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Selected physical and chemical parameters were observed at the following sites: unchannelized and channelized main-channel Missouri River, an unchannelized backwater, and 13 tributaries of the Missouri River during the period 1985 through 1988. Mean main-channel discharge is artificially maintained at a higher rate during winter since construction of the main-stem dams. The mean flow through a remnant backwater in an unchannelized reach represents about 3.1% of the main-channel discharge. Turbidity is much reduced from the pre-dam period and is highest during the March and June periods of high discharge. Specific conductance in the main channel was measured as high as 955 umhos/cm^{-1}. Water quality parameters are similar for unchannelized and channelized sites, although organic matter, as measured by total organic carbon and fine and coarse particulate organic matter, is higher as one proceeds downriver. The water quality of the unchannelized reach backwater basically reflects the water quality of the main channel, except that dissolved oxygen is reduced in some locations within the backwater and total chlorophyll values are double those found in the main channel. Tributary water quality is highly variable and most observed values were higher than main-channel values near these tributaries. Continued observations will help explain the role that tributary run-off plays in main-channel water quality as samples are acquired during run-off events such as flooding. We have hypothesized that the Missouri River may have been one of the most productive ecosystems in temperate North America. Additional research into carbon/nutrient dynamics and the mechanism through which this energy reached the aquatic system is necessary to substantiate this hypothesis.

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INTRODUCTION

Morris et al. (1986) studied chemical and physical parameters in unchannelized (without continuously armored banklines) and channelized sections of the Missouri River from 1962 through 1964, a period that encompassed the closure of the last main-stem dam. The parameter affected most by dam construction appeared to be turbidity. Unchannelized sites averaged 95 ppm in 1963 and channelized sites averaged 449 ppm. Berner (1951) reported that during the high-water period of 1945, turbidity averaged 4,500 ppm and even after August 15 averaged about 1,700 ppm. Berner (1951) reported that "turbidity and the characteristics of the river which promote turbidity are largely responsible for the paucity or total absence of many biotic forms." His comments supported those made by Ellis (1937), who considered turbidity to be the most important factor limiting aquatic life in the river. Though few studies exist that quantify fish populations in the river prior to the construction of dams, there have been many comments made in historic accounts that described high densities of the endemic fish community (Evermann and Cox, 1896). The observations of large fish populations colonizing the Missouri River are not consistent with Berner's (1951) observations.

Wallen (1951) concluded that direct mortality of adult fish due to clay turbidity was unlikely at concentrations found in nature. In his studies, most fish survived at least a week in suspensions of 100,000 mg/l. Doan (1941) maintained that turbidity actually enhanced sauger production in Lake Erie, and that channel-catfish production was higher in turbid ponds than clear ponds (Buck, 1956; Marzolf, 1957). These investigators attributed positive turbidity influences to reduced predation in turbid water and negative turbidity influences to increased light extinction and subsequent reduced primary production. Evidence now suggests that the primary production driving Missouri River aquatic communities was a function of terrestrial macrophyte and emergent aquatic plant production. This primary energy entered the aquatic ecosystem through flooding, erosion caused by main-channel meandering, and run-off from tributaries, i.e., from allochthonous sources (Carr, 1988; Hesse et al., 1988).

The intent of this paper is to present recent data concerning chemical and physical parameters in unchannelized and channelized portions of the river 20 to 25 years after the last main-stem dam was closed; to describe chemical and physical conditions within a large backwater still attached to an unchannelized reach; to report on the seasonal water quality of 13 tributary streams; and to determine the role that tributaries play in altering main-channel organic matter content.

METHODS

Collection sites are listed in Table 1 and include sites in the main channel and tributaries along unchannelized reaches between Fort Randall Dam and Lewis and Clark Lake and between Gavins Point Dam and Ponca, Nebraska; main channel and tributaries in the channelized reach between Sioux City, Iowa and Rulo, Nebraska; and backwaters in Knox County, Nebraska, along the upper unchannelized reach. Several habitats within the backwater were studied, including main chute, backup (chute with one end closed), vegetated bar, small pool, and larger lake (Fig. 1).

