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Cover Photograph: A non-native *Orconectes rusticus* (rusty crayfish) captured from Schenevus Creek (Otsego County, NY), a tributary of the Susquehanna River. Photograph © by Mark Kuhlmann.

An Evaluation of the Ichthyofauna of the Bronx River, a Resilient Urban Waterway

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Abstract - Fish were sampled from the entire 34.4-km Bronx River each year from 2001 to 2005 inclusive, yielding a database of 4000 fish comprising 23 freshwater species and 22 estuarine species. These data were compared to the historic data from 1936–1998 as recorded in the New York State Department of Environmental Conservation's digital database, Albany, NY. Only 6 freshwater species reported in the historic data—*Rhodeus sericeus* (Bitterling), *Salmo trutta* (Brown Trout), *Semotilus corporalis* (Fallfish), *Esox americanus vermiculatus* (Grass Pickerel), *Etheostoma nigrum* (Johnny Darter), and *Esox lucius* (Northern Pike)—are no longer in the river. However, the original report of the presence of the Johnny Darter probably resulted from taxonomic confusion since this species has never been in the Hudson Valley, and we strongly believe that the report of the presence of grass pickerel is also the result of misidentification of the specimen for the same reason as given for the johnny darter. The report of the Brown Trout should be discounted since this species has been only taken in the Bronx River following a stocking event. We have found a breeding population of Brown Trout in the southern end of Davis Brook, but these have not yet traversed the multi-channel marsh area to enter the Bronx River proper. Therefore, only three previously reported species—Bitterling, Fallfish, and Northern Pike—are no longer in the river. Four species—*Fundulus diaphanus* (Banded Killifish), *Ameiurus nebulosus* (Brown Bullhead), *Apeltes quadracus* (Fourspine Stickleback), and *Micropterus dolomieu* (Smallmouth Bass)—not reported in the historic database were part of our 2001–2005 freshwater collection. These discrepancies are explained, and on balance, it was determined that for the past 70 years, the Bronx River has been remarkably stable in terms of fish species and diversity. Examination of the estuarine portion of the river shows that it functions as an important nursery ground for many commercial and recreational fish harvested from New York waters.

Introduction

The impact of urbanization on river systems has been well documented (Gerhard et al. 2004, Limburg et al. 2005). As a result of increased amounts of domestic and/or industrial waste, sediment load, and trash, many urban rivers have shown degradation in water quality, decrease in species diversity, and change in the faunal composition over time (Shepp and Cummins 1977). The loss of riparian vegetation, due to the development of roadways and industrial complexes adjacent to waterways, has contributed to increased water temperatures and loss of habitat for fish (Nislow 2005). In recent

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years, significant attention has been focused on the plight of aquatic systems in the face of urban sprawl (Brown et al. 2005). As a result of this attention, many rivers and streams have been designated as primary sites for cleanup and restoration. In 1992, the New York State Department of Environmental Conservation, which is responsible for monitoring the "health" of over 900 rivers and streams throughout the State, incorporated the Bronx River into its monitoring program (Bode et al. 2004).

The Bronx River, a 34.4-km urban river, flows from its current source at Davis Brook, Valhalla, NY, south to its mouth between Clason and Hunts Points on the East River, at the extreme western end of Long Island Sound (Fig. 1). For the first 22.3 km of its course, the river passes through a suburban and lightly urbanized landscape, essentially following the Bronx River Parkway, America's first scenic parkway. In many communities along this 22.3-km reach, the river has been incorporated, by means of small impoundments, into village and town parks. During construction of the Bronx River Parkway, between 1916 and 1925, the river was re-channeled and straightened so that it would parallel the course of the parkway and reduce flooding, which was a significant problem due to the original sinuous course of the river in Westchester County. The last section of the Parkway was begun in 1931 near East 233rd Street in the Bronx and was completed in the fall of 1960, and the section of the river paralleling the parkway in the Bronx was also modified and in places re-channeled. In this last 12.1 km, the river enters New York City and flows through an ever more densely urbanized area. As it enters the city, the river first traverses a section known as the shoelace, with reduced bank forest cover and poor bank stabilization, then proceeds through a restored section known as the Bronx Forest before it enters sequentially the grounds of the New York Botanical Garden (NYBG) and the Wildlife Conservation Society's Bronx Zoo (WCS). In the section of the river within the NYBG and WCS properties, the river flows over three major dams built at their current sites between 1845 and the early 1850s; the 182nd Street Dam, the southern-most of the three, was built in the early colonial period by the De Lancey family (Bolton 1948, Comfort 1906). The northernmost of these, within the grounds of NYBG, is a 2.1-m dam at the Snuff Mill at rkm 7.2 (river mile 4.5), followed by a 4.3-m Twin Dam Complex at rkm 6.3 (river mile 3.9) within the grounds of WCS, and then the river cascades over a 5.5-m dam at the southern end of the WCS property at 182nd Street (rkm 4.8, river mile 3.0). Below this last intact dam, the river becomes tidally influenced and more estuarine as it flows southward, and its banks are heavily urbanized and industrialized.

