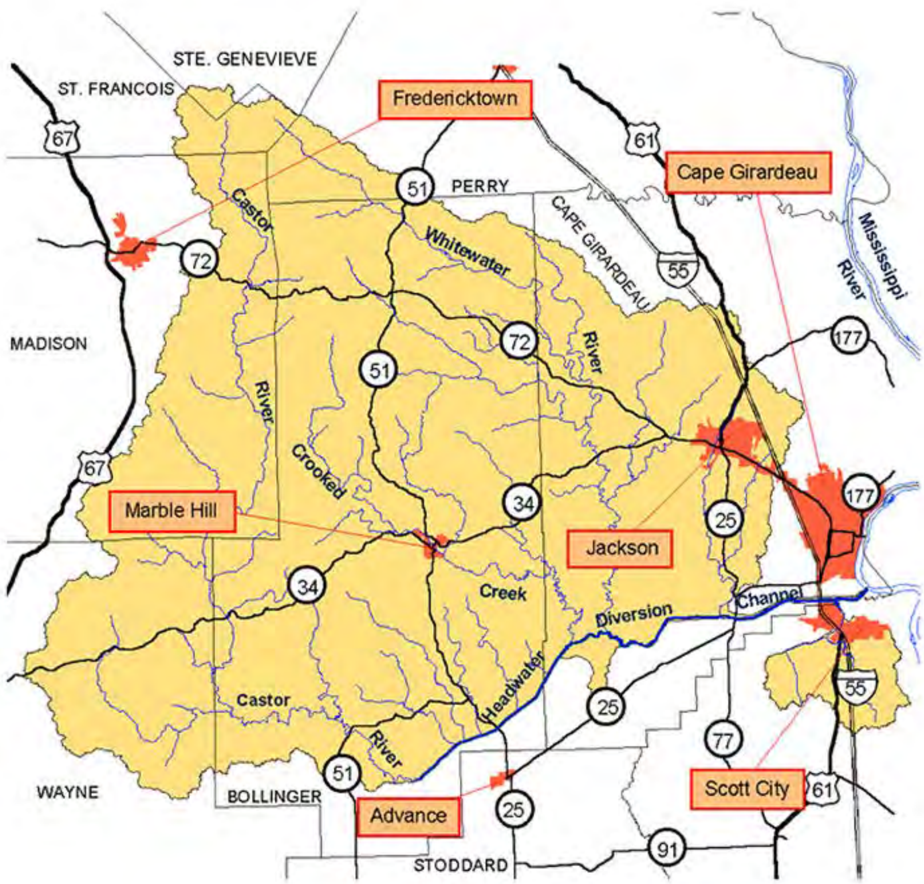


Headwater Diversion Channel

Watershed and Inventory Assessment, May 1994

Prepared by Dennis E. Norman, Fisheries District Supervisor
Missouri Department of Conservation, Cape Girardeau, MO

Table of Contents

Executive Summary

The Headwater Diversion Basin is the intercepted and diverted headwater drainage of the much larger Little River Basin. The four primary streams in the 1,207-square mile Headwater Diversion Basin are Castor River (6th order, 69 miles), Whitewater River (6th order, 56 miles) and Crooked Creek (5th order, 49 miles) which are now tributaries to the man-made Headwater Diversion Channel (7th order, 34 miles) that drains into the Mississippi River near Cape Girardeau, Missouri. The basin is primarily Ozarkian in nature with a steep descent into the Mississippi Lowlands and is characterized by a high incidence of permanent streams, diverse channel gradients and land use which is 55% woodland, 22% grassland and 19% cropland. Only 30,100 people live in the basin which is free of heavy industrial developments and major urban centers.

Stream ecology throughout most of the basin is particularly healthy and no obvious chronic threats to stream resources are apparent. This plan describes the current status and addresses opportunities for preserving or improving four major resource elements within the basin.

Stream Use

The basin receives moderate fishing pressure and very limited amounts of other recreational activities. In 1977, an estimated 58,000 fishing trips ranked the basin in the 42nd percentile (15th out of 36) when fishing pressures in 36 Missouri basins were compared. Telephone survey estimates of 1987 and 1988 fishing trips averaged 33,000 trips per year. Telephone survey data indicate that fishing pressure within the basin is concentrated on the Diversion Channel, which receives 3 times as many trips and 7 times more angling hours per acre than Castor River.

Public access to 190 miles of floatable mainstem streams and 130 miles of wadable tributaries is generally good; but, some locations in the basin need more access. Currently, 15 public access areas, with over 10 miles of frontage and 5 boat ramps, are available for public use. Eight additional boat ramp sites and 8 larger frontage tracts are proposed for the basin in approved Missouri Department of Conservation (MDC) acquisition plans.

Recreational opportunities can best be enhanced by developing additional access facilities on the Diversion Channel to relieve current crowded conditions. Other sites should be developed upstream to encourage the dispersal of public use throughout more of the basin. Then, information directed at increasing public awareness of specific recreational opportunities, particularly those in the upper watersheds, should help encourage a more widespread and diversified public interest in the basin.

Water Quality

An abundant water supply provided by adequate precipitation, good infiltration, high subsurface storage and minimal runoff assures clean, sustained and stable base flows which help maintain high water quality. Point source pollution is no longer considered a serious threat anywhere in the basin and nonpoint source pollution problems are generally moderate and local in nature. Nutrient loading from livestock waste, non-permitted gravel mining, sawdust leachate and occasional raw sewage bypasses sometimes constitute minor threats to basin streams. These effluent problems can best be addressed by simply maintaining the current good water quality conditions at state standards and increasing public, industrial and political awareness of the conditions, causes and solutions to local runoff problems.

Stream Habitats

The quality and diversity of habitats throughout the basin are exceptional. The in-stream habitat component is providing good elements of abundant cover, clean substrates and high base flows, which assures a stable water supply with adequate depths and flow during droughts. Most channels are well shaded and the basin is relatively free of problems related to turbidity, siltation and algal blooms.

Channel alterations are usually associated with small gravel mining operations and occasional attempts by landowners to cut off stream meanders. Movement of excessive gravel bedloads in the disturbed uplands, however, can disrupt channel hydraulics and smother good habitats.

Only 6% of the streambanks are severely or moderately eroding. The quality of the corridor vegetation is typically good with 75% of the existing corridors in dense timber. Corridor widths, however, are variable and agricultural encroachment into narrow corridors causes some streambank erosion problems.

Soils in the basin are highly erosive when disturbed. The potential for sheet, rill and gully erosion is the highest in the state; but, few fine sediments actually reach stream channels because of modest cropland acreage and fairly good farming practices. Coarse sediments, however, are eroding from the wooded uplands and clogging some downstream reaches because of poor timber harvest and woodland grazing practices.

Habitat problems are usually minor, scattered and most often associated with shifting gravel bedloads and streambank instability caused by a poor land-use practice. To maintain good habitats and make any needed habitat improvements, we will need to applaud and promote good forest and riparian stewardship by landowners through awareness, assistance and incentive programs. Unique habitats, including those occupied by threatened and wetland species, must be protected from degradation through the acquisition of lands and easements or special Landowner Cooperative Project (LCP) efforts.

Stream Biota

An assemblage of 113 fish species and 123 taxa of benthic macroinvertebrates, including 37 naiad species and 9 crayfish species have been identified. Threatened species include 10 rare, extirpated or watch list fishes and 5 rare or endangered naiads. A 36% increase in the total number of fish species since 1941 and the current abundant and widespread distribution of 29 intolerant fish species are indicators of good water quality and habitat conditions in the basin. Similar patterns of size structure are generally shared by sport species throughout the basin. Recruitment of all sportfishes to stock-size is good and problems related to annual production or early mortalities are not apparent. Some species are recruiting to quality-, preferred- and memorable-sizes. Nearly one half of the channel and flathead catfish populations are quality- and preferred-sized fish. Common carp and freshwater drum are producing some memorable-sizes. Low recruitment of spotted bass to quality-size from proportionally high stock-size densities is a concern. Another concern is the low recruitment of preferred-size shadow bass from relatively high quality-size densities.

Species richness will be monitored and maintained at or above current basin levels by ensuring that stream and corridor habitats remain healthy and diverse through the promotion, acquisition and creation (wetlands) of needed habitat components. Size and density parameters associated with catfishes, crappies, shadow bass and spotted bass populations can be addressed through special fishing regulations if a creel survey suggests that angler harvest is significantly responsible for the parameters

Location

The Headwater Diversion Basin, which primarily drains the diverted Castor and Whitewater Rivers and Crooked Creek, is located in southeast Missouri, and since 1913, has been part of the Upper Mississippi River Basin below St. Louis, Missouri. The Castor River originates in Ste. Genevieve County and flows 69 miles south through St. Francois, Madison, Wayne and Bollinger Counties (Figure 1). The Whitewater River originates in St. Francois County and flows 56 miles south through Perry, Bollinger and Cape Girardeau Counties. Flow from both rivers is intercepted and diverted 34 miles east to the Mississippi River by the Headwater Diversion Channel, a large artificial channel located in Bollinger, Cape Girardeau and Scott counties. Forty-nine miles of Crooked Creek, which separates the Castor and Whitewater River subbasins, is the only other major tributary to the Headwater Diversion Channel.

Prior to the construction of the Headwater Diversion Channel and associated levee system, Crooked Creek and the Castor and Whitewater River drainages were the headwaters of the large Little River which drained the entire bootheel region of southeast Missouri into the Arkansas-White-Red River Basin. The large Headwater Diversion Channel main levee has never been over-topped and effectively isolates the upper basin from the bootheel region.

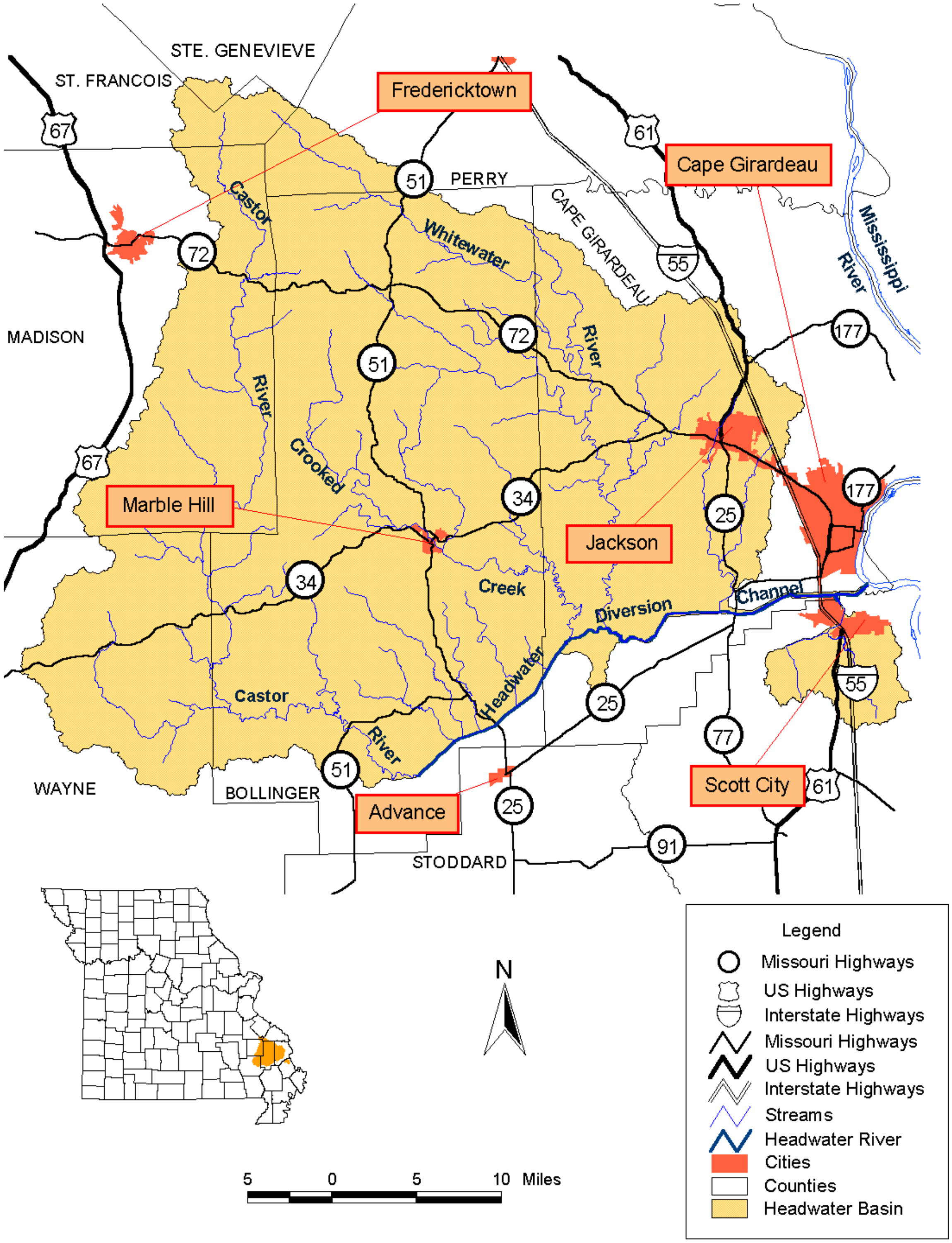


Figure 1. Location of the Headwater Diversion Watershed in Missouri.

Geology

Physiographic Region

Most of the basin lies entirely within the dissected Salem Plateau Subdivision of the Ozark Plateau (Figure nd). The basin, however, has some distinct topographic features associated with the rapidly descending Ozark Escarpment that forms the prominent boundary between the high relief Ozark Plateau and the low relief Mississippi Alluvial Plain Divisions (Missouri Department of Natural Resources 1986). Land elevations range from 1,230 ft NGVD (National Geodetic Vertical Datum of 1929) in the Castor River headwaters to 314 ft NGVD at the Headwater Diversion Channel confluence with the Mississippi River.

Geology

The geology of the basin is greatly influenced by the nearby St. Francois Mountains uplift (Ozark Dome) which has exposed outcrops of irregularly distributed Precambrian igneous rock and elevated the upper watersheds (MDNR 1986, Figure ge). The tilt of the uplifted strata exposes progressively younger and less resistant limestone and dolomite bedrock in all downstream easterly and southeasterly directions (MDNR 1984). The fractured limestone and dolomite bedrock on all slopes is overlaid by a thick (200 ft at some sites) weathered layer of cherty residuum (Soil Conservation Service 1981).

The ancient uplift has had the time and energy to carve moderately wide floodplain valleys which are overlaid with a deep gravel alluvium that is occasionally interrupted by igneous outcrops (pink granite shut-ins) and remnant limestone bluffs. The soluble cherty residuum, fractured bedrock and unconsolidated alluvium allow rapid groundwater movement that sustains most base flows during dry periods and yields clear water. Springs, however, are not common in the basin. Occasional karst features are restricted to the northeast edge of the basin near the city of Jackson in the upper Byrd Creek and Hubble Creek watersheds.

Soil Types

Soils in the basin are transitional from the dominant Ozark Border region on the west side to the secondary Central Mississippi Valley Wooded Slopes region on the east side (MDNR 1986). Soils formed in the upland loess and cherty limestone residuum are typically infertile, droughty, slightly acidic, extremely gravelly (65% chert by volume) and generally suitable for only woodland and grass production (SCS 1992 and 1986). The more fertile soils formed in the lowland alluvium contain sand, silt, loam and clay components that are marginally to highly suitable for improved pasture and row crop production (SCS 1981).

The primary soil series associated with the basin are: (moving upstream in the basin) Sharkey, Falaya, Wakeland, Wideman and Elk in the bottoms; Holstein, Peridge, Poynor, Goss and Clarksville on the slopes; and Menfro, Goss and Hilderbracht on the ridgetops. Unfortunately, all of these soil classifications share two distinct characteristics — a large volume of chert which is responsible for excessive gravel bedloads, and severe to hazardous erosion potential when disturbed.

The basin has some of the highest erosion potential in the state. Annual sheet and rill erosion on tilled land (24-30 tons/acre) and undisturbed forest land (0.25-0.50 tons/acre) exceeds most of the other basins in the state (Anderson 1980). Sheet and rill erosion on permanent pasture, however, are considered acceptable with a rate of 2-5 tons/acre. Gully erosion (0.3-0.8 tons/acre) often exceeds the severe rates in north Missouri and is uncharacteristic of the remainder of the Salem Plateau.

Despite the high potential for serious erosion on disturbed soils, relatively little sediment (1.8 tons/acre/year) actually enters basin streams. Active soil conservation programs, good local land management practices, low topographic relief and relatively few acres in row crop production all contribute to the currently low fine-sediment loads in the lower watersheds. Historically, poor timber management practices and conversion of woodland to pasture have contributed to the more serious problem of shifting gravel deposits in the stream channels of the upper watersheds.

Watershed Area

The drainage area of the basin is 1,207 square miles. Three primary watersheds, Castor River, Whitewater River and Crooked Creek drain 81 percent of the basin (Table 1). The Cape La Croix Creek watershed (50.6 square miles), which is sometimes included as part of the basin in SCS and U.S. Department of Agriculture (USDA) publications, is diverted directly into the Mississippi River. Therefore, the city and suburbs of Cape Girardeau are not part of the Headwater Diversion Basin. Also, Dark Cypress Swamp (Hawker, Cane, Dry, Malone and Gizzard Creeks) drains directly into the Diversion Channel below the Greenbrier Bridge and is included in the Diversion Channel subbasin, not the Castor River watershed.

Stream Mileage, Order and Permanency

A total of 2,366 streams occupying 2,984 miles of channel were identified, ordered, measured (by hand dividers) and classified as either intermittent or permanent as indicated on U.S. Geological Survey (USGS) 7.5 minute topographic maps (Table 2). All 104 third order and larger streams were tabulated by name, length, order and basin position (Table 1-A). The apparently liberal designation of 715 miles of permanent streams on USGS topographic maps does not agree with the designated 439 miles of permanent streams classified under Missouri Water Quality Standards (CSR 1981). The Missouri Water Quality Standards figure is probably the more accurate estimate. The percentages of second and third order permanent stream mileage measured from USGS topographic maps appear to be much too high, based on field observations by Fisheries District staff.

In this part of Missouri, only 2.7 square miles of watershed are needed to maintain each mile of permanent stream (MDNR 1984). The ratio of watershed area to length of permanent stream is probably the lowest of all Missouri river basins. The high incidence of stream permanency is the result of basin geology and the abundant water supply provided by favorable precipitation, runoff and evaporation patterns in the southeast portion of the state. The influence of geology and weather patterns can even affect stream permanency within the basin. Streams in the southeast portion of the basin tend to have more permanent water and lower watershed to stream length ratios.

Channel Gradient

Gradient information for 80 third order stream channels has been tabulated (Table 2-A) and is on file at Fisheries District headquarters for convenient reference and conversion to graphical gradient plots.

Diverse channel gradients throughout the basin reflect the complicated influences of variables associated with transcending geological formations, bedrock composition, channel age and watershed size.

Steeper gradients on the west side of the basin (Castor River) are generally a result of the Ozark Escarpment transition from the Salem Plateau to the Mississippi Alluvial Plains. However, steeper gradients also tend to occur in some east sloping drainages (Bear Creek and Little Whitewater Creek) because of the tilt provided by the St. Francois Mountains uplift. The uplift has also exposed scattered outcrops of erosion resistant granites that provide hardpoints, vertical control and rigid channel boundaries which produce some undulating channel profiles in the higher elevations in the northwest part of the basin.

Table 1. Drainage area of major watersheds, Headwater Diversion Basin, Missouri. (Modified from: USDA. 1981. Watersheds in Missouri) The Hydrologic Unit Code 07140107- is the prefer to the USDA code.

USDA Code	Watershed	Max Ord	Area (acres)		Area (Sq. Mi)	% of Basin
	Total Castor River Subbasin	6°	286,274	***	447.3	37.4
20	Bear Creek	5°	-56,973		-89	-7.4
10	Upper Castor River	5°	-135,266		-211.4	-17.6
30	Lower Castor River	6°	-94,035		-14.9	-12.3
	Castor R. above Zalma gage	6°	-270,270	**	-423	-35.3
50	Total Whitewater River Subbasin	6°	217,987		340.6	28.4
	Little Whitewater Creek	5°	-59,981		-93.7	-7.8
	Byrd Creek	5°	-43,218		-67.5	-5.6
40	Total Crooked Creek Subbasin	5°	118,976		185.9	15.5
60	Total Hubble Creek	5°	59,027		92.2	7.7
	Total Dark Cypress Swamp	4°	52,736		82.4	6.9
80	Total Ramsey Creek	4°	31,360		49	4.1
TOTAL HEADWATER DIVERSION BASIN			766,360	*	1,197.40	100

( ) = Watershed subtotal within a subbasin
*** = Does not include Dark Cypress Swamp
** = Does not include Dark Cypress Swamp or Bear Creek
* = Does not include Cape La Croix Creek

Table 2. Stream mileage summary, by order, subbasin and permanency, Headwater Diversion Basin, Missouri. (Measured directly from USGS 7.5 minute topographic maps).

SUBBAIN STREAM MILEAGES (includes all unprofiled reaches of 1° and 2° mileage)									
	DIVERSION CHANNEL*			CASTOR RIVER			WHITEWATER RIVER		
Order	# of Reach.	Total Mi.	% Perm.	# of Reach.	Total Mi.	% Perm.	Reach.	Total Mi.	% Perm.
7°	1	17.65	100	-	-	-	-	-	-
6°	1	16.8	100	1	18.75	100	1	20.1	100
5°	-	-	-	2	43.6	100	3	24.55	100
4°	3	10.35	72	9	44.3	100	6	57.35	100
3°	15	55.2	65.4	40	70.9	81.7	29	68.55	87.7
2°	68	69.3	26	195	198.4	29.6	151	141.2	49
1°	288	228.1	0.4	867	701.55	0.5	667	536.8	0.5
TOTAL	376	397.4	24.3	1114	1077.5	21.1	857	848.55	27.6

SUBBAIN STREAM MILEAGES (includes all unprofiled reaches of 1° and 2° mileage)						
Order	# of Reach	Total Mi.	% Perm.	# of Reach	Total Mi.	% Perm.
	CROOKED CREEK			HUBBLE CREEK		
7°	-	-	-	-	-	-
6°	-	-	-	-	-	-
5°	1	24.8	100	1	4.65	100
4°	4	29.05	100	2	10.45	100
3°	14	33.5	86.7	6	18.3	97.3
2°	78	78	32.8	35	36.35	34.7
1°	365	296.85	1	179	128.45	0.5
TOTAL	462	462.2	24.1	223	198.2	23.3

TOTAL BASIN STREAM MILEAGE (includes all unprofiled reaches of 1° and 2° mileage)					
Order	# of Streams	# of Reaches	Total Miles	Miles Permanent	% Permanent
7°	1	1	17.65	17.65	100
6°	2	3	55.65	55.65	100
5°	5	7	97.6	97.6	100
4°	17	24	151.5	148.6	98.1
3°	80	104	246.45	201.05	81.6
2°	423	527	523.25	184.15	35.2
1°	1,839	2,366	1,891.75	10.5	0.6
TOTAL	2,366	3,032	2,983.85	715.2	24

* = Includes Dark Cypress Swamp and Ramsey/Marquette subbasins.

