Ichthyofauna of the Monongahela River Basin in Pennsylvania: A Contemporary Evaluation

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ABSTRACT

By the 1900s, the ichthyofauna of Pennsylvania's Monongahela River basin was decimated by a combination of discharges from industrial, coal extraction, and municipal sources. Over the past half-century, water quality improvements resulting from federal and state mandates have initiated a continuing recovery of fish populations throughout the mainstem. We compiled the results of recent (2003-06) collections from the river and its tributary network by a number of state, federal, and academic agencies employing a variety of gear. The combined sampling methods yielded 32,999 fishes on the mainstem, representing 14 families and 64 species/hybrids, while 6,825 fishes representing 10 families and 51 species/hybrids were captured from the tributaries. Tributary species richness ranged from 24 to 0 concomitant with declining water quality. Members of the families Ictaluridae and Cyprinidae dominated mainstream communities, while the Percidae and Cyprinidae were prevalent in its tributaries. Twenty-two species were captured only from the Monongahela mainstem, while 11 were unique to its tributaries and 39 were cosmopolitan. Overall, the Monongahela Basin ichthyofaunal complement currently numbers 75 species/hybrids.

INTRODUCTION

The earliest published account of fish biodiversity in the Monongahela River in Pennsylvania, dating from the late 1800s, lists 40 species (Evermann and Bollman 1886). Subsequent population growth and industrial development within the region brought detrimental changes to its ichthyofauna (Ortmann 1909). Acid mine drainage (AMD), untreated sewage, and industrial discharges concurrent with modifications of river hydrology for navigational purposes caused significant declines in riverine fish communities. Ortmann (1909) said of the Monongahela drainage and many of its tributaries that it "is utterly polluted, chiefly by mine water" and therefore not surprising that the Ohio River, below Pittsburgh is in a "deplorable condition". Surveys conducted in the mid 1950s and 1960s reported continuing reductions in fish diversity and abundance along the length of the mainstem (Pearson and Krumholz 1994). One of the more telling reports of continued environmental decline was that of Preston (1974), who in a 1957 survey documented a pH of 3.8 and two bluegill (*Lepomis macrochirus*) sunfish from the Elizabeth Lock and Dam area (river km 66).

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Enactment of the Pennsylvania Clean Streams Law and Amendments of 1970, the federal Clean Water Act and Amendments of 1972, and the Surface Mine Control and Reclamation Act of 1972 prompted remediation efforts in the Monongahela River basin (PFEB 1972) and concomitant improvements in water quality. Fish and other aquatic organisms responded to improving water quality by recolonizing the once degraded reaches (Preston and White 1978, Cooper 1983, Weller et al. 1991, Argent et al. 1997). Thomas et al. (2005) documented similar trends in fish community recovery in the Ohio River and attributed those trends to improving water quality as well. Contemporary surveys may represent or approach an asymptote of recovery for this once-decimated ichthyofauna and a benchmark against which future changes can be measured.

Our objective was to provide a contemporary (2003-2006) assessment of the Monongahela River Basin ichthyofauna from the Pennsylvania/West Virginia border to Braddock Lock and Dam. The data sets for this summary were derived from several sampling paradigms employing a variety of gear over a short time frame (three years) and wide geographic area.