It was our goal to study the fishes of both the freshwater and estuarine sections of this urban river and to compare its species composition with past reports of ichthyofaunal data for the Bronx River, derived from the Historic Distribution of Inland Fishes of New York State (Carlson 2001), the comprehensive study of the status of fish in New York State (Carlson

and Daniels 2004), and the 1984 report of Bronx River fishes (Schmidt and Samaritan 1984). The historic database (Carlson 2001, Carlson and Daniels 2004) has records for the years 1936, 1954, 1957, 1986, and 1998, and covers the river from rkm 9.0 (river mile 5.6)–rkm 31.7 (river mile 19.7). This database lists a total of 21 species of freshwater fish

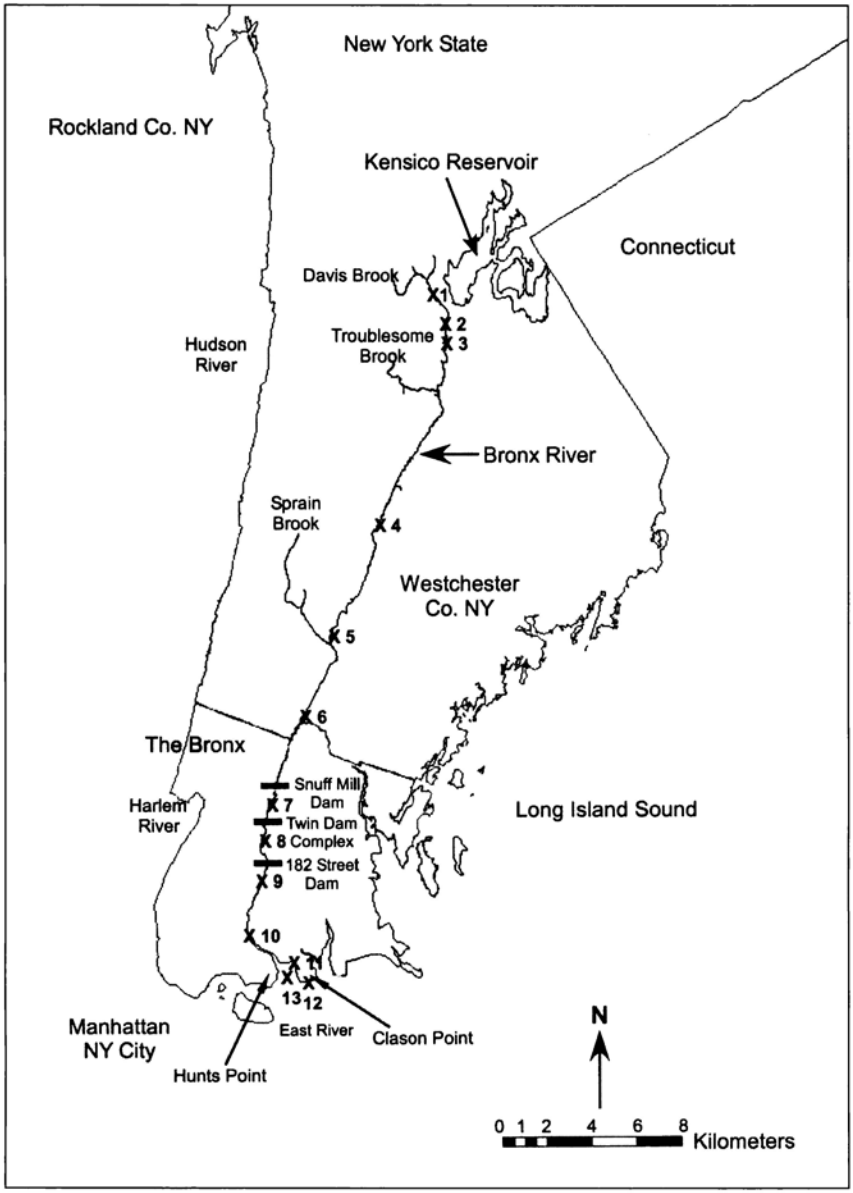

Figure 1. Map of the Bronx River from its source in Davis Brook to its mouth at the East River between Hunts Point and Clason Point, New York, NY. Station locations marked with an X, followed by the station number.