Table 1-A. Stream mileage summary, Headwater Diversion Basin, Missouri. (All profiled 3° and larger tributaries, tabulated by order, subbasin and hierarchal mile position from the headwaters of Castor River to the confluence with the Mississippi River)

Mile M+L1+ A1:L11 2	TRIBUTARY NAME			7° MILE S	6° MILES	5° MILE S	4° MILE S	3° MILES	2° MILES	1° MILES	TOTAL MILES
68.7	Mainstem of the Castor River				18.75	30.5	12.25	3.6	3.3	0.30*	68.7
61.45	ID# 340830A**							1.05	0.85	1.55*	3.45
61.3	ID# 340830B							0.50*	0.30*	1.20*	2
57.35	Dry Branch							2.65	1.35*	0.60*	4.6
49.25	Henderson Creek						0.4	2.75	0.95	1.10*	5.2
		0.4	Indian Creek					1.3	1.7	0.50*	3.5
47.7	Grounds Creek						3.3	0.7	1.20*	0.50*	5.7
		3.25	ID# 320802					0.6	0.55	0.60*	1.75
44.45	Greasy Creek							4.05	1.85*	0.80*	6.7
43.6	Whitener Creek							0.6	2.1	0.85*	3.55
33.9	Shetley Creek						3.65	4.55	0.50*	0.70*	9.4
		3.65	East Prong					2.4	1.15*	0.25*	3.8
		3.9	ID# 310712					0.70*	0.15*	0.50*	1.35
33.05	Gimlet Creek							1.4	1.15	0.60*	3.15
30.6	Big Creek						6.05	2.85	0.95*	0.55*	10.4
		2.7	Little Creek					2.2	0.4	1.35*	3.95
		3.05	Johnson Hollow					0.55*	0.45*	0.65*	1.65
		5.75	East Fork					4.4	1.00*	1.05*	6.45
		6.05	West Fork					2.45	0.90*	0.50*	3.85
29.65	Trace Creek							5.8	2.95*	0.20*	8.95
27	Grassy Creek							2.15	5	0.55*	7.7
26.45	Campground Hollow							1.25	1.45*	0.90*	3.6
22.3	Turkey Creek						4.2	0.95	1.75*	0.60*	7.5
		4.4	Gizzard Creek					0.85	1.35*	0.55*	2.75
18.8	Bear Creek					13.1	3.8	1.5	0.50*	1.40*	20.3
		2.75	Andys Creek					1.5	0.35*	0.50*	2.35
		4.7	Barnes Creek					2.1	0.85*	1.50*	4.45
		8.35	Goose Creek					1.55*	2.25*	1.15*	4.95
		9.4	McCabe Creek					1.50*	1.65*	1.40*	4.55
		11.85	ID# 290613					0.40*	1.10*	0.85*	2.35
		13.15	West Fork				2.65	0.95*	0.20*	0.85*	4.65
				0.65	ID# 290602			2.35	0.65*	0.55	3.55
				2.65	White Hollow			0.65*	1.00*	1.20*	2.85
		16.9	Graham Hollow					0.75	0.85*	0.80*	2.4
		BEAR CREEK SUBBASIN TOTALS				13.1	6.45	13.25	9.4	10.2	52.4
17.15	Lick Log Creek							0.8	2.20*	1.00*	4
16.3	Jesse Creek							0.55*	1.35*	1.30*	3.2
12.7	Pond Creek							3.20*	2.60*	0.80*	6.6
8.45	Perkins Creek						8	1.6	3.15	0.85*	13.6
		5.75	ID#290 907					0.70*	1.60*	0.70*	3

Mile M+L1+A1:L112	TRIBUTARY NAME			7° MILE S	6° MILES	5° MILE S	4° MILE S	3° MILES	2° MILES	1° MILES	TOTAL MILES
		8	ID#300836					0.50*	0.95*	0.70*	2.15
0	CASTOR RIVER SUB-TOTALS				18.75	43.6	44.3	70.9	54.55	32.5	254.6
29.9	Hawker Creek						4.75	0.75	3	2.05*	10.55
		4.75	Clubb Creek					4.8	0.85*	1.05*	6.7
		5.45	Virgin Creek					0.6	1.75*	0.90*	3.25
28.45	Cane Creek							13.7	0.55	0.80*	15.05
28.3	Dry Creek							9.95	3.25*	1.10*	14.3
25.45	Malone Creek							3.9	4.9	0.95*	9.75
22.7	Gizzard Creek							1.5	2.55*	0.65*	4.7
20.3	Crooked Creek					24.8	17.8	1.25	2.75	1.90*	48.5
		42.6	Summers Creek					1.7	1.9	0.80*	4.4
		41.3	Huffman's Creek					0.95	1.3	1.25*	3.5
		31.8	Indian Creek					2.2	0.60*	0.70*	3.5
		24.8	Little Crooked Creek				5.65	0.75	1.7	1.00*	9.1
				5.7	ID# 310932			0.80*	0.90*	0.55*	2.25
				4.6	Limbaugh Branch			1.85*	0.35*	1.35*	3.55
		20.8	Hurricane Creek				4.4	9.2	0.25*	1.15*	15
				4.4	Cedar Branch			0.55	4.1	1.40*	6.05
		20.65	Opossum Creek					2.25	1.1	2.15*	5.5
		14.7	ID# 300913					0.90*	1.20*	1.80*	3.9
		10.3	Hog Creek				1.2	8.9	1.1	1.45*	12.65
				1.25	Granny Creek			1.3	1.75*	1.00*	4.05
		3.9	ID# 301128					0.90*	1.30*	0.45*	2.65
	CROOKED CREEK SUBBASIN TOTALS					24.8	29.05	33.5	20.3	16.95	124.6
18.55	No-Name ID# 301135							1.90*	0.80*	0.65*	3.35
17.65	Whitewater River				20.1	4.5	25.3	4.9	0.40*	0.60*	55.8
		49.9	No-Name ID# 340930					0.5	1.2	0.70*	2.4
		47.95	Martin Hollow Ck.					0.7	0.45	1.10*	2.25
		46	Blue Creek					4.1	0.7	0.50*	5.3
		41.8	Shrum Creek					2.95*	0.85*	0.60*	4.4
		38.8	Jack Creek					2.7	0.3	0.70*	3.7
		36.3	Lix Hollow Creek					0.75*	0.65*	0.80*	2.2
		29.35	Wolf Creek					3.6	1.1	1.80*	6.5
		24.6	Caney Fork				12.2	2.8	1.4	0.60*	17
				1.85	Sandy Branch			2.2	0.85*	0.70*	3.75
				6.2	ID# 331134			0.9	0.50*	1.15*	2.55
				12.2	ID# 331117			0.40*	0.85*	0.55*	1.8
		20.8	No-Name ID# 321135					0.05*	0.55*	1.05*	1.65
		20.1	Little Whitewater R.			17.7	2	2.7	1.35	0.55*	24.5
				2	Panther Ck.			2.85	1.35	0.90*	5.1
				6.7	Little Mjuddy Ck.			7.8	1.65*	0.75*	10.2

Mile M+L1+A1:L112	TRIBUTARY NAME			7° MILE S	6° MILES	5° MILE S	4° MILE S	3° MILES	2° MILES	1° MILES	TOTAL MILES
				11.2	Mayfield Ck.			4.6	1.15	0.55*	6.3
				17.7	Stones Branch		1.7	1.5	0.30*	0.80*	4.3
				1.7	ID# 320911			0.65*	0.85*	0.95*	2.45
				19.7	Baltimore Ck.			3.3	0.30*	0.90*	4.5
		16.85	Schroder Branch					1.10*	1.10*	0.40*	2.6
		14	Dillard Creek					4.1	0.60*	0.85*	5.55
		12.05	Byrd Creek			2.35	10.45	1.5	0.5	1.00*	15.8
				2.35	Cane Creek		5.7	2.5	2.55	1.60*	12.35
				0.1	Helderman Ck.			1.10*	0.50*	1.00*	2.6
				5.7	ID# 311204			2.1	1.75	1.70*	5.55
				10.9	Horrell Ck.			4.1	2.80*	0.75*	7.65
				12.8	ID# 321209			1.6	0.70*	0.50*	2.8
		10.25	No-Name ID#311236					0.50*	0.90*	0.50*	1.9
	WHITEWATER R. SUBBASIN TOTALS				20.1	24.55	57.35	68.55	28.15	24.55	223.25
14.8	Bean Branch						2.90*	1.00*	1.70*	1.15*	6.75
		2.9	No-Name ID# 301230					2.90*	0.10*	0.80*	3.8
12	No-Name ID#301228							1.00*	1.90*	0.55*	3.45
10.95	No-Name ID#301227							0.90*	0.80*	1.80*	3.5
9.45	Hubble Creek					4.65	7.15	4.5	1.75*	1.15*	19.2
	4.65	Williams Creek					3.3	7.9	0.80*	0.95*	12.95
		3.3	Randol Ck.					0.1	4	0.80*	4.9
	6.05	Foster Creek						1.7	2.85*	0.45*	5
	11	No-Name ID#311223						0.50*	0.65*	0.70*	1.85
	11.8	Goose Creek						3.6	1.5	1.35*	6.45
	HUBBLE CREEK SUBBASIN TOTALS					4.65	10.45	18.3	11.55	5.4	50.35
2.25	Ramsey Creek						2.7	7.20*	0.70*	1.10*	11.7
	2.7	Sals Creek						4.20*	1.60*	0.70*	6.5
0.9	Marquette Lake Creek							0.9	0.05*	0.55*	1.5
0	Headwaters Diversion Channel			17.65	16.8	—See Castor River Mainstem—-					34.45
HEADWATERS DIVERSION BASIN TOTALS				17.65	55.65	97.6	151.5	246.45	139.05	94.2	802.1

*=intermittent to the nearest order on USGS topographic maps.

**=un-named, mouth, Township, Range and Section.

Table 2-A. Channel gradient summary, Headwater Diversion Basin, Missouri. (All profiled 3° and larger tributaries, tabulated by order, subbasin and hierarchal mile position from the headwaters of the Castor River to the confluence with the Mississippi River).

MILE MARKER	TRIBUTARY NAME			7° GRAD	6° GRAD.	5° GRAD.	4° GRAD.	3° GRAD.	2° GRAD.	1° GRAD.
68.7	Mainstem of the Castor River				1.65	7.33	17.31	36.81	43.64	123.33
61.45	ID# 340830A							52.29	68.94	83.87
61.3	ID# 340830B							76.2	37.67	100
57.35	Dry Branch							37.85	60.67	111.17
49.25	Henderson Creek						39	43.64	42.11	90.91
		0.4	Indican Creek					44.46	89.65	226.6
47.7	Grounds Creek						33.64	48.57	77.25	146.6
		3.25	ID# 320802					51.83	76.73	117.17
44.45	Greasy Creek							43.9	76	110
43.6	Whitener Creek							57.5	61.24	107.53
33.9	Shetley Creek						21.29	38.75	93.4	104.71
		3.65	East Prong					38.79	71.48	80
		3.9	ID# 310712					76.86	100	80
33.05	Gimlet Creek							38.07	49.3	83.33
30.6	Big Creek						18.02	41.05	76.84	109.1
		2.7	Little Creek					45.14	74.25	84.67
		3.05	Johnson Hollow					63.82	95.33	123.08
		5.75	East Fork					32.36	62.9	87.05
		6.05	West Fork					36.73	75.56	104
29.65	Trace Creek							30.88	45.93	50
27	Grassy Creek							26.23	41.22	68.18
26.45	Campground Hollow							12.8	37.86	146.67
22.3	Turkey Creek						20.38	36.21	62.06	122.38
		4.4	Gizzard Creek					46.35	50.81	145.45
18.8	Bear Creek					10.61	19.73	33.53	43.4	76.64
		2.75	Andys Creek					38.87	80	104
		4.7	Barnes Creek					29.1	40	72.6
		8.35	Goose Creek					27.55	53.33	69.57
		9.4	McCabe Creek					30.33	46.3	63.29
		11.85	ID# 290613					34	59.1	90.24
		13.15	West Fork				25.32	40.63	57	74
			0.65 ID# 290602					34.43	61.54	84.91
			2.65 White Hollow					35.54	43.1	73.33
		16.9	Graham Hollow					43.07	56.82	81.25
17.15	Lick Log Creek							15.75	50.41	100
16.3	Jesse Creek							20	46.44	86.15
12.7	Pond Creek							19.53	49.85	78.63
8.45	Perkins Creek						16.16	34.81	40.67	104.59
		5.75	ID#290907					31.43	57.06	109.57
		8	ID# 300836					69.8	54.84	122.43
0	CASTOR R. SUBBASIN AVE. GRADIENTS				1.65	8.97	23.42	39.89	60.27	99.92
29.9	Hawker Creek						6.32	7.73	40.97	76.63
		4.75	Clubb Creek					30.38	52.94	100
		5.45	Virgin Creek					22.17	47.49	160
28.45	Cane Creek							16.29	52.55	130.5
28.3	Dry Creek							19.56	33.23	30.91
25.45	Malone Creek							7.69	42.43	42.11
22.7	Gizzard Creek							13.07	50.31	110.77
20.3	Crooked Creek					4.04	14.89	21.6	28.73	52.63

MILE MARKER	TRIBUTARY NAME			7° GRAD	6° GRAD.	5° GRAD.	4° GRAD.	3° GRAD.	2° GRAD.	1° GRAD.
		42.6	Summers Creek					31.18	48.95	75
		41.3	Huffman's Creek					28.42	47.19	81.6
		31.8	Indian Creek					41.36	78.33	142.86
		24.8	Little Crooked Creek				20.07	30.67	45.29	63
			5.7	ID# 310932				47.5	76.67	63.64
			4.6	Limbaugh Branch				43.24	57.14	88.89
		20.8	Hurricane Creek				17.73	26.3	92	101.74
			4.4	Cedar Branch				39.09	49.76	111.43
		20.65	Opossum Creek					40.44	48.18	82.33
		14.7	ID# 300913					13.33	50	63.89
		10.3	Hog Creek				9.67	21.72	43.91	101.17
			1.25	Granny Creek				17.69	42.29	111
		3.9	ID# 301128					25.56	37.69	97.78
	CROOKED CK SUBBASIN AVE. GRADIENTS					4.04	15.59	30.58	53.33	88.35
18.55	No-Name ID#301135							16.26	35.75	143.54
17.65	Whitewater River				2.68	3.56	11.3	38.57	97.5	150
		49.9	No-Name ID#340930					56	78.33	187.14
		47.95	Martin Hollow Ck.					44.71	82.67	88.27
		46	Blue Creek					32.78	90.43	140
		41.8	Shrum Creek					43.42	58	106.67
		38.8	Jack Creek					36.63	66.67	85.71
		36.3	Lix Hollow Creek					43.6	83.08	145
		29.35	Wolf Creek					25.89	37.64	67.5
		24.6	Caney Fork				13.11	28.57	48.57	26.67
			1.85	Sandy Branch				25.82	51.76	126.71
			6.2	ID# 331134				18.22	30.8	73.57
			12.2	ID# 331117				49	64	81.82
		20.8	No-Name ID#321135					88	55.09	98
		20.1	Little Whitewater R.			10	22.35	30.11	65.93	160
			2	Panther Ck.				31.23	79.26	88.89
			6.7	Little Muddy Ck.				23.37	44.24	69.33
			11.2	Mayfield Ck.				34.41	60	120
			17.7	Stones Branch			26.65	62	110	102.5
				1.7	ID# 320911			58.46	70.59	105.26
				19.7	Baltimore Ck.			49.79	80	122.22
		16.85	Schroder Branch					8.82	57.14	250
		14	Dillard Creek					36.63	71.67	76.47
		12.5	Byrd Creek			6.81	7.56	28	52	80
				2.35	Cane Creek		7.02	14.8	27.45	56.25
					0.1	Helderman Ck.		4	36.8	53.3
					5.7	ID# 311204		17.62	31.43	38.24
				10.9	Horrell Ck.			18.68	33.93	80
				12.8	ID# 321209			34.19	42.86	86.6
		10.25	No-Name ID# 311236					30	30.56	170
	WHITEWATER R. SUBBASIN AVE. GRADIENTS				2.68	6.79	14.67	34.94	59.95	104.66
14.8	Bean Branch						9.79	8.4	22.06	98.52
		2.9	No-Name ID# 301230					1.24	1	56.88
12	No-Name ID# 301228							17.4	22.05	103.09

MILE MARKER	TRIBUTARY NAME			7° GRAD	6° GRAD.	5° GRAD.	4° GRAD.	3° GRAD.	2° GRAD.	1° GRAD.
10.95	No-Name ID# 301227							13.56	10.38	56.5
9.45	Hubble Creek					6.84	5.4	17.49	31.26	95.65
		4.65	Williams Creek				3.3	17.47	45	105.26
				3.3	Randol Ck.			20	20.5	87.5
		6.05	Foster Creek					6.71	20.35	122.22
		11	No-Name ID#311223					20	26.15	85.71
		11.8	Goose Creek					20.39	40	88.89
2.25	Ramsey Creek						6.11	8.35	21.71	67.27
		2.7	Sals Creek					5.95	26.06	85.71
0.9	Marquette Lake Creek							27	18	74.18
0	Headwater Diversion Channel			0.69	1.42	—See Castor River Mainstem—				
HEADWATERS DIVERSION BASIN AVE. GRADIENTS				0.69	1.92	7.03	16.34	32.18	53.92	97.99

*=difference in reach elevations/total reach distance

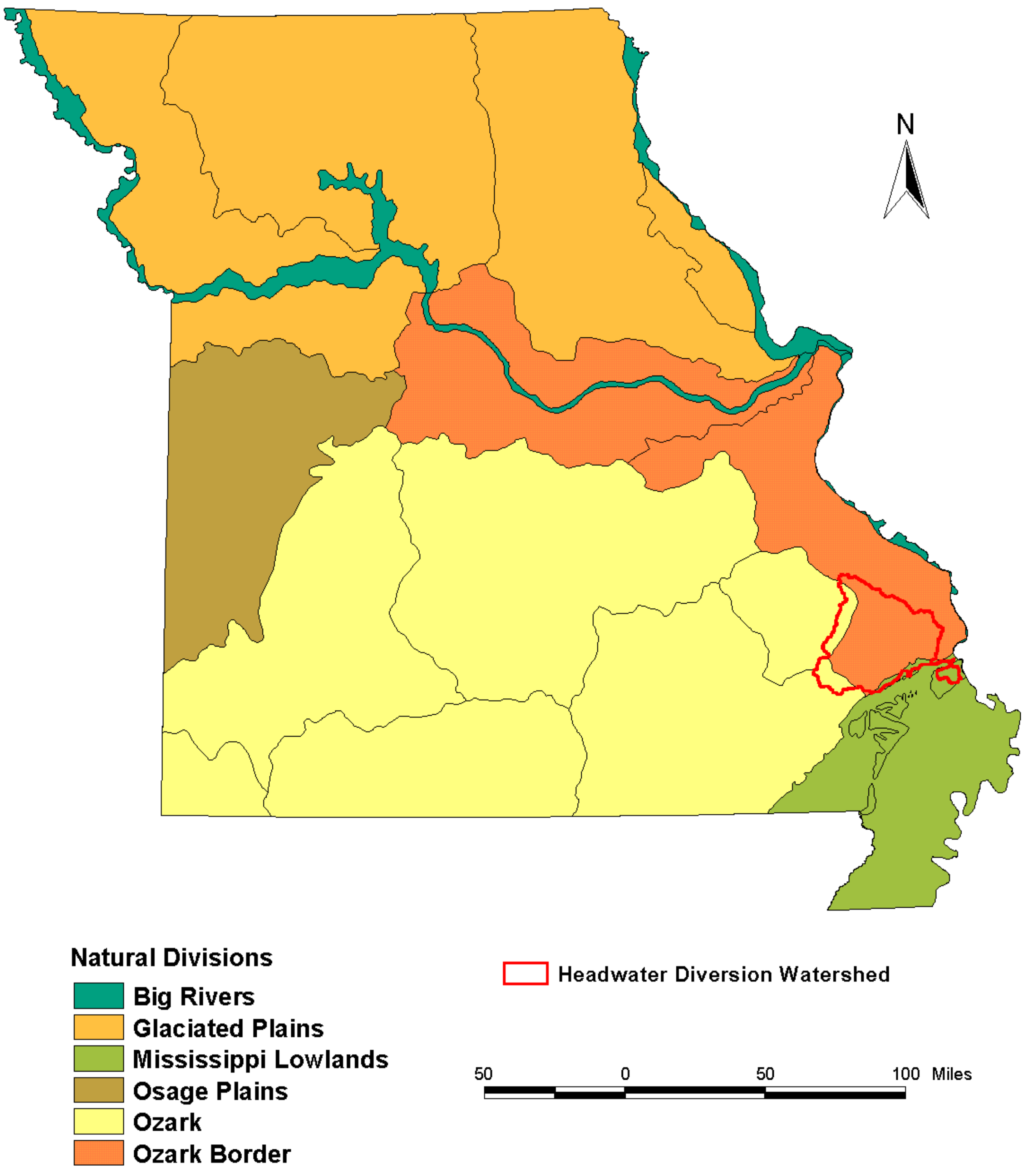


Figure nd. Natural divisons of the Headwater Diversion Basin in Missouri.

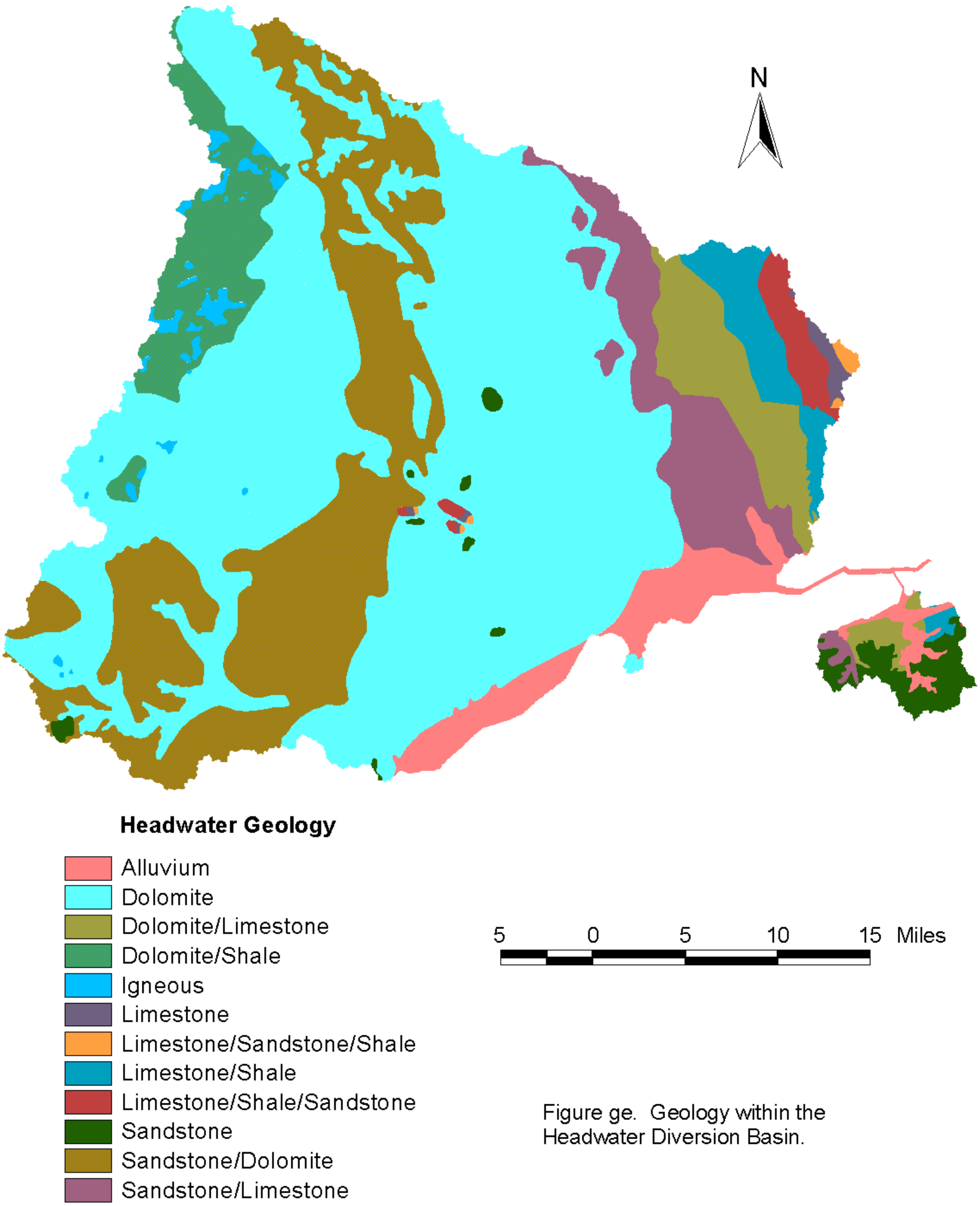


Figure ge. Geology within the Headwater Diversion Basin.

Land Use

Historical Land Use

Prior to the late 1800's, most of the basin was in the historic Pine Range — a wildfire-maintained savannah dominated by shortleaf pine with a prairie grass (big and little bluestem, Indian grass and switchgrass) understory. The upland savannah remained relatively unsettled by white immigrants. The more fertile soils and lower topographic relief on the east side of the basin (Whitewater River and Hubble Creek) appealed to German immigrant farmers attracted to the area by Mississippi River commerce.

Land abuse began in the 1890's when large timber companies moved deep into the basin and built huge lumber mills, employed thousands of people, cut all of the pine, selectively cut the best oak and then left after the old growth timber resource had been depleted (about 1920). The harvest of the virgin forests, however, was only a prelude to the more serious watershed devastation that occurred for the next 40 years.

Many of the unemployed loggers and lumber mill workers settled on the tax delinquent lands vacated by the departing timber companies. The new tenants were poor land stewards. The remnant forest was burned each year, indiscriminate logging took most of the remaining trees, livestock over-grazed the newly converted range land and subsistence hill farms lost soil at a rate exceeding 200 tons per acre each year. One consequence of this poor stewardship was the accumulation and shifting of large gravel deposits that still clog and alter some stream channels today.

It took until the 1950's before erosive conditions in the forest watersheds began to significantly improve. Passage of an Open Range Law (required livestock fencing), changes in landowner attitudes concerning deliberate burning (fewer fires) and the acceptance of sensible soil conservation practices (reforestation of marginal pasture and row crop acreage) accelerated the recovery. Forest canopies closed, leaf litter accumulated and an understory developed.

Current Land Use

Collectively, the watershed areas of the basin can be classified as 55 percent woodland, 22 percent grassland and 19 percent cropland. However, a transition within the basin from 80 percent woodland on the west side to 75 percent agriculture on the east side provides a wide diversity of land use (Figure lu). Land use patterns have apparently stabilized. Woodland acreage has only expanded by 1 percent since 1972 (Leatherberry 1990) and cropland rotation acreage (row crop to pasture conversions) has remained near 38 percent for the past 10 years (SCS, Bollinger County District Conservationist, Personal Communication).

Most of the uplands are large contiguous tracts of oak-hickory forest dominated by a black-scarlet oak association (52%) and a secondary white oak association (24%). Succession is toward conversion to a white oak forest type. An odd feature of the basin is the occurrence of species such as yellow poplar, beech and sweetgum that are not usually found in the Ozark uplands (MDC 1992). The tracts are considered moderately to fully stocked with proportional stand size-classes of 50 percent sawtimber, 25 percent poletimber and 25 percent seedlings and saplings (Leatherberry 1990). Livestock grazing in all basin woodlands still presents some ecological and hydrologic concerns relating to canopy closure, leaf litter accumulation and soil compaction (MDC, Perryville Forest District, Personal Communication). Only about 20 percent of the Castor River and Crooked Creek wooded uplands are grazed because of the low agricultural potential and the impracticality of fencing rugged terrain. By contrast, about 80 percent of the Whitewater

River, Hubble Creek and Diversion Channel wooded uplands are grazed because of smaller tract size, gentler terrain, richer soil and a higher landowner reliance on agricultural production. Agriculture dominates the floodplains of all major tributaries wherever topography and drainage will allow the use of farm machinery or fences. Floodplain widths, field sizes, soil types and soil fertilities generally dictate specific land use. Agriculture in the floodplains varies from small, unimproved pastures in the extreme upper watersheds to intensive row crop production in the lower subbasins. Nearly equal emphasis on improved pasture, row crops and hay fields can be expected at some point along the downstream (linear) transition of land use. Lateral land use transitions (perpendicular to stream channels) from row crop and hay fields to pasture and woodlands also occur. Most of the remnant woodlands in the larger floodplains are restricted to high relief topography or low lying wet areas.

The bottomland immediately adjacent to the Diversion Channel (from the community of Whitewater to the Mississippi River) functions as a floodway and also contains 23,000 acres of dry detention storage that protects the main Diversion Channel Levee from high flood flows (Little River Drainage District, 1989). Most drainage within the extensively rowcropped floodway/detention system is controlled with only a few miles of small, privately owned drainage ditches and levees. All remnant natural stream channels within the waterway, including the lower reaches of Crooked Creek, Whitewater River and Hubble Creek, have been channelized to improve agricultural drainage.

About 97 percent of the basin is agrarian and contains a rural population of 14,600 (12 people/square mile). An urban population of 15,500 (431 people/square mile) is concentrated in the communities of Jackson, Marble Hill and Scott City, which currently have no industrial developments that pose serious threats to local streams. The heavy industrial areas associated with the nearby city of Cape Girardeau, Interstate Highway-55, the Scott County Port Authority and a regional airport are all located just outside of the southeast corner of the basin.

Soil Conservation Projects

A Special Area Land Treatment project (SALT Project No. 37) in the 5,509-acre Malone Creek watershed (Dark Cypress subbasin) in south Bollinger County, was started in 1990 and is funded through 1995. The project addressed grade stabilization, gully erosion and stormwater runoff through the construction and fencing of small retention ponds. In all, 15 ponds totaling 24 acres have been built with 75 percent cost share funding from the Bollinger County Soil and Water Conservation District.

Landowner participation was considered good (NRCS, Bollinger County District Conservationist, Personal Communication).

The most recent SALT (project No. 127), completed in July, 1999, occurred in the 11,300-acre Greasy Creek watershed (Castor River subbasin) in east central Madison County. Goals for the project were improve pasture quality and decrease over-grazing while reducing gully erosion and providing greater stabilization for unfenced streambanks. Landowner participation was good (NRCS, Madison County District Conservationist, Personal Communication). The basin has no completed, ongoing or scheduled projects authorized by the Watershed Protection and Flood Prevention Act, P.L. 83-566. In 1981, a Hubble Creek watershed project (PL 566 Project No. 56) was terminated in the planning phase because of low landowner interest. The ambitious 47,500 acre project design would have addressed stormwater runoff, floodwater protection and channel sedimentation through the construction of retention structures and levees and extensive channel clearing, dredging and realignment (SCS, Cape Girardeau County District Conservationist, Personal Communication). Today, such a project plan would probably be opposed by most resource agencies and conservation groups.

