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Quality of Ozark Streams and Ground Water, 1992-95

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Land use and human activities result in water quality differences in the Ozarks. These differences can affect humans and biota that live in or visit the Ozarks.

What are some of the major land uses and human activities that can affect water quality in the Ozarks?

- Land use is almost equally divided between forested and agricultural land (the two most extensive land uses in the Ozarks), but is not distributed evenly across the area. The eastern and extreme southern parts of the Ozarks are primarily forested, while agricultural land is most common in other areas.
- Much of the agricultural land is pastureland associated with production of poultry and cattle.
- Lead and zinc mining occurs or has occurred in some areas.
- Large urban areas are not common and only four cities have populations exceeding 25,000 (1990 census). However, even small urban areas can affect water quality.

What differences in water quality can result from these land uses and activities?

- Nutrients, bacteria, pesticides, and other organic compounds generally are found in higher concentrations or more frequently in agricultural or urban areas than in forested areas.
- Lead, zinc, and some other metals are found in higher concentrations in water, bed sediment, or biological tissue downstream from mining areas.

What does this mean to humans, animals, and plants in the Ozarks?

- Elevated nutrient concentrations in some areas appear to be affecting biological communities but generally do not make water unsafe for drinking.
- Bacteria concentrations may be high enough to cause concern in some areas at some times.
- Pesticides and other organic compounds generally are not of concern.
- Metal concentrations in some mining areas are of concern to humans and wildlife.
- Biological communities are being altered by habitat and water-quality changes.

Inside...

Specific information about nutrients, bacteria, pesticides, and metals and their effects

On the back...

Information about effects on biological communities

How to get more information

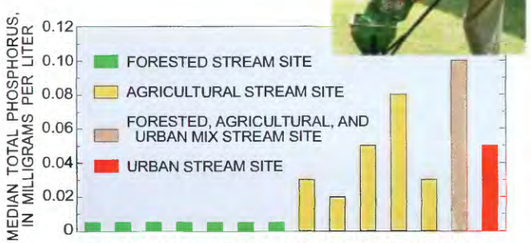
How Do Land Use and Human Activities in the Ozarks Affect Concentrations of:

Nutrients?

Nutrient concentrations in streams and ground water are higher in areas with greater agricultural land use or downstream from wastewater-treatment plants than in forested areas. These higher concentrations seldom exceed U.S. Environmental Protection Agency drinking-water standards, but may result in increased algal growth in streams and lakes.

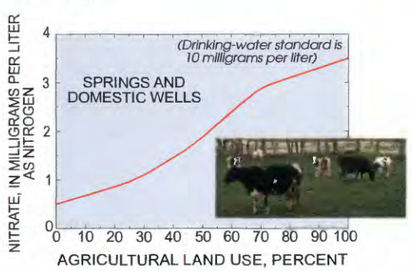
Nitrogen and phosphorus are essential plant nutrients. However, elevated concentrations can cause excessive growth of aquatic plants and can have detrimental effects upon desired uses of water. Major sources of nitrogen and phosphorus are poultry, cattle, and swine wastes, human wastes, and fertilizers.

Nitrate and phosphorus concentrations are higher at Ozark stream sites representing agricultural (mostly poultry and cattle production) basins than at sites in forested basins. Streams downstream from wastewater-treatment plants or urban areas can have nutrient concentrations that are substantially higher than concentrations in some agricultural basins.



Nutrient concentrations are elevated in streams in agricultural or urban areas.

