Fish Phenology in an Urban Stream

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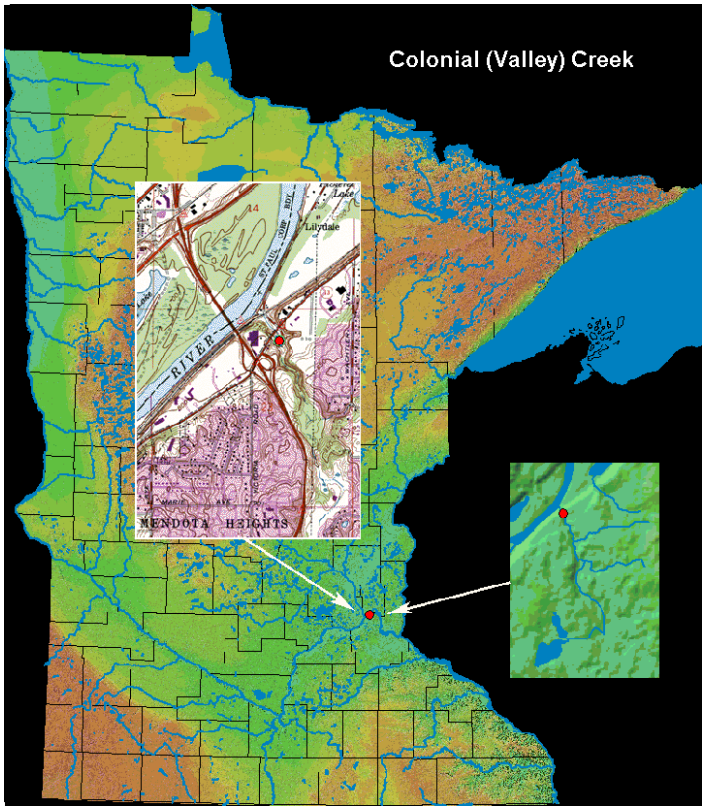
Even under pristine conditions, streams and the life they support lead a dynamic existence. Woody snags come and go with windfall and floods. Streams meander back and forth across floodplains. Spring snow melt swells streams and scours substrates that settle out downstream in constantly shape-shifting riffles, runs, and pools. Beavers dam streams creating ponds and sometimes temporary barriers to fish migration. All are profound habitat-changing events, but nevertheless natural processes functioning in equilibrium of checks and balances. In comparison, urban streams endure tortured lives. The building of homes, businesses, roads, parking lots, and storm sewers in the short-term cause severe erosion, but the long-term "occupation" is an astronomical increase in impervious surface area. The impacts are immense causing flashy streams from snow melt and rain running off roofs and roads. This greatly increases flooding in both frequency and volume along with a Pandora's Box of chemicals and rapidly fluctuating water temperatures. Conversely, groundwater recharge "trickles" from the "capped" surfaces above and the normally life-supporting base flows fade to critical. Finally, some perennial streams perish entirely leaving white, skeletal courses of cobble and boulders. As bleak as this picture paints, nature abhors a vacuum and there are fish communities composed of tolerant and pioneer species that have adapted to these harsh environments where a few "super fishes" actually thrive.

In northern Dakota County only 3.5 miles from downtown St. Paul, a small unnamed creek joins the Mississippi River downstream of the I-35E Bridge. Locally, some residents called it Valley Creek for the deep swath this little stream has cut over several millennia as it descended through the bluffs above the Mississippi River. I had always called it Colonial Creek from an old, tattered map I used to explore the Twin Cities Metro Area. I first learned of the stream's existence riding the school bus in the early 1970s. The route paralleled the stream along I-35E. At that time, the land use was still predominately agriculture and the idyllic valley was pastured with flocks of grazing sheep. However, the winds of change had already been blowing for years. The stream flowed through the blossoming "bedroom community" of Mendota Heights which was ideally located for residents commuting daily to St. Paul. Soon, bulldozers could be seen from the interstate on the far side of the valley carving and leveling lots. Then, frames of houses sprang up one by one and eventually every suitable inch of bluff was developed. The creek's floodplain was "spared" as a city park, but the tributaries draining the bluffs were choked with sand for several years following construction. The pasture disappeared in what seemed like a blink of an eye as Cottonwood trees invaded and soon "filled" the valley hiding the stream and most of the homes under a forest canopy.