Public Areas

Public lands in the basin total 33,250 acres on 26 areas with 96.3 miles of stream frontages (Table 4). However, about 90 percent of the public acreage and stream mileage is concentrated in scattered state or federal ridge-top forest tracts that lack permanent flow or pools and offer few stream angling opportunities. The Missouri Department of Conservation (MDC) currently maintains nearly 10.5 miles of public frontage on fourth order and larger streams that attract bank angling, float fishing and other stream related activities (Figure pa). The MDC stream access areas at Dark Cypress Swamp, Headwaters, Maple Flats and Sweetgum have concrete boat launching ramps. Convenient canoe launching is available at Amidon Memorial Conservation Area, Marquand Access, Hawn Access and Bollinger Mill State Park.

Fisheries Division acquisition plans (MDC 1989) include the purchase of eight additional stream access sites within the basin (Table 5, contact authors for Table 5 information). The proposed Crook's Landing acquisition site at RM 33.8 on the Castor River is a high priority because it represents the furthest upstream location that is floatable during most of the year. The proposed Whitewater River site at RM 7.0 should also be considered as a high priority because of its proximity to the proposed Allenville Bridge site on the Diversion Channel. Not included in the acquisition plan is a highly desirable site in the vicinity of RM 10.0 in Crooked Creek which would complement the location of the newly developed Blockhole Access on the Diversion Channel.

Also planned for the basin, through the Stream Areas Program Plan (MDC 1988), is the eventual acquisition of six large frontage tracts (Table 5). In addition to expanding public use and access, frontage tracts can also provide the preservation of representative, threatened, remnant or critical stream habitats. Currently, a specific Streams Frontage Acquisition Plan (MDC 1993) is being developed. The new acquisition plan will certainly include the recently identified unique reaches on the Castor and Whitewater Rivers (see Unique Habitat section). The unique Castor River reach has also been addressed in the Castor River Conservation Area Plan (MDC 1992) as a desirable area expansion. The availability of the Little River Drainage District's 4,400 acres and 11 miles of Diversion Channel frontage along the remnant Dark Cypress Swamp will also appear in the new acquisition plan.

Corps of Engineers 404 Jurisdiction

The entire Headwater Diversion Basin is under the jurisdiction of the St. Louis District. All applications or inquiries regarding 404 permits should be directed to the St. Louis office: St. Louis District USA COE, Regulatory Office, 1222 Spruce St. Telephone: 314-331-8579.

Table 4. Stream frontages on public areas in the Headwater Diversion Basin, Missouri. CA=MDC Conservation Area; AC=MDC Stream Access Area; SP=DNR State Park, USFS=United States Forest Service, MUNIP=Municipality; RM=River Mile on primary stream.

MILES OF FRONTAGE (TOTAL ALL SEGMENTS), BY ORDER											
AREA NAME	TYPE	ACRES	RM	7°	6°	5°	4°	3°	2°	1°	PRIMARY STREAM (S)
Castor River	CA	9750	12.6		0.03			1.14	3.5	20.87	Castor R., Pond Ck.
Amidon	CA	1152	55.7				2.6		1.61	1.66	Castor R., Stannet Ck.
Clubb Creek	CA	662								1.66	Club Creek
Coldwater	CA	4486							1.36	10.18	Gizzard Ck., Turkey Ck.
Grassy Tower	CA	15									No streams
Grisham Tract	CA	247								0.66	Crooked Creek
Hiram Tract	CA	240								0.1	Andy's Creek
Lt. Whitewater	CA	80								0.32	Little Whitewater Ck.
Dk. Cypress	CA/AC	470	0.4		1.25				0.5	0.4	Castor River
Lake Girardeau	CA	351							0.2	0.49	Crooked Creek
Maintz	CA	804						1.69		1.43	Sandy Branch
Duck Ck. Ditch	CA	7								0.54	Water Supply Ditch
Sank	CA/AC	118	3.8				0.95			1.33	Hawker Creek
Headwaters	AC	10	3.1	0.1							Diversion Channel
Blockhole	AC	10	20.7		0.15						Diversion Channel
Maple Flats	AC	72	5.6		0.39				0.3	0.22	Castor River
Sweetgumm	AC	161	11.7		1.1						Castor River
Marquand	AC	63	40.1			0.55				0.1	Castor River
Duchesne	AC	4	56.4				0.07			0.05	Castor River
Old Plantation	AC	70	29				0.75				Whitewater River
Hawn	AC	81	40.2				0.87				Crooked Creek
Iron Bridge	AC	70	5.9			0.45					Bear Creek
Mark Twain	USFS	14302	42.8				0.72	0.01	2.45	31.53	Castor R., Shetley Ck.
Bollinger Mill	SP	25	16		0.15				0.2		Whitewater River
Marble Hill	MUNIP		21.7			0.28	0.06				Crooked, Hurricane Ck.
Jackson	MUNIP		13.9					1.35			Hubble Ck. Goose Ck.
	TOTAL	33250		0.1	3.07	1.28	6.02	4.19	10.12	71.54	

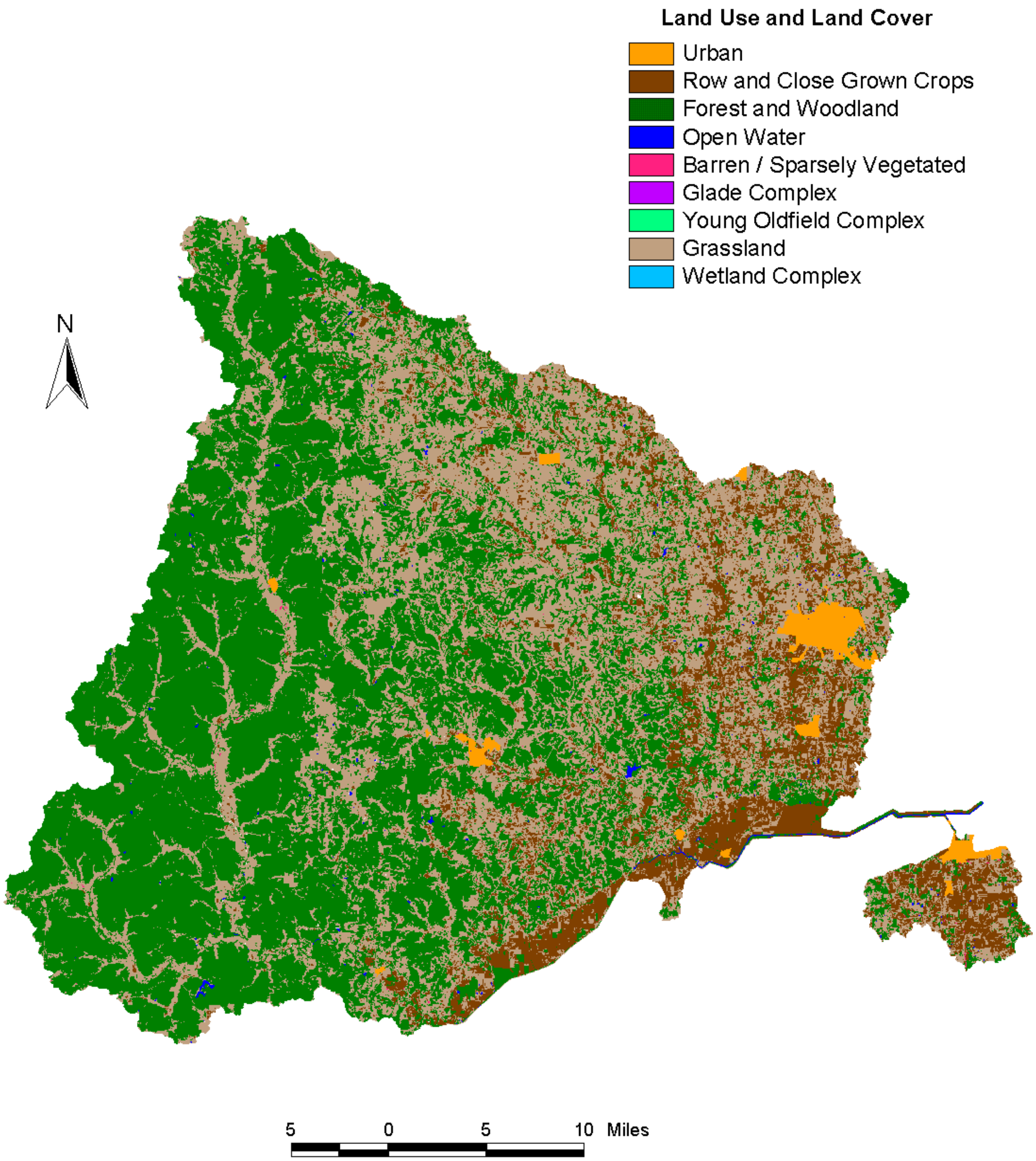


Figure lu. Land use/land cover within the Headwater Diversion Basin.

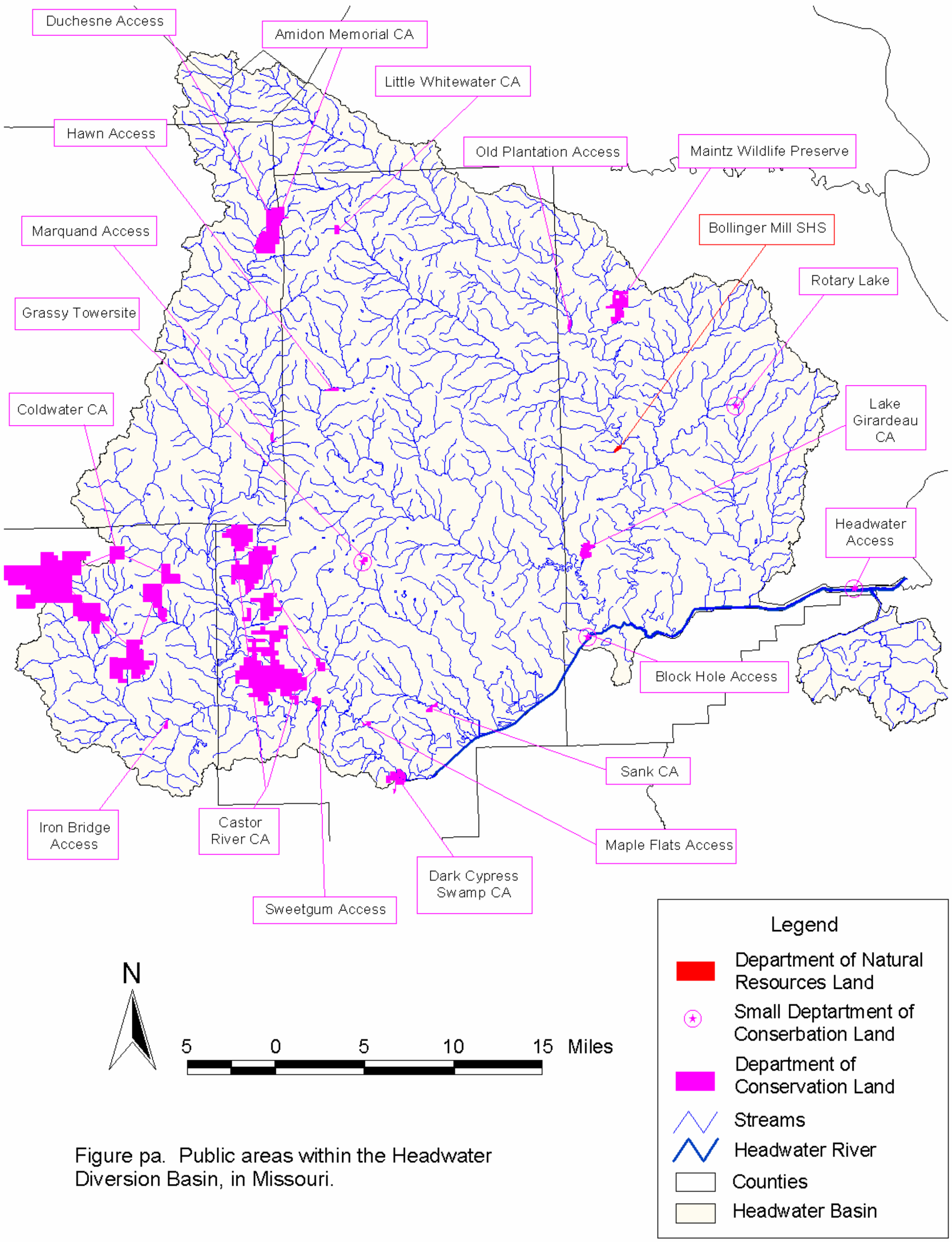


Figure pa. Public areas within the Headwater Diversion Basin, in Missouri.

Hydrology

Precipitation

The average annual precipitation for the basin is about 46.0 inches (MDNR 1984). The average annual gaged precipitation near the center of the basin at Marble Hill, Missouri is 44.4 inches (Figure 2). The basin, although situated in the wettest part of the state, receives the least amount of statewide summer rainfall, usually less than 11.0 inches during the high evapotranspirational months of June, July and August. The maximum expected precipitation for 1-, 4- and 10-day storm events with two-year recurrence intervals are 3.5, 4.5 and 6.0 inches, respectively. Maximum expected precipitation for the same storm events with 25-year recurrence intervals are 6.0, 8.5 and 11.0 inches. In May 1973, the basin received 11.5 inches of rainfall during a severe 15-hour storm which did not establish any new discharge or stage records. Snowfall averages about 9.0 inches per year.

The average annual runoff is 16.0 inches. However, when considering only precipitation and runoff amounts, perhaps as much as 35 percent of the annual average precipitation eventually appears in channels as streamflow and about 65 percent (30 inches) is lost to evapotranspiration (MDNR 1984).

U.S.G.S. Gaging Stations

One U.S. Geological Survey gage station (No. 07-0210.00) is currently operating in the basin. This continuous, stage-recording station is located on the lower Castor River at RM 5.7 on the left downstream side of the State Highway 51 bridge near Zalma, Missouri (Figure gs). The period of record is from January 1920 to the current year. The location of the gage measures most of the discharge exiting the Castor River watershed, which represents, however, only 35 percent of the total area of the basin.

The topographic and hydrologic features of the subbasins and watersheds within the Headwater Diversion Basin are quite similar. Gage information from the Castor River station at Zalma can be adjusted by watershed size and directly transposed to ungaged sites. Possible exceptions to the application of transposed gage records might be the low relief watersheds of Hubble and Ramsey creeks. For example, the streamflow and stormwater-runoff records from the Zalma gage were transposed (by direct watershed area ratios) to provide the critical engineering design specifications for a proposed 7,500-acre reservoir project in the Whitewater River subbasin (Lemons 1989).

During most of the 1960's, six USGS low flow, partial recording gage stations were operated at various locations on Castor and Whitewater Rivers, Crooked Creek and the Diversion Channel (Table 6).

These gages provided only low flow information and are currently inactive.

Streamflow Characteristics

The average annual discharge of the Castor River at the Zalma gage is 517 cubic feet per second (cfs). The median flow (greater or lesser discharges 50% of the time) is 183 cfs. The minimum, average and maximum annual hydrographs (Figure 3) and a mean daily flow duration curve (Figure 4) have been prepared from the gage records. Partial recording gages have provided low flow estimates of the magnitude and frequency of 7-day Q values (low flow discharges) for each of the four major tributaries in the basin (Table 7). The partial gages have also provided base flow depletion characteristics for the summer recession flows associated with the same tributaries (Table 6).

Inspection of the available gage records indicate that stream flows, particularly low flows, throughout the entire basin are quite stable and exhibit little variability in annual or year-to-year discharges.

Evidence of good basin-wide flow conditions include: Minimum low flow gage records of 10 to 20 cfs in fifth and sixth order stream channels; no gage records of zero flow; 7-day Q^{10} low flows usually exceeding 10 cfs; 7-day Q^{30} low flows exceeding 5 cfs; low slope indexes of about 2; low base flow summer recession rates and a low 90:10 ratio of 18 to 1 at the Zalma gage.

Favorable precipitation, evaporation and runoff conditions, combined with the high storage capacity of the soluble subsurface chert and unconsolidated alluvium, produces a natural groundwater supply that sustains stable base flows. The result is a high incidence of stream permanency which produces fewer stress factors that can affect aquatic communities. The favorable hydrological environment is evidenced by the diverse assemblage of fishes and macroinvertebrates that currently occupies the basin.

Dam and Hydropower Influences

Only one small mainstem dam currently exists in the basin. A mill dam at Bollinger Mill State Park (historical mill and covered bridge) spans the Whitewater River at RM 16.0. The pool behind the 6-ft tall concrete and timber dam has filled with gravel and no longer provides storage capacity. The entire top of the dam now functions as the primary spillway, but some flow can still be diverted through the mill to operate machinery. The plunge pool and downstream channel are stable. Moderate storm events frequently flood the dam. However, during normal flows the dam inhibits the upstream movement of fish.

On the Castor River at RM 53.8, a 5-ft tall steel reinforced concrete dam with its western abutment completely washed out remains intact in the river channel. The dam, which was once part of the Daniel Boone Lodge (private development), failed immediately after completion nearly 60 years ago. The dam now functions as an effective wing dike with its bottom and eastern abutment firmly anchored in bedrock. After 60 years, the new downstream channel (displaced around the west side of the dam) has apparently stabilized. The original river channel now functions as an overflow channel. The site is entirely within the boundaries of the Amidon Memorial Conservation Area (MDC). Any attempt to remove the old dam would most probably have serious consequences on channel hydraulics and aquatic habitats above and below the site.

On the Diversion Channel at RM 20.8, a well-engineered and maintained USACOE grade control structure functions as a 10-ft high falls that can prevent the upstream movement of fish into the Castor River subbasin. Backwater from the Mississippi River completely inundates the top of the structure (known locally as the Blockhole) at a river stage of 35 ft (340 ft NGVD) on the USACOE Cape Girardeau gage. However, strong swimming fish can probably pass over the angled lip of the rock structure at a Mississippi River flood stage of 32 ft. During normal flood years (14 of the last 21 years) Mississippi River flood stages exceeding 32 ft can be expected 42 percent of the time during April and May and 34 percent of the time March through June. The duration of a typical spring flood is 28 days. The less frequent fall floods last about 9 days.

A proposed 7,680-acre recreational lake on the mainstems of the Whitewater River and Little Whitewater Creek (Figure 2-A in Appendix A) was jointly suggested by the Cape Girardeau and Bollinger county commissions in 1987. A $100,000 geology/ engineering/economics feasibility study (Lemons 1989) that supported the proposed lake project was completed in 1989. The lake proposal became inactive in 1991 after the Bollinger County Commission refused to include a one cent sales tax issue on the November ballot that would help fund the $73 million project. Local public opinion regarding the lake was sharply divided between positive in the business and urban communities to adamantly negative in the rural community. The Department did not take a position and the Missouri Chapter of the American Fisheries Society, through a 1990 resolution, opposed the lake development. The lake would have flooded parts of the Old Plantation AC, Maintz CA and about 36 miles of permanent streams (Table 9).

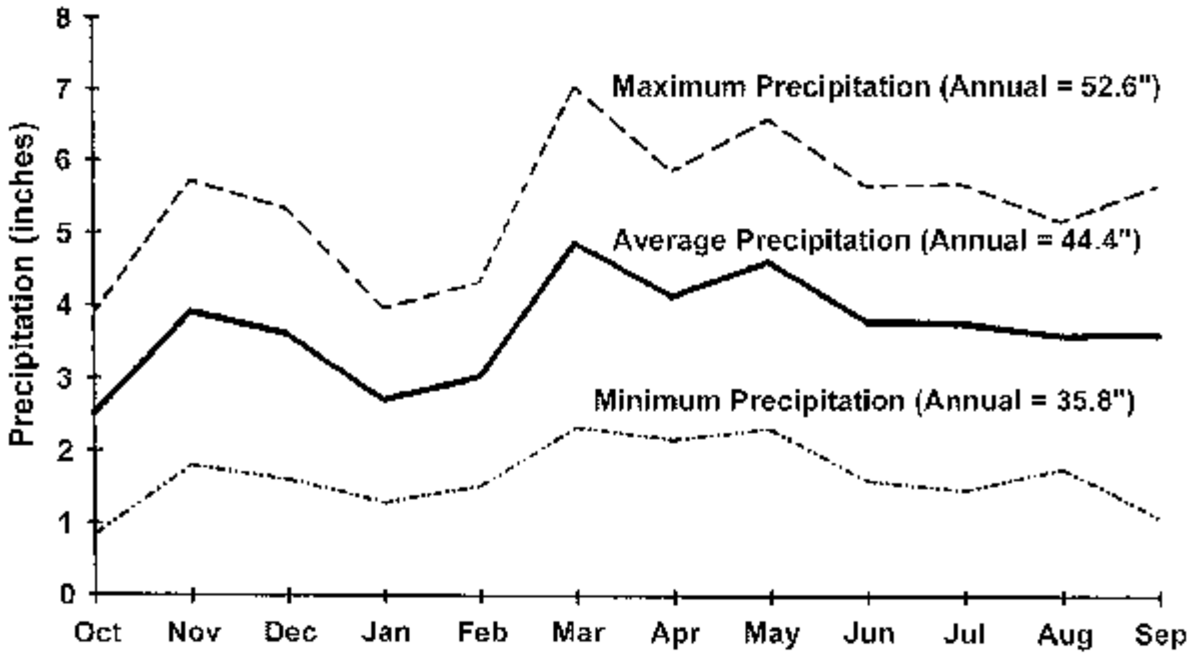


Figure 3. Monthly maximum, minimum, and average stream flow at the Castor River Zalma gage station for the period of record (1920-1990).

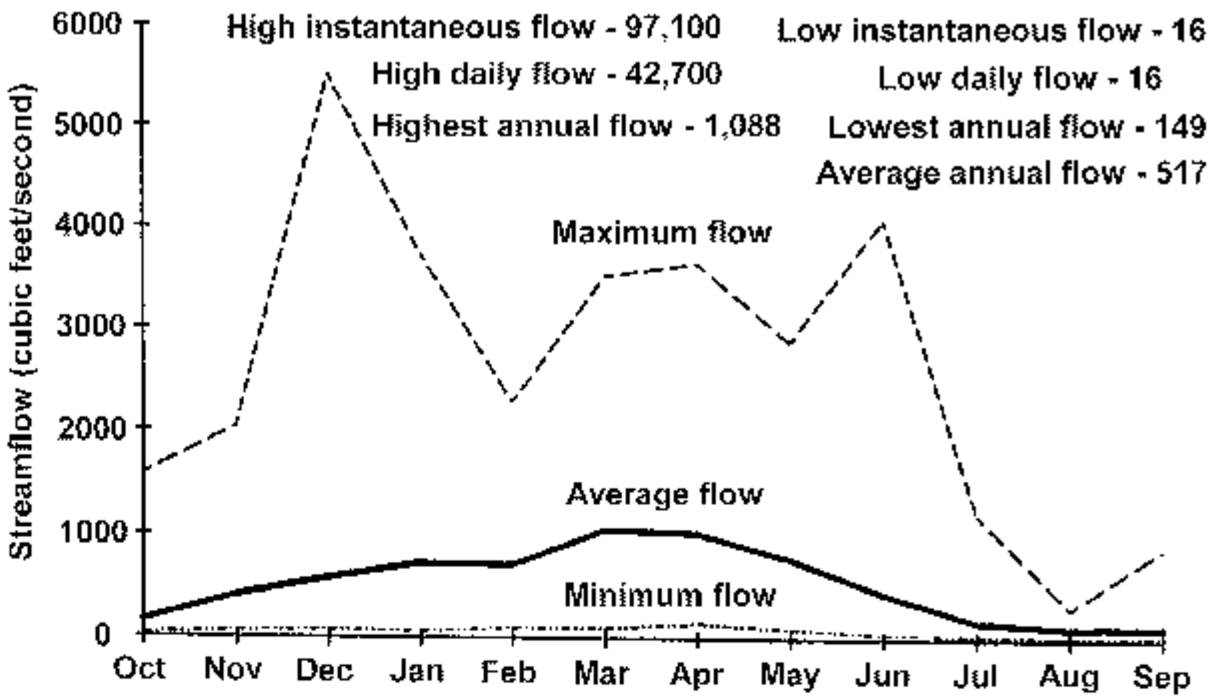
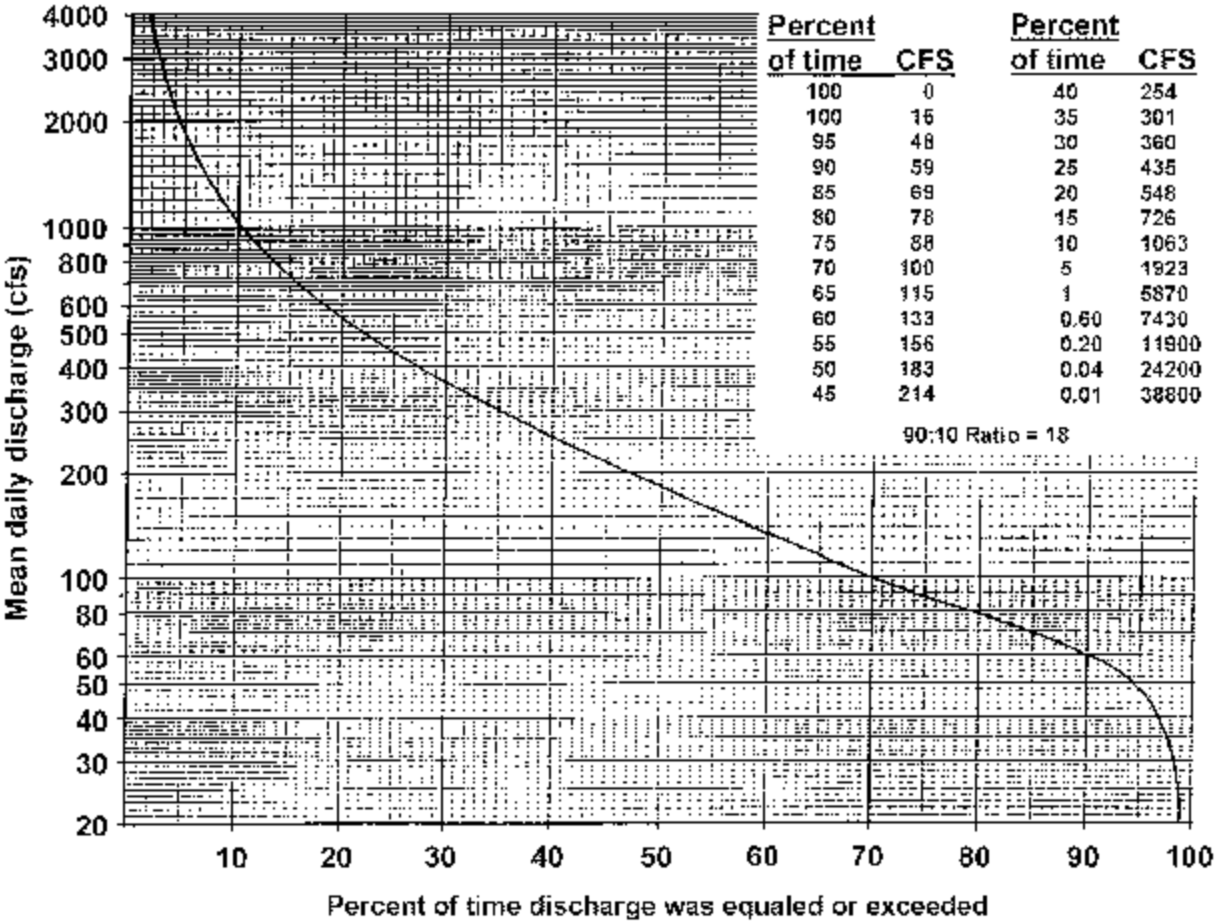
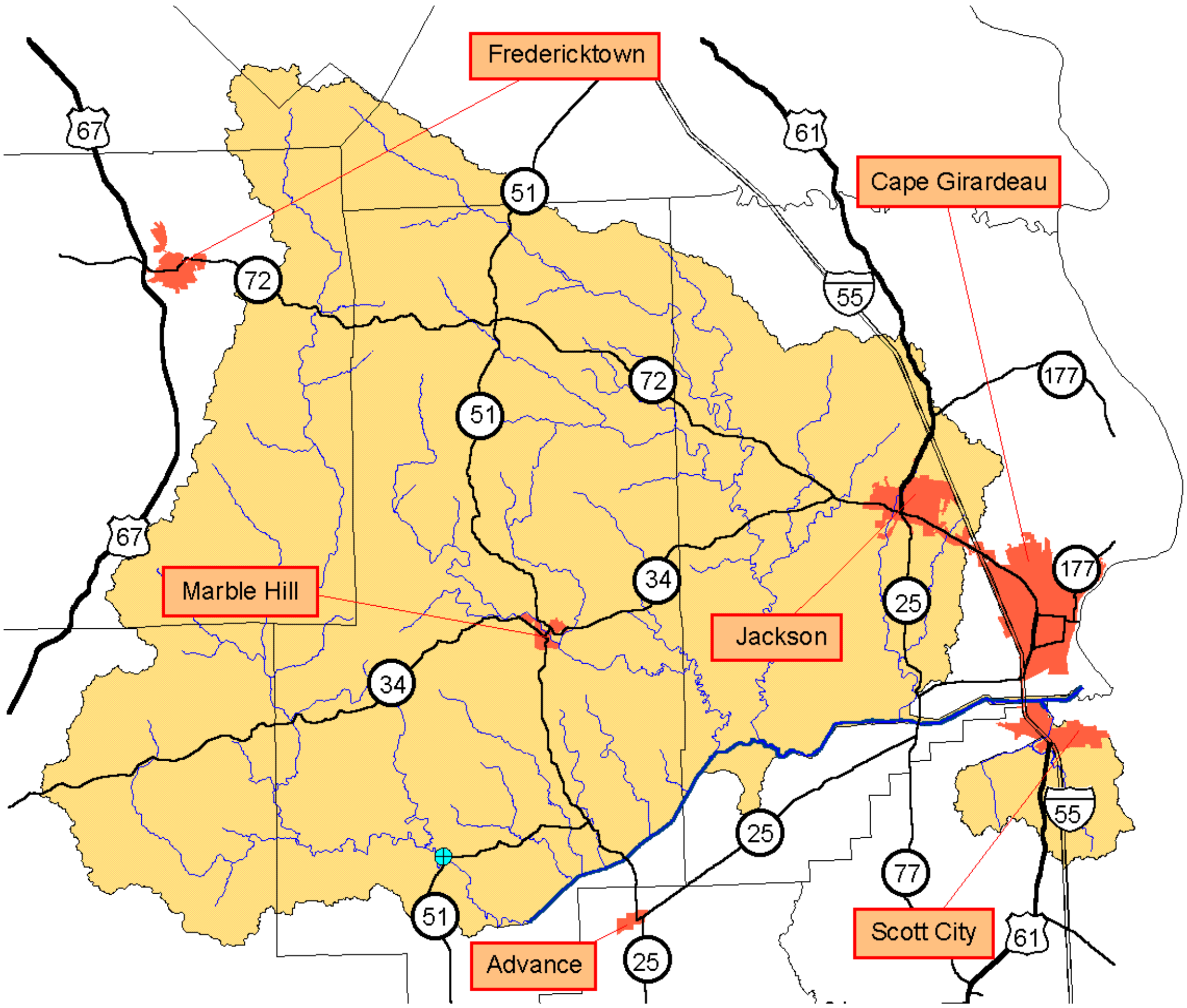


