed islands	164.3-65.3	20	n/a	None
	Tidioute Island (complex)	166.2-166.4	5	n/a	None

	McGuire Island (complex)	167.0-167.8	25	n/a	None
	Courson Island	167.7-168.6	60	n/a	None
	Fuelhart Island (complex)	169.6-170.4	35	n/a	Low
	Millstone Island	170.9-171.3	15	n/a	None
	Unnamed island (at Shanley Eddy)	171.7-171.9	5	n/a	None
	Stewards Island	172.5-173.2	55	n/a	None
	6 unnamed islands	173.0-176.9	90	n/a	None
	Thompsons Island (complex)	177.3-178.6	70	n/a	None
	Crulls Island (complex)	179.5-180.6	95	n/a	None
	Grass Flat Island (complex)	182.5-183.1	35	n/a	None
	Leek Island (complex)	183.3-183.9	30	n/a	None
	Mead Island[2]	184.5-185.6	Land = 55 Water = 65	n/a	High
	8 unnamed islands (at Warren)	187.8-190.7	10	n/a	Medium
	Knight Island	190.7-191.2	15	n/a	None
	Reiff Island (complex)	191.8-192.1	10	n/a	None
	Verbeck Island	192.7-193.1	15	n/a	None
	Wardwell Island (complex)	193.6-194.2	15	n/a	None
	Harmon Island (complex)	194.7-195.5	35	n/a	None
	Dixon Island (complex)	195.7-196.6	40	n/a	None
	Unnamed island	197.0-197.1	< 5	n/a	None
	Kinzua Dam = RM 197.4				

[1]Looking downstream; islands listed as n/a are upstream of the navigation channel.
[2]Due to past commercial dredging activities, this island resembles an atoll.

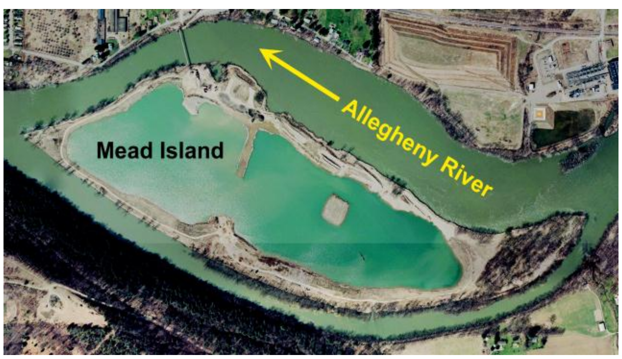

Figure 7.10. Allegheny River's Mead Island (RM 184.5-185.6) showing interior pool formed by commercial sand and gravel dredging. Arrow depicts direction of flow (modified aerial photograph from PASDA 2010).

Figure 7.11. Sycamore Island (left) (RM 9.8-10.3) and Ninemile Island (right) (RM 9.9-10.2) in the Allegheny River near Pittsburgh provide relatively undisturbed riparian and instream wildlife habitat (from Allegheny Land Trust 2010).

7.4. Manmade Habitats

Manmade structures that can add to the complexity of riverine habitats include navigation locks and dams and bridges (Table 7.4). Bridge piers constructed of hand-cut sandstone (Figure 7.12) may provide more realistic fish cover than bridge piers constructed of poured concrete. For example, these bridge pier habitats provided smallmouth bass catches to many professional anglers competing in both the 2005 Bassmaster Classic and 2009 Forest L. Wood Cup Tournament. Several recent bridge replacement projects of the upper Allegheny River (*e.g.*, West Hickory Bridge, Kennerdell Bridge, Foxburg Bridge, Sergeant Carl F. Curran II Memorial Bridge in East Brady) involved recovering and relocating tens of thousands of individual mussels representing many species, including federally endangered northern riffleshell and clubshell, from areas of impact. Similar projects are in the planning stages for Hunter Station Bridge near Tionesta and Jonathan Hulton Bridge in Oakmont.

Figure 7.12. Featuring bridge piers constructed of hand-cut sandstone, the Panhandle Bridge across the Monongahela River affirms Pittsburgh's moniker the "City of Bridges" (from Pittsburgh Bridges 2010).

Table 7.4. Bridge crossings of the Three Rivers.

River	Bridge	Thoroughfare	RM	Bridge Pier
Ohio	Pennsylvania-Ohio Border = RM 40.0			
	Shippingport Bridge	PA-168	34.7	Concrete
	Vanport Bridge	I-376	28.0	Concrete
	Monaca-Beaver Railroad Bridge	CSX Transportation	25.7	Cut stone
	Rochester-Monaca Bridge	PA-18	25.1	Concrete
	Monaca-East Rochester Bridge	PA-51	24.3	Concrete
	Ambridge-Aliquippa Bridge	11th Street	16.8	Concrete
	Sewickley Bridge	Orange Belt	11.8	Cut stone
	Coraopolis-Neville Island Bridge (Neville Island back channel span)	Yellow Belt	9.6	Concrete
	Neville Island Bridge (Neville Island main channel span)	I-79	8.7	Concrete
	Neville Island Bridge (Neville Island back channel span)		8.6	Concrete
	Neville Island Bridge (Neville Island back channel ramp)		8.5	Concrete
	Pittsburgh, Chartiers, & Youghiogheny Railroad Bridge (Neville Island back channel span)	Pittsburgh & Ohio Central Railroad	5.3	Cut stone
	Fleming Park Bridge (Neville Island back channel span)	Neville Road	5.2	Concrete
	McKees Rocks Bridge	Blue Belt	3.3	Cut stone
	Ohio Connecting Railroad Bridge (Brunot Island main channel and back channel spans)	Norfolk Southern Railway	2.3	Cut stone
	West End Bridge	US-19	0.8	Cut stone

Allegheny	Fort Duquesne Bridge	I-279	0.3	Concrete
	Roberto Clemente Bridge	6th Street	0.6	Cut stone
	Andy Warhol Bridge	7th Street	0.7	Cut stone
	Rachel Carson Bridge	9th Street	0.8	Cut stone
	Fort Wayne Railroad Bridge	Norfolk Southern Railway and Amtrak	1.0	Cut stone
	Veterans Bridge	I-579	1.2	Concrete
	16th Street Bridge	16th Street	1.4	Cut stone
	Herrs Island Railroad Bridge (Herrs Island back channel span)	Three Rivers Heritage Trail	2.2	Concrete
	30th Street Bridge (Herrs Island back channel span)	30th Street	2.5	Concrete
	31st Street Bridge (Herrs Island main channel and back channel spans)	31st Street	2.5	Cut Stone and concrete
	33rd Street Railroad Bridge (Herrs Island main channel and back channel spans)	Allegheny Valley Railroad	2.7	Concrete
	Washington Crossing Bridge	40th Street	3.2	Concrete
	Senator Robert D. Fleming Bridge	62nd Street / PA-8	5.4	Concrete
	Highland Park Bridge	Blue Belt	6.8	Concrete
	Brilliant Branch Railroad Bridge	Allegheny Valley Railroad	7.2	Cut stone
	Jonathan Hulton Bridge	Hulton Road	12.7	Cut stone
	Allegheny River Turnpike Bridge (Fourteen Mile Island main channel and back channel spans)	PA-Turnpike I-76	14.1	Concrete
	Bessemer & Lake Erie Railroad Bridge (Fourteen Mile Island main channel and back channel spans)	Canadian National Railway	14.2	Cut stone
	C.L. Schmitt Bridge	9th Street	19.0	Concrete
	George D. Stuart Bridge	PA-366	21.8	Concrete
	Donald R. Lobaugh Bridge	PA-356	28.2	Concrete
	Freeport Railroad Bridge	Norfolk Southern Railway	29.9	Cut stone
	Ford City Veterans Bridge	PA-128	41.0	Concrete
	Benjamin Franklin Highway Bridge	US-422	43.8	Concrete
	Kittanning Citizens Bridge	Butler Road	45.1	Cut stone and concrete
	Mosgrove Railroad Bridge	Buffalo & Pittsburgh Railroad	50.6	Cut stone
	Reesedale Railroad Bridge	Buffalo & Pittsburgh Railroad	55.6	Concrete
	Sergeant Carl F. Curran II Memorial Bridge	PA-68	69.5	Concrete
	Parker Bridge	PA-368	83.5	Concrete
	Foxburg Bridge	PA-58	86.2	Concrete
	Allegheny River Bridge	I-80	89.2	Concrete
	Emlenton Bridge	PA-38	89.7	Concrete
	Kennerdell Bridge	Kennerdell Road	107.4	Concrete
	Belmar Railroad Bridge	Sandy Creek Trail	118.3	Cut stone
	8th Street Bridge	US-322	123.7	Concrete

	Petroleum Street Bridge	US-62	131.1	Concrete
	Veterans Memorial Bridge	State Street	131.3	Concrete
	Oil City Railroad Bridge	Abandoned	132.2	Cut stone
	Hunter Station Bridge	US-62	148.8	Concrete
	Tionesta Bridge	US-62 / PA-36	152.0	Concrete
	West Hickory Bridge	PA-127	158.2	Concrete
	Tidioute Bridge	PA-127	166.6	Cut Stone
	Allegheny Springs Bridge	US-62	181.8	Concrete
	National Forge Bridge	US-6	187.6	Concrete
	West Warren Railroad Bridge	Buffalo & Pittsburgh Railroad	188.1	Concrete
	Hickory Street Bridge	Hickory Street	188.6	Concrete
	East Warren Railroad Bridge	Abandoned	189.0	Concrete
	Glade Bridge	Business US-6	190.7	Concrete
	Kinzua Dam = RM 197.4			
Monongahela	Fort Pitt Bridge	I-376 / Truck US-19 / US-22 / US-30	0.2	Concrete
	Smithfield Street Bridge	Smithfield Street	0.8	Cut stone
	Panhandle Bridge	Port Authority T-Light Rail Line	1.0	Cut stone
	Liberty Bridge		1.1	Concrete
	Phillip Murray Bridge	South 10th Street	1.5	Cut stone
	Birmingham Bridge		2.3	Concrete
	Hot Metal Bridge	Hot Metal Street (South 29th Street) and Eliza Furnace Trail	3.1	Cut stone
	Glenwood Bridge	PA-85	5.9	Concrete
	Glenwood Railroad Bridge	Allegheny Valley Railroad	6.1	Concrete
	Homestead Grays Bridge	Blue Belt	7.3	Cut stone
	Pinkerton's Landing Railroad Bridge	CSX Transportation	8.5	Cut stone
	Carrie Furnace Hot Metal Railroad Bridge	Abandoned	9.3	Cut stone
	Rankin Bridge	Green Belt	9.6	Concrete
	Union Railroad Port Perry Railroad Bridge	Union Railroad	11.5	Cut stone
	Pennsylvania Railroad Port Perry Railroad Bridge	Norfolk Southern Railway	11.6	Cut stone
	McKeesport-Duquesne Bridge	Green Belt	14.1	Concrete
	Riverton Railroad Bridge	Steel Valley Trail	14.3	Cut stone
	W.D. Mansfield Memorial Bridge	Yellow belt	16.7	Concrete
	Clairton-Glassport Bridge		19.3	Concrete
	Clairton Coke Works Railroad Bridge	Abandoned	21.1	Cut stone
	Regis R. Malady Bridge	PA-51	22.9	Cut stone
	Monongahela City Bridge	PA-136	32.4	Concrete
	Donora-Webster Bridge	10th Street	36.3	Cut Stone
	C. Vance Deicas Memorial Bridge	C. Vance Deicas Highway	38.1	Concrete

	Charleroi-Monessen Bridge	Lock Street	41.0	Cut stone
	Speers Railroad Bridge	Wheeling & Lake Erie Railway	43.2	Concrete
	Belle Vernon Bridge	I-70	43.3	Concrete
	West Brownsville Junction Railroad Bridge	Norfolk Southern Railway	55.1	Cut stone
	Lane Bane Bridge	US-40	55.9	Concrete
	Brownsville Bridge	Bridge Boulevard	56.2	Cut stone
	Mon-Fayette Expressway Bridge (under construction)	PA Turnpike-43	59.1	Concrete
	Masontown Bridge	PA-21	79.2	Cut stone
	Friendship Hill Railroad Bridge	Norfolk Southern Railway	86.1	Cut stone
	Point Marion Bridge	PA-88	89.9	Concrete
	Pennsylvania-West Virginia Border = RM 91.3			

7.5. Riparian Habitats

Riparian habitats are transition zones between instream habitats and upland terrestrial habitats and include riparian wetlands, hydric to mesic floodplains, and mesic to xeric riparian forests. Riparian habitats of the Three Rivers are shaped and maintained through seasonal flooding, scour, and sediment deposition. Flood events replenish nutrients, recharge groundwater, and initiate successional processes of riparian habitats. Native plant species compositions of riparian habitats are influenced by elevation, river gradient, floodplain width, and spatial and temporal aspects of flood events.

Wetlands

Habitats of the Three Rivers include riparian wetlands identified by the new National Wetlands Inventory (NWI) maps, which typically depict wetland areas that are readily photointerpreted (USFWS 2010) (Table 7.5). NWI maps generally do not identify all wetland areas as they are derived from aerial photointerpretation with varying limitations due to scale, photo quality, inventory techniques, and other factors. Older NWI maps from 1970s black and white photography tend to be very conservative with many forested and seasonally dry emergent wetlands not mapped. Maps derived from CIR aerial photographs tend to yield more accurate results, except when photography was captured during a dry year, making wetland identification difficult.

According to NWI maps, riparian habitats contiguous with the Ohio River maintain only 22 acres of palustrine wetlands with 0.3 of an acre emergent, 2.5 acres as ponds on Davis Island, and the remaining 19.5 acres forested. For the Monongahela River, contiguous riparian habitats maintain only 53 acres of palustrine wetlands, including 6.9 acres emergent, 26.4 acres scrub-shrub, and the remaining 19.5 acres forested. The lower Allegheny River's (RM 0-72) contiguous riparian habitats sustain 71 acres (roughly 1 acre per rivermile) of palustrine wetlands, with 12.4 acres emergent, 36.3 acres forested/scrub-shrub, and 22.6 acres forested. In contrast, riparian habitats contiguous with the upper Allegheny River (RM 72-198) support 940 acres (approximately 7 acres per rivermile) of mostly palustrine (some riverine, unconsolidated shores on islands) wetlands, nearly all of which exist on its many islands. This comparison demonstrates how drastically altered by man the navigational portion of the Three Rivers has been. Most (87 percent) of the upper Allegheny's island wetlands are classified as forested.

Table 7.5. NWI riparian wetlands of the Three Rivers (USFWS 2010).

River	NWI Wetland[1]	System/Class/Modifier	Side*	RM	Area (acres)
Ohio	PEM1C	Palustrine, emergent, persistent, seasonally flooded	Brunot Island	2.7	0.3
	PUBHx	Palustrine, unconsolidated bottom, permanently flooded, excavated	Davis Island	4.9	1.7
	PUBHx	Palustrine, unconsolidated bottom, permanently flooded, excavated	Davis Island	4.9	0.8
	PFO1A	Palustrine, forested, broad-leaved deciduous, temporarily flooded	LDB (at Moon Run)	8.7-9.0	4.1
	PFO1A	Palustrine, forested, broad-leaved deciduous, temporarily flooded	RDB	10.8	0.8
	PFO1A	Palustrine, forested, broad-leaved deciduous, temporarily flooded	LDB	11.0	2.2
	PFO1A	Palustrine, forested, broad-leaved deciduous, temporarily flooded	LDB	11.6-11.8	3.0
	PFO1A	Palustrine, forested, broad-leaved deciduous, temporarily flooded	RDB	17.5-17.6	3.2
	PSS1A	Palustrine, scrub-shrub, broad-leaved deciduous, temporarily flooded	RDB	17.6	1.1
	PFO1A	Palustrine, forested, broad-leaved deciduous, temporarily flooded	RDB	20.3	0.8
	PFO1A	Palustrine, forested, broad-leaved deciduous, temporarily flooded	RDB	37.2-37.5	4.3
Allegheny	PFO1C	Palustrine, forested, broad-leaved deciduous, seasonally flooded	RDB (at Squaw Run)	8.7	3.9
	PEMC	Palustrine, emergent, seasonally flooded	Sycamore Island	10.3	1.3
	PEM/UBH	Palustrine, emergent / unconsolidated bottom, permanently flooded	LDB	25.0-25.2	2.4
	PFO1A	Palustrine, forested, broad-leaved deciduous, temporarily flooded	Nicholson Island	36.7-37.3	18.7
	PFO1/SS1C	Palustrine, forested, broad-leaved deciduous / scrub-shrub, broad-leaved deciduous, seasonally flooded	Cogley Island	42.5-42.9	7.5
	PEMC	Palustrine, emergent, seasonally flooded	Cogley Island	42.9-43.1	4.9
	PFO1/SS1A	Palustrine, forested, broad-leaved deciduous / scrub-shrub, broad-leaved deciduous, temporarily flooded	RDB	43.6-43.7	6.4
	PEMA	Palustrine, emergent, temporarily flooded	RDB	43.8	1.3
	PEMC	Palustrine, emergent, seasonally flooded	Unnamed island (L/D	45.6-45.5	1.4
	PEMC	Palustrine, emergent, seasonally flooded	Tarrtown Embayment	48.5	1.1
	PFO1/SS1C	Palustrine, forested, broad-leaved deciduous / scrub-shrub, broad-leaved	LDB	53.2-53.8	22.4
	PEMF	Palustrine, emergent, semipermanently flooded	Upper Allegheny River islands	95.8-197.4	1.1
	PEMC	Palustrine, emergent, seasonally flooded			43.6
	R2USC	Riverine, lower perennial, unconsolidated shore, seasonally flooded			17.0

	PUBH	Palustrine, unconsolidated bottom, permanently flooded			22.6
	PSS1C	Palustrine, scrub-shrub, broad-leaved deciduous, seasonally flooded			13.4
	PSS1E	Palustrine, scrub-shrub, broad-leaved deciduous, seasonally flooded / saturated			1.2
	PSS1/EMC	Palustrine, scrub-shrub, broad-leaved deciduous / emergent, seasonally flooded			27.3
	PFO1A	Palustrine, forested, broad-leaved deciduous, temporarily flooded			785.2
	PFO1C	Palustrine, forested, broad-leaved deciduous, seasonally flooded			24.5
	PFO1/SS1A	Palustrine, forested, broad-leaved deciduous / scrub-shrub, broad-leaved deciduous, temporarily flooded			3.9
Monongahela	PSS1A	Palustrine, scrub-shrub, broad-leaved deciduous, temporarily flooded	LDB	54.6-55.0	24.6
	PEM1A	Palustrine, emergent, persistent, temporarily flooded	RDB	66.3	0.9
	PEM1C	Palustrine, emergent, persistent, seasonally flooded	RDB	66.2-66.3	5.4
	PEM1Ch	Palustrine, emergent, persistent, seasonally flooded, impounded	RDB	67.8	0.6
	PFO1A	Palustrine, forested, broad-leaved deciduous, temporarily flooded	RDB	68.5-68.8	9.7
	PSS1A	Palustrine, scrub-shrub, broad-leaved deciduous, temporarily flooded	RDB	68.5	1.8
	PFO1A	Palustrine, forested, broad-leaved deciduous, temporarily flooded	RDB	70.4-70.5	4.7
	PFO1A	Palustrine, forested, broad-leaved deciduous, temporarily flooded	RDB	86.7-87.0	5.1

[1]U.S. Fish and Wildlife Service classification (Cowardin *et al*. 1979).

Figure 7.13. Ohio River riparian plant community near Georgetown Island infested with purple loosestrife (PFBC photograph).

In many wetland and island-fringe plant communities of the Three Rivers, several non-native plant species possess the potential to threaten the diversity and abundance of native plant species as well as the ecological stability of the Three Rivers. These non-native species include the common reed (*Phragmites australis*), reed canary grass (*Phalaris arundinacea*), purple loosestrife (*Lythrum salicaria*), narrow-leaf cattail (*Typha angustifolia*), and hybrid cattail (*Typha ×glauca*). These five species are highly aggressive and tend to replace diverse, native wetland plant communities with a dense monoculture. In particular, purple loosestrife is becoming increasingly abundant, overrunning riparian and channel wetland habitats of the Three Rivers (Figure 7.13).

Floodplains
During flood and other wet weather events, the Three Rivers convey more water than their channels can contain. Excess floodwater inundates adjacent lowlands known as floodplains until river discharge decreases enough to be contained within the river channel again. Although unpredictable, flood events of the Three Rivers occur with relatively high frequency. Large, damaging floods occur statistically once every 100 years, and truly devastating floods occur once every 500 years.

Flood Insurance Rate Maps (FIRM) depicting regulatory floodways and 100-year and 500-year regulatory (not ecological) floodplains of the Three Rivers have been prepared by the Federal Emergency Management Agency (FEMA). During flood events, floodways convey water downstream at a relatively higher rate than storage water in the flood fringe. River valleys of the Three Rivers are relatively narrow and are characterized by high local relief and precipitous slopes. As a result, 100-year and 500-year floodplains of the Three Rivers are depicted on FIRM maps as tapering and discontinuous bands contiguous with river channels. For the Three Rivers impounded by navigation dams, wide flat river reaches permanently inundate what little floodplains exist, which otherwise would flood only seasonally or intermittently. Kinzua Dam and Allegheny Reservoir are most likely impacting floodplains of the upper Allegheny River.

Forests
Riparian forests are important components of the ecological functioning of the Three Rivers. Common riparian tree species, including silver maple (*Acer saccharinum*), eastern sycamore (*Platanus occidentalis*), box elder (*Acer negundo*), and black willow (*Salix nigra*), stabilize riverbanks, reduce erosion, trap and accumulate overbank alluvial sediments, and ameliorate overland runoff and nutrient and pollutant loads to rivers. Riparian trees also input allochthonous carbon (*i.e*., deciduous leaf litter), provide fish habitat (*e.g.*, attenuating trees contribute to large woody debris), and maintain river water temperature through canopy shading. Hardwood floodplain forests are among the rarest plant community types globally. The Pennsylvania Natural Diversity Inventory (PNDI) considers all floodplain forests to be imperiled in Pennsylvania.

Like riparian wetland habitats, riparian forests contiguous with river shorelines and channel islands are threatened by expanding non-native ANS. The most notorious nuisance plant species of riparian uplands of the Three Rivers is Japanese knotweed (*Polygonum cuspidatum–Polygonum sachalinense* complex). These plants are so aggressive that they have entirely replaced native flora along many riverbanks of the Three Rivers. Forming single-species stands, Japanese knotweed has become prolific to the point that it compromises native biodiversity and ruins riparian wildlife habitat.

7.6. <u>Natural Heritage Areas</u>
The Pennsylvania Natural Heritage Program (PNHP) is responsible for collecting, tracking, and interpreting information regarding the biological diversity of Pennsylvania, including both species and habitats. County Natural Heritage Inventories have been prepared by PNHP for most counties of the Three Rivers (inventories for Armstrong, Venango, and Clarion Counties are in the process of being prepared). County Natural Heritage Inventories identify and map Natural Heritage Areas (NHAs), which are areas that support species of conservation concern, exemplary natural communities, and broad expanses of intact natural ecosystems that support important components of Pennsylvania's biodiversity. NHAs mapped by PNHP for the Three Rivers fall under the following four general categories (Table 7.6):

- Biological Diversity Area (BDA) (also known as Conservation Area (CA)) – An area containing plants or animals of conservation concern at state or federal levels, exemplary natural communities, or exceptional native diversity. BDAs include both the immediate habitat and surrounding lands important in supporting these special elements.
- Landscape Conservation Area (LCA) – A large contiguous area that is important because of its size, open space, habitats, and/or inclusion of one or more BDAs. Although an LCA includes a variety of land uses, it typically has not been heavily disturbed and thus retains much of its natural character.
- Dedicated Area (DA) – A property, possibly disturbed in the past, where the owner's stated objectives are to protect and maintain the ecological integrity and biological diversity of the property largely through a hands-off management approach with intervention only when there are demonstrable threats to the ecology of the area.

Table 7.6. Natural Heritage Areas of the Three Rivers (PNHP 2010).

River	Natural Heritage Area	County	Significance Rank	Description
Ohio	Georgetown Island BDA	Beaver	Exceptional	Unique natural communities. Also recognized as part of Ohio River Islands National Wildlife Refuge (ORINWR) DA.
	Phillis Island BDA	Beaver	Exceptional	Unique natural communities. Also recognized as part of ORINWR DA.
	Ohio River Islands National Wildlife Refuge DA (Georgetown and Phillis Islands)	Beaver	Exceptional	Includes two river islands and their associated natural communities and county rare ecosystems. These islands are presently protected from development. Threats to the islands include dredging, water pollution, manipulation of water level due to dams, and overuse for recreation. Present management includes allowing for natural succession to occur and permitting only low impact recreation. A somewhat more strict natural area management and dedication is encouraged.
	Ohioview Peninsula BDA (Montgomery Slough)	Beaver	Exceptional	Unique habitat and a natural community/ ecosystem conservation area for terrestrial and aquatic animal species of conservation concern. Comprised of floodplain forest and a shallow water back channel area as well as sections of the Ohio River pool above Montgomery Dam.
	Ohio River BDA	Allegheny and Beaver	High	Recovering river system that provides habitat for several animal species of conservation concern. River continues to be altered by human influences including effluent discharges, point source discharges, locks and dams, and dredging.
Allegheny	Allegheny River BDA	Allegheny and Westmoreland	High	Recovering river system that provides habitat for several animal species of conservation concern. River continues to be altered by human influences including effluent discharges, point source discharges, locks and dams, and dredging.
	Lower Allegheny River Islands BDA (Twelvemile and Fourteen Mile Islands)	Allegheny	High	Section of Allegheny River that represents pre-lock and dam conditions of the river. The islands represent the most natural of such features in this part of Pennsylvania and exhibit a recovering floodplain forest community.
	Oakmont Floodplain BDA	Allegheny	Notable	One of the few sections of floodplain forest remaining along the Allegheny River in the county.
	Jacks Island BDA	Westmoreland	County	Remnant of a large river island.
	Allegheny River LCA	Forest	Exceptional	Wild and Scenic designated section of the Allegheny River that encompasses a number of smaller-scale CAs for which it functions as supporting landscape.
	Little Tionesta Creek Confluence CA	Forest	Exceptional	Section of the Allegheny River that provides habitat for two animal species of conservation concern.
	Middle Allegheny River CA	Forest	Exceptional	Section of the Allegheny River that supports seven mussel species (*e.g.*, northern riffleshell, clubshell), five fish species (*e.g.*, northern madtom, mountain madtom), and one plant species (stalked bulrush (*Scirpus pedicellatus*)) of conservation concern.
	Lower Tionesta Creek CA	Forest	High	Section of the Allegheny River that support populations of long-solid and round pigtoe.

	Tionesta Creek Confluence CA	Forest	Notable	Section of the Allegheny River that supports red-head pondweed (*Potamogeton richardsonii*), a Pennsylvania-rare plant species.
	Allegheny River BDA/LCA	Warren	Exceptional	Over 21 miles of aquatic and riverine habitats along the Allegheny River that supports ten animal species (*e.g*., Ohio lamprey, wavy-rayed lampmussel, Wabash pigtoe) and five plant species (*e.g*., grassy pondweed (*Potamogeton gramineus*)) of conservation concern.
	Conewango Creek BDA	Warren	Exceptional	Over 15 miles of aquatic and riverine habitats that support 14 animal species (*e.g*., gravel chub, elktoe, and pocketbook) and three plant species (*e.g*., broad-leaved water-plantain (*Alisma trivial*)) of conservation concern.
	Allegheny River Islands BDA	Warren	Notable	Alluvial islands in the Allegheny River that support tufted hairgrass (*Deschampsia cespitosa*), a plant species of conservation concern.
Monongahela	Riverview Floodplain BDA	Washington	High	One of the very few remnant patches of floodplain forest along the Monongahela River and location of a plant species of conservation concern.
Monongahela	Blainsburg Floodplain BDA	Washington	Notable	Large, undeveloped floodplain area along the Monongahela River containing a wetland community and sections of young floodplain forest.
Monongahela	Glassworks BDA	Greene	Notable	Shore of the Monongahela River that is the location of blue mistflower (*Eupatorium coelestinum*), a plant species of conservation concern.
Monongahela	Greensboro BDA	Greene	Notable	Levee of the Monongahela River that is the location of river oats (*Chasmanthium latifolium*), a plant species of conservation concern.
Monongahela	Muddy Creek Confluence BDA	Greene	Notable	Shore of the Monongahela River that is the location of blue mistflower and river oats, two plant species of conservation concern.
Monongahela	Nemacolin BDA	Greene	Notable	Shore of the Monongahela River that is the location of blue mistflower and river oats, two plant species of conservation concern.
Monongahela	Point Marion West BDA	Greene	Notable	Shore of the Monongahela River that is the location of blue mistflower, a plant species of conservation concern.
Monongahela	Friendship Hill Slopes BDA	Fayette	Exceptional	Slopes and shore of the Monongahela River and part of the Friendship Hill National Historic Site. Supports a significant natural community and five plant species of conservation concern.
Monongahela	Point Marion Riverside BDA	Fayette	Notable	Shore of the Monongahela River that is the location of a plant species of conservation concern.

7.7. Proposed Management Actions

For this Section of the *Management Plan*, PFBC first developed each proposed Management Action in consideration of Stewardship Goal 7.1, and then prioritized these actions into one of three levels with expectation of commencing within the following timeframes:

1 (Red) = Proposed Management Action initiated within two years.
2 (Yellow) = Proposed Management Action initiated within three years.
3 (Green) = Proposed Management Action initiated within five years.

Stewardship Goal 7.1. Evaluate the ecological functioning of instream and riparian habitats of the Three Rivers, and determine their values to fisheries to assist in conservation and restoration efforts.

Stewardship Goal 7.1 – Proposed Management Actions		Priority
7.1.1	Prepare a grant proposal to fund biological and bathymetric surveys of Montgomery Slough on the Ohio River and manmade embayments on the lower Allegheny River to characterize assemblages and determine ecological use and productivity.	**2**
7.1.2	Prepare a grant proposal to fund a study to determine the use of bulkhead structures and bridge piers as artificial fish habitats within the Three Rivers.	**3**
7.1.3	If and when data are supportive, petition Pennsylvania Natural Heritage Program to classify additional areas as Biologically Diverse Areas for county inventories.	

8. BIOTA

PFBC is responsible for overseeing management strategies and supporting and coordinating planning obligations for all aquatic species under its jurisdictional authority, including game and nongame fish, reptiles, amphibians, mussels, aquatic invertebrates, and all aquatic organisms including plants. PFBC's mission is to protect, conserve, and enhance Pennsylvania's aquatic resources and to provide fishing and boating opportunities. Statutory authority to address this mission is defined under 58 Pennsylvania Code Chapter 57 as well as Pennsylvania Fish and Boat Code – Title 30 Pennsylvania Consolidated Statutes. PFBC is the only state agency with a specific focus on aquatic resources such as the Three Rivers and aquatic organisms that inhabit the Three Rivers. As an independent agency, PFBC serves as an advocate for protection, conservation, and enhancement of the aquatic resources and recreational interests under its jurisdiction. This section describes biotic components of the Three Rivers ecosystem that warrant PFBC's attention for protection, conservation, and enhancement.

