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Abstract

Environmnetal data related to water quality of the Caddo River and its tributaries were collected from March - October, 1992, and compared with data from August, 1974 - May, 1975. Bacterial, chemical and physical parameters were investigated at six river locations and thirteen tributary sites. Ammonia, nitrates, soluble phosphorus, turbidity and fecal coliform were signficantly lower, and sodium and postassium were significantly higher in 1992 than during the previous study. Bacterial loading exceeded EPA criteria at some locations during both studies.

Introduction

Environmental data related to water quality of the Caddo River and its tributaries were collected form March - October, 1992, and compared with a previous study from August, 1974 - May, 1975 (Nix et al., 1975). The Caddo River above DeGray Reservoir drains a portion of the southeastern flank of the Ouachita Mountains in southwest Arkansas. There are two wastewater facilities, several chicken houses, a barite mine and septic drainages located on the watershed, as well as non-point sources such as grazing livestock.

In recent years considerable concern has been shown for the quality of Arkansas waterways. In 1989 it was reported that almost one-fourth of the miles of streams in the state have impaired quality due to pollution (Ridlehoover, 1992). This study was directed toward determination of current water quality of the Caddo River system, and elucidation of any changes which have occured in quality since the mid-1970s.

Methods and Materials

Study sites are listed in Table 1. Bacterial parameters included enumeration of total coliforms (TC), fecal coliforms (FC) and fecal streptococci (FS). Chemical and physical parameters included soluble phosphorous, ammonia, nitrates, sulfates, chloride, manganese, sodium, potassium, iron, calcium, magnesium, alkalinity, pH, conductivity and turbidity.

Samples were collected an analyzed according to standard methods (American Public Health Association, 1989). Bacterial analyses were by membrane filtration on mEndo (TC), mFC (FC) and mEnterococcus (FS) media (Difco). A 500 ml raw water sample was collected for testing pH, turbidity, alkalinity and conductivity. Approximately 2 ml of 1:1 hydrochloric acid was added to a 250 ml sample of water for analyses of soluble phosphorus and ammonia. A 175 ml filtered sample was used for analyses of chloride, sulfates and nitrates. A 20 ml sample was acidified with 2 ml of concentrated sulfuric acid for determination of iron, clacium, sodium, potassium, magnesium and manganese.

Table 1. Location of sampling stations for the Caddo River, Arkansas

River Stations	River Tributaries
Black Springs	Beech Creek
Norman	Polk Creek
Caddo Gap	Lick Creek
Glenwood	Huddleston Creek
Amity	Collier Creek
Highway 84	Smith Creek
	Gap Creek
	Mill Creek
	South Fork Caddo River
	Mudlick Creek
	Sweetwater Creek
	Rock Creek
	Caney Creek

The data were analyzed by use of the Statistical Analysis System (SAS). Analysis of variance (ANOVA) was used to evaluate differences in physio-chemical and bacteriological parameters. When significant, Tukey-Kramer tests (Sokal and Rohlf, 1981) were used to determine which locations was different. Two-way ANOVA was used to evaluate variations due to year of sample and location

of sample.

Results and Discussion

Data from the river sites collected during 1992 were averaged and compared to that of 1974-75 (Table 2). Ammonia, nitrates, soluble phosphorus, turbidity and fecal coliform were significantly lower, and sodium and potassium were significantly higher in 1992. Alkalinity and conductivity were significantly higher in the upper river. Previous studies have noted the presence of limestone in the upper watershed, and its absence in the lower reaches of the river (Nix et al., 1975). Therefore, dilution by the tributaries tend to occur in the lower regions of the river.

The means of the physio-chemical and bacteriological parameters measured for the entire river were compared to Enviromental Protection Agency (EPA) quality criteria (EPA, 1986). The values for these parameters were within EPA criteria except for 9% of the samples of fecal coliform.