Stage and discharge data were from main-channel locations at (successively downstream) Fort Randall Dam, South Dakota; Gavins Point Dam, Nebraska; Vermillion, South Dakota; Sioux City, Iowa; and Decatur, Blair, Omaha, Plattsmouth, Nebraska City, Brownville, and Rulo, Nebraska, for the period from 1872 to the present. Data were unavailable from some years at all gauges, but some gauges yielded fairly consistent information, and these data are stored and available in our IBM system for future biotic/abiotic modeling.

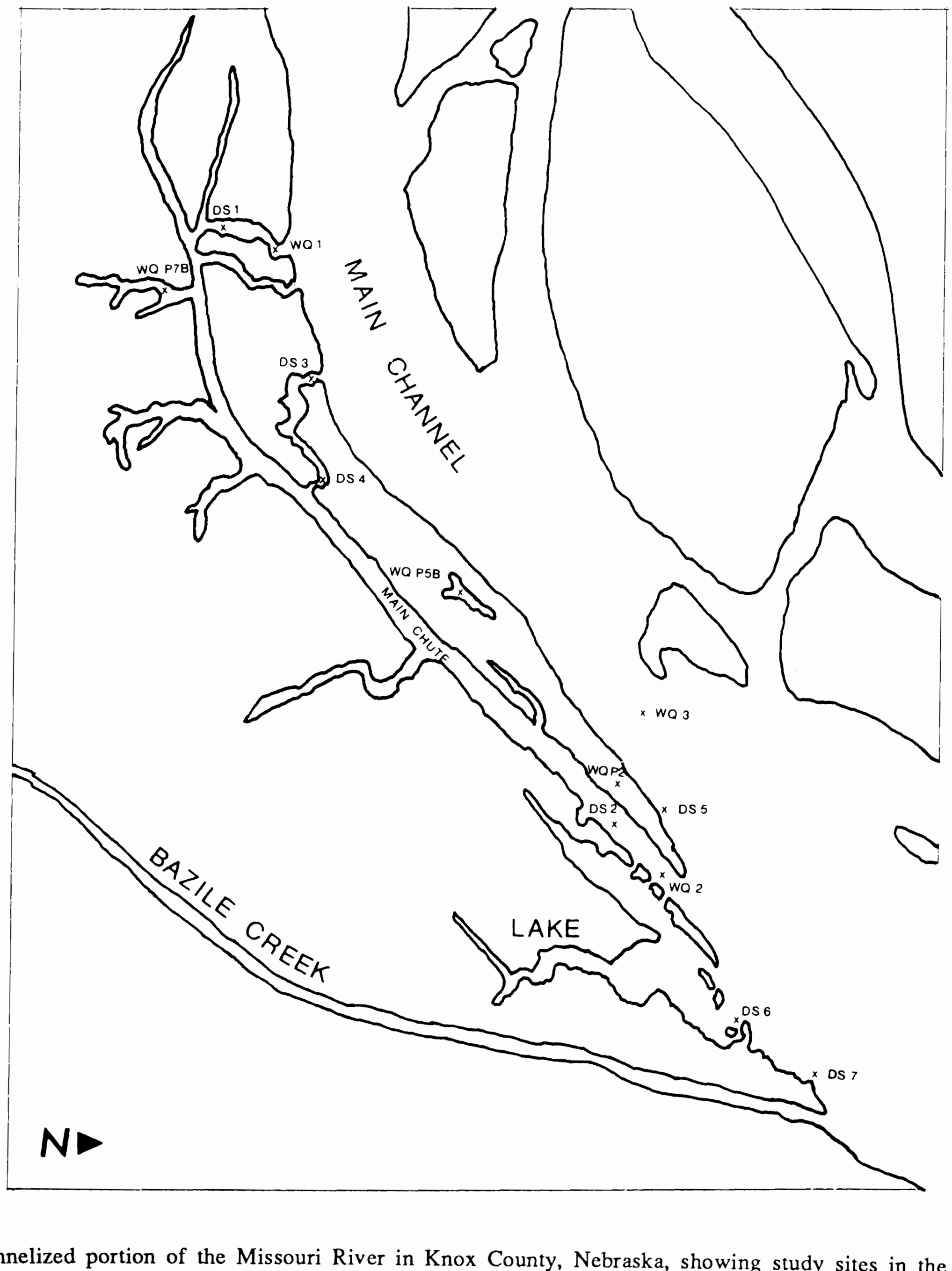

FIGURE 1. Unchannelized portion of the Missouri River in Knox County, Nebraska, showing study sites in the river and its backwaters. Area is about 4.5 mi (7.2 km) east of the town of Niobrara.

