produce this type of differential preservation (Fig. 3).

Evidence indicates that primitive man altered lithic raw materials by slowly heating them to critical temperatures for sustained periods. He was probably well aware of the advantages this practice conferred in the manufacture of chipped stone implements.

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Channelization: A Case Study

Abstract. *Channelization of the Blackwater River in Johnson County, Missouri, 60 years ago nearly doubled the gradient, which caused an increase in the rate of erosion for the river and its tributaries. Since the present channel is much wider and deeper than it was when newly dredged, there have been bridge repairs and loss of farmland. Downstream reduction in channel capacity due to termination of dredging has caused channel sedimentation and increased flooding.*

Channelization means straightening of a stream or the dredging of a new channel to which the stream is diverted. The purpose is to minimize local flooding by shortening the distance traveled and thereby moving the floodwaters downstream more rapidly. This technique has been practiced for many years by private drainage districts, the Army Corps of Engineers, and, more recently, the Soil Conservation Service under Public Law 566 (*1*). Recently several articles concerning channelization have appeared in newspapers and magazines (*2, 3*). The detrimental effects on game and fish populations and on landscape esthetics have been widely described, but there has been a paucity of data about changes in stream channel geometry. This report documents the increase in erosion caused by channelizing a stream and thereby increasing its gradient.

The headwaters of the Blackwater River are in northwest Johnson County, Missouri, about 65 km east of Kansas City. The river flows east to join the Missouri River just west of Boonville, Missouri. A local drainage district was formed in 1909, and in 1910 a new channel was dredged for the lowland portion of the Blackwater River eastward nearly to the county line.

The pre-1910 river in Johnson County had an average of 1.8 meanders per kilometer, with a meander radius ranging from 60 to 140 m. This former channel is now blocked off, silted up, full of vegetation, and used as a dump wherever the original bridge remains in use. These bridges over the former channel are from 15 to 30 m wide, the majority being of the smaller width. The length of the old channel, from the beginning of the new ditch to the county line, was 53.6 km, and the gradient was 1.67 m per kilometer.

County Circuit Court records state the dimensions of the new Blackwater ditch, those of the dredged tributaries, and the length of new bridges to cross the dredged channels (*4*). The new Blackwater channel was 9 m wide at top, 1 m at bottom, and 3.8 m deep, giving a cross-sectional area of 38 m^2.

Length and elevation measurements for the former and present channels were made on topographic maps. Channel widths were taken by taping across bridges on straight portions of the present river. Channel depth was obtained by lowering a lead line, marked in meter increments, from the bridge. A hand level was used to sight from one bank to the other, and the height of the intersection of the line of sight with the lead line was noted. At the same time, bottom elevation was obtained by measuring the length from the bridge floor to the stream bed and subtracting this distance from the bridge elevation given on the topographic map. The measurements are given in Table 1 and in the stream profile (Fig. 1).

The present Blackwater River is 29 km long from beginning of channelization to the county line and has a gradient of 3.1 m per kilometer. The dredging shortened this portion of the river by 24.6 km and nearly doubled the gradient. The present channel has increased from a cross-sectional area of 38 m^2 when newly dredged to a size now ranging from 160 to 484 m^2. The maximum figure represents an area increase of 1173 percent in 60 years. For a comparison of the present channel width with the width of the old abandoned channel, measurements of the bridges that cross both are useful. At

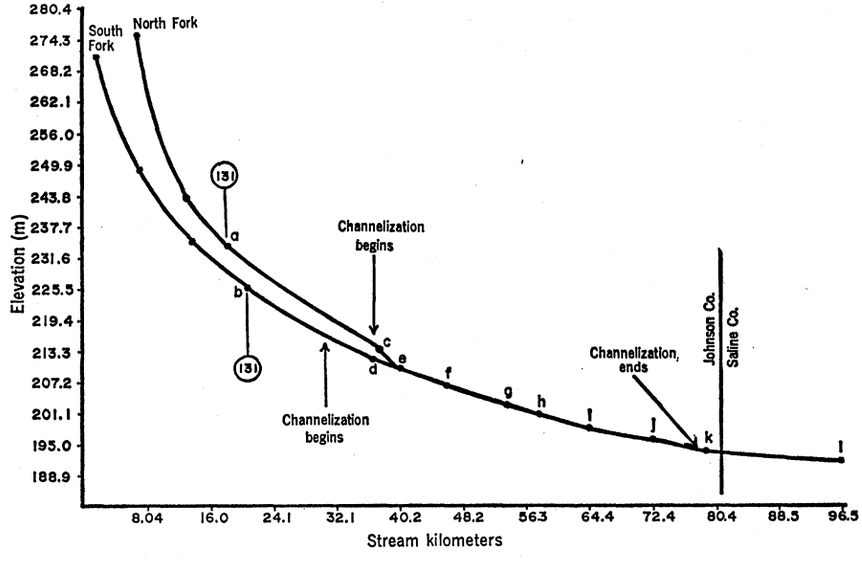

Fig. 1. Stream profile of the Blackwater River in Johnson County and the western part of Saline County. Location of the measured bridges is designated by letters a through l. Measurements were made in 1970.