The first time I "wet a net" in the creek was in 1975. Most of the stream's length was too narrow or shallow to seine, but we had discovered a culvert pool below County Road 45. I can still picture that sunny spring day, but there is a reason why I remember it so vividly. In the first haul, we scooped up a very frightened Muskrat which lunged from one end of the seine toward an equally frightened collector. The net was tossed in the air as everyone fled the pool and the Muskrat likewise retreated downstream.



Following high school, I followed my heart (and not my head) pursuing a career in natural resources. I found one of the most interesting subjects of my college experience was phenology, which is the study of natural phenomena that recur periodically such as fish and wildlife migrations and their relation to climate and changes in season. A classic example is noting the date when the first Robin arrives every spring. I knew this also applied to fish having witnessed the incredible (although not so universally revered!) spring spawning migrations of Common Carp, Shortnose Gar, White Sucker, and other rough fish. I later read in some "really big books" like George Becker's *Fishes of Wisconsin* that photoperiod (length of day) and water temperature were the triggers for these mass movements, but this knowledge merely whet my appetite for more.

In March 1987, I returned to the culvert pool to begin a weekly phenolog (Schmidt 1988). The term "pool" was a bit of stretch, but it did possess very "stable" dimensions consisting of a concrete apron which encased the stream within vertical walls 42 feet long that tapered from 5 feet wide at the head to 11 feet at the bottom lip. The pool portion of the apron varied dramatically

in length and depth depending on streams flows, but was about 25 feet long and 2 to 4 feet in depth. The downstream end of the apron was a shallow glide 6 to 12 inches deep. A thick blanket of sand covered the concrete floor, but cobble and gravel dominated the riffles, runs, and pools downstream of the culvert pool. The site was one-quarter mile from its confluence with the Mississippi River and descended 45 feet in elevation. The pool created a bottleneck and partial barrier to fish migration due to a sloping culvert pipe that passed under the county road for at least 100 feet. In high flows, the velocity was too great for fish passage, but in low flows, there was barely enough water to "moisten" the bottom of the pipe.

Mary Stefansky

Culvert Pool

The study began in the first of a three-year drought and the worst since the Great Depression of the 1930s. Flows decreased to barely a perceptible trickle until 23 July 1987 when a record 14-inch rainfall drenched the Twin Cities. I attempted a survey a few days later, but the pool was a drowning machine and the roar of the water was deafening. Huge swathes of vegetation, mature trees, and soil had slid en masse down the steep valley walls. The streambed and banks downstream of the culvert had been scoured clean of soil and sand exposing fresh limestone boulders and rubble. The scene and the forces that created it were truly humbling!

In 1988, I switched from weekly to monthly surveys during ice-free seasons until October 1992 when limestone rubble completely buried the pool from a major storm event. I believed the pool was gone forever and did not visit the site in 1993. However in March 1994, I discovered to my surprise the pool had "returned" and I continued the surveys through September 1998. Each survey consisted of the two passes with a push seine along opposite walls of the culvert. All species were sorted and tallied; however, in 1998 data was restricted to species presence. Water temperatures were recorded in Fahrenheit degrees and comments noted water clarity, change in substrates, recent storm events, and the reproductive status and general health of species sampled.

From 1987-1998, the site was sampled 97 times chalking up an impressive list of 32 species in 10 families (Table 1). In addition to these results, a Johnny Darter (*Etheostoma nigrum*) was sampled in 1985 and Smallmouth Bass (*Micropterus dolomieu*) in 1986 with "pull" seines; Hornyhead Chub (*Nocomis biguttatus*) in 1994 with minnow traps; and Bigmouth Shiner (*Notropis dorsalis*) in 1999 with a backpack electroshocker. Noteworthy "significant finds" include the Finescale Dace, Blacknose Shiner, and Banded Killifish. One Finescale Dace (see image page 15) was collected on 29 April 1997 and three on 20 April 1998. These occurrences pushed the known distribution of the species in Minnesota 23 miles farther south than previously reported. One Blacknose Shiner was sampled on 29 May 1995 and again on 28 May 1996. One Banded Killifish was sampled on 16 May 1991, 31 May 1997, and 29 June 1997. Both species are still present in a handful of metro area lakes, but have been reduced to a fraction of their pre-World War II distribution.