Current-velocity measurements during 1983 through 1988 were obtained during ichthyoplankton drift-sampling using a General Oceanics flowmeter Model 2030. Discharge volumes traversing a large backwater were determined at various surface-water elevations from six transects within the backwater in 1985, using a Price Current Meter. Physico-chemical parameters were measured from main-river channelized and unchannelized, unchannelized backwater, and tributary locations between 1983 and 1988. Not all sites were sampled each year; some were sampled infrequently. Parameters measured included water temperature (C); Secchi disk transparency (cm); pH; specific conductance (umhos/cm^{-1}) (K25); turbidity (NTU); alkalinity (mg/l $CaCO_3$); dissolved oxygen (mg/l); total solids (mg/l); total dissolved solids (mg/l); total chlorophyll (ug/l); chemical oxygen demand (COD) (mg/l); fine particulate organic matter (mg/l); coarse particulate organic matter (mg/l); total organic carbon (mg/l); nitrate (mg/l); and total phosphorus (mg/l). Standard methods were used to process raw-water samples (American Public Health Association, 1981; U.S. Environmental Protection Agency, 1974).

Fine particulate organic matter (FPOM) was collected and processed according to Carr (1988). Coarse particulate organic matter (CPOM) was collected using a Miller Sampler with a 0.001-mm nytex net, and the samples were then processed according to Carr (1988). Carr (1988) used a 1-mm mesh net in the field, and therefore our samples would have included material as CPOM that Carr would have labelled FPOM. Total organic carbon samples were sent to the Nebraska Department of Environmental Control for analysis, and nitrate and phosphorus samples were sent to the Nebraska Department of Health for analysis.

RESULTS AND DISCUSSION

Table 2 presents mean discharge rates at Omaha, Nebraska, for three years (1930–1932) prior to the closure of the Fort Peck Dam in Montana, for four years after closure of the last main-stem dam (Big Bend Dam in South Dakota), and for the last six years (1983–1988). It is evident that the dams have played a role in increasing the absolute instantaneous minimum discharge observed at Omaha, although all of the observed minima from 1930 to 1966 occurred in winter, when discharges are naturally reduced and ice bridges can also reduce discharges. These data also suggest that the period from 1983 through 1987 was unusually moist. Dry years in the Missouri Basin were quite common over the last 50 years, and the 1988 discharge rate is probably closer to an overall average than that of the wet years.

During 1963, Morris et al. (1968) measured the mean current-velocity in the main channel as 1.52 m/s (unchannelized) and 1.56 m/s (channelized). Slizeski et al. (1982) stated that mid- channel velocities from channelized and unchannelized locations ranged from 0.89 to 2.1 m/s and were directly related to discharge volumes. During drift-net operations conducted simultaneously with the present research, samples were acquired from near the cutting bank, mid-channel, and near the filling bank. Flow-meter readings were used to calculate current velocity as well as the volume of water filtered by a drift net. Velocities acquired in this fashion are dependent upon the maintenance of a steady position in the channel; the most accurate velocity estimates were secured in unchannelized locations where average velocity across the channel ranged from 0.85 m/s in 1986 to 1.30 m/s in 1984.

Backwater habitat has been eliminated from nearly 1,200 km of the lower Missouri River due to channelization. Most backwaters along the lower unchannelized reach from Gavins Point Dam to Ponca, Nebraska, have been eliminated due to channel-bed degradation. Several large backwaters remain connected to the unchannelized Missouri River between Fort Randall Dam and Lewis and Clark Lake. The Bazile Creek backwater in Nebraska (Fig. 1) is characterized by a main chute; at collection location DS1 (inflow) the maximum depth was 3.9 m, mean width 21.8 m, mean velocity 0.44 m/s, and mean discharge 19.2 m^3/s; at DS2 (outflow) the maximum observed depth was 1.9 m, mean width 54.9 m, mean velocity 0.28 m/s, and mean discharge 25.2 m^3/s. A smaller channel drains into the backwater from the main channel (DS3, inflow; DS4, outflow). At DS4, maximum depth was observed to be 1.4 m, mean width 8.2 m, mean velocity 0.35 m/s, and mean discharge 2.8 m^3/s. The main channel adjacent to the backwater at DS5 averaged 3 m deep and had a velocity of 0.33 m/s measured 2.9 m from the waterline. The large lake (DS6) did not empty into the chute but directly into the main channel. It was wide (70.3 m), shallow (only 25% of the cross-section was deeper than one meter), and slow-moving (0.05 m/s average); average discharge to the main channel was 4.6 m^3/s.