Table 2. Physio-chemical and bacteriological data from Caddo River stations. *Significant differences between years (0.05 level)

Variable	1992 No. samples	1992 Mean/Std. Dev.	1974-75 No. samples	1974-75 Mean/Std. Dev.
chloride (mg/L)	42	1.77/0.34	na	na
pH	42	7.44/0.30	42	7.38/0.19
ammonia (mg/L)*	42	0.06/0.03	42	0.11/0.06
manganese (ug/L)	42	0.07/0.02	na	na
alkalinity (mg/L)	42	49.0/10.3	42	45.4/10.6
nitrates (mg/L)*	41	0.10/0.07	42	0.17/0.18
conductivity	42	107.0/19.2	42	106.2/29.3
phosphorus (ug/L)*	36	0.02/0.008	42	0.03/0.06
sodium (mg/L)*	42	2.22/0.87	42	1.19/0.34
sulfates (mg/L)	42	5.16/0.67	na	na
potassium (mg/L)*	42	0.92/0.17	42	0.59/0.35
iron (mg/L)	41	0.59/0.19	na	na
calcium (mg/L)	42	16.3/4.45	36	15.19/5.14
magnesium (mg/L)	42	1.81/0.35	30	1.82/0.40
turbidity*	42	2.25/1.20	30	4.30/3.76
FC (cfu/100ml)*	47	58/882	48	861/1202
FS (cfu/100ml)	48	173/380	na	na
TC (cfu/100ml)	35	17312/8390	na	na

na = not available

The data from each specific sampling stie were grouped and compared with EPA recommendation. All chemical and physical parameters were within EPA criteria. However, fecal coliform bacteria surpassed EPA criteria at Black Springs (25% of samples) and at Glenwood (13% of samples) (Table 3).

Table 3. Bacterial data from river stations. EPA criterion for Fecal Coliforms=200/100ml. *Some samples exceeded EPA criterion.

Site	Variable	No. Samples	Mean/Standard Deviation
Black Springs	FC	8	109.125*
	FS	8	165/108
	TC	6	10750/2840
Norman	FC	8	75/48
	FS	8	106/70
	TC	5	18650/6147
Caddo Gap	FC	7	43/45
	FS	8	209/437
	TC	6	24558/12902
Glenwood	FC	8	83/151*
	FS	8	387/817
	TC	6	10200/8453
Amity	FC	8	19.28
	FS	8	52/41
	TC	6	14583/7150
Highway 84	FC	8	21/18
	FS	8	115/96
	TC	6	15133/2988

Thirteen tributaries were investigated for bacterial loading (Table 4). Fecal coliform bacteria did not exceed the EPA criterion in any samples from Beech and Huddleston Creeks, but 13% of samples from Caney Creek and South Fork Caddo River and 14% of samples from Gap, Smith and Polk Creeks exceeded EPA criteria. Excessive bacteria were also present in 25% of samples from Lick and Collier Creeks, 38% of samples from Mill and Sweetwater Creeks, 63% of samples from Mudlick Creek and 86% of samples from Rock Creek. Sweetwater and Mudlick tributaries are located above the Glenwood site in the river proper and would relate to the high counts at the river station.

Chemical and physical parameters of the Caddo River and its tributaries are generally within acceptable limits. However, there appear to be excessive bacterial loading in some tributaries and around the middle reaches of the river proper. Statistically significant changes seem to have occured since the 1970s study. However, one must exercise care in accepting such data at face value, particularly becauses of the impact of heavy rainfall runoff on such a small river system.

Table 4. Bacterial data from thriteen tributaries during 1992. EPA criterion for FC=200/100ml. *Some samples exceeded EPA criterion.

Site	Variable	No. Samples	Mean/Std Dev.
Beech	FC	8	37/41
	FS	8	157/135
	TC	6	15126/6994
Polk	FC	7	190/348*
	FS	7	1210/2428
	TC	4	29050/28049
Lick	FC	8	190/194*
	FS	8	205/125
	TC	6	17400/9014
Huddleston	FC	8	36/32
	FS	8	336/473
	TC	6	13790/9833
Collier	FC	8	162/241*
	FS	8	118/71
	TC	6	16875/5337
Mill	FC	8	504/723*
	FS	8	335/292
	TC	6	24256/14283
Smith	FC	8	158/157*
	FS	8	291/324
	TC	6	23006/15047
Gap	FC	7	102/185*
	FS	8	199/177
	TC	6	7615/3689
South Fork Caddo River	FC	8	59/78*
	FS	8	88/73
	TC	6	15325/3648
Mudlick	FC	8	1927/4214*
	FS	8	143/130
	TC	6	26566/27306
Sweetwater	FC	8	320/336*
	FS	8	458/358
	TC	6	19767/11344
Rock	FC	7	402/389*
	FS	7	265/142
	TC	5	18650/5871
Caney	FC	8	45/76*
	FS	6	377/424
	TC	6	1651/3998

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