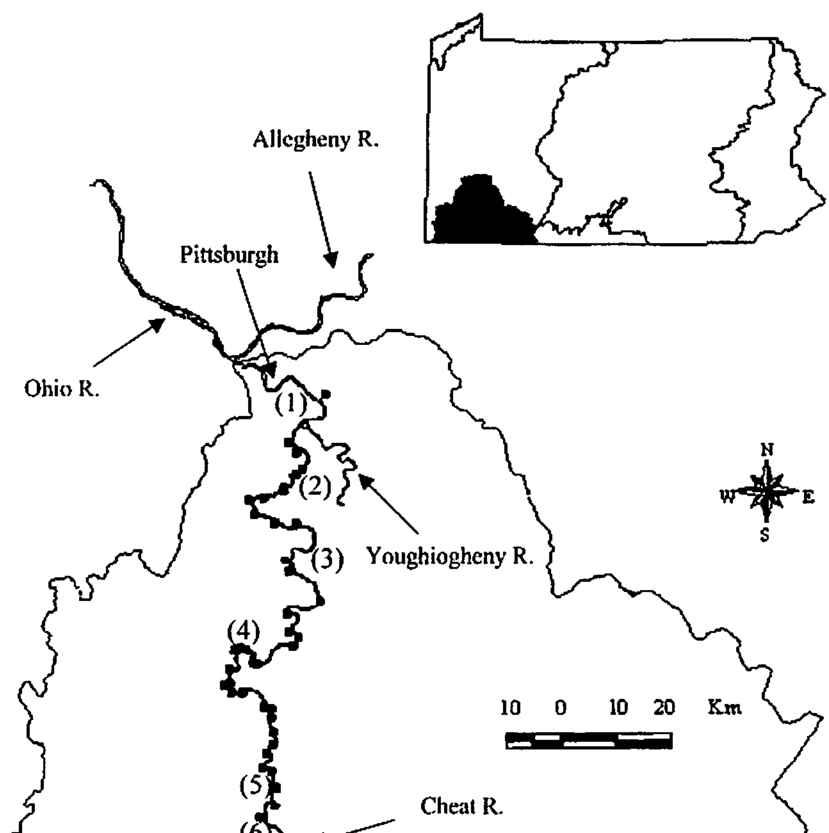

Figure 1. Monongahela River basin of Pennsylvania and its tributaries identified by lock and dam structures: 1 = Braddock, 2 = Elizabeth, 3 = Charleroi, 4 = Maxwell, 5 = Gray's Landing, and 6 = Point Marion.

METHODS

The Monongahela River, originating at the confluence of the West Fork River and Tygart River in West Virginia (WV) lies entirely within the Appalachian Plateau physiographic province. The river flows north over 206 km to Pittsburgh, Pennsylvania (PA) where it joins the Allegheny River to form the Ohio River. Fish sampling efforts were focused on the reach bounded by the WV/PA border extending north to the Braddock Lock and Dam (Fig 1; Table 1). This 130 km reach includes six navigation lock and dam structures.

Fish surveys were conducted between 2003 and 2006 by personnel from California University of Pennsylvania (CUP), the PA Fish and Boat Commission (PFBC), the Ohio River Valley Water Sanitation Commission (ORSANCO), the PA Department of Environmental Protection (PADEP), the WV Division of Natural Resources (WVDNR), the U.S. Army Corps of Engineers (USACE), and the U.S. Environmental Protection Agency (USEPA). Five different sampling gears were employed to collect fishes from a variety of habitats along the mainstem and selected tributaries ($\leq 5^{th}$ order). Sampling efforts were geared to fish a variety of habitats, water depths, and fish communities (e.g., benthic and pelagic).

In summer 2003, the PFBC conducted tailwater night-electrofishing at two dams within the study reach, Grays Landing Dam and Maxwell Lock and Dam (Fig 1; Table 1). These sites were resampled in fall 2003 by ORSANCO using identical methodology. Surveys consisted of ten, ten-minute transects at each tailwater using pulsed-DC boat-mounted electrofishing equipment. All fishes collected were identified and enumerated in the field, and a subset was retained as vouchers.

During late summer 2003, as part of its river-monitoring program, ORSANCO assisted by the PFBC, PADEP, WVDNR, USACE, USEPA, and CUP directed the sampling of three lock chambers (Braddock, Maxwell, and Grays Landing; Fig 1) on the Monongahela River using the piscicide rotenone (Murphy and Willis 1996). All fish were collected from each chamber, identified, and enumerated, and a subset was retained as vouchers.