The only discharge data available for the main channel during 1985 near the Bazile Creek backwater were inflow volumes for Lewis and Clark Lake, measured just 8 km downstream. Backwater transects were visited five times during 1985. Discharge volumes at DS2 were used to determine the percentage of main-channel flow traversing this backwater (Table 3). From May through September, 1985, an average 3.1% of the main-channel volume was circuited through this backwater. It is apparent that as the main-channel discharge volume was increased from 651 to 906 m^3/s, the channel configuration changed sufficiently to exclude at least a proportion of the flow from the backwater as evidenced by the fact that percent of total flow was at its lowest in September (2.6%) and the water level declined by 0.51 m from 2 May (-0.88 m) to 30 September (-1.39 m).

Mean water temperature, specific conductance (K_{25} values), and turbidity (1 NTU equals approximately 1 ppm) for the period 1983 and 1984 is presented in Table 4; Table 5 represents mean observations for 16 parameters for unchannelized versus channelized sites for 1987 and 1988. Monthly mean values are presented in Hesse et al. (1989). Average turbidity in 1987-1988 was 26 NTU (Table 5), while average discharge was about 990 m^3/s (Table 2). Morris et al. (1968) reported mean turbidity values in this same reach were 95 ppm (1962-1963 measurements) when the average discharge was only 650 m^3/s (Table 2). The reduction of turbidity between 1962-1963 and 1987-1988 reflects the ongoing re-arrangement of sediment dynamics in the unchannelized portions of the Missouri River after the dams were completed.

Water temperature peaked at 27°C in 1983 and 1984. Monthly mean water temperatures were similar between 1983 and 1984, and average water temperature is 2°C higher in the channelized reach. Morris et al. (1968) noted a similar situation.

Specific conductance was lowest in spring and autumn and highest during mid-summer. Peak values reached 910 umhos/cm^{-1} on 23 July 1983 and 955 umhos/cm^{-1} on 1 August 1984.

Mean total alkalinity in the unchannelized river was similar to the average value reported by Morris et al. (1968) for 1962, although channelized-river alkalinities were slightly higher in the present study (Table 5). The fact that unchannelized and channelized total alkalinity values are somewhat similar may be reflective of relatively low algal photosynthesis in the reservoirs (Neel et al., 1963). Carr (1988) discovered that benthic and planktonic algae composed 7.2–21.8

Table 1. Missouri River collection sites and their distance to the mouth of the river based upon 1960 data.

		FROM		TO	
Site	Name	Kilometer	Mile	Kilometer	Mile
1	Boyd Co. (Lynch)	1,406	874	1,393	866
2	Knox Co. (Niobrara)	1,376	855	1,342	834
3	Lewis and Clark Lake	1,319	820	1,307	812
4	Gavins Point Tailwater	1,305	811	1,297	806
5	Cedar Co. (St. Helena)	1,295	805	1,268	782
6	Cedar Co. (Wynot)	1,268	788	1,258	782
7	Dixon Co. (Ponca)	1,221	759	1,199	745
8	Dakota Co. (South Sioux)	1,181	734	1,170	727
9	Burt Co. (Decatur)	1,121	697	1,104	686
10	Burt Co. (Tekamah)	1,091	678	1,075	668
11	Washington Co. (Blair)	1,047	651	1,031	641
12	Otoe Co. (Nebraska City)	911	566	895	556
13	Nemaha Co. (Brownville)	869	540	853	530
14	Richardson Co. (Rulo)	806	501	797	495
15	Niobrara River	1,358	844		
16	James River	1,288	800		
17	Vermillion River	1,242	772		
18	Big Sioux River	1,181	734		
19	Little Sioux River	1,076	669		
20	Soldier River	1,068	664		
21	Boyer River	1,022	635		
22	Platte River	957	595		
23	Little Nemaha	850	528		
24	Big Nemaha	796	495		
25	Ponca Creek	1,366	849		
26	Bazile Creek	1,352	840		
27	Nishnabotna	872	542		

Table 2. Instantaneous discharge in cubic meters per second of the Missouri River for selected years at Omaha, NE.