8.1. <u>Fish Assemblages</u>

In the interest of management implications for all of PFBC's jurisdictional fish species, including species classified as game, nongame, native, non-native, and migratory, an important element of this *Management Plan* is the attempt to accurately portray the remarkable changes that fish assemblages of the Three Rivers have experienced over the past 150 years, as well as depict these changes in a meaningful context.

Since colonization by Europeans, many fish assemblages of North American large river ecosystems have undergone dramatic, human-induced changes (Hughes *et al.* 2005). Instabilities in large river fish assemblages have typically resulted from extinctions, extirpations, declines, recoveries, and/or introductions of non-native species. To reconstruct some point of departure, few biological data are available from the earliest records – the Nineteenth Century, especially for taxa other than fish. Even then, fisheries data were typically collected only on species having sport and/or commercial value. Historical relative abundance data, if reported at all, is usually superficial or inadequate by modern standards. Regardless, taking into account levels of destruction to large river ecosystem components such as physical habitat and water quality during the industrial era (circa 1860-1960), the Three Rivers are making an impressive and continuing recovery, and these changes are most reflected in its fish assemblages.

Review of Nineteenth and Early Twentieth Century Records

Fortunately, the work of Nineteenth and early Twentieth Century naturalists, including Le Sueur, Rafinesque, Cope, Bean, Bollman, and Fowler, provide an important baseline for depicting the diversity of pre-industrialization fish assemblages as well as a list of species that have been extirpated from the Three Rivers. Important considerations when evaluating these data include the overall shallow nature and low turbidity of the rivers at the time of the surveys, high diversity and abundances of pre-industrialization assemblages, methods used to collect fish, and confidence in early identifications and descriptions. Beach seines of unknown dimensions were most likely the primary collection gear used during these early surveys and are not as efficient as more modern methods such as boat electrofishing.

In the early Nineteenth Century, the relatively unexplored upper Ohio River valley attracted several renowned naturalists from Europe, and as a result, there is a relatively high number of fish species described from specimens collected from the upper Ohio River (RM 0 in Pittsburgh to RM 605 at Falls of the Ohio). The Ohio River served as the type locality (*i.e.*, geographical location where a type specimen was originally discovered) for 30 currently recognized fish species (Table 8.1). Species described by Le Sueur (1817a and 1818) and Rafinesque (1820) are based on specimens collected from the Ohio River in the vicinity of Pittsburgh.

Table 8.1. Currently recognized fish species with Ohio River type localities (Pearson and Pearson 1989).

Common Name	Original Scientific Name	Current Scientific Name	Author
American brook lamprey	*Petromyzon appendix*	*Lampetra appendix*	DeKay 1842
Bigeye chub	*Rutilus amblops*	*Hybopsis amblops*	Rafinesque 1820
Black buffalo	*Amblodon niger*	*Ictiobus niger*	Rafinesque 1819
Black bullhead	*Silurus melas*	*Ameiurus melas*	Rafinesque 1820
Black redhorse	*Catostomus duquesnii*	*Moxostoma duquesnii*	Le Sueur 1817a
Blue sucker	*Catostomus elongatus*	*Cycleptus elongatus*	Le Sueur 1817a
Bluegill	*Lepomis macrochirus*	*Lepomis macrochirus*	Rafinesque 1819
Bluntnose minnow	*Minnilus notatus*	*Pimephales notatus*	Rafinesque 1820
Channel catfish	*Silurus punctatus*	*Ictalurus punctatus*	Rafinesque 1818b
Fantail darter	*Etheostoma flabellaris*	*Etheostoma flabellare*	Rafinesque 1819
Flathead catfish	*Silurus olivaris*	*Pylodictis olivaris*	Rafinesque 1818b
Freshwater drum	*Aplodinotus grunniens*	*Aplodinotus grunniens*	Rafinesque 1819
Goldeye	*Clupea alosoides*	*Hiodon alosoides*	Rafinesque 1819
Golden redhorse	*Catostomus erythrurus*	*Moxostoma erythrurum*	Rafinesque 1818b
Green sunfish	*Lepomis cyanellus*	*Lepomis cyanellus*	Rafinesque 1819
Greenside darter	*Etheostoma blennioides*	*Etheostoma blennioides*	Rafinesque 1819
Highfin carpsucker	*Catostomus velifer*	*Carpiodes velifer*	Rafinesque 1820
Logperch	*Sciaena caprodes*	*Percina caprodes*	Rafinesque 1818b
Mooneye	*Hiodon tergisus*	*Hiodon tergisus*	Le Sueur 1818
River carpsucker	*Catostomus carpio*	*Carpiodes carpio*	Rafinesque 1820
Shortnose gar	*Lepisosteus platostomus*	*Lepisosteus platostomus*	Rafinesque 1820
Shovelnose sturgeon	*Accipenser platorynchus*	*Scaphirhynchus platorynchus*	Rafinesque 1820
Silver redhorse	*Catostomus anisurus*	*Moxostoma anisurum*	Rafinesque 1820
Skipjack herring	*Pomolobus chrysochloris*	*Alosa chrysochloris*	Rafinesque 1820
Smallmouth buffalo	*Catostomus bubalus*	*Ictiobus bubalus*	Rafinesque 1818b
Spotted bass	*Calliurus punctulatus*	*Micropterus punctulatus*	Rafinesque 1819
Spotted sucker	*Catostomus melanops*	*Minytrema melanops*	Rafinesque 1820
Stonecat	*Noturus flavus*	*Noturus flavus*	Rafinesque 1818c
White bass	*Perca chrysops*	*Morone chrysops*	Rafinesque 1820
White crappie	*Pomoxis annularis*	*Pomoxis annularis*	Rafinesque 1818d

One of the earliest accounts of fish species composition of the Ohio River was made in 1803 by Captain Meriwether Lewis during his trip from Pittsburgh to Louisville, Kentucky, to meet his co-captain William Clark (Quaife 1916). The Ohio River was experiencing a drought that year and, according to Lewis, was "low and clear." Near the Pennsylvania-West Virginia border at the mouth of Mill Creek (RM 40 in Beaver County), Lewis observed "a great number of fish of different kinds, the sturgeon, bass, cat fish, pike, etc." Although these vernacular identifications might represent a variety of extant species, Lewis's list at minimum affords a glimpse of fish diversity in upper Ohio River at that time.

In his renowned monograph of the suckers, Charles-Alexandre Le Sueur (1817a) was the first naturalist to formally describe fish species collected from the Ohio River, including blue sucker (*Cycleptus elongatus*), which is now presumed to be extirpated from the Three Rivers as well as Pennsylvania (Cooper 1985), and black redhorse (*Moxosotma duquesnii*). Black redhorse, according to Le Sueur, "inhibits the Ohio; and was discovered at Pittsburg, the ancient Fort Duquesne, by Mr. Thomas Say." Le Sueur (1818) later described mooneye (*Hiodon tergisus*), also collected from the Ohio River by Thomas Say, Le Sueur's colleague at the Academy of Natural Sciences of Philadelphia. During his time, Le Sueur was recognized as a prolific illustrator famous for accurate and detailed line drawings of specimens. Le Sueur published 20 papers on fishes in the *Journal of the Academy of Natural Sciences of Philadelphia*, and Le Sueur 1817a is the journal's first article on fishes. Depictions of two Ohio River sucker species are presented below from Le Sueur's 1817a monograph (Figures 8.1 and 8.2):

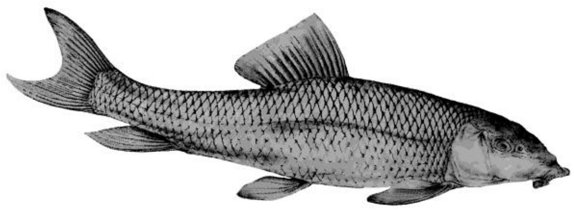

Figure 8.1. Ohio River black redhorse type specimen (from Le Sueur 1817a).

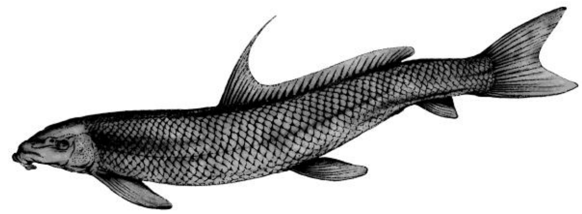

Figure 8.2. Ohio River blue sucker type specimen (from Le Sueur 1817a).

In 1820, Constantine Samuel Rafinesque-Schmaltz published his famous treatise on Ohio River fishes, *Ichthyologia Ohiensis*. This work reported Rafinesque's observations made during an intensive collecting trip in 1818 down the Ohio River from Pittsburgh to southern Illinois for the purpose of finding and describing new specimens of plants, animals, and fossils. In *Ichthyologia Ohiensis,* Rafinesque states "Fishes are very abundant in the Ohio, and are taken sometimes by thousands with the seines…The most usual manners of catching fish in the Ohio are, with seines or harpoons at night and in shallow water, with boats carrying a light, or with the hooks and lines, and even with baskets." Pearson and Krumholz (1984) conjectured that Rafinesque surveyed only three sites along the Ohio River between late May and early September in 1818. Two of the three sites were located in Kentucky. However, most of Rafinesque's efforts, about a month, were spent collecting fish at the third site in Pittsburgh.

Rafinesque (1820) described over 100 new fish species from specimens he collected from the Ohio River. According to Pearson and Krumholz (1984), only 52 of these are species recognized today. This list includes species previously described by Le Sueur (including black redhorse dubbed "Pittsburgh Sucker" by Rafinesque), as well as species that are currently extirpated from the Three Rivers (Table 8.2). Contrary to Pearson and Krumholz, Rafinesque in all likelihood collected more than 52 extant species, including "red-tail sucker", which was either river redhorse or smallmouth redhorse. Several species collected by Rafinesque in 1818, including central stoneroller, common shiner, green sunfish, yellow bullhead, stonecat, northern hog sucker, white sucker, and fantail darter, today are typically found in greater relative abundances in the free-flowing reach of the upper Allegheny River (RM 72-198) as well as wadeable tributary streams of the Three Rivers than they are in the impounded mainstems, where they are generally uncommon and not usually collected with any regularity. Species such as these that prefer more shallow habitats were probably more abundant in the Ohio River during Rafinesque's time. The fact that they are not collected with any frequency from the impounded Three Rivers today provides another line of evidence of how deepening by navigation dams has changed the diversity and composition of the corresponding ichthyofauna. On the other hand, modern survey gear designed for deeper waters (*e.g.*, benthic trawl) is providing new information about the distribution and habitats of fish species previously thought to prefer shallow river reaches.

Table 8.2. Historical records of fish species collected from the Three Rivers with their Nineteenth Century accounts and current status.

Common Name (Scientific Name)	Ohio River (Rafinesque 1820)	Three Rivers (Cope 1883)	Monongahela River (Evermann and Bollman 1886)	Three Rivers (Bean 1892)	Current Status [1]
Petromyzontidae (Lampreys)					
American brook lamprey (*Lampetra appendix*)	Rare, found as far as Pittsburgh	Occasional			Candidate (Tributaries)
Acipenseridae (Sturgeons)					
Lake sturgeon (*Acipenser fulvescens*)	Occasional, found as far as Pittsburgh	Abundant in Ohio and Allegheny		Abundant in Allegheny	Endangered (Extirpated)
Shovelnose sturgeon (*Scaphirhynchus platorynchus*)	Common, found as far as Pittsburgh	Occasional in Ohio		Abundant in Ohio	Extirpated
Polyodontidae (Paddlefishes)					
Paddlefish (*Polyodon spathula*)	Occasional, found as far as Pittsburgh	Common in Ohio, Allegheny, and Monongahela		Common in Allegheny and Monongahela	Extirpated (Reintroduced)
Lepisosteidae (Gars)					
Alligator gar (*Atractosteus spatula*)	Rare, found only in lower Ohio				Extirpated
Longnose gar (*Lepisosteus osseus*)	Occasional	Abundant	Abundant	Abundant in Allegheny	Abundant
Shortnose gar (*Lepisosteus platostomus*)	Common, also found in Allegheny	Occasional, found only in Allegheny		Occasional	Extirpated
Amiidae (Bowfins)					
Bowfin (*Amia calva*)		Abundant		Occasional	Candidate
Hiodontidae (Mooneyes)					
Goldeye (*Hiodon alosoides*)	Occasional, found as far as Pittsburgh			Common in Ohio	Extirpated
Mooneye (*Hiodon tergisus*)	Common	Abundant		Abundant in Ohio	Common
Anguillidae (Freshwater Eels)					
American eel (*Anguilla rostrata*)	Rare, found as far as Pittsburgh	Occasional		Abundant	Rare
Clupeidae (Herrings & Shads)					
Gizzard shad (*Dorosoma cepedianum*)	Common		Abundant	Common	Abundant
Skipjack herring (*Alosa chrysochloris*)	Common, found as far as Pittsburgh	Occasional in Ohio		Common in Ohio	Rare
Cyprinidae (Minnows)					
Bigeye chub (*Hybopsis amblops*)	Rare			Common	Rare
Bluntnose minnow (*Pimephales notatus*)	Occasional	Abundant	Rare		Common
Bullhead minnow (*Pimephales vigilax*)			Abundant		Extirpated
Central stoneroller (*Campostoma anomalum*)	Occasional	Abundant	Occasional	Common	Tributaries
Common carp (*Cyprinus carpio*)				Abundant	Abundant (Introduced)
Common shiner (*Luxilus cornutus*)	Occasional	Common	Abundant	Common	Tributaries
Emerald shiner (*Notropis atherinoides*)	Abundant	Common	Occasional	Abundant	Abundant
Golden shiner (*Notemigonus crysoleucas*)	Common				Common
Hornyhead chub (*Nocomis biguttatus*)	Rare	Common			Rare
River shiner (*Notropis blennius*)			Occasional	Occasional	Endangered
Silver chub (*Macrhybopsis storeriana*)			Abundant		Common
Spotfin shiner (*Cyprinella spiloptera*)			Abundant	Common	Common
Catostomidae (Suckers)					
Bigmouth buffalo (*Ictiobus cyprinellus*)		Occasional in Ohio		Occasional	Rare
Black buffalo (*Ictiobus niger*)	Occasional	Occasional in Ohio		Occasional	Rare
Black redhorse (*Moxostoma duquesnii*)	Common, found as far as Pittsburgh	Abundant, sold in Pittsburgh markets		Occasional in Ohio	Common

Common Name (Scientific Name)	Ohio River (Rafinesque 1820)	Three Rivers (Cope 1883)	Monongahela River (Evermann and Bollman 1886)	Three Rivers (Bean 1892)	Current Status [1]
Blue sucker (*Cycleptus elongatus*)	Occasional, found as far as Pittsburgh	Occasional in Allegheny, sold in Pittsburgh markets		Common in Ohio, occasional in Allegheny	Extirpated
Creek chubsucker (*Erimyzon oblongus*)	Rare, found only in lower Ohio	Occasional		Occasional	Extirpated
Golden redhorse (*Moxostoma erythrurum*)	Common	Occasional		Occasional	Abundant
Highfin carpsucker (*Carpiodes velifer*)	Occasional, found as far as Pittsburgh	Occasional in Ohio	Rare	Rare	Rare
Northern hog sucker (*Hypentelium nigricans*)	Occasional	Abundant	Abundant	Abundant	Tributaries
Quillback (*Carpiodes cyprinus*)		Abundant in Ohio and Allegheny		Abundant	Abundant
River carpsucker (*Carpiodes carpio*)	Occasional, found as far as Pittsburgh	Occasional		Common	Common
River redhorse (*Moxostoma carinatum*)	Common	Occasional		Occasional	Common
Silver redhorse (*Moxostoma anisurum*)	Abundant	Occasional		Common in Allegheny	Abundant
Smallmouth buffalo (*Ictiobus bubalus*)	Common, found as far as Pittsburgh	Common		Common	Abundant
Smallmouth redhorse (*Moxostoma breviceps*)	Common	Common in Allegheny	Abundant		Common
Spotted sucker (*Minytrema melanops*)	Rare	Abundant		Common	Threatened
White sucker (*Catostomus commersonii*)	Common	Occasional	Abundant		Tributaries
Ictaluridae (Bullhead Catfishes)					
Black bullhead (*Ameiurus melas*)	Occasional	Abundant		Occasional	Endangered
Blue catfish (*Ictalurus furcatus*)	Common, found only in lower Ohio	Occasional in Ohio, sold in Pittsburgh markets	Occasional	Occasional	Extirpated
Brown bullhead (*Ameiurus nebulosus*)		Common		Abundant	Rare
Channel catfish (*Ictalurus punctatus*)	Common, found as far as Pittsburgh	Common	Abundant	Abundant	Abundant
Flathead catfish (*Pylodictis olivaris*)	Occasional	Abundant		Abundant	Abundant
Stonecat (*Noturus flavus*)	Common	Abundant		Occasional	Tributaries
Yellow bullhead (*Ameiurus natalis*)	Occasional	Common in Ohio		Abundant	Tributaries
Esocidae (Pikes)					
Grass pickerel (*Esox americanus vermiculatus*)	Rare	Rare in Allegheny		Common in Ohio	Rare
Muskellunge (*Esox masquinongy*)	Rare, found as far as Pittsburgh	Rare in Allegheny		Occasional	Common
Northern pike (*Esox lucius*)	Rare	Rare in Allegheny		Common	Common
Percopsidae (Trout-perches)					
Trout-perch (*Percopsis omiscomaycus*)		Rare	Abundant	Common	Rare
Atherinopsidae (New World Silversides)					
Brook silverside (*Labidesthes sicculus*)		Abundant		Common	Rare
Cottidae (Sculpins)					
Mottled sculpin (*Cottus bairdii*)			Occasional		Tributaries
Moronidae (Temperate Basses)					
White bass (*Morone chrysops*)	Occasional	Common		Abundant	Abundant
Centrarchidae (Sunfishes)					
Black crappie (*Pomoxis nigromaculatus*)		Occasional	Abundant	Common	Common
Bluegill (*Lepomis macrochirus*)	Common	Abundant		Abundant	Abundant
Green sunfish (*Lepomis cyanellus*)	Occasional	Abundant		Abundant	Tributaries
Largemouth bass (*Micropterus salmoides*)	Occasional	Common		Common	Common
Longear sunfish (*Lepomis megalotis*)		Abundant		Abundant	Endangered

Common Name (Scientific Name)	Ohio River (Rafinesque 1820)	Three Rivers (Cope 1883)	Monongahela River (Evermann and Bollman 1886)	Three Rivers (Bean 1892)	Current Status [1]
Rock bass (*Ambloplites rupestris*)		Abundant	Occasional	Abundant	Abundant
Smallmouth bass (*Micropterus dolomieu*)	Common	Common	Abundant	Common	Abundant
Spotted bass (*Micropterus punctulatus*)	Occasional				Abundant
White crappie (*Pomoxis annularis*)	Occasional	Abundant	Abundant	Abundant	Common
Percidae (Perches)					
Banded darter (*Etheostoma zonale*)		Occasional	Rare	Occasional	Tributaries
Eastern sand darter (*Ammocrypta pellucida*)		Occasional	Common	Common	Endangered (Extirpated)
Fantail darter (*Etheostoma flabellare*)	Common	Abundant	Abundant	Abundant	Tributaries
Greenside darter (*Etheostoma blennioides*)	Occasional		Rare	Common	Common
Johnny darter (*Etheostoma nigrum*)			Abundant	Abundant	Tributaries
Longhead darter (*Percina macrocephala*)		Occasional		Occasional	Common
Logperch (*Percina caprodes*)	Common	Abundant	Abundant	Common	Abundant
Rainbow darter (*Etheostoma caeruleum*)			Most abundant darter in Monongahela	Rare	Tributaries
Sauger (*Sander canadensis*)		Abundant in Ohio		Abundant	Abundant
Sharpnose darter (*Percina oxyrhynchus*) [2]			Occasional		Extirpated
Variegate darter (*Etheostoma variatum*)		Common in Allegheny	Rare	Rare	Rare
Walleye (*Sander vitreus*)	Occasional, found as far as Pittsburgh	Common in Allegheny	Rare	Common	Abundant
Sciaenidae (**Drums**)					
Freshwater drum (*Aplodinotus grunniens*)	Abundant in Ohio, Monongahela, and Allegheny	Abundant in Allegheny	Abundant	Abundant	Abundant

[1] Based on 58 Pennsylvania Code Chapter 75 listings, Pennsylvania Biological Survey rankings, and PFBC data and rulemakings. Those listed as “Tributaries” are typically not collected with any regularity from impounded reaches of the Three Rivers today.
[2] Originally reported by Evermann & Bollman (1866) as slenderhead darter (*Percina phoxocephala*), but re-examination of voucher specimens found these to be sharpnose darter (Cooper 1983).

Rafinesque’s methods have often been described as unconventional by both his contemporaries and successors (*e.g.*, Rafinesque did not preserve any type specimens). Celebrated ichthyologist David Starr Jordan (1902) portrayed Rafinesque as “Brilliant, erudite, irresponsible, fantastic, he wrote of the fishes of Sicily and later of the fishes of the Ohio River, with wide knowledge, keen taxonomic insight, and a hopeless disregard of the elementary principles of accuracy. Always eager for novelties, restless and credulous, his writings have been among the most difficult to interpret of any in ichthyology.”

Fortunately for Rafinesque, the Ohio River provided him one of the world’s most diverse ichthyofaunas for study. As a result of this diversity, coupled with Rafinesque’s ambition, *Ichthyologia Ohiensis* is regarded by many scientists as the foundation of both American and modern ichthyology. Although Rafinesque’s collections were made from only a few locations on the Ohio River and its tributaries, *Ichthyologia Ohiensis* embodies the beginning of our knowledge of Ohio River and North American fish species. The Allegheny River and Monongahela River were not surveyed until much later, but likely sustained comparable ichthyofaunas to the one described by Rafinesque in 1820. After Rafinesque, Ohio River surveys were completed by Jared Kirtland (1838 and 1840-1846), but his collection sites were located much further downstream of Pittsburgh, primarily in the vicinity of Cincinnati.

As part of PFBC's annual reports of operations, Edward Drinker Cope (1881, 1883), Professor of Zoology and Comparative Anatomy at the University of Pennsylvania in Philadelphia, published *The Fishes of Pennsylvania*, which provided the first statewide inventory of fish species in Pennsylvania. These works were later revised by Tarleton Hoffman Bean (1892), the first Curator of Department of Fishes at the Smithsonian National Museum of Natural History in Washington, D.C. Although lacking distribution maps and complete locality information, these works mention at least some species as occurring in the Three Rivers, including some not reported by Rafinesque (Table 8.2).

In 1886, Barton Warren Evermann, Professor of Biology at Indiana State Normal School, and one of his first students, Charles Harvey Bollman, published the earliest accounts of fish species in the Monongahela River and its tributaries (Evermann and Bollman 1886). Bollman was born and raised in the small river town of Monongahela, Pennsylvania. Using a 12-foot beach seine, Bollman collected fish at two locations on the Monongahela: one near his hometown and another at L/D 9 (RM 92.7). Bollman's Monongahela River accounts include species reported by Rafinesque, Cope, and Bean, as well as ones not listed by these authors (Table 8.2).

In 1894, Henry Weed Fowler became the first full-time Curator of the newly-formed Department of Ichthyology and Herpetology at the Academy of Natural Sciences of Philadelphia and published on Pennsylvania fishes (Fowler 1907, 1919, 1940). Like Cope and Bean, Fowler's works provided generalized statewide listings of fish species reported from Pennsylvania waters. His accounts for the Three Rivers only include the headwaters of the Allegheny River in McKean and Potter Counties.

While the publications of Cope, Bean, and Fowler are important as compendia, they are not as valuable as the works of Le Sueur, Rafinesque, and Bollman. The inventories compiled by the former are based primarily on literature review, and in many cases, it remains unknown if they actually conducted any fieldwork and collected fish for their accounts. At least for the latter, their publications provide information on collection locations and dates, which is important for reconstructing historical fish assemblages of the Three Rivers. But since not all of the Three Rivers were surveyed in the 1800s, compiling accurate portrayals of changes to fish assemblages of the Three Rivers over time is challenging. In analyzing these data, certain assumptions were made, foremost being that species found in the upper Ohio River by Le Sueur and Rafinesque also inhabited the Allegheny River and Monongahela River. Since Evermann and Bollman's (1886) findings were comparable to Rafinesque (1820), this assumption can be validated for the Monongahela River.

Twentieth Century Destruction

If the most intensively human influenced ecosystems on Earth are large rivers, according to Vugteveen *et al.* 2006, then the Three Rivers would probably head up the "Most Disturbed" list. Even during the time of the Nineteenth Century naturalists, the Three Rivers were probably experiencing habitat and water quality degradation, and were most likely not pristine. Before Le Sueur's time, European settlers colonized western Pennsylvania along the floodplains of the Three Rivers, which were found to be most suitable for development. Forests were cleared, soils were disturbed, minerals were extracted, paths and canals were constructed, followed by railroads and paved roads, and rivers were excavated and dammed. Civilization spread rapidly within the river valleys, leading to further expansion and industrialization, and the Three Rivers served not only for navigation purposes, but also as a convenient sink for municipal and industrial wastes. By the turn of the Twentieth Century, the Three Rivers were experiencing habitat and water quality degradation at ecosystem levels of destruction.

Arnold Edward Ortmann (1909), Curator of Invertebrate Zoology at Carnegie Museum in Pittsburgh, was the first to evaluate the ecological integrity and degree of pollution of major streams within the upper Ohio River basin. Although stream invertebrates and mussels served as the primary indicators, Ortmann also recorded cursory observations on fish, reptiles, amphibians, and mammals. The following is a synopsis of Ortmann's assessment of the Three Rivers in 1909:

- The upper Allegheny River upstream of the confluence with Oil Creek was moderately disturbed, and supported fish, mussels, and other invertebrates.
- Downstream of the confluence with Oil Creek (RM 132), the lower Allegheny River proceeded through a series of impact-recovery-impact zones. As a result, aquatic life was unsettled and extensive reaches were found to be devoid of fish. Locations and degrees of impact were regulated by polluted tributary streams as well as areas of industrialization. The major reported impacts (upstream to downstream) were:
  - Oil Creek (pollution from oil refineries).
  - Oil City and Franklin (pollution from oil refineries).
  - Clarion River (pollution from wood-pulp mills, saw mills, tanneries, chemical factories, and coal mine drainage; "possibly is one of the worst streams in the state" according to Ortmann).
  - Red Bank Creek (pollution from coal mine drainage).
  - Mahoning Creek (pollution from coal mine drainage).
  - Kittanning and Ford City (pollution from factories and mills).
  - Kiskiminetas River (pollution from coal mine drainage; where "fresh-water life is extinct" according to Ortmann).
  - Natrona and Tarentum (pollution from factories and mills).
  - Pittsburgh (pollution from factories and mills).
- The entire length of the Monongahela River was polluted by coal mine drainage, mostly from input of major tributaries (Georges Creek, Redstone Creek, Youghiogheny River, and Turtle Creek).
- The entire length of the Ohio River in Pennsylvania was polluted by numerous sources, including (1) inputs of the Allegheny River and Monongahela River; (2) areas of industrialization in Pittsburgh; and (3) inputs of polluted tributaries (Chartiers Creek and Beaver River).

According to Ortmann (1909), "both the Allegheny and Monongahela are as badly polluted as they could possibly be, and, consequently, it is not astonishing that the Ohio immediately below Pittsburgh is also in a deplorable condition. . .Generally, there is not much life in this part of the Ohio."

In contrast, Allegheny River tributary French Creek was spared major ecosystem destruction throughout the Twentieth Century, most likely as a result of lack of fossil fuel resources (especially oil and coal) in its watershed. In 1909, Ortmann described French Creek as "one of the best collecting grounds for all forms of fresh-water life", and most likely served as refugia and/or provided source populations for downstream (Allegheny River) recolonization during the recovery period. Today, this biologically diverse stream supports 89 fish species (including eastern sand darter, which is now extirpated from the Three Rivers) and 28 mussel species.

A review of past issues of *Pennsylvania Angler* (1931-1981) as well as archival newspaper articles since the late 1800s corroborates Ortmann's findings. In general, (1) the upper Allegheny River upstream of Oil Creek maintained a high-quality fishery; (2) the lower Allegheny

River downstream of Oil Creek sustained a marginal fishery; and (3) only a depauperate fishery persisted in the Ohio River and Monongahela River, if any at all.

Of particular infamy was the number of fish kills that occurred in the Allegheny River, especially downstream of the confluence with the exceedingly acidic Kiskiminetas River, where major fish kill events were reported July 1905, August 1937, June 1958, July 1960, September 1962, September 1965, August 1966, August 1968, and May, June, and July 1970. These events occurred during low-flow times of the year and water quality at the mouth of the Kiskiminetas was found to be exceptionally poor (pH < 4). Dead fish reported typically included carp, minnows, chubs, shiners, suckers, catfish, sunfish, bluegill, bass, walleye, and muskies.

Other notable fish kill events on the Allegheny River included July 1939 (oil refinery hydrochloric acid spill at Oil City), July 1947 (oil refinery sulfuric acid spill first into tributary Bear Creek), May 1951 (unknown source on entire upper Allegheny River), and September 1972 (chemical spill first into tributary Brokenstraw Creek). The worst fish kill event reported occurred October 1968 when 3,000 gallons of industrial waste spilled from an oil refinery lagoon into Bear Creek, then made its way to the Allegheny River at RM 82.2, killing over 4,000,000 fish by the time it reached Pittsburgh. Surfactants in the spill created surface foam “up to six-feet thick and over twelve miles long”, blanketing the width of the Allegheny River bank-to-bank (*Pittsburgh Press*, December 8, 1968).

Historical documents mention only one fish kill on the upper Ohio River, which occurred September 1909, with report of thousands of dead fish floating down the river. During this event, many people swimming in the Monongahela River became afflicted with “boils” because the water there was so acidic! No reports of fish kills on the Monongahela River were found in the historical records, probably because there were so few fish living in the river at that time to contribute to such an event. For the amount of carnage occurring over the past century on the Allegheny River, it is remarkable that the Monongahela River fish populations were so depauperate that a fish kill was difficult to detect. Many Three Rivers’ fish kill events were probably not reported.

In 1957, a joint effort was initiated by the Department of Biology at the University of Louisville and ORSANCO to inventory the aquatic life resources of the Ohio River. The primary objective of their effort was to determine the impacts of pollution on the uses of interstate water as well as to evaluate the river’s potential for maintaining aquatic life. This project included determining distributions, relative abundances, and species compositions of fish assemblages inhabiting the entire length of the Ohio River primarily from data collected during lockchamber surveys using rotenone (a piscicide). The first lockchamber survey was completed on May 27, 1957 at Lock 30 near Greenup, Kentucky (Ohio River RM 339.4), which yielded 739 fish representing 16 species (Krumholz 1958).