Over the summers of 2003 and 2004, CUP sampled 38 named flowing Pennsylvania tributaries to the Monongahela River. Using pulsed-DC backpack electrofishing gear, each minor tributary (order <3) was sampled upstream from its mouth over 200-m or to the nearest blockage to fish passage. In addition to backpack units on wadeable reaches, boat electrofishing was utilized to sample the non-wadeable mouths of major tributaries. The Youghiogheny River and the Cheat River were excluded from the survey due to their size. Gamefish and large specimens were identified and enumerated in the field and released. All other

Table 1. Fish species richness and community diversity (H') among Monongahela River navigation pools.

Name	Length (km)	Species richness	Diversity (H')
Braddock	20.2	45	1.24
Elizabeth	28.5	50	1.25
Charleroi	31.7	55	1.20
Maxwell	33.5	66	1.10
Gray's Landing	14.2	60	1.23
Point Marion[a]	2.4	32	1.45

[a]Pool length extends from the WV/PA border to the lock and dam.

fishes were preserved, and voucher specimens were retained in the Fish Museum at CUP.

In summer 2005, CUP sampled the large-bodied ichthyofauna of the Monongahela River in Pennsylvania from the WV/PA border downriver to Braddock Lock and Dam utilizing multi-mesh gill nets set approximately every 1.3 river km (Argent and Kimmel 2005, Kimmel and Argent 2006c). Nets were also set at the mouth of tributaries surveyed by CUP with electrofishing gear in 2003-2004 (Kimmel and Argent 2005). Nets were fished approximately 24 hours at each site. Captured fish were identified in the field and released.

In summer 2006, CUP systematically sampled the Monongahela River using a benthic trawl (Herzog et al. 2005) from the WV/PA border, approximately every 1.6 km and at each tributary mouth, to the Braddock Lock and Dam (Fig. 1 and Table 1). Each sampling station consisted of three, two-minute hauls – one within 2 m of each shoreline and a third along the mid-channel. All captured fish were preserved and stored at CUP.

Data from the various surveys were combined to generate a species list for the reach impounded by each of the six navigable pools within Pennsylvania and its respective tributary network. Fishes that could not be identified were eliminated from consideration. The resulting inventory was created to distinguish among fishes that were unique to the river, unique to its tributaries, or common to both lotic systems, and to document the occurrence and distribution of rare species. The PFBC employs a hierarchical system to categorize the vulnerability of rare fishes, identifying them as "species of special concern". "Endangered" fishes are those facing imminent extinction; "threatened" species exist in such small numbers throughout their range that they may become endangered; and, "candidate" species are so uncommon or restricted in distribution that they may become endangered or threatened in the foreseeable future (Argent et al. 1998, Argent et al. 2000).

The buffalo, redhorse, and carpsucker catastomid assemblage was treated as a complex (BRC) since it represents an integral component of large river ichthyofauna occupying several trophic levels and including a number of species of special concern (Argent et al. 2000). Species richness and relative abundance among the contiguous navigational pools were integrated into the index of community diversity (H') for comparison (Hunter 1990).

RESULTS

The combined sampling paradigms implemented on the Monongahela River mainstem yielded 32,999 fishes representing 14 families and 64 species/hybrids, while 6,825 fishes representing 10 families and 51 species/hybrids were collected by backpack and boat electrofishing from its tributaries (Table 2). Several hatchery-reared salmonids were also collected, but were excluded from consideration as they represent incidental rather than resident components of the ichthyofauna. Twenty-two species were captured only from the Monongahela mainstem, while 11 were unique to its tributaries and thirty-nine were cosmopolitan. Members of the families Ictaluridae and Cyprinidae dominated mainstem communities (Kimmel and Argent 2006c, Lorson and Smith 2004), while the Pericdae and Cyprinidae were prevalent in the tributaries (Kimmel and Argent 2005).