Year	Minimum discharge	Maximum discharge	Mean discharge
1930	163	5,607	1,011
1931	140	2,390	748
1932	113	1,464	425
1944	295	4,191	1,163
1945	127	2,974	932
1946	71	2,285	730
1963	170	1,626	654
1964	91	1,546	650
1965	219	901	859
1966	326	1,164	925
1983	439	2,280	1,219
1984	629	3,228	1,379
1985	422	1,948	982
1986	481	2,161	1,278
1987	552	1,691	1,016
1988	351	1,235	894

Table 3. Backwater discharge (m^3/s), percent age of main-channel flow, Lewis and Clark Lake inflow volume (m^3/s), Fort Randall Dam outflow volume (m^3/s), elevation of Lewis and Clark Lake (m above mean sea level) and the elevation of the water line at DS 2 relative to a bench mark (m) on five days during 1985.

Date	Backwater discharge	%	L & C inflow	FR outflow	L & C elevation	Water elevatio at DS 2 (outfl
2 May	24.6	3.8	651	509	367.5	-0.88
28 May	25.2	2.9	877	727	367.4	-0.90
8 July	28.1	3.3	849	775	367.6	-0.90
19 Aug	24.7	3.0	821	756	368.2	-0.92
30 Sept	23.3	2.6	906	688	368.3	-1.39

Table 4. Mean monthly values (standard deviation in parenthesis) for selected water quality parameters from the unchannelized Missouri River in 1983 and 1984.

1983

Date	No. of obs.	Air temp (C)	Water temp (C)	Specific conductance umhos/cm^{-1} (K_{25})	Turbidity (NTU)
May	1	20	17	--	21
June	3	23(5)	20(4)	--	33(35)
July	6	30(3)	24(3)	655(277)	41(34)
Aug	5	31(5)	26(1)	892(56)	15(5)
Sept	3	20(2)	23(2)	818(8)	13(3)
Oct	11	14(4)	15(2)	348(237)	14(4)

1984

Date	No. of obs.	Air temp (C)	Water temp (C)	Specific conductance umhos/cm^{-1} (K_{25})	Turbidity (NTU)
Apr	9	16(5)	9(3)	483(58)	70(68)
May	10	10(-)	14(5)	659(119)	36(24)
June	9	--	19(4)	689(54)	37(34)
July	8	--	22(2)	781(78)	24(6)
Aug	6	--	25(1)	840(30)	14(5)
Sept	4	--	21(1)	735(34)	15(5)
Oct	2	--	13(4)	570(-)	13(-)

Table 5. Mean values of selected water quality parameters from sites on the unchannelized and channelized Missouri River from Boyd County to Richardson County recorded in April and August, 1987, and in April, June and October, 1988

	Unchannelized			Channelized		
Parameters	Mean	(Std. Dev.)	No. of Obs.	Mean	(Std. Dev.)	No. of Obs.
Water temperature (C)	17.63	(7.36)	30	19.55	(6.52)	39
Alkalinity, total (mg/l-CaCO3)	168.75	(9.47)	24	174.69	(12.44)	32
Specific conductance (umhos/cm^{-1} K_{25})	662.43	(126.07)	30	641.21	(144.56)	39
pH	7.55	(0.73)	18	7.60	(0.67)	22
Total organic carbon (mg/l)	3.91	(0.43)	18	3.67	(0.70)	25
Fine particulate organic matter (mg/l)	9.79	(2.55)	18	19.00	(8.49)	25
Coarse particulate organic matter (mg/l)	540	(349)	25	1,001	(1,029)	32
Nitrates (mg/l)	0.1	(0.02)	18	0.35	(0.42)	25
Total phosphorus (mg/l)	<0.1	(0.04)	24	0.12	(0.07)	32
Total solids (mg/l)	527.51	(58.34)	30	587.30	(73.68)	39
Total dissolved solids (mg/l)	486.14	(30.12)	30	496.74	(34.14)	39
Turbidity (NTU)	25.97	(40.17)	30	42.31	(20.04)	39
Total chlorophyll (mg/l)	10.61	(7.33)	24	32.33	(17.53)	32
Secchi disk transparency (cm)	63.08	(27.85)	26	32.16	(11.83)	39
Dissolved oxygen (mg/l)	8.81	(0.49)	6	8.55	(0.83)	7