Figure 4. Flow duration curve, Castor River at the Zalma gage, 1922 through 1992, Headwater Diversion basin, Missouri.



Percent of time	CFS	Percent of time	CFS
100	0	40	254
100	16	35	301
95	48	30	360
90	59	25	435
85	69	20	548
80	78	15	726
75	88	10	1063
70	100	5	1923
65	115	1	5870
60	133	0.60	7430
55	156	0.20	11900
50	183	0.04	24200
45	214	0.01	38800



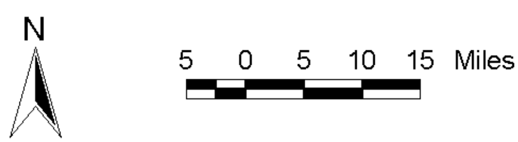


Figure gs. Gaging station location in the Headwater Diversion Basin, in Missouri.

Table 6. Base-flow (cfs) recession characteristics. Average rate of depletion of base flow during May through October drought periods, Headwater Diversion Basin, Missouri. From Skelton (1970)

GAGE NO.	STREAM	SITE	PERIOD OF ANALYIS	MEASURED LOW FLOW	TIME, IN DAYS, OF DROUGHT				
					0*	10	20	30	40
**7-0218.00	Diversion Channel	Allenville	1951-67	44	120	80	55	41	30
**7-0209.50	Castor River	Cascade	1967-71	23.8	—	—	—	—	—
7-0210.00	Castor River	Zalma	1922-67	16	65	45	33	25	19
**7-0216.00	Whitewater River	Whitewater	1961-67	16	30	19	13	9	6.5
**7-0214.00	Whitewater River	Millersville	1961-67	11	20	15	11	8.5	6.2
**7-0211.50	Crooked Creek	Marble Hill	1961-67	2.1	3.5	1.6	0.8	0.5	0.2
**7-0213.00	Crooked Creek	Highway U	1962-64	1.1	—	—	—	—	—

*=Upper limit of base flow, no surface runoff.
**=Low flow partial - recording station provides only low flow data.

Table 7. Estimated magnitude and frequency of annual low flows, Headwater Diversion Basin, Missouri. (Modified from MDNR (1984)

GAGE NO.	STREAM	SITE	PERIOD Of ANALYSIS	7-DAY LOW FLOW (CFS) FOR INDICATED RECURRENCE INTERVAL (YEARS)					SLOPE INDEX
				Q2	Q5	Q10	Q20	Q30	(Q2/Q20)
7-0218.00	Diversion Channel	Allenville	1951-69	78	55	42	32	29.7	2.4
7-0210.00	Castor River	Zalma	1920-81	46	34	27	21.6	19	2.1
7-0216.00	Whitewater River	Whitewater	1961-67	19	13	10	7.6	6.5	2.5
7-0214.00	Whitewater River	Millersville	1961-69	14	10.3	8.2	6.5	5.7	2.2
7-0211.50	Crooked Creek	Marble Hill	1961-69	2.3	1.6	0.8	0.5	0.4	4.6

Table 9. Stream resources, by watershed, that would be flooded by a proposed 7,680-acre Cape Girardeau/Bollinger County recreational lake. (conservation pool at 480 NGVD)

Order	Whitewater River		Little Whitewater Ck.		Lake Basin Totals	
	No. Reaches	No. Miles	No. Reaches	No. Miles	No. Reaches	No. Miles
5	1	0.3	1	8.4	2	8.7
4	2	19.8	—	—	2	19.8
3	3	4.9	2	3.8	5	8.7
2	9	3	5	3.3	14	6.3
1	38	18	34	12.2	72	30.2
	53	46	42	27.7	95	73.7

Lake Girardeau, a 162-acre MDC public fishing area, is the largest lake in the basin. Forty additional privately owned small lakes that total 856 acres are scattered throughout the lower elevations in the basin (MDNR 1984).

Water Quality

Beneficial Use Attainment

There are no serious water quality problems in the Headwater Diversion Basin (MDNR, 1986a). In fact, full beneficial use attainment can be expected from about 571 miles (80%) of the total 715 miles of permanent streams in the basin (MDNR, 1986b). Water quality is suitable for fish, wildlife and livestock use. The Diversion Channel is the only designated drinking water supply (unused to date); however, all surface water in the basin will meet water supply standards after disinfection and removal of suspended solids. Whole-body contact recreation is a designated use in the Diversion Channel, Castor River, Whitewater River and Little Whitewater Creek.

The basin ranked last (38th out of 38) in a 1981 statewide survey of basin recreational values (Bachant, 1982). However, the basin ranked 21st (58,154 angling trips) in a 1977 statewide angling pressure survey (Hanson, 1980). Channel modification, poor land use and intensive agriculture were cited as the primary problems that lowered recreational worth in the recreational value survey. Actually, less than 5 percent of the basin's permanent stream mileage is channelized and most of the intensive rowcrop acreage is concentrated in 20 percent of the basin that is associated with drainage district floodways and water detention systems. Perhaps the recreational value survey reflects more on the perceived low value of the 34 miles of artificial Diversion Channel and not necessarily on the value of the entire basin (more than 250 floatable miles) where channelization is certainly not a negative factor.

Water Quality

Favorable hydrological and geological conditions (adequate precipitation, good infiltration, high subsurface storage capacity, minimal surface runoff) throughout the basin produce well-sustained base and subsurface flows that have no significant water quality problems (MDNR, 1984). Potential problems with aquatic communities exposed to low dissolved oxygen concentrations and wide temperature fluctuations during summer low flow or drought periods are typically neutralized by adequate base flow discharges. Acute water quality problems, which might involve low dissolved oxygen or high ammonia levels, tend to occur only in conjunction with an incidence of nutrient loading pollution.

The USGS does not maintain water quality records at the Zalma gage station. Deep and shallow well province records indicate that high quality surface and subsurface water is typically hard and well buffered, 300 to 500 mg/l calcium-magnesium-bicarbonate total hardness (MDNR, 1986a). In 1991, the Long Term Resource Monitoring (LTRM) facility at Cape Girardeau, Missouri established a chemical sampling station at RM 0.6 on the Diversion Channel to monitor possible trend relationships between land use and water quality. The LTRM sampling regime includes weekly chemical measurements of surface and bottom parameters plus selected mid-water measurements during periods of stratification. Data for the following variables are currently being recorded and are on file at the LTRM headquarters are:

Secchi	Total phosphorus	Silica
Temperature	Soluble reactive phosphorus	Ammonium
Dissolved Oxygen	Total soluble phosphorus	Chloride
Conductivity	Total nitrogen	Dissolved calcium
Ph	Total soluble nitrogen	Dissolved manganese
Velocity	Nitrate/nitrite	Dissolved potassium
Turbidity	Chlorophyll a	Dissolved iron
Suspended solids	Phacophyton	Organic matter

Fish Kills and Contaminants

No particular stream reaches in the basin have been identified that frequently suffer chronic benthos or fish kills. Only six fish kills have been reported since 1980. Five incidents involved partial fish kills from storm related discharges of livestock waste into small tributary streams. In 1990, a golf course application of a fungicide (chlorthalonil) was responsible for a total fish kill on 2.2 miles of Goose Creek, a small tributary to Randol Creek.

No recent attempts have been made by government agencies to collect fish tissue samples for contaminant analyses. Therefore, no basin health advisories have been issued. However, some Mississippi River fish populations (particularly catfishes, carp and long-fin suckers) are apparently attracted into the Diversion Channel backwater, especially during flood periods. It is not known what portion of the fish community in the Diversion Channel is resident or transient. Perhaps future health advisories issued for the adjacent Mississippi River should also consider including the Diversion Channel.

Water Use

There are few surface water withdrawals in the basin. All municipal, domestic industrial, and most agricultural water needs are supplied by wells which can collectively pump a maximum volume of 15.5 million gallons/day (MDNR, 1986a).

Point Source Pollution

Point source pollution is no longer considered a problem in the Headwater Diversion Basin (Figure ps). There are no mining or stream-threatening industrial discharges. The potential for point source discharge is associated with the municipal sewage treatment facilities at Jackson, Marble Hill and Scott City, on Hubble, Crooked and Ramsey creeks, respectively. Upgraded facilities and the improved operation and maintenance of these municipal systems (lagoons and trickling filters designed for a total of 20,000 human population equivalents) have reduced the impacts and occurrence of untreated effluent releases. Raw sewage bypasses are expected to produce minor aesthetic stream impacts instead of major fish kills that once affected about four miles of permanent and intermittent streams (MDNR, 1984).

The low potential for non-municipal point source discharge is limited to 21 NPDES (National Pollution Discharge Elimination System) low flow lagoons (eg. subdivisions, schools, nursing homes). The lagoons, which have no record of causing pollution problems, are generally situated on small, dry-channel tributaries. Total design capacity is 2,863 Human Population Equivalents (PE).

Prior to 1990, Biokyowa Industries of Cape Girardeau pumped industrial wastes directly into the Diversion Channel at RM 4.5. The unsightly effluent, a harmless purple lignin stain (MDNR, Personal Communications), generated numerous pollution complaints from private citizens. However, no fish kills occurred and MDNR NPDES Permit stipulations were never violated. In order to reduce complaints and improve public relations, Biokyowa installed a pipeline and since 1990 has discharged all plant effluents directly into the Mississippi River.

Nonpoint Source Pollution

The basin has no chronic or significant basin-wide problems related to nonpoint source pollution (MDNR, 1984). Sedimentation from erosion in disturbed watersheds and nutrient enrichment from livestock waste can contribute to some moderate, localized concerns.

Severe gully erosion (0.8 tons/acre) can create local shifting gravel bedloads, particularly in the upper watersheds. The gravel can fill pool habitats, change channel alignment or alter channel hydraulics, which can result in reduced habitat diversity and bank instability. Sheet erosion (up to 30 tons/acre) can produce fine sediment deposits that can impact local benthos communities. Inorganic turbidity, which occurs only for short periods during storm events, is definitely not a problem. Except for 34 miles of artificial Diversion Channel, channelization is uncommon and of little water quality concern.

Runoff from livestock waste (1,101,000 PE) probably constitutes the largest potential nonpoint source pollution threat in the basin. Organic loading from pasture grazing and stream watering livestock is not considered as much of a pollution threat as runoff from confined feedlot operations and no-discharge waste lagoons. Approximately 60 lagoon facilities in the basin can generate about 52,700 PE of livestock waste (MDNR, 1984). Occasional lagoon breaches have caused fish kills. The chip mill industry represents another nonpoint source pollution threat, as part of two chip mill source areas are located within Castor River watershed. The environmental impact of forest product industries in Missouri depends on whether best management practices (BMP's) are used during harvest and total volume of wood harvested. Potential impacts from improper lumbering practices includes sedimentation, soil compaction, degradation of aquatic species, and water contamination.

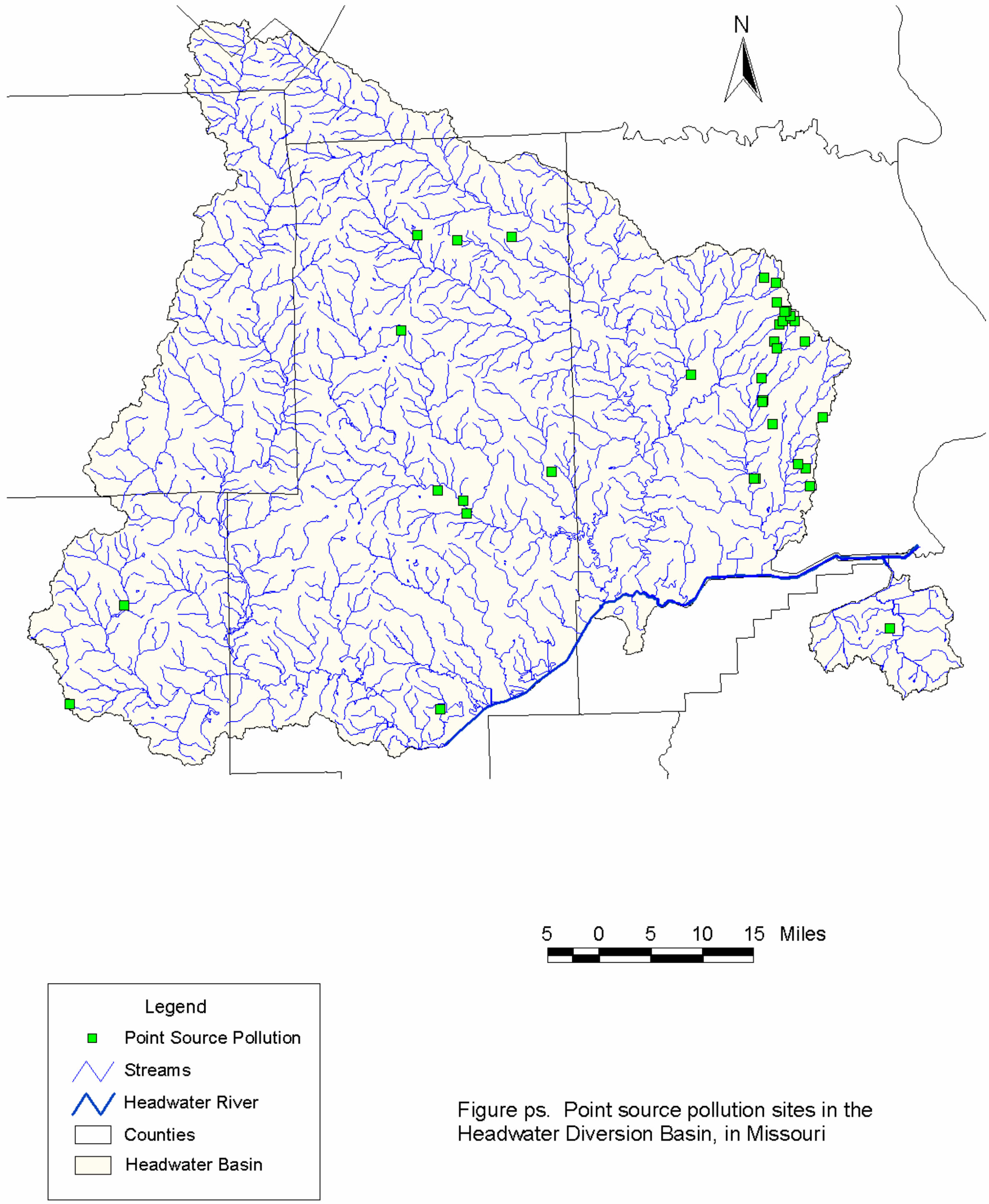


Figure ps. Point source pollution sites in the Headwater Diversion Basin, in Missouri

Habitat Conditions

Channel Alterations

Construction of the Diversion Channel and levee system in 1913, which created and then separated the Headwater Diversion Basin from the larger Little River Basin, is the only significant channelization project in the basin. The mouths of major tributary streams entering the Diversion Channel have grade control structures or channel realignments engineered to prevent upstream movement of headcuts.

Much of the Diversion Channel Levee (right descending bank of the Diversion Channel) is reveted with riprap and anchored concrete slabs. The left bank of the Diversion Channel is not leveed and is subject to frequent flooding by the Mississippi River. However, the left bank and all channel alignments in the entire 34-mile channelized reach are relatively stable and require little maintenance.

The incidence of channel disturbances caused by private landowners is apparently low and minor. Few specific sites and no stream reached have been identified, through Stream Habitat Assessment Device (SHAD) surveys, as seriously disturbed or altered by private landowner activities such as meander cutoffs, overflow channel blockages, gravel mining, gravel pushing or levee and road construction.

Unique Habitats

The clustered distribution of threatened fish species in two particular stream reaches is significant and suggests a unique and subtle presence of critical habitat components that provide the needs for two diverse fish assemblages. Combined, both reaches account for 78 percent of the sample sites where state listed species have been found and 80 percent of the threatened species identified in the basin (see Threatened and Endangered Species section). Both reaches are about 15 miles long and are located on the mainstem of the Castor River and nearby tributaries between RM 4 and RM 19 in section 11, T28N, R11E to section 18, T29N, R8E and on the mainstem of the Whitewater River and nearby tributaries between RM 16 and RM 32 in section 23, T31N, R11E to section 29, T33N, R11E (Figure 1-B and Table 1-B in Appendix B, contact authors for Appendix B information).

Land use, streambank protection and corridor conditions in both reaches are rated as fairly good, but not necessarily outstanding, and streambank erosion does not appear to be a serious problem. However, both reaches share channel transitions that include abrupt changes in decreased gradient, increased pool/riffle ratios, greater depths, more instream woody structure, finer substrates and promotion to sixth order. Both reaches are also located on the peripheral edges of three overlapping faunal divisions, which contributes to the comparatively higher species richness found at these sites.

The 7,680-acre lake proposed by the Cape Girardeau and Bollinger County Commissions would inundate most of the unique Whitewater River reach. Discharges from the proposed dam would impact the remainder of the reach.

The Castor River Shut-ins Natural Area at RM 56.4 is part of the Amidon Memorial Conservation Area. The rigid boundaries of the extensive pink granite outcrops provide extremely stable and aesthetic stream and overflow channels that are protected and managed under special natural area planning considerations (MDC, 1993b). No state listed fish species have been found near the area.

The Blue Pond Natural Area features the deepest (60 ft) and coldest natural lake (one-acre sinkhole) in the state. The extreme depth and pronounced thermal stratification associated with the clear steep-sided lake results in low seasonal dissolved oxygen concentrations that may limit the density of fishes (common *centrarchids*) found in the lake. Several state listed aquatic plants have been collected on the area (endangered *Scirpus subetminalis*, *Potomogetion pusillus;* and watch-listed *Carex decomposita, Potomogeton pulcher*). A small spring entering the lake also supports a blind, white amphipod *(Bactrurus brachycaudis)* that has limited distribution in the state. The lake is protected and managed under special natural area considerations (MDC, 1992) and drains into an un-named tributary to Pond Creek in the Castor River subbasin.

Improvement Projects

Since 1990, five improvement projects have been installed on three streams in the basin for the purposes of streambank stabilization, streambank revegetation, corridor revegetation or creation of instream fish habitats. Four of the projects are located on public lands owned by the MDC or DNR and one MDC Landowner Cooperative Project (LCP) has been installed on private land. Other MDC landowner stream incentive programs are not being piloted in the basin.

- **Hawn Access** Cedar Tree Revetment Project: Crooked Creek at RM 40.2 (Figure pa, Land Use Chapter); fourth order; 800 ft vertical eroding streambank; single row tree revetment installed November 1990; tree seedlings, stakes and wattles planted March 1991; tree seedlings and stakes replanted March 1992; stakes replanted March 1993. The revetment successfully stabilized the eroding toe and the willow stakes quickly revegetated the backsloped streambank. But, tree seedling survival in the corridor was poor due to uncontrolled weed competition.
- **Zohn Kuhlman LCP** Cedar Tree Revetment Project: Crooked Creek at RM 40.1 (Figure 3-A in Appendix A, contact authors for Appendix A information); fourth order; 450 ft vertical eroding streambank; single row tree revetment installed August 1991; tree seedlings and stakes planted April 1992; stakes replanted March 1993. To date, the young revetment is stabilizing the toe and the willow stakes are beginning to revegetate the backsloping streambank. First-year tree seedling survival in the corridor appears to be poor because of uncontrolled weed competition.
- **Marquand Access** Scouring Rack and Rootwad Project: Castor River at RM 40.3 (Figure pa); fifth order; lack of instream habitat diversity; three scouring racks installed and local drift anchored in place September 1992. The scouring racks survived two minor floods and then were completely washed out in a major January 1993 flood (anchors set too shallow). The anchored drift is still in place, but habitat diversity has not increased.
- **Old Plantation Access** Willow Staking Project: Whitewater River at RM 29.1 (Figure pa); fourth order; willows from different sources and of different sizes were staked November 1990 and March 1991; tree seedlings were planted March 1991. All sizes of willows staked in November suffered higher mortality than willows staked in March. There was no apparent difference in mortality between willow stakes cut on-site and in-basin. MDC nursery stock suffered the highest mortality. The number and length of stems produced is positively correlated to the size of the cutting. Willow leaf beetle infestations did not occur. Tree seedling survival in the corridor was poor due to uncontrolled weed competition.
- **Bollinger Mill State Park** Privately Contracted (by DNR, Figure pa) Cedar Tree Revetment Project: Whitewater River at RM 15.9; fifth order; 330 ft vertical eroding streambank; single row tree revetment installed by a St. Louis landscaping firm August 1990; sycamore stakes planted March 1991. the revetment failed to stabilize the site, which has since eroded back another five feet because the DNR did not allow the streambank to revegetate.

The sycamore stakes suffered 100 percent mortality, and adequate corridor was never established and the invasion of natural vegetation was not allowed.

Other stream improvement concerns related to adequate corridor widths and healthy streambank vegetation on frontages owned by the MDC are addressed in Area Management Plans for the Amidon Memorial, Castor River and Maintz observation areas. The Castor River and Maintz management plans also contain objectives that specify the establishment of Eastern redcedar plantations as a future source of streambank revetment materials. Cedar trees do not commonly occur in the lower elevations of Whitewater River and Castor River watersheds.

Stream Habitat Assessment:

The MDC Stream Habitat Assessment Device (SHAD, Version II) was used to describe the quality of channel, streambank and corridor habitat conditions in the basin. SHAD is an assessment method that uses objective measurements and subjective ratings to rank particular habitat parameters into categories that allow inter- and intrabasin evaluation and comparison. Ninety-two SHAD sites and nine restricted-access SHAD sites (101 total sites) were selected and sampled or observed in the late summer base flow periods during 1988-1990.

SHAD Site Selection. The selection, distribution and densities of SHAD sample sites were dictated by stream orders in the four major subbasins: Diversion Channel, Castor River, Whitewater River and Crooked Creek. the frequency of SHAD sample sites increased in a downstream direction. It was assumed that the potential for habitat problems to develop would be greater with the increased flood frequencies, discharge volumes (energy) and agricultural activities in the lower watersheds. Therefore, SHAD sample sites were concentrated in the lower reaches of subbasin mainstem streams so that obvious and subtle changes in habitat condition in the more complex segments could be accurately defined and located. Consequently, over 20 percent of the length of sixth order segments were sampled with close site spacing, whereas only about seven percent of the length of fourth order segments were sampled with wider site spacing (Table 10, contact authors for Table 10 information). An exception was the Diversion Channel where only 4.5 percent of the sixth and seventh order reach was sampled because of the homogenous nature of the habitat parameters associated with the artificial channel. Also, sampling on the lower reaches of Crooked Creek was restricted by poor access. No second order reaches were sampled and most of the third order assessments were conducted on important tributaries to the subbasin mainstem streams.

