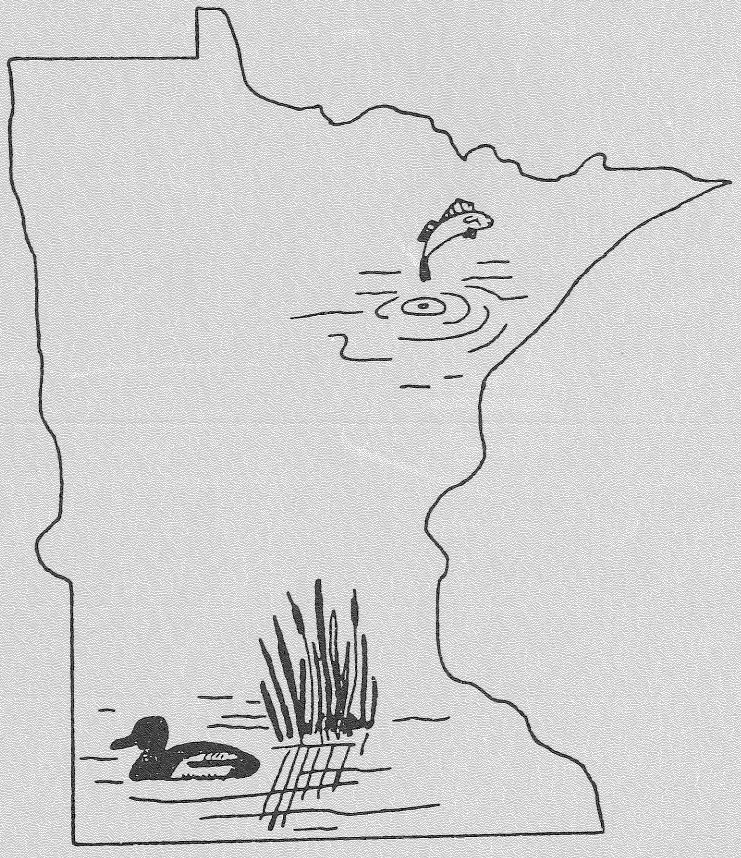
Fish and Wildlife Resources of the St. Louis River



Minnesota Department of Natural Resources
Division of Fish and Wildlife
Ecological Services Section

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FISH AND WILDLIFE SURVEY OF THE ST. LOUIS RIVER

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By

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Figure 1. A rapids where the water is confined to a narrow channel in the Upper St. Louis River between Seven Beaver Lake and the Partridge River.

SUMMARY

Excepting for a short distance in Brookston and near Floodwood the rivers shoreline was wooded. Excepting localized areas the St. Louis River can be navigated by canoes and similar small boats from near the mouth of the Partridge River to Cloquet and in the estuary downstream from the Fond du Lac bridge.

The principal species of fishes in the St. Louis River were walleye, northern pike, channel catfish, northern redhorse, and common suckers. Black bullheads were caught in the lake like pools of the upper reach and in the estuary. There was an abundance of young-of-the-year yellow perch in the estuary. Carp were caught only in the estuary. Most of the waterfowl were observed in the upper reach, between Floodwood and Cloquet, and in the Thomson Reservoir. Signs of Aquatic furbearers and upland wildlife were commonly observed between the rivers source and Cloquet.

One of the outstanding features of the St. Louis River System is that it supports a wide variety of fish, northern woodland and aquatic wildlife. This variety is related to the wide range of habitat available to the animals. Many of the smaller tributary streams support populations on coldwater flora and fauna. The St. Louis River and the larger rivers support warm water fish populations, a variety of mammals that use the waterways and adjacent woodlands are present, and waterfowl are abundant where aquatic plants are present. Throughout the length of the river there is a considerable difference in the density of animals and the type of habitat available for them. The type of habitat is largely related to the topography of the adjacent lands. There are six natural river segments that are related to the topography.