(Table 1). The study by Schmidt and Samaritan (1984) listed a total of 17 species of which only two—*Notropis hudsonius* (Clinton) (Spottail Shiner) and *Cyprinus carpio* Linnaeus (Common Carp)—were not reported in the historic database, bringing the total reported species number for the freshwater reach of the Bronx River to 23. The finding of Spottail Shiner in the Bronx River was first reported in 1982 (Samaritan and Schmidt 1982). Our current study of the ichthyofauna of this river began in 2001, and continued annually through 2005.

Methods

For our sampling protocol, we established a series of stations along the length of the river from its source in Davis Brook to its mouth at buoy markers 5 and 6 between Hunts and Clason Points (Fig. 1). The nine freshwater stations consisted of: Station 1 at Davis Brook (rkm 34.4, river mile 21.4), now the source of the Bronx River; Station 2 (rkm 33.3, river mile 20.7); Station 3 (rkm 31.2, river mile 19.4); Station 4 (rkm 21.9, river mile 13.6); Station 5 (rkm 16.9, river mile 10.5); Station 6 (rkm 12.1, river mile 7.5) at Nereid Avenue at the border between Bronx and Westchester Counties; Station 7 (rkm 6.8, river mile 4.2) within the New York Botanical Garden just south of the Snuff Mill Dam; Station 8 (rkm 6.3, river mile 3.9) within the Wildlife Conservation Society's Bronx Zoo just south of the Twin Dam Complex; and Station 9 (rkm 4.5, river mile 2.8) in the West Farms Section of the river, where the river, being south of the 182nd Street Dam, is tidally influenced but still essentially freshwater. The four estuarine stations were: Station 10 (rkm 1.8, river mile 1.1); Station 11 (rkm 0.3, river mile 0.2), Station 12 at Clason Point (a marine, shore based station in the East River, south of the mouth of the Bronx River); and Station 13, the Federal Channel, which runs from the mouth (rkm 0, river mile 0) north to Station 10. Each of the sampling stations 1–9 was sampled over a length of 150 m at each visit. The distances, north from the mouth of the river, given for each station are at the midpoint of this 150-m run. Stations 10, 11, and 12 were sampled over a 50-m run at each visit; again the distance given is for the midpoint of each sampling run. Station 13, the Federal Channel, was sampled by trawl over the entire 1.8-km distance between the mouth and Station 10 at each sampling event.

Sampling in the freshwater reaches of the river was conducted using 1.22-m^2 fine-mesh (0.32-cm, stretched nylon mesh) seines. On five occasions, one each in March 2005 at Station 5, in May 2005 at Station 6, and in June 2005 at Station 4, and twice in April 2005 at Stations 1 and 5, when conductivity was appropriate, a Smith-Root backpack electro-shocker was employed to supplement the seine sampling. Sampling in the Federal Channel was accomplished using a benthic shrimp trawl, 3.3 m wide with 3.8-cm

stretch mesh #9 nylon body and 3.3-cm stretch mesh #15 nylon cord end (Nylon Net Co., Memphis, TN), operated from the stern deck of a 14.02-m buoy-tender chartered from SUNY Maritime College, Bronx, NY. The net was towed for sequential 10-minute tows at a speed of one knot, traveling both north and south at each sampling visit. Tow line, between the stern deck of the vessel and the "doors" of the net, was 28 m to insure that the net fished at the bottom. The 2.0-m mean low water depth of the Federal Channel is maintained by the US Army Corps of Engineers. Other shore-based stations in the estuary or adjacent East River were sampled using the same seines as in the freshwater reaches of the river, and minnow traps supplemented this sampling; traps were left to soak for 2 hrs. Since each collecting day occupied the same amount of time on station, regardless of which station was being sampled or the gear used, we designated each collection date as a unit of effort and were therefore able to compute "catch per unit effort" to gain a sense of the relative abundance of each species by station (Table 1).

The sampling protocol of our 13 sampling stations was designed so that each station was visited at least once per month during the sampling season. All sampling was conducted between March and September of each year (2001–2005) to be consistent with and overlap the sampling periods in the historic data base (Carlson 2001, Carlson and Daniels 2004) for the Bronx River. These periods in the historic data base were: July, for the 1936 data at rkm 10.0–31.7; July, for the 1954 data at rkm 31.1; June–July, for the 1957 data at rkm 24.8–31.1; September, for the 1986 data at rkm 22.1–31.1; and September, for the 1998 data at rkm 9.0–27.8. All of the New York State historic data (Carlson 2001, Carlson and Daniels 2004) for the Bronx River are presented as species presence in our Table 1.