The lengths and spacing of the SHAD sample stations contained random and uniform sampling elements. For various reasons, a predetermined number of SHAD stations might have been planned for a particular section (usually a one day float). However, the actual selection of a sampling station within a section depended on the ground-truthing of map, channel and photographic information, and then locating and separating truly representative stations within that section. The distance between stations averaged about two miles in the lower watersheds (Table 10). The length of a sampling station was adjusted (usually extended to include more riffle/pool sequences) to enhance the accuracy of station averages if an obvious anomaly was measured. Calculated channel conditions such as pool/riffle ratio, cover density, average width and maximum average depth, do represent the best estimate for the site. SHAD station lengths ranged from 1.3 miles to 0.05 mile and averaged 0.3 mile. About 27.3 miles of stream channels were surveyed (Table 10).

Habitat Evaluation

The 92 SHAD survey sites and the nine restricted-access SHAD sites were assigned identification numbers and located on subbasin maps (Figure hb). Many of the SHAD survey parameters are summarized and tabulated for convenient reference (Table 11, contact authors for Table 11 information). Based on the summarized data, most of the surveyed habitats in the basin are generally in good condition. A subjective habitat assessment using SHAD, Version I scored the mainstem of the Castor River at 0.86 and the mainstem of the Whitewater River at 0.81, which suggests some good to excellent habitat conditions. The few problems that occur in the basin usually minor, scattered and most often associated with streambank instability.

Streambank Conditions:

Analyses of the SHAD, Version II summaries (Table 11) suggest that streambank erosion in the basin is not excessive. Less than three percent of the surveyed streambanks are severely eroding (unstable, vertical and sloughing). An additional three percent of the streambanks are moderately eroding (unstable toes with bank angles exceeding 45 degrees). More than 90 percent of all sampled streambanks are relatively stable (no accelerated erosion). The occurrence and severity of streambank erosion does not appear to correlate well with reach gradient, land use, corridor or vegetation factors. Perhaps substrate composition, in conjunction with the complexities of site-specific disturbances, soil types and channel hydraulics, are responsible for most of the incidences of accelerated streambank erosion that are occurring in the basin.

SHAD frontages exhibiting severe erosion are most frequently associated with loose gravel substrates that tend to produce migrating point bars. Most of the severely eroding streambanks in the basin are located in the fourth and fifth order reaches of the middle watersheds where clay substrates are infrequent and loose gravel accumulates. The mainstem of Crooked Creek, with perhaps the highest incidence of accelerated erosion in the basin, is a good example. The non-eroding SHAD frontages are most often associated with clay and sometimes bedrock or tightly embedded gravel substrates. Clay can protect the toe of the slope and is probably responsible for the stable streambanks that commonly occur on the larger, low elevation sixth order stream reaches where clay is usually the dominant substrate. Greater stability is also apparent in the smaller, high elevation third order reaches; but, streambank stability in the clayless upper watersheds might be more related to the shorter duration of unit hydrographs. Moderately eroding SHAD frontages seem to occur in all types of substrate materials.

Thirteen percent of the streambank protection on the SHAD frontages is rated as poor (sparsely vegetated and weakly armored). The quality of streambank protection, as measured and described during the SHAD surveys, does not correlate well with the occurrence and severity of streambank erosion. The stable streambanks in the basin are usually associated with high quality vegetative cover. However, incidents of severe erosion occur as often with good cover as poor cover. Moderate rates of streambank erosion actually occur four times more often on well vegetated streambanks as poorly vegetated streambanks.

Erosion of some well-vegetated streambanks is not necessarily cause for concern when considering the low incidence of serious erosion (<3%) and high incidence of timbered corridors (75%) and well-armored streambanks (87%) in the basin. Wandering point bars, moving drift (e.g. 200 woody structures/mile) and the flashy nature of flood flows contribute to normal channel dynamics that may attack any streambank location. Occurrences of naturally healed streambank blowouts and major sloughs are evident throughout the basin.

Corridor Conditions:

The vegetative quality of the wooded portion of the corridors is rated as good (dense stands of trees and understory) throughout most of the basin. Seventy-five percent of the SHAD sites contain corridor conditions that are predominantly well timbered, while only four percent of the SHAD sites have corridors that are dominated by poor vegetative conditions. The widths of the corridors, however, are extremely variable.

Variation in the width of the wooded corridors is dependent on the extent of agricultural activity, which is usually dictated by topographic relief and the width of the subbasin floodplains. The widths of the wooded SHAD corridors, throughout the basin, are most often great enough to promote streambank stability and deter floodplain scour. However, problems that can occur because of inadequate corridor widths are definitely subbasin specific and may therefore offer some focal points for directing management efforts and corrective action (Table 12, contact authors for Table 12 information). For example, the complete absence of some wooded corridors and the high incidence of narrow corridors in the agriculturally important Diversion Channel subbasin may never be adequately addressed because of serious political, economic, and engineering factors. But, some reaches of narrow wooded corridor in the Whitewater River and Crooked Creek subbasins may eventually be widened and improved through a concentrated effort of landowner education and assistance. The issue of wooded corridor width in the Castor River subbasin does not warrant a high priority concern because of the adequate corridor widths and good land use patterns that are currently present in most of that particular drainage.

The primary land use associated with the corridors in the SHAD surveys are: row crop (39%), timber or woodland (28%), pasture (21%), hay fields (6%) and developments (6%) (Table 11). Changes in land use patterns closely parallel subbasin transitions in geology, soil fertility and topography. Row crops are concentrated in the Whitewater River (61%) and Diversion Channel (100%) subbasins.

Woodlands dominate the Castor River (42%) and Crooked Creek (38%) subbasins. Pastures are also most frequently found in the Castor River (38%) and Crooked Creek (31%) subbasins. Streambank instability can occur anywhere in the basin and is not related to any particular type of adjacent land use. Intensive row crop agriculture in or near the corridors will not necessarily increase streambank instability if favorable substrates and streambank protection factors are present. the most frequent incidents of severe streambank erosion are occurring on pastures and hay fields where landowners are, perhaps, trying to get the most utility out of a narrow floodplain. In these instances landowners are reluctant to give up the space for needed corridor development and believe that livestock fencing cannot withstand out-of-channel flood flows.

Channel Conditions:

Pool and riffle habitats are extremely diverse and are distributed in similar patterns in most stream channels throughout the basin (Table 11). Pools are usually more abundant than riffles, regardless of channel size, with pool/riffle ratios most often ranging between 2:1 and 3:1 (Table 13). Pool morphology is highly variable in length, depth, current and substrate, thus providing abundant and essential microhabitats for many forms of aquatic life, particularly fish species and invertebrate forage bases. The lengths, depths and substrates associated with riffle habitats also vary considerably; but fairly shallow, short, high gradient, cobbled riffles appear most frequently.

The average maximum pool depth at most SHAD sites throughout the basin is not particularly good, relative to stream order. Maximum depths at fifth and sixth order SHAD sites average a marginal five to eight feet (Table 13). Third and fourth order sites have poor maximum depths averaging usually less than three feet. Because of the irregularity of channel bottom profiles, the value of the average maximum pool depth is often deflated by the numerous shallow and medium depth pools included in the SHAD site measurements. The approximate maximum depth of the deepest pool measured at any particular SHAD site is about 162 percent of the calculated average maximum depth. Deep water habitats are available; and, when combined with the excellent groundwater supply, provide sufficient water depths in most stream channels to easily maintain aquatic communities during severe drought conditions. Depth diversity is also providing the horizontal and vertical habitat components need to increase niche volume and species richness.

Depth in most of the Diversion Channel is completely dependent upon Mississippi River stages. Normal Mississippi River stages will back water up to the Blockhole grade control structure at RM 21 and provide minimum depths of 5 to 25 feet in much of the channel during most of the year. However, drastic dewatering (depth less than one foot) of the wide, lower reaches occurs when the Mississippi River falls to a stage below the evapotranspiration and drought. The most severe dewatering occurred during the hot August drought of 1988 when the Mississippi River fell to 4.6 feet on the Cape Girardeau gage. Less sever dewatering has occurred at lower gage heights that happened to have coincided with cool winter temperatures and normal tributary base flows.

Instream cover is definitely abundant in the mainstem channels throughout the basin, including the artificial Diversion Channel. The density of woody cover is apparently related to channel size and flood flows. Particularly high densities of woody cover tend to accumulate in the lower reaches of the Castor and Whitewater Rivers, where 100 to 200 woody structures per mile were recorded at most SHAD sites (Table 11). The upper mainstem reaches and smaller tributaries have considerably lower, but generally adequate, concentrations of woody cover (Table 13). Only nine percent of the SHAD sites on the mainstem channels of the four subbasins contain low densities (<20/mile) of woody cover; whereas about 40 percent of the SHAD sites on the smaller tributary channels have low densities of woody cover. Little Whitewater Creek and Little Crooked Creek are the only tributary streams with limited amounts of instream cover and marginally significant recreational fisheries that might benefit from efforts to increase woody habitats.

Woody structure most often occurs in the form of entire trees, with rootwads attached, that are well anchored (partially buried) in the channel bottoms. Attrition eventually breaks the trees into smaller parts that are either redistributed and anchored or formed into numerous drift piles and log jams of various shapes and sizes. Intricate current patterns and subtle scour holes develop around the woody structures that provide additional channel diversity and microhabitats. Other types of instream cover structures, which appear less frequently than the woody elements, are large boulders in the upper watersheds, undercut banks in the lower watersheds and scattered stands of water willow throughout the basin. The instream cover component is, perhaps, the habitat forte of the basin.

Streambed Conditions:

Substrate composition provides another significant dimension of diversity for channel habitats. Each of seven types of substrate material, ranging in size from clay to boulders, was the dominant substrate present at a SHAD site somewhere in the basin (Table 11). And, a mixture of all substrate materials, except bedrock and boulders, was usually observed, if not measured, at most SHAD sites. The distribution and composition of the diverse substrate materials, however, is dependent on watershed and subbasin locations.

Coarse sediments are absent in the Diversion Channel substrates, which are dominated by sand, silt and clay. Coarse sediments are also scarce in Diversion Channel subbasin tributaries. The upper watersheds of Castor and Whitewater Rivers are dominated by large amounts of clean gravel and cobble, which eventually cede some importance to clay and bedrock in the lower reaches of the watersheds. The entire mainstem of Crooked Creek is dominated by clean gravel. Outside of the Diversion Channel subbasin, silt is fairly rare and only occasionally dominates the substrate. The substrates in all tributaries to the Castor River, Crooked Creek and Whitewater River contain huge amounts of gravel, cobble and sand which supply the three mainstems with large bedloads.

The transport of coarse sediments is responsible for most of the channel dynamics that occur in the upper mainstem reaches of Castor River and Crooked Creek and to a lesser extent in the Whitewater River. Excessive bedloads of gravel can smother riffles, fill pools and upset channel hydraulics at some locations. Channel stability generally improves downstream, but thalweg displacement can cause local site specific incidents of accelerated erosion anywhere in the basin. Channel disturbances involving gravel deposition are currently present in all stages of development and stabilization, ranging from deeply-embedded, well-armored, willow-covered islands to soft and soggy point bars on inside bends. With time, old deposits will stabilize and fresh deposits will accumulate, which actually contributes to the dynamic nature and diversity of instream habitat development in the basin.

Water Quality:

No water quality problems were evident at any SHAD site. Water clarity ranges from clear in the upper watersheds to a slightly green color in the lower elevations. Little inorganic turbidity was noted anywhere outside of the Diversion Channel subbasin. Algae concentrations are usually restricted to backwater areas. Partial shade is abundant throughout the basin and many reaches have closed tree canopies.

Channel Alterations:

Major channel alterations are rare outside of the Diversion Channel subbasin. No channelized cutoffs have been identified and only scattered incidents of clearing, snagging or gravel pushing have been observed. The Regulatory Office of the USCOE has issued two Cease and Desist orders to landowners conducting channel disturbances: Shetley Creek at RM 0.6 in 1992 and Bear Creek at RM 11.5 in 1993. Non-permitted gravel mining activities (personal/private/County) are numerous and widespread throughout the basin, and have the potential to cause local problems.

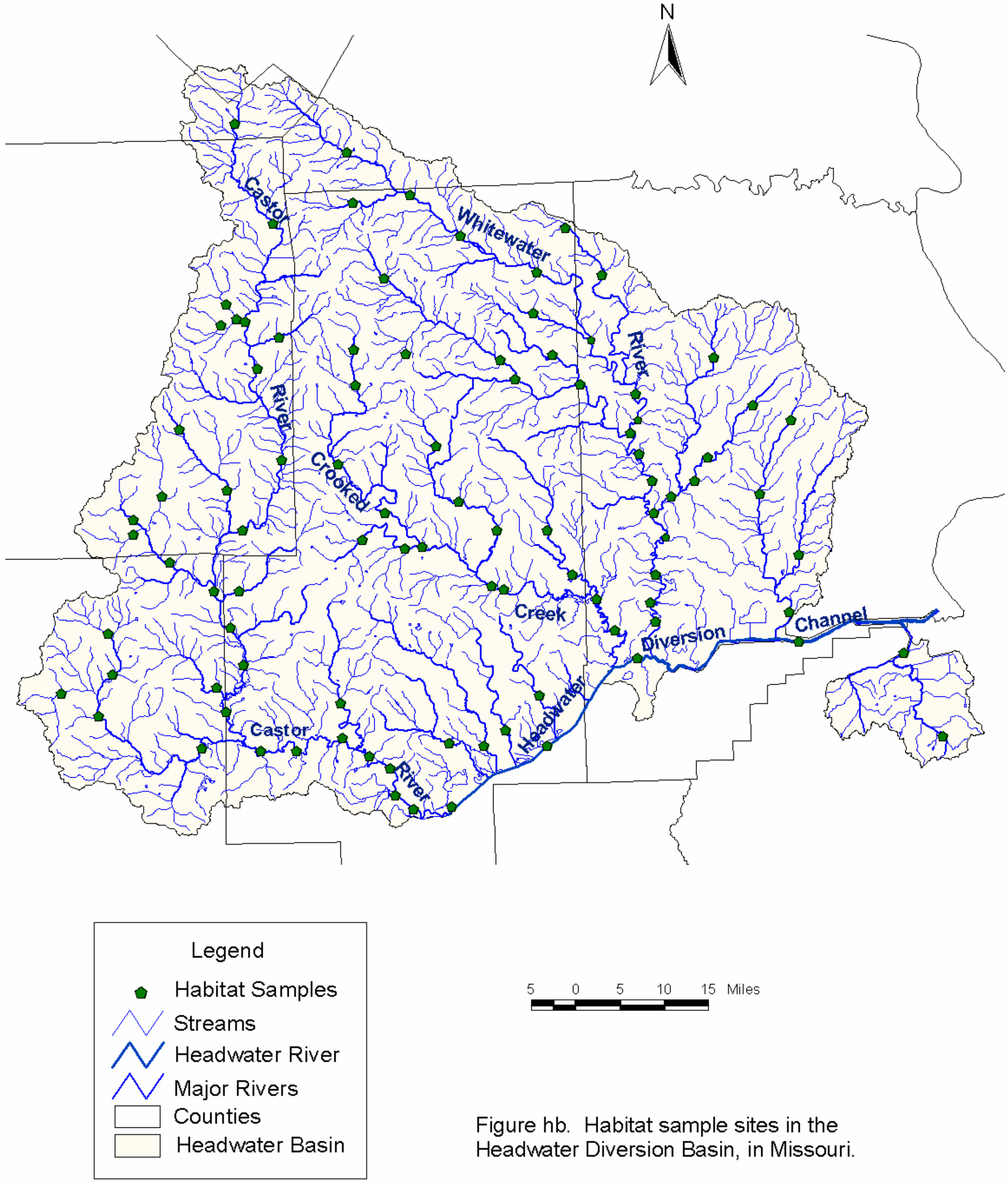


Figure hb. Habitat sample sites in the Headwater Diversion Basin, in Missouri.

Biotic Community

Fish Community Information

The fishes of the Headwaters Diversion Basin have been sampled extensively with seines and electrofishing equipment since 1940. Well distributed collection data are available from 85 seine sites (Pflieger et al. 1981 and McCord 1985), 4 private collection sites (MDC Natural History data base) and 17 electrofishing sites (Fisheries District). Site information and species specific site occurrences were tabulated and mapped (Tables 1-B, 2-B and Figure fs). Sample site number and letter designations were assigned by Fisheries District staff and are not related to the five digit site code used by MDC Fisheries Research staff. Stream orders and river mile distances were meticulously determined by Fisheries District staff and do not always agree with MDC Fisheries Research computer records.

Seine samples, based on purpose, techniques, methods and gear specifications described by Pflieger (1991), currently provide the qualitative and quantitative indicators that can best define entire fish communities. The seine data were organized by families of fishes. However, electrofishing samples based on boat-mounted DC equipment with a minimum station length of two miles and three hours of gear time, emphasized the collection of species which could have some angling value. No attempt was made to collect nektonic or benthic fish species. Electrofishing data were organized by groups of fishes which might generate similar angling interests or share similar management concerns.

The Headwaters Diversion Basin is contained within the Ozark-Southeast Division of the Ozark Faunal Region. This division contains no unique fish species and is actually characterized by combinations of peripherally distributed species found in seven adjacent divisions representing three faunal regions (Pflieger 1989). Consequently, the small basin supports a particularly diverse assemblage of fishes; 19 families and 113 species have been identified in seine and electrofishing collections (Table 14).

Seine Data

The number of species appearing in seine hauls has steadily increased since the 1940 sampling efforts where only 69 species were recorded from 1 sites. By the 1980's, 94 species were identified at 85 sites. The extirpated pallid shiner *(Notropis amnis)* and the watch-listed pugnose minnow *(Opsodoedus emiliae)* are the only species that have not appeared in post-1940 collections. Four low-density species that appeared in extensive sampling efforts (63 sites) during the 1960's and 1970's but did not appear in the 1980's collections are: blacktail shiner *(Cyprinella venustus),* bluntnose darter *(Etheostoma chlorosomum),* stippled darter *(Etheostomapunctulatum)* and blackstripe topminnow *(Fundulus notatus).* The blacktail shiner and bluntnose darter are Lowland, turbid water species which no longer have easy access into the basin. The stippled darter is a disjunct species with a distribution typically limited to the west side of the Ozarks; and, the blackstripe topminnow is another Lowland species that rarely occurs in association with the blackspotted topminnow *(Fundulus olivaceus),* which is the most frequently occurring fish in the basin.

The apparent increase in species richness from 69 to 94 species over a period of 50 years is probably attributable to improved sampling methods and skills by more knowledgeable collectors. It is doubtful that habitat and channel conditions could have improved in the last 50 years to allow species diversity to expand by 25 new species. It is encouraging to note that the basin appears to have lost only two species since 1940.

Species Composition

The composition of subbasin fish communities are not similar, which accounts for the variable distribution and frequency of occurrence of species within the basin. The Castor River, Crooked Creek, Whitewater River and the Diversion Channel subbasins share only 22 of the 92 species identified in seine hauls (Table 15). Even the Castor River, Crooked Creek and the Whitewater River drainages, which provide adjacent and similar channel elements for longitudinal species succession, share only 45 species. Apparently, longitudinal species succession is not a factor in the homogeneous habitats found in the Diversion Channel, which may account for the reduced species diversity in the lower part of the basin. No single species is the most frequently occurring fish in all subbasins (Table 15). The blackspotted topminnow is probably the most ubiquitous species in the basin and appears at nearly 90 percent of all sample sites on the Castor and Whitewater rivers. However, depending on the subbasin, redfin shiner *(Lythrurus umbratilis),* striped shiner *(Luxilus chrysocephalus),* bleeding shiner *(Luxilus zonatus),* bigeye chub *(Notropis boops)* and longear sunfish *(Lepomis megalotis)* are widely distributed species than can be present at more than 75 percent of the sites in some drainages. At least 12 other common species can be expected to occur at 50 percent of the sites in the basin.

Due to the unique subbasin species distributions, management considerations, particularly those relating to nektonic and benthic fishes, may need to focus on specific localities within the basin and not necessarily on particular species throughout the basin. Site management may produce more consequence than species management.

Relative Abundance

The relative abundance within subbasin fish communities, especially at the family level, are quite similar (Table 15). Castor River, Crooked Creek and Whitewater River have nearly identical minnow, sunfish and darter components (descending order of dominance) that account for about 90 percent of the community densities. The dominant order of component densities in the more sluggish Diversion Channel, however, is sunfish, darter and minnow which total about 70 percent of the community numbers. Variation in the order of abundance of particular species within a family is apparently related to subbasins. The Ozark minnow *(Notropis nubilus),* bluntnose minnow *(Pimephales notatus)* and bleeding shiner are probably the three most abundant species in the basin and are definitely the most abundant fish in the Castor and Whitewater subbasins.

The bluntnose minnow is also the most abundant species in Crooked Creek, followed by the speckled darter *(Etheostoma stigmaeum)* and largescale stoneroller *(Campostoma oligolepis)* which are absent or minor components in the other subbasins. The Diversion Channel community is dominated by the cypress darter *(Etheostoma proeliare),* redfin shiner and pirate perch *(Aphredoderus sayanus),* which occur in low numbers in the other subbasins. Longear sunfish occur at moderate densities throughout the basin and bluegill *(Lepomis macrochirus)* are important only in the Diversion Channel.

Benthic and nektonic species are probably quantified better by seine samples than larger, longer-lived fish species, especially those catfish, sunfish and sucker species that attract most of the angling and resource management attention. Seine data, however, can indicate the presence, possible nursery locations and maybe even the relative abundance of the juveniles of large species that seldom appear in boat-mounted electrofishing collections.

Electrofishing Data

Boat-mounted electrofishing efforts, directed at only large or easily dipped species, (Table 17) resulted in the collection of six families and 18 additional species. Ten of the additional species are members of the gar, herring, sea bass, paddlefish, eel and drum families. Four long-fin sucker species (e.g. buffaloes), walleye *(Stizostedionvitreum),* sauger *(S. canadense),* black crappie *(Pomoxis nigromaculatus)* and a single goldfish *(Carassius auratus)* were collected exclusively with electrofishing gear. Species composition appears to be a useful parameter which tends to be independent of electrofishing variables. The standard deviation of replicate site samples is small and most of the variation is accountable in the gizzard shad *(Dorosoma cepedianum)* portion of the sample. The standard deviations of site relative densities (electrofishing catch rate), however, are quite large and are probably caused by temporal and physical variables.

Species Composition

Basin fish communities are good examples of longitudinal succession. Species diversity decreases with increased elevations and gradient which promotes some species such as longear sunfish, shadow bass *(Ambloplites ariommus),* green sunfish *(Lepomiscyanellus),* smallmouth bass *(Micropterus dolomieu)* and the short-fin suckers (eg. redhorse spp.) to dominance in the upper watersheds; while bluegill, spotted bass *(Micropterus punctatus),* crappies and the long-fin suckers tend to dominate the communities lower in the watersheds.

Spotted bass is the predominant black bass (85 to 90% of EF samples) throughout most of the basin. Spotted bass begin to avoid gradients steeper than 12 ft/mile and are totally replaced by smallmouth bass (80 to 90%) in the upper watersheds at gradients greater than 14 ft/mile. The composition of largemouth bass *(Micropterus salmoides)* (6 to 10%) is fairly uniform throughout the basin and appears to be independent of elevation and gradient. A single significant concentration (99%) of largemouth bass occurs at the confluence of the Diversion Channel and Mississippi River. Further upstream in the Diversion Channel (10 to 20 miles), juvenile spotted bass dominate the black bass component. The concentration of juvenile spotted bass in the altered Diversion Channel, however, is probably a result of flood displaced fish trapped downstream of the Blockhole grade control structure, which functions as a 10-ft high barrier (falls) during normal flows.

Angler Guide.

Most smallmouth bass throughout the basin are <12", however, Master Angler size fish (> 17" have been collected in good numbers from the Middle Castor River and Whitewater River.

The largemouth bass size structure is considerably better than the other black bass species. Body condition and growth are also better. Because largemouth bass densities are low, negative population responses to spotted bass management efforts should not become an issue or consequence in most of the basin. An exception is the extreme lower reaches of the Diversion Channel where largemouth bass management concerns (because of high densities) should definitely take precedence over the other black bass species.

Shadow bass size structures throughout the basin include a high proportion of fish longer than seven inches. Preferred-size fish (> 12"), however, are fairly uncommon. Growth rates are above average (Carlander, 1977), densities are low and longevity is evident, which suggests that the large difference between PSD and RSD parameters is probably related to angler exploitation. Harvest restrictions could regulate angler exploitation if overfishing or high angler use can be demonstrated.

The dense, slow growing subbasin populations of longear sunfish produce few quality-size fish (6 inches long) and virtually no fish longer than eight inches. Most longear sunfish do not live long enough (age 6) to reach six inches long. Unless it can be demonstrated that anglers are willing to harvest abundant and easily caught small panfish, the contributions of the longear sunfish populations to the basin are probably more related to the ecology of the stream system than to providing angling opportunity.

Bluegill are providing an excellent fishery in the lower Diversion Channel subbasin. An outstanding size structure, which includes some fish eight inches long, and growth rates that produce fish six inches long in three years, are characteristic of the lower basin where competition with other sunfishes is minimal. Elsewhere in the basin, a high proportion of bluegill reach six inches in length (and sometimes 8 inches), however, densities are low and the species cannot be expected to contribute significant numbers to the creel.

Channel and flathead catfish size structures are represented by excellent proportions of fish 16 and 24 inches long. Most of the catfish captured by standard electrofishing and one-inch mesh hoopnets in all District 11 basins have reached stock-size (11 inches long) and few juvenile catfish, of any species, are ever observed. The best bet for anglers are the lower portions of the Castor River and the Diversion Channel.

Anglers certainly rate the quality of fishing on the Castor River as being considerably better than the Diversion Channel. Catfish are the only species that anglers on the Castor River rate below 5.0 (on a 10-point scale where 10 is the best). Diversion Channel anglers rate all species, except carp, below 5.0. It is important to note that catfish anglers are the least satisfied anglers on both streams, and the large contingent of crappie anglers on the Diversion Channel rate the fishery as poor (2.6).

Anglers on both streams release a significant portion of their total catch (Castor River 49%; Diversion Channel 59%). Bass anglers on both streams release about four out of five bass caught and Diversion Channel crappie anglers release one out of three crappie caught.

The species composition of the total catch generally parallels angler preference effort. Exceptions are a high proportion of sunfish in the total catch on both streams, and a low proportion of catfish in the total Castor River catch. About 90 percent of the total Castor River catch is represented by (in descending order): sunfish, bass, shadow bass and catfish. Ninety percent of the total Diversion Channel catch is composed of: crappie, catfish, carp, sunfish and freshwater drum.

