COMMUNITY-BASED WATER QUALITY MONITORING BY THE UPPER OCONEE WATERSHED NETWORK

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Abstract. The Upper Oconee Watershed Network is a nonprofit organization dedicated to protecting streams and rivers by community oriented water quality education, advocacy and monitoring. Presently, community volunteers have collected water quality data on over 150 sites in the Middle and North Oconee Rivers. The purpose of this study was to compile data on visual assessments, physical and chemical analyses (temperature, pH, turbidity, conductivity and dissolved oxygen) and biological measurements (fecal coliform levels and macroinvertebrate indices) from 11 primary sites to evaluate seasonal trends in water quality and to assess the effects of land-use on water quality in the Upper Oconee watershed. Of all parameters tested, biological measurements were the most sensitive indicators of degraded water quality. Seasonally, water temperatures and fecal coliform levels were highest in the summer, whereas dissolved oxygen concentrations were lowest. Turbidity was highest in the spring and winter possibly because of increased rainfall and corresponding runoff during that time. Water quality degradation was more apparent at sites with urban land-uses. Together, these data illustrate the importance of including land-use observations and seasonal biological assessments in community-based water quality monitoring.

INTRODUCTION

Human population growth and land development in drainage basins can substantially impair water quality in streams and rivers. Urbanization resulting in the creation of impervious surfaces, reduced riparian vegetation and increased surface runoff has been associated with alterations in stream hydrology, geomorphology, water and sediment chemistry and aquatic biota (Klein, 1979; Booth 1990; Lenat and Crawford 1994; Schueler 1994; Wallace et al. 1996). Presently, many streams and rivers have not been protected adequately from the adverse effects of urbanization.

Environmental monitoring plays an essential role in watershed protection by identifying sources of stress to aquatic habitats and by ensuring compliance with water quality regulations. Efforts to protect water quality in streams and rivers are often limited by a lack of financial resources to support governmental and academic monitoring programs. In Georgia, many of the state's 3725 river miles have not been surveyed. Recently, volunteer environmental monitoring programs have become a valuable approach for collecting much needed water quality data.

The Upper Oconee Watershed Network (UOWN), formerly known as Athens Community Watershed Project, is a collaborative organization composed of citizens, grassroots organizations, government officials and academic scientists that seeks to improve water quality in Georgia's waterways by community education and participation in stream monitoring (Barfield and Haines, 1999). To date, UOWN has been paramount in collecting water quality data on approximately 150 sites in reference and impaired reaches of the Middle Oconee and North Oconee River basins. The purpose of this study was to compile data collected by UOWN on 11 primary sites in the Upper Oconee watershed to evaluate seasonal trends in water quality and to assess the effects of land-use on a variety of water quality indicators. Indicators that were monitored include visual assessments, physical and chemical analyses (temperature, pH, turbidity, conductivity and dissolved oxygen) and biological measurements (fecal coliform levels and macroinvertebrate indices).

METHODS

Site Selection and Description

The streams sampled in this study were located in the Upper Oconee River basin, Georgia, USA (USGS Cataloging Unit 03070101). Eleven sample sites were selected with a judgement-based sampling design to reflect a range of land uses (i.e., reference, parks, suburban and urban) and to represent wide geographic coverage in the watershed. The majority of sites were located in tributaries that drain into the Middle Oconee or North Oconee rivers. One site was located in the Middle Oconee River.

Measurements and Analyses

Environmental monitoring was conducted in streams on a quarterly basis during the months of April, July and October, 2000 and January, 2001. Visual surveys of land use and habitat quality were taken within ¼ mile of the sites (www.georgialegalwatch.org/cwp). *In situ* measurements of temperature, pH, dissolved oxygen and conductivity were taken with YSI portable field meters. Turbidity was measured either *in situ* or on water samples that were collected and analyzed within 24 hours. Water samples were collected for fecal coliform levels, and were analyzed within 24 hours. Fecal coliform levels were assessed by membrane filtration (APHA et al., 1992). Macroinvertebrates were collected with D-nets or kick seines (1.0 mm mesh size). A variety of habitats (i.e., leaf packs, riffles and pools) were sampled by disturbing substrates and then, invertebrates from these habitats were combined, identified to order and counted. Relative abundances and pollution tolerance values of invertebrates were used to compute a biological index according to GA Adopt-a-Stream protocols (GA DNR, 1997).

RESULTS AND DISCUSSION

Summer and fall water quality monitoring was conducted during base-flow conditions, while spring and winter monitoring was conducted within 48 hours of a rain event. All water quality data are summarized in Table 1.

Visual Assessments

Visual assessments revealed that all streams did not exhibit any obvious signs of degradation such as bank erosion, eutrophication, siltation or reduced riparian vegetation (Figure 1). Visual scores showed some seasonal variation that may be the result of either land alterations or observer bias for different volunteers conducted visual surveys on different dates. The only apparent land use change was at Ben Burton Park where much of the riparian vegetation was removed in January 2001.