Among the mainstem pools, Maxwell supported the highest species richness (Table 2), likely due to its greatest overall length and tributary network. Redbreast sunfish (*Lepomis auritus*) and black crappie (*Pomoxis nigromaculatus*) were unique to collections from the Maxwell pool; redear sunfish (*Lepomis microlophus*) was unique to the Braddock pool; and white crappie (*Pomoxis annularis*), muskellunge (*Esox masquinongy*), and spottail shiner (*Notropis hudsonius*) were unique to the Gray's Landing pool. Overall, eight members of the BRC complex including two species designated as recently extirpated from Pennsylvania (Argent et al. 1998), the river (*Carpiodes carpio*) and highfin carpsuckers (*Carpiodes velifer*) were ubiquitous.

Ichthyofaunal species richness of the individual tributaries ranged from 0 to 24 (Table 3; Kimmel and Argent 2006a), a likely direct result of widespread point and non-point source pollution (Kimmel and Argent 2006b). Rainbow darter (*Etheostoma caeruleum*) was ubiquitous within the tributary fauna and dominated the catch in many streams (Kimmel and Argent 2005). Other common tributary fishes included the emerald shiner (*Notropis atherinoides*), bluntnose minnow (*Pimephales notatus*), mimic shiner (*Notropis volucellus*), blacknose dace (*Rhinichthys atratulus*), and creek chub (*Semotilus atromaculatus*) (Kimmel and Argent 2005). We collected two species of special concern – the river redhorse from Redstone Creek and Tenmile Creek and the silver chub from Tenmile Creek and Dunkard Creek.

Boat electrofishing, concentrated in the dam tailrace areas, captured the highest species richness, followed by chemical sampling, benthic trawling, and gillnetting. Four species, including three that are species of special concern, were taken only by chemical sampling – brook silverside (*Labidesthes sicculus*), ghost shiner, skipjack herring (*Alosa chrysochloris)*, and redbreast sunfish (Table 2). Relatively few new species were added to the inventory by the latter two methods. However, bottom-dwellers such as the channel shiner (*Notropis wickliffi*) and fantail (*Etheostoma flabellare*) and banded (*Etheostoma zonale*) darters were taken only by benthic trawling (Argent and Kimmel 2007), while highfin carpsucker and black buffalo, species currently not recognized as part of Pennsylvania's ichthyofauna, were collected only by gillnetting (Kimmel and Argent 2006c).

DISCUSSION

The current ichthyofauna of the Monongahela River basin in Pennsylvania as summarized here numbers 75 species. Included are 10 species of special concern – one species previously undocumented (black buffalo) and two species considered recently extirpated (river and highfin carpsuckers). This recolonization occurred over a rather short period of about 40 years driven by continuing improvements in water quality (Anderson et al. 2000, Thomas et al. 2005).

As recently as the mid-1980's, Cooper (1985) considered as extirpated – the paddlefish, skipjack herring, and mooneye (*Hiodon tergisus*); as endangered – smallmouth buffalo, silver chub, and ghost shiner, as vulnerable – spotted bass (*Micropterus punctulatus*), channel darter, and freshwater drum (*Aplodinotus grunniens*); and, as status undetermined – longnose gar and river redhorse. Only fifteen years later, Argent et al. (2000) updated Cooper's (1985) tiered listing using criteria developed by the Pennsylvania Fishes Technical Committee for its species of special concern and adopted by the PFBC (Argent et al. 1998). As a result, silver chub and ghost shiner are designated as endangered; skipjack herring, mooneye, smallmouth buffalo, and channel darter as threatened; and longnose gar, river redhorse, and brook silverside as candidate. The combined surveys summarized

Table 2. Ichthyofauna of six contiguous Monongahela River navigation pools and their tributaries. No tributaries were sampled from the WV/PA border to Point Marion Lock and Dam. 1 = Braddock, 2 = Elizabeth, 3 = Charleroi, 4 = Maxwell, 5 = Gray's Landing, 6 = Point Marion, Y = mainstem only, X = tributary only, Z = collected in mainstem and tributary, E = endangered, T = threatened, C = candidate, RX = recently extirpated, NL = unlisted, and R = recovering through propagation (Argent et al. 1998, Argent and Kimmel 2007).