With assistance from USEPA, USACE, USFWS, WVDNR, and PFBC, ORSANCO continued lockchamber surveys of the Three Rivers until 2010 (Table 8.3). Results of the first surveys reflected deplorable water quality of the Three Rivers prior to enactments of state and federal water pollution control legislation of the 1970s (Table 8.4). Lockchamber data documented the staggering decline of Ohio River fish populations and calamitous eradication of Monongahela River fish populations (*e.g.*, not a single fish collected at Maxwell in 1967, and only one individual bluegill collected there in 1968) since the 1800s, when Rafinesque and Bollman easily collected 30 to 50 species of fish from these waters using only a beach seine.

Table 8.3. Summary of lockchamber surveys of the Three Rivers (ORSANCO unpublished data).

River	Lockchamber	RM	# Surveys	Year(s)
Ohio	Emsworth L/D	6.2	4	1958-1992
	Dashields L/D	13.3	17	1958-1991
	Montgomery L/D	31.7	17	1957-2005
Monongahela	L/D 2 (now Braddock)	11.3	17	1967-1992
	Braddock L/D	11.3	2	2003-2010
	L/D 3	23.8	1	1957
	Maxwell L/D	61.2	14	1967-2010
	Grays Landing L/D	82.0	2	2003-2010
Allegheny	L/D 3	14.5	12	1968-1991
	L/D 7	45.7	1	1957
	L/D 8	52.6	6	1957-1987
	L/D 9	62.2	1	1957

Continuing Recovery of the Twentieth and Twenty-First Centuries

Demises to the fish assemblages of the Three Rivers were eventually met with recoveries. Concerted state and federal efforts in the 1970s eventually led to tremendous improvement in river water quality. Improved river water quality culminated in recoveries of fisheries, expressed as range expansions of native species, increases in fish population abundances, and a revival of angling opportunities within historically impacted river reaches. Documentation of the recovering fisheries can be found in an examination of ORSANCO's lockchamber data (Table 8.4). Using fish species richness alone as an indicator of ecological integrity, these data suggest overall improvement trends for both the Ohio River and Monongahela River (Figures 8.3-8.8). Table 8.5 includes the numerically dominant species collected and their percent relative abundances, as well as "remarkable species", which include:

1. Fish species either previously (*e.g.*, smallmouth buffalo) or currently (*e.g.*, ghost shiner) protected under 58 Pennsylvania Code Chapter 75;
2. Sport fish species maintained by natural reproduction (*e.g.*, smallmouth bass, walleye, and sauger);
3. Species classified as pollution intolerant (*e.g.*, river redhorse; Figure 8.9) by ORSANCO (Thomas *et al*. 2005); and
4. Otherwise remarkable species either collected for the first time in Pennsylvania (*e.g.*, orangespotted sunfish) or not typically collected with any regularity (*e.g.*, trout-perch).

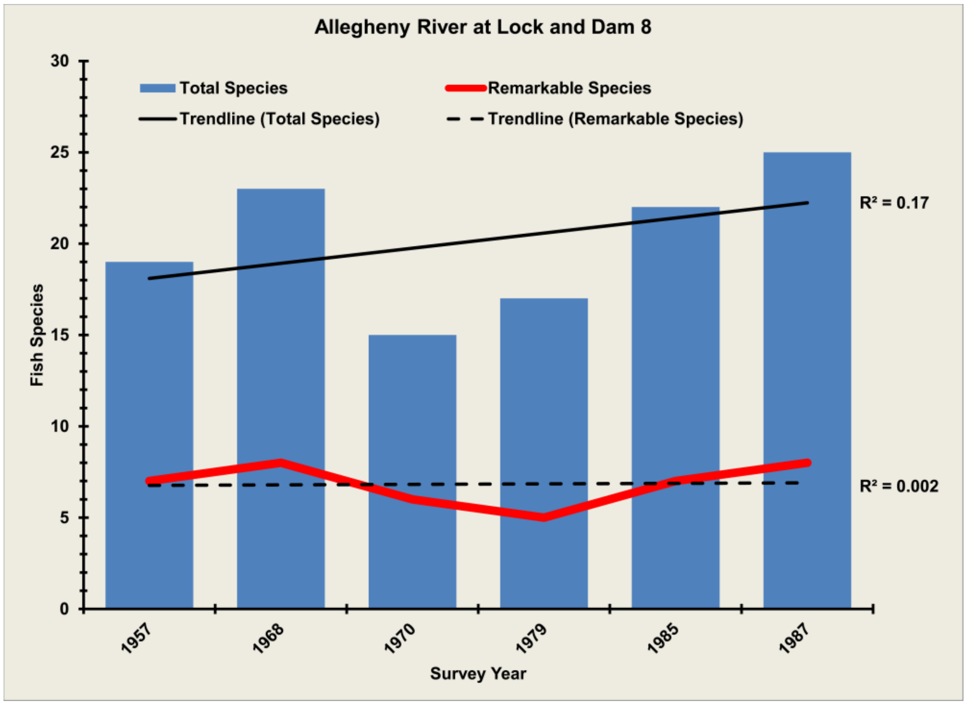

Figure 8.3. Lockchamber fisheries survey results at Allegheny River L/D 8 depicting positive improvement trends (solid and dashed black lines) from 1957 through 1987 for total species richness (blue columns) and remarkable species richness (red line) (based on ORSANCO unpublished data).

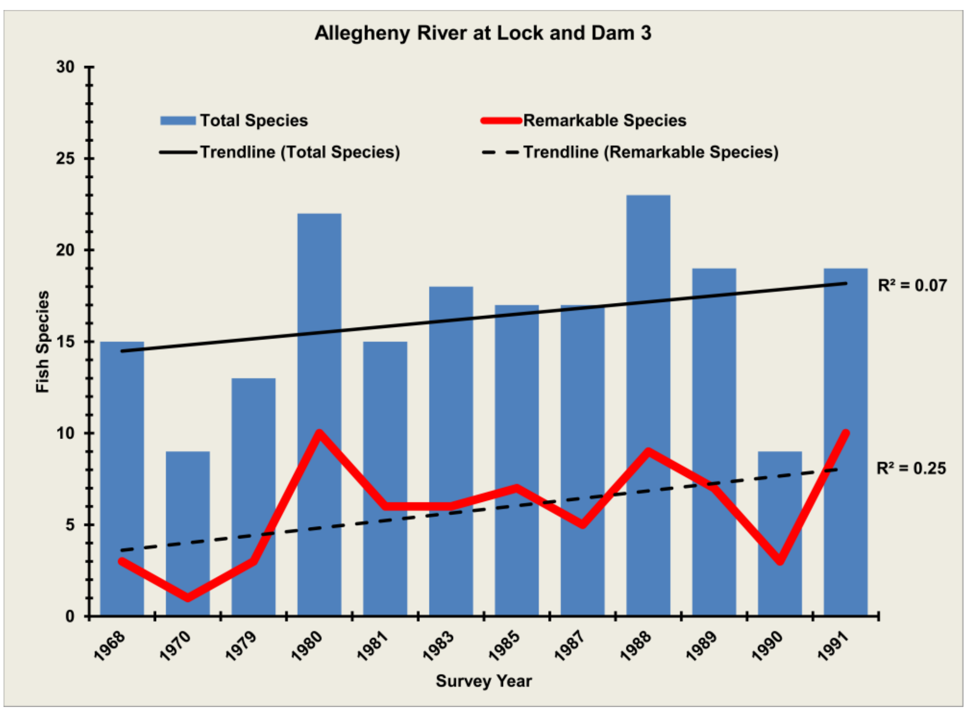

Figure 8.4. Lockchamber fisheries survey results at Allegheny River L/D 3 depicting positive improvement trends (solid and dashed black lines) from 1968 through 1991 for total species richness (blue columns) and remarkable species richness (red line) (based on ORSANCO unpublished data).

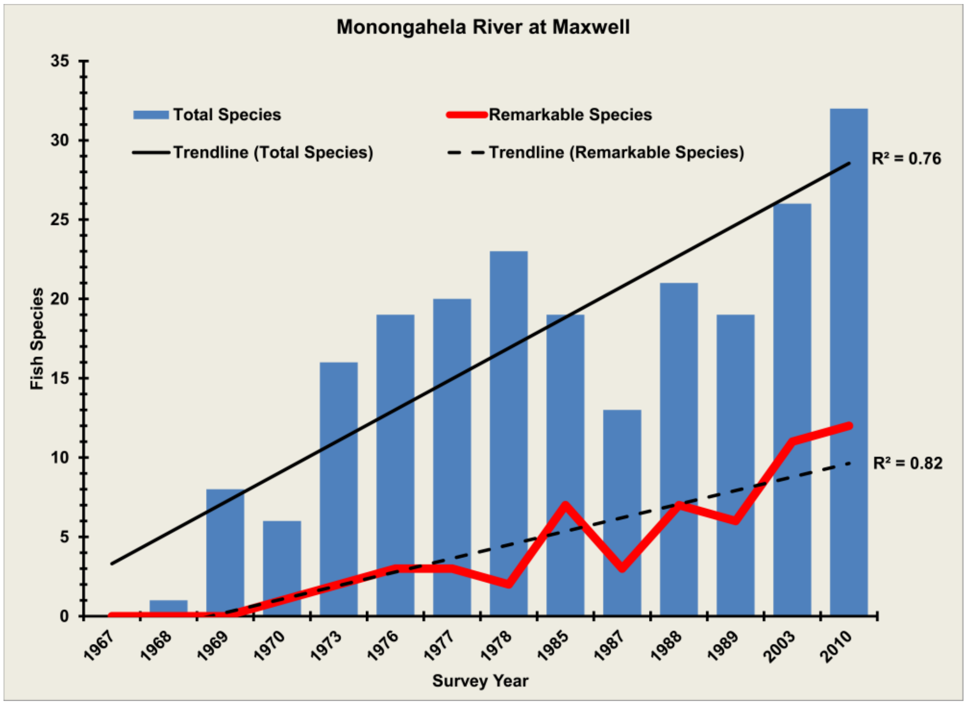

Figure 8.5. Lockchamber fisheries survey results at Monongahela River Maxwell L/D depicting positive improvement trends (solid and dashed black lines) from 1967 through 2010 for total species richness (blue columns) and remarkable species richness (red line) (based on ORSANCO unpublished data).

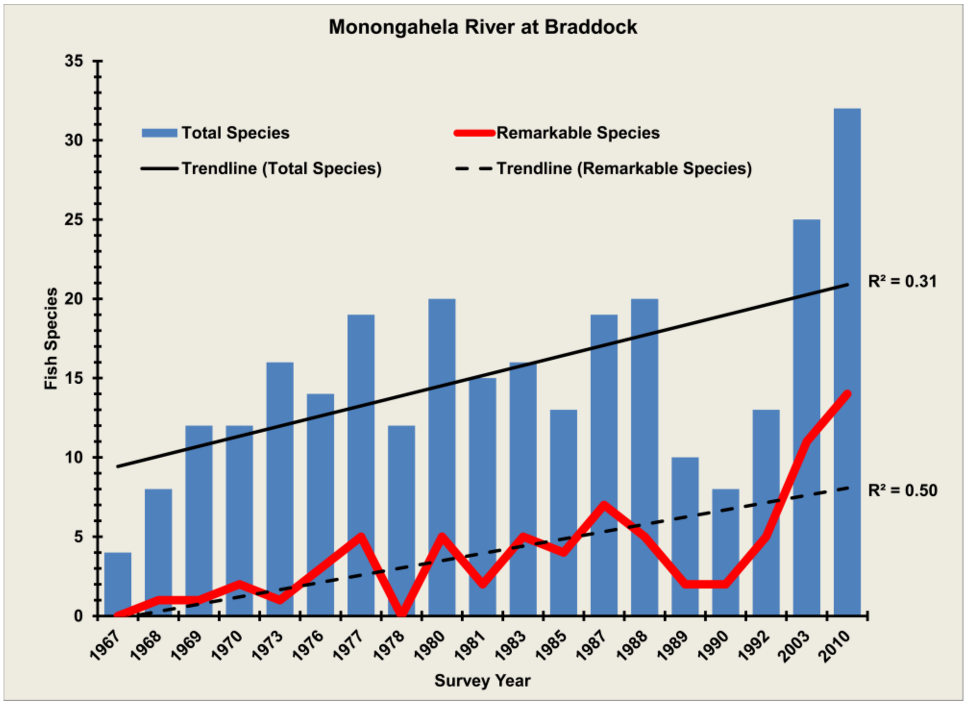

Figure 8.6. Lockchamber fisheries survey results at Monongahela River Braddock L/D depicting positive improvement trends (solid and dashed black lines) from 1967 through 2010 for total species richness (blue columns) and remarkable species richness (red line) (based on ORSANCO unpublished data).

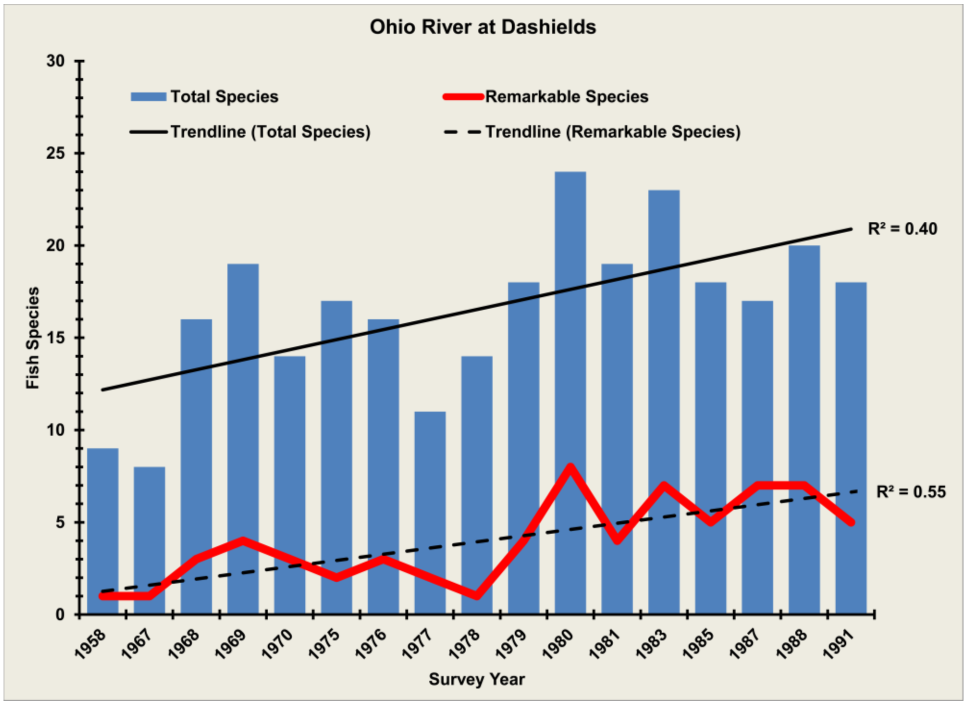

Figure 8.7. Lockchamber fisheries survey results at Ohio River Dashields L/D depicting positive improvement trends (solid and dashed black lines) from 1958 through 1991 for total species richness (blue columns) and remarkable species richness (red line) (based on ORSANCO unpublished data).

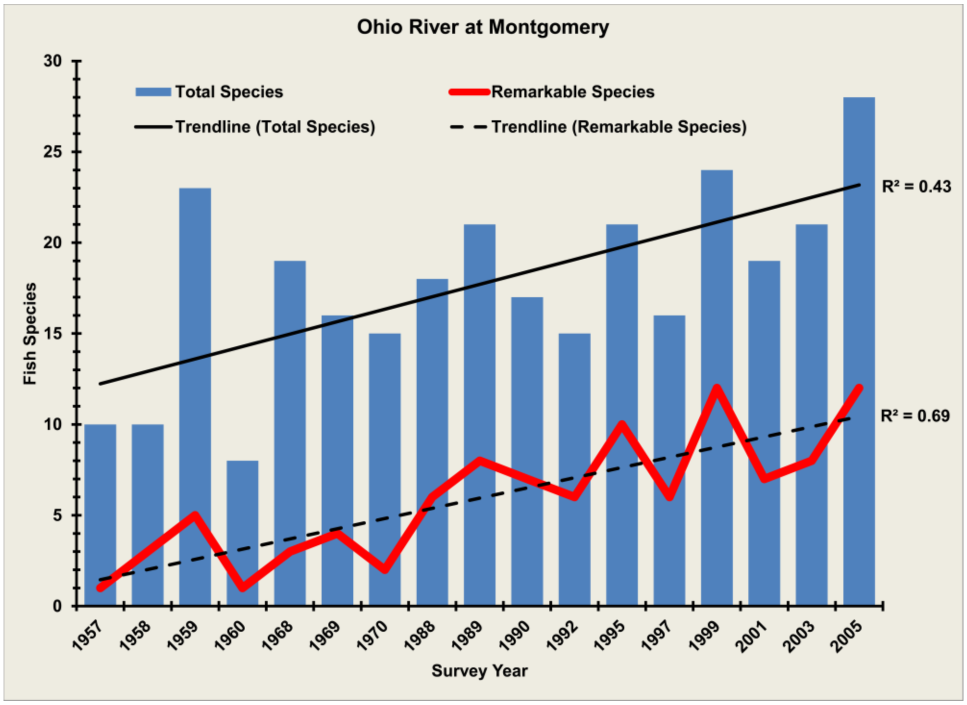

Figure 8.8. Lockchamber fisheries survey results at Ohio River Montgomery L/D depicting positive improvement trends (solid and dashed black lines) from 1957 through 2005 for total species richness (blue columns) and remarkable species richness (red line) (based on ORSANCO unpublished data).

Table 8.4. Results of lockchamber surveys of the Three Rivers (ORSANCO unpublished data).

	Monongahela River				Allegheny River				Ohio River			
	Braddock L/D		Maxwell L/D		L/D 3		L/D 8		Dashields L/D		Montgomery L/D	
Year	# Species	# Fish	# Species	# Fish	# Species	# Fish	# Species	# Fish	# Species	# Fish	# Species	# Fish
1957							19	9,404			10	219
1958									9	234	10	199
1959											23	3,071
1960											8	1,686
1967	4	20	0	0					8	917		
1968	8	207	1	1	15	576	23	22,133	16	1,656	19	742
1969	12	1,626	8	204					19	2,181	16	1,029
1970	12	261	6	54	9	99	15	194	14	1,284	15	2,843
1973	16	869	16	8,071								
1975									17	30,202		
1976	14	754	19	1,943					16	1,136		
1977	19	6,363	20	1,158					11	300		
1978	12	2,103	23	5,207					14	844		
1979					13	234	17	734	18	2,953		
1980	20	1,158			22	724			24	3,364		
1981	15	4,426			15	1,382			19	6,641		
1982												
1983	16	1,310			18	1,596			23	4,132		
1984												
1985	13	418	19	4,107	17	691	22	1,035	18	3,270		
1987	19	3,556	13	1,290	17	2,725	25	65,827	17	450,896		
1988	20	123,443	21	1,434	23	940			20	961	18	56,530
1989	10	6,581	19	611	19	374					21	1,109
1990	8	102			9	69						
1991					19	702			18	4,585	17	339
1992	13	194										
1993											15	248
1995											21	3,125
1997											16	2,994
1999											24	2,644
2001											19	16,131
2003	25	1,127	26	7,310							21	1,973
2005											28	14,320
2010	32	23,370	32	29,690								

Figure 8.9. Pollution intolerant river redhorse (*Moxostoma carinatum*) collected by PFBC biologists in April 2010 during a daytime boat electrofishing survey of Allegheny River Pool 6 (Section 17) near Cogley Island (RM 43) (PFBC photograph).

Table 8.5. Dominant and remarkable fish species collected during lockchamber surveys of the Three Rivers. Year of collection for numerically dominant species are followed by percent relative abundance (ORSANCO unpublished data).

	Monongahela River		Allegheny River		Ohio River	
Species	Braddock L/D	Maxwell L/D	L/D 3	L/D 8	Dashields L/D	Montgomery L/D
American eel [4]			1970	1970 1979	1970 1978-79	
Bigeye chub [3]				1968		1959
Bigeye shiner [4]					1975	
Black redhorse [3]	1977	1976	1980	1968 1970	1970	
Bluegill		1968 (100%) 1976 (25%)				
Bluntnose minnow					1970 (37%)	1970 (60%)
Brook silverside [1, 3]	2010	2003 2010	1981 1989	1987	1983	1995
Brown bullhead [5]	1968 (33%)	1969 (53%) 1970 (70%)	1970 (42%)		1958 (82%) 1968 (30%)	1957 (46%) 1958 (80%) 1959 (41%)
Channel catfish	1990 (30%)				1977 (36%)	1968 (20%)
Channel darter [1, 3]	2010		1991			1995 2005
Common carp	1969 (46%) 1970 (38%) 1980 (47%)	1989 (29%)			1967 (58%)	1969 (46%)
Cyprinid (unknown)			1987 (74%)	1987 (97%)	1987 (99%)	
Emerald shiner	1968 (33%) 1976 (74%) 1977 (50%) 1978 (86%) 1981 (85%) 1985 (48%) 1989 (98%) 2003 (31%)	1973 (68%) 1977 (41%) 1978 (91%) 1985 (77%) 1988 (34%) 2003 (83%)	1968 (84%) 1980 (38%) 1981 (78%) 1883 (92%) 1985 (61%)	1957 (82%) 1968 (70%) 1985 (71%)	1969 (35%) 1975 (98%) 1976 (53%) 1978 (60%) 1979 (86%) 1980 (63%) 1981 (62%) 1983 (49%) 1985 (71%)	1960 (77%) 1989 (64%)
Freshwater drum					1988 (38%)	1990 (32%) 1992 (27%) 1995 (55%) 1997 (49%)
Ghost shiner [1]	2003 2010	1985 2003 2010				1959
Gizzard shad	1973 (31%) 1987 (91%) 1988 (98%) 1992 (18%) 2010 (57%)	1987 (48%) 2010 (37%)	1988 (47%) 1989 (28%) 1990 (29%) 1991 (60%)		1991 (76%)	1988 (98%) 1999 (64%) 2001 (95%) 2005 (89%)
Highfin carpsucker [4]						1990 1999 2001
Largemouth bass [2]	1968-70 1977 1980 2010	1970 1973 1976-77 1985 1989	1968 1988		1968-69 1987	1958 1968-69 1988 1999

Species	Monongahela River		Allegheny River		Ohio River	
	Braddock L/D	Maxwell L/D	L/D 3	L/D 8	Dashields L/D	Montgomery L/D
Logperch [3]	1980-81 1985 1987-89 2010	1987-89 2010	1968 1979-81 1983 1985 1987-89 1991	1957 1968 1970 1985 1987	1967 1969 1976 1980-81 1988	1969 1989 1999 2001 2005
Longnose gar [1]	2010	2010				
Mimic shiner [3]	1970 1973 1976-77 1980-81 1983 1985 1987 1992 2003	1976-77 1985 1987-88 2003 2010	1980-81 1983 1985 1991	1957 1968 1970 1979 1985 1987	1958 1969-70 1975 1979-81 1983 1985 1987	1959-60 1968-70 1989 1992 1995 1999 2001 2003 (66%) 2005
Mooneye [1, 3]	1992 2003	2003	1991		1991	1990 1995 1997 2005
Muskellunge [2]		1989	1980 1987	1968 1987	1977 1988	1988
Ohio lamprey [1, 3]			1968	1957		
Orangespotted sunfish [4]	1970	1969 1977				1970
Paddlefish [1, 3]		2003				
Pumpkinseed	1967 (70%)					
River carpsucker [4]	2003	2003				1958 1992 1999
River redhorse [1, 3]	1983		1988 1991			
River shiner [1]	1977				1968	1957
Saugeye [2]	2003					2005
Sauger [2]	1977 1987-88 1990 1992 2003 2010	1988-89 2003 2010	1980 1985 1990-91		1976 1983 1985 1987-88 1991	1988-90 1992 1995 1997 1999 2001 2003 2005
Silver chub [1]	2010	2003				1959 1995 2003
Skipjack herring [1]	1983 (41%) 2003 2010	2003 2010	1988		1979 1988 1991	1989-90 1995 1997 1999 2001 2003 2005
Smallmouth bass [2, 3]	1983 1985 1987-88 2003	1973 1977-78 1985 1988-89	1979-80 1983 1988-89 1991	1957 1985 1987	1980 1983 1985 1987-88	1988 1997 1999 2003

Species	Monongahela River		Allegheny River		Ohio River	
	Braddock L/D	Maxwell L/D	L/D 3	L/D 8	Dashields L/D	Montgomery L/D
	2010	2003 2010			1991	2005
Smallmouth buffalo [1]	2003 2010	1988 2010	1987			1989-90 1992 1995 1997 1999 2001 2003 2005
Smallmouth redhorse [3]	1985 1987-90 1992 2003 2010		1980 1985 1988-91	1968 1985	1980 1985 1987	1989-90 1992 1995 2005
Spotted bass [2]	1987 2010	1985 1988 2010	1983 1985 1988-89 1991		1976 1980 1983 1987-88	1958 1988-89 1992 1999 2005
Stonecat [3]			1980-81 1987	1957 1987	1980	
Tadpole madtom [1]				1979		
Threadfin shad [4]						1999
Tiger muskellunge [2]		1985	1985	1985	1983 1985	
Trout-perch [4]	1980		1979 (48%) 1980-81 1983 1985 1987-89	1957 1968 1970 (45%) 1979 (77%) 1985 1987	1977 1979-81	
Walleye [2]	1980 1983 1987-88 1992 2003 2010	1978 1985 1987-89 2003 2010	1980-81 1983 1988-91	1957 1968 1970 1979 1985 1987	1968-69 1980-81 1983 1987-88 1991	1968-69 1988-90 1995 1997 2001 2003 2005
Warmouth [1]	1976					1959

[1] Species currently or previously protected under 58 Pennsylvania Code Chapter 75.
[2] Important sport fish species.
[3] Species classified as pollution intolerant by ORSANCO (Thomas *et al*. 2005).
[4] Otherwise remarkable species (*e.g.*, first collection for the Three Rivers).
[5] ORSANCO originally reported the Ohio River fish as black bullheads, but investigation of voucher specimens revealed characters between brown bullhead and black bullhead, so the identifications were later changed to brown bullhead (Preston and White 1978).

Compared to previous lockchamber surveys, the 2010 surveys on the Monongahela River (32 species total and 12 remarkable species at Maxwell, Figure 8.5; and 32 species total and 14 remarkable species at Braddock, Figure 8.6) and 2005 surveys on the Ohio River (28 species total and 11 remarkable species at Montgomery, Figure 8.8) are a testament to the improving fish populations of the Three Rivers. Compared to the Ohio River and Monongahela River, the

Allegheny River at L/D 8 (which is located a considerable distance upstream of confluence with the Kiskiminetas River) appears to have maintained a more persistent fishery, in terms of total fish species richness (consistently ≥ 15) and remarkable fish species richness (consistently ≥ 5) throughout the years of degradation and amelioration, which is consistent with other data (Figure 8.3). In this regard, the 15 total species / 5 remarkable species could serve as defensible biocriteria or a reference location for evaluating fish lockchamber data of the Three Rivers.

Unique species collected during the lockchamber surveys include (see also Table 8.5):

- Monongahela River – orangespotted sunfish (1969, 1970, 1977), warmouth (1976), and paddlefish (2003).
- Allegheny River – bigeye chub (1968) and American eel (1970, 1979).
- Ohio River – black bullhead (1957, 1958, 1959), warmouth (1959), bigeye chub (1959), orangespotted sunfish (1970), American eel (1970, 1978, 1979, 2003), bigeye shiner (1975), and threadfin shad (1999).

Cooper (1983) states that the orangespotted sunfish "has never been reported for Pennsylvania" and does not include threadfin shad, so documentation of these species form lockchamber surveys are the only reports for Pennsylvania. The individual paddlefish (standard length = 27 inches) collected in 2003 at Maxwell was found tagged with Visible Implant Elastomer (i.e., VIE tag) and later tracked to a fish stocked by the West Virginia DNR (Rick Lorson, personal communication).

Since 1970, many entities have collected fisheries data from the Three Rivers for various purposes. Such data residing in PFBC databases and reports (2009a and 2009b; Lee *et al*. 1992; Urban *et al*. 2004), ORSANCO publications (2004, 2006, 2007a, 2008, and unpublished data), California University of Pennsylvania reports (Kimmel and Argent 2006; Argent and Kimmel 2003, 2005, 2008, and 2009; Argent *et al*. 2003, 2007, and 2009), Penn State University reports (2008 and 2009; Argent *et al*. 1997 and 1998; Freedman *et al.* 2008), USFWS publications (Plewa and Putnam 1985a and 1985b), and reports prepared by industry consultants (Aquatic Systems 1982 and 1992; Beak Consultants 1999; Ecological Analysts 1978a and 1978b; Environmental Research and Consulting 1992; Equitable Environmental Health 1979a and 1979b; Koryak *et al.* 2008 and 2009; NUS 1982; RMC Environmental Services 1990; Westinghouse 1976) were procured and examined during preparation of this *Management Plan*.

After review, 1970-2011 data were then compiled and arranged as fish species presence according to PFBC Fisheries Management sections (Ohio River Sections 1-4, Monongahela River Sections 1-6, and Allegheny River Sections 7-22 downstream of Kinzua Dam). This information is summarized in Table 8.6. For the Allegheny River, Sections 7-22 were combined into four more simplified reaches (*i.e.*, two lower reaches on the navigable portion, and middle and upper reaches on the free-flowing portion). In addition to fish species presence, Table 8.6 denotes special species designations with superscripts, including migratory (^{M}) according to Wilcox *et al.* 2004 classification, introduced (^{I}), and 58 Pennsylvania Code Chapter 75 designations endangered, threatened, and candidate (^{E}, ^{T}, and ^{C}).

Table 8.6. Fish species collected from the Three Rivers since 1970 (Family order follows Nelson *et al*. 2004; see text for data sources).

