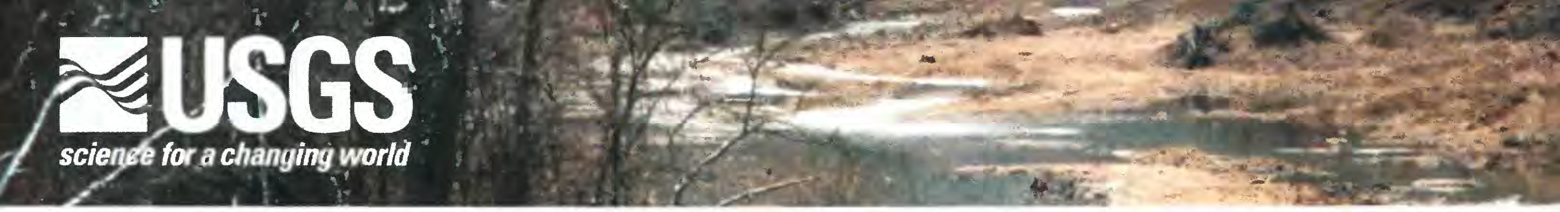

Instream Gravel Mining and Related Issues in Southern Missouri

—Suzanne R. Femmer

The issue of instream gravel mining has many dimensions. In a growing economy, the availability of construction materials can be a limiting factor of growth and the economic benefits of gravel production must be weighed against the environmental costs. At the present time, quarry rock is used in much greater quantities than instream gravel in most counties in southern Missouri and for most uses, though the physical properties of instream gravel make it desirable for use as an aggregate for concrete. The extent of gravel mining in southern Missouri streams is not well known because only commercial entities need permits to operate. State conservation and regulatory agencies need information on the extent, character, and effects of instream gravel mining to manage and protect streams, streamside wetlands, and the beneficial uses these resources provide while also accommodating a viable mining industry. The economic benefits of gravel production must be weighed against the environmental costs. The Missouri Department of Conservation, U.S. Environmental Protection Agency, and the U.S. Geological Survey are working together to study these issues.

This fact sheet presents an overview of instream gravel mining, including economic and environmental issues, in southern Missouri. As the streams respond to mining disturbances, real estate can be lost, aquatic habitats altered, and fisheries and recreation damaged. An understanding of the effects of gravel mining will contribute to the establishment of an environment of minimal impact.

INTRODUCTION

In southern Missouri, gravel is mined extensively from the channels and flood plains of streams. Research in other regions has shown that instream gravel mining destabilizes stream channels and substantially degrades instream habitats and habitats of associated wetlands (Bull and Scott, 1974; Woodward-Clyde Consultants, 1980; Lyttle, 1993; Kondolf, 1997). There is very little information on gravel mining and its related issues in Missouri.

Considerations

There are many questions about the effects of instream gravel mining on the aquatic resources of Missouri. What is the extent of gravel mining? How are habitats affected by changing the shape of the channel? How does instream mining affect erosion and sedimentation? What are the short- and long-term effects on stream habitat? What are the effects on stream biota? How is public and private property affected by mining? Should guidelines be developed to govern how instream mining is conducted?

Known Effects

Extraction of gravel from a stream alters the sediment budget creating the potential for channel instability, increased turbidity, and degradation of habitats (fig. 1). Wetlands may be altered or lost by erosion, the lowering of the water table, relocation of the stream channel, or by moving gravel into wetland areas. Instream gravel mining may be linked to loss of fishery resources and wetlands, increased bank erosion, and damage to infrastructure caused by channel degradation. The extent to which this potential is realized depends on the hydrologic character, sediment load, and riparian condition of a stream. In Missouri, there is little information about the extent and distribution of instream mining. This information is needed for a science-based understanding for future instream mining policy in Missouri.

Figure 1. An example of habitat degradation at a gravel mining site at Sellars Creek in Camden County, 2000.