Konrad Schmidt

Blacknose Shiner

Konrad Schmidt

Banded Killifish

Most phenological events are not as black and white as the swallows of San Juan Capistrano, which depart and arrive on the same day each year. Fish in the culvert pool showed both strong and weak cyclic patterns and I admit my interpretation at times was arbitrary and subjective. The monthly data showed seasonal patterns in presence and the frequency each species was sampled. Green Sunfish, Fathead Minnow, Blacknose Dace, and Creek Chub were present at least once every month from March-November (Table 1). However, on a frequency basis, Green Sunfish was present in 100% of the June, August, and September surveys. Fathead Minnow was always present in May and June surveys. Black Bullhead, White Sucker, Brook Stickleback, Pumpkinseed, Bluegill, and Golden Shiner made appearances 8 of 9 months, but the Brook Stickleback was never present in November while the rest were never present in March.

Other species exhibited patterns of early, mid- and late- season occurrence. Again these are arbitrary delineations and species only found once or twice suggest a very weak pattern at best. "Early season" species vanish after July and include Central Mudminnow, Iowa Darter, Banded Killifish, and perhaps, Finescale Dace, Blacknose Shiner, and Common Shiner. Mid-season species (April-September) include Yellow Perch, Yellow Bullhead, Orange-spotted Sunfish, and maybe, Northern Pike, Walleye and Black Crappie. Late season species (June-November) include Common Carp, Largemouth Bass, and possibly, Emerald Shiner, Bluntnose Minnow, and Gizzard Shad. Split-season species are present in two time periods which are interrupted by at least one month of absence. These include the Central Stoneroller (absent June-August), Brassy Minnow, and perhaps Brown Bullhead which were both absent in July.

Water temperature and photoperiod have been mentioned previously as key factors why species migrate in and out of habitats on a seasonal cyclic basis. This also applies to species diversity in the culvert pool. In March, when the average water temperature was 35° F, only six species in four families were collected. Diversity tripled to 18 in April (50° F) and peaked at 21° F (8 families) in June (63° F). I expected a rapid drop in diversity after the peak when most of the initial spawning should have ended. However, diversity remained at 20 species through September (57° F) before finally dropping off to 12 species in November (42° F).

The long, severe drought that began in 1987 and lasted into early 1990 severely impacted the pool community in several ways. Low and no flows disrupted stream connectivity preventing fish from moving into preferred seasonal habitats. The pool shrank in depth, area, and volume, which reduced the habitat's carrying capacity. This caused fish abundance to decline from poor water quality, disease, and predators from within and outside the pool. In 1989, diversity hit bottom in both species (7) and families (4) which contrasts with the maximum diversity of 23 species and 8 families in 1997. The total annual catch of all species declined to record lows of 332 in 1988 and 406 in 1989 which pales to the average annual catch of 1,821 fish from 1987-1997 and maximum catch of 4,376 fish in 1987. Seven species present in 1987 vanished from 1988-1989, but six returned in 1990 and White Sucker in 1991. The Black Bullhead hung on through the drought, but declined in sampling frequency from 71% in 1987 to 11% in 1988. The Green Sunfish was the most drought-resistant species, declining to only 63% in 1989. The Blacknose Dace initially appeared even more tolerant maintaining frequencies in the high 80s through the worst of the drought, but disappeared in 1990 and never fully recovered during the remainder of the study.

I have not surveyed the pool in over a decade, and wonder how much longer the species list would have been if I had continued and what other phenological events may have surfaced. Dusting off the data to write this article has reignited my curiosity and I must return soon to reconnect with an old friend.

References

Becker, G. C. 1983. Fishes of Wisconsin. University of Wisconsin Press. Madison, WI. 1052 pp.

Schmidt, K. P. 1988. The Phenology of Colonial Creek. American Currents. July-Oct. pp 22-25.

Images on pages 28 and 30 provided by Konrad Schmidt

Green Sunfish

Central Mudminnow

Female Brook Stickleback

Table 1. Times Sampled and Percent Frequency of Species in Monthly Surveys of Colonial (Valley) Creek.