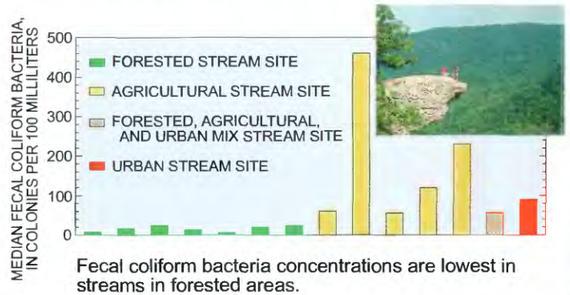
Land use also affects nutrient concentrations in wells and springs. Nitrate concentrations are strongly associated with the percentage of agricultural land near wells or springs. Concentrations in samples from densely forested areas almost always are less than 1 mg/L (as nitrogen). Concentrations increase as the percentage of agricultural land increases. Concentrations in areas with greater than 75 percent agricultural land use generally are about 3 mg/L.



Nitrate concentrations in ground water increase as nearby agricultural land use increases.

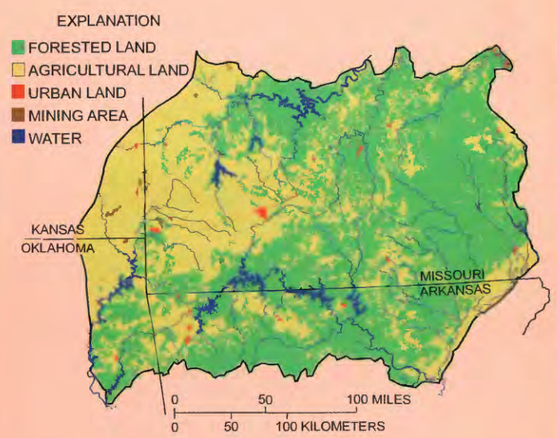
Bacteria?

Bacteria concentrations in streams are lower in basins with greater forest land use. Fecal coliform bacteria concentrations generally are higher at stream sites representative of agricultural and urban basins than at sites in forested basins. Median concentrations ranged from about 10 to 20 colonies per 100 milliliters (col/100 mL) at forested sites and about 60 to 460 col/100 mL at other sites.



Fecal coliform bacteria concentrations are lowest in streams in forested areas.

State water-quality standards vary from State to State, by time of year, and with use of the water body. A value of 200 col/100 mL (subject to specific sample frequency and statistics and time of year) is often used by State regulatory agencies as the maximum allowable concentration for whole-body contact waters. Median fecal coliform bacteria concentrations at some sites in agricultural areas are greater than this concentration.

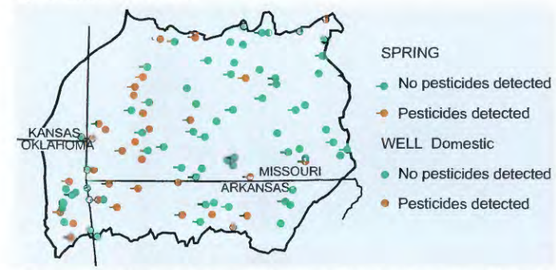


The Ozarks is almost equally divided between forest and agricultural land use; small areas of urban and mining land also occur. About 2.1 million people live in the area (1990) and about 30 percent of these people get their water from relatively shallow domestic wells. Geology of much of the area allows rapid and substantial movement of water between the surface-water and ground-water environments.

Pesticides?

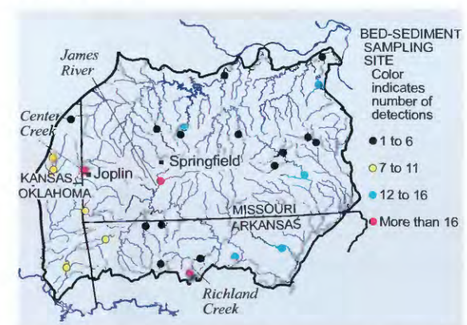
Concentrations of pesticides and other organic compounds in water, bed sediment, and biological tissue were usually low. Concentrations are usually below detection limits and when detected are usually relatively low compared to concentrations from other areas of the Nation, and to water-quality standards or criteria. However, no standards or criteria exist for many of the detected compounds.