Species of Conservation Concern

No federally listed (USFWS Endangered Species Act) threatened or endangered fish occur in the basin. The state of Missouri, however, lists the status of 10 basin fishes as either Rare (4 species), Extirpated (1 species) or Watch List (5 species). The extirpated pallid shiner *(Notropis amnis)* and the watch listed pugnose minnow *(Opsodoedusemiliae)* have not been collected in the basin since 1941. The other eight threatened species have been sampled or identified more recently (Table 22).

None of the threatened species are unique to the Ozark-Southeast faunal community, which is the dominant Division in the Headwaters Diversion Basin. Parts of three bordering faunal divisions are responsible for the diversity and distribution of the threatened species. The lake chubsucker *(Erimyzon sucetta),* Eastern slim minnow *(Pimephalestenellus pariceps),* scaly sand darter *(Ammocrypta vivax),* flier *(Centrarchus macropterus),* American brook lamprey

(Lamperta appendix), pugnose minnow and pallid shiner are all largely confined to the Lowland-Flowing Water Division. The silverjaw minnow *(Notropis buccatus)* is definitely restricted to the Ozark-Mississippi 1 Subdivision; the blacknose shiner *(Notropis heterolepis)* is associated with the Prairie-Lower Missouri Division; and the paddlefish *(Polyodonspathula)* migrates out of the Big River-Overflow Waters Division.

The distribution of threatened fish species within the basin is significant. Twenty-one of the 27 sample sites where 8 of the 10 threatened fish species have been found are concentrated in two specific stream reaches on the Castor and Whitewater Rivers (see Unique Habitat section). The Castor River reach also contains all five of the state or federal threatened naiad species that have been collected in the basin. Both of these particular stream reaches are located within the peripheral edges of the overlapping Ozark-Southeast and the Lowland-Flowing Water Faunal Divisions. The Whitewater River reach may also include some Ozark-Mississippi 1 Subdivision influence, as evidenced by the fairly common occurrence and abundance of the silverjaw minnow. Basin management decisions and efforts will certainly need to emphasize these two river reaches when considering the protection of threatened species and associated habitats.

Aquatic Invertebrates

The aquatic invertebrate community has been sporadically surveyed by various MDC collectors using specialized sampling methods and reporting techniques. Survey results are in the MDC Natural Heritage data base.

Thirty-seven species of naiades were collected in the basin by Ronald Oesch and Al Buchanan between 1978 and 1983 (Table 23). Five naiad species are state listed as rare or endangered: elephant ear *(Elliptio dilatata),* Western fanshell *(Cyprogeniaaberti),* Southern hickorynut *(Obovaria jacksoniana),* snuffbox *(Epioblasmatriquetra)* and Curtis pearlymussel *(Epioblasma f. curtisi).* The Western fanshell and Curtis pearlymussel also have a federally endangered status. All five of the threatened naiad species have been collected in a reach of the Castor River between RM 1 and RM 12. The Southern hickorynut has also been collected in Crooked Creek at RM 21 and at an unknown site on the Whitewater River.

The mucket *(Actinonaias l. carinata)* is a commercially important naiad species that is quite common throughout the basin and comprises about 31 percent of the total species composition. The buckhorn *(Tritogonia verrucosa),* black sandshell *(Ligumia recta)* and yellow sandshell *(Lampsilis teres)* are also commercially important species, but occur only in low densities (usually <1% of the total species composition). The lady finger *(Elliptio dilatatus),* which has no commercial value, is the most commonly occurring species in the basin and accounts for about 46 percent of the naiad species composition.

Eight species of crayfish were collected in the basin by William Pflieger between 1984 and 1987 (Table 24). Crayfish abundance is definitely dominated by Ozark Faunal Region species; however, it is the presence of the Lowland species that is responsible for the diversity of the crayfish community.

One hundred-twenty three benthic taxa were identified in the basin by Frank Ryck and Linden Trail during 1975 and 1976. The mayflies *(Ephemeroptera),* stoneflies *(Plecoptera),* caddisflies *(Trichoptera),* aquatic beetles *(Coleoptera)* and midges *(Diptera)* account for about 87 percent of the benthic abundance and 76 percent of the taxa diversity (Table 25). The composition and diversity of the benthic community are indicative of good water quality.

Wetland Species

The basin contains a diverse wetland fauna, which, again, is indicative of the broad spectrum of habitats that are available in the basin. Recent guidelines for managing wetland resources (MDC 1993c) identify 87 species of fishes, naiades and crayfishes that tend to inhabit wetlands during part of their life cycle. Sixty-three of these designated wetland species have been collected in the basin (Table 26).

Opportunities to take advantage of the many remnant wetland populations may be present in the lower basin, even though specific information related to the management and habitat requirements of wetland species is limited. Acquisition of low lying areas (particularly the old Dark Cypress Swamp) and then the creation of frequently flooded slackwaters with numerous mainstream channel connections would do much to replace some of the wetland habitats lost to agricultural land improvements.

Fish Introductions and Stockings

There are no known records of any authorized resource agency introduction or supplemental stocking of exotic or native fishes in the streams of the basin. However, lentic water overflow, bait bucket distribution and immigration of extrinsic fishes do occur, as evidenced by the unusual presence of redear sunfish *(Lepomis microlophus),* fathead minnow *(Pimephales promelas),* goldfish and bighead carp *(Hypophthalmichthysnobilis)* in an occasional fish sample.

Commercial Harvest

The only commercial fishing opportunity in the basin is limited to 0.6 mile of overflow flood water near the mouth of the Diversion Channel (less than 150 acres). Adequate flood conditions (approximately 36 ft on the Cape Girardeau gage), which allow legal and effective deployment of commercial gear, usually only last about two weeks each year. The commercial harvest of fish in the remainder of the basin is illegal and probably insignificant. Commercial fishing interest and activity on the adjacent Mississippi River in Cape Girardeau County is low and on the decline.

The 1990 Mississippi River species composition (by weight) of the reported Cape Girardeau County total commercial catch was: (in descending order) buffalo, paddlefish, carp and blue catfish. It is not likely that significant numbers of paddlefish would concentrate in the shallow overflow flood waters.

Other Management And Research Efforts

On the middle Whitewater River, McCord (1986) tried to test several proven hypotheses relating longitudinal succession of fish community structures to the variables of: habitat volume, habitat depth and physicochemical conditions. Multiple seine and backpack electrofishing samples were collected between February 1985 and February 1986. The results did not support the hypotheses and the study was inconclusive.

The Long Term Resource Monitoring Program (LTRM) established a fish component sampling site on the lower Diversion Channel at RM 0.7 in 1992. Samples are collected during three periods between June and October with gillnets, fyke nets, minnow fyke nets, hoopnets and boat-mounted electrofishing equipment. The primary information collected relates to community structure: percent composition, relative abundance, length, weight and possibly some centrarchid and ictalurid age and growth. The LTRM also monitors for the zebra mussel *(Dreissena polymorpha)* at this site, and may eventually add an invertebrate monitoring component.

Present Regulations

Statewide stream fishing regulations (creel limits, size limits, methods and seasons) apply to most of the streams in the basin. Exceptions to the statewide stream regulations that refer to specific areas on the Diversion Channel are:

3CSR 10-6.310 (2) Sport Fishing Seasons: Seasons, Limits.

Black bass may be taken throughout the year on the Diversion Channel from the mouth of the Diversion Channel at the Mississippi River to the Missouri Highway 77/25 bridge (RM 8.5).

3CSR 10-10.725 (1) Commercial Fishing: Seasons and Methods.

- Commercial fishing is allowed on the Diversion Channel, only in the temporary Mississippi River overflow waters, from the mouth of the Diversion Channel at the Mississippi River to the Union Pacific Railroad bridge (RM 0.6).
- No changes in fishing regulations or the establishment of special stream management areas are planned at this time.
- Most captured carp, throughout the basin, are typically more than 16 inches long and carp less than 11 inches long have never been sampled anywhere in the basin. The Whitewater River subbasin, in particular, produces large carp — where individuals approaching memorable-size (26 inches long) are common.
- Freshwater drum, in the Castor River, is the only species that tends to have a size structure influenced by position in the watershed. Larger individuals are more frequently captured (electrofishing) in the steeper gradients of the upper watershed. Improved gear efficiency in the clearer and shallower pools may be a factor. Preferred-size fish (15 inches long) are quite common and memorable-size fish (20 inches long) are occasionally caught.
- Golden redhorse occur at remarkably similar densities in the Castor River, Whitewater River and Crooked Creek subbasins; however, the subbasin size structures of golden redhorse are considerably different. The Whitewater River typically produces large fish and Crooked Creek produces particularly small fish. The size of the Castor River fish appears to be intermediate. The Whitewater River watershed is probably the most fertile and Crooked Creek definitely has the least fertile watershed in the basin. Unfortunately, comparative age and growth information is not yet available. Possibly more significant is the fact that Crooked Creek is the clearest stream and Whitewater River is the most turbid stream in the basin. Gigging exploitation on Crooked Creek or under-utilization by anglers on Whitewater River may be factors that are influencing the size structures of golden redhorse populations.

Creel Data

The Missouri State-Wide Angler Survey (Weithman, 1991) is the only source of creel information for the basin. Accurate estimates of total angler pressure, catch and harvest are not likely obtainable in small, low-use basins where the number of anglers interviewed is low (403 anglers during the six-year survey period). However, the raw survey data which partitions angler species preference, effort, success and satisfaction can provide some inferences that describe angler utilization of the fishery resource.

Two of the more popular Headwater Diversion Basin streams are reported in the State-Wide Angler Survey: The smaller (4E, 5E, 6E), rural, free flowing, clear, Castor River in the upper basin; and, the larger (6E and 7E), urban, channelized, turbid, Diversion Channel in the lower basin. Differences in angler effort and success are quite apparent between the two contrasting streams and fish communities (Tables 20 and 21).

Most of the angling effort on both streams is nonspecific ("Anything"). Species-specific anglers seek mostly black bass, catfish and sunfish on the Castor River; while carp, crappie and catfish dominate the effort on the Diversion Channel. Catfish is the only species that shared a relatively high common effort on both streams.
Catfish angler catch rates are higher on the Castor River than on the Diversion Channel and bass angler catch rates are higher on the Diversion Channel. The total overall angler catch and harvest rates on the Castor River appear to be much higher than on the Diversion Channel. The higher overall success on the Castor River, however, is probably inflated by the abundance of longear sunfish available to the nonspecific angler. Also, the less abundant crappie probably deflates the success of the Diversion Channel nonspecific angler.

Table 14. Species list of all fishes collected in the Headwaters Diversion Basin by MDC personnel (X), University studies (U) and recognized private collectors (P). State threatened species status is indicated.

Family/Species		Decade Collected				
		1940	1960	1970	1980	1990
PETROMYSONTIDAE (LAMPREYS)						
	Ichthyomyzon castaneus (Chestnut lamprey)		X		X	
	I. (Ammocoete) (larvae)		X	X	X	
RA	*Lampetra appendix (American brook lamprey)*			X		
	L. aepyptera (Least brook lamprey)				U	
POLYODONTIDAE (PADDLEFISH)						
WL	*Polyodon spathula (Paddlefish)*				X	
LEPISOSTEIDAE (GARS)						
	Lepisosteus oculatus (Spotted gar)				X	
	L. osseus (Longnose gar)				X	
	L. platostomus (Shortnose gar)				X	
AMIIDAE (BOWFINS)						
	Amia calva (Bowfin)		X		X	
ANGUILLIDAE (EELS)						
	Anguilla rostrate (American eel)				X	
CLUPEIDAE (HERRINGS)						
	Alosa chrysochloris (Skipjack herring)				X	
	Dorosoma cepedianum (Gizzard shad)				X	
ESOCIDAE (PIKES)						
	Esox a. vermiculatus (Grass pickerel)	X	X		X	
CYPRINIDAE (MINNOWS)						
	Campostoma anomalum (Central stoneroller)	X	X	X	X	
	C. oligolepis (Largescale stoneroller)	X	X	X	X	
	Carassius auratus (Goldfish)				X	
	Cyprinella lutrensis (Red shiner)	X			X	
	C. venusta (Blacktail shiner)	X	X	X		
	C. whipplei (Steelcolor shiner)	X	X	X	X	
	Cyprinus carpio (Common carp)		X		X	

Family/Species		Decade Collected				
		1940	1960	1970	1980	1990
	Hybognathus nuchalis (Miss. Silvery minnow)	X			X	
	Hypophthalmichthys nobilis (Bighead carp)				X	
	Luxilus chrysocephalus (Striped shiner)	X	X		X	
	L. zonatus (Bleeding shiner)	X	X	X	X	
	Lythrurus fumeus (Ribbon shiner)	X		X		
	L. umbratilis (Redfin shiner)	X	X	X	X	
	Nocomis biguttatus (Hornyhead chub)	X	X		X	
	Notemigonus crysoleucas (Golden shiner)	X	X		X	
EX	*Notropis amnis (Pallid shiner)*	X				
	N. amblops (Bigeye chub)	X	X	X	X	
	N. atherinoides (Emerald shiner)	X			X	
	N. boops (Bigeye shiner)	X	X	X	X	
WL	*N. buccatus (Silverjaw minnow)*		X		X	
	N. greenei (Wedgespot shiner)	X	X	X	X	
RA	*N. heterolepis (Blacknose shiner)*		P			
	N. nubilus (Ozark minnow)	X	X	X	X	
	N. rubellus (Rosyface shiner)	X	X	X	X	
	N. telescopus (Telescope shiner)	X	X	X	X	
	N. volucellus (Mimic shiner)	X	X	X	X	
WL	*Opsopoeodus emiliae (Pugnose minnow)*	X				
	Phenacobius mirabilis (Suckermouth minnow)	X			X	
	Phoxinus erythrogaster (Southern redbelly dace)		X		X	
	Pimephales notatus (Bluntnose minnow)	X	X	X	X	
	P. promelas (Fathead minnow)				U	
RA	*P. tenellus parviceps (Eastern slim minnow)*	X	X		X	
	P. vigilax (Bullhead minnow)	X	X	X	X	
	Semotilus atromaculatus (Creek chub)	X	X		X	

Family/Species		Decade Collected				
		1940	1960	1970	1980	1990
CATOSTOMIDAE (SUCKERS)						
	Carpiodes carpio (River carpsucker)		X		X	
	C. cyprinus (Quillback)				X	
	Catostomus commersoni (White sucker)				X	
	Erimyzon oblongus (Creek chubsucker)	X	X	X	X	
RA	*E. sucetta (Lake chubsucker)*		P			
	Hypentelium nigricans (Northern hog sucker)	X	X	X	X	
	Ictiobus bubalus (Smallmouth buffalo)				X	
	I. cyprinellus (Bigmouth buffalo				X	
	I. niger (Black buffalo)				X	
	Minytrema melanops (Spotted sucker)	X	X	X	X	
	Moxostoma anisurum (Silver redhorse)	X	X		X	
	M. carinatum (River redhorse)	X	X		X	
	M. duquesnei (Black redhorse)	X	X	X	X	
	M. erythrurum (Golden redhorse)	X	X	X	X	
	M. macrolepidotum (Shorthead redhorse)	X	X		X	
ICTALURIDAE (CATFISHES)						
	Ameiurus melas (Black bullhead)	X	X		X	
	A. natalis (Yellow bullhead)	X	X		X	
	Ictalurus punctatus (Channel catfish)	X	X		X	
	Noturus exilis (Slender madtom)	X	X		X	
	N. gyrinus (Tadpole madtom)	X			X	
	N. miurus (Bridled madtom)	X	X	X	X	
	N. nocturnus (Freckled madtom)			X	X	
	Pylodictis olivaris (Flathead catfish)				X	
APHREDODERIDAE (PIRATE PERCHES)						
	Aphredoderus sayanus (Pirate perch)	X	X	X	X	

Family/Species		Decade Collected				
		1940	1960	1970	1980	1990
CYPRINODONTIDAE (KILLFISHES)						
	Fundulus catenatus (Northern studfish)	X	X	X	X	
	F. notatus (Blackstripe topminnow)		X	X		
	F. olivaceus (Blackspotted topminnow)	X	X	X	X	
POECILIIDAE (LIVE BEARERS)						
	Gambusia affinis (Western mosquitofish)	X	X	X	X	
ATHERINIDAE (SILVERSIDES)						
	Labidesthes sicculus (Brook silversides)	X	X	X	X	
COTTIDAE (SCULPINS)						
	Cottus carolinae (Banded sculpin)		X			
	C. hypselurus (Ozark sculpin)		X	X	X	
PERCICHTHYIDAE (SEA BASSES)						
	Morone chrysops (White bass)				X	
	M. mississippiensis (Yellow bass)				X	
CENTRARCHIDAE (SUNFISHES)						
	Ambloplites ariommus (Shadow bass)	X	X	X	X	
WL	*Centrarchus macropterus (Flier)*			X	X	
	Elassoma zonatum (Banded pygmy sunfish)			X	X	
	Lepomis cyanellus (Green sunfish)	X	X	X	X	
	L. gulosus (Warmouth)	X	X	X	X	
	L. humilis (Orangespotted sunfish)	X	X	X	X	
	L. macrochirus (Bluegill)	X	X	X	X	
	L. megalotis (Longear sunfish)	X	X	X	X	
	L. punctatus (Spotted sunfish)	X	X	X	X	
	Micropterus dolomieu (Smallmouth bass)	X	X		X	
	M. punctulatus (Spotted bass)	X	X	X	X	
	M. salmoides (Largemouth bass)	X		X	X	
	Pomoxis annularis (White crappie)				X	

Family/Species		Decade Collected				
		1940	1960	1970	1980	1990
	P. nigromaculatus (Black crappie)				X	
PERCIDAE (PERCHES)						
WL	*Ammocrypta vivax (Scaly sand darter)*	X	X		X	
	Etheostoma blennioides (Greenside darter)	X	X	X	X	
	E. caeruleum (Rainbow darter)	X	X	X	X	
	E. chlorosomum (Bluntnose darter)	X	X	X		
	E. flabellare (Fantail darter)	X	X	X	X	
	E. gracile (Slough darter)		X		X	
	E. histric (Harlequin darter)					X
	E. nigrum (Johnny darter)	X	X	X	X	
	E. proeliare (Cypress darter)		X	X	X	
	E. punctulatum (Stippled darter)		X			
	E. spectabile (Orangethroat darter)	X	X		X	
	E. stigmaeum (Speckled darter)	X	X	X	X	
	E. zonale (Banded darter)	X	X	X	X	
	Percina caprodes (Logperch)	X	X	X	X	
	P. shumardi (River darter)	X	X	X	X	
	P. sciera (Dusky darter)	X	X	X	X	
	P. vigil (Saddleback darter)			X	X	
	P. maculata (Blackside darter)	X	X	X	X	
	Stizostedion canadense (Sauger)				X	
	S. vitreum (Walleye)				X	
SCIAENIDAE (DRUMS)						
	Aplodinotus grunniens (Freshwater drum)				X	

TABLE 15. Species distribution, occurrence and composition in the Headwaters Diversion Basin, Missouri. From a total of 85 seine sites (% OCURR) of which 35 samples were enumerated (% COMP) by Pflieger and McCord.

Famiy/ Species	CASTOR RIV No. Sites		CROOKED CK No. Sites		WHITEWATER No. Sites		D. CHANNEL No. Sites		TOTAL BASIN No. Sites	
	24 (%) OCCUR	15 (%) COMP	22 (%) OCCUR	3 (%) COMP	24 (%) OCCUR	12 (%) COMP	11 (%) OCCUR	5 (%) COMP	85 (%) OCCUR	35 (%) COMP
PETROMYSONTIDAE (LAMPREYS)										
Ichthyomyzon castaneus (Chestnut lamprey)	8	<0.1							2	<0.1
I. (Ammocoete) (larvas)	8	<0.1			4	<0.1			3	<0.1
Lampetra appendix (American brook lamprey)	4	0.3							1	0.1
L. aepyptera (Least brook lamprey)					4	<0.1			1	<0.1
AMIIDAE (BOWFINS)										
Amia calva (Bowfin)			5						1	
ESOCIDAE (PIKES)										
Esox a. vermiculatus (Grass pickerel)	46	0.2	23	0.7			33	0.8	25	0.1
CYPRINIDAE (MINNOWS)										
Campostoma anomalum (Central stoneroller)	33	0.5	14	2.1	42	1.4			25	1.1
C. oligolepis (Largescale stoneroller)	50	3.2	9	7.9	38	4			27	3.8
Cyprinella lutrensis (Red shiner)					8	0.1	7	0.7	3	0.1
C. venusta (Blacktail shiner)	17	0.7			17	<0.1			9	0.2
C. whipplei (Steelcol	42	1.2	9	1.7	17	0.2			19	0.5

Famiy/ Species	CASTOR RIV No. Sites		CROOKED CK No. Sites		WHITEWATER No. Sites		D. CHANNEL No. Sites		TOTAL BASIN No. Sites	
	24 (%) OCCUR	15 (%) COMP	22 (%) OCCUR	3 (%) COMP	24 (%) OCCUR	12 (%) COMP	11 (%) OCCUR	5 (%) COMP	85 (%) OCCUR	35 (%) COMP
or shiner)										
Cyprinus carpio (Common carp)	8	0.1	5				7	0.1	5	<0.1
Hybognathus nuchalis (Miss. silvery minnow)					17	<0.1	7	0.1	6	0.1
Luxilus chrysocephalus (Striped shiner)	13	2.3	68	6.6	75	2.8	33	0.2	48	2.7
L. zonatus (Bleeding shiner)	75	8.5	64	2.1	71	9.8			58	8.9
Lythrurus fumeus (Ribbon shiner)	8	0.1							2	<0.1
L. umbratilis(Redfin shiner)	54	0.4	18	0.7	33	1.6	80	11.6	44	1.6
Nocomis biguttatus (Hornyhead chub)	21	0.7	9	0.1	17	0.2			13	0.4
Notemigonus crysoleucas (Golden shiner)			9		8	<0.1	13	2.7	7	0.1
Notropis amnis (Pallid shiner)					4	<0.1	7	0.1	2	<0.1
N.amblops (Bigeye chub)	33	1.7	5	0.1	33	1.2			20	1.2
N. atherinoides (Emerald shiner)	4	0.3			17	4.8			6	3.3
N. boops (Bigeye shiner)	75	5.8	59	7.8	67	5.8	27		60	5.7
N. buccatus (Silverjaw minnow)					21	0.1			6	0.5

Famiy/ Species	CASTOR RIV No. Sites		CROOKED CK No. Sites		WHITEWATER No. Sites		D. CHANNEL No. Sites		TOTAL BASIN No. Sites	
	24 (%) OCCUR	15 (%) COMP	22 (%) OCCUR	3 (%) COMP	24 (%) OCCUR	12 (%) COMP	11 (%) OCCUR	5 (%) COMP	85 (%) OCCUR	35 (%) COMP
N. greenei (Wedgespot shiner)	16	0.8							5	0.2
N. heterolepis (Blacknose shiner)	4								1	0.1
N. nubilus (Ozark minnow)	50	9.8	46	6.4	62	16.8			44	14
N. rubellus (Rosyface shiner)	50	3.1	18	2.1	33	0.5			28	1.2
N. telescopus (Telescope shiner)	46	2.2	36	4.6	58	4.4			39	3.7
N. volucellus (Mimic shiner)	12	0.4			17	0.2			8	0.2
Opsopoeodus emiliae (Pugnose minnow)	4						7	0.2	2	<0.1
Phenacobius mirabilis (Suckermouth minnow)	4	0.4			13	0.1	7	0.1	5	0.2
Phoxinus erythrogaster (So. redbelly dace)	4		18		17				11	
Pimephales notatus (Bluntnose minnow)	63	8	41	15.8	58	11	60	1.8	55	10.1
P. promelas (Fathead minnow)					4	<0.1			1	<0.1
P. tenellus parviceps (E. slim minnow)	13	0.2							3	0.1
P. vigilax (Bullhea	17	2.6			4	<0.1	7	0.1	7	0.7

Famiy/ Species	CASTOR RIV No. Sites		CROOKED CK No. Sites		WHITEWATER No. Sites		D. CHANNEL No. Sites		TOTAL BASIN No. Sites	
	24 (%) OCCUR	15 (%) COMP	22 (%) OCCUR	3 (%) COMP	24 (%) OCCUR	12 (%) COMP	11 (%) OCCUR	5 (%) COMP	85 (%) OCCUR	35 (%) COMP
d minnow)										
P. Semotilus atromaculatus (Creek chub)	25	0.5	46	0.1	63	0.3	33	0.1	42	0.3
CATOSTOMIDAE (SUCKERS)										
Carpiodes carpio (River carpsucker)			5						1	
Erimyzon oblongus (Creek chubsucker)	21	0.4	32	0.5	29	0.1	53	1.1	32	0.2
Hypentelium nigricans (Northern hog sucker)	50	0.9	32	0.5	46	1.3			35	1.2
Minytrema melanops (Spotted sucker)	13	0.1	5	0.1	8	<0.1	13	1.4	9	0.1
Moxostoma anisurum (Silver redhorse)	8	0.1	5		17	0.1			8	0.1
M.carinatum (River redhorse)	8	0.2			4	<0.1			3	<0.1
M. duquesnei (Black redhorse)	38	0.2	27	2.6	33	0.3			27	0.4
M. erythrurum (Golden redhorse)	30	2.2	18	0.2	25	0.4			20	0.8
M. macrolepidotu m (Shorthead redhorse)	8	0.1			8	<0.1			5	<0.1
ICTALURIDAE (CATFISHES)										

Famiy/ Species	CASTOR RIV No. Sites		CROOKED CK No. Sites		WHITEWATER No. Sites		D. CHANNEL No. Sites		TOTAL BASIN No. Sites	
	24 (%) OCCUR	15 (%) COMP	22 (%) OCCUR	3 (%) COMP	24 (%) OCCUR	12 (%) COMP	11 (%) OCCUR	5 (%) COMP	85 (%) OCCUR	35 (%) COMP
Ameiurus melas (Black bullhead)	8	<0.1	9				13	1.5	7	0.1
A. natalis (Yellow bullhead)	13	0.1	27	0.2	33	0.3	7	1.5	21	0.3
Ictalurus punctatus (Channel catfish)			9		12	<0.1	13	0.1	7	<0.1
Noturus exilis(Slender madtom)	17	0.1	27		29	0.6			20	0.4
N. gyrinus (Tadpole madtom)			5	0.1			13	2.6	3	0.1
N. miurus (Bridled madtom)	38	0.4	5	0.5	17	0.1	7	0.2	17	0.2
N. nocturnus (Freckled madtom)	4	<0.1			4	<0.1			2	<0.1
Pylodictis olivaris(Flathead catfish)										
Aphredoderus sayanus (Pirate perch)	29	0.1	36	0.4	25	0.1	13	10.2	27	0.4
CYPRINODONTIDAE (KILLFISHES)										
Fundulus catenatus (Northern studfish)	58	3.1	55	0.1	67	1.9	7	0.5	48	2.1
F. notatus (Blackstripe topminnow)					8	0.1			2	0.1
F. olivaceus (Blackspotted topminnow	88	5	59	6.7	88	2	67	5.9	77	2.4
POECILIIDAE (LIVE BEARERS)										