Species	**Times (X) Sampled 1987-1998**	X Sampled (Mar)	% Frequency (Mar)	X Sampled (Apr)	% Frequency (Apr)	X Sampled (May)	% Frequency (May)	X Sampled (Jun)	% Frequency (Jun)	X Sampled (Jul)	% Frequency (Jul)	X Sampled (Aug)	% Frequency (Aug)	X Sampled (Sep)	% Frequency (Sep)	X Sampled (Oct)	% Frequency (Oct)	X Sampled (Nov)	% Frequency (Nov)
Black Bullhead *Ameiurus melas*	**61**			3	18	9	69	9	75	11	92	11	92	11	92	6	60	1	25
Yellow Bullhead *Ameiurus natalis*	**7**							2	17	3	25	1	8	1	8				
Brown Bullhead *Ameiurus nebulosus*	**2**							1	8			1	8						
Central Stoneroller *Campostoma anomalum*	**7**			1	6	2	15							2	17	1	10		
White Sucker *Catostomus commersonii*	**33**			5	29	6	46	4	33	4	33	4	33	6	50	3	30	1	25
Northern Redbelly Dace *Chrosomus eos*	**28**			6	35	10	77	7	58	3	25	1	8	1	8				
Finescale Dace *Chrosomus neogaeus*	**2**			2	12														
Brook Stickleback *Culaea inconstans*	**48**	5	100	14	82	13	100	7	58	3	25	1	8	2	17	3	30		
Spotfin Shiner *Cyprinella spiloptera*	**9**					1	8					1	8	4	33	2	20	1	25
Common Carp *Cyprinus carpio*	**16**							1	8	4	33	5	42	4	33	1	10	1	25
Gizzard Shad *Dorosoma cepedianum*	**1**													1	8				
Northern Pike *Esox lucius*	**2**									1	8	1	8						
Iowa Darter *Etheostoma exile*	**7**			3	18	3	23	1	8										
Banded Killifish *Fundulus diaphanus*	**3**					2	15	1	8										
Brassy Minnow *Hybognathus hankinsoni*	**17**			5	29	6	46	4	33			1	8	1	8				
Green Sunfish *Lepomis cyanellus*	**77**	1	20	6	35	12	92	12	100	11	92	12	100	12	100	8	80	3	75
Pumpkinseed *Lepomis gibbosus*	**42**			2	12	6	46	3	25	4	33	9	75	9	75	7	70	2	50
Orangespotted Sunfish *Lepomis humilis*	**7**					1	8	3	25	1	8	2	17						
Bluegill *Lepomis macrochirus*	**48**			2	12	3	23	7	58	6	50	10	83	10	83	7	70	3	75
Hybrid Sunfish *Lepomis* hybrid	**29**			1	6	4	31	6	50	6	50	6	50	4	33	2	20		
Common Shiner *Luxilus cornutus*	**1**			1	6														
Largemouth Bass *Micropterus salmoides*	**34**							4	33	6	50	9	75	8	67	5	50	2	50
Golden Shiner *Notemigonus crysoleucas*	**17**			3	18	4	31	2	17	1	8	2	17	2	17	2	20	1	25
Emerald Shiner *Notropis atherinoides*	**1**													1	8				

Table 1 Continued. Times Sampled and Percent Frequency of Species in Monthly Surveys of Colonial (Valley) Creek.

Species	Times (X) Sampled 1987-1998	X Sampled (Mar)	% Frequency (Mar)	X Sampled (Apr)	% Frequency (Apr)	X Sampled (May)	% Frequency (May)	X Sampled (Jun)	% Frequency (Jun)	X Sampled (Jul)	% Frequency (Jul)	X Sampled (Aug)	% Frequency (Aug)	X Sampled (Sep)	% Frequency (Sep)	X Sampled (Oct)	% Frequency (Oct)	X Sampled (Nov)	% Frequency (Nov)
Blacknose Shiner *Notropis heterolepis*	**2**					2	15												
Yellow Perch *Perca flavescens*	**18**			4	24	4	31	4	33	3	25	2	17	1	8				
Bluntnose Minnow *Pimephales notatus*	**1**															1	10		
Fathead Minnow *Pimephales promelas*	**75**	4	80	16	94	13	100	12	100	9	75	6	50	7	58	6	60	2	50
Black Crappie *Pomoxis nigromaculatus*	**1**									1	8								
Blacknose Dace *Rhinichthys atratulus*	**41**	2	40	8	47	9	69	6	50	6	50	4	33	2	17	2	20	2	50
Walleye *Sander vitreus*	**2**									2	17								
Creek Chub *Semotilus atromaculatus*	**49**	1	20	6	35	6	46	7	58	7	58	9	75	9	75	3	30	1	25
Central Mudminnow *Umbra limi*	**12**	1	20	7	41	1	8	1	8	2	17								
Times Sampled	**97**	5		17		13		12		12		12		12		10		4	
Species Total	**32**	6		18		20		21		20		20		20		16		12	
Family Total	**10**	4		7		8		8		8		7		7		5		4	
Water Temp Average (F)	**54**	35		49		61		64		69		64		57		43		42	

Male Bluntnose Minnow

Male Central Stoneroller

Gizzard Shad

Fish Phenology in an Urban Stream

Finescale Dace

Orangespotted Sunfish

Spotfin Shiner

Iowa Darter