APPENDIX V

GRAND RIVER WATERSHED INVENTORY AND ASSESSMENT

GRAND RIVER
WATERSHED
INVENTORY AND ASSESSMENT

This information is based on the
Grand River Watershed Inventory and Assessment
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EXECUTIVE SUMMARY

The purpose of this plan is to consolidate information regarding streams and stream fish populations within the Grand River Basin. The size and complexity of the basin combined with limited existing information requires this document to be very general.

The Grand River Basin is located in northwest Missouri and southwest Iowa. The watershed consists of 7,900 square miles with over three-fourths of this area in Missouri. The basin is best characterized as rural with a declining population and no major urban areas. Land use is predominantly agricultural with cropland the largest component. The basin contains more than 1,000 third-order and larger streams. Approximately 2% of the basin is in public ownership.

Streams within the basin are typically turbid. Historical accounts indicate many basin streams have always been muddy. Even under pristine conditions it is unclear whether current water quality standards for turbidity would be achieved. Water quality standards for iron, magnesium and fecal coliform bacteria are frequently exceeded. Most water quality problems are associated with non-point source pollutants such as soil erosion and manure runoff.

Habitat loss within the basin is a major factor limiting stream fish populations. Filling of the channel with sand and silt has resulted in the loss of pool habitat and coarse substrate. Channelization and excessive levee construction are viewed as legitimate stream management practices by many landowners. Several streams have been channelized for over half their length and lack a suitable corridor. The combination of channel alterations and inadequate corridors has resulted in tall streambanks that are rapidly eroding. Except in the uppermost portions of the watershed, nearly all streambank erosion problems are too severe for biotechnical measures to be practical. Due to the severe streambank erosion problem, Missouri Department of Conservation (MDC) stream improvement efforts throughout the basin have very limited application.

The basin contains several remnant high quality stream reaches supporting diverse aquatic communities. These streams are characterized by unchannelized portions that are vertically stable due to bedrock control. Floating and fishing these streams would appeal to people if they were aware of their existence.

Sixty species of fish have been collected in the Grand River Basin since 1963. Most species are generalists that are tolerant of turbid water. Channel catfish (*Ictalurus punctatus*) are the most popular sportfish within the basin. Flathead (*Pylodictus olivaris*) and blue catfish (*I. furcatus*) provide trophy fishing opportunities. Topeka shiner (*Notropis topeka*), blue sucker (*Cycleptus elongatus*) and pallid sturgeon (*Scaphirhynchus albus*) are the fish species on or considered for the Federal endangered species list. Trout-perch (*Percopsis omiscomaycus*) and mooneye (*Hiodon tergisus*) are state listed as rare in Missouri. Paddlefish (*Polyodon spathula*) is listed as a watch list species. Anglers fished an estimated 74,357 days on the Missouri portion of the Grand River in 1987.

Management efforts will concentrate on the protection of high quality watersheds or those that can be improved with a reasonable amount of effort. Cooperative efforts with other resource agencies during the permitting process will be important to protect high quality habitat. Landowner assistance through technical assistance, cost share and education will be vital to success within high priority sub-basins. An emphasis on public awareness will be maintained throughout the basin through various media outlets, aquatic education programs and increased stream access.

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LOCATION

The Grand River originates in southwestern Iowa and flows through northwestern Missouri (Figure 1) to its confluence with the Missouri River near Brunswick, Missouri (Missouri River Mile 250). The main stem of Grand River is formed by the confluence of the West Fork (also known as the Grand River) with the Middle and East forks near Albany, Missouri.

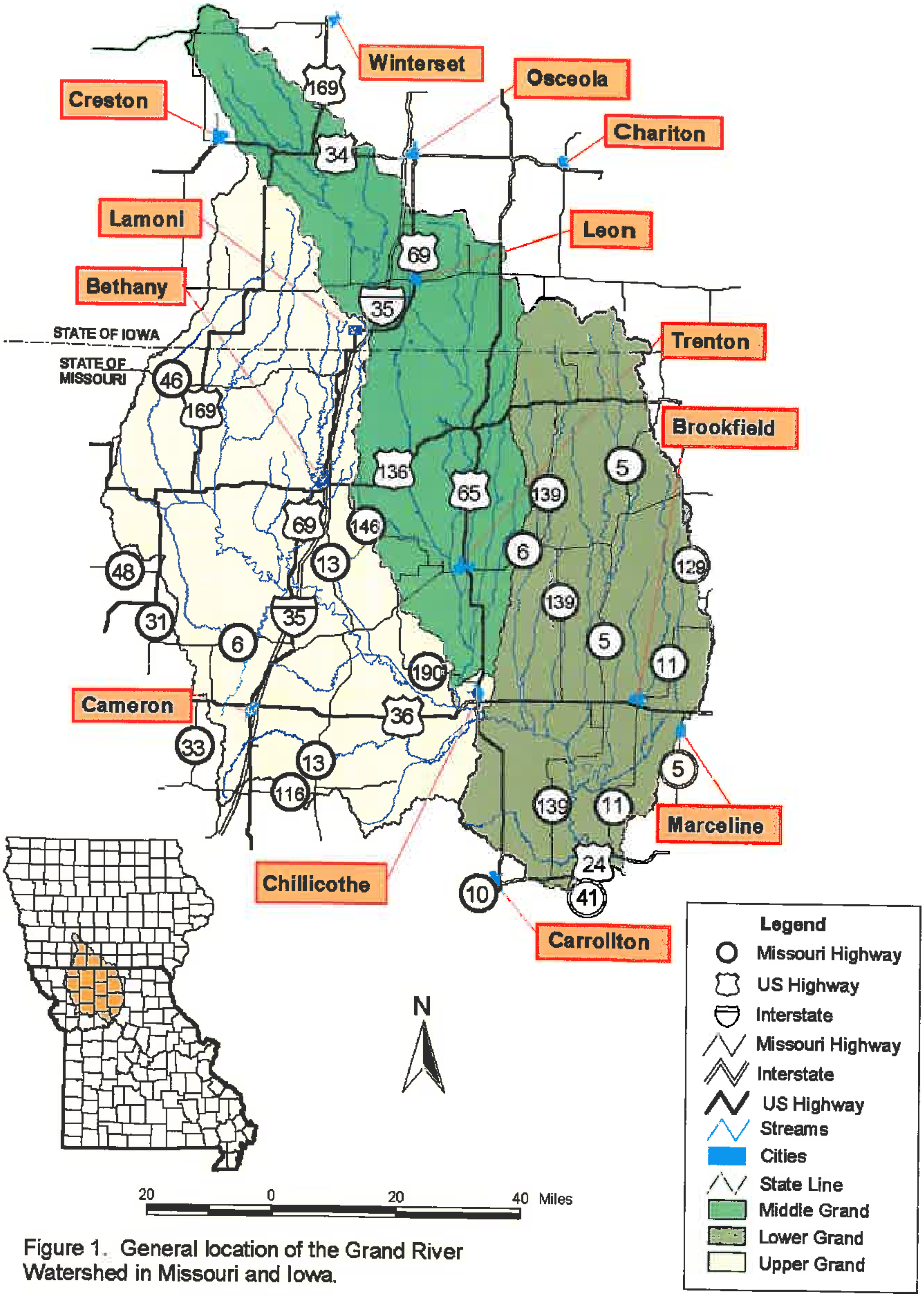

Figure 1. General location of the Grand River Watershed in Missouri and Iowa.

GEOLOGY

Physiographic Region

The Missouri portion of the basin lies entirely within the Dissected Till Plain (MDNR 1986) (Figure 2). The topography consists of broad, flat stream valleys and rolling to undulating (occasionally hilly) uplands (Pflieger 1989).

Geology and Soils (USCOE 1963)

Pennsylvanian shales, sandstones, and limestones underlie the basin (Figure 3). The formations dip slightly to the northwest, exposing outcrops of successively younger formations from the mouth to the headwaters. The entire area was glaciated and later subjected to extensive loessial deposits. The predominating soils are derived from the glacial drift and loess, however, the soil types owe their characteristics more to the stage of weathering than the parent material. Loessial silt loam soils cover the greater part of the broad divides and gentle slopes. Glacial silt loams and silty clay loams, usually highly eroded, occur on the slopes. The alluvial soils consist principally of the Wabash series, of which silt loams are the most extensive and most important agriculturally. Generally, the soils are fine-grained and easily erodible.

Watershed Area

The Grand River Basin is the largest basin in Missouri, north of the Missouri River (MDNR 1986). The drainage area of the basin is 7,900 square miles. A majority of the basin (78%) is in Missouri (USCOE 1963). The basin is approximately 150 miles long and 90 miles wide. The drainage pattern is asymmetrical; almost one-fifth of the area is to the south and four-fifths to the north of the main stem which serves as a collector channel for many parallel tributary basins of similar elongated configuration (USCOE 1963). The funnel shape of the basin makes it ideal for flooding in the lower portion of the basin (Wells 1948).

In the Locust Creek basin, watershed area appeared to correlate well with link magnitude (the number of first order segments above any given point on a channel; Osborne and Wiley 1992), though no statistical analysis was performed.

Channel Gradient

There are more than 1,000 third-order and larger streams within the Grand River Basin. Due to the large number of streams within the basin, gradient information was calculated for only fifth-order and larger streams.

Average gradients for streams fifth-order and larger range from 3 feet/mile on Grand River to 44 feet/mile on Pop's Branch (near Princeton, Missouri). Gradient plots were drawn for all streams fifth-order and larger. Higher gradient streams were mostly located in the northwest part of the basin. This area is characterized by steep hills with narrow floodplains. For gradient information on specific streams please contact:

Missouri Department of Conservation
Greg Pitchford
15368 LIV 2386
Chillicothe, MO 64601
660-646-6122

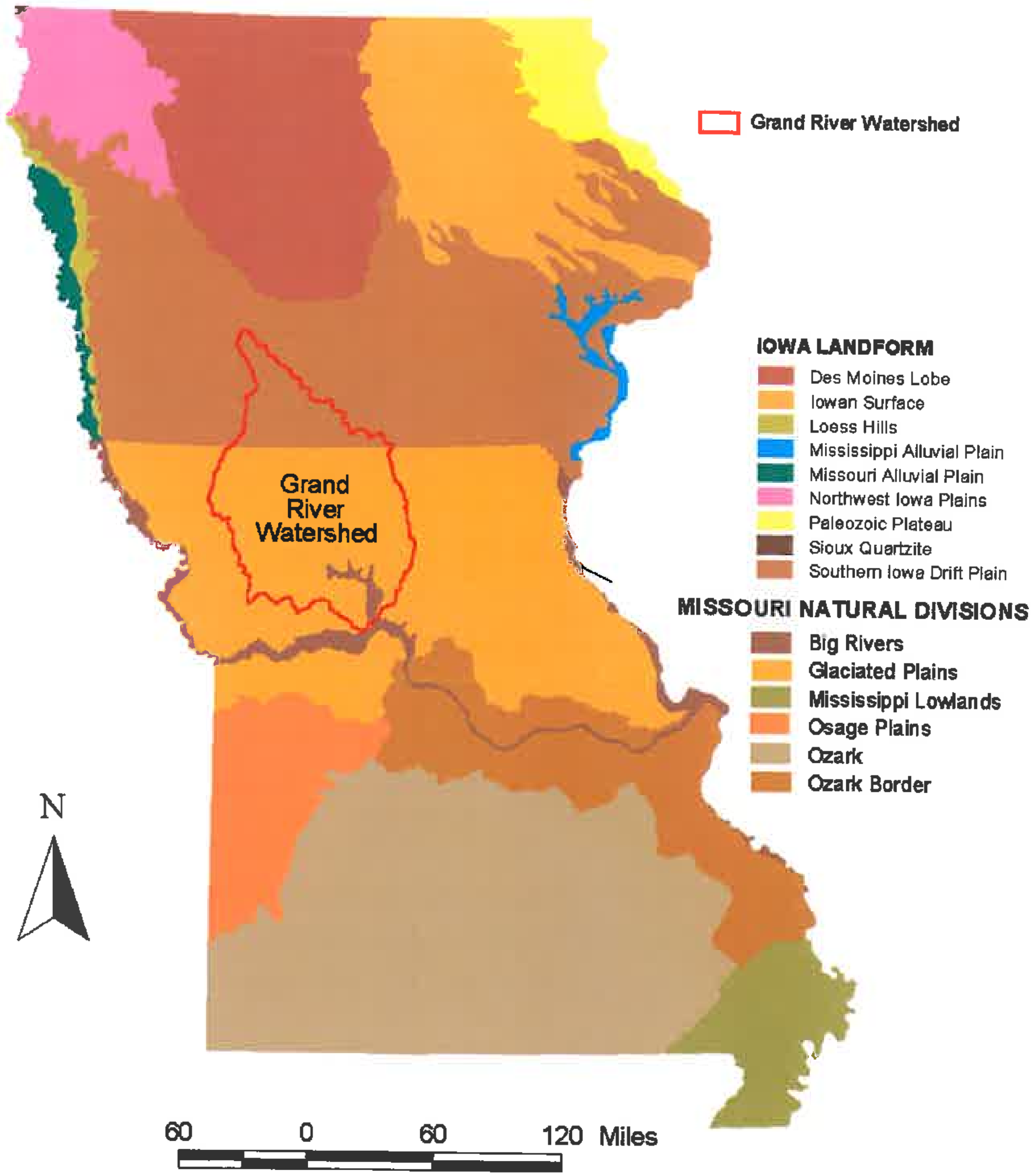

Figure 2. Location of the Grand River watershed in the natural divisions of Missouri and the landforms of Iowa.

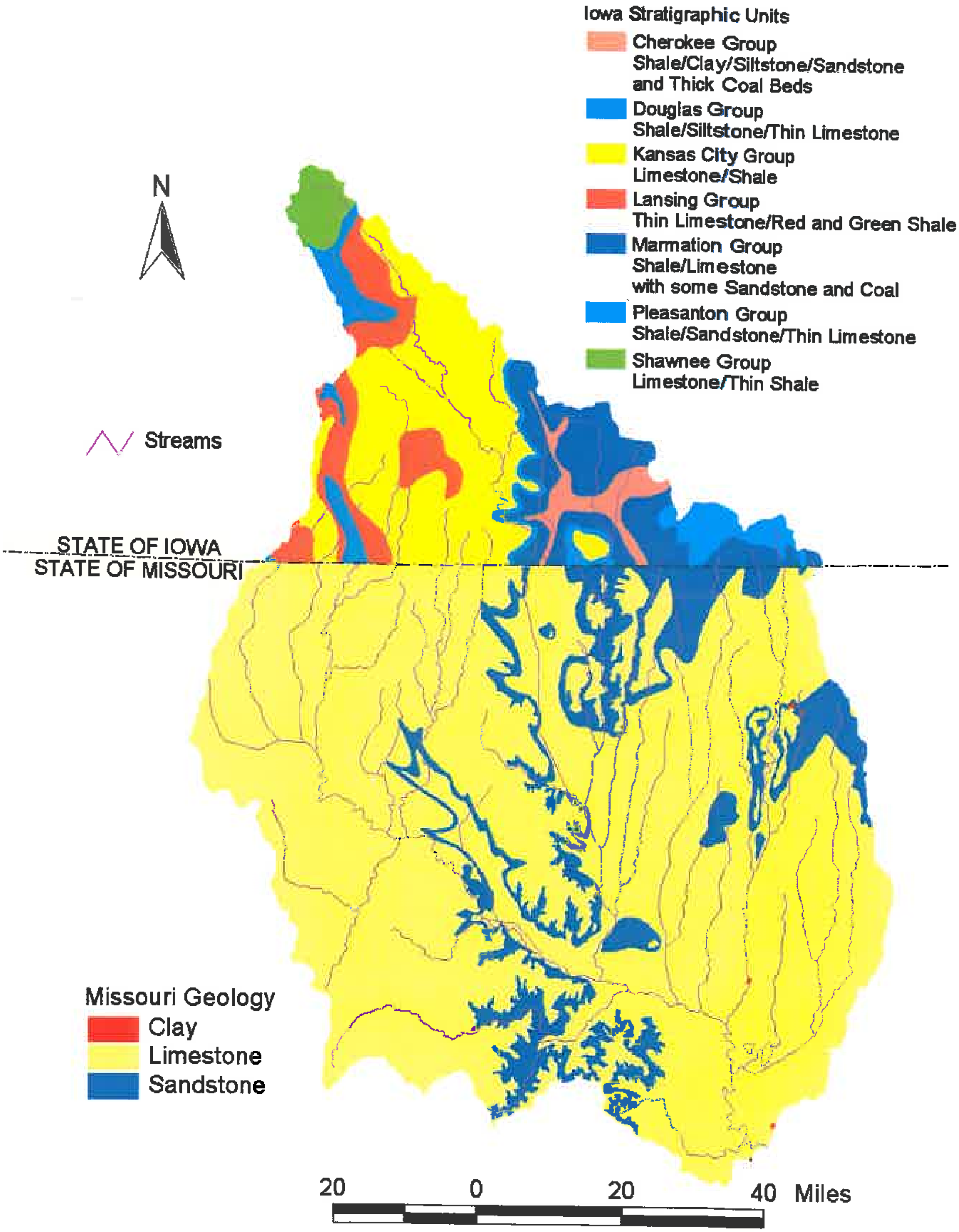

Figure 3. Geology in the Grand River watershed in Missouri and Iowa.

LAND USE

Historic and Recent Land Use

The presettlement Grand River Basin was characterized by long narrow prairies generally oriented north-south and divided by timbered ridge tops and stream valleys (Schroeder 1982). Only in the southwest part of the basin did prairies open up to wide expanses averaging one or two miles across.

Schroeder (1982) describes the riparian areas common to the basin.

> "In addition to the upland prairies, bottomland prairies occurred regularly on the flood plains of streams, sometimes becoming so extensive that timber was restricted to the river bank and rougher valley slopes.
>
> Large areas of the broad flood plains of streams in the Grand-Chariton region supported a `luxuriant growth of coarse wild grass' (Watkins et al. 1921). Sometimes these wet prairies occupied the entire bottomland, except for a timber strip fringing the banks of streams. Clay or gumbo soils prevented good drainage, and marshes and ponds abounded.
>
> Survey notes reveal a complex pattern of small lakes or ponds, wet prairie, intensively meandering creeks with and without river bank timber, and dense timber only along the Grand River channel in northwest Chariton County in what is now the Swan Lake area. There was nothing but wet prairie at the present Swan Lake site."

The first European settlers came to the Grand River region in 1817. However, extensive settlement did not begin until after 1830 (Boehner 1937). Much of the agricultural activity was related to clearing trees for firewood and row crop production. Prairie areas, especially those near streams were not farmed because primitive implements could not plow the tough soil. Early settlers also believed that land that did not grow trees could not grow crops (Boehner 1937). Grazing and timber clearing probably had the most impact on streams during this time.