Taxon	1	2	3	4	5	6
Atherinidae						
Labidesthes sicculus (brook silverside)[C]		Y	Y	Y		
Catastomidae						
Carpiodes carpio (river carpsucker)[RX]	Z	Y	Y	Y	Y	Z
C. cyprinus (quillback)	Y	Y	Z	Z	Z	Z
C. velifer (highfin carpsucker)[RX]		Y	Y	Y		
Catostomus commersoni (white sucker)	X	X	X	X	X	
Hypentelium nigricans (northern hogsucker)			X	Z	X	
Ictiobus bubalus (smallmouth buffalo)[T]	Y	Y	Y	Y	Y	Y
I. niger (black buffalo)[NL]	Z			Y	Y	
Moxostoma anisurum (silver redhorse)	Z	X	X	X	Z	Y
M. breviceps (shorthead redhorse)	Y		Z		Y	
M. carinatum (river redhorse)[C]	Y		Z	Z	Y	Y
M. duquesnei (black redhorse)			Z	Y	Z	
M. erythrurum (golden redhorse)	Y	Y	Z	Z	Z	Y
Centrarchidae						
Ambloplites rupestris (rock bass)	Z	Z	Z	Z	Z	Y
Lepomis auritus (redbreast sunfish)				Y		
L. cyanellus (green sunfish)		X	Z	Z	Z	Y
L. gibbosus (pumpkinseed)		Z	Z	Y	Y	
L. hybrid (sunfish hybrid)		X	Z	X		
L. macrochirus (bluegill)	Z	Z	Z	Z	Z	Y
L. microlophus (redear sunfish)	Y					
Micropterus dolomieu (smallmouth bass)	Z	Z	Z	Z	Z	Y
M. punctulatus (spotted bass)	Z	Z	Z	Z	Z	Y
M. salmoides (largemouth bass)	Z	Z	Z	Z	Y	Y
Pomoxis annularis (white crappie)					Y	
P. nigromaculatus (black crappie)				Y		
Clupeidae						
Alosa chrysochloris (skipjack herring)[T]	Y			Y	Y	
Dorosoma cepedianum (gizzard shad)	Z	Y	Z	Z	Y	Y
Cottidae						
Cottus bairdi (mottled sculpin)					X	
Cyprinidae						
Campostoma anomalum (central stoneroller)		X	X	X		
Cyprinella spiloptera (spotfin shiner)	Z	Z	Z	Z	X	
Cyprinus carpio (common carp)	Z	Z	Z	Z	Z	Y
Luxilus chrysocephalus (striped shiner)	X			X	X	
L. cornutus (common shiner)		X	X	X		
Macrhyboposis storeriana (silver chub)[E]		Y	Y	Z	Z	
Nocomis micropogon (river chub)			X	X		
Notemigonus crysoleucas (golden shiner)				X	Y	

(continued)

Table 2 (continued)