Famiy/ Species	CASTOR RIV No. Sites		CROOKED CK No. Sites		WHITEWATER No. Sites		D. CHANNEL No. Sites		TOTAL BASIN No. Sites	
	24 (%) OCCUR	15 (%) COMP	22 (%) OCCUR	3 (%) COMP	24 (%) OCCUR	12 (%) COMP	11 (%) OCCUR	5 (%) COMP	85 (%) OCCUR	35 (%) COMP
Gambusia affinis (Western mosquito fish)										
	17	0.3	18	0.2	8	0.2	13	2.3	14	0.3
ATHERINIDAE (SILVERSIDES)										
Labidesthes sicculus (Brook silversides)	42	1.3	27	2.8	13	0.1	7	0.5	23	0.5
COTTIDAE (SCULPINS)										
Cottus carolinae (Banded sculpin)			9	0.2	25	0.4			9	0.2
C. hypselurus (Ozark sculpin)	29	0.2	5						9	<0.1
CENTRARCHIDAE (SUNFISHES)										
Ambloplites ariommus (Shadow bass)	42	0.2	9	0.2	29	0.9			22	0.7
Centrarchus macropterus (Flier)	4	<0.1					7	0.5	2	<0.1
Elassoma zonatum (Banded pygmy sunfish)	8	1.7					13	3.1	5	0.5
Lepomis cyanellus (Green sunfish)	25	0.8	59	0.2	38	2.6	67	3.2	45	2.1
L. gulosus (Warmouth)	17	0.1	9	0.1			13	5.4	9	0.2
L. humilis (Orangespotted sunfish)			5	0.6			7	1.6	2	0.1
L. macrochirus (Bluegill)	30	3.7	9	1.3	25	0.9	20	6.8	21	1.8
L. megalotis (Longear sunfish)	79	7	41	7.8	63	6.7	60	5.7	61	6.8

Famiy/ Species	CASTOR RIV No. Sites		CROOKED CK No. Sites		WHITEWATER No. Sites		D. CHANNEL No. Sites		TOTAL BASIN No. Sites	
	24 (%) OCCUR	15 (%) COMP	22 (%) OCCUR	3 (%) COMP	24 (%) OCCUR	12 (%) COMP	11 (%) OCCUR	5 (%) COMP	85 (%) OCCUR	35 (%) COMP
L. punctatus (Spotted sunfish)	4	<0.1	5		4	<0.1	13	1.9	6	0.1
Micropterus dolomieu (Smallmouth bass)	46	2.6	18	0.1	38	0.7			28	1.2
M. punctulatus (Spotted bass)	38	0.8	23	0.6	29	0.3	20	0.5	28	0.4
M. salmoides (Largemouth bass)	13	<0.1	5	0.2	17	0.4	7	0.3	11	0.3
Pomoxis annularis (White crappie)					4	<0.1	7	0.2	2	<0.1
PERCIDAE (PERCHES)										
Ammocrypta vivax (Scaly sand darter)	12	0.5			12	0.1			7	0.2
Etheostoma blennioides (Greenside darter)	38	0.2	9		21	0.4			19	0.3
E. caeruleum (Rainbow darter)	50	4.4	36	1.1	50	7.3			38	6.1
E. chlorosomum (Bluntnose darter)	8	<0.1			8		13	4.1	7	0.1
E. flabellare (Fantail darter)	33	0.9	23		46	3.5			28	2.6
E. gracile (Slough darter)	8	0.1			4	<0.1	7	1.8	5	0.1
E. nigrum	17	0.3	18	0.1	21	0.6	13	0.6	18	0.5

Famiy/ Species	CASTOR RIV No. Sites		CROOKED CK No. Sites		WHITEWATER No. Sites		D. CHANNEL No. Sites		TOTAL BASIN No. Sites	
	24 (%) OCCUR	15 (%) COMP	22 (%) OCCUR	3 (%) COMP	24 (%) OCCUR	12 (%) COMP	11 (%) OCCUR	5 (%) COMP	85 (%) OCCUR	35 (%) COMP
(Johnny darter)										
E. proeliare (Cypress darter)	5	2.9	5				20	17.2	9	1.3
E. punctulatum (Stippled darter)	4								1	
E. spectabile (Orangethroat darter)	30	0.2	27		58	1	20	0.7	35	0.7
E. stigmaeum (Speckled darter)	30	2.9	9	11.4	21	0.1			17	1.2
E. zonale (Banded darter)	42	0.9	23	1.2	33	0.8			27	0.8
Percina caprodes (Logperch)	21	0.1	14	1.1	4	<0.1			11	0.1
P. sciera (Dusky darter)	21	0.4	9	0.2	21	0.1			14	0.1
P. vigil (Saddleback darter)	4		5	0.5					2	<0.1
P. maculata (Blackside darter)	17	0.2	9	0.8	21	<0.1			13	0.1

TABLE 20. Castor River 6-year summary of selected creel parameters reported in the Missouri State-Wide Angler Survey, 1983 - 1988. Because of limited angler contacts (221 anglers during the 6-year period) all data were combined. Parameters involving estimates (pressure, total catch and total harvest) were avoided.

Species Preference Angler	% All Anglers	% All Hours	Per Hour Species Specific		Angler Quality Rating (10 = Best)	Ave Trp Len	% Species Composition Of Total Catch
			CR	HR			
Anything	34.9	37.3	1.1	0.7	5.3	4.7	
Bass	31.2	31.8	0.3	0.1	6.6	3.7	29.9
Catfish	18.1	14.3	0.3	0.3	3.5	4.6	5.3
Sunfish	6.3	6.1	2.2	2.2	5.6	1.9	39.7
Crappie	2.7	0.9	0.8	0.8	5.7	4.2	1
Shadow Bass	1.8	6.7	0.2	0.2	8.5	6.8	15.8
Sucker	1.8	0.7	8.3	8.3	7.5	3	4.2
FW Drum	1.4	0.4	0.3	0.3	7	4	0.4
Walleye	0.9	1.1	0	0	5	3.5	0.1
White Bass	0.9	0.7	3.9	3.2	5	3	2.2
Gar	-	-	-		-	-	0.8
Carp	-	-		-	-	-	0.4
Buffalo	-	-	-	-	-	-	0.2
WTD Ave	100	100	1.1	0.6	5.5	4.6	100

TABLE 21. Headwaters Diversion Channel 2-year summary of selected creel parameters reported in the Missouri State-Wide Angler Survey, 1987-1988. Because of wide annual fluctuations and limited angler contacts (182 anglers during the 2-year period) all data were combined. Parameters involving estimates (pressure, total catch, and total harvest) were avoided.

Species Preference Angler	% All Anglers	% All Hours	Per Hour Species Specific		Angler Quality Rating (10 = Best)	Ave Trp Len	% Species Composition Of Total Catch
			CR	HR			
Anything	34.9	37.3	1.1	0.7	5.3	4.7	
Bass	31.2	31.8	0.3	0.1	6.6	3.7	29.9
Catfish	18.1	14.3	0.3	0.3	3.5	4.6	5.3
Sunfish	6.3	6.1	2.2	2.2	5.6	1.9	39.7
Crappie	2.7	0.9	0.8	0.8	5.7	4.2	1
Shadow Bass	1.8	6.7	0.2	0.2	8.5	6.8	15.8
Sucker	1.8	0.7	8.3	8.3	7.5	3	4.2
FW Drum	1.4	0.4	0.3	0.3	7	4	0.4
Walleye	0.9	1.1	0	0	5	3.5	0.1
White Bass	0.9	0.7	3.9	3.2	5	3	2.2
Gar	-	-	-		-	-	0.8
Carp	-	-		-	-	-	0.4
Buffalo	-	-	-	-	-	-	0.2
WTD Ave	100	100	1.1	0.6	5.5	4.6	100

TABLE 22. State rank and location of species of conservation concern from the Headwaters Diversion Channel.

CONSERVATION CONCERN SPECIES	STATE RANK	SITE NO.	DATE	STREAM	RM	NO. SPECIMENTS	AUTHORITY
Notropis amnis (Pallid shiner)	SX	3	1940	Hubble Ck.	2.4	1	Pflieger, MDC
N. Amnis		4	1941	Whitewater R.	21.5	3	Pflieger, MDC
N. Amnis		U	1941	L. WhWater Ck.	0	3	Bauman, A.C.
Erimyson sucetta (Lake chubsucker)	S2	T	1969	Cane Creek	4.8	2	Thomerson, J.E.
E. sucetta		R	1969	Castor River	5.7	1	Thomerson, J.E.
Lampetra appendix (Am. Brook lamprey)	S2	68	1963	Castor River	17.2	20	Pflieger, MDC
Notropis heterolepis (Blacknose shiner)	S2	S	1969	Castor River	41.6	1	Thomerson, J.E.
Pimephales t parviceps (E. slim minnow)		64	1941	Castor River	18.8	4	Pflieger, MDC
P. t parviceps	S2S3	72	1964	Castor River	5.3	9	Pflieger, MDC
P. t parviceps		75	1984	Castor River	11.6	1	Pflieger, MDC
Etheastama histrio (Harlequin Darter)	S2	72	1996	Castor River	5.3	-	Bruenderman, MDC
Ammocrypta vivax (Scaly sand darter)		4	1941	Whitewater R.	21.5	10	Pflieger, MDC
A. vivax	S3	5	1941	Whitewater R.	24	5	Pflieger, MDC
A. vivax							
A. vivax		67	1964	Castor River	13.6	nc	Pflieger, MDC
A. vivax		72	1984	Castor River	5.3	24	Pflieger, MDC
A. vivax		75	1984	Castor River	11.6	8	Pflieger, MDC
Percenia shumardi (River darter)	S3	NO DATA					
Centrarchus macropterus (Flier)	74	1978	Un-named	0.5	1	Pflieger, MDC	
C. macropterus	S3	59	1980	Hawker Creek	3.5	4	Pflieger, MDC
C. macropterus		D	1990	Castor River	4.2	3	Norman, MDC
C. macropterus		E	1990	Castor River	12.2	2	Norman, MDC
C. macropterus		F	1990	Castor River	18.3	1	Norman, MDC
C. macropterus		J	1990	Crooked Creek	19.5	1	Norman, MDC
C. macropterus		N	1990	Whitewater R.	15.2	1	Norman, MDC
Opsopoeodus emiliae (Pugnose minnow)		3	1940	Hubble Creek	2.4	2	Pflieger, MDC
O. emiliae	S4	26	1941	Crooked Creek	20.5	1	Pflieger, MDC

CONSERVATION CONCERN SPECIES	STATE RANK	SITE NO.	DATE	STREAM	RM	NO. SPECIMENTS	AUTHORITY
Polyodon spathula (Paddlefish)	S3	A	1990	Diversion Ch.	1.5	2	Norman, MDC
Hognathus nuchalis (Mississippi Silvery Minnow)	S3		1990	Whitewater R.	NO DATA		

*SX = Extirpated: Element is believed to be extirpated from the state
*S1= Critically imperiled in the state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state (typically 5 or fewer occurrences or very few remaining individuals
*S2= Imperiled in the state because of rarity or because of some factor (s) making it very vulnerable to extirpation from the state. (6 to 20 occurrences or few remaining individuals or acres)
*S3= Rare and uncommon in the state. (21 to 100 occurrences)
*S4= Widespread, abundant, and apparently secure in state, with many occurrences, but the species is of long-term concern. (usually more than 100 occurrences)

TABLE 23. Species list and status (state and federal) of naiades collected in the Headwater Diversion Basin, Missouri. From the MDC Natural Heritage data base.

	Species	Common Name	Castor River	White-Water River	Crooked River
	Anodonta imbecilis	Paper pondshell			x
	A. g. grandis	Floater		x	x
	Strophitus u. Undulatus	Squawfoot	x	x	x
S2	*Alasmidonta margineta*	Elktoe		x	x
	Lasmigona complaneta	White heelsplitter		x	x
	L. costata	Fluted shell	x	x	x
	Megalonaias nervosa	Washboard	x	x	x
	Tritogonia verrucosa	Buckhorn	x	x	
	Quadrula quadrula	Mapleleaf		x	
	Q. metanevra	Monkeyface	x	x	x
	Q. pustulosa	Pimpleback	x	x	
	Amblema p. plicata	Threeridge	x	x	x
	Fusconaia flava	Wabash pigtoe	x	x	x
	Pleurobema sintoxia	Pigtoe			x
	P. coccineum	Round pigtoe	x		
	Elliptio dilatata	Lady finger	x	x	x
S2S3	*E. c. crassidens*	Elephant ear	x		
	Ptychobranchus occidentalis	Kidney shell	x	x	
S1S2*	*Cyprogenia aberti*	Western fanshell	x		
	Actinonaias l. carinata	Mucket	x	x	x
S1	*Obovaria jacksoniana*	Southern hickorynut	x	x	x
	Truncilla truncata	Deertoe		x	
	Leptodea fragilis	Fragile papershell	x	x	x
	Potamilus alatus	Pink heelsplitter	x		
	P. purpuratus	Bleufer	x	x	x
	Toxolasma parvus	Lilliput	x		x
S1S2	*Ligumia recta*	Black sandshell	x	x	
	L. subrostrata	Pond mussel		x	x
	Villosa i. iris	Rainbow	x		
	V. l. lienosa	Little spectacle case	x		x
	Lampsilis teres	Yellow sandshell	x	x	x
	L. r. luteola	Fat mucket	x	x	x

	Species	Common Name	Castor River	White-Water River	Crooked River
	L. ventricosa	Pocketbook	x	x	x
	L. r. breviculus	Ozark brokenray	x	x	x
S1	*Epioblasma triquetra*	Snuffbox	x		
S1*E	*E. f. curtisi*	Curtis pearly mussel	x		
	Corbicula leana	Asiatic clam		x	

*=Federally listed

TABLE 24. Species list and relative abundance of crayfish species collected in the Headwater Diversion Basin, Missouri. (From MDC Natural Heritage data base)

Crayfish Species	Number of crayfish collected						Basin Totals	
	Castor River	White-Water River	Crooked River	Hubble Creek	Hawker Creek	Clubb Creek	No.	% Comp
Cambarus diogenes	1						1	0.2
Orconectes luteus	246	5	50	8			309	77.4
O. palmeri		3	23	6			32	8
O. virilis		3		3			6	1.5
O. punctimanus	13		1			7	21	5.3
Procambarus acutus	4		2	3			9	2.3
P. clarkii					1		1	0.2
P. viaeveridus	13						13	3.3
Fallicambarus fodiens	7						7	1.8
Total numbers sampled	284	11	76	20	1	7	399	100
No. of sample sites	7	1	4	3	1	1		
Total effort (hrs)	9.7	0.5	4.4	1.1	0.4	0.4	16.5	
Catch rate	29.3	22	17.3	18.2	2.5	17.5	24.2	

TABLE 25. Relative abundance of taxonomic classes of benthos collected in the Headwater Diversion Basin, Missori. (From MDC Natural Heritage data base)

Class	Castor River RM 6 & RM 41			Whitewater R. RM 36			Crooked Ck. RM 22			Basin Totals		
	No. Taxa	No./10 ft2	% Comp	No. Taxa	No./10 ft2	% Comp	No. Taxa	No./10 ft2	% Comp	No. Taxa	Ave#/ 10 ft2	% Comp
Annelida	2	109	17.6	1	22	1.3	2	4	0.5	3	58	6.2
Amphipoda				1	1	</1	2	1	0.1	2	<1	<.1
Isopoda				1	4	0.2				1	1	0.2
Decapoda	1	3	0.5	1	<1	<.1	1	2	0.2	1	2	0.1
Ephemeroptera	23	176	28.3	17	360	21.4	19	480	61.7	27	306	32.4
Odonata	6	5	0.8	4	2	0.1	3	2	0.3	7	3	0.3
Plecoptera	8	16	2.6	11	121	7.2	10	25	3.2	21	46	4.9
Hemiptera	1	1	0.2	1	1	<.1				1	1	<.1
Megaloptera				2	8	0.5	2	3	0.3	3	3	0.2
Trichoptera	14	23	3.7	16	434	25.9	11	81	10.4	19	148	15.7
Lepidoptera	1	1	0.1				1	<1	<.1	1	<1	<.1
Coleoptera	12	54	8.6	9	55	3.3	7	16	2.1	14	44	4.7
Diptera	9	207	33.3	12	664	39.6	9	162	20.8	13	317	33.6
Gastropoda	4	5	0.8	2	1	0.1	1	1	0.2	4	3	0.3
Plecypoda	1	22	3.5	1	1	0.1				2	10	1.1
Miscellaneous	1	1	0.1	4	3	0.2	2	2	0.2	4	1	0.3
Totals	83	623		83	1677		70	779		123	943	
No. of samples		7			4			4			15	
No. of organisms		4342			6703			3112			14157	

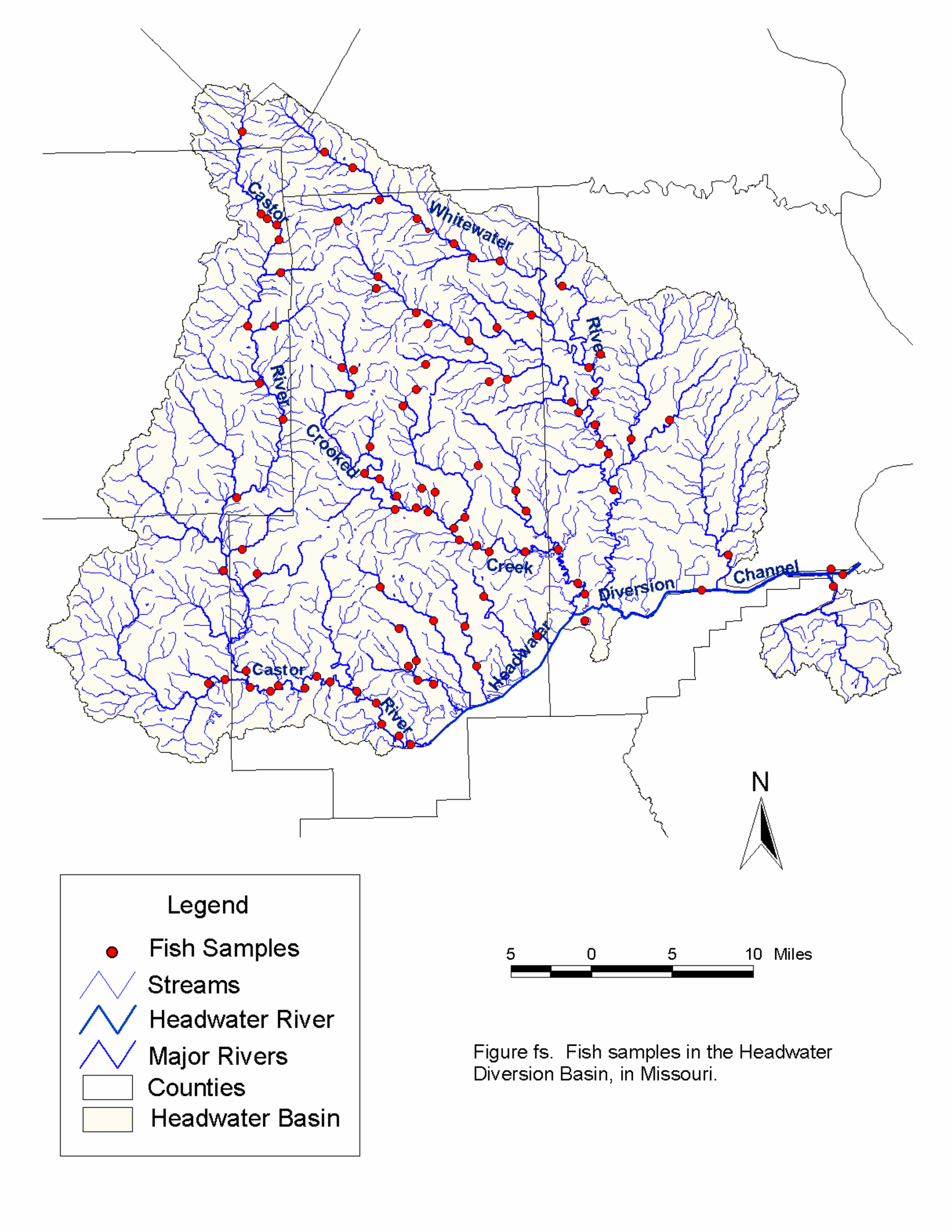


Figure fs. Fish samples in the Headwater Diversion Basin, in Missouri.

Management Problems and Opportunities

The goals, objectives and tasks developed for this planning document represent reasonable outcomes and expectations that, for the most part, can be achieved by fisheries district staff during the next 15 years. All goals, objectives and tasks are not of equal importance and are therefore arranged in order of priority to reflect current basin needs related to aquatic habitats, fish communities, recreational use and water quality.

Goal I: Reduce the supply and transport of coarse sediments in basin streams.

Status: High quality instream habitat components such as abundant cover, high base flows, good water
quality, diverse substrate composition and adequate depths are typical good channel conditions associated with most mainstem reaches. However, all disturbed soils in the basin are hazardously erosive and represent the highest potential for sheet, rill and gully erosion in the state. Consequently, the transport of coarse sediments (excessive gravel bedloads), caused by historically poor timber harvest and grazing practices in the uplands, and streambank instability, caused by occasional agricultural encroachments into some narrow or absent floodplain corridors, can cause changes in channel hydraulics and loss of streambank protection that can quickly lead to serious streambank erosion problems anywhere in the basin.

Objective 1.1: Reduce soil erosion in the uplands.

Strategy: Much of the gravel that has accumulated in the floodplains originated from the cherty residuum on the steep-sloped uplands, as evidenced by fresh gravel deposits at the mouths of many first and second order dry stream channels after storm events. The basin contains 2,893 first and second order channel reaches that total 2,415 miles. Landowner involvement and participation is, therefore, essential in order to effectively address upland soil disturbances and losses. We must focus on promoting and encouraging landowner awareness of good land stewardship practices, especially those timber harvest and grazing practices that will produce canopy closure, leaf litter accumulation and less soil compaction. This is a long-term objective that may not produce obvious results quickly.

- Promote and publicize the advantages of all private land management assistance and services that are available through MDC Forestry Division, University Extension Service, ASCS, SCS and SWCD.
- Promote awareness and encourage landowner enrollment in and contribute to the preparation of Forest Stewardship Management plans, which by definition include consideration of resource elements related to soil erosion, re-vegetation, wetlands, threatened species, recreation, fish habitats and riparian corridors.
- Promote awareness and encourage qualified landowners to participate in the Stewardship Incentive Program (SIP).
- Cooperate with the SCS and county SWCD boards in the establishment, planning and implementation of erosion reduction projects, such as SALT, EARTH, PL-566 and EPA 319 grants.

- Through local Forestry staff recommendations and the SCS information network, implement a Neighbor-to-Neighbor type of program that recognizes and applauds landowners for good forest stewardship efforts.

Objective 1.2: Reduce streambank erosion in the floodplains.

Strategy: The extensive unconsolidated alluvium in the floodplains is a gravel source that enters stream channels primarily through accelerated streambank erosion. Reducing erosion and increasing streambank stability will depend on gaining private and public landowner acceptance of restorative and preventative erosion management approaches that include riparian corridor as well as streambank locations. Restoration will address correcting (with landowner cooperation) the most serious incidents of accelerated erosion that are within the limits of staff expertise, MDC guidelines and administrative approval. Erosion prevention will focus on increasing landowner awareness of and involvement in good streambank and riparian corridor stewardship.

Streambank and Corridor Restoration Tasks:

- Provide technical stream management advice to all landowners who request assistance. Conduct on-site visits, determine solutions, assess cost and effort feasibilities and then provide appropriate written recommendations to landowners whose interest indicates that the recommendations will be implemented.
- Implement Landowner Cooperative Projects (tree revetments, hardpoints, grade control structures, solar powered electric fencing and other fencing that withstands out of channel flows, solar powered livestock watering facilities) whenever suitable sites and opportunities occur.
- In appropriate and favorable situations, promote state and federal agency incentive programs that assist landowners (through technical and financial assistance) with streambank and corridor restoration problems.
- Photograph (aerial videotape and still) the riparian corridors and streambanks on selected third order and all fourth order and larger streams (approximately 567 miles) to identify, assess and record current streambank and corridor conditions. Reassess and compare the condition of the corridors and streambanks in 10-year intervals by aerial photography, videotape or satellite imagery.
- Inventory stream frontages and riparian corridors on current and future acquisitions of public lands and recommend corrective or enhancement projects when necessary.
- Participate in MDC conservation area planning efforts to ensure that all appropriate stream resource needs and opportunities are addressed in approved plans.
- Provide technical advice to landowners, county and city commissions, highway departments and construction companies on how to properly remove gravel from streams.
- Review all 404 permit applications, bridge construction, road construction and other development projects to identify possible positive or negative stream impacts.

Erosion Prevention Tasks:

- Contact all landowners with floodplain frontages and make them aware of the importance of proper streambank and riparian corridor management (Contacts will be prioritized by the greatest frontage lengths and riparian acreages). Also, introduce them to the technical and financial assistance that is available through county, state and federal programs.
- Sponsor and conduct stream management workshops for landowners and other interested groups.
- Promote stream programs and stewardship through the information services of SCS, ASCS, SWCD, Farm Bureau and other agriculture media.
- Develop close working relationships with other private land managers and administrators (MDC Forestry, Wildlife and Natural History, SCS) to cultivate mutual interests and concerns for all land and water stewardship issues.

- Maintain and advertise stream improvement projects on public and private lands for demonstration purposes.
- Implement a Neighbor-to-Neighbor type of program that recognizes and applauds good unassisted streambank and corridor stewardship efforts that are currently occurring in the basin.
- Conduct mail or telephone surveys to measure landowner awareness of stream programs.

Goal II: Maintain fish species richness at or above current levels while improving the quality of the sport fishery.

Status: Species richness, as determined by our sampling efforts, has increased by 36% over the past 50 years to 113 species. Only the extirpated pallid shiner and watch listed pugnose minnow have failed to re-appear in post-1941 collections. Eight other state listed threatened fish species, 45 wetland species and 29 intolerant species have enjoyed widespread distribution and abundance throughout most of the basin since 1984. Reproduction, early survival and recruitment of young sportfishes to stock-size are apparently good. Some quality- and preferred-size recruitment are occurring for all fish species that provide angling interest. Recruitment to quality-size is particularly adequate for common carp, freshwater drum, shadow bass, channel catfish, flathead catfish, bluegill and redhorse suckers. Low recruitment of black basses to quality-size (>12 inches) and shadow bass to preferred-size (>9 inches) is cause for concern. Anglers have indicated disappointment in the density of catfishes and the size of crappies.

Objective 2.1: The diversity and abundance of non-game fishes maintained at or above current levels.