In 1835, the Missouri State Legislature declared Grand River to be navigable to the Iowa state line, but steamboat navigation was never possible much above Chillicothe (Boehner 1937). There are accounts of steamboats making trips up the Grand River as far as the vicinity of Utica and Breckenridge (Livingston County) in the period of 1842-1865 (Boehner 1937). The steamer trips up the Grand River often experienced long delays due to low water conditions and navigation hazards. The town of Bedford in Livingston County derived its name from a steamer of that name that struck a log and was wrecked beyond repair during low water on the Grand River 12 miles southeast of Chillicothe (Boehner 1937). In the 1848-49 session, the General Assembly appropriated $200,000 to improve Grand River for navigation (Birdsell and Dean 1882). Much of that activity was probably snag removal. By 1886, the use of channelization, jetties, and rip-rap was being considered to facilitate navigation and improve the floodplain for farming (St. Louis National Historical Co. 1886).

In the late 1800's and early 1900's limited channelization was done using pilot channels (USCOE 1963). Around 1915, channelization became a common practice (Wells 1948). Drainage districts were formed to cooperate on stream channelization projects. Much of the early channelization was done in the upper reaches of the Grand River. In Grundy County, channels were dug in all of the major rivers and streams by the 1920's (USDA-SCS 1990). No organized maintenance has been done since the early 1950's (USDA-SCS 1990). The rapid accumulation of sediment in the lower Grand River decreased the channel capacity. Channelization projects were then undertaken in the lower portion of the basin to solve the resulting floods (Wells 1948).

The 1970's and 1980's are considered the private levee construction periods (USDA-SCS 1982). Rising land prices and the increased availability of heavy equipment made levees an attractive alternative along streams even without federal cost share assistance. Today channelization and levee construction are viewed by landowners as legitimate stream management practices throughout the basin. Since 1915, approximately 50 drainage districts and 10 privately-financed organizations have spent more than $10,000,000 on channel straightening, drainage facilities, and levees to protect 385,000 acres of land. However, the construction of the various projects was not coordinated and they provide differing levels of protection (USCOE 1989).

The basin has been described as a "typical Midwestern rural area with scattered small towns and a low population density" (USDA-SCS 1982). There are no major urban areas within the basin. Chillicothe (pop. 9,000), Trenton (pop. 6,129), Brookfield (pop. 4,888), Cameron (pop. 4,831), Carrollton (pop. 4,406), Bethany (pop. 3,005), Lamoni, Iowa (pop. 2,705), and Greenfield, Iowa (pop. 2,074) are the major towns within the Grand River Basin.

Land use in the Missouri portion of the Grand River Basin is estimated to be 92% agricultural and 5% forest (Table 1) (Figure 4, Lower Grand, Middle Grand, and Upper Grand sub-basins).

Soil Conservation Projects

Missouri has approximately 1.3 million acres (26%) of the basin within Watershed Protection and Flood Prevention Act (Public Law 83-566) watershed projects (USDA-SCS 1993). The Panther Creek Watershed project in Harrison County, is the first completed PL-566 project. Ten other projects within the basin are in various stages of planning and construction (Table 2).

Special Area Land Treatment (SALT) projects have been initiated in the watersheds of 37 streams and lakes within the basin (Table 3). SALT projects are state-funded programs administered by local Soil and Water Conservation Districts (SWCD) to reduce soil erosion. Approximately 360,430 acres are enrolled in SALT projects throughout the Missouri portion of the basin. When all projects are completed, 4% of Missouri's portion of the basin will be treated.

Public Areas

There are 72,342 acres of public land within the Grand River Basin (Figures lp, mp, and up). A total of 54,281 acres are in Missouri with the Missouri Department of Conservation (MDC) managing approximately 56% of that land. In Iowa, 18,061 acres of the basin are in public ownership.

Management of MDC lands ranges from an intensively managed wetland area to moderately managed upland and natural areas. Opportunities for both consumptive and non-consumptive recreational activities are available on public land within the basin.

There are 22 stream access sites within the Missouri portion of the basin (Figure sa). Seven additional sites will complete MDC's stream access acquisition plan objectives (McPherson 1994). Twelve access sites on the mainstem of Grand River provide opportunities for float trips. Portions of Thompson River, Grindstone Creek, Big Creek (Harrison and Daviess counties), Grand River and Locust Creek have been highlighted as good stream reaches for floating (Pemberton 1982).

There are 27 public fishing lakes that exist or are in the planning phase (20 in Missouri, 16 in Iowa; Figure lk). Construction of a public fishing lake near Braymer, Missouri would complete MDC's public lake acquisition goal of providing close to home fishing opportunities to Missouri residents within the basin (Ryck 1991).

Corps of Engineers 404 Jurisdiction

The Missouri portion of the Grand River Basin is under the jurisdiction of the Kansas City District of the U.S. Army Corps of Engineers. The Iowa portion is administered by the Rock Island District. Applications for 404 permits should be addressed to one of the following offices:

In Missouri:

700 Federal Building
Kansas City, MO 64106-2896
Attention: MRKOD-P
816/983-3670
website: www.nwk.usace.army.mil

In Iowa:

Clock Tower Building
RockIsland,IL61201-2004
Attention: NCROD-S
309/794-5371
website:www.mvr.usace.army.mil/

Table 1. Land use in the Missouri portion of the Grand River Basin in 1987 (S. Baima, USDA-Soil Conservation Service, personal communication).

Watershed	Cropland (Acres)	Forest (Acres)	Pasture (Acres)	Other (Acres)
Upper Grand (above Chillicothe)	1,019,600	92,900	574,000	143,600
Lower Grand (below Chillicothe)	730,100	86,200	421,900	37,000
Thompson	397,600	23,600	202,000	43,200
	2,147,300	202,700	1,197,900	223,800
	(60%)	(5%)	(32%)	(6%)

Table 2. Status of PL-566 watershed projects in the Grand River Basin as of November 1993. (USDA-SCS 1993)

Watershed	Acres	Status
East Fork Big Creek	62,073	Approved for operations
Panther Creek	22,035	Project completed, January 1976
West Fork Big Creek	187,290	Approved for operations
Grindstone/Lost/Muddy Creeks	209,100	Approved for operations
Upper Locust Creek (amended) MO/IA	238,700	Approved for operations
Big/Hurricane Creeks (amended)	176,800	Approved for operations
East Yellow Creek	122,700	Approved for operations
East Fork Grand River	168,400	Active planning
East Locust Creek	78,700	Approved for operations
Little Otter Creek	6,410	Active planning
Town Branch (Albany)	6,745	Approved for operations

Table 3. Special Area Land Treatment (SALT) projects within the Missouri portion of the Grand River Basin.

District	Project Name	Watershed
Caldwell	Hamilton City Reservoir	900
Caldwell/Daviess	Lick Fork	5,700
Carroll	Little Hurricane	6,300
Carroll	Wolf Creek	4,274
Carroll	Snow Branch	2,000
Carroll/Ray	Turkey Creek AgNPS SALT	62,000
Chariton	Hickory Branch	7,824
Chariton	Upper Salt Creek	9,785
Daviess	Lake Viking	6,284
Daviess	Hog Creek	3,030
Daviess	Marrowbone/Dog/Honey Creeks	61,800
Daviess	Bear Creek	4,023
Daviess/Harrison	Tombstone Creek	12,800
DeKalb/Clinton	Grindstone Creek AgNPS SALT	13,500
Gentry	Town Branch	2,400
Gentry	Linn Creek	4,300
Gentry	Long Branch	9,000
Gentry	Walnut Fork	11,000
Grundy	Middle Creek	4,000
Grundy/Harrison	Furnace Creek	3,162
Harrison	Upper Pole Cat Creek	10,580
Harrison	Upper Little Creek	11,000
Harrison	Trail Creek	17,300
Harrison	Cypress Creek	11,600
Harrison/Grundy/Daviess	Sugar Creek AgNPS SALT	68,000
Linn	West Yellow Creek Trib.	2,320
Linn	Little Turkey Creek	6,410
Linn	Bear Branch	5,179
Linn/Chariton	Silver Lake Trib.	2,875
Livingston	Parson Creek	63,000
Mercer	Wildcat Creek	3,250
Mercer	West Muddy/Lake Paho	19,360
Sullivan	Elmwood Lake	4,164
Sullivan	West Yellow Creek	3,170
Sullivan	Yellow Creek	10,638
Worth	Jay Creek	6,000
Worth	Bear Creek	5,200
Worth	Marlowe Creek	6,000
Worth/Harrison	Little Rock Creek	5,032
Worth/Harrison	Big Rock Creek	8,770

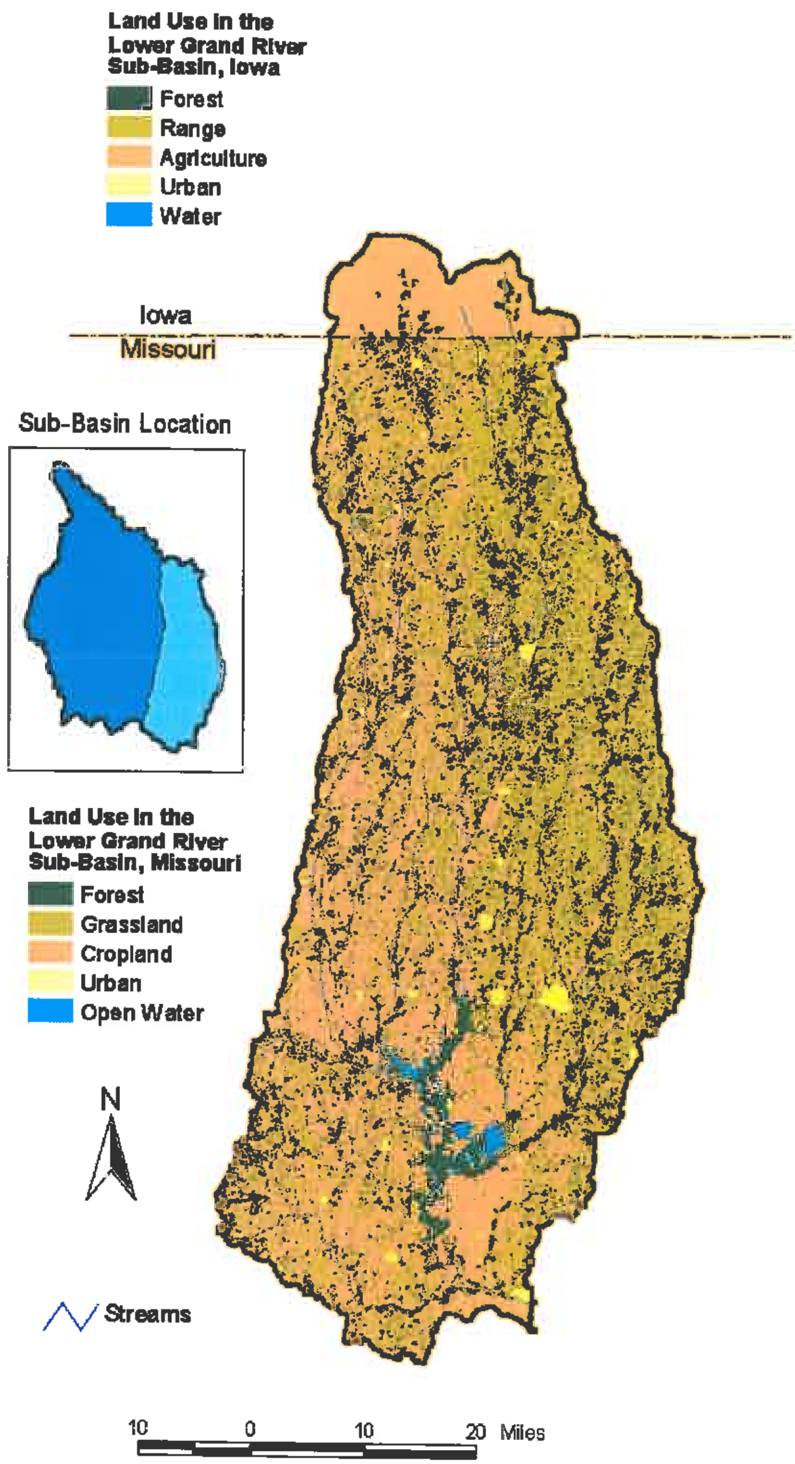

Figure 4a. Land use in the lower Grand River sub-basin in Missouri and Iowa (MORAP 1999, preliminary data).

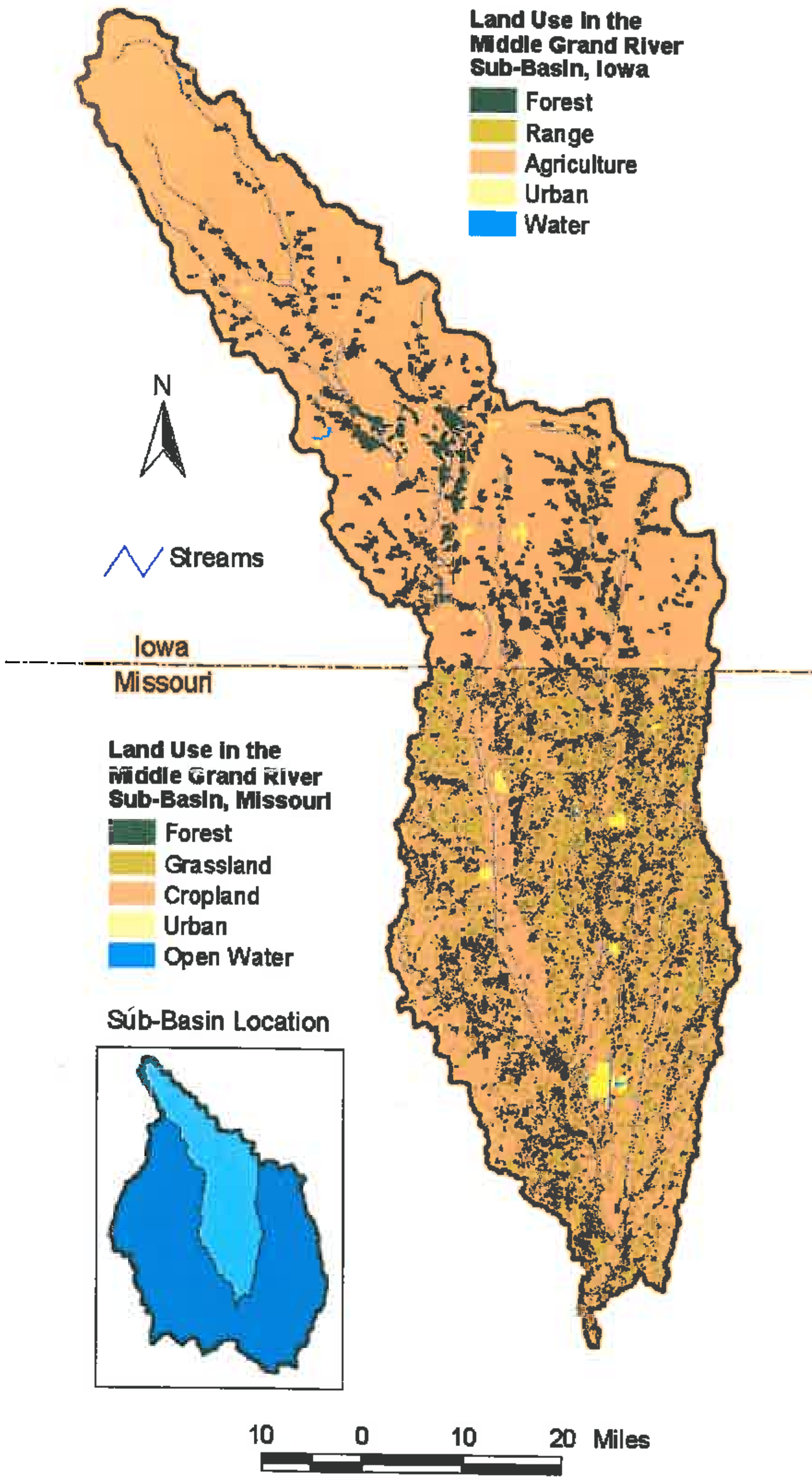

Figure 4b. Land use in the middle Grand River sub-basin in Missouri and Iowa (MORAP 1999, preliminary data).

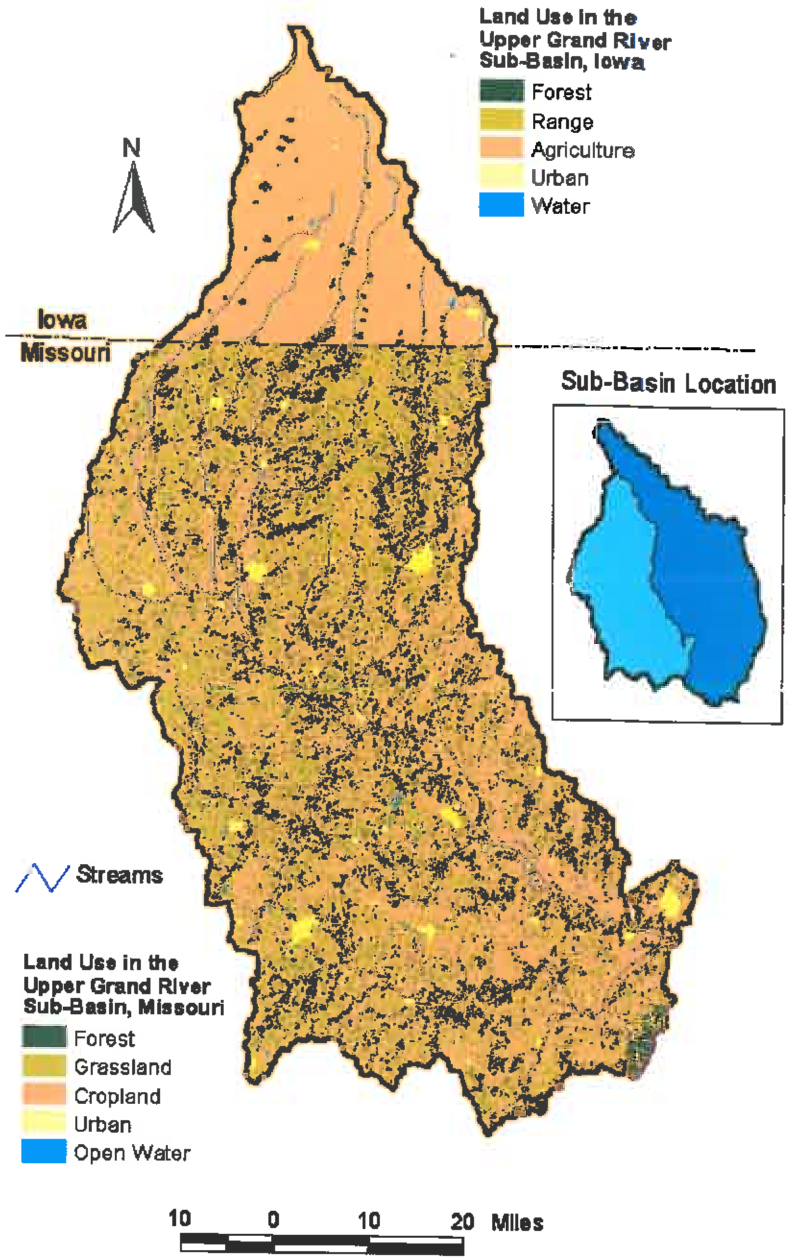

Figure 4c. Land use in the upper Grand River sub-basin in Missouri and Iowa (MORAP 1999, preliminary data).