In streams and ground water, pesticides are less prevalent in forested areas than in other areas. Pesticides are detected more commonly and in higher concentrations in streams in agricultural or urban basins than in streams in forested basins. Pesticides in ground water are detected more frequently at sites associated with greater percentages of agricultural land use.



In ground water, more pesticides are found in agricultural areas.

In bed sediment, the greatest numbers of pesticides and other organic compounds generally are detected at sites downstream from urban areas. Pesticides and semivolatile organic compounds in 27 bed-sediment samples were detected more frequently at sites downstream from urban areas. Samples from three sites each contained detectable concentrations of more than 16 compounds. Two of these sites (downstream from Springfield and Joplin, Mo.) are in urban basins; the third site is in a forested basin.



In bed sediment, more organic compounds generally are found near urban areas. Concentrations generally are low.

In biological tissue, pesticides were detected at 5 of 26 stream sites. Three chlordane compounds were detected in Asiatic clam tissue at a site downstream from Springfield, Mo. These compounds frequently are present downstream from urban areas. DDT, DDE, or dieldrin was detected at four widely separated sites.

Metals?

Concentrations of sulfate and some trace elements in water from streams in areas of historical or active lead-zinc mining tend to be higher than in areas where mining has not occurred. Lead concentrations are not higher in mining areas. Metal concentrations usually did not exceed U.S. Environmental Protection Agency drinking-water standards or criteria for protection of human health or aquatic life. However, zinc concentrations often exceeded freshwater aquatic life criteria in Center Creek west of Joplin, Mo.

Lead-zinc mining areas of the Ozarks. The Viburnum Trend subdistrict is the only area currently (1999) being mined for lead or zinc.

Lead and zinc concentrations in water, bed sediment, and fish or clam tissue from mining areas of the Ozarks

[Values in red substantially exceed background concentration data. <, less than]

Site	Mining area	Water (micrograms per liter)	Bed sediment (micrograms per liter)	Tissue (micrograms per gram)
			Lead	
Center Creek	Tri-State	<1	370	0.3
Big River	Old Lead Belt	<1	2,300	134
Meramec River	Old Lead Belt	no data	180	12.2
West Fork of Black River	Viburnum Trend	<1-11	100-950	0.5-8.3
Strother Creek	Viburnum Trend	<1-3	200	0.7
			Zinc	
Center Creek	Tri-State	67-270	5,600	770
Big River	Old Lead Belt	8-19	670	514
Meramec River	Old Lead Belt	no data	140	296
West Fork of Black River	Viburnum Trend	13-33	120-460	70-110
Strother Creek	Viburnum Trend	33-148	1,200	150

Concentrations of lead and zinc in bed sediment and tissue are substantially higher in areas with mining activities (historical or active). Lead and zinc concentrations in bed sediment at sites downstream from lead-zinc mines may have adverse biological effects on stream-bed organisms.

The elevated lead and zinc concentrations in tissue and biochemical changes in fish exposed to lead in mining areas of the Ozarks (Schmitt and others, 1993) suggest that both elements are available to fish and Asiatic clams for biological processing. Missouri currently (1998) advises the public not to eat some species of fish from some rivers affected by past mining in the Old Lead Belt of eastern Missouri (Gale Carlson, Missouri Department of Health, written commun., 1998).

How Do Land Use and Human Activities in the Ozarks Affect Biological Communities?

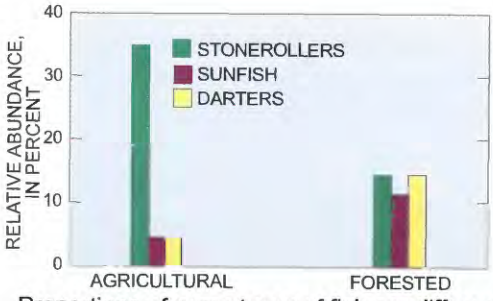
Compared to other parts of the United States, many fish species live in the Ozarks. Approximately 175 species (including introduced species) are present in the Ozarks; at least 19 of these species exist nowhere else in the world. Many of these 175 species are intolerant of habitat or water-chemistry degradation.