ECONOMIC CONSIDERATIONS

Known Gravel and Quarry Rock Production

Many Missouri stream channels and their flood plains are sources of gravel for construction, road maintenance, and other uses. In addition, the limestone and dolostone hills of southern Missouri are a plentiful source of quarry rock, which is used in some areas in place of gravel. According to the U.S. Geological Survey (USGS) and the Missouri Department of Natural Resources, Division of Geology and Land Survey, quarry rock, by value, has been Missouri's primary nonfuel mineral commodity since 1997, exceeding lead, which was leading in 1996 (U.S. Geological Survey and Missouri Department of Natural Resources, Division of Geology and Land Survey, 2000). The regions around metropolitan areas such as St. Louis and Kansas City consume a large part of the quarry rock produced (fig. 2). Missouri also is a significant producer of construction gravel. During 1999, Missouri's production of construction gravel increased by nearly one-third over that in 1998 (U.S. Geological Survey and Missouri Department of Natural Resources, Division of Geology and Land Survey, 2000). Although the 2000 total annual national production of construction gravel was the highest production level recorded for the United States as a whole, Missouri experienced a decrease of 27 percent from 1999 (U.S. Geological Survey, 2001).

Production Survey

The USGS conducted a survey, in 2000, of 70 county highway departments in southern Missouri to determine gravel and quarry rock use, estimated rock value, and locations of gravel mining operations during 1999. This information was not available from other sources because in Missouri, county highway departments do not need mining permits to remove gravel. Of the 70 counties surveyed, 46 counties responded concerning their instream gravel and quarry rock use in 1999 (fig. 2). Instream gravel used by these 46 counties in 1999 was estimated to be 376,000 tons at an approximate value of $1,454,000. Quarry rock was used in greater quantities in most of the counties that responded. Approximately 2,480,000 tons of quarry rock at a value of approximately $10,321,000 was used in 1999.

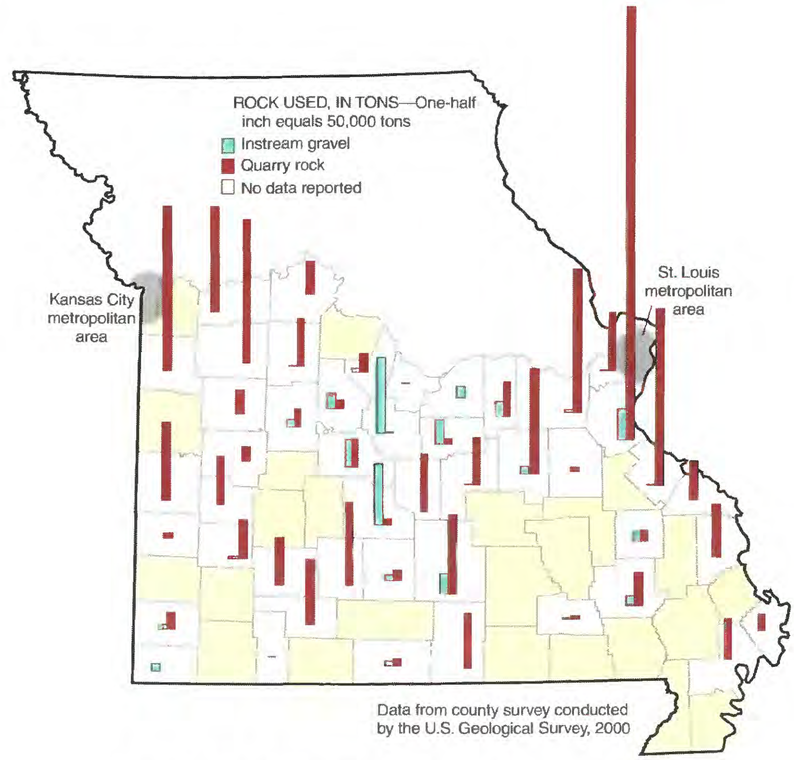

Figure 2. Rock use by county highway departments,1999.

Uses for Gravel

Commercial construction, such as home building and commercial development, is another consumer of gravel. The size, shape, hardness, and chemical composition of the gravel in many streams make the gravel ideal for use in concrete. Instream gravel can be in great demand for construction material because the water has already eroded the weak material out of the rock, leaving durable, rounded, and well-sorted gravel (Kondolf, 1997). Because of the low oil content of certain rocks, the problem of concrete crumbling is lessened. Construction near areas of population growth and high population density consume a large volume of instream gravel. Road building and maintenance is another industry that uses gravel and quarry rock. As shown by the survey described in the previous section, some county highway departments use quarry rock exclusively, while a few use only gravel.