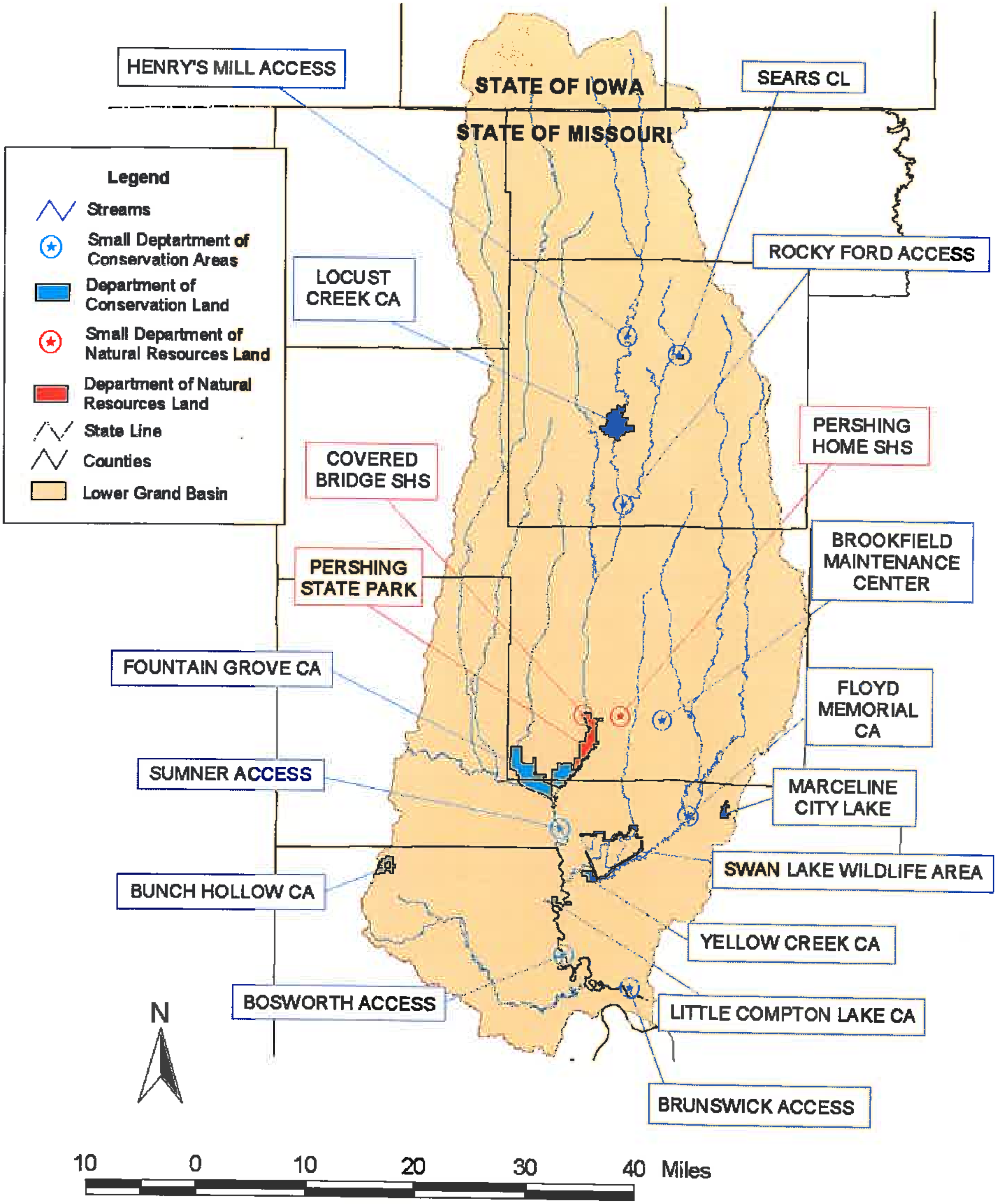

Figure Ip. Public land sites within the lower Grand River Basin, in Missouri. CA = Conservation Area. SHS = State Historic Site.

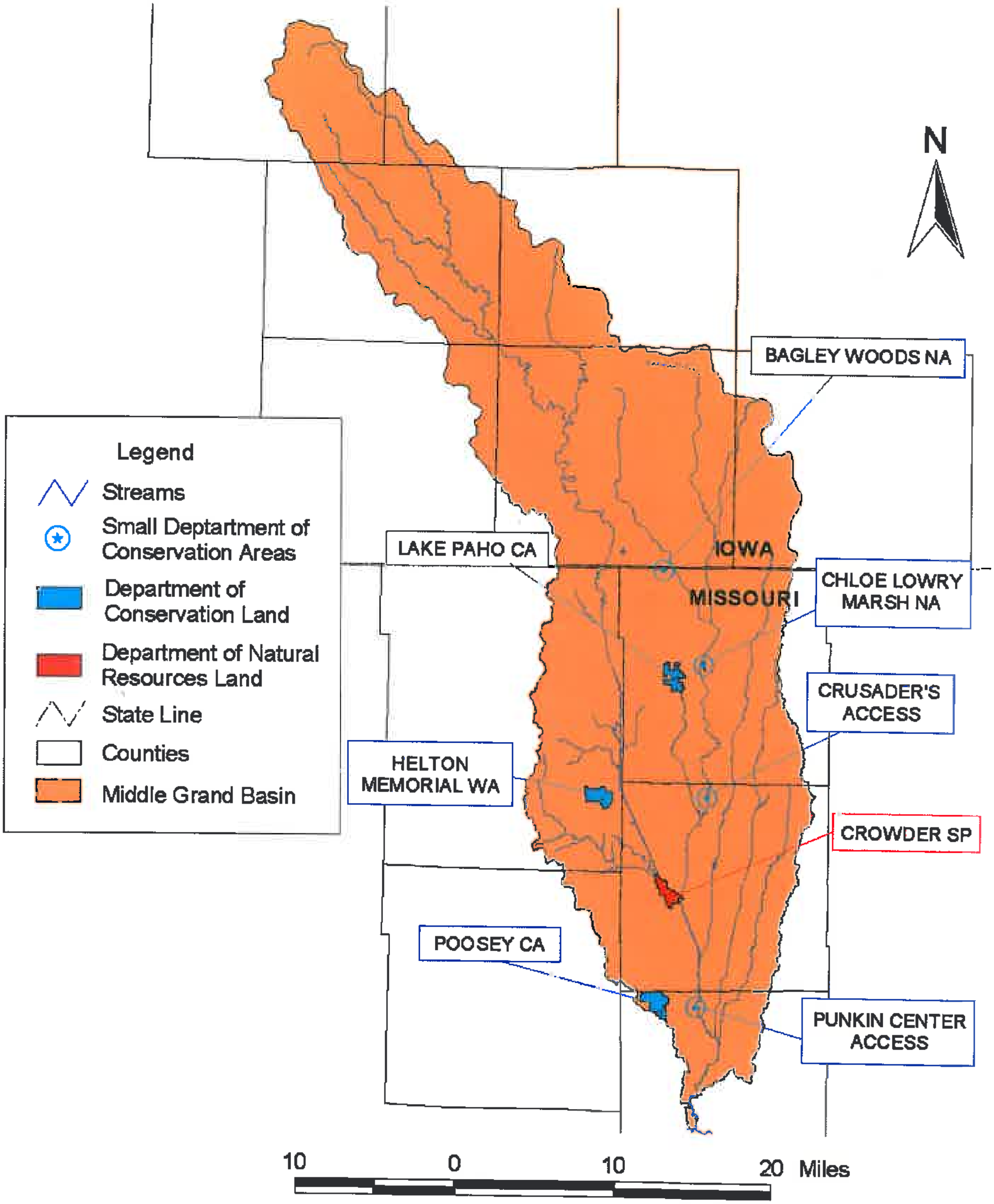

Figure mp. Public Land sites within the middle Grand River Basin, in Missouri.
CA = Conservation Area. SP = State Park. NA = Naural Area. WA = Wildlife Area.

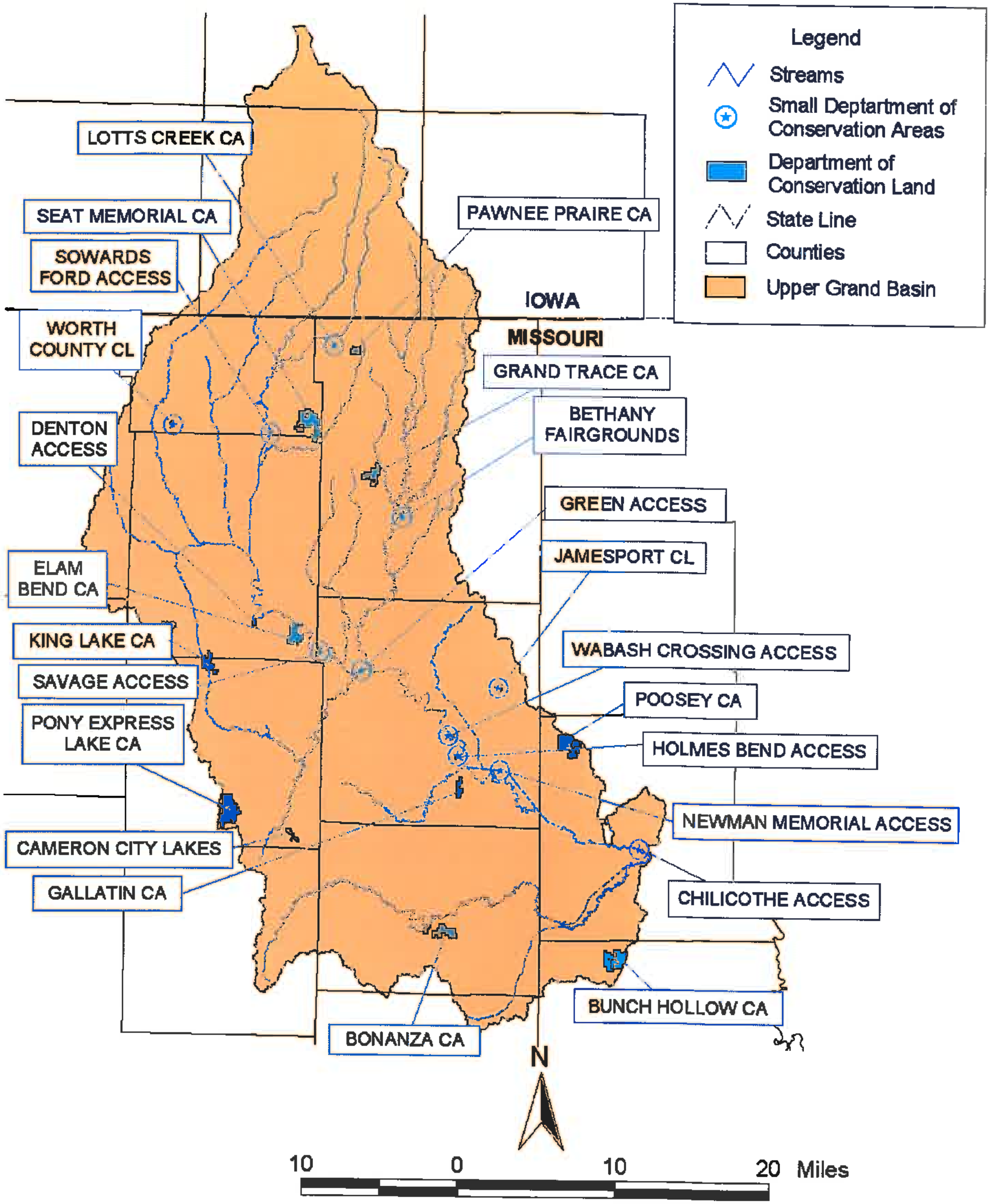

Figure up. Public land sites within the upper Grand River Basin, in Missouri.
CA = Conservation Area. CL = City Lake

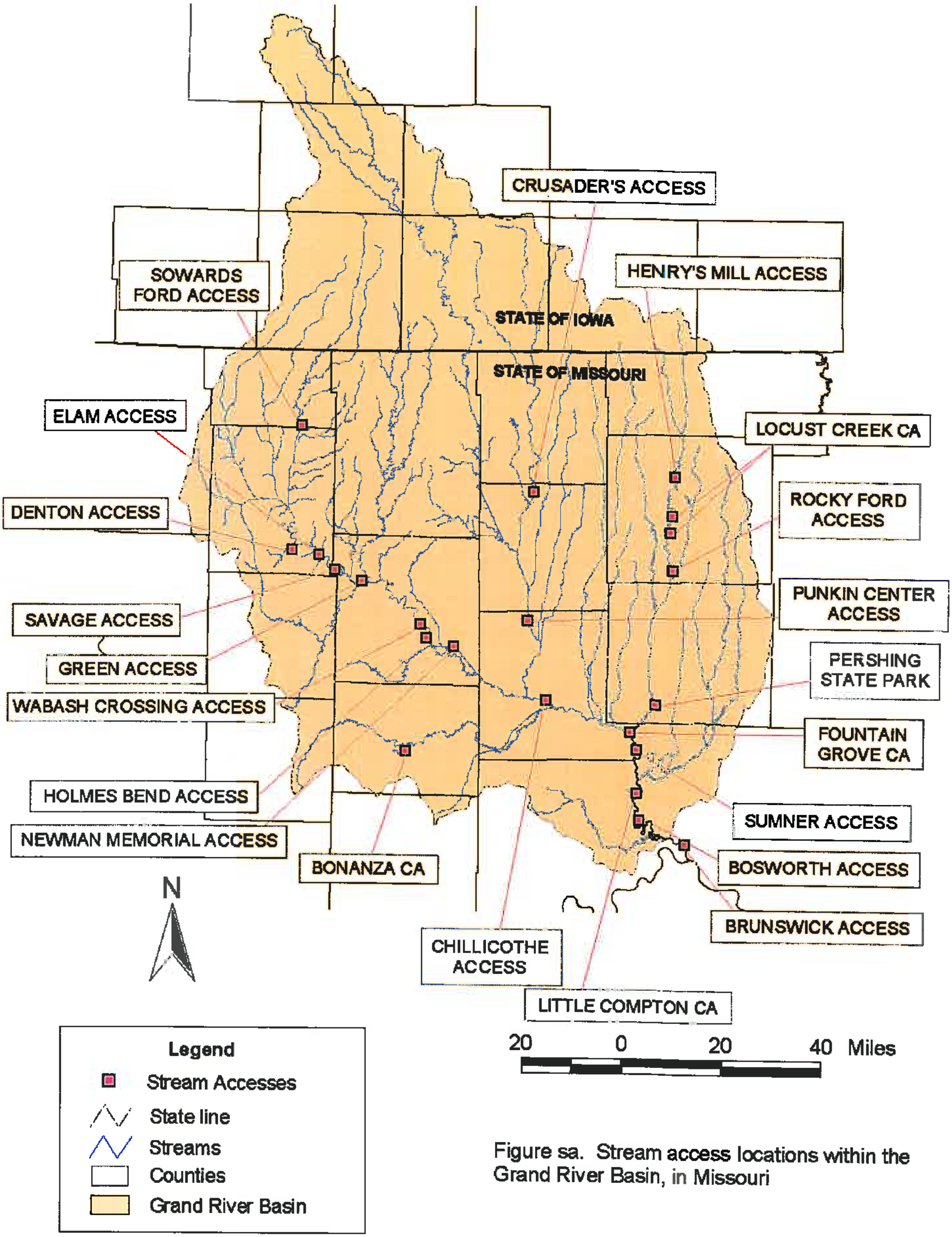

Figure sa. Stream access locations within the Grand River Basin, in Missouri

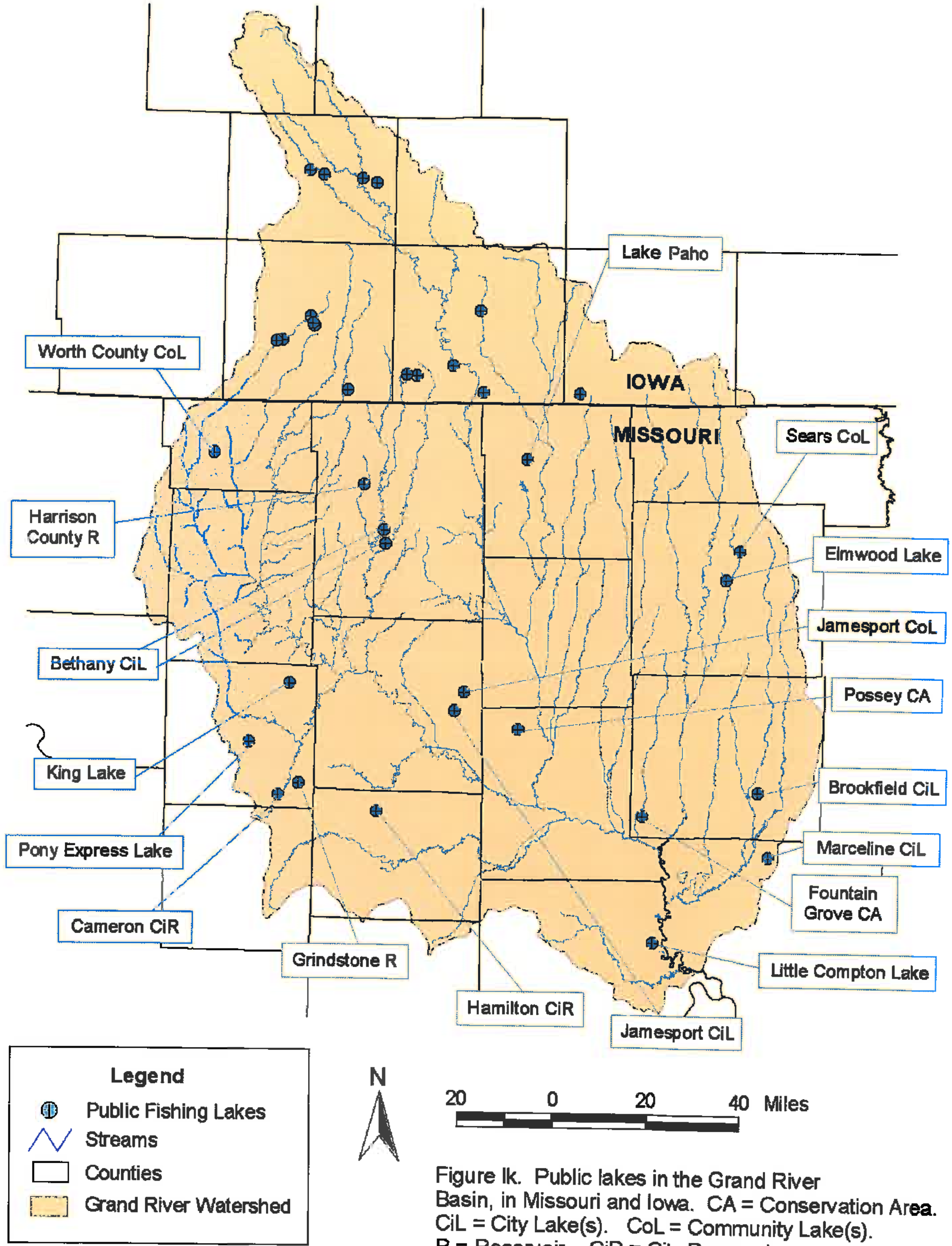

Figure Ik. Public lakes in the Grand River Basin, in Missouri and Iowa. CA = Conservation Area. CiL = City Lake(s). CoL = Community Lake(s). R = Reservoir. CiR = City Reservoir

HYDROLOGY

Precipitation

Average annual precipitation for the basin ranges from 32 inches in the northwest part of the basin to 36 inches in the southeast portion (USDA-SCS 1982). The greatest amount of precipitation normally occurs in May (4.49") and June (5.77") (USDA-SCS 1982). The basin is covered by glacial till, a clayey material that greatly retards movement of water to the subsurface (Detroy & Skelton 1983). Most rainfall runs off the surface of the land rather than soaking into the soil. Streams in the basin show rapid flow increases in conjunction with rains, but quickly return to low flow conditions when runoff stops (MDNR 1984). Runoff increases from 6" in the northwest to 8.5" in the southeast portion of the basin. Most runoff occurs in June (USDA-SCS 1982).