percent of the seston biomass in the unchannelized river, and they contributed up to 6.8 percent of the total organic carbon. During 1983–1985, Carr (1988) found the mean fine particulate organic matter (FPOM) in unchannelized sites was 5.65 mg/l (SD = 3.95), which is 42.3 percent less than the 9.79 mg/l we measured in 1987-1988 (Table 5). Channelized-reach FPOM values were 1.94 times greater than those from unchannelized locations. Coarse particulate organic matter (CPOM) was 1.85 times greater at channelized sites than unchannelized sites. CPOM values from our studies are not directly comparable with Carr's (1988) values because of different mesh sizes used during field collections.

Carr (1988) reported total organic carbon (TOC) in 1983-1985 was 4.13 ppm from unchannelized sites, a value somewhat larger than the 3.91 mg/l measured in our samples (Table 5). We determined that TOC values in the channelized reach were only slightly lower than in the unchannelized reach. We believe that the similar values indicate that the extent of bankline erosion is nearly the same in unchannelized and channelized reaches. Carr (1988) stated that up to 37.5 percent of FPOM and 62.7 percent of CPOM were from allochthonous sources, which can reach the river only through run-off or meandering erosion. Evidently, most allochthonous organic matter enters unchannelized and channelized portions from tributaries or backwaters.

Mean total phosphorus and nitrogen concentrations were low in unchannelized reaches, reflecting the paucity of nutrients in the affluent from the two reservoirs that empty into these reaches (Table 5). Martin and Novotny's (1975) nutrient enrichment studies showed that phosphorus levels in lakes Lewis and Clark and Francis Case limited summer phytoplankton density. We found total phosphorus and nitrate levels were somewhat higher in the channelized reach than in the unchannelized river (Table 5).

Table 6 presents mean values for selected water-quality parameters from six locations within an unchannelized backwater (Fig. 1). These values represent a mean of eight monthly samples (March through October, 1986). Monthly data for water quality parameters in 1985-1986-1987 can be found in Hesse et al. (1989). Water temperatures averaged several degrees higher on the vegetated bar (WQP2) as well as in the backup (WQP7B) and pool (WQP5B). Dissolved oxygen was lowest in the backup. All backwater sites showed lower conductivity values than the main channel, and dissolved solids were higher in the main channel than in all backwater sites. Total chlorophyll values were twofold higher at all backwater sites than in sites in the main channel. Secchi disk transparency was higher in the main channel than in all backwater sites, although turbidity was lower in the main channel than in all backwater locations.

Table 7 presents mean values for selected water quality parameters for 13 tributaries of the Missouri River (Table 1) for the period of April, 1987, through October, 1988. Average contribution from tributaries is best evaluated by comparing values in Table 7 with those from the main-channel stations in Table 5. Alkalinity, TOC, FPOM, nitrate, phosphorus, solids, turbidity, chlorophyll, and COD values are all higher in tributary samples. Since smaller tributary streams reflect run-off more quickly than the main channel, one might expect that specific constituent values would frequently be much higher than in the main channel. For example, conductivity was very high in April in the Vermillion River (1,510 umhos/cm^{-1}), while main-channel conductivity in April near the Vermillion River is 820 umhos/cm^{-1} (Hesse et al., 1989). The highest recorded TOC values (7.91 and 9.23 ppm) were in the James River in April and June, 1988, respectively, but TOC (9.00 ppm) in the Big Sioux River was higher than TOC (5.33 ppm) in the James River in October. Total solids and dissolved solids values were very high in Ponca Creek, the James River, and the Vermillion River in April, June, and October, compared with main-channel values. Total nitrate concentrations were highest in the Little Sioux River in April, the Boyer River in June, and the Boyer River and Bazile Creek in October. Highest total phosphorus values occurred in the Boyer River in October, but it was also high in April. Highest total chlorophyll values occurred in the Big Nemaha River in June, during a period when water clarity was low (Secchi disk transparency 28.5 cm). The highest FPOM values were found in the Little Sioux River in April, the Little Nemaha River in June, and the Platte River in October. It is apparent that tributaries contribute chemical/physical constituents that vary temporally. The intent of the tributary studies was to identify the differences in water quality and then to evaluate the contribution made to the main channel under various flow regimes, particularly during floods. Very little flooding occurred during the study period, and therefore it is our intention to acquire more observations in the future.