On the other side of economic benefits of gravel mining is the possibility of negative effects in wetlands, recreational areas, riverine habitat, and a potential loss of land. A study conducted by Arkansas State University (Kaminarides and others, 1996), in an area similar to southern Missouri, determined that the economic benefits of instream gravel mining did not outweigh the environmental costs in Crooked Creek and Kings, Spring, Illinois, and Caddo Rivers in Arkansas. The environmental costs were listed as money lost from farms, real estate, fisheries, and recreation. These conclusions indicated that although instream gravel mining was an important industry, mining would not be acceptable or safe in some streams as it was being practiced.

ENVIRONMENTAL CONSIDERATIONS

In addition to changing the aesthetic character of a stream, instream gravel mining potentially alters channel depth and width, riparian vegetation, streambed substrate texture, bank vegetation and substrate, and aquatic habitat, as shown in the two photographs of Barren Fork, Miller County, Missouri, within and downstream from gravel mining (figs. 3A and 3B). Studies have indicated that gravel mining on gravel bars and the riparian corridor of streams can result in head cutting, channel incision and lateral instability, increasing stream gradient, channel relocation, and scouring and erosion (Sandecki, 1989; Kondolf, 1994). These physical changes can result in increased stream turbidity and temperature. The removal of the larger gravel particles releases fine sediment into the stream system. These habitat disruptions and channel instability can cause overall reduction in biological diversity and production (Benke, 1990; Brown and others, 1998; Waters, 1995). The released sediments increase the turbidity of the stream, which obstructs sunlight from reaching aquatic plants and algae, reducing the primary productivity of the stream and associated wetlands.

Effects on Fish Communities

Fish communities are potentially impacted by changes in turbidity and sediment erosion, transport, and deposition. Increased turbidity can affect fish by reducing their feeding efficiency, reducing their tolerance to diseases, and increasing their overall physiological stress. Increased sediment loads also can disrupt fish reproductive success by interfering with the viability of their eggs and fry (Waters, 1995). Arkansas Game and Fish Commission conducted a short-term study on the Kings River that demonstrated a 50 percent decrease in smallmouth bass downstream from gravel mines because of a 15-fold increase in silt or turbidity. The fine sediments cause smallmouth bass and other sensitive game fish to have poor survival rates because of the smothering of their eggs and fry (Arkansas Game and Fish Commission, written commun., 1997).

Figure 3. Barren Fork in Miller County, Missouri, 2000. ***A***, Active instream gravel mining ***B***, the natural channel approximately 100 meters downstream from photograph A.

Effects on Invertebrate Communities

Benthic invertebrates can suffer significant negative effects from deposited sediments because they are adapted to specific substrate particle sizes. A stream with a diverse substrate size composition will support a diverse benthic invertebrate community. As sediment settles into the interstitial spaces in the streambed, the availability of diverse substrate decreases, resulting in decreased species diversity, abundance, and productivity. A mussel community is especially sensitive to fine sediments and substrate alteration, which can result in a total loss of a species (Parmalee, 1993). Fish communities depend on the benthic invertebrate community as a food source. Healthy fish populations rely on diverse invertebrate communities.

EXTENT OF GRAVEL MINING

Instream gravel mining in Missouri is regulated by the Missouri Department of Natural Resources, Land Reclamation Program (MDNR, LRP) and to a lesser extent, the U.S. Army Corps of Engineers. All commercial gravel operations must obtain a permit from MDNR, LRP, though non-commercial operations and county and local governments do not need a permit. Because many operations do not need to obtain a permit, it is difficult to know the extent of instream gravel operations in southern Missouri.

The survey of county highway departments, described in a previous section, contributed to the understanding of the extent and density of gravel mining operations. Drive-by field reconnaissance throughout most counties contributed information on gravel mining locations. As illustrated by figure 4, most gravel mining sites located are not permitted by the State. Of the approximately 750 gravel mining sites identified, about 23 percent were permitted by the State. Also noticeable in figure 4 are gaps of information in the dataset. As populations grow and shift locations, changes in gravel mining sites would likely occur.