United States Geological Survey (USGS) Gaging Stations

There are four active USGS water stage gages throughout the basin (USGS 1992). Two stations are on the Grand River near
Gallatin (http://wwwdmorll.er.usgs.gov/rt-cgi/gen_stn_pg?station=06897500)
and Sumner (http://wwwdmorll.er.usgs.gov/rt-cgi/gen_stn_pg?station=06902000); two are on Thompson River at Trenton (http://wwwdmorll.er.usgs.gov/rt-cgi/gen_stn_pg?station=06899500)
and Davis City, IA (http:/wwwdiaiwc.cr.usgs.gov/rt-cgi/gen_stn_pg?station=06898000).
Several inactive gaging stations are also located throughout the basin. Figure gs shows the location of the active and inactive gaging stations in the Grand River basin.

Permanent/Intermittent Streams

There are more than 1,000 third-order and larger streams within the Grand River Basin. Due to the size and complexity of the Grand River Basin, individuals will need to look at specific reaches as the need arises to determine permanency of flow. To facilitate this, a listing of 7.5' topographic maps covering the entire reach of all fifth order and larger streams is provided in Table 4. Maps can be ordered from the United States Geological Survey (USGS) in Rolla, MO (http://mapping.usgs.gov/mac/isb/pubs/booklets/usgsmaps/usgsmaps.html). The phone number is 1-888-ask-usgs. Most streams in the basin with drainage areas less than 50 square miles will stop flowing for seven consecutive days or more at some time every two years (Detroy and Skelton 1983).

Average Annual Discharge

The average discharge for the Grand River (Table 5) near Sumner, Missouri is 3,917 cfs (USGS 1992). The maximum instantaneous peak flow (180,000 cfs) occurred in June, 1947. Peak discharge for Grand River at Sumner during 1993 flooding was 150,000 cfs (Parrett et al. 1993).

Detroy and Skelton (1983) developed an equation for calculating average discharge for streams throughout the basin. Average flow can be estimated using the equation:

$$Q=0.73\ A^{0.97},$$

where average annual streamflow (Q) is in cubic feet per second, and drainage area (A) is in square miles.

The Grand River basin makes up approximately 1.5% of the Missouri River watershed but contributes 7% of the average annual discharge (USCOE 1989).

7-day Q_2 and Q_{10} Low Flows

According to Detroy and Skelton (1983):

> Streams in the Grand River Basin are not sustained by ground-water inflow because of the low hydraulic conductivity of the clays and shales of the area. Exceptions are the downstream reaches of the Grand and Thompson rivers.
>
> Most streams in the basin with drainage areas less than 50 square miles will cease to flow for 7 days every other year. Approximately half of the streams with drainage areas of 50 to 200 square miles will also cease to flow every two years. The other half of those streams will have flow of less than 0.7 cfs.
>
> Streams with drainage areas less than 150 square miles will almost always cease flowing every ten years. Approximately half of the streams draining 150 to 500 square miles will have seven day low flows of less than 2 cfs. Drainage area is not a good predictor of low flow in streams that drain larger watersheds.

Dam and Hydropower Influences

There are no major dams within the basin. Seven large flood control reservoirs were designed by the Corps of Engineers (USCOE 1963). A follow-up report concluded that the reservoirs and associated channel modification was not economically feasible. The projects were deauthorized in 1989 (USCOE 1989). Due to extensive flooding throughout the basin during 1993, support for reauthorization of these projects has surfaced in some areas. A federal buyout and relocation of Pattonsburg, Missouri appears to have satisfied most people in the area.

In the 1970's, there was an unsuccessful proposal to impound a large reach of Locust Creek in association with a proposed coal gasification plant near Milan (approximately river mile 46). In 1990, there was a renewed interest in constructing the same 5,800 acre lake for water supply and recreation. This second attempt was also unsuccessful because the Locust Creek Lake Committee could not acquire sufficient funding to construct the reservoir. This lake would have inundated several miles of unchannelized stream and altered downstream flows. There is still local interest in creating a water supply and recreation lake near Milan.

The number of lakes larger than two acres has changed dramatically since 1984. There are approximately 30 lakes larger than 50 acres within the basin. Numerous 5-10 acre watershed structures have been built both on public and private land in association with PL-566 and erosion control projects. There are concerns regarding the impact of numerous small flood control structures and their impact on low flow conditions. These structures intercept runoff and make no provisions for maintenance of stream flows.

Table 4. USGS 7.5 minute quadrangle maps covering main stream and longest arm of fifth order and above streams in the Grand River Basin. Maps are listed in order from mouth of stream to headwaters.

Stream	Order	Map Name
Big Creek (Carroll)	5	Brunswick West, Bosworth, Tina, Coloma, Bogard
Big Creek (Daviess and Harrison)	6	Coffey, Pattonsburg, Mitchellville, Bethany, Brooklyn, Pawnee, Kellerton
Big Creek, East Fork	5	Bethany, Gardner, Eagleville, Lamoni South, Lamoni North
Big Muddy Creek	5	Gallatin, Jameson, Gilman City West
Big Muddy Creek, East Fork	5	Albany North, New Hampton, Washington Center, Hatfield
Bridge Creek	5	Tina, Avalon
Brush Creek	5	Cainsville, Eagleville
Brushy Creek	5	Cameron East, Winston
Coon Creek	5	Meadville, Eversonville
East Locust Creek	5	Browning, Milan West, Milan East, Pollock, Unionville West
Elk Creek (Chariton)	5	Mendon, Sumner, Rothville, Marceline, Brookfield
Elk Creek (Decatur, IA)	5	Lamoni North, Grand River, Ellston

Table 4 continued

Grand River	8	Brunswick East, Brunswick West, Bosworth, Hale, Fountain Grove, Avalon, Utica East, Chillicothe, Sampsel, Breckenridge, Jamesport, Gallatin, Altamont, Coffey, Pattonsburg, Berlin, Albany South, Darlington, Gentry, Alanthus Grove, Parnell East, Sheridan, Blockton, Maloy, Benton, Diagonal, Shannon City, Arispe, Creston East
Grand River, East Fork	6	Albany South, Albany North, Allendale, Blockton S.E., Hatfield, Mount Ayr, Tingley, Arispe
Grand River Middle Fork	5	Darlington, Gentry, Grant City, Blockton S.E., Benton
Grand River (Old Channel)	5	Breckenridge, Nettleton, Gallatin
Grindstone Creek	7	Pattonsburg, Weatherby, Winston, Fordham, Cameron West
Honey Creek (Grundy)	5	Farmersville, Trenton East, Spickard, Mill Grove, Half Rock, Ravanna
Honey Creek (Daviess)	5	Gallatin, Nettleton, Kidder, Altamont
Island Creek	5	Stanberry, King City
Little Creek	5	Bethany, Brooklyn
Little East Locust Creek	5	Browning, Milan S.E., Milan East
Little Medicine Creek	5	Laredo, Galt, Half Rock, Ravanna, Cleopatra
Little River	5	Princeton, Lineville, Pleasanton, Leon, Davis City, Van Wert, Lacelle
Little Shoal Creek	5	Cameron West, Lathrop
Locust Creek	7	Fountain Grove, Sumner, Laclede, Linneus, Browning, Milan West, Pollock S.W., Pollock N.W., St. John, Seymour West
Log Creek	5	Hamilton East, Cowgill, Polo, Hamilton West, Elmira
Long Branch	5	Cameron East, Winston
Long Creek	5	Grand River, Van Wert, Hopeville, Murray
Lost Creek	7	Weatherby, Maysville, Wood, Ford City
Lost Creek, East Fork	5	Maysville, Berlin

Table 4 continued

Lost Creek, Middle Fork	6	Maysville, Berlin, Ford City
Lost Creek, West Fork	6	Maysville, Fordham, Amity
Lotts Creek	5	Allendale, Blockton S.E., Hatfield, Mount Ayr, Kellerton, Ellston
Marrowbone Creek	5	Nettleton, Kidder, Winston
Medicine Creek	6	Avalon, Wheeling, Chula, Laredo, Lindley, Osgood, Harris, Lucerne, Powersville, Allerton
Mill Creek	5	Hamilton West, Kidder
Mud Creek Ditch	5	Utica West, Braymer, Stet, Millville
Muddy Creek (Carroll County)	5	Avalon, Wheeling, Chula, Eversonville, Lindley, Osgood
Muddy Creek (Grundy County)	5	Trenton East, Spickard, Mill Grove, Princeton, Cleopatra, Lineville
Muddy Creek (Linn County)	5	Laclede, Linneus
No Creek	5	Farmersville, Trenton East, Laredo, Galt, Half Rock
No Name (T56N,R30W, S15)	5	Cameron West
No Name (T58N, R31W, S2)	5	Fordham, Amity, Wood
Parson Creek	6	Fountain Grove, Meadville, Eversonville, Lindley
Pops Branch	5	Princeton, Lineville
Raccoon Creek	5	Brimson, Trenton West, Bancroft
Sampson Creek	5	Pattonsburg, Matkins, New Hampton
Sheep Creek	5	Hamilton West, Winston
Shoal Creek	6	Utica East, Utica West, Flat Creek, Hamilton East, Hamilton West, Cameron East, Cameron West, Lathrop
Smith Branch	5	Weatherby, Winston
Sugar Creek	6	Brimson, Gilman City East, Gilman City West, Gardner
Thompson River (Old Channel)	5	Trenton East, Trenton West

Table 4 continued

Thompson River	7	Chillicothe, Farmersville, Trenton East, Trenton West, Brimson, Mount Moriah, Cainsville, Akron, Davis City, Lamoni North, Grand River, Tingley N.E., Lorimor South, Afton, Macksburg, Arbor Hill, Greenfield
Three-Mile Creek	5	Lorimor South, Afton, Creston East, Zion
Tom Creek	5	Hamilton East, Hamilton West, Kidder
Trail Creek	5	Mount Moriah, Gardner
Turkey Creek (Chariton County)	5	Sumner, Laclede, Linneus
Turkey Creek (Gentry County)	5	Stanberry, Guilford
Unnamed #31	5	Browning, Milan West, Osgood
Wamsley Creek	5	Fordham, Winston
Weldon River	6	Trenton West, Brimson, Spickard, Mill Grove, Princeton, Lineville, Woodland, Leon, Garden Grove S.W., Weldon, Lacelle
West Elk Creek (Decatur County, Iowa)	5	Lamoni North, Kellerton, Ellston
West Fork Lost Creek	6	Maysville, Fordham, Amity
West Locust Creek	6	Linneus, Browning, Milan West, Osgood, Harris, Lucerne
West Muddy Creek	5	Spickard, Brimson, Modena, Goshen
West Yellow Creek	5	Rothville, Brookfield, Shelby, Bucklin N.W., Milan S.E., Winigan, Milan East, Mystic, Green City, Pollock
Wildcat Creek	6	Darlington, Stanberry, Ravenwood
Wolf Creek	5	Trenton West
Yellow Creek	6	Hale, Mendon, Indian Grove, Rothville, Marceline, Bucklin, Bucklin N.W., Winigan, Mystic

Table 5. Discharge information (cfs) for the period of record at various locations within the Grand River Basin (USGS 1992, USGS 1993).

Location	Max.	Min.	Mean	10% Exceeds	50% Exceeds	90% Exceeds
Grand River: Gallatin (1921 - 1992)	69,100	2.0	1168	2,330	205	25
Grand River: Sumner (1923 - 1992)	180,000	10.0	3896	9,810	925	121
Thompson River: Trenton (1928 - 1992)	95,000	1.0	969	2,230	200	27
Thompson River: Davis City, Ia (1941 - 1993)	57,0001	---	402	855	80	9
Elk Creek: Decatur, IA (1968 - 1993)	32,000	0.0	37	50	4	0

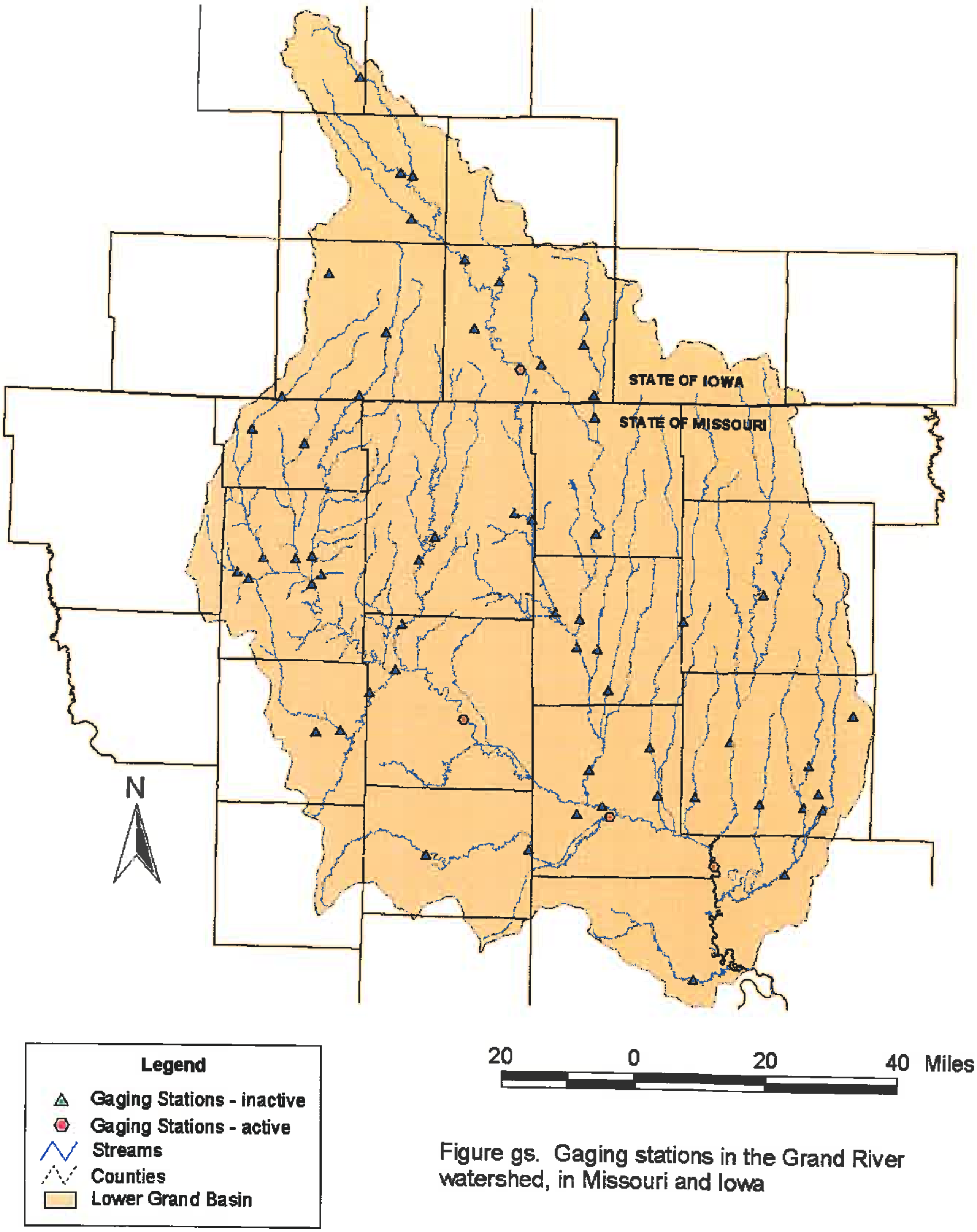

Figure gs. Gaging stations in the Grand River watershed, in Missouri and Iowa

WATER QUALITY

Beneficial Use Attainment (MDNR 1984)

The major fisheries resource problem is loss of habitat due to siltation and channelization. Soil erosion causes chronic violations of the secondary drinking water supply standards for iron and manganese. There are also localized problems with low dissolved oxygen concentrations below sewage treatment plants during low flow conditions.

Although whole-body contact recreation is a designated use of the Grand River, conditions are marginal because of poor access, steep mud banks, soft mud bottoms and violations of the fecal coliform standard during runoff periods.

Many streams within the Grand River Basin were naturally turbid under pristine conditions (MDNR 1986b). Most will probably not be brought into compliance with water quality standards for turbidity even with strict erosion control programs (MDNR 1986b).

Chemical Quality of Stream Flow

The principal water quality problems in north Missouri streams are suspended sediment, elevated water temperatures, acidic waters, pesticide spills and the loss of pool habitat (USDA-SCS 1982). USGS water quality data indicates that water in Grand River is often turbid. Water quality standards are commonly exceeded for bacteria, manganese and iron (Table 6). From 1984-1986 there were increasing amounts of nitrogen in various forms entering Grand River (MDNR 1986b). This was attributed to increased runoff of nitrogen fertilizer and possibly increased runoff of animal wastes (MDNR 1986b).