Table 1. Dimensions of the present Blackwater River in Johnson and Saline counties, Missouri. Size of the original dredged channel: width at top, 9 m; width at bottom, 1 m; and depth, 3.8 m.

Bridge location	Present channel dimensions			
	Top width (m)	Bottom width (m)	Depth (m)	Cross-sectional area (m^2)
a. North Fork, Route 131	21.9	7.0	4.7	67.9
b. South Fork, Route 131	20.1	5.0	4.1	51.2
c. North Fork	67.6	9.2	9.2	353.2
d. South Fork, Route 50	45.7	12.2	9.4	280.1
e. Elevation, 729 feet (222 m)	53.3	12.8	10.9	360.2
f. Elevation, 711 feet (217 m)	60.9	11.6	10.0	362.5
g. Elevation, 696 feet (212 m)	64.0	22.8	10.0	434.0
h. Bear Creek	71.0	12.5	11.6	484.3
i. Valley City	51.8	15.8	8.2	277.1
j. Route J	35.0	15.2	6.4	160.6
k. Dunksburg	29.8	15.2	5.8	130.5
l. Sweet Springs	42.7	15.3	5.8	168.2

location c, the old channel bridge is 15.2 m wide; the present channel bridge, originally 15.2 m, has been extended to 60.9 m. At location g, the old channel bridge is 15.2 m wide; the present channel bridge, originally 22.8 m, is now 124.2 m wide.

The dredged lower reaches of the tributary streams have also increased in size. Honey Creek, one such tributary, has gone from a cross-sectional area of 12 m^2 when newly dredged to 255 m^2 today. Along the channelized portion of several tributaries, parts of the predredging channels are preserved about 3.5 m above the present stream bed. In the unchannelized reaches of the tributaries, meanders have become entrenched. This condition is also evident in the unchannelized parts of the Blackwater.

The widening and deepening of the streams have caused serious erosional problems along their banks and headward erosion of gullies that lead to the tributaries. Most bridges in Johnson County have been replaced or lengthened and have had vertical extensions added to the lower supports. In most cases the ends of the present bridges are threatened by bank erosion. An example of this rapid widening is illustrated by the experience of a local farmer. A county bridge spanning the Blackwater had collapsed, owing to bank erosion, and was replaced with a chain bridge constructed by area farmers in 1930. The new bridge was 27 m wide. That bridge had to be replaced in 1942 and again in 1947. The final bridge had a span of 70 m, but it too has collapsed because of erosion. Channelization increased the gradient of the Blackwater River and initiated a degradational regimen, which is still in progress. The present channel has displayed no tendency to resume meandering, and so it apparently has not yet reached equilibrium. For the central part of the county (locations c through i), erosion since channelization has averaged 1 m in width and 0.16 m in depth per year.

The lithology in most of Johnson County consists of thin-bedded Pennsylvanian shale, coal, sandstone, and limestone. Continual degradation on easily eroded stream beds have produced a smooth chutelike condition, which is not conducive to bottom fauna. Preliminary observations indicate a negative correlation between channelized portions of the stream and density of macroinvertebrates (*5*). These observations are reinforced by the work of the Missouri Department of Conservation, which reports 256 kg of fish per acre in unchannelized portions of the Blackwater but only 51 kg per acre in the channelized portions (*2*).

The low resistance of the Pennsylvanian rocks made dredging nearly to the county line economically possible. In Saline County to the east, the change in lithology to Mississippian limestone made dredging unfeasible, and the project was abandoned. Channel constriction as a result of the lithology change causes a large difference in the amount of water that can be transported without flooding. The channelized part of the Blackwater in Johnson County has a capacity of 280 to 850 m^3 per second, whereas the downstream reaches in eastern Johnson County and in Saline County have a capacity of 170 to 255 m^3 per second (*6*). The Blackwater drainage basin in Johnson County receives 102 cm of rainfall yearly, with frequent cloudbursts from April to September. The stream gauging station on bridge i near Valley City recorded maximum flows during these months of 198 to 1840 m^3 per second for the water years 1960 to 1965 (*7*). Owing to the abrupt decrease in cross section in the unchannelized part of the Blackwater River, flooding is extremely common in the adjoining parts of Johnson and Saline counties. Long-time residents of the area near bridge k stated that there was no extensive flooding prior to channelization. Since the channelization upstream, two successive generations of fence posts have been buried by overbank deposits on the floodplain near bridge k. This would amount to about 2 m of deposition in 50 to 60 years. A number of public hearings conducted in the 1940's indicated that flooding in Saline County had greatly increased since channelization and that the effectiveness of the lower end of the new channel is being reduced by channel sedimentation, which is slowly progressing upstream (*6*). The area now affected most by flooding extends from Valley City (bridge i) to U.S. Highway 40 in central Saline County, a distance of about 70 km of stream.

Channelization has enabled more floodplain land to be utilized in the upper reaches of the Blackwater River. This benefit must be weighed against erosional loss of farmland, cost of bridge repair, and the downstream flood damage resulting from termination of the dredging project.

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