Common Name (Scientific Name)	Ohio River				Monongahela River						Allegheny River			
	Section 1 (Emsworth Pool)	Section 2 (Dashields Pool)	Section 3 (Montgomery Pool)	Section 4 (New Cumberland Pool)	Section 6 (Emsworth Pool)	Section 5 (Braddock Pool)	Section 4 (Elizabeth Pool)	Section 3 (Charleroi Pool)	Section 2 (Maxwell Pool)	Section 1 (Grays Landing Pool)	Sections 22, 21, 20, 19 (Emsworth Pool – Pool 4)	Sections 18, 17, 16, 15, 14 (Pool 5 – Pool 9)	Sections 13, 12, 11 (Sugar Creek to Oil Creek)	Sections 10, 9, 8, 7 (Oil Creek to Kinzua Dam)
Petromyzontidae (Lampreys)														
Ohio Lamprey (*Ichthyomyzon bdellium*) [C]											X	X	X	X
Polyodontidae (Paddlefishes)														
Paddlefish (*Polyodon spathula*) [M]	X	X	X	X	X	X	X	X			X	X	X	X
Lepisosteidae (Gars)														
Spotted gar (*Lepisosteus oculatus*) [E]												X		
Longnose gar (*Lepisosteus osseus*) [M]	X	X	X	X	X	X	X	X	X	X	X	X		
Amiidae (Bowfins)														
Bowfin (*Amia calva*) [C]									X		X	X		
Hiodontidae (Mooneyes)														
Goldeye (*Hiodon alosoides*) [M]	X		X	X								X	X	
Mooneye (*Hiodon tergisus*) [M]	X	X	X	X	X	X	X	X	X		X	X	X	
Anguillidae (Freshwater Eels)														
American eel (*Anguilla rostrata*) [M]			X	X							X	X	X	
Clupeidae (Herrings & Shads)														
Skipjack herring (*Alosa chrysochloris*) [M]	X	X	X	X	X	X	X	X	X		X	X		
Alewife [I] (*Alosa pseudoharengus*) [M]				X										
Gizzard shad (*Dorosoma cepedianum*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Threadfin shad (*Dorosoma petenense*)				X										
Cyprinidae (Minnows)														
Goldfish [I] (*Carassius auratus*)	X	X	X	X	X	X	X	X	X	X	X	X		
Central stoneroller (*Campostoma anomalum*)	X	X	X	X			X				X	X	X	X
Grass carp [I] (*Ctenopharyngodon idella*)			X	X								X		
Spotfin shiner (*Cyprinella spiloptera*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Steelcolor shiner (*Cyprinella whipplei*)											X			
Common carp [I] (*Cyprinus carpio*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Streamline chub (*Erimystax dissimilis*)											X	X	X	X
Gravel chub (*Erimystax x-punctatus*) [E]												X	X	X
Tonguetied minnow (*Exoglossum laurae*)														X
Bigeye chub (*Hybopsis amblops*)											X	X	X	X
Striped shiner (*Luxilus chrysocephalus*)			X	X			X						X	X
Common shiner (*Luxilus cornutus*)											X	X	X	X
Silver chub (*Macrhybopsis storeriana*)	X	X	X	X	X	X	X	X	X	X	X	X		

Common Name (Scientific Name)	Ohio River				Monongahela River						Allegheny River			
	Section 1 (Emsworth Pool)	Section 2 (Dashields Pool)	Section 3 (Montgomery Pool)	Section 4 (New Cumberland Pool)	Section 6 (Emsworth Pool)	Section 5 (Braddock Pool)	Section 4 (Elizabeth Pool)	Section 3 (Charleroi Pool)	Section 2 (Maxwell Pool)	Section 1 (Grays Landing Pool)	Sections 22, 21, 20, 19 (Emsworth Pool – Pool 4)	Sections 18, 17, 16, 15, 14 (Pool 5 – Pool 9)	Sections 13, 12, 11 (Sugar Creek to Oil Creek)	Sections 10, 9, 8, 7 (Oil Creek to Kinzua Dam)
Hornyhead chub (*Nocomis biguttatus*) [C]													X	X
River chub (*Nocomis micropogon*)				X			X				X	X	X	X
Golden shiner (*Notemigonus crysoleucas*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Emerald shiner (*Notropis atherinoides*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
River shiner (*Notropis blennius*) [E]	X	X	X	X	X		X				X			
Bigeye shiner (*Notropis boops*)			X								X			
Silverjaw minnow (*Notropis buccatus*)			X	X			X							
Ghost shiner (*Notropis buchanani*) [E]					X	X	X	X	X	X				
Spottail shiner [I] (*Notropis hudsonius*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Silver shiner (*Notropis photogenis*)			X	X				X	X	X	X	X	X	X
Rosyface shiner (*Notropis rubellus*)	X	X	X	X							X	X	X	X
Sand shiner (*Notropis stramineus*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mimic shiner (*Notropis volucellus*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Channel shiner (*Notropis wickliffi*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bluntnose minnow (*Pimephales notatus*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fathead minnow (*Pimephales promelas*)			X	X	X		X				X	X		
Blacknose dace (*Rhinichthys atratulus*)			X	X	X		X				X	X	X	X
Longnose dace (*Rhinichthys cataractae*)													X	X
Creek chub (*Semotilus atromaculatus*)			X	X	X		X				X	X	X	X
Catostomidae (Suckers)														
River carpsucker (*Carpiodes carpio*)	X	X	X	X	X	X	X	X	X	X	X	X		
Quillback (*Carpiodes cyprinus*) [M]	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Highfin carpsucker (*Carpiodes velifer*) [M]	X	X	X	X			X	X	X			X		
White sucker (*Catostomus commersonii*) [M]			X	X	X	X	X	X			X	X	X	X
Northern hog sucker (*Hypentelium nigricans*) [M]	X	X	X	X	X	X	X	X	X		X	X	X	X
Smallmouth buffalo (*Ictiobus bubalus*) [M]	X	X	X	X	X	X	X	X	X	X	X	X	X	
Black buffalo (*Ictiobus niger*)	X	X	X	X	X				X	X	X	X		
Bigmouth buffalo (*Ictiobus cyprinellus*) [E, M]			X											
Spotted sucker (*Minytrema melanops*) [T, M]				X										
Silver redhorse (*Moxostoma anisurum*) [M]	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Smallmouth redhorse (*Moxostoma breviceps*) [M]	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Common Name (Scientific Name)	Ohio River				Monongahela River						Allegheny River			
	Section 1 (Emsworth Pool)	Section 2 (Dashields Pool)	Section 3 (Montgomery Pool)	Section 4 (New Cumberland Pool)	Section 6 (Emsworth Pool)	Section 5 (Braddock Pool)	Section 4 (Elizabeth Pool)	Section 3 (Charleroi Pool)	Section 2 (Maxwell Pool)	Section 1 (Grays Landing Pool)	Sections 22, 21, 20, 19 (Emsworth Pool – Pool 4)	Sections 18, 17, 16, 15, 14 (Pool 5 – Pool 9)	Sections 13, 12, 11 (Sugar Creek to Oil Creek)	Sections 10, 9, 8, 7 (Oil Creek to Kinzua Dam)
River redhorse (*Moxostoma carinatum*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Black redhorse (*Moxostoma duquesnii*) [M]	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Golden redhorse (*Moxostoma erythrurum*) [M]	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ictaluridae (Bullhead Catfishes)														
White catfish [I] (*Ameiurus catus*)			X	X	X		X	X			X	X		
Black bullhead (*Ameiurus melas*) [E]				X										
Yellow bullhead (*Ameiurus natalis*)		X	X	X	X	X	X	X	X	X	X	X	X	X
Brown bullhead (*Ameiurus nebulosus*)		X	X	X	X		X	X			X	X	X	X
Channel catfish (*Ictalurus punctatus*) [M]	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mountain madtom (*Noturus eleutherus*) [E]													X	X
Stonecat (*Noturus flavus*)			X	X							X	X	X	X
Tadpole madtom (*Noturus gyrinus*) [E]												X		
Northern madtom (*Noturus stigmosus*) [E]													X	X
Flathead catfish (*Pylodictis olivaris*) [M]	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Umbridae (Mudminnows)														
Central mudminnow (*Umbra limi*) [C]													X	
Esocidae (Pikes)														
Grass pickerel (*Esox americanus vermiculatus*)													X	X
Northern pike (*Esox lucius*) [M]			X	X			X				X	X	X	X
Tiger muskellunge (*Esox lucius* x *Esox masquinongy*) [I]	X	X	X	X	X	X	X	X	X		X	X	X	
Muskellunge (*Esox masquinongy*)	X	X	X	X		X	X	X	X	X	X	X	X	X
Chain pickerel [I] (*Esox niger*)								X	X	X		X	X	X
Percopsidae (Trout-perches)														
Trout-perch (*Percopsis omiscomaycus*)			X	X	X		X				X	X	X	X
Gadidae (Cods)														
Burbot (*Lota lota*) [E, Z]														X
Atherinopsidae (New World Silversides)														
Brook silverside (*Labidesthes sicculus*)			X	X			X	X	X	X	X	X	X	X
Fundulidae (Topminnows)														
Banded killifish (*Fundulus diaphanus*)	X	X	X	X			X				X	X		
Cottidae (Sculpins)														
Mottled sculpin (*Cottus bairdii*)												X	X	X
Moronidae (Temperate Basses)														
White perch (*Morone americana*) [I, M]	X	X	X	X	X	X	X	X	X	X	X	X	X	
White bass (*Morone chrysops*) [M]	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Common Name (Scientific Name)	Ohio River				Monongahela River						Allegheny River			
	Section 1 (Emsworth Pool)	Section 2 (Dashields Pool)	Section 3 (Montgomery Pool)	Section 4 (New Cumberland Pool)	Section 6 (Emsworth Pool)	Section 5 (Braddock Pool)	Section 4 (Elizabeth Pool)	Section 3 (Charleroi Pool)	Section 2 (Maxwell Pool)	Section 1 (Grays Landing Pool)	Sections 22, 21, 20, 19 (Emsworth Pool – Pool 4)	Sections 18, 17, 16, 15, 14 (Pool 5 – Pool 9)	Sections 13, 12, 11 (Sugar Creek to Oil Creek)	Sections 10, 9, 8, 7 (Oil Creek to Kinzua Dam)
Hybrid striped bass (*Morone chrysops* x *Morone saxatilis*) [I]	X	X	X	X	X	X	X	X	X	X	X	X		
Centrarchidae (Sunfishes)														
Rock bass (*Ambloplites rupestris*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Redbreast sunfish (*Lepomis auritus*) [I]										X				
Green sunfish (*Lepomis cyanellus*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pumpkinseed (*Lepomis gibbosus*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Warmouth (*Lepomis gulosus*) [E]			X		X		X							
Orangespotted sunfish (*Lepomis humilis*)				X	X			X						
Bluegill (*Lepomis macrochirus*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Longear sunfish (*Lepomis megalotis*) [E]				X										
Redear sunfish (*Lepomis microlophus*) [I]			X	X	X	X								
Smallmouth bass (*Micropterus dolomieu*) [M]	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Spotted bass (*Micropterus punctulatus*)	X	X	X	X	X	X	X	X	X	X	X	X		
Largemouth bass (*Micropterus salmoides*) [M]	X	X	X	X	X	X	X	X	X	X	X	X	X	X
White crappie (*Pomoxis annularis*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Black crappie (*Pomoxis nigromaculatus*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Percidae (Perches)														
Greenside darter (*Etheostoma blennioides*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rainbow darter (*Etheostoma caeruleum*)			X	X	X	X	X	X	X	X	X	X	X	X
Bluebreast darter (*Etheostoma camurum*) [T]			X	X	X						X	X	X	X
Fantail darter (*Etheostoma flabellare*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Spotted darter (*Etheostoma maculatum*) [T]			X								X	X	X	X
Johnny darter (*Etheostoma nigrum*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tippecanoe darter (*Etheostoma tippecanoe*) [T]			X								X	X	X	X
Variegate darter (*Etheostoma variatum*)											X	X	X	X
Banded darter (*Etheostoma zonale*)			X	X	X	X	X	X	X	X	X	X	X	X
Logperch (*Percina caprodes*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Channel darter (*Percina copelandi*)	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Gilt darter (*Percina evides*) [T]											X	X	X	X
Yellow perch (*Perca flavescens*)			X	X	X	X	X	X	X	X	X	X	X	X
Longhead darter (*Percina macrocephala*)											X	X	X	X
Blackside darter (*Percina maculata*)			X								X	X	X	X

Common Name (Scientific Name)	Ohio River				Monongahela River						Allegheny River			
	Section 1 (Emsworth Pool)	Section 2 (Dashields Pool)	Section 3 (Montgomery Pool)	Section 4 (New Cumberland Pool)	Section 6 (Emsworth Pool)	Section 5 (Braddock Pool)	Section 4 (Elizabeth Pool)	Section 3 (Charleroi Pool)	Section 2 (Maxwell Pool)	Section 1 (Grays Landing Pool)	Sections 22, 21, 20, 19 (Emsworth Pool – Pool 4)	Sections 18, 17, 16, 15, 14 (Pool 5 – Pool 9)	Sections 13, 12, 11 (Sugar Creek to Oil Creek)	Sections 10, 9, 8, 7 (Oil Creek to Kinzua Dam)
River darter (*Percina shumardi*)			X	X										
Sauger (*Sander canadensis*) [M]	X	X	X	X	X	X	X	X	X	X	X	X		
Saugeye (*Sander canadensis* x *Sander vitreus*)	X	X	X	X	X	X	X	X	X	X	X	X		
Walleye (*Sander vitreus*) [M]	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sciaenidae (**drums**)														
Freshwater drum (*Aplodinotus grunniens*) [M]	X	X	X	X	X	X	X	X	X	X	X	X	X	X
# Species	54	55	82	83	64	54	69	60	57	53	83	88	79	75
# Hybrids	3	3	3	3	3	3	3	3	3	2	3	3	1	0
# Native Species	50	51	75	75	58	49	64	54	52	47	78	81	75	72
# Introduced Species (Not Including Hybrids)	4	4	7	8	6	5	5	6	5	6	5	7	4	3
# Migratory Species	22	21	26	27	21	21	23	22	20	16	23	25	21	16
# PA-Endangered Species	1	1	3	3	3	1	3	1	1	1	1	3	3	4
# PA-Threatened Species	0	0	3	2	1	0	0	0	0	0	4	4	4	4
# PA-Candidate Species	0	0	0	0	0	0	0	0	1	0	2	2	3	2

[C] Species is listed as *Candidate* under 58 Pennsylvania Code Chapter 75.
[E] Species is listed as *Endangered* under 58 Pennsylvania Code Chapter 75.
[I] Introduced species.
[M] Species is considered migratory (Wilcox *et al*. 2004).
[T] Species is listed as *Threatened* under 58 Pennsylvania Code Chapter 75.
[Z] Allegheny River burbots have been found to be genetically distinct from Lake Erie burbots. A manuscript describing the river type as a new species is presently under review (Jay Stauffer, personal communication)

Compared to Pennsylvania's other large rivers – the Delaware River and Susquehanna River, the Three Rivers sustain greater native fish diversity with 115 species and hybrids total, including only 10 introduced species (Table 8.7). As part of the Monongahela River Biomonitoring Study, 2003, 2009, and 2011 fisheries data are currently under analysis using ORSANCO's Modified Ohio River Fish Index (MORFIn), a multimetric index that evaluates ecological integrity using large river fish assemblages (Robert Ventorini, personal communication).

Table 8.7. Fish species richness of Pennsylvania's large rivers.

River	# Native Fish Species (% of total)	# Introduced Fish Species (Not including Hybrids)	# Fish Hybrids	Total # Fish Species
Delaware River (Non-Tidal, including West Branch)	50 (68%)	24	1	74
Susquehanna River (including West Branch)	45 (67%)	22	2	67
Three Rivers	102 (91%)	10	3	112
Allegheny River	93 (93%)	7	3	100
Ohio River	81 (91%)	8	3	89
Monongahela River	68 (89%)	8	3	76

Among the Three Rivers, the Allegheny River is the most diverse with 100 species and three hybrids (stocked tiger muskellunge, hybrid striped bass, and naturally-occurring saugeye) in 21 families. Twenty-five Allegheny River species are considered to be migratory (*e.g.*, sauger, walleye, channel catfish, and redhorses). Species unique to the Allegheny River include Ohio lamprey, spotted gar, grass pickerel, steelcolor shiner, streamline chub, gravel chub, bigeye chub, hornyhead chub, common shiner, tonguetied minnow, longnose dace, central mudminnow, mottled sculpin, tadpole madtom, mountain madtom, northern madtom, burbot, longhead darter, gilt darter, and variegate darter. Of the Allegheny River's 100 species, 15 are protected under 58 Pennsylvania Code Chapter 75, including seven listed as endangered (spotted gar, gravel chub, river shiner, mountain madtom, tadpole madtom, northern madtom, and burbot), four darters listed as threatened (bluebreast darter, spotted darter, Tippecanoe darter, and gilt darter), and four listed as candidate (Ohio lamprey, bowfin, hornyhead chub, and central mudminnow).

The Ohio River is second in terms of fish diversity with 89 species and three hybrids in 16 families. Twenty-eight Ohio River species are considered to be migratory. Species unique to the Ohio River include threadfin shad, alewife, bigmouth buffalo, spotted sucker, black bullhead, longear sunfish, and river darter. Of the Ohio River's 88 species, nine are protected under 58 Pennsylvania Code Chapter 75, including five listed as endangered (river shiner, black bullhead, bigmouth buffalo, warmouth, and longear sunfish) and four listed as threatened (spotted sucker, bluebreast darter, spotted darter, and Tippecanoe darter).

Last, the Monongahela River has 76 species and three hybrids in 16 families. Twenty-three Monongahela River species are considered to be migratory. Species unique to the Monongahela River include ghost shiner and redbreast sunfish. Of the Monongahela River's 76 species, five are protected under 58 Pennsylvania Code Chapter 75, including three listed as endangered (river shiner, ghost shiner, and warmouth), one listed as threatened (bluebreast darter), and one listed as candidate (bowfin).

Remarkable species occurrences over the past 30 years include one black bullhead collected from an Ohio River gill net set in 1975 by Aquatic Systems (1982) near Phillis Island (New Cumberland Pool, RM 35.3). Aquatic Systems (1992) also collected one spotted sucker from an Ohio River gill net set in 1992 upstream of Georgetown Island (New Cumberland Pool, RM 37.1). A single American eel was collected during a boat electrofishing survey of Allegheny River Section 13, upstream of East Brady (RM 72) in 1994 by PFBC (Al Woomer, personal communication). One warmouth was found impinged in 1977 on intake structures at the Elrama Power Station (Elizabeth Pool, RM 25.1) on the Monongahela River (Ecological Analysts 1978a). Another warmouth was found impinged in 1978 on intake structures at the Frank R. Phillips Power Station (Montgomery Pool, RM 15.2) on the Ohio River (Equitable Environmental Health 1979a).

Thirty-five bigeye shiners, considered to be a more western species (Cooper 1983), were collected in 1975 during boat electrofishing surveys of the Allegheny River near the Cheswick Power Station (Pool 3, RM 13.5-17.7) (Westinghouse 1976). Eleven steelcolor shiners, not previously listed as occurring in Pennsylvania (Cooper 1983), were collected by ORSANCO in 1991 during boat electrofishing surveys of the Allegheny River near Ninemile Island (Pool 2, RM 10.2) and near Barking (Pool 3, RM 15.3). One bigmouth buffalo was collected by ORSANCO in 2010 during electrofishing surveys of the Ohio River Montgomery Pool.

The present fish assemblages of the Three Rivers are characteristic of a relatively diverse, large river, warmwater ichthyofauna of the upper Ohio River basin. These fish assemblages have rebounded remarkably over the past 40 or so years. Despite the recovery of fish assemblages and resilience of most fish species, several species, especially large migratory fish (*e.g.*, blue sucker; Figure 8.10), have been extirpated from the Three Rivers (Table 8.8). Each migratory fish species has unique behavioral responses to a combination of environmental cues, including water temperature, photoperiod, and river flow, all which induce migration. The timing of these cues needs to be very precise for some species, such as paddlefish, in order to achieve successful reproduction (Jennings and Zigler 2009). Most migratory fish species are known to travel considerable distances, usually upstream or sometimes even into tributary streams during seasonal migrations to spawning, foraging, or overwintering habitats (Wilcox *et al*. 2004). The fact that many migratory species are now extirpated or rare provides further evidence of how navigation dams have altered the composition of the Three Rivers' ichthyofauna.

Figure 8.10. Extirpated from the Three Rivers, this impressive blue sucker (*Cycleptus elongatus*) was collected by the Tennessee Wildlife Resource Agency Region 4 from the Mississippi River (photograph provided by Jim Negus).

Table 8.8. Fish species extirpated from the Three Rivers.

Species	Comments
Blue catfish	Migratory; sold in Pittsburgh markets in late 1800s (Cope 1883).
Blue sucker	Migratory; sold in Pittsburgh markets in late 1800s (Cope 1883); reported as occasional in Allegheny River (Cope 1883; Bean 1892).
Bullhead minnow	Reported as abundant in Monongahela River (Evermann and Bollman 1886).
Creek chubsucker	Reported as rare and found only in lower Ohio River (Rafinesque 1820).
Eastern sand darter	Reported as common in Monongahela River (Evermann and Bollman 1886).
Lake sturgeon	Migratory; reported as occasional and found in Ohio River as far upstream as Pittsburgh (Rafinesque 1820), and abundant in Ohio River and Allegheny River (Cope 1883; Bean 1892).
Paddlefish	Migratory; reported as occasional and found in Ohio River as far upstream as Pittsburgh (Rafinesque 1820), and common in Ohio River, Allegheny River, and Monongahela River (Cope 1883; Bean 1892); currently being reintroduced into Ohio River and Allegheny River by PFBC (Lorson 2008).
Sharpnose darter	Reported as occasional in Monongahela River (Evermann and Bollman 1886).
Shortnose gar	Reported as common in Ohio River and Allegheny River (Rafinesque 1820), and occasional in Allegheny River (Cope 1883; Bean 1892).
Shovelnose sturgeon	Migratory; reported as common and found in Ohio River as far upstream as Pittsburgh (Rafinesque 1820), and occasional (Cope 1883) and abundant (Bean 1892) in Ohio River.

Even with the loss of some of the more unique species of the Three Rivers (Table 8.8), there are species previously considered to be of conservation concern that are making recoveries. At the PFBC April 2010 quarterly meeting, the Commissioners adopted amendments to its regulations and approved changes to 58 Pennsylvania Code Chapter 75 by delisting silver chub (endangered); mooneye (Figure 8.11), goldeye, skipjack herring (all threatened); and brook silverside (candidate) (Figure 8.12). These delistings were based on recommendations of the Fishes Technical Committee of the Pennsylvania Biological Survey (PABS) and review of contemporary fish assemblage data. Recent data suggest that silver chub, mooneye, skipjack herring, and brook silverside have all expanded their ranges over the last 20 years as well as enlarged their population sizes within the Three Rivers. As these species are now apparently widespread, PABS recommended changing their status to either secure or apparently secure.

Figure 8.11. Pollution intolerant mooneye (*Hiodon tergisus*) collected by PFBC biologists in July 2009 during a nighttime boat electrofishing survey of Monongahela River Emsworth Pool (Section 6) near Pittsburgh's South Side (RM 3) (PFBC photograph).

PABS also recommended that goldeye be assigned extirpated status, based on reviews of available literature and contemporary fish assemblage data. Only a few Pennsylvania records of goldeye exist from the past 50 years. These include observations made during surveys of Ohio River Section 4 (New Cumberland Pool) in June 1990, Allegheny River Sections 12, 15, and 16 in July 1994 by PFBC staff, and a 1986 record in PFBC's Natural Diversity Section database from Allegheny River Section 17 (Pool 6). In 2009, Penn State University collected two goldeye specimens from Ohio River Section 3 (Montgomery Pool) and one specimen from Ohio River Section 1 (Emsworth Pool) (Jay Stauffer, personal communication). As goldeye are similar to mooneye, and misidentifications are suspected in the field, the presence and status of goldeye in the Three Rivers should be the subject of additional studies, including retention and verification of voucher specimens as well as molecular research.

Figure 8.12. Pollution intolerant brook silverside (*Labidesthes sicculus*) collected by PFBC biologists in September 2009 during a beach seining survey of Allegheny River Pool 2 (Section 21) along the shoreline of Sycamore Island (RM 10) (PFBC photograph).

Some species that are extirpated or rare in the Three Rivers are recovering within the Ohio River basin in other states. In Ohio, bullhead minnow, bigmouth buffalo, spotted sucker, and warmouth have been collected recently from the Ohio River downstream of Pennsylvania (Thomas *et al*. 2005), and blue sucker are now found in the Little Miami River (Harrington 1999) and Ohio River at the Falls of the Ohio (RM 605.0) (John Spaeth, personal communication). With continuing improvements in water quality as well as installation of fish passage structures, these species could potentially repopulate the Three Rivers in western Pennsylvania. An effort is underway by PFBC to reintroduce paddlefish in Pennsylvania (Lorson 2008).

Under a joint effort among PFBC, NYDEC, and PSU, gilt darters (listed as threatened in Pennsylvania) collected from the upper Allegheny River are being used as broodstock for translocation projects in other states where this species is endangered or extirpated. Approximately 400 and 70 gilt darters were collected in September 2008 and September 2009, respectively, from the Allegheny River near East Brady (RM 72.0) for a gilt darter restoration project in New York.

In accordance with 58 Pennsylvania Code Chapter 75 as well as Pennsylvania Fish and Boat Code – Title 30 Pennsylvania Consolidated Statutes, it is PFBC's fundamental obligation to protect, conserve, and enhance all of PFBC's jurisdictional fish species, both game and nongame. This responsibility is consistent with goals, objectives, and priority conservation actions in *Pennsylvania's Wildlife Action Plan* (PGC-PFBC 2008).

8.2 Mussel Assemblages

Since the turn of the Twentieth Century, mussel assemblages (family Unionidae) of the Three Rivers have also undergone dramatic, human-induced declines due to widespread pollution (Ortmann 1909) and habitat alterations including channel deepening by navigation dams (Bogan 1993). Most mussel species are dependent on a specific host, typically fish or even salamanders, to complete their life cycle. A lack of such hosts can impact juvenile recruitment. Competition with invasive Mollusks (*e.g.*, zebra mussels) has been found to be a contributing factor of mussel decline in some regions of the United States (Schloesser *et al.* 1996). Many mussel species of the Three Rivers are difficult to identify to species, even for trained malocologists. Some have nearly indistinguishable morphological characteristics (Figure 8.13), anomalous shells, and many are sexually dimorphic (*i.e*., females differ from males).

Two federally endangered mussel species (both listed in 1993), clubshell (*Pleurobema clava*) and northern riffleshell (*Epioblasma torulosa rangiana*), and three federal candidate mussel species, rayed bean (*Villosa fabalis*), rabbitsfoot (*Quadrula cylindrica cylindrica*), and sheepnose (*Plethobasus cyphyus*) occur in the free-flowing upper Allegheny River (Table 8.9). Recent surveys by federal agencies (USFWS and USGS) as part of bridge replacement projects revealed that the upper Allegheny River supports the largest reproducing populations of clubshell and northern riffleshell in the world. Under the Endangered Species Act, USFWS has jurisdictional authority over federally listed mussel species of the Allegheny River.

Table 8.9. Mussel species collected from the Three Rivers since 1960 (PFBC 2009b; WPC 2009).

Common Name (Scientific Name)	Pennsylvania Status	Federal Status	Ohio River	Monongahela River	Impounded Allegheny River (RM 0-72)	Free-Flowing Allegheny River (RM 72-198)
Black Sandshell (*Ligumia recta*)			X		X	X
Clubshell (*Pleuroblema clava*)	Endangered	Endangered			X	X
Creek heelsplitter (*Lasmigona compressa*)					X	X
Creeper (*Strophitus undulates*)					X	X
Deertoe (*Truncilla truncate*)			X			
Eastern Pondmussel (*Lasmigona compressa*)						X
Elktoe (*Alasmidonta marginata*)					X	X
Fatmucket (*Lampsilis siliquoidea*)			X	X	X	X
Fawnsfoot (*Truncilla donaciformis*)			X		X	
Flat floater (*Anodonta suborbiculata*)			X			
Fluted-shell (*Lasmigona costata*)			X	X	X	X
Fragile papershell (*Leptodea fragilis*)			X	X	X	X
Giant floater (*Pyganodon grandis*)			X	X	X	X
Kidneyshell (*Ptychobranchus fasciolaris*)					X	X
Lilliput (*Toxolasma Parvus*				X		
Long-solid (*Fusconaia subrotunda*)					X	X
Mapleleaf (*Quadrula quadrula*)			X	X	X	
Mucket (*Actinonaias ligamentina*)			X		X	X
Northern Riffleshell (Epioblasma torulosa rangiana)	Endangered	Endangered			X	X
Paper pondshell (*Utterbackia imbecillis*)			X		X	X
Pink heelsplitter (*Potamilus alatus*)			X	X	X	
Pink papershell (*Potamilus ohiensis*)					X	X
Pistolgrip mussel (*Tritogonia Verrucosa*)					X	
Plain pocketbook (*Lampsilis cardium*)					X	X
Pocketbook (*Lampsilis ovata*)					X	X
Rabbitsfoot *(Quadrula cylindrical)*	Endangered	Candidate				X
Rainbow mussel (*Villosa iris*)					X	X
Rayed bean mussel (*Villosa Fabalis*)		Candidate			X	X
Round pigtoe (*Pleurobema sintoxia*)					X	X
Salamander mussel (*Simpsonaias ambigua*)	Endangered				X	
Sheepnose mussel (*Plethobasus cyphysus*)	Threatened	Candidate				X

Common Name (Scientific Name)	Pennsylvania Status	Federal Status	Ohio River	Monongahela River	Impounded Allegheny River (RM 0-72)	Free-Flowing Allegheny River (RM 72-198)
Snuffbox *(Epioblasma triquetra)*	Endangered					X
Spike (*Elliptio dilatata*)			X		X	X
Threehorn wartyback (*Obliquaria reflexa*)			X			
Three-ridge (*Amblema plicata*)			X	X	X	X
Wabash pigtoe (*Fusconaia flava*)			X		X	
Wavy-rayed lampmussel (*Lampsilis fasciola*)					X	X
White heelsplitter (*Lasmigona complanata*)			X		X	

Mussel species richness is quite variable among the Three Rivers. Since 1960, only eight species have been found in the Monongahela River, 17 species in the Ohio River, and 34 species in the Allegheny River (including 27 species in the upper 126-mile free-flowing reach and 30 species in the lower 72-mile impounded reach) (Table 8.9). This phenomenon may be partly due to differences in level of collection effort. According to Pennsylvania Scientific Collector's Permit reports, 209 mussel collection surveys occurred on the Three Rivers between 2006 and 2009 (PFBC 2009b). Eighty-five percent (or 178) of these surveys occurred on the Allegheny River, followed by the Monongahela River (13% or 27 surveys) and Ohio River (2% or only four surveys).

Figure 8.13. Relatively common mussel species of the Three Rivers, including kidneyshell (*Ptychobranchus fasciolaris*; top), mucket (*Actinonaias ligamentina*; bottom left) and fatmucket (*Lampsilis siliquoidea*; bottom right) (from *Mussels of Illinois* in the collection of the Illinois State Museum).

Historically, in terms of mussel fauna, the Allegheny River and Ohio River were the most species rich in all of Pennsylvania (Ortmann 1909, 1911, and 1919). Thirty-five mussel species of the Three Rivers are now considered extirpated (Table 8.10).

Table 8.10. Mussel species extirpated from the Three Rivers (WPC 2009; Bates 1969).