Detailed water quality surveys have been conducted for Big Creek in Daviess and Harrison counties (Kangas and Crawford 1977), Grindstone, Lost, and Muddy creeks (Rowe 1979) and Big and Hurricane creeks in Carroll County (Mid-Missouri Engineers 1980).

Conclusions of the various investigators were that these streams had moderate nutrient enrichment. Both pollution tolerant and intolerant species of invertebrates were present at the various sites. Bacteria levels indicated that much of the enrichment in these streams was from livestock runoff. Habitat loss seemed to be more of a limiting factor to fish and invertebrates than the chemical quality of the water.

Fish Contamination Levels, Health Advisories, and Chronic Fish Kill Areas

Due to elevated chlordane levels the Missouri Department of Health currently recommends not eating more than one pound of catfish, carp, buffalo, drum, sucker and paddlefish per week from anywhere in Missouri outside the Ozarks (Table 7). This consumption advisory applies to the entire Missouri portion of the Grand River Basin. This advisory will probably be lifted within the next 10 years as chlordane levels decline (A. Buchanan, MDC, personal communication).

Contaminant samples were collected in Brookfield City Lake, Cameron City Reservoir #2, Cameron City Reservoir #3, Jamesport Community Lake, Lake Paho, Limpp Lake, Pony Express Lake and Worth County Community Lake. Contaminant levels were below threshold levels in all lakes sampled in the Missouri portion of the basin.

Fish kills throughout the basin have been scattered. Many have been associated with sedimentation of farm ponds, improper management of wastewater holding facilities and chemical spills. Undoubtedly, many undocumented fish kills occur within the basin. Fish kills due to increased use of agricultural chemicals have been suggested as one reason for the decline of the Topeka shiner (*Notropis topeka*) within the basin (Pflieger, MDC, personal communication). Large fishkills have occurred recently as large corporate farms have become established in the watershed.

Four companies (Williams, Amoco, Mapco, and Arco) have a network of oil pipelines within the basin. These pipelines were buried under channelized streams. Downcutting and meander formation have exposed pipelines at various locations creating the potential for major oil spills. Recent efforts to protect these pipelines have reduced the threat.

Water Use

a. **Municipal** - In Missouri, there are 28 surface water withdrawals from the Grand River Basin. Most municipal water comes from city reservoirs located on tributary streams. Chillicothe, Ridgeway, Trenton and Brookfield withdraw water from Grand River, Big Creek, Thompson River and Yellow Creek, respectively.

b. **Agricultural** - Minimal irrigation takes place within Missouri's portion of the basin and is limited mainly to three counties (Livingston, Carroll and Grundy). Less than one thousand acres are irrigated annually in any of these counties (MDNR 1986a).

c. **Wetland areas** - MDC's Fountain Grove CA pumps approximately 4,000 acre-feet of water from the lower Grand River during late summer and early fall. Several private waterfowl hunting clubs in the lower portion of the basin also pump water from Grand River when conditions necessitate.

Currently, water withdrawal from streams within the Grand River Basin is probably not a widespread problem. Water quantity may become more of an issue in the future as large corporate farms expand operations in the basin.

Point Source Pollution

Figure ps highlights the point source discharges throughout the basin. Most of the discharges are small and scattered with limited impact on any particular reach. An exception to this is East Fork of Big Creek in Harrison County, Missouri. There have been chronic violations of water quality standards in East Fork of Big Creek below the City of Lamoni, Iowa and Bethany, Missouri.

The wastewater treatment plant at Milan has experienced numerous algae blooms that have escaped into receiving streams. The green water has caused concerns to adjacent landowners. In 1990, the City of Cameron was issued a series of citations for releases of poorly treated water into Brushy Creek. No recent violations have been reported.

Non-Point Source Pollution

Water quality within the basin is most affected by non-point water pollution sources (MDNR 1984, Figure ca). Soil erosion and the runoff of animal waste are the principal sources of concern. Sheet and rill erosion is excessive on tilled land throughout the basin. Erosion rates vary from 13 to 24 tons/acre/year. On permanent pasture lands, soil loss is at "tolerable" levels (2-5 tons/acre/year). Gully erosion varies from moderate (100-199 tons/mi²/year) in the lower Grand River Basin and Thompson River Basin to very severe (500-750 tons/mi²/year) in the upper reaches of the watershed (Anderson 1980).

It is estimated that 9.5 million PE (human population equivalent) of cattle and hogs existed in the basin in the mid 1980's (MDNR 1984). Animal waste causes problems with low oxygen and toxicity problems in streams both during runoff and low flow periods. The corporate hog industry has designated the Grand River Basin as a favorable site for large scale hog production. Premium Standard Farms and Continental Grain have brought more than 4 million PE into five counties (Daviess, Grundy, Mercer, Putnum and Sullivan counties).

Table 6. Selected water-quality data for the Grand River near Sumner at gage station 06902000, water years 1988 and 1992 (USGS 1988; USGS 1992, MDNR 1992, Code of State Regulations 10 CSR 20.7).

	State Standard				Water Year	
Parameter	I	III	VI	VII	1988	1992
Temperature (°F)	90° max				32-86	32-77.9
Specific Conductance (ys/cm)					220-540	318-510
Ph					7.4-8.1	7.8-8.2
Turbidity (NTU)						16-140
Sediment, suspended (mg/L)					39-2930	75-384
Oxygen, dissolved (mg/L)	5				6.4-13.9	7.3-13.7

Table 6 continued

Parameter	I	III	VI	VII	1988	1992
Coliform, fecal				200-storm runoff	K60-12,000	K16-K70,000
Streptococci, fecal (colonies/100ml)					K25-95,000	K52-K83,000
Total Hardness (mg/L $CaCO_3$)					110-260	140-250
Nitrogen, Total Ammonia (mg/L as N)	Depends on temp & Ph				<0.010-0.340	0.030-0.100
Phosphorus, Total (mg/L as P)					0.070-0.250	0.110-0.340
Manganese, dissolved (yg/L as Mn)		50		50	34-370	8-61
Iron, dissolved (mg/L as F_e)	1,000	300		300	12-400	7-130

K: Non-ideal count of colonies (e.g., sample was not diluted enough, colonies merged)
I: Protection of aquatic life
III: Drinking water supply
VI: Whole-body-contact recreation
VII: Groundwater

Table 7. Contaminants in fish in Grand River (ppb).

Year	Water	Species	Chlordane	Mercury
1990	Grand River/Gentryville	Carp Channel Catfish	165 57	56 88
1998	Grand River/Gallatin	Carp Flathead catfish	60 ---	--- 220

Level of concern for chlordane = 300 ppb; for mercury = 1,000 ppb. Fish fillet composites.

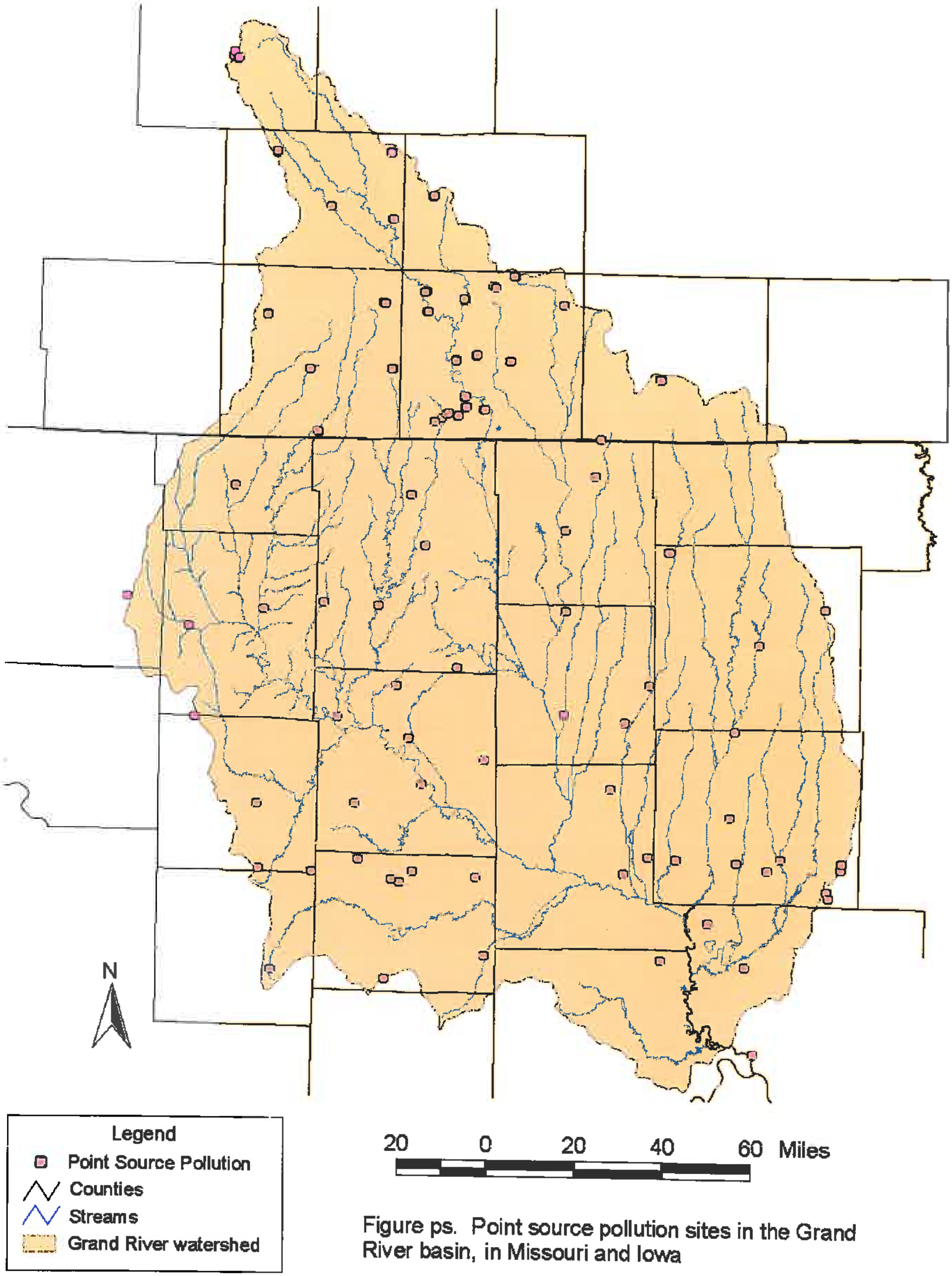

Figure ps. Point source pollution sites in the Grand River basin, in Missouri and Iowa

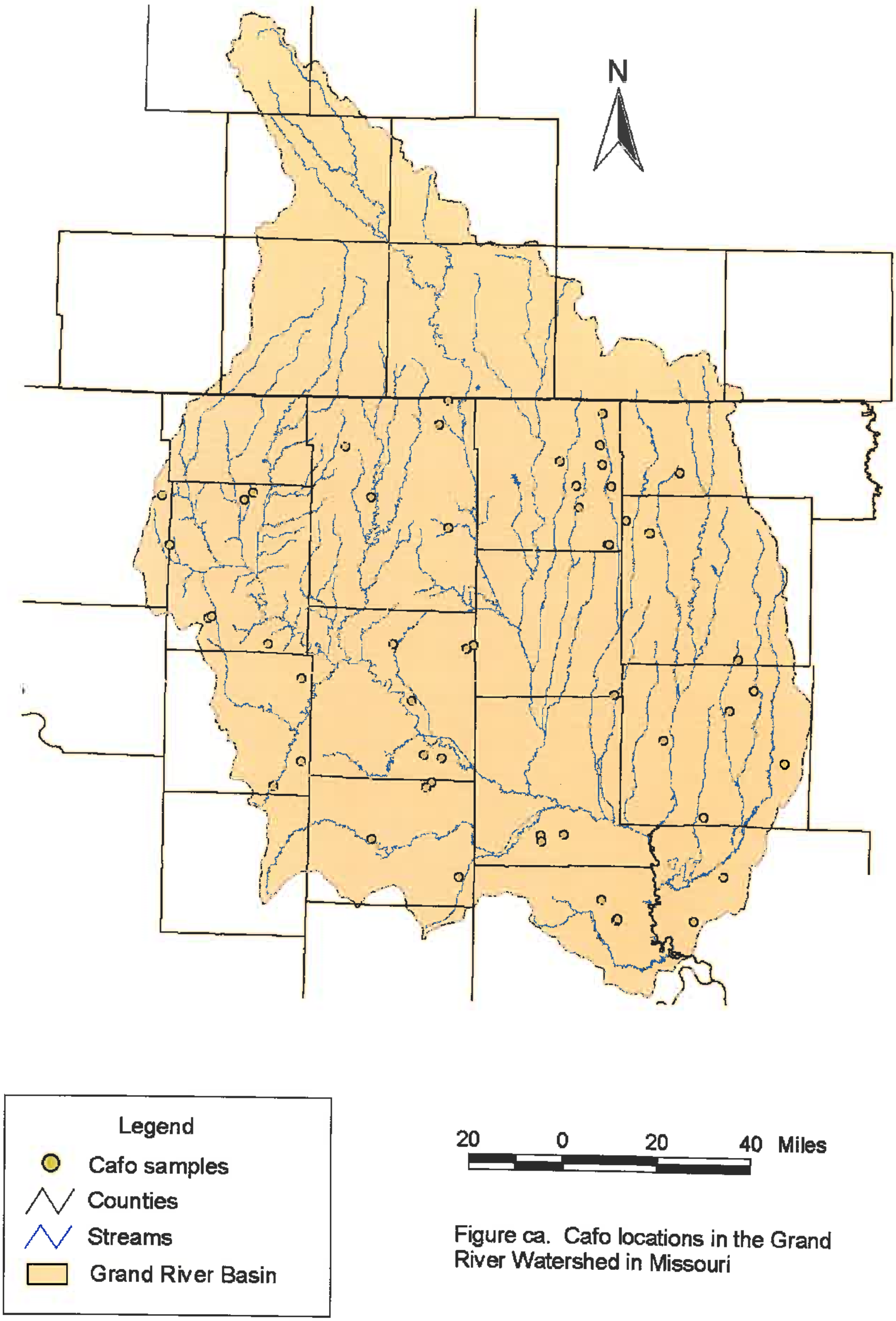

Figure ca. Cafo locations in the Grand River Watershed in Missouri

HABITAT CONDITIONS

Channel Alterations

Channelization and levee construction are considered legitimate stream management practices by many landowners. Channelization includes straightening natural stream meanders, clearing the banks, and widening and deepening the channel (Funk and Ruhr 1971). This results in a loss of stream habitat, increased bank erosion, and lower ground water levels (Funk and Ruhr 1971). Levee construction separates the stream from its floodplain. Flood water can no longer spread out and is concentrated within the channel causing further streambank erosion.

Several streams within the basin have been channelized for over one-half their length. A substantial portion of the streams in the basin are confined by levees.

The USDA-NRCS (MO) (IA) has determined that much of the downcutting in the basin due to channelization has been completed and filling of the main channel is now occurring. Any flood control benefits due to channelization in the 1920's is rapidly diminishing due to in-channel sedimentation (USDA-SCS 1982).

Anecdotal evidence suggests that lateral erosion rates of streams within the basin have probably always been high. Channel alterations have increased the amount of bedload being carried by streams and have intensified these changes so that erosion rates of more than 50 feet in a single event are not uncommon. A good example of the dynamic nature of these streams is the recent chute cutoff of the Grand River channel at Elam Bend CA (Gentry County, MO). Grand River shifted more than five hundred feet during a high water event in 1991. This also occurred upstream of the area at two other locations. It is unclear whether this phenomenon is isolated or a basin wide phenomenon.

Unique Habitat

Fish habitat throughout much of the Grand River Basin has been degraded. Much of the unique habitat consists of streams that have not been channelized or contain coarse substrate and bedrock.

Unique habitat was identified by searching MDC fisheries files, publications and through interviews with MDC Protection Division and Iowa Fisheries Division personnel.

Unique areas worthy of special attention follow:

Grand River from the mouth to river mile 35 is the largest prairie river in Missouri that is relatively unaffected by impoundments or channelization (Kramer 1991). Forty-seven species of fish including rare and unusual species have been collected in the lower Grand River.

Marrowbone Creek (5th order; Daviess County) is one of the least disturbed tributaries in the upper Grand River drainage. This stream has a relatively undisturbed riparian corridor at most localities (Kramer 1991). Marrowbone Creek was the only northwest Missouri stream included in the proposed

Natural Streams Act.

Sugar Creek (6th order; Harrison County) is relatively unchannelized for most of its length. The stream is characterized by bedrock outcroppings. Sugar Creek and Tombstone Creek (a major tributary) contain Topeka shiners (*Notropis topeka)*, a federally listed endangered species. Sugar Creek supports a high quality channel catfish population.

Thompson River (River Mile 58-88.5; Harrison County, MO and Decatur County, Iowa) is relatively unchannelized. It is characterized by occasional bedrock outcroppings. Iowa DNR personnel have collected trout-perch (*Percopsis omiscomaycus*), johnny darters (*Etheostoma nigrum*), and sauger (*Stizostedion canadense*) from this reach.

Chloe Lowry Marsh (Mercer County) is a 40-acre wetland in the Weldon River flood plain. The marsh has been described as one of the best natural marshes remaining in Missouri (Gremaud 1987, 1993). The marsh is too shallow to support fish. The marsh contains a population of northern leopard frogs (*Rana pipiens*) and rare plants. This area is designated as a state natural area.

Shoal Creek (6th order; Caldwell County) is largely unchannelized throughout most of its length. One half mile of Shoal Creek in the Bonanza C.A. has been designated as an outstanding state water resource. Crabapple Creek is a high quality tributary to Shoal Creek. One mile of Crabapple Creek has been designated as an outstanding state water resource.

Grindstone Creek (7th order; Daviess and DeKalb counties) is relatively unaltered and contains gravel substrate. The stream contains trout-perch and a high quality catfish population. Grindstone Creek is one of the few streams in northern Missouri that flows north. The majority of the corridor is tree-lined (Pemberton 1982). The stream also supports a relatively diverse mussel population (A. Buchanan, MDC, personal communication).

East and West Forks of Big Creek (Harrison County) are considered exceptional examples of creeks in the prairie region (Gremaud 1987).

Locust Creek has two largely unchannelized reaches. One was recognized by the National Park Service in the 1982 Nationwide Rivers Inventory and has both state and national significance. This reach is a "unique riffle-pool arrangement and maintains one of the last largely unchannelized, undisturbed landform features in northern Missouri exhibiting oxbow lakes, meanders, unimpeded flooding typical of natural prairie streams, one of the best examples of aquatic community types in the region and diverse fish types including the unique stone cat". The second reach has well-established wooded corridors, abundant instream cover and unique fish species including trout-perch.

Improvement Projects

There have been numerous attempts throughout the Grand River Basin to stabilize eroding banks. These attempts range from ineffective measures such as further channelization and tire revetments to rock projects that have been professionally engineered.