Results

From 2001 through 2005, we documented a total of 4000 fish comprising 23 species from the freshwater section and 22 from the estuarine section (Table 1), for a total of 45 species; two species, *Apeltes quadracus* (Mitchill) (Fourspine Stickleback) and *Fundulus heteroclitus* (Linnaeus) (Mummichog) were found in both zones. We do, however, know that *Anguilla rostrata* (Lesueur) (American Eel), being catadromous, would also be in the estuary, although it was not taken by our sampling at Stations 10–13. Not included in Table 1, but for completion, we mention that one specimen each of *Alosa aestivalis* (Mitchell) (Blueback Herring), in December 2002, and *Alosa mediocris* (Mitchell) (Hickory Shad), in October 2002, were taken by hook and line at Hunts Point just south of the mouth of the Bronx River by local fisherman and deposited in our laboratory collection.

A careful examination of Table 1 shows that of the 23 species of freshwater fish listed, only *Rhodeus sericeus* (Pallas) (Bitterling), *Semotilus corporalis* Mitchill (Fallfish), *Etheostoma nigrum* Rafinesque (Johnny Darter), *Esox*

Table 1. Catch per unit effort for fish species collected from 13 stations in the Bronx River, years 2001–2005, and occurrence of fish species, as reported in the New York State Department of Environmental Conservation's digital database, Albany, NY by year and as collected in this current study, are designated by an X.

	Station designations													Collection years					
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	1936	1954	1957	1986	1998	2001–2005
Ameiurus nebulosus				0.3	1.0				1.0										X
Anguilla rostrata					0.3				9.8								X		X
Apeltes quadracus							2.0	3.3	35.5	0.4			0.1						X
Carassius auratus (L.) (Goldfish)									1.0								X		X
Catastomus commersoii	13.3	30.3	19.0	27.3	34.5	7.0		12.3						X	X	X	X	X	X
Cyprinus carpio		0.3			0.8		0.7												X
Esox americanus americanus		0.3																	X
E. americanus vermiculatus																X			
E. lucius															X				
Etheostoma nigrum															X				
E. olmstedi	4.7	9.0		27.0	2.0	2.5	6.0	7.5	28.0					X		X	X	X	X
Fundulus diaphanus				0.5	0.5														X
F. heteroclitus				0.3			7.3	6.8	7.0	12.8	0.5	65.6					X	X	X
Gambusia affinis								0.3											X
Lepomis auritus (L.) (Redbreast Sunfish)		6.7		0.5	5.5													X	X
L. gibbosus (L.) (Pumpkinseed)	2.7	0.3		0.3		0.5										X		X	X
L. macrochirus Rafinesque (Bluegill Sunfish)	0.3			0.5				0.5	1.3					X					X
*Luxilus cornutus (*Mitchill)					0.5									X				X	
Micropterus dolomieu	0.7																		X
M. salmoides (Lacépedè) (Largemouth Bass)			2.0	2.3	0.5	0.7	1.0						X			X		X	
Notemigonus crysoleucas (Mitchill) (Golden shiner)			1.0										X			X		X	
Perca flavescens (Mitchill) (Yellow Perch)	0.7	1.0														X			X
Pimephales promelas Rafinesque (Fathead Minnow)				0.5			2.7	0.8										X	X

Table 1, continued.

Species	Station designations													Collection years					
	1	2	3	4	5	6	7	8	9	10	11	12	13	1936	1954	1957	1986	1998	2001–2005
Rhinichthys atratulus	23.3	0.3	25.0	4.8	5.0	2.0	0.3		2.3					X	X	X	X	X	X
Rhodeus sericeus														X					
Salmo trutta	2.0														X	X	X		X
Semotilus atromaculatus (Mitchill)	0.7																X		X
S. corporalis														X					
Anchoa mitchilli (Valenciennes) (Bay Anchovy)										7.7		1.9	0.9						X
Archosargus probatocephalus (Walbaum) (Sheepshead)													0.1						X
Brevoortia tyrannus										11.0			1.0						X
Cynoscion regalis												0.1	0.7						X
Dorosoma cepedianum (Lesuer) (Gizzard Shad)														0.2					X
Gobiosoma bosc										0.4									X
G. ginsburgi													0.1						X
Menidia menidia										55.6	72.8	0.9	1.4						X
Microgadus tomcod										0.1									X
Morone saxatilis										0.8			3.3						X
Myoxocephalus aenaeus (Mitchill) (Grubby)											0.1	0.3							X
Paralichthys dentatus													0.1						X
Peprilus triacanthus (Peck) (Butterfish)													0.3						X
Pholis gunnellus													0.1						X
Pomatomus saltatrix												0.1							X
Prionotus carolinus (L.) (Northern Searobin)														0.1					X
Pseudopleuronectes americanus										3.9	1.0	0.4	1.1						X
Syngnathus fuscus Storer (Northern Piperfish)											0.1								X
Tautogolabrus adspersus										0.1									X
Urophycis regia (Walbaum) (Spotted Hake)														0.3					X