Common Name (Scientific Name)	**Monongahela River**	**Ohio River**	**Allegheny River**
Black Sandshell (*Ligumia recta*)	X		
Brook floater *(Alasmidonta varicose)*			X
Butterfly mussel *(Ellipsaria lineolata)*	X	X	X
Creeper *(Strophitus undulates)*	X	X	
Eastern lampmussel *(Lampsilis radiate)*		X	
Elephant ear *(Elliptio crassidens)*	X	X	X
Fanshell *(Cyprogenia stegaria)*	X	X	X
Green floater *(Lasmigona subviridis)*		X	X
Hickorynut *(Obovaria olivaria)*		X	
Kidneyshell (*Ptychobranchus fasciolaris*)	X		
Long-solid *(Fusconaia subrotunda)*	X	X	
Monkeyface *(Quadrula metanevra)*		X	X
Mucket (*Actinonaias ligamentina*)	X		
Ohio pigtoe *(Pleurobema cordatum)*		X	X
Orange-foot pimpleback *(Plethobasus cooperianus)*		X	
Pimpleback *(Quadrula pustulosa)*		X	X
Pink mucket *(Lampsilis abrupta)*		X	X
Pistolgrip mussel (*Tritogonia Verrucosa*)	X	X	
Plain pocketbook *(Lampsilis cardium)*	X	X	
Pocketbook *(Lampsilis ovata)*		X	
Purple wartyback *(Cyclonaias tuberculata)*		X	X
Pyramid pigtoe *(Pleurobema rubrum)*		X	X
Rabbitsfoot *(Quadrula cylindrical)*		X	
Ring pink *(Obovaria retusa)*		X	
Rough pigtoe *(Pleurobema plenum)*		X	X
Round hickorynut *(Obovaria subrotunda)*		X	X
Round pigtoe *(Pleurobema sintoxia)*		X	
Sheepnose mussel *(Plethobasus cyphyus)*		X	
Snuffbox *(Epioblasma triquetra)*		X	
Spike *(Elliptio dilatata)*	X		
Threehorn wartyback *(Obliquaria reflexa)*	X		
Tubercled blossum *(Epioblasma torulosa)*			X
Wabash pigtoe *(Fusconaia flava)*	X		

Wavy-rayed lampmussel *(Lampsilis fasciola)*		X	
White wartyback *(Plethobasus cicatricosus)*		X	

8.3. Invertebrate Assemblages

Due to their sheer diversity and habitat-specific lifeways, invertebrates, especially insects, are one of the best groups of animals for use as biological indicators in aquatic systems. Stream invertebrates are routinely used by government agencies and others as reliable indicators of water quality based on known pollution-tolerant or intolerant taxa. Detailed knowledge of most groups of Pennsylvania invertebrates, including those of the Three Rivers, is limited for a variety of reasons. The best-known groups are the aquatic insects with baseline inventories done, or in progress, for mayflies (order Ephemeroptera), dragonflies and damselflies (order Odonata), caddisflies (order Trichoptera), stoneflies (order Plecoptera), crane flies (family Tipiludae), and dobsonflies and alderflies (order Megaloptera). Distributions of other aquatic invertebrates, including aquatic beetles (order Coleoptera), true flies (order Diptera), bugs (order Heteroptera), Decapods (crayfish), Amphipods (scuds and sideswimmers), Isopods (aquatic sowbugs), Copepods, Ostracods (seed shrimp), Cladocerans (water fleas), Hydrachnids (water mites), Gastropods (snails), Pelecypods (clams and mussels), and Annelids (segmented worms and leeches) are largely unknown for Pennsylvania (Rawlins and Bier 1998).

Crayfish play a critical role in river systems, serving as an important food for fish and other vertebrates as well as used for bait by anglers. Although considered to be keystone species and indicators of water quality, little is known about their life histories or distribution in Pennsylvania (Fetzner 2010). Crayfish are found in a variety of aquatic habitats, including the Three Rivers. Nine of the fourteen species in Pennsylvania occur in the Ohio River basin, with three of these inhabiting large rivers (Table 8.11).

Table 8.11. Crayfish found in the Ohio River basin. Species in **bold** occur in large rivers (based on Bouchard *et al*. 2008 and Fetzner 2010).

Scientific Name	Common Name	Comments
Cambarus carinirostris	**Rock crayfish**	Found widely in western Pennsylvania streams and rivers (included in *Cambarus bartonii bartonii* in Bouchard *et al*. (2008)).
Cambarus dubius	Upland burrowing crayfish	Burrowing species known only from Fayette and Somerset counties.
Cambarus monongalensis	Blue crayfish	Primarily burrowing species found in southwestern Pennsylvania; the type locality is in Allegheny County.
Cambarus robustus	**Big water crayfish**	Large variable species found in big rivers; probably includes undescribed species.
Cambarus thomai	Little brown mudbug	Primarily burrowing species; the massasauga rattlesnake uses burrows as a refuge in winter.
Oronectes immunis	Calico crayfish	Collected from ponds in Clarion and Clearfield counties; also sold as fish bait.
Oronectes obscurus	**Allegheny crayfish**	Common in most of Pennsylvania; found in large rivers.
Oronectes rusticus	Rusty crayfish	Invasive in other parts of Pennsylvania.
Procambarus clarkii	Red swamp crayfish	Sold in pet stores and used as bait.

Another river crustacean, glass shrimp (*Palaemonetes kadiakensis*), was recently documented in the Monongahela River during benthic trawling. Further study documented the species in five of the six navigation pools of the Monongahela, associated mostly with dense beds of submerged aquatic vegetation. They have been found in the Ohio River as far upstream as Wheeling, West Virginia, so may also be present in the Pennsylvania portion of the Ohio. Glass shrimp are sensitive to pollution and are used as bioindicators of environmental health. These shrimp are likely part of the overall recolonization of the rivers by fish and other aquatic organisms with improvements in water quality (Kimmel and Argent 2008).

8.4. Amphibians and Reptiles

Protection and management of amphibians and reptiles in Pennsylvania falls under PFBC's jurisdiction. Harvest of some species is permitted with a valid fishing license and Scientific Collector's Permit. These species and regulations for their harvest are in the *Pennsylvania Summary of Fishing Regulations* distributed annually with license purchase. Many of the amphibian and reptile species that are found in the Ohio River basin are primarily terrestrial, but a range of species utilize the Three Rivers (Table 8.12).

While none of the species is listed as endangered or threatened in Pennsylvania, eastern hellbender and mudpuppy are species of conservation concern. Assessments are currently in progress to determine if hellbenders should be given federal protection. Immature hellbenders are preyed upon by large fish, turtles, and water snakes. Hellbenders have been harvested for food, and they are sometimes inadvertently caught by anglers with baited hooks. Hellbenders are classified as an endangered species in Arkansas, Illinois, Indiana, Maryland, Mississippi, Missouri, and Ohio; threatened in Georgia; and rare or of special concern in Kentucky, New York, North Carolina, Tennessee, Virginia, and West Virginia (Humphries 2010). Populations have declined dramatically due to several reasons (Humphries 2010):

- Reduced water quality through pollution and siltation.
- Increase in the number of dams decreasing suitable hellbender habitat.
- Over-collection for the pet trade.
- Persecution by anglers, who erroneously believe that hellbenders eat large amounts of game fish.
- Endocrine disrupting compounds.

Table 8.12. Amphibians and reptiles that use the Three Rivers (based on Hulse *et al*. 2001).

Common Name (Scientific Name)	River	Comments
Lungless Salamanders (Pelthodontidae)		
Northern dusky salamander (*Desmognathus fuscus fuscus*)	Allegheny, Monongahela, and Ohio	Semi-aquatic; reside near running water; take shelter on banks with abundant rocks or woody debris; more abundant in smaller streams.
Appalachian seal salamander (*Desmognathus monticola monticola*)	Impounded Allegheny, Monongahela	Semi-aquatic; stay close to running water, will dive in if disturbed; prefer hiding under rocks, also found under woody debris or leaf litter.
Mountain dusky salamander (*Desmognathus ochrophaeus*)	Free-flowing Allegheny	Semi-aquatic; most common near cooler streams with abundant shade; hide beneath rocks and woody debris.
Northern two-lined salamander (*Eurycea bislineata bislineata*)	Allegheny, Monongahela, and Ohio	Semi-aquatic; tolerate wide range of habitats; found near large and small lotic waters as well as floodplains.
Northern red salamander (*Pseudotriton ruber ruber*)	Allegheny, Monongahela, and Ohio	Semi-aquatic; prefer cool, clean water of smaller streams with gravel or rocky bottom; hide under variety of debris.
Giant Salamanders (Cryptobronchidae)		
Eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*)	Free-flowing Allegheny	Inhabits midsized streams and rivers with clean water and abundant benthic shelter including varying sized rocks, woody debris, and snags.
Mudpuppy Salamanders (Proteidae)		

Common Name (Scientific Name)	River	Comments
Mudpuppy (*Necturus maculosus maculosus*)	Allegheny and Ohio	Aquatic; prefer clear fast-moving water, also occur in slower turbid water and lakes; hide beneath underwater structures on or near bottom..
Newts (Salamandridae)		
Red-spotted newt (*Notophthalmus viridescens viridescens*)	Allegheny, Monongahela, and Ohio	Aquatic larvae and adults, terrestrial sub-adults; live near standing or slow moving clean water; sub-adults inhabit nearby forests; adults prefer aquatic vegetation for shelter and foraging.
Toads (Bufonidae)		
Eastern American toad (*Bufo americanus americanus*)	Allegheny, Monongahela, and Ohio	Primarily terrestrial; require moisture and shallow slow-moving or still water to breed; hides under variety of debris.
Fowler's toad (*Bufo woodhousii fowleri*)	Impounded Allegheny, Monongahela and Ohio	Primarily terrestrial; prefer floodplains with sandy soils; burrows for shelter; need shallow water to breed.
Treefrogs (Hylidae)		
Northern spring peeper (*Hyla crucifer crucifer*)	Allegheny, Monongahela, and Ohio	Prefer trees and shrubs near permanent bodies of clean water and floodplains with dense understory; migrate to woodland in spring.
True Frogs (Ranidae)		
Bullfrog (*Rana catesbeiana*)	Allegheny, Monongahela, and Ohio	Mostly aquatic; prefer still water, but found in slow moving water in emergent vegetation; more common than other frogs in large bodies of water.
Northern green frog (*Rana clamitans melanota*)	Allegheny, Monongahela, and Ohio	Mostly aquatic; more commonly associated with smaller streams; found in areas with shade and fallen trees near water's edge.
Pickerel frog (*Rana palustris*)	Allegheny, Monongahela, and Ohio	Semi-aquatic, spend more time out of water than many frogs; found near slow-moving water with areas of dense vegetation; move into fields and meadows during summer.
Northern leopard frog (*Rana pipiens*)	Allegheny, Monongahela, and Ohio	Semi-aquatic, will wander into moist fields in summer; inhabit shallow, almost still water into floodplains that remain moist and covered with dense vegetation.
Snapping Turtles (Chelydridae)		
Common snapping turtle (*Chelydra serpentina serpentina*)	Allegheny, Monongahela, and Ohio	Aquatic; found in variety of water conditions; prefer some muddy substrate and vegetation.
Softshell Turtles (Trionchidae)		
Eastern spiny softshell turtle (*Trionyx spiniferus spiniferus*)	Allegheny, Monongahela, and Ohio	Aquatic; prefer larger rivers with mudbars to burrow into; rarely leave the water.
Pond, Marsh, and Box turtles (Emydidae)		
Midland painted turtles (*Chrysemys picta marginata*)	Allegheny, Monongahela, and Ohio	Semi-aquatic; bask near water edge; found near shallow, slow-moving water; like soft substrate with vegetation and woody debris.
Map turtle (*Graptemys geographica*)	Impounded Allegheny and Monongahela	Aquatic; prefers larger, slow-moving shallow rivers with muddy bottom and plentiful aquatic vegetation.
Eastern box turtle (*Terrapene carolina carolina*)	Allegheny, Monongahela, and Ohio	Mostly terrestrial, buy found in moist floodplains with plentiful vegetation and soft mud.
Colubrid Snakes (Colubridae)		

Common Name (Scientific Name)	River	Comments
Northern water snake (*Norodia sipedon sipedon*)	Allegheny, Monongahela, and Ohio	Semi-aquatic; prefer slower-moving water, but also found in swift water; hide in aquatic vegetation and rocks near water.
Queen snake (*Regina septemvittata*)	Allegheny, Monongahela, and Ohio	Semi-aquatic; usually found in brooks, but also near larger water; hide under rocks and timber close to water edge.

8.5. Non-Native and Invasive Species

Invasive species are a large and growing threat to native biodiversity, including that of the Three Rivers. Although native species can become invasive, the greatest threats are from non-native plants and animals. While the introduction of non-native species into Pennsylvania began in the 1600s, the speed and frequency of modern travel and commerce has drastically increased opportunities for plants and animals to enter the state from other areas of the world. Most introduced species cause few problems, but others can cause extensive damage to both native species and ecosystems. The threats posed by invasive species include displacement of native species, loss of habitat, hybridization, and introduction of pathogens.

PFBC, PGC, PADCNR, Pennsylvania Department of Agriculture (PDA), Pennsylvania Department of Health, and Pennsylvania Department of Transportation are collectively tasked with managing invasive species that fall under their jurisdictions. The agencies work together, along with academic, industry, and conservation partners, through the Pennsylvania Invasive Species Council (PISC), which was established by an executive order in 2004. The Pennsylvania Aquatic Invasive Species Management Plan (PAISMP) was completed in 2006 and updated in 2007 by the Aquatic Invasive Species Management Plan Committee (AISMPC 2007). PFBC regulations prohibit the "sale, purchase or barter, possession, introduction, importation and transportation" of the following invasive species:

- Bighead carp (*Hypophthalmichthys nobilis*)
- Black carp (*Mylopharyngodon piceus*)
- European rudd (*Scardinius erythrophthalmus*)
- Quagga mussel (*Dreissena rostriformis bugensis*)
- Round goby (*Apollonia* (*Neogobius*) *melanostomus*)
- Ruffe (*Gymnocephalus ceernuus*)
- Rusty crayfish (*Orconectes rusticus*)
- Silver carp (*Hypophthalmichthys molitrix*)
- Snakehead (*Channa* spp.)
- Tubenose goby (*Proterorhinus semilunaris*)
- Zebra mussel (*Dreissena polymorpha*)

Non-Native Fish

Over the past 40 years, 12 fish species not native to the Ohio River basin have been collected from the Three Rivers (Table 8.13). Non-native fish introductions, intentional or unintentional, can disrupt ecosystem processes of large rivers and consequences of such introductions include hybridization with native species; transmission of diseases and parasites; alteration of native species distributions through aggressive behavior or overcrowding; competition with native species for food and habitat; reduction or elimination of native species by predation; degradation of water quality; and deterioration of physical habitat (USGS 2010c).

Table 8.13. Non-native fish species collected from the Three Rivers since 1970.

Species	Native Range	Three Rivers Abundance	Pathways of Introduction
Alewife	Atlantic slope drainages	One individual collected in 1992 from Ohio River Section 4 (New Cumberland Pool)	Likely intentional bait bucket release
Common carp	Eurasia	Currently abundant within the Three Rivers	Stocked by the U.S. Commission of Fish and Fisheries in the late 1800s
Grass carp	Eastern Asia	One individual collected in 2005 from Ohio River Section 4 (New Cumberland Pool), one individual collected in 2006 from Ohio River Section 3 (Montgomery Pool), and one individual collected in 2011 from Allegheny River Section 15 (Pool 8).	Possible unintentional escape from aquaculture
Goldfish	Eastern Asia	Historically abundant in the Three Rivers; populations appear to be declining	Possible unintentional escape from aquaculture; intentional bait bucket release; intentional release of unwanted aquarium fish
Spottail shiner	Atlantic and Gulf slope drainages	Currently abundant within the Three Rivers	Likely intentional bait bucket release
White catfish	Atlantic and Gulf slope drainages	Historically abundant in the Three Rivers; last collected from Monongahela River Section 6 (Emsworth Pool) in 1983	Likely intentional, unauthorized stocking
Redbreast sunfish	Atlantic and Gulf slope drainages	One individual collected in 2003 from Monongahela River Section 1 (Grays Landing Pool)	Likely intentional, unauthorized stocking
Redear sunfish	Atlantic and Gulf slope drainages	One individual collected by ORSANCO from Monongahela River Section 6 (Emsworth Pool) in 2003; four individuals collected by ORSANCO from Ohio River Section 3 (Montgomery Pool) in 2006	Likely intentional, unauthorized stocking
Tiger muskellunge	PFBC hatchery-reared hybrid	Currently abundant within the Three Rivers	Currently stocked by PFBC
Chain pickerel	Atlantic and Gulf slope drainages	Currently abundant within Allegheny and Monongahela Rivers	Likely intentional, unauthorized stocking
Hybrid striped bass	PFBC hatchery-reared hybrid	Currently abundant within the Three Rivers	Currently stocked by PFBC
White perch	Atlantic slope drainages	Currently abundant within the Three Rivers	Likely intentional, unauthorized stocking

The most publicized example of non-native introductions in the United States is the common carp. Due to their foraging behaviors and uprooting of macrophytes, common carp cause increased levels of suspended solids and turbidity as well as decreases in water transparency, macrophyte densities, and habitat heterogeneity (Zambrano *et al.* 2006). Common carp also feed on fish eggs and destroy spawning beds, leading to declines of native species. Common carp have been a major component of fish assemblages of the Three Rivers, in both abundance and biomass, for the past 150 years. Their distribution is ubiquitous, occupying all 26 management sections of the Three Rivers. Common carp can negatively impact the native fish fauna of the Three Rivers; however, identifying the magnitude of their impacts is confounded by the severe destruction-recovery sequences that major ecosystem components of the Three Rivers have endured over this time.

At this time, it is unknown if introduced fish found in the Three Rivers are causing any impacts to native fish or ecological integrity. Alewife and grass carp collected from Ohio River Sections 3 (Montgomery Pool) and 4 (New Cumberland Pool) and redbreast sunfish from Monongahela River Section 1 are likely transients (*i.e*., stray individuals that arrived by chance). Occurrences of redear sunfish in Ohio River Section 3 and Monongahela River Section 6 may be unintentional escapees from reservoirs where they have been stocked by PFBC.

Goldfish and white catfish populations appear to be on the decline. Spottail shiner is probably serving as a valuable forage fish for predators. Tiger muskellunge and hybrid striped bass, which are stocked on a regular basis by PFBC, are important game fish. Although tiger muskellunge is reported to be functionally sterile, hybrid striped bass are fertile (Hodson 1989), and have breed, although infrequently, with native white bass in the Savannah River (Avise and Van Den Avyle 1984). The level of natural reproduction of hybrid striped bass stocks with native white bass of the Three Rivers is unknown.

Over the past decade, white perch has been increasing in the Three Rivers. In western Lake Erie, walleye eggs comprise up to 100 percent of white perch diet, depending on time of year (Schaeffer and Margraf 1987). Given the economic importance of the Three Rivers walleye fishery, white perch should be considered an aquatic invasive species (AIS), because they have the potential to threaten the diversity and abundance of native species, especially walleye, as well as ecological stability of the Three Rivers

Recently, anglers fishing the Three Rivers have reported catching tropical fish (USGS 2010c and anecdotal angler reports to PFBC), including:

- Red-bellied pacu (*Piaractus brachypomus*) – three reported from Ohio River Section 4 (New Cumberland Pool) August and September 2001 and two reported from Allegheny River Section 22 (Emsworth Pool) July 2006 and June 2007.
- Black pacu (*Colossoma macropomum*) – one reported from Monongahela River Section 4 (Elizabeth Pool) September 2010.
- Nile tilapia (*Oreochromis niloticus*) – one reported from Monongahela River Section 6 (Emsworth Pool) August 2006.
- South American redtail catfish (*Phractocephalus hemioliopterus*) – one reported from the Monongahela River Section 6 (Emsworth Pool) August 2008 (Figure 8.14).

Figure 8.14. South American redtail catfish caught from the Monongahela River near Pittsburgh (PFBC photograph).

Pacu, tilapia, and redtail catfish are probably intentional releases of unwanted aquarium fish, or they may have been introduced as part of a “ritual release” of wildlife practiced by some Asian cultures for religious or spiritual reasons. Due to their low abundances within the Three Rivers and general intolerance to cold water, these tropical fish should not be considered major threats or an AIS.

The most notorious AIS that could potentially invade the Three Rivers are four robust minnow species collectively known as Asian carp. Asian carp species include grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*), bighead carp

(*Hypophthalmichthys nobilis*), and black carp (*Mylopharyngodon piceus*). Over the past 20 years, all four of these species have been collected within the Mississippi River basin. Grass carp, silver carp, bighead carp, and black carp have all become established with coinciding, but unrelated, distributions throughout major tributaries of the Mississippi River (Schofield *et al*. 2005). In their native ranges, Asian carp thrive at latitudes analogous the western Pennsylvania (and the Three Rivers). Asian carp populations have spread rapidly and profusely over the past 20 years as they reproduce in large numbers and grow quickly to large size. Asian carp pose a serious threat to native fish species by damaging habitats and outcompeting for forage and habitat resources as well as a threat to recreational boaters. Several boaters have been injured by flying silver carp as they demonstrate a jumping response to outboard motors. In terms of threats to Pennsylvania waters, bighead carp and silver carp pose more critical threats than the other two species (Bob Morgan and Chris Urban, personal communication). Bighead carp and silver carp are both planktivorous, and many state and federal fisheries biologists believe that they will outcompete native larval fish as well as other riverine planktivores, including paddlefish, bigmouth buffalo, and mussels.

On July 19, 2010, Pennsylvania joined Great Lakes States Michigan, Minnesota, Wisconsin, and Ohio in filing a federal lawsuit against USACE and the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) for regulation of the Chicago Area Waterway System (CAWS) where Asian carp are known to occur. Since CAWS is hydrologically connected to Lake Michigan, the lawsuit seeks a court order directing USACE and MWRDGC to take immediate and comprehensive action to minimize the risk that Asian Carp will migrate into the Great Lakes, and to plan and implement permanent measures designed to physically separate carp-infested waters in Illinois from Lake Michigan. Since filing of the lawsuit, PFBC must consider legal ramifications during preparation of any management directives or recommendations that pertain to Asian carp.

Currently, there are no known occurrences of bighead or silver carp in Pennsylvania. The most proximate known occurrence is an individual bighead carp caught May 2002 by an angler fishing the Ohio River near Rayland, Ohio at rivermile 82.0 (only 42 miles from the Pennsylvania-Ohio border; USGS 2010) (Figure 8.15). The most upstream silver carp were two individuals collected in 2007 by ORSANCO during nighttime boat electrofishing surveys of the Ohio River Newburgh Pool upstream of Owensboro, Kentucky (at rivermiles 752.0 and 754.8; ORSANCO 2007). Two bighead carp were also collected by ORSANCO during the same surveys at rivermile 752.0 (ORSANCO 2007). Silver carp observations have also been occasionally reported downstream of the Falls of the Ohio at rivermile 605.0 (John Spaeth, personal communication).

Figure 8.15. Bighead carp caught in 2002 from the Ohio River near Rayland, Ohio (RM 82) (from USGS 2010c).

Isolated occurrences of just a few individuals of bighead carp and silver carp at 42 and 712 rivermiles, respectively, from the Pennsylvania-Ohio border are probably not representative of a viable fishery and/or a reproducing population at the Ohio River reaches where they were collected. Gonzal *et al.* (1987) found that waters having relatively low hardness concentrations

(< 200 mg/L $CaCO_3$ equivalents) caused premature bursting of silver carp eggs. Water quality samples collected from the upper Ohio River by PFBC biologists over the last 20 years had total hardness concentrations ranging from 101 mg/L (Montgomery Pool) to 161 mg/L $CaCO_3$ (New Cumberland Pool) (unpublished data, PFBC Agency Resource Database). It is conceivable, then, that the relatively low ionic strength of the upper Ohio River does not provide favorable conditions for successful reproduction of silver carp.

As Asian carp are thought to have not yet invaded Pennsylvania, under PFBC's *Draft Aquatic Invasive Species Action Plan – Asian Carp Complex*, the preemptive Management Goal is to fundamentally prevent their invasions (Bob Morgan and Chris Urban, personal communication). At this time, the upper Ohio River appears to be the most likely pathway for upstream invasions into Pennsylvania. Lock and dam structures on the upper Ohio River may restrict upstream movements; however, to unknown extents. Notwithstanding, it still seems highly probable that their invasions into Pennsylvania could occur, given the ability of Asian carp to move through lockchambers. Following invasions, PFBC's Management Goals would adjust to include eradication, or, more likely, fisheries management and compensatory mitigation following damage assessment (Bob Morgan and Chris Urban, personal communication).

Non-Native Invertebrates

Zebra mussels and quagga mussels are both well-known invasives introduced to the Great Lakes via ballast water discharges in the late 1980s. Zebra mussels have also infiltrated the Ohio River in southwest Pennsylvania and recently were found in several tributaries to the upper Allegheny River. Transfer of this species to inland waters is usually unintentional and likely the result of attachment to recreational boats. These species out-compete and smother native mussels, foul water intakes, and dramatically alter water quality. Zebra mussels first appeared in the lower portion of the Allegheny River near Pittsburgh in 1994. Asian clams (*Corbicula fluminea*), first reported in the United States in the 1930s is found in all the major river drainages of Pennsylvania, including the Three Rivers. Shipping and barge traffic as well as recreational watercraft are likely vectors for zebra mussels and other AIS.

Introduction of exotic crayfish, usually as live bait, is a threat not only to native crayfish biodiversity, but also negatively impacts aquatic systems. The species of most concern in western Pennsylvania is rusty crayfish, a large and aggressive crayfish that is native to the other areas of the Ohio River basin (western Ohio, eastern and central Indiana, southeastern Michigan, and central Kentucky). The species was introduced to the lower Susquehanna River drainage in Pennsylvania in the 1970s and since then has spread into the Juniata system. Rusty crayfish have not been found in the mainstem Three Rivers, but have been collected in western Pennsylvania from ponds near the Pymatuning Laboratory of Ecology in Linesville, nearby Linesville Creek, Shenango River system in Crawford County, and in Thorn Creek south of Butler, where it was the predominant crayfish (Bouchard *et al*. 2008; Fetzner 2010). The red swamp crayfish (*Procambarus clarkii*), used as bait and also sold in pet stores, is another potential threat. Localities in Pennsylvania include Slippery Rock University (in the Ohio River basin) and Millersville University (in the Susquehanna River basin), where they are likely introductions of live animals purchased for biology classes (Bouchard *et al*. 2008).

8.6. Proposed Management Actions

For this Section of the *Management Plan*, PFBC first developed each proposed Management Action in consideration of Stewardship Goal 8.1, and then prioritized these actions into one of three levels with expectation of commencing within the following timeframes:

1 (Red) = Proposed Management Action initiated within two years.
2 (Yellow) = Proposed Management Action initiated within three years.
3 (Green) = Proposed Management Action initiated within five years.

Stewardship Goal 8.1. Conduct annual baseline surveys and implement long-term monitoring studies of nongame fisheries resources of the Three Rivers to determine species status as well as better manage and protect PFBC's jurisdictional fish species.

Stewardship Goal 8.1 – Proposed Management Actions		Priority
8.1.1	Assist the U.S. Army Corps of Engineers, Pittsburgh District with conducting an ecological risk assessment that evaluates the likelihood of Asian carp invading the upper Ohio River and to assess potential ecological impacts of such an invasion.	**1**
8.1.2	Continue to provide recommendations concerning the upper Ohio River for PFBC's Draft *Aquatic Invasive Species Action Plan – Asian Carp Complex*.	
8.1.3	Continue to evaluate the biological integrity of the Three Rivers using fish assemblage structure as the barometer with protocols developed by the Ohio River Valley Water Sanitation Commission (*i.e.*, Modified Ohio River Fish Index) or other methods developed by the PFBC.	
8.1.4	Continue and expand the Monongahela River Monitoring Study in conjunction with research partners and expand routine monitoring of the Allegheny River and Ohio River as feasible.	
8.1.5	Prepare a grant proposal to fund a study that evaluates samples collected for molecular analysis, including fish tissue as well as environmental DNA (eDNA) extracted from river water samples, for selected fish species of management (*e.g.*, Asian carp) or conservation (*e.g.*, paddlefish) importance. Genetic information derived from fin clips can be used to determine population structure, to discriminate wild stocks from hatchery-reared stocks, and to identify species. Genetic information derived from eDNA can act as a surveillance technique to detect the presence or absence of species in a given river management section.	**2**
8.1.6	Promote research for an assessment of the status of hellbenders and mudpuppies in the Three Rivers in collaborations with research partners (*e.g.*, Western Pennsylvania Conservancy).	**3**

9. Sport Fisheries

Sport fisheries of the Three Rivers possess recreational and economical importance, and are some of the most popular in Pennsylvania. PFBC continues its efforts to provide Pennsylvania anglers and nonresident anglers a variety of recreational and angling opportunities. In order to optimize angling experiences on the Three Rivers, PFBC DFM will collaboratively manage sport fisheries resources to achieve species-specific management benchmarks. We will also initiate ongoing participation with members of the ORFMT, including assisting biologists from West Virginia Division of Natural Resources for surveys of the Monongahela River and Ohio Department of Natural Resources Division of Wildlife for surveys of the Ohio River. Evaluating attainment of management benchmarks will include monitoring sport fish populations, performing stock assessments, conducting recreational use and harvest surveys, adjusting fishing regulations where needed, maintaining or removing supplemental stocking programs, and assisting PFBC DHM in restoring river reaches impacted by past and current anthropogenic perturbations.

9.1. Management Sections

Fisheries management strategies for the Three Rivers, including regulations and stocking, are targeted to specific river reaches known as management sections. Four management sections for the Ohio River, 16 sections for the Allegheny River, and six sections for the Monongahela River are delineated along the boundaries of navigation pools for the Ohio, Monongahela, and lower Allegheny Rivers and between confluences with major tributary streams for the upper Allegheny (Table 9.1). Within most of these 26 sections, PFBC DFM has historically monitored both sport fish populations as well as occurrences of nongame fish species.

Table 9.1. PFBC fisheries management sections of the Three Rivers.