Projects known to MDC fisheries management personnel have been outlined in Table 8. Most projects have been installed to stabilize streambanks.
A large rock project has been installed to improve fish habitat at MDC's Newman Memorial Access along Grand River (T.59N, R.26W, S32) in Daviess County. The MDC has an experimental area on the Locust Creek C.A. where various streambank stabilization and habitat improvement projects are being evaluated.

Stream Habitat Assessment

Stream habitat was evaluated using the Stream Habitat Assessment Device (SHAD). Habitat assessments were completed at 23 locations throughout the basin (Figure hb).

The homogenous nature of streams throughout the basin allows generalizations to be made regarding much of the stream habitat.

Streambanks:

Streambanks along most of the reaches are highly susceptible to erosion. Channels are often incised so deeply that streamside vegetation offers little erosion protection and the establishment of streambank vegetation often is limited to herbaceous, viney plants with shallow root systems. Many streambanks are taller than 15 feet and are eroding at a rapid rate. Lateral erosion rates of 15-30 feet annually are not uncommon on larger streams (>4th order). Free access to cattle contributes to streambank instability on many smaller streams throughout the basin.

Stream Corridor:

Most streams throughout the basin have little or no corridor. Often the corridor consists of a narrow band (10-20 feet) of mature hardwoods, willows, or herbaceous vegetation such as giant ragweed (*Ambrosia trifida*) or horsetail (*Equisetum*sp.). Due to excessive downcutting of stream channels, many areas of the larger streams have corridors only one or two trees wide. Many of these streams are undercutting the trees causing them to fall into the stream. Should this trend continue, there will be long reaches without large streamside trees.

Stream Corridor Land Use:

Much of the flood plain is in row crop production. Often crops are planted to the edge of the streambank. Some timber harvest does take place along streams. A narrow strip of trees along a stream is often the only timbered area on a farm.

Channel Conditions:

Stream channels are filling in with sediment throughout much of the basin. However, it depends on the location. The bottom of Grand River at Sumner has risen approximately 6 feet (629.5' to 635.5' m.s.l.) in the last 40 years. During the same period the bottom of Grand River at Gallatin has lowered 2 feet (USDA-SCS 1982).

Most sites were characterized by less than desirable pool depth. Loss of quality pool habitat is the most serious factor affecting stream fish populations throughout the Grand River Basin. Pool depth in smaller streams (1st-3rd order) is typically less than 2 feet. Pools in moderate sized streams (4th and 5th order) typically are less than 3 feet. Larger streams (6th order) typically have pool depths of less than 5 feet. Grand River (8th order) has extensive areas of shallow water, however, pools deeper than 10 feet arc common below Sumner.

Woody structure is the most common fish cover type. Trees falling into streams due to bank erosion provide important instream habitat.

Streambed Condition:

Soil parent materials vary within the basin and ultimately determine the predominant stream substrate type. Thinly glaciated or unglaciated areas within the basin such as those around Poosey Conservation Area have soils that are formed from the weathering of native rock (Bob Wilson, USDA-SCS, personal communication). Streams in this area have a lot of energy and are downcutting into an underlying residuum of limestone or shale. The alluvial material in the narrow floodplains contains large amounts of rocks imbedded with silt or clay. Streams such as Gee's, Indian and Bachelor creeks have predominantly cobble and bedrock substrates.

Much of the basin, however, has soils that are glacial-fluvial in origin. Streams in this area meander through floodplains that are predominantly sand, silt, and clay. Soils closest to the streams are sandier and better drained. Soils farthest from the streams contain more clay and are more poorly drained (Bob Wilson, USDA-SCS, personal communication). Streams in this region such as Grand River, Thompson River, Weldon River and Medicine Creek have sandy substrates.

Table 8. Streambank restoration and habitat improvement projects in the Grand River Basin, Missouri.

Stream	County	Practice	Entity
Shoal Creek	Clinton	Tree revetment	Private
W.F. Grand River	Gentry	Rock blanket	County
W.F. Grand River*	Gentry	Tire revetment	County
W.F. Grand River	Worth	Rock blanket	County
Thompson River	Grundy	Piling fence	Private
Thompson River	Harrison	Piling fence	Private
Marrowbone Creek	Daviess	Piling dikes	Private
Weldon River	Mercer	Rock jetties	County
Honey Creek	Grundy	Gradient control	Private
Honey Creek Trib.	Grundy	Gradient control	Private
Shoal Creek Trib.	Clinton	Rootwads	Private
Locust Creek C.A.	Sullivan	Various	MDC

*Project failed. A rock project is in the planning phase.

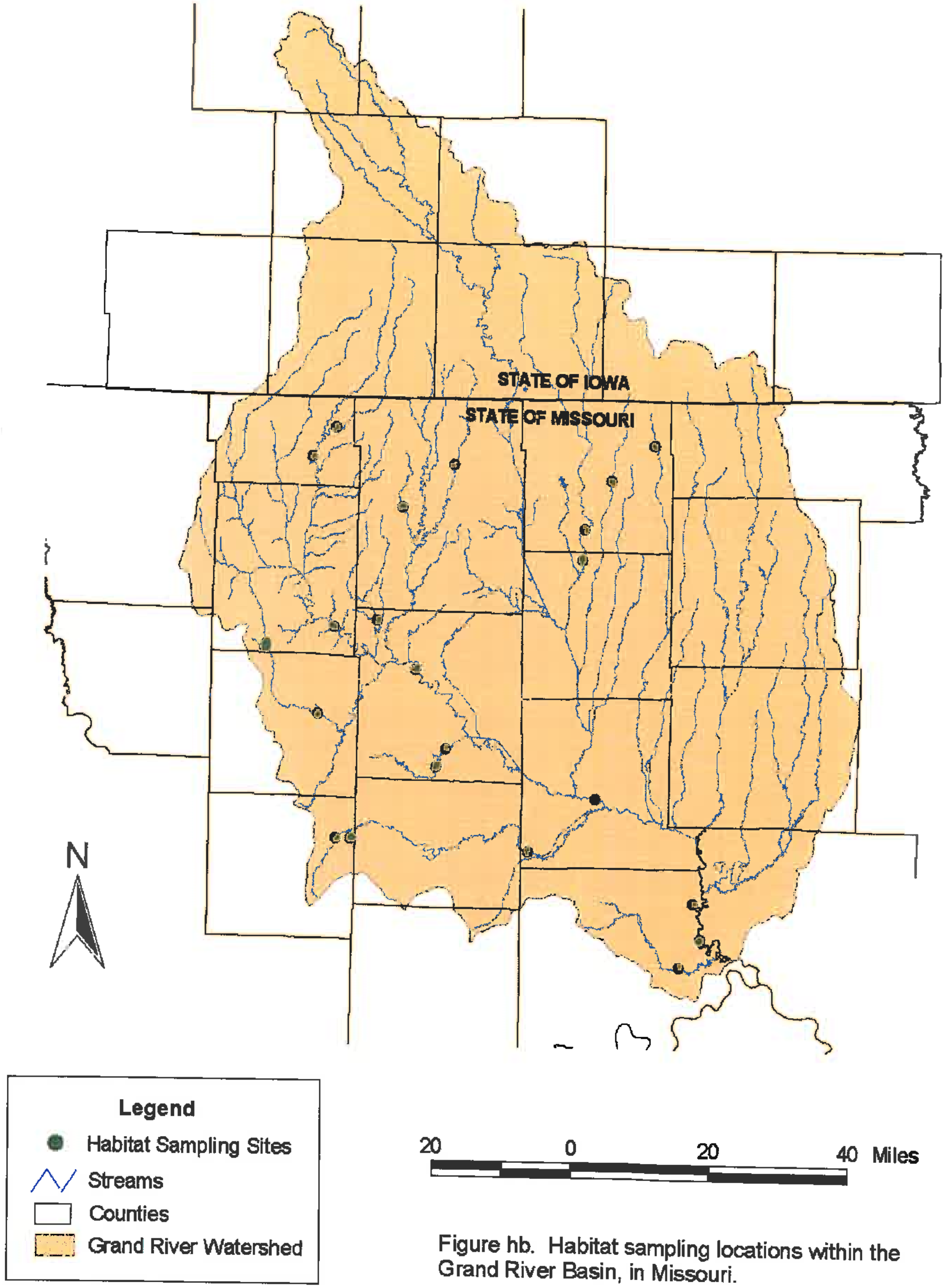

Figure hb. Habitat sampling locations within the Grand River Basin, in Missouri.

BIOTIC COMMUNITIES

Fish Community Data

Sixty species of fish have been collected by various investigators in the Grand River Basin since 1963 (Table 9, Figure fs) An additional 16 species have distributions that overlap portions of the basin (Pflieger 1971, 1975), but have not been collected. Common species within the basin are channel catfish (*Ictalurus punctatus*), black bullhead (*Ameiurus melas*), yellow bullhead (*A. natalis*), common carp (*Cyprinus carpio*), river carpsucker (*Carpiodes carpio*), creek chub (*Semotilus atromaculatus*), red shiner (*Cyprinella lutrensis*), sand shiner (*Notropis stramineus*) and green sunfish (*Lepomis cyanellus*). Grand River historically had a diverse fish population. An early naturalist reported catching "great numbers of interesting specimens...Grand River is the first stream we have seen in Missouri that is tolerably well supplied with fish" (Hoy 1872). Catfish are the most important sportfish within the basin. An estimated 72,920 catfish and bullheads were caught in Grand River in 1975 (Fleener 1977). Missouri River tributaries such as the Grand River are probably important spawning and nursery areas for big river catfish (Coon and Dames 1989; Brown and Coon 1994). A flathead catfish tagged in the Missouri River near Columbia, Missouri was captured in Grand River near Gallatin.

Channel Catfish

Grand River
Channel catfish (*Ictalurus punctatus*) are the most popular sportfish within the basin. Limited sampling has been done to assess channel catfish populations. Samples have generally been restricted to the upper Grand River and a few major tributaries. The majority of channel catfish collected were less than 11 inches long. Proportional stock density (PSD_{16}) values ranged from 13 to 35. No channel catfish longer than 24 inches were collected. Channel catfish made up 21% of the 1979 fish sample. Age 4 fish averaged 10.6 inches long. This is average when compared with statewide data (Purkett 1958).

Grindstone, Big (Daviess County), and Shoal creeks are major tributaries to Grand River that have been electrofished. Grindstone and Big creeks have quality channel catfish populations.

Thompson River
Paragamian (1990) collected fish population information from major streams throughout Iowa. Two of his study sites were on the upper Thompson River. Rotenone samples from upper Thompson River produced length frequency histograms similar to the upper Grand River electofishing samples. No fish longer than 20 inches were collected. Age 4 fish averaged 10.5 inches and 10.9 inches at the two sample sites. Density estimates were 4,402 and 721 fish/ha-hectare (Paragamian 1990).

Electrofishing Missouri's channelized portion of the river resulted in a length frequency histogram dominated by fish less than 11 inches long. The PSD_{16} value was 12. No fish longer than 24 inches were captured. Conversations with local conservation agents indicates this is similar to angler catches.

Few large channel catfish are observed during routine resource user contacts.

Flathead Catfish

Flathead catfish (*Pylodictus olivaris*) is another popular sport fish species. Many of the major streams and tributaries contain flatheads; however, most of the larger fish (>10 pounds) are caught from Grand River. An occasional large flathead is caught from the Thompson River, Weldon River and other tributaries, but these are uncommon.

Sampling in Grand River during 1976 (Gentry County) and 1979 (Daviess County) indicated good number of flatheads. The Gentry County sample was made up mostly of fish less than 16 inches long. The PSD_{16} value was 23 and the Relative Stock Density (RSD_{24}) value was 8. The Daviess County sample indicates there was a higher quality flathead population. The PSD_{16} and RSD_{24} values were 49 and 22, respectively. Age 4 fish averaged 17.2 inches long.

Very little sampling has been done in the Grand River below Chillicothe. Anecdotal evidence suggests that the lower Grand River contains more large flathead catfish than the Daviess or Gentry county sites.

Blue Catfish

Blue catfish (*Ictalurus furcatus*) (locally known as white catfish) are a prized fish in the basin. Every year anglers catch a few fish more than 30 pounds. Pflieger (1975) reported an 1854 account of a blue catfish weighing 136 pounds caught from Grand River near Chillicothe. Information on this species in the Grand River Basin is virtually non-existent. Blue catfish had never been sampled by MDC management personnel in the Grand River Basin before 1994.

Aquatic Invertebrates

Mussels

Freshwater mussels have nearly disappeared from many streams in northwestern and north central Missouri over the last fifty years (Oesch 1984). A 1913 survey indicated the Grand River had a considerable number of shells that were of commercial value (Oesch 1984). Today, mussels are drastically reduced in Grand River due to pollution from agricultural chemicals and sedimentation.

Websites: http://www.conservation.state.mo.us/conmag/1996/jul/2.html

http://www.conservation.state.mo.us/conmag/1996/feb/fe96barn.html

According to Oesch (1984) 19 species of freshwater mussels have historically occurred in the Grand River Basin (Table 10). Eleven of those species are found in the Grindstone Creek sub-basin. While mussels are sparse within the basin, none of the species sampled are listed as threatened or endangered (A. Buchanan, MDC, personal communication).

A formal survey of Locust Creek revealed that flat floaters (*Anodonta suborbiculata*) were collected for the first time in the Prairie-Upper Missouri Aquatic Faunal Division in 1998. Flat floaters are state listed as rare. They were collected in two locations within the basin (Winston et al, 1998).

Insects

Some invertebrate collections have been made. Most have been associated with USDA-SCS watershed planning projects. (Kangas and Crawford 1977, Mid-MO Engineers 1980, Rowe 1979). Eder also did some limited sampling at seven sample sites on the Grand and Thompson rivers. Locust Creek was sampled at the Locust Creek C.A. in a cooperative agreement with MDC and the Missouri Cooperative Fish and Wildlife Research Unit (Fantz 1993). Insects of 18 orders and 71 families have been collected since 1977 (Table 11).

Crayfish

Five species of crayfish have been collected within the Grand River basin (Pflieger, MDC, personal communication). The species which have been collected in order of abundance are the northern crayfish (*Orconectes virilis*), papershell crayfish (*O.immunis*), devil crayfish (*Cambarus diogenes*), grassland crayfish (*Procambarusgracilis*) and the White River crayfish (*P. acutus*).

Website: http://www.conservation.state.mo.us/nathis/arthopo/crayfish/crayfish.htm

Threatened and Endangered Species

Website: http://www.conservation.state.mo.us/nathis/endangered/index.htm

The threatened and endangered fish species in the Grand River Basin are listed in Table 12. Of particular concern is the Topeka shiner because it is a good indicator of high quality habitat of prairie creeks (Pflieger 1990) This species is experiencing a dramatic decline in population over its entire range (Tabor 1993).

Paddlefish, mooneye and blue sucker are basically large river species. Capture records of these species indicate their presence being restricted primarily to the mainstem of the Grand River. The distribution of all three species has been documented in the lower Grand River to Gallatin, Daviess County, MO (river mile 0-88). Additional collections of paddlefish have been made upstream in the Grand River in Gentry County, MO. Mooneye have been collected in the Weldon River near Princeton, Mercer County, MO. One conservation agent reports that paddlefish are caught in the Weldon River as far upstream as Princeton, MO.

Topeka shiners are found in high quality stream reaches that have not been degraded by extensive channelization or heavy sedimentation. "We learned of the presence of the Topeka shiner in Harrison County only because a student sampled many small streams of this county as part of a thesis project in 1963. There has never been a systematic survey of small streams in most other counties of the Grand River system, and such a survey might have the best potential for the discovery of additional Missouri populations of *N. topeka*" (Pflieger, personal communication). Recent Topeka shiner collections have come from the remaining high quality streams in Daviess, Grundy and Harrison counties in Missouri. A systematic fish survey of the Grand River Basin or at least a fish survey of potential occurrence sites of Topeka shiner would be beneficial in documenting the current distribution of this species in the basin.

Websites: http://www.conservation.state.mo.us/conmag/1999/02/4.html

http://www.conservation.state.mo.us/news/out/1999/012999.html

Trout-perch are typically found in deeper pools in small streams within the Grand River Basin. Trout-perch are "widespread in the Grand and Chariton stream systems..." (Pflieger 1971), but only rarely abundant at any fish sample site. Seven of the ten fish collections listed in Table 9 had trout-perch represented. A systematic fish survey of Topeka shiner localities would help in delineating the range of the trout-perch since these fish species often occur together.

A pallid sturgeon was caught by an angler on May 10, 1998 from the Grand River at the Chillicothe Access. The fish was one of 24 tagged and released into the Missouri River at river mile 299 on July 24, 1997.

Fish Stockings

Stocking of both native and non-native species has been a fisheries management tool in lakes and streams throughout the basin. Minutes of the Cameron Hunting and Fishing Club report that the Missouri Conservation Commission stocked 35,000 channel catfish and 5,000 largemouth bass in Shoal Creek during July, 1942. No information regarding lengths of those fish is available. Undoubtedly, unreported stocking by private individuals has also occurred. Two smallmouth bass were sampled from Shoal Creek in 1973 (O. Fajen, MDC, unpublished data). No other observations of this species have been noted from streams within the basin.

The most intensive stream stocking program was an effort to establish spotted bass fisheries in several north Missouri streams. Over 25,000 spotted bass were stocked in the Grand River Basin from 1965-1971 (Fajen 1975). Table 13 indicates the streams where the fish were stocked. Recent collections (since 1988) indicate that self sustaining populations are located in Grindstone, Big and Marrowbone creeks. Spotted bass were never stocked in Marrowbone Creek by MDC personnel.

Escapement of walleye (*Stizostedion vitreum*) and saugeye (*S. vitreum*) X (*S. canadense*) from several Iowa reservoirs contributes to the stream sport fishery. Limited fisheries exist downstream of these lakes. In Missouri, walleye are occasionally captured in the Weldon Fork and Thompson River. A locally popular walleye fishery exists in West Muddy Creek immediately downstream of Lake Paho near Princeton, Missouri.

Most public lakes in Missouri are supplementally stocked with channel catfish annually. Escapement of these fish into basin streams varies and may be locally significant but overall is probably negligible. In 1985, channel catfish (n=2,885) were tagged before stocking into Lake Paho to document spillway losses. As of April 1999, all tag returns (n=59) have come from the main lake. Numerous channel catfish are captured in West Muddy Creek. The fish may be coming from the Lake Paho Fish Rearing Station below Lake Paho and adjacent to the stream.

Flathead catfish were captured from the Missouri River near St. Joseph and stocked into King Lake in 1986. Five years later, one of the tagged fish was recaptured in the Missouri River near Nebraska City, Nebraska (NE). The fish traveled more than 400 miles through Lost Creek, Grindstone Creek, Grand River and the Missouri River.