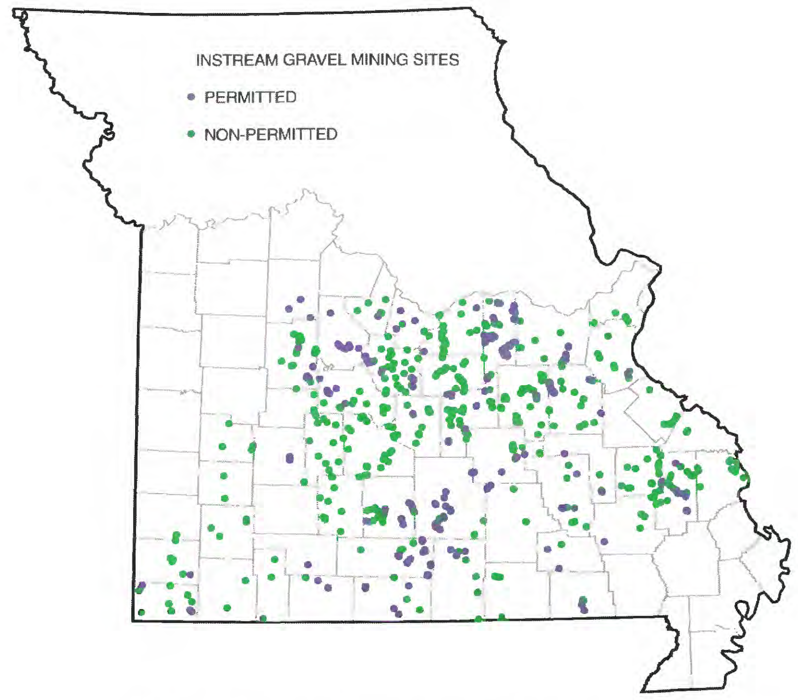

Figure 4. Sites where instream gravel mining was recorded in 1999.

REFERENCES

Benke, A.C., 1990, A perspective on America's vanishing streams: Journal of the North American Benthological Society, v. 9, p. 77–88.

Brown, A.V., Lyttle, M.M., and Brown, K.B., 1998, Impacts of gravel mining on gravel bed streams: American Fisheries Society, v. 127, p. 979–994.

Bull, W.B., and Scott, K.M., 1974, Impact of mining gravel from urban stream beds in the southwestern United States: Geology, v. 2, p. 171–174.

Kaminarides, J.S., Kesselring, R., Marburger, D., Grippo, R., Harp, G., and others, 1996, An economic impact analysis of stream bed gravel mining in the State of Arkansas: Arkansas State University, Office of Business Research, unpaginated.

Kondolf, G.M., 1994, Geomorphic and environmental effects of instream gravel mining: Landscape Urban Planning, v. 28, p. 225–243.

——— 1997, Hungary water—Effects of dams and gravel mining on river channels and floodplains, *in* P.T. Bobrowsky, ed., Aggregate Resources—A global perspective: Brookfield, Vermont, A.A. Balkema, p. 113–129.

Lyttle, M.M., 1993, Impacts of gravel mining on fish communities in three Ozark streams: Fayetteville, University of Arkansas, M.S. thesis, 76 p.

Parmalee, P.W., 1993, Freshwater mussels (Mollusa: Pelecypoda: Unionidae) of Tellico Lake—Twelve years after impoundment of the Little Tennessee River: Annals of Carnegie Museum, v. 62, p. 81–93.

Sandecki, M., 1989, Aggregate mining in river systems: California Geologist, v. 42, no. 4, p. 88–94.

U.S. Geological Survey, 2001, Mineral industry surveys—Crushed stone and sand and gravel in the fourth quarter 2000: U.S. Department of the Interior, accessed April 26, 2001, at URL http://minerals.usgs.gov/minerals.

U.S. Geological Survey and Missouri Department of Natural Resources, Division of Geology and Land Survey, 2000, The mineral industry of Missouri: U.S. Department of the Interior, accessed April 26, 2001, at URL http://minerals.usgs.gov/minerals/pubs/state/982900.pdf.

Waters, T.F., 1995, Sediment in streams—Sources, biological effects, and control: American Fisheries Society Monograph 7.

Woodward-Clyde Consultants, 1980, Gravel removal studies in artic and subartic floodplains in Alaska: Washington, D.C., U.S. Fish and Wildlife Service, Report FWS/OBS-08/09.

For more information contact any of the following:

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For more information on all USGS reports and products (including maps, images, and computerized data), call 1-888-ASK-USGS.

Additional earth science information can be found by accessing the USGS "Home Page" on the Internet at "http://www.usgs.gov".