Physical/Chemical Analyses

Site and seasonal differences were detected for many physical/chemical measurements. Water temperatures ranged from 5.0°C in the winter to 27.9°C in the summer and were similar among sites. No sites exceeded the water quality standard of 32.0°C (Figure 1). pH showed little seasonal variation and a few sites failed the water quality standard of 6.0 to 8.5 (Figure 1). Future efforts to measure alkalinity at the sites would be beneficial for determining which streams are more sensitive to acidic inputs. Turbidity levels were highest in the winter and spring and many sites failed UOWN's water quality guideline of 25 NTU (Figure 1). These seasonal variations in turbidity are likely the result of increased rainfall and corresponding runoff during the winter and spring. Conductivity levels showed little seasonal variation. Conductivity levels at Brooklyn Creek and Carr's Branch were consistently high and in excess of UOWN's water quality guideline of 80 µs/cm. At Carr's Branch gypsum contamination from a former fertilizer plant may be acting as a point source for dissolved ions. Dissolved oxygen levels were lowest in the summer and at this time one site, Trail Creek, failed the water quality standard of 4.0 mg/L.

Biological Measurements

Of all parameters tested, biological measurements were the most sensitive indicators of degraded water quality (Figure 1). Several sites exceeded the fecal coliform water quality standard of 400 CFU/100mL, and many of these failures occurred in the summer when warmer temperatures promote bacterial growth. Macroinvertebrate indices indicative of degradation were observed frequently at Carr's Branch, Trail Creek and Brooklyn Creek, all sites in highly developed areas (Figure 2).

CONCLUSIONS

Environmental monitoring is essential for protecting aquatic habitats from the adverse effects of urbanization. UOWN is community-based organization that is committed to collecting high quality data on the condition of Georgia's water resources. Present monitoring efforts suggest that water quality varies seasonally with changes in temperature and rainfall, that certain indicators are more sensitive than others at detecting degraded conditions and that urbanization may be contributing to impairment of waterways in the Upper Oconee watershed (Figure 2). As such, UOWN

Table 1. Water quality in Georgia streams during the spring. summer , fall and winter.

Season	Site ID[a]	Location	Visual Score	Temperature (°C)	pH	Turbidity (NTU)	Conductivity (µs/cm)	Dissolved Oxygen (mg/L)	Fecal Coliform (CFU/100mL)	Biological Index
Spring	MIDO601	McNutt Creek	39	15.5	**5.8**	18.0	37.5	8.20	300	19
	MIDO301	Little Bear Creek	18	19.8	6.1	14.4	41.4	8.25	< 200	32
	MIDO803	Brooklyn Creek	39	17.0	6.4	1.5	**106.1**	8.95	**2500**	**6**
	MIDO701	Call's Creek	52	---	6.2	15.1	43.7	8.70	100	**8**
	MIDO802	Ben Burton Park	42	16.3	6.3	4.5	55.1	9.54	300	20
	MIDO801	Middle Oconee	34	---	6.8	20.3	50.0	---	200	19
	NORO401	Sandy Creek	49	16.0	6.1	14.1	56.9	8.31	200	16
	NORO503	Trail Creek	39	15.8	6.3	12.1	**80.8**	9.05	< 200	**11**
	NORO601	Carr's Branch	25	15.2	6.4	6.9	**710.0**	9.11	< 200	**0**
	NORO602	UGA Golf Course	32	17.4	**5.8**	**50.5**	64.4	7.58	< 200	22
	NORO201	Hardeman Creek	41	15.6	---	11.0	59.4	8.99	< 200	22
Summer	MIDO601	McNutt Creek	31	23.7	6.8	9.0	63.0	---	**13400**	18
	MIDO301	Little Bear Creek	50	21.7	7.0	7.0	44.0	---	**1640**	16
	MIDO803	Brooklyn Creek	40	24.0	6.8	14.0	**115.0**	---	110	**10**
	MIDO701	Call's Creek	39	23.7	6.5	15.0	56.0	---	**1600**	18
	MIDO802	Ben Burton Park	44	23.5	7.0	7.0	73.0	---	**740**	16
	MIDO801	Middle Oconee	26	27.9	7.3	**29.0**	74.0	---	20	19
	NORO401	Sandy Creek	37	26.2	**4.6**	7.0	58.0	6.30	70	25
	NORO503	Trail Creek	26	24.2	6.7	9.0	**82.0**	**3.40**	**> 20000**	**11**
	NORO601	Carr's Branch	26	22.4	**5.8**	4.0	**558.0**	7.30	60	**1**
	NORO602	UGA Golf Course	41	22.0	6.3	7.0	63.0	7.10	230	20
	NORO201	Hardeman Creek	41	20.7	6.5	13.0	51.0	6.20	**600**	23
Fall	MIDO601	McNutt Creek	50	16.2	**5.8**	5.0	59.2	8.39	200	14
	MIDO301	Little Bear Creek	30	16.2	6.5	3.1	42.8	8.70	100	25
	MIDO803	Brooklyn Creek	23	15.8	6.6	7.6	**112.5**	7.63	**980**	**2**
	MIDO701	Call's Creek	46	16.6	6.2	7.0	54.3	6.50	180	12
	MIDO802	Ben Burton Park	33	16.8	**4.5**	3.0	72.7	8.80	< 20	15
	MIDO801	Middle Oconee	30	17.9	6.6	12.5	73.7	9.40	< 20	18
	NORO401	Sandy Creek	44	18.8	6.6	3.0	56.3	7.30	35	18
	NORO503	Trail Creek	41	15.1	6.5	5.0	72.0	6.65	**840**	13
	NORO601	Carr's Branch	30	15.5	6.1	9.7	**836.0**	8.66	170	**1**
	NORO602	UGA Golf Course	38	15.5	6.5	5.4	57.6	6.27	190	**7**
	NORO201	Hardeman Creek	47	15.4	6.2	3.7	48.2	7.40	**600**	21
Winter	MIDO601	McNutt Creek	52	6.2	**5.5**	**28.2**	58.9	11.7	260	17
	MIDO301	Little Bear Creek	40	8.2	**5.6**	5.4	52.9	9.10	45	24
	MIDO803	Brooklyn Creek	29	---	---	---	---	---	---	16
	MIDO701	Call's Creek	31	6.0	6.1	11.5	50.7	11.70	160	20
	MIDO802	Ben Burton Park	29	7.9	**5.9**	**29.2**	**120.7**	11.20	**> 2000**	12
	MIDO801	Middle Oconee	25	5.0	6.1	22.5	**87.5**	11.80	**> 2000**	20
	NORO401	Sandy Creek	45	5.1	7.0	16.2	54.5	12.06	120	25
	NORO503	Trail Creek	28	5.7	7.1	**28.2**	64.0	12.31	**420**	19
	NORO601	Carr's Branch	26	5.8	6.4	11.7	**784.0**	12.03	20	**2**
	NORO602	UGA Golf Course	40	5.2	7.0	**37.0**	60.4	11.51	105	16
	NORO201	Hardeman Creek	45	6.9	7.2	9.5	50.7	11.34	210	23
Values Indicative of Degradation[b]			< 15	> 32.0	<6.0 - 8.5>	> 25.0	> 80.0	< 4.00	> 400	< 11