River (Sub-subbasin)	Section	Sub-subbasin	Downstream Limit	Upstream Limit	RM
Ohio (20G)	1	20G	Emsworth L/D	Confluence (Pittsburgh)	6.2-0.0
	2	20G	Dashields L/D	Emsworth L/D	13.3-6.2
	3	20G	Montgomery L/D	Dashields L/D	31.7-13.3
	4	20D	PA-OH border	Montgomery L/D	40.0-31.7
Allegheny (18A)	7	16B	Conewango Creek	Kinzua Dam	188.9-197.4
	8	16B	Brokenstraw Creek	Conewango Creek	181.2-188.9
	9	16F	Tionesta Creek	Brokenstraw Creek	151.4-181.2
	10	16E	Oil Creek	Tionesta Creek	131.9-151.4
	11	16E	French Creek	Oil Creek	123.9-131.9
	12	16G	Richey Run	French Creek	89.4-123.9
	13	17C	Sugar Creek	Richey Run	69.6-89.4
	14	17C	L/D 9	Sugar Creek	62.2-69.6
	15	17D	L/D 8	L/D 9	52.6-62.2
	16	17E	L/D 7	L/D 8	45.7-52.6
	17	17E	L/D 6	L/D 7	36.3-45.7
	18	18A	L/D 5	L/D 6	30.4-36.3
	19	18A	L/D 4	L/D 5	24.2-30.4
	20	18A	L/D 3	L/D 4	14.5-24.2
	21	18A	L/D 2	L/D 3	6.7-14.5
	22	18A	Confluence at Pittsburgh	L/D 2	0.0-6.7
Monongahela (19A)	1	19G	Grays Landing L/D	PA-WV border	82.0-91.3
	2	19C	Maxwell L/D	Grays Landing L/D	61.2-82.0
	3	19C	Charleroi L/D	Maxwell L/D	41.5-61.2
	4	19C	Elizabeth L/D	Charleroi L/D	23.8-41.5
	5	19C	Braddock L/D	Elizabeth L/D	11.3-23.8
	6	19A	Confluence at Pittsburgh	Braddock L/D	0.0-11.3

9.2. Fishing Regulations

Recreational fishing regulations are developed and enforced by PFBC for all jurisdictional waters of Pennsylvania under the Pennsylvania Fish and Boat Code. A condensed and user-friendly version of these regulations, *Summary of Fishing Regulations and Laws*, is published annually and provided to anglers with purchase of a fishing license as well as available on PFBC's website. Fishing regulations are developed and enforced to better protect, enhance, and conserve the aquatic resources of Pennsylvania, including those of the Three Rivers. Sport fisheries of the Three Rivers are managed under Statewide Regulations for Commonwealth Inland Waters (Table 9.2), except for the put-grow-take fingerling trout program of Allegheny River Section 7 (which falls under Special Regulations).

Table 9.2. 2011 fishing regulations for the Three Rivers.

Statewide Regulations for Commonwealth Inland Waters			
Species	**Seasons**	**Minimum Size Limit**	**Creel Limit**
Smallmouth bass	January 1 → April 15 and October 1 → December 31	15 inches	4 (combined species)
Spotted bass	April 16 → June 17	NO HARVEST OF BASS	
Largemouth bass	June 18 → September 30	12 inches	6 (combined species)
Muskellunge Tiger muskellunge	Open year-round	40 inches	1
Northern pike		24 inches	2
Chain pickerel		18 inches	4
Walleye Saugeye	January 1 → March 14 and May 7 → December 31	15 inches	6
Sauger		12 inches	6
Hybrid striped bass	Open year-round	20 inches	2
White bass		No minimum	50 (combined species)
Rock bass			
Bluegill			
White crappie			
Black crappie			
Pumpkinseed			
Yellow perch			
Common carp			
Channel catfish			
Flathead catfish			
Freshwater drum			
All sucker species			
Bait fish Fish bait			
Paddlefish	NO HARVEST OF PADDLEFISH		

Allegheny River Section 7 Special Regulations (Conewango Creek upstream to Kinzua Dam)			
Species	**Seasons**	**Minimum Size Limit**	**Creel Limit**
All species of trout and salmon	Opening Day Regular Trout Season (April 16) → Labor Day (September 5)	14 inches	2 (combined species)
	September 6 → Opening Day Regular Trout Season	NO HARVEST OF TROUT	

9.3. Stocking Programs

PFBC stocks specific management sections of the Three Rivers with hatchery-reared sport fish to enhance recreational fishing opportunities and to restore limited (*e.g.*, muskellunge) or extirpated (*e.g.*, paddlefish) populations (Table 9.3). PFBC relies on several stocking strategies, but primarily uses maintenance stocking. Under this strategy, hatchery-reared fingerlings are released annually or biennially to artificially sustain a population that is believed or known not to reproduce naturally in the rivers. In addition to native species, maintenance stocking of the Three Rivers also includes interspecific hybrids that are functionally sterile, such as hybrid striped bass and tiger muskellunge. The interspecific hybrid saugeye occurs naturally in the Three Rivers, and was also stocked historically in tributary impoundments.

Table 9.3. Stocking records for the Three Rivers over the past five years.

River	Species (Stocking Program)	Lifestage	Section	Number Stocked	Stocking Year
Ohio	Paddlefish (Restoration)	Fingerling	2	13,866	2005
			2	950	2006
			3	1,756	
		Juvenile	2	4,502	2008
	Hybrid striped bass (Maintenance)	Fingerling	3	21,000	2006
			1	8,250	2007
			2	6,420	
			3	21,000	
			4	2,100	
			3	8,000	2008
			1	8,240	2009
			2	5,000	
			3	20,970	
			4	1,649	
	Tiger muskellunge (Maintenance)	Fingerling	3	5,251	2008
			3	5,251	2009
	Muskellunge (Maintenance)	Fingerling	3	2,600	2005
Allegheny	Paddlefish (Restoration)	Fingerling	18	1,342	2005
			19	5,502	
			21	11,725	
		Juvenile	21	5,077	2009
	Hybrid striped bass (Maintenance)	Fingerling	22	5,850	2007
			22	5,850	2009
	Walleye (Supplemental)	Fry	7	350,000	2005
			8	300,000	
			9	2,630,000	
			10	1,225,000	
			11	500,000	
			12	1,900,000	
			13	1,003,000	
			14	650,000	
			15	700,000	
			16	500,000	
			17	1,000,000	
			7	350,000	2006
			8	300,000	
			9	2,630,000	
			10	1,225,000	
			11	500,000	
			12	1,900,000	
			13	1,003,000	
			14	650,000	
			15	700,000	
			16	500,000	
			17	1,000,000	
			7	350,000	2007
			8	300,000	
			9	2,630,000	
			10	1,225,000	
			11	500,000	
			12	1,900,000	
			13	1,003,000	
			14	650,000	
			15	700,000	
			16	500,000	
			17	1,000,000	
	Muskellunge (Maintenance)	Fingerling	7	350	2005
			8	400	
			9	2,200	
			10	1,650	
			11	1,100	
			12	1,350	

River	Species (Stocking Program)	Lifestage	Section	Number Stocked	Stocking Year
Allegheny	Muskellunge (Maintenance)	Fingerling	13	1,350	
			14	650	
			15	925	
			16	650	
			17	1,350	
			18	650	
			19	750	
			20	1,200	
			21	1,000	
			7	350	2006
			8	400	
			9	2,200	
			10	1,650	
			11	1,100	
			12	1,350	
			13	1,350	
			14	650	
			15	925	
			16	650	
			17	1,350	
			18	600	
			19	700	
			20	2,200	
			21	1,898	
		Yearling	8	63	
			9	150	
			10	100	
			11	50	
			12	100	
			13	100	
		Fingerling	7	350	2007
			8	400	
			9	2,200	
			10	1,650	
			11	1,100	
			12	1,350	
			13	1,350	
			14	1,300	
			15	925	
			16	650	
			17	1,350	
			19	700	
			20	1,100	
			21	950	
			7	350	2008
			8	400	
			9	2,200	
			10	1,650	
			11	1,100	
			12	1,350	
			13	1,350	
			14	650	
			15	925	
			16	650	
			17	1,350	
			19	1,399	
			20	2,200	
			21	1,899	
		Small Fingerling	19	700	
			20	1,100	
			21	950	
		Fingerling	7	350	2009
			8	400	
			9	2,000	

River	Species (Stocking Program)	Lifestage	Section	Number Stocked	Stocking Year
Allegheny	Muskellunge (Maintenance)	Fingerling	10	1,650	
			11	800	
			12	2,200	
			13	1,600	
			14	700	
			15	925	
			16	1,000	
			17	1,350	
			19	1,398	
			20	2,200	
			21	1,900	
		Small Fingerling	7	500	
			9	2,000	
			10	2,000	
			12	2,000	
			13	2,000	
			15	1,000	
			16	1,000	
			17	1,000	
			19	1,400	
			20	2,200	
			21	1,900	
	Rainbow trout (Maintenance)	Fingerling	7	107,940	2005
				64,750	2006
				83,333	2007
				81,833	2008
				55,248	2009
				60,000	2010
	Brown trout (Maintenance)			7,500	2005
				178,635	2006
				72,567	2007
				86,433	2008
				49,740	2009
Monongahela	Hybrid striped bass (Maintenance)	Fingerling	4	12,450	2007
			6	9,050	
		Phase 2 Fingerling	6	2,446	
		Fingerling	4	12,450	2009
			6	9,045	
	Walleye (Supplemental)	Phase 1 Fingerling	1	1,750	2005
		Fry	4	1,188,750	
			5	849,750	
			6	850,500	
		Phase 1 Fingerling	2	4,150	2006
			3	3,850	
			4	3,900	
			5	2,860	
			6	2,850	
		Fry	1	698,000	
			2	1,247,250	
			3	1,156,300	
			4	1,169,400	
			5	849,750	
			6	850,500	
	Muskellunge (Maintenance)	Fingerling	3	1,650	2005
			5	1,150	
	Tiger Muskellunge (Maintenance)	Fingerling	1	700	2005
			2	1,650	
			4	1,600	
			6	1,150	

In supplemental stocking, hatchery-reared fry or fingerlings are stocked annually or biennially to contribute to an existing population believed to maintain some degree of natural reproduction. Walleye were the only species historically stocked in the Three Rivers under this strategy, however PFBC discontinued stocking walleye in all major rivers of Pennsylvania in 2007. For the Three Rivers, this management decision was made to determine if natural reproduction alone could provide enough recruitment (= fish added to the exploitable stock each year) to maintain the high quality and popular walleye fishery on the Allegheny River.

In 2008 and 2009, evaluation surveys using boat electrofishing gear (at night) targeting young-of-the-year (YOY; = fish < age one) walleye were conducted on the impounded lower Allegheny River near Freeport (Section 19), Templeton (Section 15), and East Brady (Section 13); and on the free-flowing upper Allegheny River near Oil City (Section 11), President (Section 10), and Tidioute (Section 9). Preliminary results of these surveys include catches of walleye not yet age 1 (*i.e.*, YOY fish), which are generally less than 7 inches total length, all less than 8 inches (Al Woomer, personal communication). In 2010, YOY walleye surveys will also be conducted to continue to monitor levels of natural reproduction. Comparison YOY walleye data has not been compiled to date comparing stocking versus no stocking.

Based on an examination of historical records, paddlefish were probably extirpated from the Three Rivers sometime in the early Twentieth Century. Paddlefish restoration stocking was initiated by PFBC in 1991 in an attempt to re-establish self-sustaining populations in the Allegheny River and Ohio River (Figure 9.1). Results of paddlefish stocking thus far suggest that it has been partially successful with evidence of a low density population of gravid females but no evidence of natural reproduction (Argent *et al.* 2009). Evaluation of paddlefish restoration efforts will continue 2011-2012 (Rick Lorson, personal communication). This evaluation can only be completed with grant money assistance of State Wildlife Grants.

Figure 9.1. PFBC fish production division stocking juvenile paddlefish in August 2008 at Ohio River Dashields Pool (Section 2) near Sewickley (RM 11.8) (PFBC photograph).

9.4. <u>Fish Consumption Advisories</u>
Fish consumption advisories are developed and updated each year through an interagency workgroup directed by PADEP that includes PFBC, PDA, and Pennsylvania Department of

Health (Table 9.4). PADEP is responsible for collecting and analyzing fish samples for routine monitoring of contaminants in fish tissue used to update the advisories. While most recreationally caught fish in Pennsylvania are safe to eat, contaminants such as mercury and PCBs have been found in some fish, including ones collected from the Three Rivers. While the levels of these unavoidable contaminants are typically low, they are potentially a health concern to pregnant and breast-feeding women, women of childbearing age, children, and individuals maintaining a diet high in fish.

Persistent contaminants such as PCBs, chlordane, and mercury have the potential to bioaccumulate in certain body tissues, such as the liver and fatty tissues. It may take months or even years of frequently consuming contaminated fish to accumulate levels that are of a human health concern. Mothers who eat highly contaminated fish for many years before becoming pregnant may have children who are slower to develop and learn. Suggestions on the number of meals with fish in fish consumption advisories are intended to protect children from these potential developmental problems. Adults are less likely to have health problems at the low levels that affect children. If advisories are followed, exposure to contaminants and risks to health are minimized.

All recreationally caught fish in Pennsylvania are subject to a statewide one-meal-per-week consumption advisory. This advisory was issued to protect the general population against eating large amounts of fish that have not been tested or that may contain unidentified contaminants and to especially protect pregnant women, women of childbearing years, and young children. Under the statewide advisory, one meal is considered to be one-half pound of fish for a 150-pound person. This meal advice is equally protective for larger people who eat larger meals (more than one-half pound of fish) and smaller people who eat smaller meals (less than one-half pound of fish).

Table 9.4. 2010 fish consumption advisories for the Three Rivers and Allegheny Reservoir.

River	Downstream Limit	Upstream Limit	Species	Meal Restriction	Contaminant
Ohio	Montgomery L/D	Confluence at Pittsburgh	Walleye, sauger, white bass, freshwater drum	1 meal per month	PCBs
			Common carp, channel catfish	DO NOT EAT	PCBs
	PA-OH Border	Montgomery L/D	White bass, hybrid striped bass, freshwater drum, walleye > 17”	1 meal per month	PCBs
			Flathead catfish, channel catfish < 17”	6 meals per year	PCBs
			Common carp, channel catfish > 17”	DO NOT EAT	PCBs
Allegheny Reservoir			Smallmouth bass	2 meals per month	Mercury
Allegheny	Morse Run at Starbrick	Kinzua Dam	Walleye	2 meals per month	Mercury
	Tubbs Run at Tionesta	Forest-Warren County border	Walleye	2 meals per month	Mercury
	Whitherup Run at St. George	Sandy Creek	Walleye	2 meals per month	Mercury
	L/D 6	L/D 7	Common carp	1 meal per month	PCBs
	Confluence at Pittsburgh	L/D 3	Common carp, channel catfish	1 meal per month	PCBs
Monongahela	Grays Landing L/D	Point Marion L/D	Common carp	1 meal per month	PCBs
	Braddock L/D	Maxwell L/D	Common carp	1 meal per month	PCBs
	Confluence at Pittsburgh	Braddock L/D	Freshwater drum	6 meals per year	PCBs
			Channel catfish	1 meal per month	PCBs
			Common carp	DO NOT EAT	PCBs

9.5. Stock Assessments and Populations Monitoring

Sport fisheries management of the Three Rivers initiated more action in the early 1970s with PFBC DFM Area 2's investigations of dredging issues on the upper Allegheny River and Area 8's assistance with lockchamber surveys. In the late 1970s and throughout the 1980s, Area 2 and Area 8 completed stock assessments and prepared affiliated management reports in an effort to improve fisheries management strategies for the sport fisheries of the Three Rivers. These activities continued and improved throughout the 1990s and 2000s.

Fixed Sites Surveys

In addition to broader-scope inventories, PFBC's more recent surveys of the Three Rivers have focused on monitoring primary game fish species (*e.g.,* smallmouth bass, walleye, and sauger). The objectives of these targeted surveys are to monitor trends in populations over time by comparing indices of relative abundance (*i.e.*, catch-per-unit-effort , or CPUE) among years to infer general increases or decreases in population size, as well as to identify trends in distribution of size structure and age structure. The targeted surveys are also designed to inform our angling public of the current status of the fisheries. General locations of targeted species surveys were typically selected based on the best known and available habitat for the species. Since locations of these surveys remain the same year after year, they are referred to as "fixed sites."

PFBC has established several fixed sites for monitoring game fish populations of the Three Rivers. Fixed sites are surveyed on an annual basis and include midsummer surveys targeting YOY smallmouth bass and early fall surveys targeting adult smallmouth bass and YOY walleye and sauger. YOY smallmouth bass surveys of the Three Rivers are typically conducted during mid- to late July or early August using either AC backpack or pulsed DC boat electrofishing gear operated as single-pass during the day (Table 9.5). A YOY smallmouth bass fixed site is defined as one 300-meter (≈ 984 feet) reach length of generally wadeable river shoreline. For older YOY sites, data are recorded for every 50 meters (≈ 164 feet) within the 300-meter site. The number of YOY smallmouth bass captured are recorded according to 25 millimeter (≈ one inch) length groups and released alive.

Table 9.5. Existing and proposed (for 2011) fixed YOY smallmouth bass sites on the Three Rivers.

River (PFBC DFM Area)	Management Section	Reach Length (meters)	Initial Survey Year	Electrofishing Gear (Waveforms)	Nearest Municipality
Ohio (Area 8)	1	6 x 50m	1991	Boat EF (Pulsed DC)	Pittsburgh (Brunot Island)
	1	2 x 50m + 1 x 200m	1991		McKees Rocks
	1	1 x 300m	1991		Bellevue
	1	1 x 300m	1991		Avalon
	3	2 x 300m	2009		Tailwaters Dashields L/D
	3	2 x 300m	2009		Tailwaters Dashields L/D
Allegheny (Area 8)	19	2 x 50m + 1 x 200m	1991	Backpack EF (AC)	River Forest
	19	1 x 300m	1991		Harrison Hills
	19	1 x 300m	1991		Garvers Ferry
	19	1 x 300m	1991		Garvers Ferry
	19	6 x 50m	1991		Kiskiminetas Junction and Freeport
Allegheny (Area 2)	17	6 x 50m	1990		Kittanning
	16	6 x 50m	1990		Mosgrove
	15	6 x 50m	1990		Rimer
	13	6 x 50m	1987		East Brady
	13	6 x 50m	1987		Foxburg
	12	6 x 50m	1987		Kennerdell
	12	6 x 50m	1987		Franklin
	10	6 x 50m	1987		President
	9	6 x 50m	1987		Tidioute

River (PFBC DFM Area)	Management Section	Reach Length (meters)	Initial Survey Year	Electrofishing Gear (Waveforms)	Nearest Municipality
	8	6 x 50m	1987		Buckaloons and Starbrick
Monongahela (Area 8)	3	2 x 300m	2011	Boat EF (Pulsed DC)	Tailwaters Maxwell L/D
	3	2 x 300m	2011		Tailwaters Maxwell L/D

Annual production and survival of immature fish are estimated from YOY smallmouth bass surveys, as well as an annual index for comparison of year-class strength. YOY smallmouth bass at standard summer survey time of the Three Rivers typically range in size between one and four inches. Over the years, CPUE of YOY smallmouth bass has been highly variable in the Three Rivers. Several years when YOY smallmouth abundance was elevated were also years during drought and/or low flow leading to the hypothesis that high early summer flows can impede YOY smallmouth bass production due to disturbances during nesting and early growth (Lorantas and Kristine 2004).

Considering 22 years of data, mean CPUE of YOY smallmouth bass of the upper Allegheny River (Sections 7-13) is considerably higher than the lower Allegheny River (Sections 14-22) and Ohio River (Table 9.6). Statewide, the upper Allegheny River (50 YOY per 300m) is comparable to the middle Susquehanna River (51 YOY per 300m), and is only eclipsed by the upper Susquehanna River (61 YOY per 300m).

Disease, tumors, lesions, sores, wounds, erosions, parasites, and/or other abnormalities are recorded on every YOY fish collected as part of this survey. To date, such abnormalities have been exceedingly rare (less than 1% of fish collected) for YOY smallmouth bass collected from the Allegheny River and Ohio River. Such is not the case for YOY smallmouth bass collected from the Susquehanna River. Since 2005, widespread disease, including two unknown (*i.e.*, bacterial or viral agents) primary internal pathogens, and a secondary external infection from columnaris (*Flavobacterium columnare*), have resulted in poor recruitment and periodic mortality of Susquehanna River YOY smallmouth bass (Geoff Smith, personal communication).

Table 9.6. Mean CPUE of YOY smallmouth bass from large rivers of Pennsylvania over the past 22 years (PFBC unpublished data).

River	Section(s)	Survey Years	Mean CPUE (# collected per 300 meters)
Upper Allegheny River	8, 9, 10, 12, and 13	1987-2009	50
Lower Allegheny River	15, 16, 17, and 19	1990-2009	13
Ohio River	1 and 3	1991-2009	9
West Branch Susquehanna River	6	1990-2009	24
Upper Susquehanna River*	2, 3, 5, 6, 7, 8, 9, and 10	1987-2009	61
Middle Susquehanna River	2 and 3	1988-2009	51
Lower Susquehanna River	5, 6, and 7	1987-2009	21
Upper Delaware River	2, 3, and 4	1987-2009	26
Middle Delaware River	5 and 6	1987-2009	18
Lower Delaware River	7 and 8	1989-2009	37

*Previously called "North Branch Susquehanna River" (Geoff Smith, personal communication).

Early fall surveys of the Three Rivers targeting adult smallmouth bass and YOY walleye and sauger are typically conducted from early September to mid-October using pulsed DC boat electrofishing gear operated as single pass at night (Table 9.7). During these surveys, captured targeted fish are identified to species, recorded by 25 millimeter length groups, measured for total length to the nearest millimeter, weighed to the nearest gram, and released alive. Lateral scale samples are collected from a maximum of ten fish per species per 25 millimeter length group for age and growth determinations. Non-target species are also typically identified and recorded for species occurrence data.

Table 9.7. Existing and proposed (for 2011) fixed adult smallmouth bass and YOY walleye sites on the Three Rivers.

River (PFBC DFM Area)	Management Section	Target Species	Survey Month	Nearest Municipality
Allegheny (Area 8)	19	Adult smallmouth bass and YOY walleye	September	Freeport
Allegheny (Area 2)	10	Adult smallmouth bass	September	President
	12	Adult smallmouth bass	September	Kennerdell
	13	Adult smallmouth bass	September	East Brady
	9	YOY walleye	October	Tidioute
	10	YOY walleye	October	President
	11	YOY walleye	October	Oil City
	13	YOY walleye	October	East Brady
	15	YOY walleye	October	Templeton
Ohio River (Area 8)	1	Adult smallmouth bass and YOY walleye	October-November	Proposed for 2011
	4	Adult smallmouth bass and YOY walleye	October-November	
Monongahela River (Area 8)	3	Adult smallmouth bass and YOY walleye	October-November	

Other Surveys

During other broader-scope inventories of the Three Rivers, including the Monongahela River Biomonitoring Study initiated in 2003 (at that time referred to as the Monongahela River Mine Pool Survey) and repeated in 2009 and 2010, abundance, age, and growth data are typically collected on target game fish species.

Black Bass Fishery

The black bass fishery of the Three Rivers, including smallmouth bass, spotted bass, and largemouth bass, are maintained entirely by natural reproduction. Of the black bass populations of all Three Rivers, smallmouth bass predominate (≈ 96% relative abundance), followed by spotted bass (≈ 3% relative abundance) and largemouth bass (≈ 1% relative abundance; Table 9.8). Of the three species, spotted bass are more tolerant of turbidity and warm water temperatures, and therefore become more abundant further downstream in the Ohio River beyond the Pennsylvania border. Spotted bass are typically not found in the free-flowing upper Allegheny River (Sections 7-13; Table 9.8).

Considering 19 years of data, CPUE of smallmouth bass of the upper Allegheny River (Sections 7-13) is considerably higher than the lower Allegheny River (Sections 14-22), Monongahela River, and Ohio River (Table 9.8). On the other hand, based on CPUE values, the Monongahela River maintains a more productive largemouth bass fishery, and the Ohio River a more productive spotted bass fishery than the other rivers. Legal-sized spotted bass (≥ 12 inches or ≥ 15 inches, depending upon time of year) are rarely collected from the Three Rivers. However, trophy-sized smallmouth bass (≥ 20 inches) are occasionally collected during nighttime boat electrofishing surveys (Figure 9.2).

Table 9.8. Mean CPUE of black bass collected during nighttime boat electrofishing surveys of the Three Rivers over the past 19 years (PFBC unpublished data).

River (Management Sections)	Survey Years	# Sites Surveyed	Effort (hours)	Smallmouth Bass			Largemouth Bass			Spotted Bass		
				Total CPUE (# per hour)	CPUE ≥ 12 inches (# per hour)	CPUE ≥ 15 inches (# per hour)	Total CPUE (# per hour)	CPUE ≥ 12 inches (# per hour)	CPUE ≥ 15 inches (# per hour)	Total CPUE (# per hour)	CPUE ≥ 12 inches (# per hour)	CPUE ≥ 15 inches (# per hour)
Ohio (1 - 4)	1990-2008	53	28.53	29.34	3.68	0.74	0.25	0.07	0.00	2.31	0.07	0.00
Monongahela (1 - 6)	1992-2009	139	33.97	32.23	6.86	0.74	1.83	0.56	0.03	1.68	0.09	0.00
Allegheny (14 - 22)	1989-2009	179	140.62	43.24	3.20	0.50	0.48	0.16	0.02	0.72	0.01	0.00
Allegheny (7 - 13)	1990-2009	74	76.33	79.81	6.52	1.60	0.09	0.04	0.00	0.00	0.00	0.00

The quality of the black bass fishery of the Three Rivers has improved tremendously over the last 30 years and has developed into one of, if not the most, popular fisheries for anglers using the Three Rivers (walleye is probably a close second). The fishery has become renowned enough that two national fishing tournaments, the 2005 Bassmaster Classic and 2009 Forrest L. Wood Cup, were held on the Three Rivers.

Figure 9.2. Trophy-sized smallmouth bass collected by PFBC biologists in September 2008 during a nighttime boat electrofishing survey of Ohio River New Cumberland Pool (Section 4) near confluence of Little Beaver Creek (RM 40.5) (PFBC photograph).

Smallmouth bass, largemouth bass, and spotted bass of the Three Rivers are currently managed using Statewide Regulations for Commonwealth Inland Waters (herein referred to as "Statewide Regs"). Big Bass Program Special Regulations (of 15-inch minimum size limit and 4 per day creel limit; herein referred to as "Big Bass Regs") were previously utilized at Allegheny River Section 20 (Pool 3) from 1995 to 2007 with objectives of improving the quality of the black bass fishery there in terms of size structure enhancement resulting from more restrictive (than Statewide Regs) regulations. According to Lorson (2006), objectives for Big Bass regulations were not met on Allegheny River Section 20 for smallmouth bass, in particular when compared relative to Statewide Regs on adjacent Section 19 (Pool 4).

Typically, smallmouth bass and largemouth bass of the Three Rivers reach legal size at about age 5 for the 12-inch minimum size limit and about age 7 for the 15-inch minimum size limit (Figures 9.3 and 9.4). All age data reported in this *Management Plan* is based on scale age determinations only.

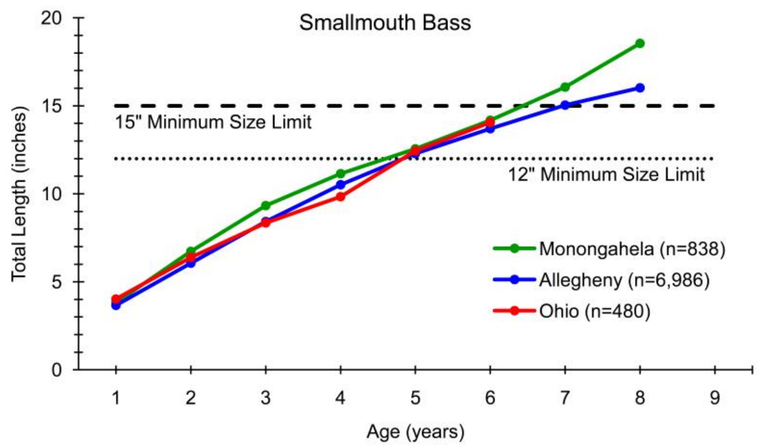

Figure 9.3. Mean length at age for smallmouth bass collected from the Three Rivers compared to minimum size limits of Statewide Regulations for Commonwealth Inland Waters (PFBC unpublished data).

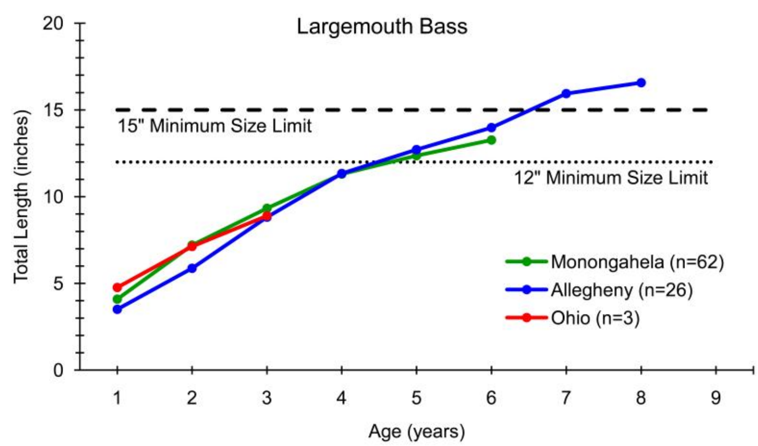

Figure 9.4. Mean length at age for largemouth bass collected from the Three Rivers compared to minimum size limits of Statewide Regulations for Commonwealth Inland Waters (PFBC unpublished data).

Spotted bass of the Three Rivers do not reach legal size (12 inches) until about age 6 or age 7. Older year classes may not reach sizes greater than 15 inches (Figure 9.5).

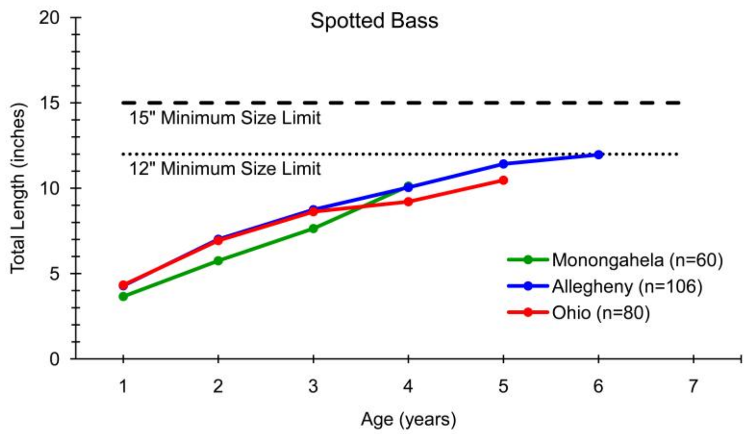

Figure 9.5. Mean length at age for spotted bass collected from the Three Rivers compared to minimum size limits of Statewide Regulations for Commonwealth Inland Waters (PFBC unpublished data).

Walleye and Sauger Fishery

Walleye were last stocked in the Allegheny River in 2007 and Monongahela River in 2006 (Table 9.3). The last time walleye were stocked in the Ohio River was 1978. Walleye stockings of the Three Rivers were discontinued in 2008 due to increased collection of YOY walleye and sentiment among PFBC fisheries biologists that sufficient recruitment from natural reproduction can maintain the walleye fishery in years ahead. The level of contribution from natural reproduction is still under investigation, especially for the upper Allegheny River at Sections 7, 8, 9, and 10 where walleye recruitment has historically been variable. Walleye stockings of these sections of the upper Allegheny River may resume dependent on results of 2010 surveys (Al Woomer, personal communication). The quality of the walleye fishery of the Three Rivers has improved tremendously over the last 30 years, especially for the lower Allegheny River. Walleye has developed into a very popular fishery for anglers using the Three Rivers, particularly at the tailwaters of navigation dams and at the mouths of large tributary streams. This highly migratory species resides in all management sections of the Three Rivers.
The sauger fishery of the Three Rivers is maintained entirely by natural reproduction. Sauger was previously extirpated from the Three Rivers and only started to recover around the mid-1970s. Of all the game fish species, the quality of the sauger fishery has probably improved the most over the past 30 years, which is testament to improved water quality of the Three Rivers. Like walleye, sauger has developed into a very popular fishery for anglers using the Three Rivers, particularly at the tailwaters of navigation dams and at the mouths of large tributary streams. This highly migratory species resides in all management sections of the Ohio River and Monongahela River, but are not typically found in the upper Allegheny River.