Fish community composition appears to be related to riparian vegetation, substrate, and water chemistry. Several factors that can be affected by land use appear to be related to community composition. These factors are riparian vegetation, substrate size and embeddedness, and nutrient and sediment concentrations. Elevated concentrations of lead, zinc, and semivolatile organic compounds in bed sediment may be factors affecting the fish community at some sites. Urbanization, agriculture, lead-zinc mining, gravel mining, and other activities can affect some of the factors, which consequently affect fish, invertebrate, and algal communities.

Cleared pastureland commonly extends to (or nearly to) streambanks in agricultural areas, probably resulting in faster growth of attached algae in these streams. Small streams in agricultural basins generally are more open to sunlight because of lack of overhead trees than small streams in forested basins. More sunlight and higher nutrient levels in streams in agricultural areas probably result in faster growth of algae in these streams.

Stonerollers make up a greater percentage of the fish at agricultural and urban sites than at forested sites. Faster algal growth in nutrient-enriched streams would encourage greater numbers of these algae-eating minnows. The relative abundance (46 percent) of stonerollers at a site downstream from a small wastewater-treatment plant and instream gravel mining may be elevated because of nutrient enrichment and other habitat changes.

Sunfish (including the black basses) and darters make up a smaller percentage of fish at agricultural sites than at forested sites. Members of the sunfish family, especially smallmouth bass, are important game fish in Ozark streams. Darters generally are considered to be sensitive to water-chemistry or habitat degradation. At least 10 species of darters in the Ozarks exist nowhere else in the world.



Proportions of some types of fish are different between agricultural and forested streams.

James C. Petersen, James C. Adamski, Richard W. Bell, Jerri V. Davis, Suzanne R. Femmer, David A. Freiwald, and Robert L. Joseph

References

Petersen, J.C., Adamski, J.C., Bell, R.W., Davis, J.V., Femmer, S.R., Freiwald, D.A., and Joseph, R.L., 1998, Water quality in the Ozark Plateaus, Arkansas, Kansas, Missouri, and Oklahoma, 1992-95: U.S. Geological Survey Circular 1158, 33 p.

Schmitt, C.J., Wildhaber, M.L., Hunn, J.B., Tieger, M.N., Steadman, B.L., and Nash, T., 1993, Biomonitoring of lead-contaminated Missouri streams with an assay for d-amino-levulinic acid dehydratase (ALA-D) activity in fish blood: Archives of Environmental Contaminants and Toxicology, v. 25, p. 464-475.

Photo credits: smallmouth bass angler, Gregg Patterson; forest area, A.C. Haralson, Arkansas Department of Parks and Tourism.

Water quality also is affected by hydrologic, geologic, and biologic factors. Some examples:

- **Hydrologic**—nutrient and bacteria concentrations downstream from wastewater-treatment plants usually are lower during wet periods because of more water for dilution.
- **Geologic**—median nitrate and phosphorus concentrations generally are higher in small springs than in wells because water flowing from small springs generally has moved along shallower pathways and thus is more susceptible to surface contamination.
- **Biologic**—riparian trees provide shade and bank stability, lowering water temperatures and the amount of sediment eroding into streams.

The National Water-Quality Assessment (NAWQA) Program of the U.S. Geological Survey is designed to describe current water-quality conditions for a large part of the Nation's ground- and surface-water resources, to describe how water quality is changing over time, and to improve our understanding of the natural and human factors that affect water quality. These goals are being achieved through investigations of more than 50 of the Nation's most important river basins and aquifer systems. The Ozark Plateaus study was among the first 20 investigations that began this water-quality assessment in 1991. This fact sheet summarizes the results of water-quality sampling and ecological assessments performed between 1992-95 in the Ozark Plateaus. A more detailed summary can be found in Petersen and others (1998).

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