Strategy: We assume that healthy water quality, excellent habitat diversity and sampling methods are primarily responsible for the increase in species richness and the continuing presence of threatened species. We also assume that successful efforts to improve, protect, diversify or create additional stream habitats will promote the maintenance and possibly increase species abundance. And, we believe that our fish distribution data base is sufficient to document changes in species occurrence and relative abundance.

- Promote and assist with the acquisition or protection (through purchase, easement and LCP agreements or stewardship programs) of two 15-mile reaches on the Castor and Whitewater rivers which have been designated as "unique habitats" in this plan. Also, all stream problems occurring within the reaches will receive the highest priority management attention.
- Provide biological and technical information to all interested parties concerning the detrimental effects that the proposed 7,680-acre Bollinger/Cape Girardeau County Lake would have on the Whitewater River "unique habitat" reach.
- Promote and participate in the acquisition, design and creation of needed wetland habitats in the lower basin. Of particular interest are frontages owned or controlled by the Little River Drainage District:
    1. The remnant Dark Cypress Swamp; 4,400 acres on 11 miles of the left descending bank of the Diversion Channel above the Blockhole grade control structure.
    2. The extreme lower reaches of Crooked Creek, Whitewater River and Hubble Creek which are part of the 23,000-acre dry detention storage area below the Blockhole grade control structure.
- Recommend, plan and assist with the installation of stream habitat projects on private frontages whenever opportunities arise. High priority locations are Little Crooked Creek and Little Whitewater Creek.
- Complete stream habitat improvement projects on public frontages which provide additional local diversity.

- Implement a survey program (probably periodic seining) to monitor and track the distribution and abundance of threatened and non-game species.
- Assist with implementing approved recovery plans for any state or federally listed rare or endangered fish species.

Objective 2.2: Improve the densities of channel and flathead catfish and the size structures of white crappie, spotted bass and shadow bass to levels that will provide greater angler satisfaction.

Strategy: We assume that recruitment to larger sizes, particularly into the quality- and preferred-sizes, can often be influenced by harvest regulations. We might also assume that angler harvest becomes progressively more critical in an upstream direction as channel environments are compressed into smaller units. We should not, however, assume that angler harvest is primarily responsible for sportfish population parameters until data that define subbasin fishing pressures and separates angling and natural mortalities are collected.

- Conduct a sound, cost-effective, Biometrics-designed creel survey to estimate subbasin angler effort, catch, harvest, satisfaction and preference.
- Until completion of the creel survey, continue to expand the sportfishes data base, with particular emphases on mortality and density estimates for Diversion Channel catfishes and crappies and upper basin spotted bass and shadow bass.
- Using regulations, stocking, habitat improvement and other techniques, implement management programs that will enhance selected population parameters for target species at appropriate basin locations.

Goal III: Increase appreciation for basin streams and improve public access to those which are capable of supporting additional recreational use.

Status: Angler survey information indicates that most fishing activity is concentrated in the lower basin, on the Diversion Channel, where public access facilities are limited and crowded conditions often occur. Float fishing and recreational canoeing are not popular activities in the middle basin, even though stream flows are adequate throughout the year. Comfortable floating in the upper basin is seasonal and dependent upon discharges considerably greater than base flows. Some wade and bank fishing occurs throughout the basin on mainstems and major tributaries. Much of the fishery resource in the basin is probably under-utilized because of a lack of awareness or interest in small streams.

Objective 3.1:

Access sites developed at locations and in sufficient numbers to encourage dispersal of public use throughout the basin.

Strategy: Completion of approved MDC stream area and stream frontage acquisition plans for the basin will do much to accommodate the expected increases in stream use activities that are predicted in the Department strategic plan. Rapid implementation of the acquisition plans, with some modifications and priorities that reflect current knowledge of basin conditions, will best provide the needed facilities to spread current and future use. Modifications should include additional access on the 34 miles of Diversion Channel where users are currently crowded onto a single site. Site priorities will focus on acquiring planned access sites that will immediately complement existing sites.

- Modify MDC acquisition plans to include a Type 4 access on the left descending bank of the Diversion Channel anywhere near the Highway 25 bridge (RM 9).
- Pursue the acquisition of planned access sites with efforts guided by the following priorities:
  1. Diversion Channel at the Allenville bridge (RM 15) - to relieve downstream congestion.
  2. Diversion Channel at Highway 91 bridge (RM 27) - to relieve downstream congestion.
  3. Whitewater River at RM 7 - to complement the proposed downstream Allenville bridge site on the Diversion Channel.
  4. Castor River at Crook's Landing (RM 34) - as the furthest upstream floatable (all year) site that will also complement the upstream Marquand Access.
  5. Castor River at Gipsy bridge (RM 17) - to complement the downstream Sweetgum Access and the proposed upstream Highway 34 site.
  6. Castor River at Highway 34 bridge (RM 27) - to complement the proposed upstream Crook's Landing site and the proposed downstream Gipsy bridge site.
- Pursue the acquisition of frontage sites with efforts guided by the following priorities:
  1. Whitewater River - north of Millersville.
  2. Whitewater River - north of Burfordsville.
  3. Whitewater River - north of Sedgewickville.
  4. Little Whitewater Creek - from the mouth to Patton.
  5. Crooked Creek - near Marble Hill.
- Improve bank fishing and other recreational opportunities on MDC frontages by implementing or modifying strategies in area management plans.
- Modify MDC acquisition plans to include a Type 2 access on Crooked Creek in the vicinity of
- RM 10 to complement the Blockhole Access on the Diversion Channel.
- Develop parking facilities at our Hawn, Iron Bridge and Old Plantation accesses.
- Acquire small, simple parking facilities (one or two cars) at desirable low water bridge crossings through purchase, lease or cooperative agreements with county road districts.

Objective 3.2:

Awareness of stream recreational opportunities and appreciation of stream advocacy increased to a level that will encourage a widespread and diversified public interest in the basin.

Strategy: Because of suspected low fishing pressure upstream from the Diversion Channel, particularly on Crooked Creek and the Whitewater River, it is assumed that many potential anglers may not be fully aware of all recreational opportunities available in the basin. Careful publicity which focuses on abundant or surplus local stocks, such as redhorse suckers, longear, large common carp or freshwater drum and crayfish, can promote increased use and appreciation of these types of resource elements with minimal risk to other basin populations.

Providing opportunities for the general public to learn about holistic stream ecology will, hopefully, create some stream advocates. More importantly, however, we believe that the ultimate key to sound basin management depends on recruiting, influencing and educating our youth, who will become our present stream advocates and our future stream stewards.

- Write an annual basin fishing prospectus, for local media publication, which describes the specific fisheries and angling opportunities associated with the Diversion Channel, Castor River, Whitewater River, Crooked Creek, Bear Creek and Little Whitewater Creek.
- Provide the local and statewide media with timely "How to", "When to", "Where to" articles and interviews that focus attention on activities and places such as: bowfishing floodwaters; wade gigging; daylight float gigging; wade fishing; seasons, baits, methods and techniques for catching particular species; life histories, habits and behaviors of various aquatic animals; scenic sights; interesting geological formations; interesting plant communities; wildlife viewing; swimming holes; sunbathing spots.

- Publicize the acquisition, development and opening of new public access sites.
- Conduct recreational use surveys at 5-10 year intervals in conjunction with creel surveys to determine levels of public use and satisfaction.
- Emphasize stream ecology and good stream stewardship (utilizing aquaria and stream tables where applicable) during presentations at primary and secondary schools and youth organizations such as the Boy Scouts of America, Girl Scouts of America, Future Farmers of America, 4-H and VoAg groups.
- Conduct outdoor youth events, such as Ecology Day and Solar Day, at a stream site with field activities that demonstrate stream ecology and good stream stewardship.
- Facilitate the development and activity of Stream Teams or other groups interested in adopting or otherwise promoting good stewardship and enjoyment of basin streams.
- Make public presentations that focus on the MDC Streams For The Future program.
- Provide promotional, educational and technical stream materials to special interest groups, fairs and other special events.

Goal IV: Meet state standards for water quality. Status:

Point and nonpoint source pollution is not a serious threat in the basin. Favorable hydrological and geological conditions have combined to produce the wettest basin in the state with permanent, clean, and well sustained base and subsurface flows. Low flow Q-values are high, summer recession rates are low and zero flows have never been recorded at a mainstem gage station. Furthermore, the lack of industrial effluents, the presence of updated municipal sewage treatment facilities and the near absence of irrigation withdrawals further decrease the potential for pollution. Organic nutrient loading from livestock waste runoff and breached no-discharge sewage lagoons probably constitutes the largest water quality threat in the basin. Leachates from sawdust piles and fine sediments from non-permitted gravel mining operations are other sources of pollution.

Objective 4.1: Meet state standards for water quality.

Strategy: Enforcement of existing state and federal water quality regulations will help reduce the violations that have occurred in the basin. Increasing public, industrial and local government awareness of potential threats should generate more local interest in water quality problems and solutions.

- Inform the public, through the local media, public presentations and personal contacts, of past and present water quality threats and problems (nutrient loading, chemical spills, agriculture runoff, excessive siltation) and the solutions necessary to protect aquatic communities.
- Cooperate with other state and federal agencies in investigating, documenting and reporting incidents of pollution and fish kills.
- Review NPDES, 404 permit applications and other permits and recommend measures to protect aquatic communities.
- Train and involve interested Stream Teams in water quality monitoring and advocacy and urge them to begin collecting baseline and early warning water quality data.
- Locate active and abandoned sawdust piles and gravel operations and check with the supervising agency for proper permits.

Angler Guide

Fishing in the Headwater Diversion watershed is mainly in the Castor River, Crooked Creek, Little Whitewater Creek, Bear Creek, Whitewater River, the Headwater Diversion and numerous small streams. A variety of fish species are available to anglers depending upon the location in the watershed and habitat. These include redhorse suckers, walleye, smallmouth bass, largemouth bass, spotted bass, crappie, sunfish, hybrid striped bass, white bass, channel catfish and flathead catfish.

The larger streams in the watershed are generally accessible by jon boats powered by small outboards and more readily by canoe. There is a 'No Wake'- idle speed only regulation on the Headwater Diversion Channel.

Water clarity can range from crystal clear in the upper Castor River to muddy in the lower Headwater Diversion Channel. In addition, Mississippi River stage can dramatically influence the flow in the Headwater Diversion Channel.

Spotted, smallmouth and largemouth bass can be caught from all the major streams. Smallmouth bass are most common in the clearer upstream sections while spotted bass will be found further downstream in the more turbid, lower gradient sections. Fish will range from 10-15 inches with the occasional larger fish. Look for smallmouth and spotted bass near rocks or woody cover adjacent to current.

Largemouth bass can be caught throughout the watershed and will often average larger than smallmouth or spotted bass. Look for them in slow current or slack water very near woody cover. Some stream segments provide the opportunity to catch all three black bass species. Baits of choice include live minnows and crayfish caught from the stream. Best lures include soft plastics, minnow plugs, spinner and buzz baits.

White bass and hybrid striped bass make their appearance in the Headwater Diversion Channel in late winter and early spring. These fish move from the Mississippi River into the Channel to spawn. Fish are taken from the confluence to the Block Hole grade control structure located in southwest Cape Girardeau county. At the peak of the spawn, great catches can be made at the Block Hole as the structure generally prohibits further upstream movement. Two pound white bass are not uncommon.

Hybrid striped bass are generally caught from the lower end of the Headwater Diversion. Fish to 15 pounds have been caught. Live bait of choice are large minnows. Lures include spinners, soft plastic jigs, small plugs and crankbaits.

Walleye are also present in the Castor River and Headwater Diversion Channel. These fish are most readily caught in late winter/early spring when these fish move to spawning sites. The Block Hole Access and Castor River near Zalma are productive fishing areas. Although most fish will be under 20 inches, fish over 10 lbs. have been taken. Walleye are caught on live minnows and worms fished on or near the bottom. Jigs and small crankbaits are also effective. Fish are more active during cloudy, dark days and can be found in deeper holes.

Crappie are found in low numbers in the larger streams. However, when the Mississippi River rises during the spring crappie often move into the Headwater Diversion Channel to spawn. Fish are caught from around the log jams and the bases of flooded timber along the channel. This fishing often is short-lived but very productive while it lasts. Small jigs and minnows fished under a shallow-set float are very effective.

Channel catfish and flathead catfish are found in the larger streams. Fishing for catfish can be very good during times of rising water. Successful anglers use jug lines or set lines near woody cover or undercut banks in deep water. Channel catfish can be taken on worms, cut bait, crayfish, chicken liver or prepared baits. Flathead catfish are most often taken on live sunfish.

Redhorse suckers are abundant. Gigging is by far the most popular method of harvesting these fish. Generally, periods of cold weather with little rainfall will allow streams to clear and enable giggers to see fish.

Glossary

Alluvial soil: Soil deposits resulting directly or indirectly from the sediment transport of streams, deposited in river beds, flood plains, and lakes.
Aquifer: An underground layer of porous, water-bearing rock, gravel, or sand.
Benthic: Bottom-dwelling; describes organisms which reside in or on any substrate.
Benthic macroinvertebrate: Bottom-dwelling (benthic) animals without backbones (invertebrate) that are visible with the naked eye (macro).
Biota: The animal and plant life of a region.
Biocriteria monitoring: The use of organisms to assess or monitor environmental conditions.
Channelization: The mechanical alteration of a stream which includes straightening or dredging of the existing channel, or creating a new channel to which the stream is diverted.
Concentrated animal feeding operation (CAFO): Large livestock (ie. cattle, chickens, turkeys, or hogs) production facilities that are considered a point source pollution, larger operations are regulated by the MDNR. Most CAFOs confine animals in large enclosed buildings, or feedlots and store liquid waste in closed lagoons or pits, or store dry manure in sheds. In many cases manure, both wet and dry, is broadcast overland.
Confining rock layer: A geologic layer through which water cannot easily move.
Chert: Hard sedimentary rock composed of microcrystalline quartz, usually light in color, common in the Springfield Plateau in gravel deposits. Resistance to chemical decay enables it to survive rough treatment from streams and other erosive forces.
Cubic feet per second (cfs): A measure of the amount of water (cubic feet) traveling past a known point for a given amount of time (one second), used to determine discharge.
Discharge: Volume of water flowing in a given stream at a given place and within a given period of time, usually expressed as cubic feet per second.
Disjunct: Separated or disjoined populations of organisms. Populations are said to be disjunct when they are geographically isolated from their main range.
Dissolved oxygen: The concentration of oxygen dissolved in water, expressed in milligrams per liter or as percent.
Dolomite: A magnesium rich, carbonate, sedimentary rock consisting mainly (more than 50% by weight) of the mineral dolomite ($CaMg(CO_3)_2$).
Endangered: In danger of becoming extinct.
Endemic: Found only in, or limited to, a particular geographic region or locality.
Environmental Protection Agency (EPA): A Federal organization, housed under the Executive branch, charged with protecting human health and safeguarding the natural environment —air, water, and land —upon which life depends.
Epilimnion: The upper layer of water in a lake that is characterized by a temperature gradient of less than 1^{o} Celsius per meter of depth.
Eutrophication: The nutrient (nitrogen and phosphorus) enrichment of an aquatic ecosystem that promotes biological productivity.
Extirpated: Exterminated on a local basis, political or geographic portion of the range.
Faunal: The animals of a specified region or time.
Fecal coliform: A type of bacterium occurring in the guts of mammals. The degree of its presence in a lake or stream is used as an index of contamination from human or livestock waste.
Flow duration curve: A graphic representation of the number of times given quantities of flow are equaled or exceeded during a certain period of record.

Fragipans: A natural subsurface soil horizon seemingly cemented when dry, but when moist showing moderate to weak brittleness, usually low in organic matter, and very slow to permeate water.
Gage stations: The site on a stream or lake where hydrologic data is collected.
Gradient plots: A graph representing the gradient of a specified reach of stream. Elevation is represented on the Y-axis and length of channel is represented on the X- axis.
Hydropeaking: Rapid and frequent fluctuations in flow resulting from power generation by a hydroelectric dam's need to meet peak electrical demands.
Hydrologic unit (HUC): A subdivision of watersheds, generally 40,000-50,000 acres or less, created by the USGS. Hydrologic units do not represent true subwatersheds.
Hypolimnion: The region of a body of water that extends from the thermocline to the bottom and is essentially removed from major surface influences during periods of thermal stratification.
Incised: Deep, well defined channel with narrow width to depth ration, and limited or no lateral movement. Often newly formed, and as a result of rapid down-cutting in the substrate
Intermittent stream: One that has intervals of flow interspersed with intervals of no flow. A stream that ceases to flow for a time.
Karst topography: An area of limestone formations marked by sinkholes, caves, springs, and underground streams.
Loess: Loamy soils deposited by wind, often quite erodible.
Low flow: The lowest discharge recorded over a specified period of time.
Missouri Department of Conservation (MDC): Missouri agency charged with: protecting and managing the fish, forest, and wildlife resources of the state; serving the public and facilitating their participation in resource management activities; and providing opportunity for all citizens to use, enjoy, and learn about fish, forest, and wildlife resources.
Missouri Department of Natural Resources (MDNR): Missouri agency charged with preserving and protecting the state's natural, cultural, and energy resources and inspiring their enjoyment and responsible use for present and future generations.
Mean monthly flow: Arithmetic mean of the individual daily mean discharge of a stream for the given month.
Mean sea level (MSL): A measure of the surface of the Earth, usually represented in feet above mean sea level. MSL for conservation pool at Pomme de Terre Lake is 839 ft. MSL and Truman Lake conservation pool is 706 ft. MSL.
Nektonic: Organisms that live in the open water areas (mid and upper) of waterbodies and streams.
Non-point source: Source of pollution in which wastes are not released at a specific, identifiable point, but from numerous points that are spread out and difficult to identify and control, as compared to point sources.
National Pollution Discharge Elimination System (NPDES): Permits required under The Federal Clean Water Act authorizing point source discharges into waters of the United States in an effort to protect public health and the nation's waters.
Nutrification: Increased inputs, viewed as a pollutant, such as phosphorous or nitrogen, that fuel abnormally high organic growth in aquatic systems.
Optimal flow: Flow regime designed to maximize fishery potential.
Perennial streams: Streams fed continuously by a shallow water table an flowing year-round.

pH: Numeric value that describes the intensity of the acid or basic (alkaline) conditions of a solution. The pH scale is from 0 to 14, with the neutral point at 7.0. Values lower than 7 indicate the presence of acids and greater than 7.0 the presence of alkalis (bases).
Point source: Source of pollution that involves discharge of wastes from an identifiable point, such as a smokestack or sewage treatment plant.
Recurrence interval: The inverse probability that a certain flow will occur. It represents a mean time interval based on the distribution of flows over a period of record. A 2-year recurrence interval means that the flow event is expected, on average, once every two years.
Residuum: Unconsolidated and partially weathered mineral materials accumulated by disintegration of consolidated rock in place.
Riparian: Pertaining to, situated, or dwelling on the margin of a river or other body of water.
Riparian corridor: The parcel of land that includes the channel and an adjoining strip of the floodplain, generally considered to be 100 feet on each side of the channel.
7-day Q^{10}: Lowest 7-day flow that occurs an average of every ten years.
7-day Q^{2}: Lowest 7-day flow that occurs an average of every two years.
Solum: The upper and most weathered portion of the soil profile.
Special Area Land Treatment project (SALT): Small, state funded watershed programs overseen by MDNR and administered by local Soil and Water Conservation Districts. Salt projects are implemented in an attempt to slow or stop soil erosion.
Stream Habitat Annotation Device (SHAD): Qualitative method of describing stream corridor and instream habitat using a set of selected parameters and descriptors.
Stream gradient: The change of a stream in vertical elevation per unit of horizontal distance.
Stream order: A hierarchical ordering of streams based on the degree of branching. A first order stream is an unbranched or unforked stream. Two first order streams flow together to make a second order stream; two second order streams combine to make a third order stream. Stream order is often determined from 7.5 minute topographic maps.
Substrate: The mineral and/or organic material forming the bottom of a waterway or waterbody.
Thermocline: The plane or surface of maximum rate of decrease of temperature with respect to depth in a waterbody.
Threatened: A species likely to become endangered within the foreseeable future if certain conditions continue to deteriorate.
United States Army Corps of Engineers (USCOE) and now (USACE): Federal agency under control of the Army, responsible for certain regulation of water courses, some dams, wetlands, and flood control projects.
United States Geological Survey (USGS): Federal agency charged with providing reliable information to: describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect the quality of life.
Watershed: The total land area that water runs over or under when draining to a stream, river, pond, or lake.
Waste water treatment facility (WWTF): Facilities that store and process municipal sewage, before release. These facilities are under the regulation of the Missouri Department of Natural Resources.

Literature Cited

Anderson. C.L. 1980. *Best management practices for erosion and sediment control.* University of Missouri - Columbia Extension Division and Missouri Department of Natural Resources Manual 17.

Bachant, J.P., D.J. Witter and J.D. Martindale. 1992. *Ranking the recreational value and associated problems of Missouri's major watersheds.* Planning Section, Missouri Department of Conservation, Jefferson City, Missouri.

Carlander, K.D. 1977. *Handbook of freshwater fishery biology.* Volume 2. The Iowa University Press, Ames, Iowa.

Hanson, W.D. 1980. *Statewide watershed fishing pressure survey.* Final report Dingell- Johnson Project F-1-R-28, Study 1-22, Job No. 1. Missouri Department of Conservation, Jefferson City, Missouri.

Hauth, L.D. 1974. *Technique for estimating the magnitude and frequency of Missouri floods.* United States Geological Survey open-file report. Rolla, Missouri.

McCord, S. 1986. *Longitudinal and habitat-related effects of the distribution of fishes in the Whitewater River of Southeast Missouri.* Master's thesis. Southeast Missouri State University, Cape Girardeau, Missouri.

Missouri Department of Conservation. 1988. *Stream area program plan.* Fisheries Division (F. Ryck), Missouri Department of Conservation, Jefferson City, Missouri.

—1989. *Stream area acquisition plan.* Fisheries Division (L. Gann), Missouri Department of Conservation, Jefferson City, Missouri.

—1991a. *Rare and endangered species of Missouri checklist.* Missouri Department of Conservation, Jefferson City, Missouri.

—1991b. *Maintz demonstration farm area management plan.* Wildlife Division, Missouri Department of Conservation, Jefferson City, Missouri.

—1992. *Castor River state forest area plan.* Forestry Division, Missouri Department of Conservation, Jefferson City, Missouri.

—1993a. *Streams frontage acquisition plan.* Fisheries Division (J. McPherson), Missouri Department of Conservation, Jefferson City, Missouri.

—1993b. *Amidon memorial conservation area plan.* Forestry Division, Missouri Department of Conservation, Jefferson City, Missouri.

—1993c. *Guidelines for managing wetlands for fisheries resource benefits.* Fisheries Division (R. Dent), Missouri Department of Conservation, Jefferson City, Missouri.

Missouri Department of Natural Resources. 1981. *(Code of State Regulations) Rules of the Department of Natural Resources. Division 20, Clean Water Commission, Chapter 7, Water Quality.* 10 CSR 20-7.031 Water Quality Standards. Missouri Secretary of State, Jefferson City, Missouri.

—1984. *Missouri water quality basin plans.* Volume 5. Meramec, Whitewater and Castor River, Mississippi River, Joachim, Plattin, Establishment, Cinque Hommes and Apple Creeks. Missouri Department of Natural Resources, Jefferson City, Missouri.

—1986a. *Missouri water atlas.* Missouri Department of Natural Resources, Jefferson City, Missouri.

—1986b. *Missouri water quality report 1986.* Missouri Department of Natural Resources Water Pollution Control Program, P.O. Box 176, Jefferson City, Missouri.

Leatherberry, E.C. 1990. *Timber resource of Missouri's eastern Ozarks.* Resource Bulletin NC-115, United States Department of Agriculture, Forest Service, North Central Forest Experiment Station, St. Paul, Minnesota.

Lemons, R.M. 1989. *Cape Girardeau-Bollinger Counties, Missouri: Feasibility report on a proposed recreational reservoir.* Freese and Nichols, Engineering Consultants. Dallas, Texas. Little River Drainage District. 1989. The Little River Drainage District of southeast Missouri: 1907-present. Little River Drainage District, P.O. Box 159, Cape Girardeau, Missouri.

Oesch, R.D. 1984. *Missouri naiades, a guide to the mussels of Missouri.* Missouri Department of Conservation, Jefferson City, Missouri.

Pflieger, W.L. 1975. *The fishes of Missouri.* Missouri Department of Conservation, Jefferson City, Missouri.

Pflieger, W.L., P.S. Haverland and M.A. Schene, Jr. 1981. *Missouri's system for storage, retrieval and analysis of stream resource data.* Pages 248-290 in N.B. Armantrout, editor.

Acquisition and utilization of aquatic habitat inventory information symposium. American Fisheries Society. Bestheda, Maryland.

Pflieger, W.L. 1989. *Aquatic community classification system for Missouri Aquatic Series Number 19.* Missouri Department of Conservation, Jefferson City, Missouri.

Pflieger, W.L. 1991. *Guidelines for obtaining fish collections for use in faunal studies of Missouri fishes.* In-house publication. Missouri Department of Conservation, Jefferson City, Missouri.

Soil Conservation Service. 1981. *Soil survey of Cape Girardeau, Mississippi and Scott Counties, Missouri.* United States Department of Agriculture, Soil Conservation Service. Columbia, Missouri.

—1986. *Soil survey of Perry County, Missouri. United States Department of Agriculture, Soil Conservation Service.* Columbia, Missouri.

—1991 (In Press). *Soil survey of Bollinger County, Missouri.* United States Department of Agriculture, Soil Conservation Service. Columbia, Missouri.

Skelton, J. 1970. *Base-flow recession characteristics and seasonal low-flow frequency characteristics for Missouri streams.* Missouri Geological Survey and Water Resources, Water Report 25. Missouri Geological Survey, Rolla, Missouri.

United States Army Corps of Engineers. 1975. *Report on the navigability status of the Little River Diversion channel, Missouri, and its three major tributaries: Castor River, Crooked Creek, and Whitewater River.* United States Army Corps of Engineers, St. Louis District. St. Louis, Missouri.

United States Department of Agriculture/Soil Conservation Service. 1981.*Watersheds in Missouri, based on Water Resource Council hydrological units.* United States Department of Agriculture, Soil Conservation Service. Columbia, Missouri.

United States Geological Survey. 1991. *Water resources data, Missouri water year 1991.* United States Geological Survey Water-Data Report MO-91-1. United States Geological Survey. Rolla, Missouri.

Weithman, S.A. 1991. *Recreational use and economic value of Missouri fisheries.* Final Report, Dingell-Johnson Project F-1-R-40, Study SI-1. Missouri Department of Conservation, Jefferson City, Missouri.

List of Tables

Table 26. Fishes, naiades and crayfishes, collected in the Headwater Diversion Basin, that tend to inhabit wetlands during part of their life cycle. (MDC 1993c)

List of Figures