Redear sunfish (*Lepomis microlophus*) have been stocked in many public lakes. Common carp *(Cyprinus carpio)* are an exotic species which have become well established throughout the basin. Various Asian carps are also becoming established. Grass carp (*Ctenopharyngodon idella*) have been stocked widely throughout the basin to control aquatic vegetation. In April 1994, an angler caught a bighead carp (*Hypophthalmichthys nobilis*) in Grand River from a borrow ditch near Chillicothe, first documented capture of this species in the basin. Another angler caught a pallid sturgeon *(Scaphirhynchus albus*) on Grand River at Chillicothe. The fish was stocked in the Missouri River at Waverly.

Muskellunge (*Esox masquinongy*) and blue catfish have been stocked in Pony Express Lake. Chances of these fish impacting stream fish communities are minimal. Plans include stocking walleye fingerlings into Grand River in June of 2000.

Creel Survey Data

Access point creel surveys were conducted in 1975 to determine recreational use of the Grand River (Fleener 1977). Anglers spent 69,000 hours (17,250 days) fishing on the upper Grand River (above Gallatin), and 198,700 hours (49,675 days) on the lower Grand River (below Chillicothe). Anglers harvested an estimated 267,700 fish (Table 14).

A statewide telephone survey conducted between 1983-1986 estimated that angler effort on Grand River ranged from 12,957 days/year to 74,357 days/year (Weithman 1987).

Table 9. List of all fish species sampled in the Grand River Basin (1963-present).

Common Name	Scientific Name
Pallid sturgeon (angler catch)	*Scaphirhynchus albus*
Shovelnose sturgeon	*S. platorynchus*
Paddlefish	*Polyodon spathula*
Longnose gar	*Lepisosteus osseus*
Shortnose gar	*L. platostomus*
Goldeye	*Hiodon alosoides*
Mooneye	*H. tergisus*
American eel	*Anguilla rostrata*
Gizzard shad	*Dorosoma cepedianum*
Central stoneroller	*Campostoma pullum*
Goldfish	*Carassius auratus*
Grass carp	*Ctenopharyngodon idella*
Red shiner	*Cyprinella lutrensis*
Common carp	*Cyprinus carpio*
Western silvery minnow	*Hybognathus argyritis*
Plains minnow	*H. placitus*
Bighead carp (angler catch)	*Hypophthalmichthys nobilis*
Redfin shiner	*Lythrurus umbratilis*
Speckled chub	*Macrhybopsis aestivalis*
Silver chub	*M. storeriana*
Golden shiner	*Notemigonus crysoleucas*
Emerald shiner	*Notropis atherinoides*
Bigmouth shiner	*N. dorsalis*
Sand shiner	*N. ludibundus*

Table 9 continued

Topeka shiner	*N. topeka*
Suckermouth minnow	*Phenacobius mirabilis*
Bluntnose minnow	*Pimephales notatus*
Fathead minnow	*P. promelas*
Creek chub	*Semotilus atromaculatus*
River carpsucker	*Carpiodes carpio*
Quillback	*C. cyprinus*
White sucker	*Catostomus commersoni*
Blue sucker	*Cycleptus elongatus*
Smallmouth buffalo	*Ictiobus bubalus*
Bigmouth buffalo	*I. cyprinellus*
Black buffalo	*I. niger*
Golden redhorse	*Moxostoma erythrurum*
Shorthead redhorse	*M. macrolepidotum*
Black bullhead	*Ameiurus melas*
Yellow bullhead	*A. natalis*
Blue catfish	*Ictalurus furcatus*
Channel catfish	*I. punctatus*
Stonecat	*Noturus flavus*
Tadpole madtom	*N. gyrinus*
Flathead catfish	*Pylodictis olivaris*
Northern Pike	*Esox lucius*
Trout-perch	*Percopsis omiscomaycus*
White bass	*Morone chrysops*
Green sunfish	*Lepomis cyanellus*
Orangespotted sunfish	*L. humilis*
Bluegill	*L. macrochirus*

Table 9 continued

Smallmouth bass	*Micropterus dolomieu*
Spotted bass	*M. punctulatus*
Largemouth bass	*M. salmoides*
White crappie	*Pomoxis annularis*
Black crappie	*P. nigromaculatus*
Johnny darter	*Etheostoma nigrum*
Sauger	*Stizostedion canadense*
Walleye	*S. vitreum*
Freshwater drum	*Aplodinotus grunniens*

<u>Collectors</u>

R.G. White (1963)
R. Green (1969)
W. L. Pflieger (1971), Missouri Department of Conservation (MDC)
O. Fagen (1973), MDC, unpublished data
D.A. Kangus and R.A. Crawford (1977)
J.R. Rowe (1979)
Mid-Missouri Engineers (1980)
V. Paragamian (1987)
L. Schrader (1989), MDC, unpublished data
L. S. Eder, (1976-1989), MDC, unpublished data
B. L. Todd, et.al. (1994)
Greg Pitchford, (1992-present), MDC, unpublished data

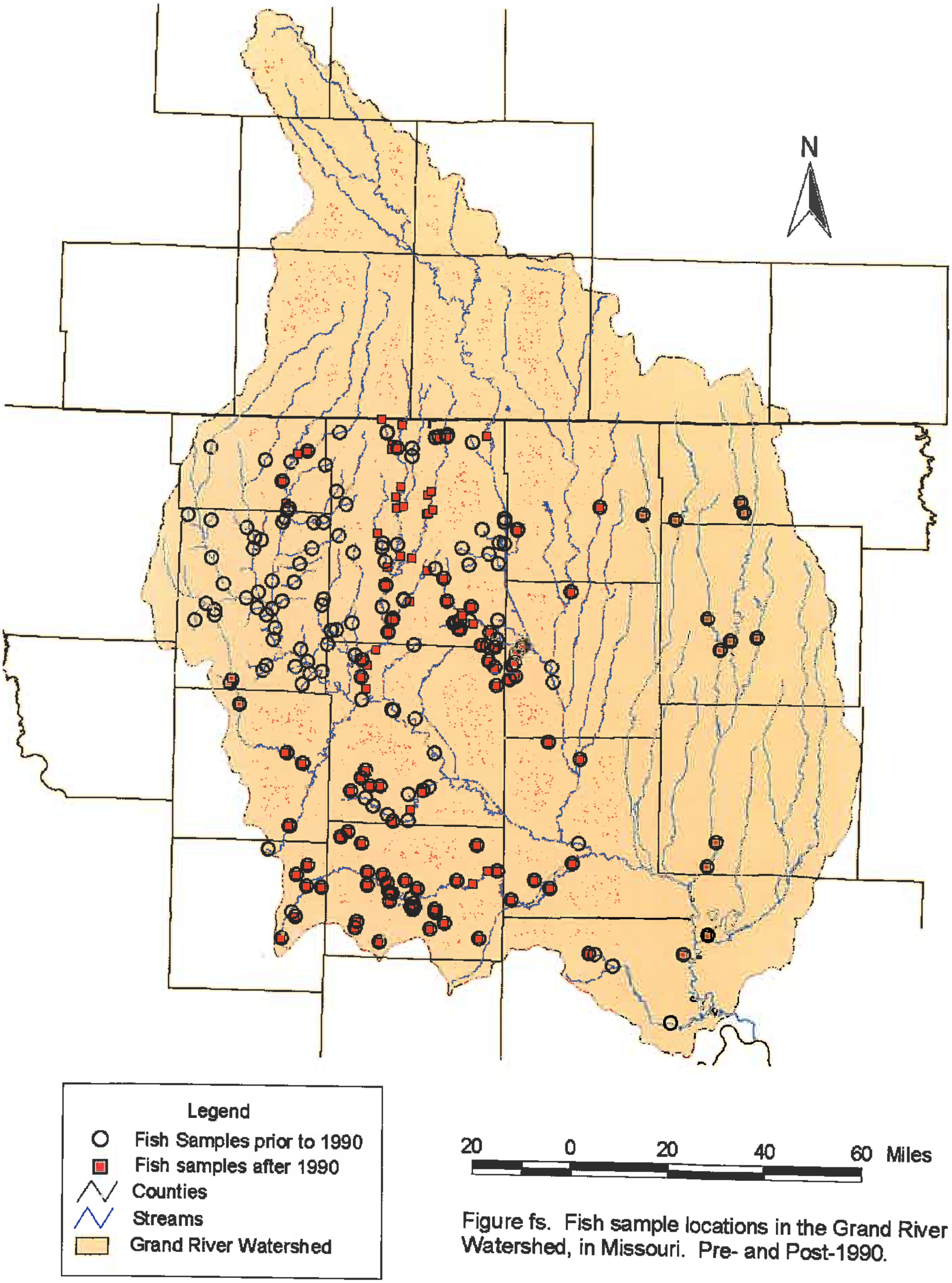

Figure fs. Fish sample locations in the Grand River Watershed, in Missouri. Pre- and Post-1990.

Table 10. List of the freshwater mussel species collected from the Grand River Basin according to Oesch (1984).*

Common Name	Scientific Name	Collection Date
Giant floater	*Anodonta grandis* sp.	After 1965
Squaw foot	*Strophitus undulatus*	Before 1920
White heel-splitter	*Lasmigona complanata*	After 1965
Washboard	*Megalonaias nervosa*	Before 1920
Pistol-grip	*Tritogonia verrucosa*	Before 1920
Maple leaf	*Quadrula quadrula*	After 1965
Pimple-back	*Q. pustulosa*	After 1965
Monkey-face	*Q. metanevra*	Before 1920
Three-ridge	*Amblema plicata*	After 1965
Wabash pig-toe	*Fusconaia flava*	After 1965
Pond-horn	*Uniomerus tetralasmus*	After 1965
Deer-toe	*Truncilla truncata*	After 1965
Fragile paper shell	*Leptodea fragilis*	After 1965
Pink heel-splitter	*Potamilus alatus*	Before 1920
Pink paper shell	*P. ohioensis*	Before 1920
Pond mussel	*Ligumia subrostrata*	After 1965
Slough sand-shell	*Lampsilis teres* ssp.	Before 1920
Yellow sand-shell	*L. teres* ssp.	After 1965
Pocketbook	*L. ventricosa*	Before 1920

* Does not include the Flat floater (*Anodonta suborbiculata*) collected in 1998.

Table 11. Invertebrate collections from the Grand River Basin.

	1	2	3	4	5	6	7	8
TRICHOPTERA								
Hydropsychidae								
Cheumatopsyche sp.	X	X		X	X		X	
Hydropsyche sp.	X	X	X	X			X	X
Potamyia sp.	X	X					X	
Hydroptilidae								
Leucotrichia sp.							X	
Leptoceridae								
Leptocella sp.			X					
Philopotamidae								
Chimarra								X
Polycentropodidae	X							
Neureclipsis sp.	X							
Psychomyiidae								
Psychomyia sp.							X	
EPHEMEROPTERA								
Baetidae			X					
Baetis sp.	X	X					X	X
Paracloedes sp.							X	
Caenidae								
Caenis sp.	X	X	X	X	X	X	X	X
Ephemeridae								
Hexagenia sp.	X	X	X	X	X	X	X	X
Heptageniidae								

Table 11 continued

	1	2	3	4	5	6	7	8
Stenonema sp.	X	X		X		X	X	X
Heptagenia sp.	X			X	X		X	
Anepeorus sp.			X					
Leptophlebiidae								
Paraleptophlebia sp.							X	
Oligoneuriidae								
Isonychia sp.	X	X	X	X				X
Palingeniidae								
Pentagenia sp.	X							
Polymitarcyidae								
Ephoron sp.	X	X						
Siplonuridae								
Ameletus sp.				X	X			
Tricorythodidae								
Tricorythodes sp.	X	X						
PLECOPTERA								
Capriidae								
Allocapnia sp.							X	
Perlidae								
Acroneuria sp.				X	X		X	
Neoperla sp.	X	X						
Perlesta sp.	X	X					X	
Taeniopterygidae								
Taeniopteryx sp.							X	
ODONATA								
Aeshnidae								

Table 11 continued

	1	2	3	4	5	6	7	8
Epiaeschna sp.				X				
Calopterygidae								
Hetaerina sp.	X	X						
Calopteryx	X		X				X	
Coenagrionidae								
Amphiagrion sp.				X	X		X	
Chromagrion sp.				X				
Enallagma sp.			X	X	X			
Ischnura sp.			X	X	X		X	
Protallagma								X
Corduliidae								
Somatochlora sp.					X		X	
Gomphidae								
Gomphus sp.	X	X	X		X	X	X	X
Dromogomphus sp.	X			X	X			
Progomphus sp.			X				X	
Lestidae								
Lestes sp.			X			X	X	
Libellulidae								
Brachymesia sp.						X		
Plathemis sp.					X			
Macromiidae								
Macromia sp.	X		X			X	X	
Tramea sp.			X					
Protoneuridae								

Table 11 continued

	1	2	3	4	5	6	7	8
Argia sp.	X	X	X			X	X	
COLEOPTERA					X			
Chrysomelidae			X					
Dryopidae								
Helichus sp.				X	X		X	
Dytiscidae			X					
Agabus sp.					X		X	
Copelatus sp.					X		X	
Dytiscus sp.							X	X
Hydroporus sp.					X			
Laccophilus sp.					X	X	X	
Thermonectus sp.					X			
Elmidae								
Ancyronyx sp.				X				
Stenelmis sp.	X	X	X				X	X
Dubiraphia sp.	X	X	X		X			
Optioservus sp.	X	X						
Gyrinidae			X					
Dineutus sp.		X					X	
Gyrinus sp.							X	
Haliplidae								
Haliplus sp.			X					
Peltodytes sp.					X	X	X	
Hydrophilidae								
Enochrus sp.							X	

Table 11 continued

	1	2	3	4	5	6	7	8
Helophorus sp.						X	X	
Hydrochus sp.							X	
Hydrophilus sp.							X	
Sphaeridium sp.			X					
Tropisternus sp.			X		X		X	
Noteridae								
Notomicrus								X
Scirtidae (Helodidae)			X					
Cyphon sp.						X	X	
Staphylinidae								X
MEGALOPTERA								
Corydalidae								
Corydalus sp.	X	X					X	
Chauliodes sp.			X					
Sialidae								
Sialis sp.		X	X					X
HEMIPTERA								
Belostomidae								
Belostoma sp.			X					
Lethocerus sp.						X	X	
Corixidae	X		X					
Sigara sp.						X	X	
Trichocorixa sp.					X		X	
Gerridae								
Gerris sp.				X	X		X	
Rheumatobates sp.				X	X			

Table 11 continued

	1	2	3	4	5	6	7	8
Hebridae								
Naeogus sp.				X				
Hydrometridae								
Hydrometra sp.					X			
Mesoveliidae								
Mesovelia sp.				X				
Nepidae								
Ranatra sp.			X				X	
Ranatra sp.				X	X			
Notonectidae								
Buenoa sp.			X					
Veliidae								
Rhagovelia sp.	X		X				X	
DIPTERA								
Ceratopogonidae (Heleidae)			X					
Bezzia sp.						X		
Culicoides sp.					X			
Stilobezzia sp.					X			
Chironomidae	X	X		X	X			X
Chironomus sp.				X	X	X	X	
Cryptochironomus sp.					X			
Dicrotendipes sp.					X	X	X	
Glyptotendipes sp.				X	X		X	
Micropsectra sp.					X	X	X	
Microtendipes sp.						X	X	
Parachironomus sp.							X	

Table 11 continued

	1	2	3	4	5	6	7	8
Pentaneura sp.			X			X	X	
Polypedilum sp.	X	X					X	
Procladius sp.				X	X			
Pseudochrionomus sp.							X	
Rheotanytarsus sp.				X			X	
Tanypus sp.				X	X			
Culicidae								X
Anopheles sp.					X	X	X	
Chaoborus sp.					X			
Empididae								
Hemerodromia sp.	X	X						
Ephydridae			X					
Dichaeta sp.				X				
Simuliidae	X	X						
Simulium sp.			X	X	X		X	X
Stratiomyiidae								
Stratiomyia sp.					X			
Tabanidae			X					
Tabanus sp.							X	
Tipulidae	X							
Erioptera sp.			X					
Pedicia								X
Tipula			X			X	X	
AMPHIPODA								X
Gammaridae								
Gammarus sp.						X	X	

Table 11 continued

	1	2	3	4	5	6	7	8
Talitridae								
Hyalella sp.			X	X	X			
DECAPODA								
Astacidae								
Orconectes sp.				X	X			
Orconectes sp.			X	X	X			
Orconectes virilis	X	X		X	X			
Procambarus sp.				X				
ISOPODA								
Asellidae								
Asellus sp.						X	X	
OLIGOCHAETA						X	X	X
Tubificidae		X			X			
Limnodrilus sp.			X	X	X			
Branchiobdellidae								
Branchiobdella sp.				X	X			
HIRUDNEA	X					X	X	
Erpobdellidae								
Erpobdella sp.			X					
Glossiphonidae			X					
Helobdella sp.				X	X			
Placobdella sp					X			
TRICLADIDA								
Planariidae								
Curtisia sp.			X					
PULMONATA								

Table 11 continued

	1	2	3	4	5	6	7	8
Ancylidae								
Ferrissia sp.			X	X				
Lymnaeidae								
Lymnaea sp.					X			
Physidae								
Physa sp.			X		X	X	X	
Physa integra				X	X			
Planorbidae								
Gyralaus sp.							X	
Helisoma sp.			X					
HETERODONTA								
Sphaeriidae								
Musculium sp.			X					
Sphaerium sp.			X	X	X	X	X	
EULAMELLIBRANCHIA								
Unionidae			X					
Anodonta sp.				X				
Anodontoides sp.				X				
GORDIIDA								
Gordiidae								
Gordius sp.			X				X	

Collection #	**Location**	**County**	**Collector**
1	Grand River		Eder, 1988
2	Thompson River		Eder, 1988

Table 11 continued

Collection #	Location	County	Collector
3	Big Creek	Harrison Co.	Kangas, 1977
4	Grindstone Creek		Rowe, 1979
5	Lost Creek		Rowe, 1979
6	Hurricane Creek		Mid-MO Engineers, 1980
7	Big Creek	Carroll Co.	Mid-MO Engineers, 1980
8	Locust Creek		Fantz, 1993

Table 12. List of the threatened and endangered fish species in the Grand River Basin* (MDC 1991).
* No fish species that occur in the Iowa portion of the Grand River Basin are state listed as threatened or endangered.

Species	Missouri Status	Federal Status
Paddlefish	Watch List	
Mooneye	Rare	
Topeka shiner	Endangered	Endangered
Blue sucker	Watch List	C2
Trout-perch	Rare	
Pallid Sturgeon	Endangered	Endangered

Table 13. List of the recent fish stockings within the Grand River Basin, except channel catfish.