N. atherinoides (emerald shiner)	Z	Z	Z	Z	Z	Y
N. buchanani (ghost shiner)[E]	Y			Y	Y	
N. hudsonius (spottail shiner)					Y	
N. rubellus (rosyface shiner)	X	X	X	X	X	
N. stramineus (sand shiner)				Z	X	
N. volucellus (mimic shiner)	Z	Z	Z	Z	Z	Y
N. wickliffi (channel shiner)	Z	Z	Z	X	Z	Y
Pimephales notatus (bluntnose minnow)	Z	Z	Z	Z	Z	Y
Rhinichthys atratulus (blacknose dace)	X	X	X	X	X	
Semotilus atromaculatus (creek chub)	X	X	X	X	X	
Esocidae						
Esox hybrid (tiger muskellunge)		Y		Y	Y	
E. niger (chain pickerel)			Y	Y		
E. masquinongy (muskellunge)					Y	
Hiodontidae						
Hiodon tergisus (mooneye)[T]	Y	Y	Y	Y	Y	
Ictaluridae						
Ameiurus natalis (yellow bullhead)			X	Z	Z	
Ictalurus punctatus (channel catfish)	Y	Y	Z	Z	Z	Y
Noturus flavus (stonecat)				X	X	
Pylodictis olivaris (flathead catfish)	Y	Y	Y	Y	Y	Y
Lepisostidae						
Lepisosteus osseus (longnose gar)[C]	Y	Y	Y	Y	Y	Y
Percichthyidae						
Morone americana (white perch)	Y			Y		
M. chrysops (white bass)	Y	Y	Y	Z	Y	Y
M. hybrid (hybrid striped bass)	Y	Y	Y	Y	Y	Y
Percidae						
Etheostoma blennioides (greenside darter)	Y	Y	Z	Z	X	
E. caeruleum (rainbow darter)	Z	X	Z	Z	Z	Y
E. flabellare (fantail darter)		Z	X	X		
E. nigrum (johnny darter)	Z	Z	Z	Z	Z	Y
E. variatum (variegate darter)				X	X	
E. zonale (banded darter)	Y	Y	Y	Y	X	
Perca flavescens (yellow perch)		Y	Y	Y	Z	
Percina caprodes (logperch)	Z	Z	Z	Z	Z	Y
P. copelandi (channel darter)[T]	Y	Y	Y	Y	Y	Y
Sander canadensis (sauger)	Z	Y	Y	Z	Y	Y
S. hybrid (saugeye)	Y	Y	Y	Y	Y	Y
S. vitreus (walleye)	Y	Y	Y	Y	Y	Y
Polyodontidae						
Polyodon spathula (paddlefish)[R]		Y		Y	Y	
Salmonidae						
Oncorhynchus hybrid (palamino trout)		Y				
O. mykiss (rainbow trout)			Y			
Salvelinus fontinalis (brook trout)				X		
Scianidae						
Aplodinotus grunniens (freshwater drum)	Z	Y	Y	Y	Y	Y

here greatly expand the presence and distribution of these species of special concern and suggest possible reclassification of smallmouth buffalo, longnose gar, and channel darter. Only the paddlefish, among the above, is not considered self-sustaining and is the subject of a significant re-introduction by the PFBC in the Allegheny River and the Ohio River that should provide colonizers to the Monongahela River (Lorson 1991, Argent and Kimmel 2006).

Likely sources of recolonizers are the lower Allegheny River and the Ohio River, which would indicate an upstream movement through the lock and

Table 3. Summary of tributaries sampled with backpack and boat electrofishing gear. A = acid mine drainage; B = net alkaline mine drainage; C = sewage.

Pool name	Stream name	Stream order	Species richness	Major stressor(s)
Braddock	Turtle Ck.	5	9	B,C
Braddock	Sandy Ck.	2	3	C
Braddock	Peters Ck.	4	6	
Braddock	Wylie R.	3	3	
Braddock	Fallen Timber Ck.	3	13	
Elizabeth	Lobbs R.	3	5	
Elizabeth	Perrymill R.	3	2	
Elizabeth	Bunola R.	2	4	
Elizabeth	Huston R.	2	0	
Elizabeth	Mingo Ck.	3	21	
Charleroi	Pigeon Ck.	3	13	
Charleroi	Sunfish R.	2	10	B
Charleroi	Pike R.	3	23	
Charleroi	Little Redstone Ck.	4	11	B
Charleroi	Maple Ck.	2	10	
Charleroi	Lilly R.	2	5	
Charleroi	Redstone Ck.	5	21	B,C
Charleroi	Dunlap Ck.	4	17	C
Charleroi	Kelley R.	1	8	
Charleroi	Meadow R.	2	1	B
Charleroi	Barneys R.	2	7	
Maxwell	Fishpot R.	3	14	
Maxwell	Tenmile Ck.	5	23	
Maxwell	Bates R.	2	3	
Maxwell	Rush R.	2	7	
Maxwell	Pumpkin R.	3	4	
Maxwell	Neel R.	2	14	
Maxwell	Muddy Ck.	4	24	
Maxwell	Wallace R.	3	7	C
Maxwell	Antram R.	2	4	
Maxwell	Middle R.	3	6	B
Maxwell	Browns R.	3	0	B,C
Maxwell	Little Whiteley Ck.	3	5	
Maxwell	Whiteley Ck.	4	14	
Maxwell	Cats R.	3	0	A
Gray's Landing	Jacobs Ck.	3	0	A
Gray's Landing	Georges Ck.	4	8	B
Gray's Landing	Dunkard Ck.	5	16	B