Considering 19 years of data, total CPUE of walleye of the lower Allegheny River (Sections 14-22) is considerably higher than the upper Allegheny River (Sections 7-13), Monongahela River, and Ohio River (Table 9.9). However, walleye CPUE ≥ 15 inches is highest and comparable for the upper and lower Allegheny River. On the other hand, based on total CPUE and CPUE ≥ 12 inches values, the Monongahela River maintains a more productive sauger fishery than the other rivers (Figure 9.6).

Table 9.9. Mean CPUE of walleye and sauger collected during nighttime boat electrofishing surveys of the Three Rivers over the past 19 years (PFBC unpublished data).

River (Management Sections)	Survey Years	# Sites Surveyed	Effort (hours)	Walleye		Sauger	
				Total CPUE (# per hour)	CPUE ≥ 15 inches (# per hour)	Total CPUE (# per hour)	CPUE ≥ 12 inches (# per hour)
Ohio (1 - 4)	1990-2008	53	28.53	2.49	0.25	14.02	1.54
Monongahela (1 - 6)	1992-2009	139	33.97	3.24	0.32	31.68	6.56
Allegheny (14 - 22)	1989-2009	179	140.62	15.23	0.66	6.94	2.63
Allegheny (7 - 13)	1990-2009	74	76.33	3.25	0.64	0.00	0.00

Figure 9.6. Memorable-sized sauger collected by PFBC biologists in July 2009 during a nighttime boat electrofishing survey of Monongahela River Emsworth Pool (Section 6) near confluence with Streets Run (RM 6) (PFBC photograph).

Typically, walleye of the Three Rivers reach legal size (15 inches) at about age 4 (Figure 9.7), and sauger of the Three Rivers reach legal size (12 inches) at about age 3 (Figure 9.8).

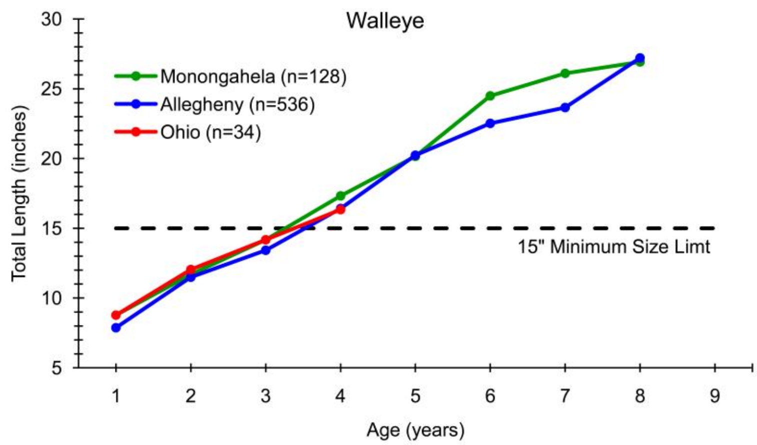

Figure 9.7. Mean length at age for walleye collected from the Three Rivers compared to minimum size limit of Statewide Regulations for Commonwealth Inland Waters (PFBC unpublished data).

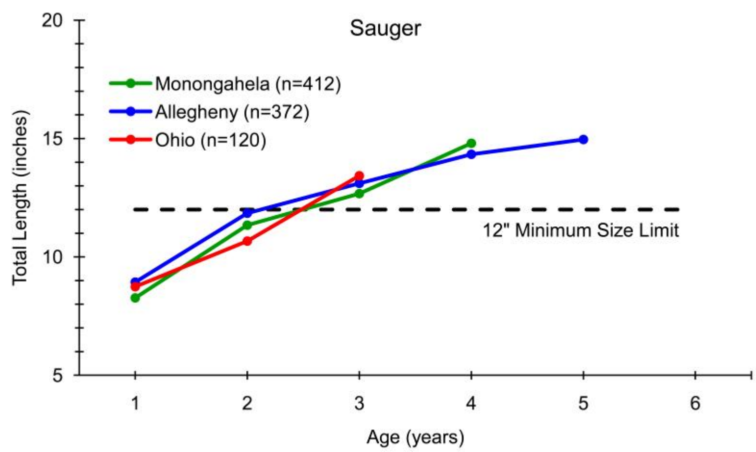

Figure 9.8. Mean length at age for sauger collected from the Three Rivers compared to minimum size limit of Statewide Regulations for Commonwealth Inland Waters (PFBC unpublished data).

Remaining Three Rivers game fish species listed below have limited CPUE data available for comparison between river reaches and are therefore not provided in this Management Plan.

Muskellunge, Tiger Muskellunge, and Northern Pike Fishery

Purebred muskellunge are stocked annually in the Allegheny River and Monongahela River, and tiger muskellunge are stocked annually in the Ohio River (Table 9.3). Maintenance stockings of both species are vital to sustain these high quality, relatively popular fisheries. There is some evidence of natural reproduction in muskellunge in the upper Allegheny River (*e.g.*, musky fingerlings observed during July YOY smallmouth bass surveys before hatchery-reared fish are stocked in the river), but due to inconsistent year classes and poor recruitment, natural reproduction is probably not sufficient on its own to maintain the muskellunge fishery without maintenance stocking (Al Woomer, personal communication). Natural reproduction of muskellunge in the upper Allegheny River warrants further investigation. Both species have been collected in most management sections of the Three Rivers, although in nominal abundances to compute valid CPUE statistics. Although age data for these species is very limited, purebred muskellunge and tiger muskellunge of the Allegheny River and Monongahela River reach legal size (40 inches) at about age 9 and age 8, respectively (Figures 9.9 and 9.10).

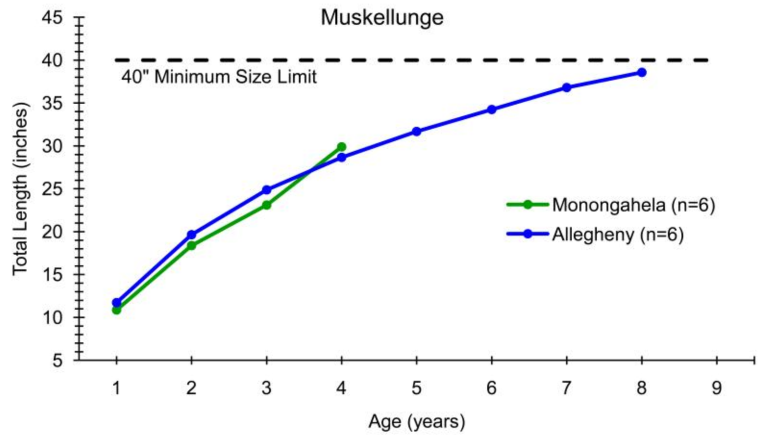

Figure 9.9. Mean length at age for muskellunge collected from the Allegheny River and Monongahela River compared to minimum size limit of Statewide Regulations for Commonwealth Inland Waters (PFBC unpublished data).

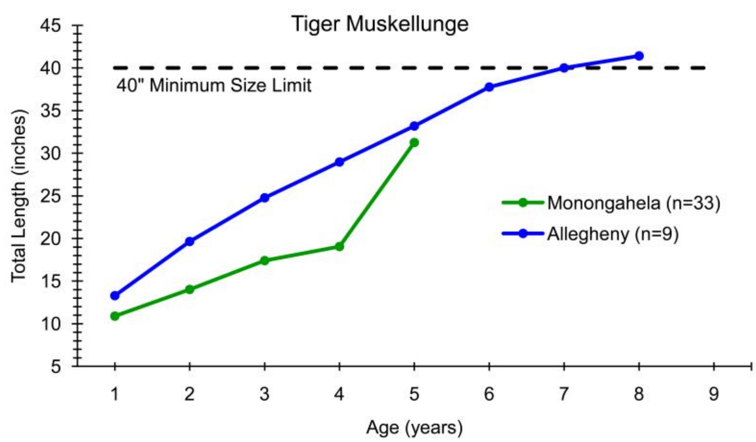

Figure 9.10. Mean length at age for tiger muskellunge collected from the Allegheny River and Monongahela River compared to minimum size limit of Statewide Regulations for Commonwealth Inland Waters (PFBC unpublished data).

Although northern pike are occasionally found in the Ohio River and Monongahela River, this is primarily a fishery of the upper Allegheny River, where it is maintained entirely by natural reproduction. Typically, Allegheny River northern pike reach legal size (24 inches) at about age 4 (Figure 9.11).

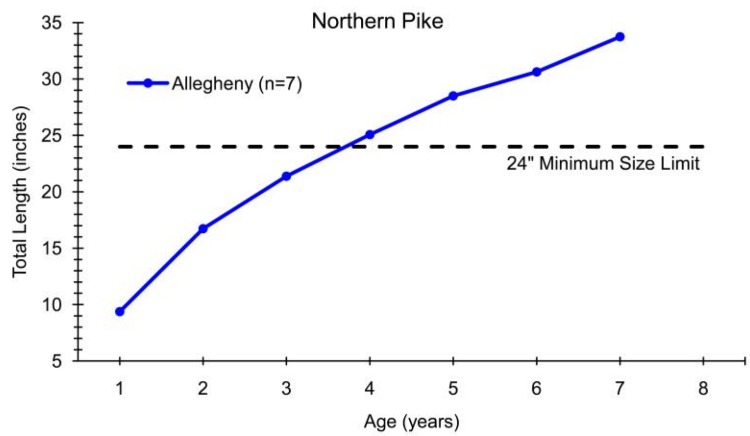

Figure 9.11. Mean length at age for northern pike collected from the Allegheny River compared to minimum size limit of Statewide Regulations for Commonwealth Inland Waters (PFBC unpublished data).

White Bass and Hybrid Striped Bass Fishery

The white bass fishery of the Three Rivers is maintained entirely by natural reproduction, whereas hybrid striped bass are stocked annually in the Three Rivers (Table 9.3). White bass reside in all management sections of the Three Rivers, and hybrid striped bass are typically not found in the upper Allegheny River. It only takes about two or three years for white bass of the Three Rivers to reach quality size (9 inches; Gabelhouse 1984) (Figure 9.12). PFBC Ohio River Section 3 beach seine catch data (1991 to 2001) have suggested variable recruitment for white bass over the years (Table 9.10), which will be reflected as fluctuating population abundances for the Three Rivers. As age data for hybrid striped bass collected from the Three Rivers is limited at this time, it is difficult to accurately depict at which age this species reaches legal size (20 inches).

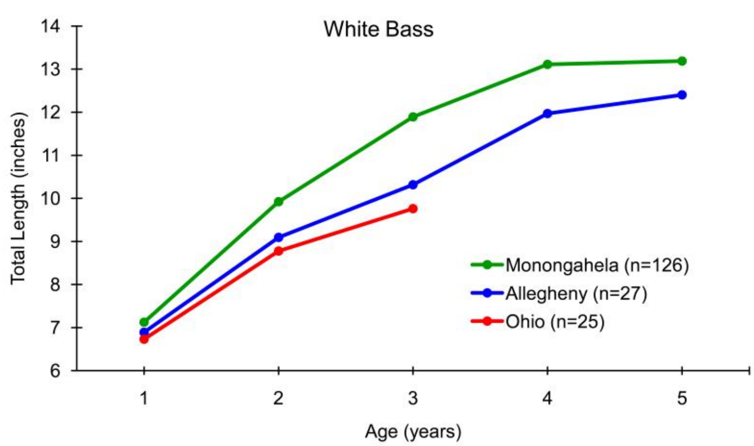

Figure 9.12. Mean length at age for white bass collected from the Three Rivers (PFBC unpublished data).

Channel Catfish and Flathead Catfish Fishery

The channel catfish and flathead catfish fishery of the Three Rivers is maintained entirely by natural reproduction, and over the last 30 years have replaced Ictalurid populations dominated by pollution tolerant brown bullheads. Flathead catfish abundances have increased in all of the Three Rivers, but most notably in the Monongahela River (Lorson and Smith 2004). Being highly migratory, channel catfish and flathead catfish reside in all management sections of the Three Rivers. With common carp, channel catfish are a frequent addition to annual fish consumption advisories for the Three Rivers (Table 9.4). These catfish species require more fish population work to be completed for appropriate fish management decisions to be made. Some of this work for channel catfish will be outlined in PFBC's *Pennsylvania Channel Catfish Plan*, scheduled to be initiated in 2011.

Rock Bass, Bluegill, and Crappie Fishery

Panfish fisheries of the Three Rivers, including rock bass, bluegill, white crappie, and black crappie, are all maintained entirely by natural reproduction. An under-utilized fishery, rock bass reside in all management sections of the Three Rivers. Over the years, catch data have indicated relatively high proportions of quality size rock bass (7 inches; Gabelhouse 1984). It takes about six years for rock bass of the Three Rivers to reach quality size of 7 inches (Figure 9.13).

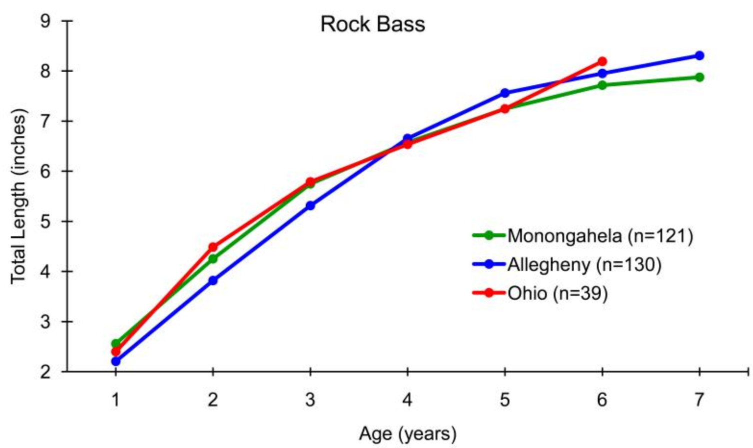

Figure 9.13. Mean length at age for rock bass collected from the Three Rivers (PFBC unpublished data).

Although their population sizes are generally small compared to other Centrarchid species of the Three Rivers, bluegill and crappie reside in all management sections. Over the years, catch data have indicated relatively high proportions of quality size fish (6 inches for bluegill, 8 inches for crappie; Gabelhouse 1984). It takes at least four years for bluegill of the Monongahela River and Allegheny River to reach quality size of 6 inches and five years for bluegill of the Ohio River (Figure 9.14).

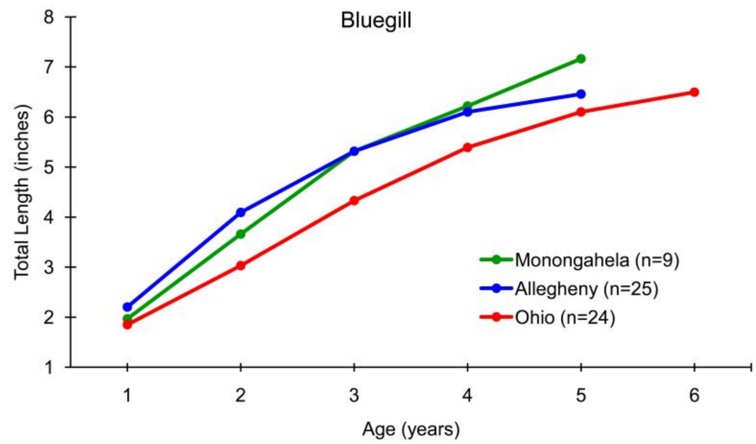

Figure 9.14. Mean length at age for bluegill collected from the Three Rivers (PFBC unpublished data).

Freshwater Drum Fishery
The freshwater drum fishery of the Three Rivers is maintained entirely by natural reproduction. This migratory species resides in all management sections of the Three Rivers. In 1994, the state record freshwater drum (19 pounds, 14 ounces) was caught from the Monongahela River.

Common Carp Fishery
Common carp are an introduced species that has naturalized in the Three Rivers, and their fishery is maintained entirely by natural reproduction. Their distribution is ubiquitous, occupying all 26 management sections of the Three Rivers. Many anglers target common carp on the Three Rivers for catch-and-release sport fishing.

Brown Trout and Rainbow Trout Fishery
Since 1988, the trout fishery of the upper Allegheny River has been maintained by stocking spring fingerlings of both brown trout and rainbow trout in the three- to four-inch size range. PFBC DFM Area 2 recommends stocking Allegheny River Section 7 with 50,000 brown trout and 50,000 rainbow trout annually (Al Woomer, personal communication). Allegheny Reservoir's metalimnetic and hypolimnetic outflow from six bottom release sluices (123 feet deep below summer pool elevation) of Kinzua Dam is substantially colder than ambient Allegheny River water temperature. As a result, the coldwater tailwater trout fishery is sustained throughout the year, and an 8.5-mile reach of Allegheny River Section 7 (from Kinzua Dam downstream to confluence with Conewango Creek) is managed under Special Regulations (Table 9.2).

Paddlefish Restoration Fishery
Paddlefish have been extirpated from the Three Rivers since probably the early Twentieth Century. In 1991, PFBC initiated a paddlefish restoration stocking program in an attempt to re-establish self-sustaining populations in the Allegheny River and Ohio River (Lorson 1991 and 2008). Of all the migratory fish species of the Three Rivers, paddlefish probably travel the longest distances. Paddlefish also require precise timing of environmental cues, including water temperature, photoperiod, and river flow, to induce migration and achieve successful reproduction. From 1991 to 2006, PFBC stocked paddlefish fingerlings in 40 miles of the lower Allegheny River and 40 miles of the Ohio River (Figure 9.15). However, since 2007, stocking locations were reduced to only Allegheny River Section 21 (Pool 2) in odd years and Ohio River Section 2 (Dashields Pool) in even years. The 2007 change was implemented due to research

findings at that time (by biologists at California University of Pennsylvania), which justified concentrating stocking efforts to develop a higher density population. Preliminary results of paddlefish restoration stocking suggest that populations have not been restored and that natural reproduction is at best extremely limited (Argent *et al.* 2009). Continuing evaluation of this program is planned for 2011 and 2012 using funding from State Wildlife Grants.

Figure 9.15. Adult paddlefish (32 pounds, 48 inches total length) collected in May 2005 by California University of Pennsylvania scientists from Ohio River Montgomery Pool (Section 3) near tailwaters of Dashields L/D (RM 14) (photograph provided by David Argent).

Other Fisheries
Other game fish and panfish species of the Three Rivers, including chain pickerel, yellow perch, pumpkinseed, and yellow bullhead, are all maintained by natural reproduction. These fisheries are not as productive or popular as other fisheries of the Three Rivers. Several species typically classified as nongame, including longnose gar, mooneye, skipjack herring, and several redhorse sucker species have recently become popular and are now targeted by anglers. In 2003, the state record sucker was caught from Allegheny River Section 9 near West Hickory (Figure 9.1).

Figure 9.16. Angler with state record sucker (a 12-pound, 14.4-ounce river redhorse) caught in 2003 from Allegheny River Section 9 (from PFBC Website).

Beach seine surveys of Ohio River Section 3 (Montgomery Pool) were conducted annually (in August) by PFBC DFM Area 8 from 1991 to 2001 to monitor YOY game fish and nongame fish abundances as well as forage abundances (Table 9.10). Thus far, these data depict a highly fluctuating annual recruitment for the Ohio River that is likely widespread throughout the Three Rivers.

Table 9.10. Summary of Ohio River Section 3 (Montgomery Pool) annual beach seine surveys (PFBC unpublished data).

Survey Year	Fish Species Occurrence	Total # Fish Collected	FBI*	Total # Smallmouth Bass Collected
1991	12	1,231	581	22
1992	2	363	179	0
1993	18	3,479	1,513	28
1994	10	1,320	590	11
1995	17	8,343	4,033	3
1996	8	2,222	1,063	2
1997	19	7,939	3,504	16
1998	9	4,356	2,146	2
1999	14	3,619	1,700	47
2000	5	3,628	1,802	1
2001	14	2,901	509	7
Means:	**12**	**3,582**	**1,602**	**13**

*FBI = Forage base Index = (# gizzard shad + # emerald shiner)/2.

9.6. Angler Use, Harvest, and Opinion

The Three Rivers are in urgent need of a comprehensive recreational use survey that collects and compiles data on angler use, angler harvest, and angler opinion, recreational boating, as well as administers an economic benefits assessment. Such a comprehensive survey has already been completed in 2008 by PFBC on the Susquehanna River and Juniata River. Although proposed, funding for a recreational use survey has not yet been allocated for the Three Rivers. The most recent and extensive angler use, harvest, and opinion surveys of the Three Rivers were completed in the early 1990s, are obviously outdated, but summarized below to provide some level of information for this *Management Plan*.

During the *Ohio River Recreational Use Survey* of 1992, of the 1,924 anglers interviewed fishing the New Cumberland Pool (Ohio portion only), Schell *et al.* (1996) found that 74 percent of anglers were targeting “anything”, followed by 12 percent targeting black bass, six percent targeting white bass and hybrids, only three percent targeting walleye and sauger, and only three percent targeting channel catfish and flathead catfish. Terrestrial Environmental Specialists, Inc. (TES 1996) found that species caught by anglers fishing the Three Rivers is somewhat variable for navigation pools in the vicinity of Pittsburgh (Table 9.11).

Table 9.11. Top three fish species caught by anglers fishing the Three Rivers for six navigation pools in the vicinity of Pittsburgh (TES 1996).

	Navigation Pool (River)					
	New Cumberland Pool (Ohio River)	**Montgomery Pool (Ohio River)**	**Dashields Pool (Ohio River)**	**Emsworth Pool (Three Rivers)**	**Pool 2 (Allegheny River)**	**Braddock Pool (Monongahela River)**
First	Bass (Species)	Smallmouth Bass	Walleye	White Bass	Walleye	White Bass
Second	Sauger	Panfish	Striped Bass	Striped Bass	Sauger	Smallmouth Bass
Third	Walleye	Sauger	Catfish (Species)	Sauger	Channel Catfish	Walleye
Average # Fish Caught	11	5	3	7	16	14

Using random utility models (RUMs), TES (1996) also evaluated the recreational value of fishing on the Three Rivers within the vicinity of Pittsburgh. In 1992, TES estimated that shore fishing in six navigation pools of the Three Rivers in the vicinity of Pittsburgh had a value of $844,152, and boat fishing was valued at $68,493. If these values are extrapolated to the entire navigable area of the Three Rivers (39,494 acres at $68.85 per acre), the value of shore fishing and boat fishing could be estimated at approximately $2.7 million annually. Given the reported 51 percent inflation rate since 1993 (USDL 2010), the realized value today is likely in the neighborhood of $4.1 million annually.

From a comprehensive creel survey of anglers fishing the Allegheny River in 1994, Lorson and Miko (1995) found that on Section 19 (Pool 4) and Section 20 (Pool 3), the greatest amount of angler directed effort targeting an individual species was walleye (34%), followed by smallmouth bass (21%), and then sauger (16%). However, sauger dominated both angler catch (41%) and angler harvest (59%) in this investigation, followed by smallmouth bass (28% catch, 14% harvest), and walleye (10% catch, 12% harvest). This creel survey was repeated in 2000 (Lorson and Smith 2001), with similar results for angler directed effort (walleye at 36%, smallmouth bass at 27%, sauger at 16%), angler catch (smallmouth bass at 47%, sauger at 19%, and walleye at 6%), and angler harvest (sauger at 54%, smallmouth bass at 11%, and walleye at 10%).

9.7. Proposed Management Actions

For this Section of the *Management Plan*, PFBC first developed each proposed Management Action in consideration of Stewardship Goal 9.1, and then prioritized these actions into one of three levels with expectation of commencing within the following timeframes:

1 (Red) = Proposed Management Action initiated within two years.
2 (Yellow) = Proposed Management Action initiated within three years.
3 (Green) = Proposed Management Action initiated within five years.

Stewardship Goal 9.1. Monitor and promote sport fisheries resources of the Three Rivers to better manage and protect PFBC's jurisdictional fish species.

Stewardship Goal 9.1 – Proposed Management Actions		Priority
9.1.1	Continue to conduct targeted surveys of young-of-the-year (YOY) and adult smallmouth bass, walleye, and sauger, and collect abundance, age, and growth data at historic fixed sites on the Allegheny River and Ohio River.	**1**
9.1.2	Establish new fixed sites for YOY and adult smallmouth bass, walleye, and sauger, and collect abundance, age, and growth data on the Monongahela River Section 03 (Charleroi Pool) and Ohio River Sections 03 (Montgomery Pool) and 04 (New Cumberland Pool).	
9.1.3	Employ procedures developed and used by the Ohio River Fisheries Management Team and assist biologists from the Ohio Department of Natural Resources, Division of Wildlife, with September surveys for smallmouth bass and November surveys for walleye and sauger at tailwaters of Montgomery and Dashields Locks and Dams on the upper Ohio River.	
9.1.4	Conduct targeted surveys of channel catfish and flathead catfish using baited, tandem hoop nets and low-frequency nighttime boat electrofishing on the Three Rivers.	
9.1.5	Annually post sport fisheries information for the Three Rivers on the PFBC's Website.	
9.1.6	Continue Statewide Regulations for Commonwealth Inland Waters for the Three Rivers as well as special regulations for trout on Allegheny River Section 07 (confluence of Conewango Creek upstream to Kinzua Dam). Adjust these regulations for individual fisheries when needed.	
9.1.7	Resurrect the annual beach seine surveys of Ohio River Section 3 (Montgomery Pool) initially conducted 1991-2001.	
9.1.8	Prepare a grant proposal that funds a study that continues to evaluate the success of Pennsylvania's Paddlefish Restoration Program. This investigation should determine paddlefish movement and improve methods to distinguish hatchery-reared fish from fish produced from natural reproduction.	
9.19	Evaluate the feasibility of implementing a restoration program for blue catfish on the Three Rivers.	
9.1.10	Prepare a grant proposal that funds a study to determine the extent and degree of natural reproduction and recruitment of muskellunge on the upper Allegheny River.	**2**
9.1.11	Direct a comprehensive Recreational Use Survey of the Three Rivers, which includes angler use, angler opinion, fish harvest, recreational boating, and economic benefits study components. This study should be similar in design and scope to investigations conducted on the Susquehanna and Juniata Rivers in 2008 (Geoff Smith, personal communication).	**3**
9.1.12	Evaluate the put-grow-take trout fingerling program in terms of abundance and survival, as well as angler use of Allegheny River Section 7 (confluence of Conewango Creek upstream to Kinzua Dam).	
9.1.13	Prepare stock assessment reports that evaluate status of sport fish populations (primarily walleye, sauger, and smallmouth bass) of the Three Rivers, including analysis of size structure, age structure, estimated total annual mortality, stocking programs, and fishing regulations.	

10. HUMAN DIMENSIONS

Since before European settlement, humans have used, and continue to use, the Three Rivers in a variety of ways, including as a source of food and water, venue for recreation, transportation avenue, and as a waste dump. The rivers have shaped human occupation of the area and in return, people have shaped and altered the rivers. Understanding the interactions between people and the aquatic resources of the Three Rivers is an important part of this comprehensive *Management Plan*. PFBC's mission includes the human dimension of aquatic resources, *i.e.* to provide fishing and boating opportunities.

10.1. Boating Activities

The Three Rivers are not only working rivers with heavy commercial barge traffic, but also support many recreational boaters.

Commercial Vessels

The lock and dam navigation system is something that PFBC would like to see disappear both from an aquatic life use and aquatic habitat perspective. However, the reality of river transport is still the most economical method of transporting raw materials and bulk goods in western Pennsylvania. As a result, commercial navigation on the Three Rivers has remained an important component of the regional economy for the past 170 years or so, probably since the completion of L/D 1 in 1841 on the Monongahela River. Today, shipping costs for raw materials average $0.97 per ton per mile shipped by barge on the Three Rivers compared with $2.53 per ton per mile shipped by railroad and $5.35 per ton per mile delivered by truck (USACE 2010). On one gallon of fuel, barges can move one ton of cargo 576 miles (Port of Pittsburgh Commission 2010). A railroad car moves the same ton of cargo 413 miles and a truck only 155 miles, giving barges an energy efficiency 3.5 times that of trucks.

As a major shipping operations center, the Port of Pittsburgh is the country's largest inland harbor in terms of tonnage originating and passing through it. More than 50 million tons of cargo per year – primarily coal and other raw materials including sand, gravel, and iron ore; manufactured goods; petroleum and petroleum products; and chemicals and related products – are shipped by barge on the Three Rivers. As a port situated at the head of the Ohio River, Pittsburgh offers convenient access to the nation's inland waterway system, the Mississippi River (via Ohio River), on 8,000 miles of navigable rivers flowing through 24 states. The port system affects almost a half million river-dependent jobs.

Tour Boats

Gateway Clipper Fleet: Station Square on the south shore of the Monongahela River (RM 0.6) in Pittsburgh is homeport to the Gateway Clipper Fleet, a major tour boat operation comprised of five boats: *Majestic* (277 feet, 1,000 passengers); *Empress* (212 feet, 600 passengers); *Duchess* (125 feet, 310 passengers); *Princess* (120 feet, 400 passengers); and *Countess* (55 feet, 150 passengers).

Figure 10.1. RiverQuest *Explorer* (from RiverQuest).

Just Ducky Tours: Station Square on the south shore of the Monongahela River (RM 0.5) in Pittsburgh is also homeport to Just Ducky Tours, a tour boat operation featuring six DUKWs (D = 1942; U = utility; K = front wheel drive; W = two rear driving axles), amphibious trucks built by General Motors Corporation during World War II for transporting soldiers and supplies over land and water.

RiverQuest: Carnegie Science Center on the north shore of the Ohio River (RM 0.4) is homeport to RiverQuest, a not-for-profit organization offering river-based educational adventure for students, teachers, and the community. RiverQuest operates the world's first green education/passenger vessel, the *Explorer* (90 feet, 150 passengers) (Figure 10.1). *Explorer* features a hybrid diesel-electric engine system that is projected to reduce emissions by a significant amount as compared to decommissioned vessels of RiverQuest's fleet.