Location	Sub-basin	Species
Twelve Mile Lake (Iowa)	Upper Thompson	Walleye, Saugeye
Little River Lake (Iowa)	Upper Weldon	Walleye, Saugeye
Sun Valley Lake (Iowa)	Middle Thompson	Walleye
Loch Ayr (Iowa)	Upper Grand	Saugeye
Lake Paho	Lower Weldon	Walleye, Brook silversides
Pony Express Lake	Lost Creek	Muskellunge, Blue catfish
Che-Ru Lake	Locust Creek	Walleye, Smallmouth bass
Cameron City Lake #3	Grindstone Creek	Hybrid striped bass
Big Creek	Big Creek	Spotted bass
Grindstone Creek	Grindstone Creek	Spotted bass
Sugar Creek	Sugar Creek	Spotted bass
Shoal Creek	Upper Shoal Creek	Spotted bass
Locust Creek	Near Jo Shelby Lake	Largemouth bass

Table 14. Estimated number of various fish species captured by anglers from the upper and lower Grand River from January 12, 1975 to January 10, 1976 (Fleener 1977).

Species	Lower Grand	Upper Grand	Total
Bullheads	*47,850		47,850
Carp	21,080	4,010	25,090
Channel catfish	11,240	11,170	22,410
Crappie	2,820		2,820
Buffalo	2,240	40	2,280
Flathead catfish	1,840	820	2,660
Freshwater drum	850	340	1,190
American eel	320		320
Bluegill	210		210
Sucker sp.	60		60
Largemouth bass	20		20
Other spp.	480	530	1010
Total Fish	89,010	16,910	105,920
Total Hours	198,680	69,250	267,930
Fish per Hour	0.45	0.24	0.40
Total Anglers	34,510	23,640	58,150

* A majority of the bullheads were caught in a 300-acre pool at Fountain Grove C.A.

MANAGEMENT PROBLEMS AND OPPORTUNITIES

The Missouri Department of Conservation (MDC) is charged with the '...control, management, restoration, conservation and regulation of the bird, fish, game, forestry and all wildlife resources of the state...' As stated in MDC's recent Regional Management Guideline documents, 'The Conservation vision is to have healthy sustainable plant and animal communities throughout the state of Missouri for future generations to use and enjoy, and that fish, forest, and wildlife resources are in appreciably better condition tomorrow than they are today.' In order to achieve this vision, efforts to better manage streams and their watersheds will be a continuing priority in the Grand River watershed.

This section includes strategic guidelines to provide MDC Fisheries Division staff working in the watershed with management direction to address the issues detailed in earlier sections. These issues include point and non-point source pollution, loss of riparian vegetation, the effects of large confined animal feeding operations, instream flow issues, and threats to aquatic life within the watershed. The guidelines will be used to address future stream management, public awareness, and public access issues and needs. Efforts specifically related to the management of impounded waters are addressed in detail elsewhere and are not included here.

GOAL I: IMPROVE WATER QUALITY AND MAINTAIN OR IMPROVE WATER QUANTITY IN THE GRAND RIVER BASIN SO ALL STREAMS ARE CAPABLE OF SUPPORTING HIGH QUALITY AQUATIC COMMUNITIES.

Status: Many streams throughout the basin do not meet water quality standards. Excessive nutrients and sediment from agricultural runoff are the chief sources of pollution. Progress has been made in improving land use, but extensive areas are still without treatment. The Conservation Reserve Program (CRP) has reduced the amount of highly erodible land in rowcrop production. Some ground is returning to intensive production as CRP contracts expire. Unrestricted access to streams by livestock has created problems of degrading streambanks and increasing the direct input of nutrients. Additionally, a large sediment source is found in excessive streambank erosion. Streambank erosion is usually the byproduct of poor land use and stream practices (ie. channelization) Biotechnicial solutions have little impact on streams with 15-20 foot vertical banks. Recently the move of large corporate farms into the watershed has provided threats to both water quality and quantity.

Objective 1.1: Basin streams meet state standards for water quality.

Guidelines:

! Review NPDES, 404 and other permits, cooperate with other state and federal agencies to investigate pollution and fish kill reports, assist with the enforcement of existing water quality laws and recommend measures to protect aquatic communities.

! Collect fish for contaminant analysis for the Missouri Department of Health and cooperate in advising the fishing public on the impacts of contaminant levels.

- Monitor water quality and insure compliance with discharge permits. Most of this work is under the jurisdiction of MDNR. With training, volunteer groups such as Stream Teams can assist with water quality improvement. These volunteer groups can be strong advocates for good water quality throughout the Grand River Basin. Encourage development of at least one Stream Team in each community (population >2,000) in the Missouri portion of the basin. These teams can monitor water quality using simple macro invertebrate and chemical techniques.

- Inform the public of water quality problems (i.e. excessive siltation, animal waste runoff, etc.) affecting the aquatic biota and solutions through media contacts, personal contacts and literature development.

Objective 1.2: Maintain base flows within the Grand River Basin at or above current levels within the constraints imposed by natural seasonal variations and precipitation.

Guidelines: The most efficient way to address these concerns is through existing agricultural agencies and the legislative process.

- Gather available flow information to create flow duration curves-for streams within the basin.

- Support development of water laws and an interstate compact/agreement that will address the quantity of water in Missouri's streams.

- Inform the public of water quantity problems, the affected aquatic biota and potential solutions through media contacts, personal contacts and literature development.

- Train and involve local volunteer groups such as Stream Teams in water quality/quantity monitoring and advocacy in the Grand River Basin.

- Make presentations and provide technical assistance for Special Area Land Treatment (SALT) and EARTH projects, as requested, to SWCD boards which govern these projects.

- Review gaging station needs in the basin and recommend reactivation of needed gaging stations that are currently inactive or new locations for stations within the Grand River Basin.

GOAL II: IMPROVE RIPARIAN AND AQUATIC HABITAT CONDITIONS OF THE GRAND RIVER BASIN TO MEET THE NEEDS OF NATIVE AQUATIC SPECIES WHILE ACCOMMODATING SOCIETY'S DEMANDS FOR WATER AND AGRICULTURAL PRODUCTION.

Status: Streams in the Grand River Basin are generally characterized by a narrow riparian corridor of trees less than 20 feet wide that is rapidly being eroded. Large reaches of stream lack a wooded riparian corridor or have no corridor. In many locations where trees are present; the stream channels have downcut below the root systems. Thus these trees provide little if any streambank stabilization benefits. Landowners within the basin are very reluctant to restore a 100 foot wide corridor along streams on their property. They want to maintain agricultural production within the corridor zone and many view trees as a cause of stream problems rather than a solution. The Conservation Reserve Program and the Wetland Reserve Program provide the opportunity to make significant improvements in riparian habitat. Both programs have been well received by landowners.

Objective 2.1: All riparian landowners within the Grand River Basin exposed to the messages of the importance of good stream stewardship and where to go to get technical assistance for sound stream habitat improvement. Efforts to improve riparian conditions will be concentrated in the following sub-basins (sub-basins are listed in order of priority):

Sugar Creek
Locust Creek
Marrowbone Creek
Upper Shoal Creek
Grindstone Creek
East Fork Grand River
Big Creek - (Daviess and Harrison counties)
Lower Yellow Creek
Big Creek - (Carroll County)

Guidelines: Advertising and promoting stream programs, installing and maintaining demonstration projects, and providing educational opportunities to landowners will make them more aware of the reasons and techniques for protecting streams. Emphasizing economic aspects of stream improvement will encourage more landowners to participate. The quality and availability of stream management information for landowners will be improved.

- Provide technical recommendations to all landowners that request assistance and who are willing to reestablish and maintain an adequate riparian corridor.

- Cooperate with MDC Outreach and Education Division to develop materials and present stream conservation and related courses for elementary and secondary school teachers.

- Once every 5 years provide a stream management workshop for NRCS personnel with responsibility for programs in the Grand River Basin.

- Establish stream management demonstration sites in the listed watersheds.

- Participate in existing SALT and EARTH projects through SALT/EARTH Coordinator to incorporate fish and wildlife values and promote streambank stabilization practices. Cooperate with NRCS and SWCD boards to establish SALT and EARTH projects within the listed sub-basins, if none exist.

- Encourage incorporation of fish and wildlife values in design and construction of PL-566 structures through NRCS personnel and private landowners.

- Work with Farm Service Agency (FSA) to promote cost share programs that include streambank stabilization and stream stewardship practices.

- Promote good stream stewardship through landowner workshops and stream demonstration site tours targeting these sub-basins.

- Cooperate with MDC Outreach and Education Division in utilizing these streams for aquatic education programs.

- Prepare GIS layers of important habitat variables for each watershed listed.

- Continue promoting and assisting with the CRP and WRP programs.

Objective 2.2: Critical and unique Grand River Basin aquatic habitats identified and protected from degradation.

Guidelines: Identification, acquisition, targeting private landowner programs and cooperation with other agencies/organizations can provide greater control and better management of critical and unique aquatic areas.

- Coordinate fish population sampling in the Grand River Basin with MDC-Fisheries Research, MDC-Northwest Fisheries Management Region personnel and Iowa DNR personnel to further define and delineate unique and critical habitats.

- Continue to solicit information from the public and resource professionals on critical and unique aquatic habitats.

- As opportunities develop, make recommendations for proper management and/or acquisition of critical and unique aquatic habitats in the basin (identified in Unique Habitat portion of this plan).

- Promote continuous CRP signups in critical habitat areas.

GOAL III: MAINTAIN DIVERSE AND ABUNDANT POPULATIONS OF NATIVE AQUATIC ORGANISMS WHILE ACCOMMODATING ANGLER DEMANDS FOR QUALITY FISHING.

Status: The Grand River Basin supports a fish assemblage that lacks diversity. Only 55 fish species have been collected throughout the Grand River Basin since 1963. An additional 6 species are know to exist in the basin, 5 of the 6 species can be directly attributed to artificial stockings. A comprehensive survey of the fishes of the Grand River Basin is needed to document current fish distribution from previously unsampled (or inadequately sampled) streams and document changes in fish distribution throughout the basin. Several fish species desirable to anglers are found in the basin. Catfish (blue, channel and flathead) are the most sought after fish species in the streams of the Grand River Basin. Other fish of interest to anglers in these rivers are: bluegill; buffalo; bullheads; carp; crappie and green sunfish. Sufficient samples to assess the status of these populations is lacking. The MDC walleye committee selected Grand River as a location to stock walleye fingerlings. Stocking is scheduled to begin in June of 2000. Several non-game fish species of concern occur in the basin. The Topeka Shiner, a federally listed endangered species is found within the basin. Some invertebrate sampling has been conducted in the basin, but a system-wide comprehensive invertebrate collection has not been made.

Objective 3.1: Evaluate and maintain sportfish populations, with emphasis on channel and flathead catfish, at sufficient quality and condition to satisfy the angling public.

Guidelines: Assess the populations of emphasis species and take steps to improve their populations through public education, regulation, harvest restrictions, habitat improvement, stocking or other methods. No information has been collected on angler use or desires since the mid-1970's. Gathering this information will be a major objective over the next several years. This information will be used to develop appropriate management strategies.

! Develop a standardized sampling procedure for target species and implement a monitoring program to obtain trend data on fish populations which will be used to determine population objectives for management of the Grand River and its tributaries. Encourage MDC Fisheries Research Section to undertake a project to establish quality catfish population criteria for north Missouri streams.

! Identify critical habitat areas for channel and flathead catfish throughout the basin and maintain or enhance these areas as needed to improve the habitat. Encourage MDC Fisheries Research Section to undertake a project to identify critical habitat parameters for channel and flathead catfish in north Missouri streams.

- Identify critical spawning and nursery areas for Missouri River fishes (especially blue, channel and flathead catfish) and acquire, maintain or enhance these areas as needed to improve the habitat. Encourage University of Missouri-Columbia (through MDC Fisheries Research Section) to undertake a project(s) to determine the contribution the fish utilizing the Grand River as a spawning and nursery area are making to the Missouri River system.

- Using regulations, habitat improvement and other methods, implement population improvement programs for target species once population objectives have been determined for these species.

- Conduct a creel survey of Grand River Basin anglers to document harvest, species preference and fishing pressure. Determine changes in these parameters that might have occurred since Fleener's (1977) recreational use survey of Grand River.

- Increase awareness of the recreational potential of fishes other than catfish such as buffalo, carp, drum and gar.

Objective 3.2: Populations of native non-game fishes and aquatic invertebrates assessed and maintained at or above present levels throughout the basin.

Guidelines: Assess the status of fish and invertebrate communities throughout the basin through a cooperative effort between MDC Fisheries Division and Iowa DNR. It is assumed that a decline in diversity, distribution and abundance of non-game fishes is largely related to land use changes over the last 100 years. Available fish distribution data is sufficient to document current levels of diversity and in certain streams and stream reaches relative abundance; but not basin wide. Techniques to maintain or improve non-game fishes will depend on the fish communities in decline and the causative agent. It is also assumed that improvements in other aquatic life will occur s
imultaneous to those occurring in fish communities.

- Develop standard sampling techniques for assessing fish and invertebrate communities, including the use of indicator species, and implement a monitoring program to track trends in species diversity and abundance.

- Design a comprehensive sampling regime for non-game fishes throughout the basin. Sampling in the Missouri portion of the basin will be conducted by MDC Fisheries Management and Research personnel. Sampling the Iowa portion of the basin will be conducted by Iowa DNR personnel.

- Using regulations, stocking, habitat improvement and other techniques, implement programs to protect or enhance fish species diversity and abundance.

- Coordinate invertebrate sampling with other groups collecting and identifying invertebrates within the basin (i.e. Stream Teams, University of Missouri, etc.). Based on these collections, determine information gaps within the basin to determine invertebrate sampling sites.

Objective 3.3: Populations of Topeka shiners assessed and maintained at or above current levels in the basin.

Guidelines: Assess the status of Topeka shiner populations throughout the basin. Assist in implementing the action plan for Topeka shiner (Notropis topeka) in Missouri (MDC 1999). "We learned of the presence of the Topeka shiner in Harrison County only because a student sampled many small streams of this county as part of a thesis project in 1963. There has never been a systematic survey of small streams in most other counties of the Grand River system, and such a survey might have the best potential for the discovery of additional Missouri populations of N. topeka" (Pflieger, MDC, personal communication). Known Topeka shiner populations have shown a significant decline since 1963, so restoration efforts will be aimed at maintaining or improving existing populations and enhancing habitat in streams where Topeka shiners have been most recently extirpated. We assume the decline in this species is land use related, so enhancement efforts need to be directed at land use improvement. Land use is a resource largely beyond our direct control. By keeping populations at current levels and monitoring their health, an adequate "seed source" will be available from which to assist with restoration efforts.

- Within the framework of a basin-wide comprehensive fish sampling regime, concentrate initial efforts in areas with historic Topeka shiner capture sites or areas where Topeka shiners are likely to occur.

- Examine possibilities of outside MDC funding (i.e. USFWS Section 6 grant) for Topeka shiner inventory work, initial public awareness efforts and administration of cost share incentives to protect and enhance Topeka shiner habitat.

- Encourage stream related cost share practices to be included on SWCD dockets that would benefit Topeka shiner streams (i.e. livestock fencing, alternative water sources, etc.).

- Assist with the implementation of the action plan for the Topeka shiner (Notropis topeka) in Missouri as it relates to the Grand River Basin.

- Participate in the development of the Federal recovery plan for the Topeka shiner.

GOAL IV: INCREASE RECREATIONAL USE OF STREAMS IN THE GRAND RIVER BASIN.

Status: Public use of Grand River Basin streams for recreational activities other than fishing is limited. Information on recreational use of the Grand River was conducted in the 1970's; a survey to determine current usage would be valuable. Turbid water and the intensively rowcropped landscape can be aesthetically unappealing and thus limit recreational floating on the streams in the Grand River Basin. However, some scenic stretches still exist. With increased public awareness and restoration of wooded corridors limited increases in recreational use is possible.

Objective 4.1: Access sites, bank fishing and trails developed in sufficient numbers to accommodate public use.

Guidelines: The MDC strategic plan anticipates an increase in stream use because of an overall increase in the levels of fishing. We must determine the level of public satisfaction with existing recreational opportunities and undertake acquisition and development projects to improve those opportunities.

- Continue acquisition and development of public access and frontage sites (for boating and bank fishing) at strategic points within the basin, based on the Stream Areas Program Strategic Plan.
- Improve bank fishing and other aquatic wildlife-based recreational opportunities on MDC lands in the basin through implementation of recommended strategies in area plans.
- Conduct a recreational use survey within the basin in conjunction with a creel survey to determine existing levels of use and satisfaction with recreational opportunities in the basin.

Objective 4.2: All anglers and floaters have access to information on the stream recreational opportunities within the Grand River Basin.

Guidelines: Make the public aware of various opportunities through media outlets, fair exhibits, and Missouri Conservationist articles. Increase recreational stream use within the basin.

- Maintain the stream emphasis at public events such as the Bethany and Trenton district fairs, St. Joseph Sportshow, National Hunting and Fishing Day, etc.
- Assist in the development of prairie stream articles in the Missouri Conservationist and make suggestions for a future MDC video ("Missouri Outdoors", etc.) to highlight north Missouri prairie stream recreational opportunities.
- Gather information during activities in Grand River Basin to contribute to a revised edition of An Introduction to Floatable Streams North of the Missouri River.

GOAL V: INCREASE PUBLIC APPRECIATION FOR STREAM RESOURCES THROUGHOUT THE GRAND RIVER BASIN.

Status: Citizens throughout the basin have little appreciation for stream resources; there is a fundamental lack of understanding the importance of streams culturally, biologically and historically. As a result there is little concern for the well-being of the stream resource within the basin. Streams For The Future has received a "lukewarm" reception in the area. Certain practices which are detrimental to streams have become a part of the local culture.

Channelization riparian clearing and improper placement of levees are stream practices that are deeply rooted and considered good stream management practices by many landowners within the basin.

Objective 5.1: Increase current level of public awareness of local stream resources and good stream management practices.

Guidelines: Increased appreciation of the stream resource should follow increased public awareness and education of stream values. Heightened knowledge and use of the basin's streams should lead to appreciation of this resource and result in concerns about the quality and quantity of water within the basin's streams. Newspaper articles, talks and special events highlighting streams should help foster this awareness.

! Cooperate with MDC Outreach and Education Division in utilizing these streams for aquatic education programs. Identify stream locations appropriate for educational field trips near participating schools.

! Promote the formation of Stream Teams within the basin through talks with local civic organizations and contacts with local school districts.

! Maintain the stream emphasis at public events such as the Bethany and Trenton district fairs, St. Joseph Sportshow, etc.

! Assist in the development of prairie stream articles in the Missouri Conservationist and make suggestions for a future MDC video ("Missouri Outdoors", etc.) to highlight north Missouri prairie stream values.

! Track success through MDC's current Gallup polling efforts.

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