CONCLUSIONS

Early investigators of the Missouri River such as Berner (1951) were faced with evaluating data from restricted sampling areas. Moreover, their equipment was limited and often ill-suited to solve unique sampling problems inherent in all large rivers. In the Missouri River, high turbidity was evident even to the casual observer, but the connection between high turbidity and total organic matter content and nutrient availability primarily from allochthonous sources was obscure. As a result, the river was described as having a very low level of system productivity when, in fact, it was possibly one of the most productive ecosystems in temperate North America. The construction of dams and the constraining of the meandering channel has probably reduced system productivity. Additional insight into organic matter and nutrient dynamics in the altered Missouri River is needed.

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Parameters	Mean	(Std. Dev.)	Number of Observations
Water temperature (C)	19.43	(6.41)	62
Alkalinity, total (mg/l-CaCO3)	224.31	(56.97)	51
Specific conductance (umhos/cm^{-1} K_{25})	696.65	(307.86)	62
pH	7.59	(0.75)	36
Total organic carbon (mg/l)	5.24	(1.79)	38
Fine particulate organic matter (mg/l)	25.86	(11.74)	38
Nitrates (mg/l)	1.61	(1.75)	38
Total phosphorus (mg/l)	0.25	(0.14)	49
Total solids (mg/l)	732.34	(345.18)	62
Total dissolved solids (mg/l)	581.55	(324.65)	62
Turbidity (NTU)	65.32	(40.88)	62
Total chlorophyll (mg/l)	71.20	(60.94)	50
Secchi disk transparency (cm)	22.66	(8.45)	60
Dissolved oxygen (mg/l)	9.28	(1.85)	13
Chemical oxygen demand (mg/l)	54.54	(31.76)	13

Table 7. Mean values of selected water quality parameters from sites on thirteen tributaries of the Missouri River recorded in April and August, 1987, and April, June and October, 1988.

Table 6. Mean values for selected water quality parameters from six locations within an unchannelized backwater of the Missouri River, Nebraska for 1986 (mean standard deviation).

Parameter	WQ 1	WQ 2	WQ 3	WQ P2	WQ P5B	WQ P7B
Water temperature (C)	16(8)	16(8)	17(7)	18(6)	21(5)	20(7)
Total Alkalinity (mg/l-CaCO3)	165(12)	170(17)	160(16)	159(14)	158(19)	172(15)
Dissolved oxygen (mg/l)	9.8(1.7)	9.5(2.0)	9.5(1.3)	8.6(1.5)	8.7(1.1)	7.6(2.2)
pH	7.1(0.7)	7.3(0.7)	7.6(0.7)	7.5(0.6)	7.7(0.6)	7.7(0.4)
Total hardness (mg/l)	255(59)	226(95)	276(36)	266(45)	263(40)	260(35)
Calcium hardness (mg/l)	121(24)	151(47)	86(66)	98(51)	90(71)	111(94)
Specific conductance (umhos/cm)	658(96)	662(94)	742(108)	688(98)	678(105)	658(102)
Total solids (mg/l)	529(30)	530(44)	565(33)	607(106)	513(107)	469(61)
Total dissolved solids (mg/l)	422(46)	423(49)	555(23)	484(44)	486(53)	481(19)
Total chlorophyll (ug/l)	17.9(11.5)	15.9(13.1)	8.5(4.8)	20.6(11.4)	18.3(8.6)	20.8(13.1)
Chemical oxygen demand (mg/l)	64(39)	54(44)	55(44)	70(40)	63(37)	69(41)
Secchi disk transparency (cm)	48(32)	43(22)	77(34)	41(24)	39(15)	32(28)
Turbidity (NTU)	47(27)	45(30)	13(10)	31(15)	25(12)	31(17)