Recreational Vessels
The Three Rivers provide nearly unlimited opportunities for the recreational boater. For the past ten years, Allegheny County has the highest number of registered boats in Pennsylvania, averaging about 27,000 registered boats per year (PFBC unpublished data). The impounded Ohio, Monongahela, and lower Allegheny Rivers (RM 0-72) have no general horsepower restrictions, and both powered (*e.g*., fishing boats, bass boats, ski boats, pontoon boats, bowriders, center consoles, runabouts, deck boats, cruisers, cuddy cabins, houseboats, and even motor yachts) and non-powered vessels (canoes, kayaks, rowboats, sweep boats, sculling shells, and even dragon boats) of various shapes, sizes, and configurations take advantage of the relatively easy-to-navigate, quiescent navigation pools of the Three Rivers. On riffles and runs of the upper Allegheny River (RM 72-198), vessels of shallower draft (*e.g*., flat-bottom jon boats and tunnel hull boats with jet-drive outboard motors, as well as canoes and kayaks) are more suitable.

Military Vessels
The Department of Homeland Security maintains a U.S. Coast Guard (USCG) Station at Sewickley on the Ohio River (RM 11.0). Sewickley Station is a small boat and aids to navigation station of the USCG's Eighth District, Sector Ohio Valley. Sewickley Station is home to a shoreside detachment and a small boat unit and is also homeport for the 65-foot inland river buoy tender USCG Cutter *Osage* (WLR-65505).

The *Osage* typically pushes around a 100-foot barge (Figure 9.2), and its crew is responsible for maintaining approximately 800 aids to navigation in and along the banks of the Three Rivers, while also brush-cutting areas around shore aids during the summer months. The *Osage* is responsible for maintaining a safe and navigable inland water system to ensure that commerce is flowing up and down the Three Rivers, with an area of responsibility covering the Allegheny, Monongahela, Ohio, Kanawha, and Big Sandy Rivers in and throughout the Pittsburgh area.

Figure 10.2. USCG Cutter *Osage* at Point State Park in Pittsburgh (from U.S. Coast Guard).

Access Facilities
USACE's *Navigation Charts* for the Ohio, Allegheny, and Monongahela Rivers, PFBC's website, and the annual *Pittsburgh Boater's Guide* all provide some of this information, however incomplete.

10.2. Tourism and Recreational Use

The Three Rivers provide a wide array of recreational opportunities, with some of the most popular being boating, fishing, swimming, and wildlife watching. Other activities include camping, hiking, biking, and hunting. Angling is probably the highest direct use of the rivers as demonstrated by fishing license sales (Table 10.1). Allegheny County, location of the confluence of the Three Rivers, repeatedly has the highest number of fishing license sales in the state.

Boating represents another major source of recreation on the Three Rivers. On the pool sections of the rivers, boaters can enjoy water-skiing, tubing, and wakeboarding. Canoeing and kayaking is possible on all Three Rivers. Eighty-five miles of the upper Allegheny River, a popular paddling destination, is designated as a National Wild and Scenic River. In conjunction with partners, PFBC has designated six water trails, boat routes suitable for canoes, kayaks and small motorized watercraft, in the Ohio Basin (Table 10.1). Water trail guides and information on trail activities can be found on PFBC's website. For thrill seekers, whitewater conditions exist on several tributaries, most notably the Youghiogheny River, a tributary to the Monongahela River.

Table 10.1. Water trails in the upper Ohio River basin.

Trail	Length (miles)	River Reach	Trail Sponsors
Clarion River Water Trail	100 mi	Confluence of East and West Branch Clarion Rivers to Parker Bridge	• Allegheny National Forest • Western Pennsylvania Conservancy
Kiski-Conemaugh River Water Trail	50 mi	Johnstown to Freeport	• Pennsylvania Environmental Council • Conemaugh Valley Conservancy
Middle Allegheny River Water Trail	30 mi	Kinzua Dam to Emlenton	• Allegheny National Forest • Oil Heritage Region
Three Rivers Water Trail	30 mi	Freeport to Pittsburgh	• Friends of the Riverfront
Upper Monongahela Water Trail	68 mi	Fairmont, West Virginia to Maxwell L/D	• Morgantown Area Chamber of Commerce Vision 2020 • Monongahela River Recreation & Commerce Committee
Youghiogheny River Water Trail	46 mi 30 mi	Connellsville to McKeesport Confluence to S. Connellsville	• Pennsylvania Environmental Council

In addition to the water trails, many miles of the Three Rivers have bicycle and walking trails along them, including the Armstrong Trail (Allegheny River), Three Rivers Heritage Trail (all Three Rivers in Pittsburgh), and the Great Allegheny Passage Trail, which follows the Monongahela from Pittsburgh to its junction with the Youghiogheny River and from there goes on to Washington, D.C.

Abundant wildlife can be seen throughout the Ohio River Basin. Unique sightings include elk in north-central Pennsylvania and migratory bird species throughout the basin. Seven state and federally-owned properties along the Three Rivers provide recreational opportunities and educational programs (Table 10.2).

Table 10.2. State and federal lands along the Three Rivers.

River	Name	County(ies)
Allegheny River	Allegheny Islands State Park	Allegheny County
	Allegheny National Forest	Elk, Forest, McKean, Warren Counties
	Clear Creek State Forest	Venango County
	State Game Lands 86	Warren County
	State Game Lands 105	Armstrong County
Monongahela River	Friendship Hill National Historic Site	Fayette County
Ohio River	Ohio River Islands National Wildlife Refuge	Beaver County

The economic value of recreational activities based on the Three Rivers is largely undocumented or out-of-date figures. As an example of the potential value of these resources, the 2005 Bassmaster Classic generated about $28.5 million in revenue; while the 2009 Forrest L. Wood Cup drew 60,000 visitors to Pittsburgh and produced over $35 million in revenue (Organizer supplied information).

10.3. Funding Opportunities

There are a diversity of funding sources for conserving, managing, and enjoying the Three Rivers from public as well as private sources (Table 10.3). The Commonwealth has two major sources of funding for conservation land acquisitions – bond funding and appropriated funding. Each of these sources is used not only for state land and easement acquisitions, but also to support local and nonprofit acquisitions. The Keystone Recreation, Park, and Conservation Fund Act, passed in 1993, provides funding for acquisition of natural areas and open space, using the proceeds from bond sales and a portion of state realty transfer tax revenues.

Growing Greener, enacted in December 1999, is the other significant source for conservation funds. Sources of the funds include new money from the General Fund and funds redirected from the Recycling and Hazardous Sites Cleanup funds and the Landfill Closure Accounts. Growing Greener supports farmland preservation, open space acquisition, watershed improvements, local grant programs, and other programs. Funds are divided among PADCNR, PADEP, PDA, and PENNVEST.

A state funding program with a specific focus on research of distribution and abundance of wild plants and nongame animals is the Wild Resource Conservation Fund (WRCF), established in 1982 by the Wild Resource Conservation Act. Housed within PADCNR, funding from WRCF addresses recommendations from that agency as well as PFBC and PGC.

Another federal to state funding program, the State Wildlife Grants (SWG) program, is sponsored by the USFWS. Annually appropriated by U.S. Congress, Pennsylvania's SWG funds are apportioned between PFBC and PGC to address each agencies trust species and habitats. For the Three Rivers, SWG has funded projects involving mussel surveys and distribution assessments on the Allegheny River (completed by malacologists from WPC) and nongame fish surveys and distribution assessments (including paddlefish) on all Three Rivers (completed by ichthyologists from California University of Pennsylvania and Penn State University).

Private Funding

In addition to government funding, conservation organizations and land trusts raise their own funds from donors and foundations. Organizations like the Western Pennsylvania Conservancy, The Nature Conservancy, Trust for Public Land, Conservation Fund, and other members of the Pennsylvania Land Trust Alliance provide substantial benefits to river management by acquiring lands – either for management themselves, or more often, conveyance to the PGC, PADCNR, or other public entities. Land trusts can often identify lands, put the deal together and arrange financing in a more rapid and nimble fashion than governmental agencies.

Table 10.3. Government funding programs.

Program / Agency	Key Aspects of Funding
State Programs	
Wild Resource Conservation Program (administered by PADCNR)	• Established by the Wild Resource Conservation Act in 1982 • Funds research, conservation, and restoration of wild plants and nongame animals • Uses taxpayer-contributed funds, funds from license plate and other sales, and Growing Greener money • Future funding levels uncertain, due to declines in tax check-offs and license sales • Funding addresses recommendations from PADCNR, PGC, and PFBC
Community Conservation Partnerships Program (administered by PADCNR)	• Offers grants annually for community recreation, trails, river conservation, critical natural areas, and open space • Uses federal funds, Pennsylvania general funds, Growing Greener, and other state funds • Land Trust Grants program gives priority to habitat for threatened and endangered species
Department of Environmental Protection	Various grant programs with potential impacts on river management: • Watershed restoration • Riparian buffers • Mine land restoration • Oil and gas well plugging
Agricultural Easement Program	• Pennsylvania's largest publicly funded conservation acquisition program • Provides for purchase of conservation easements in Agricultural Security Areas, using state and county funds to acquire easements on agricultural lands in order to keep them in open space and prevent conversion to development • May acquire easements on forest lands, but generally eligible only if associated with crop land, grazing, or pasture lands. •
Federal Programs	
Conservation Reserve Program (USDA)	• Pays landowners to convert highly erodible cropland or other environmentally sensitive acreage to native grasses, wildlife plantings, trees, filter strips, or riparian buffers
Conservation Reserve Enhancement Program (USDA)	• Focuses on highly erodible land and streamside buffers
Environmental Quality Incentives Program (USDA)	• Provides technical, financial, and educational assistance to eleven priority areas in Pennsylvania • Landowners receive cost-shares for conservation practices
Wildlife Habitat Incentives Program (USDA)	• Gives landowners cost-shares to provide habitat for wildlife, endangered species, and fisheries
Forest Stewardship Program (USDA)	• Provides technical assistance to landowners voluntarily seeking to enhance wildlife habitat, protect soil and water quality, increase wood production, and fulfill other multiple use objectives • Assists with developing Forest Stewardship Plans
Forest Legacy (USDA)	• Provides funding to purchase conservation easements on forest land to retain forest cover and forestall conversion to developed uses
National Park Service	• Administers grant programs under the Land and Water Conservation Fund and other programs. • Helps acquire and improve state lands, greenways, trails, and other conservation and recreational infrastructure.
National Fish and Wildlife Foundation	• Partnership with federal agencies • Administers grant programs to sustain, restore, and enhance the nation's fish, wildlife, and plants and their habitats

Program / Agency	Key Aspects of Funding
Partners for Wildlife (USFWS)	• Provides funding and technical assistance, in cooperation with PGC, to private landowners for restoration of native wildlife habitat, including wetlands, riparian buffers and streambank stabilization
Sport Fish Restoration Act (USFWS)	• Restoration of sport fish populations
State Wildlife Grants (USFWS)	• Federal grants to states to fulfill the needs of wildlife not met by other sources • Administered by PGC and PFBC
Environmental Protection Agency	• Provides funds that support state actions to protect the environment.
Transportation Enhancement Act (TEA-21)	• Enhancements include acquisition of scenic easements or scenic sites, wildlife underpasses, rails-to-trails projects, and environmental mitigation to address water pollution due to highway runoff or reduce vehicle-caused wildlife mortality while maintaining habitat connectivity
Local Program	
Property Tax and Earned Income Tax	• Municipalities authorized in 1996 to levy property tax or earned income tax for acquiring open space, if approved by the voters • A few municipalities in rapidly developing areas have used this authority
Act 515	• Allows counties to enter into covenants with owners to maintain land in open space, farm, forest, or water supply uses in exchange for a property assessment that values the land as open space • Five counties in eastern Pennsylvania participate (as of 2002)
Farmland and Forest Assessment Act (Clean and Green)	• Property tax relief program • Allows counties to assess agricultural land, agricultural reserve land, and forest reserve land at current use value rather than market value • More than 5 million acres in 48 counties assessed under Clean and Green

Western Pennsylvania is fortunate in having many foundations that focus at least part of their substantial assets on aquatic resources, including the Benedum Foundation, Foundation for Pennsylvania Watersheds, Heinz Endowments, McCune Foundation, and R.K. Mellon Foundation. PFBC must continue to pursue opportunities for funding from these organizations. At the national level, the FishAmerica Foundation awards grant for local projects to enhance fish populations, restore fish habitat, improve water quality and advance fisheries research (FishAmerica 2010). FishAmerica is the fisheries conservation and research foundation of the American Sportfishing Association, and is dedicated to keeping the nation’s fish and waters healthy and to improve sportfishing success. Corporate foundations also provide funding for watershed work. RRI Energy Foundation has partnered with PFBC since 2007 to provide grants for watershed restoration in tributary streams and research activities on the rivers.

Research on the Three Rivers is conducted by a number of non-profit organizations and individual researchers at academic institutions, utilizing a variety of funding sources, including those listed above as well as monies internal to the organizations and federal sources such as the National Science Foundation and National Institute of Health.

10.4. Education and Research

PFBC staff provides educational materials and opportunities at all levels from kindergarten through high school (K-12) and college as well as partnering on research and education in the Ohio Basin with several academic institutions. At the K-12 level, PFBC works with schools throughout Pennsylvania to provide materials on aquatic resources, fishing, and boating. Both PFBC and PGC are contributors to ProjectWILD, a network of wildlife agencies that provides a wildlife-focused conservation education program for kindergarten through grade-12 educators and students. PFBC is the state sponsor for WILD Aquatic, which emphasizes aquatic wildlife and aquatic ecosystems and also developed a curriculum on Pennsylvania amphibians and reptiles. Courses and family days are offered on fishing skills, basic boating, and boating and water safety awareness. Interactions with K-12 and the general public are handled primarily by PFBC's southwest regional education and outreach coordinator and staff, with offices in Somerset. Among the many colleges and universities in western Pennsylvania, there are a handful that provide undergraduate and graduate programs with a specific focus on aquatic resources (Table 10.4).

Table 10.4. Colleges and Universities in western Pennsylvania.

Institution	Location
Allegheny College	Meadville, PA
California University of Pennsylvania	California, PA
Carnegie Mellon University	Pittsburgh, PA
Clarion University	Clarion, PA
Duquesne University	Pittsburgh, PA
Indiana University of Pennsylvania	Indiana, PA
Pennsylvania State University	State College, PA
Slippery Rock University	Slippery Rock, PA
University of Pittsburgh	Pittsburgh, PA
University of Pittsburgh	Johnstown, PA

In addition to those academic institutions, research activities are conducted on the Three Rivers by a number of different agencies and organizations. Federal agencies include the USEPA (Region 3 Field Office), Pennsylvania Cooperative Fisheries and Wildlife Research Unit, USACE, USDA (Allegheny National Forest and Northern Research Station), USGS, and USFWS. State agencies include PADEP, PADCNR, PGC, and PFBC. The sole interstate agency is ORSANCO. Other organizations include Carnegie Museum of Natural History, The Nature Conservancy, and Western Pennsylvania Conservancy.

10.5. <u>River Stewardship</u>

The best stewards of the rivers are likely the people who use them the most, including angler, boating, and environmental organizations working on river issues. Angling and boating organizations include Federation of Fly Fishers, Fox Chapel Yacht Club, Kinzua Fish and Wildlife Association, Oakmont Yacht Club, Penn's Woods West Chapter of Trout Unlimited (largest TU chapter in the state and one of the largest in the country), Pennsylvania B.A.S.S. Federation, Pennsylvania Federation of Sportsmen's Clubs, Pirates of the Allegheny, Pittsburgh Downriggers, Pittsburgh Power Squadron, Three Rivers Chapter of Muskies, Inc., Three Rivers Rowing, and Western Pennsylvania Anglers. The Tri-River Marine Trade Association sponsors a Pittsburgh Boat Show every year, a major event for boaters in the region.

There are many watershed organizations and other advocacy groups in the basin, but most of these focus on smaller tributaries streams to the Three Rivers. A few organizations have projects involving the main rivers, including Friends of the Riverfront, RiverLife, RiverQuest, Sierra Club Allegheny Chapter, Upper Monongahela River Association, Venture Outdoors, The Nature Conservancy, and Western Pennsylvania Conservancy.

Although not as large as in other areas, Riverkeeper programs exist for the Monongahela River and Allegheny River. Their missions are to increase awareness of the conditions of the individual rivers, advocate compliance with environmental laws, and develop methods to address and solve the problems of pollution, degradation, and abuse. The Riverkeeper programs and partners also educate citizens on threats to the waters and the benefits provided by our major rivers (Friends of the Riverfront 2010).

10.6. Proposed Management Actions

For this Section of the *Management Plan*, PFBC first developed each proposed Management Action in consideration of Stewardship Goal 10.1, and then prioritized these actions into one of three levels with expectation of commencing within the following timeframes:

1 (Red) = Proposed Management Action initiated within two years.
2 (Yellow) = Proposed Management Action initiated within three years.
3 (Green) = Proposed Management Action initiated within five years.

Stewardship Goal 10.1. Develop and participate in public service, exhibit, and educational programs of PFBC and other organizations to provide informative activities on large river resources for anglers, boaters, and the general public to promote understanding and enjoyment of these resources.

Stewardship Goal 10.1 – Proposed Management Actions		Priority
10.1.1	Work with participating states of the Ohio River Fisheries Management Team to update and produce a Web-based *Ohio River Fishing Guide*.	**1**
10.1.2	Annually prepare and submit articles on fisheries resources of the Three Rivers for the PFBC Website or *Pennsylvania Angler and Boater* including summaries of fisheries surveys and research activities conducted.	**2**
10.1.3	Assist with the development of new access areas on the Three Rivers in accordance with the 2010 *Pennsylvania Fishing and Boating Access Strategy*.	
10.1.4	Provide data, expertise, and other support as appropriate to community development projects that involve the Three Rivers (such as water trails, riverfront parks, and pedestrian/bicycle trails along the rivers).	**3**
10.1.5	Develop and expand a habitat restoration approach with PFBC's Bureau of Fisheries, Habitat Management Division and other partners that focuses on river reaches impacted by past industrial disturbances. This approach must incorporate means of adding new and enhancing existing access areas on the Three Rivers, including boat launches and shoreline facilities.	
10.1.6	Prepare grant proposals to secure annual funding opportunities made available through foundations, endowments, nonprofit organizations, and other philanthropies for purchase of large river survey gear and to support proposed studies of the Three Rivers presented in this *Management Plan*.	

11. SUMMARY OF PROPOSED MANAGEMENT ACTIONS

For Sections 5 through 10 of the *Management Plan*, PFBC developed proposed Management Actions in consideration of achievable Stewardship Goals, and then prioritized these actions into one of three levels with expectation of commencing within the following timeframes:

1 (Red) = Proposed Management Action initiated within two years.
2 (Yellow) = Proposed Management Action initiated within three years.
3 (Green) = Proposed Management Action initiated within five years.

Although changes to this *Management Plan* can occur at any time, serving as a working document, it is expected that routine updates will take place every five years (next in 2016). However, the list of proposed management actions, summarized below, will be reviewed at least annually to measure progress toward stewardship goals.

Stewardship Goal 5.1. Evaluate the impacts of human activities, such as navigation dams, emerging contaminants, and other threats on fish species and fish habitats of the Three Rivers, to assist in conservation and restoration efforts.

	Stewardship Goal 5.1 – Proposed Management Actions	Priority
5.1.1	Depending upon the results of the Asian Carp Risk Assessment (see proposed Management Action 8.1.1), continue to request that the U.S. Army Corps of Engineers (USACE) Pittsburgh District conduct annual assisted fish passage lockages throughout the spring spawning season at Allegheny River Locks and Dams 5 through 9 and finalize a Memorandum of Agreement for these lockages.	1
5.1.2	Continue to serve on the Upper Ohio Interagency Working Group and provide recommendations to the USACE with input on fish passage structures and habitat enhancement mitigation projects proposed at the Emsworth, Dashields, and Montgomery Locks and Dams on the upper Ohio River.	1
5.1.3	Continue to assist scientists from the U.S. Geological Survey Leetown Science Center during research investigations of fish health and levels of intersex within the Three Rivers.	1
5.1.4	Assist biologists from the Pennsylvania Department of Environmental Protection (PADEP) with fish collection activities on the Three Rivers for Pennsylvania's Fish Consumption Advisory Program.	1
5.1.5	Prepare a grant proposal to fund a study to determine fish passage through lock structures of the Three Rivers.	3
5.1.6	Investigate the potential of redesignation of the free-flowing upper Allegheny River (rivermile 72 at East Brady upstream to rivermile 198 at Kinzua Dam) from Warm Water Fishes (WWF) to High Quality – Warm Water Fishes (HQ-WWF).	3

Stewardship Goal 6.1. Evaluate the impacts of past commercial dredging activities on fish species and fish habitats of the Allegheny River and Ohio River to assist in conservation and restoration efforts.

Stewardship Goal 6.1 – Proposed Management Actions		Priority
6.1.1	Form collaborative research partnerships with other resource agencies (e.g., PADEP, ORSANCO) and prepare a grant proposal to fund a study that reevaluates the impacts of past commercial dredging activities on fisheries and/or ecological functioning at historic dredge sites of the upper Allegheny River (Franklin, Oil City, Tionesta, and Warren) and lower Allegheny River (Pool 3 through Pool 9).	2

Stewardship Goal 7.1. Evaluate the ecological functioning of instream and riparian habitats of the Three Rivers, and determine their values to fisheries to assist in conservation and restoration efforts.

Stewardship Goal 7.1 – Proposed Management Actions		Priority
7.1.1	Prepare a grant proposal to fund biological and bathymetric surveys of Montgomery Slough on the Ohio River and manmade embayments on the lower Allegheny River to characterize assemblages and determine ecological use and productivity.	2
7.1.2	Prepare a grant proposal to fund a study to determine the use of bulkhead structures and bridge piers as artificial fish habitats within the Three Rivers.	3
7.1.3	If and when data are supportive, petition Pennsylvania Natural Heritage Program to classify additional areas as Biologically Diverse Areas for county inventories.	

Stewardship Goal 8.1. Conduct annual baseline surveys and implement long-term monitoring studies of nongame fisheries resources of the Three Rivers to determine species status as well as better manage and protect PFBC's jurisdictional fish species.

Stewardship Goal 8.1 – Proposed Management Actions		Priority
8.1.1	Assist the U.S. Army Corps of Engineers, Pittsburgh District with conducting an ecological risk assessment that evaluates the likelihood of Asian carp invading the upper Ohio River and to assess potential ecological impacts of such an invasion.	1
8.1.2	Continue to provide recommendations concerning the upper Ohio River for PFBC's Draft *Aquatic Invasive Species Action Plan – Asian Carp Complex*.	
8.1.3	Continue to evaluate the biological integrity of the Three Rivers using fish assemblage structure as the barometer with protocols developed by the Ohio River Valley Water Sanitation Commission (*i.e.*, Modified Ohio River Fish Index) or other methods developed by the PFBC.	
8.1.4	Continue and expand the Monongahela River Monitoring Study in conjunction with research partners and expand routine monitoring of the Allegheny River and Ohio River as feasible.	
8.1.5	Prepare a grant proposal to fund a study that evaluates samples collected for molecular analysis, including fish tissue as well as environmental DNA (eDNA) extracted from river water samples, for selected fish species of management (*e.g.*, Asian carp) or conservation (*e.g.*, paddlefish) importance. Genetic information derived from fin clips can be used to determine population structure, to discriminate wild stocks from hatchery-reared stocks, and to identify species. Genetic information derived from eDNA can act as a surveillance technique to detect the presence or absence of species in a given river management section.	2
8.1.6	Promote research for an assessment of the status of hellbenders and mudpuppies in the Three Rivers in collaborations with research partners (*e.g.*, Western Pennsylvania Conservancy).	3

Stewardship Goal 9.1. Monitor and promote sport fisheries resources of the Three Rivers to better manage and protect PFBC's jurisdictional fish species.

Stewardship Goal 9.1 – Proposed Management Actions		Priority
9.1.1	Continue to conduct targeted surveys of young-of-the-year (YOY) and adult smallmouth bass, walleye, and sauger, and collect abundance, age, and growth data at historic fixed sites on the Allegheny River and Ohio River.	**1**
9.1.2	Establish new fixed sites for YOY and adult smallmouth bass, walleye, and sauger, and collect abundance, age, and growth data on the Monongahela River Section 03 (Charleroi Pool) and Ohio River Sections 03 (Montgomery Pool) and 04 (New Cumberland Pool).	
9.1.3	Employ procedures developed and used by the Ohio River Fisheries Management Team and assist biologists from the Ohio Department of Natural Resources, Division of Wildlife, with September surveys for smallmouth bass and November surveys for walleye and sauger at tailwaters of Montgomery and Dashields Locks and Dams on the upper Ohio River.	
9.1.4	Conduct targeted surveys of channel catfish and flathead catfish using baited, tandem hoop nets and low-frequency nighttime boat electrofishing on the Three Rivers.	
9.1.5	Annually post sport fisheries information for the Three Rivers on the PFBC's Website.	
9.1.6	Continue Statewide Regulations for Commonwealth Inland Waters for the Three Rivers as well as special regulations for trout on Allegheny River Section 07 (confluence of Conewango Creek upstream to Kinzua Dam). Adjust these regulations for individual fisheries when needed.	
9.1.7	Resurrect the annual beach seine surveys of Ohio River Section 3 (Montgomery Pool) initially conducted 1991-2001.	
9.1.8	Prepare a grant proposal that funds a study that continues to evaluate the success of Pennsylvania's Paddlefish Restoration Program. This investigation should determine paddlefish movement and improve methods to distinguish hatchery-reared fish from fish produced from natural reproduction.	
9.19	Evaluate the feasibility of implementing a restoration program for blue catfish on the Three Rivers.	
9.1.10	Prepare a grant proposal that funds a study to determine the extent and degree of natural reproduction and recruitment of muskellunge on the upper Allegheny River.	**2**
9.1.11	Direct a comprehensive Recreational Use Survey of the Three Rivers, which includes angler use, angler opinion, fish harvest, recreational boating, and economic benefits study components. This study should be similar in design and scope to investigations conducted on the Susquehanna and Juniata Rivers in 2008 (Geoff Smith, personal communication).	**3**
9.1.12	Evaluate the put-grow-take trout fingerling program in terms of abundance and survival, as well as angler use of Allegheny River Section 7 (confluence of Conewango Creek upstream to Kinzua Dam).	
9.1.13	Prepare stock assessment reports that evaluate status of sport fish populations (primarily walleye, sauger, and smallmouth bass) of the Three Rivers, including analysis of size structure, age structure, estimated total annual mortality, stocking programs, and fishing regulations.	

Stewardship Goal 10.1. Develop and participate in public service, exhibit, and educational programs of PFBC and other organizations to provide informative activities on large river resources for anglers, boaters, and the general public to promote understanding and enjoyment of these resources.

Stewardship Goal 10.1 – Proposed Management Actions		Priority
10.1.1	Work with participating states of the Ohio River Fisheries Management Team to update and produce a Web-based *Ohio River Fishing Guide*.	**1**
10.1.2	Annually prepare and submit articles on fisheries resources of the Three Rivers for the PFBC Website or *Pennsylvania Angler and Boater* including summaries of fisheries surveys and research activities conducted.	**2**
10.1.3	Assist with the development of new access areas on the Three Rivers in accordance with the 2010 *Pennsylvania Fishing and Boating Access Strategy*.	
10.1.4	Provide data, expertise, and other support as appropriate to community development projects that involve the Three Rivers (such as water trails, riverfront parks, and pedestrian/bicycle trails along the rivers).	**3**
10.1.5	Develop and expand a habitat restoration approach with PFBC's Bureau of Fisheries, Habitat Management Division and other partners that focuses on river reaches impacted by past industrial disturbances. This approach must incorporate means of adding new and enhancing existing access areas on the Three Rivers, including boat launches and shoreline facilities.	
10.1.6	Prepare grant proposals to secure annual funding opportunities made available through foundations, endowments, nonprofit organizations, and other philanthropies for purchase of large river survey gear and to support proposed studies of the Three Rivers presented in this *Management Plan*.	

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APPENDIX 1. ABBREVIATIONS AND ACRONYMS

$7Q_{10}$ = Average minimum river flows for seven consecutive days once every ten years
AIS = Aquatic Invasive Species
AISMPC = Aquatic Invasive Species Management Plan Committee
ALCOSAN = Allegheny County Sanitary Authority
ANF = Allegheny National Forest
ANS = Aquatic nuisance species
BDA = Biological Diversity Area
CA = Conservation Area
cfs = Cubic feet per second
CMNH = Carnegie Museum of Natural History
CPOM = Coarse particulate organic matter
CPUE = Catch-per-unit-effort
CSO = Combined sewer overflow
CUP = California University of Pennsylvania
DA = Dedicated Area
DFM = Division of Fish Management (Pennsylvania Fish and Boat Commission)
DOC = Dissolved organic carbon
EDC = Endocrine disrupting compound
EDM = Emsworth, Dashields, and Montgomery locks and dams
EIS = Environmental Impact Statement
EMAP-GRE = Environmental Monitoring and Assessment Program for Great Rivers Ecosystems
EPA = U.S. Environmental Protection Agency
FEMA = Federal Emergency Management Agency
FIRM = Flood Insurance Rate Maps
FPOM = Fine particulate organic matter
GIS = Geographical Information System
LCA = Landscape Conservation Area
L/D = Lock(s) and dam
LDB = Left descending bank
LWD = Large woody debris
MICRA = Mississippi Interstate Cooperative Resource Association
MNC = Monongahela Navigation Company
MOU = Memorandum of understanding
MRBP = Mississippi River Basin Panel on Aquatic Nuisance Species
MSL = Mean sea level
NFWCO = National Fish and Wildlife Conservation Office
NHA = Natural Heritage Area
NWSRS = National Wild and Scenic Rivers System
NYDEC = New York Department of Environmental Conservation
ORBFHP = Ohio River Basin Fish Habitat Partnership
ORFMT = Ohio River Fisheries Management Team
ORINWR = Ohio River Islands National Wildlife Refuge
ORSANCO = Ohio River Valley Water Sanitation Commission
PABS = Pennsylvania Biological Survey
PADCNR = Pennsylvania Department of Conservation and Natural Resources
PADEP = Pennsylvania Department of Environmental Protection
PAISMPC = Pennsylvania Aquatic Invasive Species Management Plan Committee

PCB = Polychlorinated biphenyl
PDA = Pennsylvania Department of Agriculture
PFBC = Pennsylvania Fish and Boat Commission
PGC = Pennsylvania Game Commission
PHMC = Pennsylvania Historical and Museum Commission
PISC = Pennsylvania Invasive Species Council
PNDI = Pennsylvania Natural Diversity Inventory
PNHP = Pennsylvania Natural Heritage Program
PSU = Pennsylvania State University
RA = Relative abundance
RDB = Right descending bank
RM = Rivermile
SGL = State Game Lands
SWG = State Wildlife Grant
TMDL = Total maximum daily load, or total amount of pollutants that can be assimilated by a waterbody without causing water quality standards to be exceeded
TSG = Tionesta Sand and Gravel, Inc.
USACE = United States Army Corps of Engineers
USCG = United States Coast Guard
USFS = United States Forest Service
USFWS = United States Fish and Wildlife Service
USGS = United States Geological Survey
WPC = Western Pennsylvania Conservancy
WVDNR = West Virginia Division of Natural Resources
WWF = Warm water fishes
YOY = Young-of-year