lucius Linnaeus (Northern Pike), and *Esox americanus vermiculatus* Lesueur (Grass Pickerel) were not part of the 2001–2005 collection. But the 2001–2005 collection included *Ameiurus nebulosus* (Lesueur) (Brown Bullhead), fourspine stickleback, *Cyprinus carpio* (Common Carp), *Esox americanus americanus* Gmelin (Redfin Pickerel), *Fundulus diaphanus* (Lesueur) (Banded Killifish), *Gambusia affinis* (Baird and Girard) (Western Mosquitofish), and *Micropterus dolomieu* Lacépède (Smallmouth Bass), which are absent from the historic database. The estuarine species listed in Table 1–those collected from Stations 10–13 (Fig. 1)–represent the first time that a species list for the estuarine portion of the Bronx River has been compiled; it includes 22 species. Thus the current total fish species count, both freshwater and estuarine, consists of 45 species with mummichog, fourspine stickleback, and American eel being found in both zones of the Bronx River.

Table 1 also shows the catch-per-unit-effort data for the 2001–2005 collection for both the freshwater and estuarine portions of the river. The southernmost portion of Station 9 (rkm 4.5, river mile 2.8; Fig. 1) represents the northern-most excursion of measurable salinity (0.5 ppt) during summer low-flow periods, although the tidal pulse is felt as far north as 180th Street (rkm 4.7, river mile 2.9) during spring tides (Larson et al. 2004, Rachlin 2005). These "catch-per-unit-effort" data provide an indication of the relative abundance of fish species by station, and their lateral distribution throughout the system. It can be seen (Table 1) that in the freshwater reaches of the river, *Etheostoma olmstedi* Storer (Tessellated Darter) is the most widely distributed fish with a range extending from Station 1 in the north to Station 9 in the south (Fig 1). The next two most widely distributed species are *Rhinichthys atratulus* (Hermann) (Blacknose Dace), whose range also extends from Station 1 south to Station 9, and Mummichog, which is found from Station 4 (Fig. 1) in the north to and throughout the estuary, except in the Federal Channel (Station 13). All other species have more restricted ranges (Table 1).

By summing the catch-per-unit-effort data for a species across all stations from which that species was collected (Table 1), one gets an estimate of its relative abundance in the river. From the point of view of overall abundance in the river as a whole, *Catostomus commersoii* (Lacépède) (White Sucker) is the most abundant species, followed by *Menidia menidia* (Linnaeus) (Atlantic Silverside), which is restricted to the estuarine portion of the river. Next in abundance is Mummichog, followed in order by Tessellated Darter, Blacknose Dace, and Fourspine Stickleback. None of the other fish species, in either the freshwater or estuarine sections of the river, approach the catch-per-unit-effort values of these species.

Discussion

Examination of the data presented in Table 1 shows a remarkable consistency in the majority of fish species in the Bronx River from the period

1936 through 2005. This would indicate that over this 70-year period, the river, from the point of view of its ichthyofaunal content and diversity, has remained as a relatively resilient aquatic environment in spite of occasional episodes of anthropogenic pollution resulting from combined sewage outflows (CSOs) and industrial spills from the various communities through which the river flows. There are, however, a few species that were present in the historic database, but are no longer found in the river. The first missing species is *Semotilus corporalis* Mitchill (Fallfish), reported in the 1936 collection between rkm 9.98–31.7 (river mile 6.2–19.7), and then disappearing from all subsequent collections. It had been speculated that poor water quality in the Bronx River caused the elimination of this species (Schmidt and Samaritan 1984); however, it is possible, since these fish readily take a fly lure and have been, on occasion, the object of a recreational fishery (Werner 2004), that a relatively marginal population was simply overfished. This explanation has some support since the Bronx River in this region has often been stocked with *Salmo trutta* Linnaeus, (Brown Trout) to support a recreational fly fishery, and these animals (Fallfish) could have been taken along with the trout. Further, we found no meaningful degradation in habitat or water quality (Rachlin 2005) in this stretch of the river to account for the extirpation of this species. Additional support for this idea is the fact that Blacknose Dace have been associated with the same habitats favored by Fallfish and have even been reported to spawn on Fallfish nests (Smith 1985). However, elimination of the Fallfish due to sensitivity to pollutants and/or poor water quality, post 1936, can not be explicitly ruled out. Our data indicate that populations of Blacknose Dace show good representation in the river from Station 1 south to Station 9 (Fig 1, Table 1).