[a] MIDO = Middle Oconee; NORO = North Oconee

[b] Values are from GA EPD (temperature, pH, dissolved oxygen and biological index), US EPA (fecal coliform) or UOWN.

will continue to support the use of biological indices in monitoring efforts and seek to evaluate further water quality during various flow regimes.

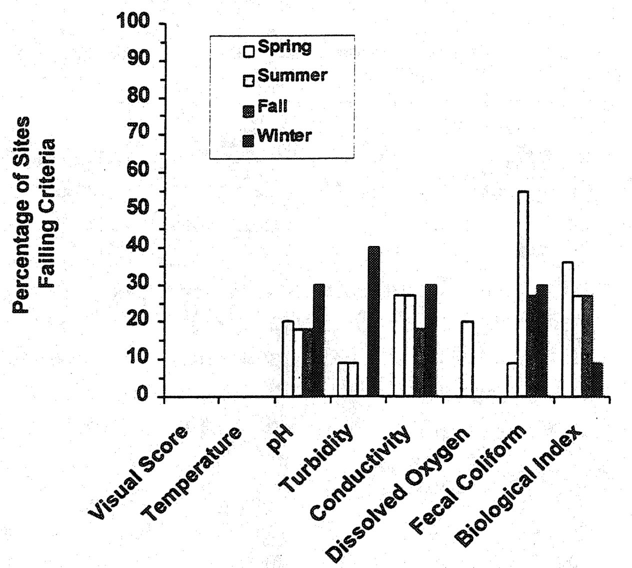

Figure 1. Seasonal patterns in water quality degradation.

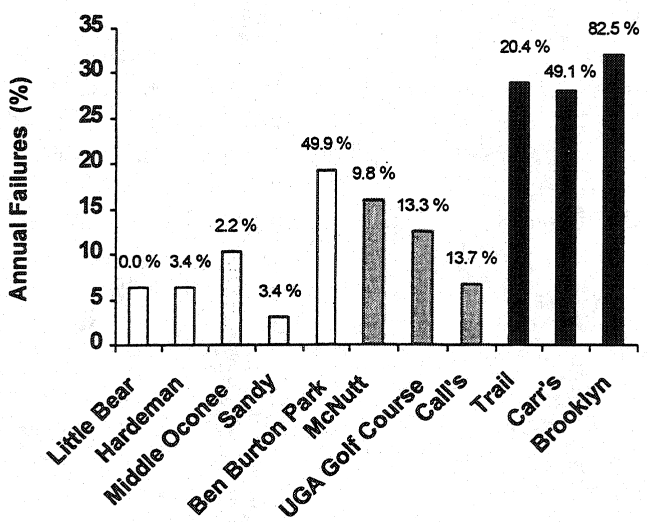

Figure 2. Effects of land use on water quality degradation. Sites are designated as ☐ reference, ▨ parks, ■ suburban or ■ urban based on 1993 MRLC Landsat Thematic Imagery (data labels are % developed land). Failures were computed from (total # of failures among all parameters and all seasons / total # of measurements taken) x 100.

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