dam structures concomitant with improving water quality (Preston and White 1978, Pearson and Krumholz 1994, Koryak and Hoskin 1994, Thomas et al. 2005). Although daily operation of these locks can significantly alter hydrologic conditions, fish passage may freely occur (Holland et al. 1984). Species richness, species diversity, and the faunal contribution of the BRC complex indicate that the recolonizations had been relatively uniform across all navigational pools. The contribution of the BRC to the riverine ichthyofauna may be a useful tool in assessing recovery from environmental insults and/or health due to its importance to the ecosystem and its susceptibility to gillnetting in systematic riverine surveys.

The major tributaries also have experienced severe water quality declines concomitant with the mainstem (Stauffer et al. 1978, Welsh and Perry 1997), and the current disjunct distribution of fishes between the mainstem and its minor tributaries makes these unlikely sources of colonizers. Although 39 species were common to the mainstem and its tributary network, only two of its large-bodied species (>250 mm), the river and silver redhorses (*Moxostoma anisurum*) were collected, coming from the mouths of two major tributaries and upstream in one minor tributary. Therefore, the connectivity among the mainstem and its tributaries may by largely temporal or transitory and restricted to major tributaries at least for the large-bodied ichthyofauna.

Species selectivity of the various gear types as illustrated here indicates the necessity of utilizing a variety of sampling methodologies when inventorying the ichthyofauna of a major river basin, particularly for benthic fishes (Gutreuter et al. 1998, Herzog et al. 2005). Boat electrofishing and chemical sampling, while effective in sampling localized areas, do not provide the profile of longitudinal distribution that can be obtained by sampling with gillnetting and benthic trawling. Effective assessment of tributary ichthyofaunal diversity may require backpack and/or boat electrofishing depending on the size and depth of selected reaches.

While the mainstem water quality is generally good with the exception of occasional consolidated sewer overflow discharges, the opposite is true of many of the small tributaries which continue to receive inputs of untreated sewage and acid and net alkaline mine drainage (Kimmel and Argent 2006b). These tributaries are essentially point-source discharges of pollutants causing localized water quality declines in the mainstem, which have been severely impacted for nearly a century (Ortmann 1909). However, the continued recovery of the Monongahela River basin may hinge on the potential rupture of flooded abandoned underground mines (Ziemkiewitz et al. 2004), which could decimate fish populations once again

ACKNOWLEDGEMENTS

Funding for the tributary survey was provided by the U.S. Fish and Wildlife Service through State Wildlife Grants Program Grant T-2 (Contract # WM-6-02 G-0062), administered through the Pennsylvania Came Commission and the Pennsylvania Fish and Boat Commission. Gillnet surveys were funded by the Wild Resources Conservation Program with Grant Agreement WRCP-04019 and benthic trawling studies were funded by the Faculty Professional Development Center at California University of Pennsylvania. We also wish to thank all those who assisted with field collections.

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Received: 4 May 2007 Accepted: 13 July 2007