Brown trout reported in the 1954, 1957, and 1986 collections from rkm 22.0–31.1 (river mile 13.7–19.3) were the result of seasonal stocking, and never established themselves as a breeding population in the Bronx River. We did, however, find a breeding population in the southernmost reaches of Davis Brook (Station 1) just south of Valhalla, NY, which is adjacent to the Kensico Reservoir (Fig 1). From here, Davis Brook opens into a multi-channel marsh before coalescing again into a single stream, which at this point is called the Bronx River. This marsh area serves as an effective barrier preventing the downstream migration of the trout. We have never collected any trout south of this marsh area.

The next fish to be considered is the Johnny Darter, reported once in the 1954 collection from rkm 31.1 (river mile 19.3) and never reported again from any section of the Bronx River. This fish, found in streams and rivers of the western drainages in New York State (Smith 1985, Werner 2004), is typically not part of the fauna of the Bronx River. However, the more characteristic Tessellated Darter can easily be confused with the Johnny Darter, especially during the breeding season when the males become quite dark, obscuring the lateral V, W, or X markings used to quickly distinguish

between these two species. Since the Tessellated Darter is common in and ranges throughout the freshwater reaches of the Bronx River, it is reasonable to assume, given the known distribution of the Johnny Darter, that the reported occurrence of this species in the 1954 collection could have resulted from a misidentification.

Equally problematical is the report of Grass Pickerel in the 1957 collection between rkm 24.8 and 31.1 (river mile 15.4–19.3), and our finding of Redfin Pickerel at our Station 2 (rkm 33.3, river mile 20.7) in essentially the same stretch of river. These subspecies of *Esox americanus* Gmelin (Pickerel) are very difficult to tell apart, especially in their juvenile stages, which are the stages captured in both studies. It is quite possible that the 1957 report represents a misidentification; we are reasonably certain of our identification, having used the characteristics discussed by Crossman (1966), Smith (1985), and Werner (2004). Based on Crossman's taxonomic study of Pickerel in eastern North America, using 13 morphological characters and including distribution maps of Redfin Pickerel, Grass Pickerel, and their intergrades (Crossman 1966), it seems very unlikely that Grass Pickerel, which in New York State is found only in the central and western parts of the state, would be, or ever had been, in the Bronx River. There is also some question regarding the taxonomic status of these subspecies and therefore, it is best to simply state that Pickerel is found in this section of the river. The presence of Northern Pike, only reported once in the 1954 collection from the same section of the river as Pickerel, and its absence from all other collections, including our current survey, cannot be explained; nor do we have an explanation for the absence of Spottail Shiner, reported by Schmidt and Samaritan (1984) but not collected by us nor reported in the historic database (Carlson 2001, Carlson and Daniels 2004) for the Bronx River.

The only other fish that has been extirpated from the river is Bitterling. This fish, common in northern Europe and central and northeastern Asia, was probably introduced into the United States in the early 1920s (Smith 1985, Werner 2004); at various times it has been reported from both the Bronx and Sawmill rivers in New York State (Carlson 2001, Schmidt and Samaritan 1984, Smith 1985, Werner 2004). Although reported in the 1936 collection, Schmidt and Samaritan (1984) last reported it from the Bronx River in 1979, and we had collected three specimens from the river at Paxton Avenue (rkm 16.9, river mile 10.5) in 1981. No collections since that date have ever reported finding Bitterling, and one of us (A. Pappantoniou), who has recently collected in the Sawmill River, also reports the absence of Bitterling from that river. This fish requires the presence of a unionid mussel in order to complete its life cycle because it, by obligation, deposits its eggs into the mantle cavity of these mussels (Breeder 1933, Przybylski and Garcia-Berthou 2004). It had been suggested that the assumed "demise" of unionid mussels from the river, due to pollution, might have accounted

for the Bitterling's extinction. Schmidt et al. (1981) speculated that the Bitterling, which was last seen in the Sawmill in 1951, continued to exist as a marginal population in a small 1.2-km stretch of the Bronx River in the vicinity of Paxton Avenue where there were small populations of the unionid mussel *Pyganodon cataracta* (Say), with which the Bitterling had been associated. Since populations of this unionid mussel, specimens of which are quite large (between 7.46–13.87 cm in length), are currently found at an average population density of 1.4 mussels/m^2 in the Paxton Avenue section of the Bronx River just south of its confluence with the Sprain Brook, we believe that the absence of Bitterling cannot be explained by the assumed "absence" of these mussels; instead we suggest that by the late 1950s for the Sawmill and by the late 1980s for the Bronx River, these marginal populations of Bitterling were no longer able to sustain themselves and went extinct in these rivers.

Based on the current presence of a total of 23 species of fish in the freshwater reaches of the Bronx River (Table 1), and the fact that the majority of these species have been part of the historic data base of ichthyofauna for the river since 1936 (Table 1), we conclude that this river has been remarkably stable in terms of its fish species for the past 70 years. The species do represent, for the most part, stress-tolerant forms (Schmidt and Samaritan 1984), which is what one would expect from an urban river flowing through communities with zones of light industry, residential areas, and community parks at various distances from its banks. The presence in our collections of Fourspine Stickleback, Brown Bullhead, Banded Killifish, and Smallmouth Bass, which were not reported in the historic data base (Table 1), do not necessarily represent new introductions into the river. Rather, it likely reflects that the historic database consists of collections made at intermittent times and was not the result of intensive surveys. Our sampling, conducted in each collecting season (March through September) from 2001 to 2005, and using a variety of sampling gear, was an intensive survey.

An examination of Table 1 shows a community of 22 marine and estuarine fish species, many of which are important to the commercial and recreational fisheries of New York. Among these are American Eel, *Brevoortia tyrannus* (Latrobe) (Atlantic Menhaden), *Cynoscion regalis* (Bloch and Schneider) (Weakfish), *Microgadus tomcod* (Waldbaum) (Atlantic Tomcod), *Morone saxatilis* (Waldbaum) (Striped Bass), *Paralichthys dentatus* (Linnaeus) (Summer Flounder), *Pomatomus saltatrix* (Linnaeus) (Bluefish), *Pseudopleuronectes americanus* (Waldbaum) (Winter Flounder), and *Tautogolabrus adspersus* (Waldbaum) (Cunner). Since the majority of these species are found in the Bronx River Estuary in their juvenile to young-adult stages, it is clear that this estuary serves as an important nursery ground for these species. If we consider the estuary proper to begin just south of Drew Garden (rkm 4.34, river

mile 2.7) at the southern end of Station 9 (Fig 1), and to extend south to the river's mouth on the East River, then our sampling stations from Station 10 (rkm 1.8, river mile 1.1) and south including the Federal Channel (Station 13) are in the heart of the estuary. Catch-per-unit-effort data (Table 1) shows that the most abundant species in the estuary are Atlantic Silverside and Mummichog, both of which serve as a food resource for many of the commercially and recreationally important fish species listed above. Among the least abundant species in the estuary were *Gobiosoma bosc* (Lacépède) (Naked Goby), *Gobiosoma ginsburgi* Hildebrand and Schroeder (Seaboard Goby), *Paralichthys dentatus* (Summer Flounder), *Pomatomus saltatrix* (Bluefish), and *Pholis gunnellus* (Linnaeus) (Rock Gunnel). The low values for Summer Flounder and Bluefish can be explained by the fact that these are seasonal migrants into the area, and both of these species were taken only at Clason Point and in the Federal Channel near the mouth of the river. The Seaboard Goby was also taken from the Federal Channel, but was found in tires brought up by our trawl net, and thus are easily missed. The Rock Gunnel also was taken in the Federal Channel, and the Naked Goby was collected by seine at Station 10. These last two species represent first records for their presence in the Bronx River Estuary, and as such, the specimens have been forwarded to the ichthyological collection at the New York State Museum at Albany for cataloging; their catalogue numbers are NYSM 57943 for Naked Goby, and NYSM 58903 for Rock Gunnel.

Together, the total of 45 fish species throughout the entire extent of the Bronx River and its estuary justifies the continuing efforts of organizations in the Bronx and Westchester counties to continue their efforts to clean its shoreline and banks, and to mitigate the introduction of contaminants from combined sewage and storm water outflows, as has been the goal and involvement of organizations such as the Bronx River Alliance, other local NGOs, New York City's Department of Environmental Protection, New York State's Department of Environmental Conservation and the Office of the Attorney General of the State of New York. So far these efforts have proven to be remarkably successful (Bode et al. 1999, Larson et al. 2004, Rachlin 2005). This success and the use of the river's fish fauna as the object of a recreational fishery, especially for youngsters, provides the various communities along its banks with a sense of ownership, and argues well for this urban river's continued improvement in terms of water quality and visual appearance.

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Literature Cited

Bode, R.W., M.A. Novak, L.E. Abele, and D. Carlson. 1999. Biological stream assessment: Bronx River, Bronx and Westchester Counties, New York. New York State Department of Environmental Conservation, Albany, NY.

Bode, R.W., M.A. Novak, L.E. Abele, D.L. Heitzman, and A.J. Smith. 2004. 30-year trends in water quality of rivers and streams in New York State based on macroinvertebrate data 1972–2002. Technical Report, New York State Department of Environmental Conservation, Albany, NY.

Bolton, R., Jr. 1948. History of The County of Westchester, From its First Settlement to the Present Time. Alexander S. Gould Press, New York, NY.

Breeder, C.M., Jr. 1933. *Rhodeus amarus* spawning in American mussels. Copeia 1933:147–148.

Brown, L.R., R.H. Gray, R.M. Hughes, and M.R. Meador. 2005. Effects of urbanization on stream ecosystems. American Fisheries Society, Symposium 47, Bethesda, MD.

Carlson, D.M. 2001. Historic distribution of inland fishes of New York State. CD-ROM New York State Department of Environmental Conservation, Albany, NY.

Carlson, D.M., and R.A. Daniels. 2004. Status of fishes in New York: Increases, declines, and homogenization of watersheds. American Midland Naturalist 152: 104–139.

Comfort, R. 1906. History of the Bronx Borough: City of New York. North Side News Press, New York, NY.

Crossman, E.J. 1966. A taxonomic study of *Esox americanus* and its subspecies in eastern North America. Copeia 1966:1–20.

Gerhard, P., R. Morales, and S. Molander. 2004. Stream fish communities and their associations to habitat variables in a rain forest in southeastern Brazil. Environmental Biology of Fishes 71:321–340.

Larson, M., D. Sugar, A.R. Brash, B. Tai, and J.W. Rachlin. 2004. Phase 1 final report to Wildlife Conservation Society/NOAA partnership grants: Fish passage needs and feasibility assessment. Wildlife Conservation Society, New York, NY.

Limburg, K.E., K.M. Stainbrook, J.D. Erickson, and J.M. Gowdy. 2005. Urbanization consequences: Case studies in the Hudson River watershed. Pp. 23–37, *In* L.R. Brown, R.H. Gray, R.M. Hughes, and M.R. Meador (Eds.). Effects of Urbanization on Stream Ecosystems. American Fisheries Society, Symposium 47, Bethesda, MD.

Nislow, K.H. 2005. Forest change and stream fish habitat: Lessons from "Olde" and New England. Journal of Fish Biology 67 (Supplement B):186–204.

Przybylski, M., and E. Garcia-Berthou. 2004. Age and growth of European Bitterling (*Rhodeus sericeus*) in the Wieprz-Krzna Canal, Poland. Ecohydrology and Hydrobiology 4:207–213.

Rachlin, J.W. 2005. Final report to Wildlife Conservation Society/NOAA partnership grants: Fish passage needs assessment study. New York, NY.

Samaritan, J.M., and R.E. Schmidt. 1982. Aspects of the life history of a freshwater population of the Mummichog, *Fundulus heteroclitus* (Pisces: Cyprinodontidae), in the Bronx River, New York, USA. Hydrobiologia 94:149–154.

Schmidt, R.E., and J.M. Samaritan. 1984. Fishes of an urban stream: The Bronx River, New York. Northeastern Environmental Science 3:3–7.

Schmidt, R.E., J.M. Samaritan, and A. Pappantoniou. 1981. Status of the Bitterling, *Rhodeus sericeus*, in Southeastern New York. Copeia 1981:481–482.

Shepp, D.L., and J.D. Cummings. 1997. Restoration in an urban watershed: Anacostia River of Maryland and the District of Columbia. Pp. 297–317, *In* J.E. Williams, C.A. Wood, and M.P. Dombeck (Eds.). Watershed Restoration: Principles and Practices. American Fisheries Society, Bethesda, MD.

Smith, C.L. 1985. The Inland Fishes of New York State. New York State Department of Environmental Conservation, Albany, NY.

Werner, R.G. 2004. Freshwater Fishes of the Northeastern United States, Syracuse University Press, Syracuse, NY.

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