In the headwaters area above the mouth of the Partridge River (Sector 5) the river flows through a series of parallel ridges that decrease in elevation from east to west with the western extent of the ridges being east of the mouth of the Partridge River. Much of the river here is a series of steep boulder rapids and large pools with dark bog stained, soft water, and good aquatic plant growth, including wild rice beds in the shallower waters. The pools have good populations of fish including northern pike. There are active beaver colonies in the stream between the large pools. Several black ducks were observed in the large pools near the beds of aquatic plants. In the low-

lands between the ridges, the land is wet and is covered with brush in the lowest areas near the river. Black spruce, ash, and other wet trees tolerant of wet soils are present between the upland ridges and lowland brush.

From the mouth of the Partridge to the dam near Forbes, the characteristics of the land are quite different. Except for an occasional farm or dwelling most of the land is forested, usually aspen and birch on dryer land and spruce ash, and or fir in the lower areas. Much of the uplands are flat and the river meanders through a shallow sandy floodplain with many cutoff oxbows. The river is clear, has harder water, much less bog stain, and sandy eroding banks. Larger sized fish species are present in the occasional pools below rapids and where brush and trees are present. A few mergansers (fish ducks) and signs of aquatic upland mammals such as beaver, mink, deer, bear, otter, and woodchuck were observed. Several schools of minnows and several wood turtles were sighted where the river has many meanders.

Starting above Forbes the river enters a narrow valley dominated by hardwoods with some conifer stands. Between Forbes and the mouth of the Swan River the river has many bends. No oxbows are present, but there are many rocky rapids and sandy pools with few aquatic plants which have good fish populations.

Below the mouth of the Swan River to the Whiteface River mouth, the river still flows through the deep narrow valley, but the river is fairly straight and has very little gradient so it has few pools, riffles or rapids. Much of the land is forested, but the amount of farmland increases as the St. Louis approaches the mouth of the Whiteface River. Where deep pools are present, especially below rapids, good populations of fish (including cutfish walleye, and northern pike) were present. Few fish are present in the long straight sections of channel. Except for some mergansers, few ducks and submerged aquatic plants are present. Tracks or signs of bear, deer, beaver, otter, were commonly observed. Deer, grouse, woodchucks, and a muskrat were observed.

The next reach of river extends from the mouth of the Whiteface River to Cloquet. For a short distance from near the mouth of the Whiteface River to Floodwood the river flows through a flat featureless area where three major tributaries, the Whiteface, Floodwood, and Savanna Rivers enter. Then the river drops rapidly through a series of boulder rapids into a deep broad valley. Good populations of fish, including walleye, catfish, and northern

pike were present in pools below rapids where boulders were present and were least abundant along straight shallow stretches with sandy shores. Beds of submerged aquatic plants such as wild celery and river pondweed were observed in many areas. Several groups of ducks including bluewinged teal, mallards, and blackducks were observed. Muskrat, porcupine, deer tracks, and raccoon tracks were observed. This area has a considerable amount of farmland interspersed with woodlands near the river. Pasture and hayland dominate, but some row crops and small grains are raised.

The most scenic and most modified reach of river extends from Cloquet to the Fond du Lac bridge. The river drops rapidly over bedrock to the estuary in a gorge where rock outcrops occur commonly. Five power dams create pools of varying size. Jay Cooke State Park is located on the lower part between the Thomson and Fond du Lac dams. Pollution has altered the fish population to the extent that it is primarily composed of white suckers where minimal amounts of dissolved oxygen are present. A large number of mallards were using Thomson Reservoir which is shallow and has beds of aquatic plants. Bald eagles are frequently sighted near Fond du Lac Reservoir in Jay Cooke park.

Below the Fond du Lac bridge the St. Louis River winds through a broad estuary in a deep, more or less distinct channel, to the inner harbor where water depths and the shoreline have been modified considerably. The outer harbor is protected by a long bar that has two entrances to Lake Superior, a ship canal in Duluth and the easterly entrance near Superior Wisconsin. The upper part of the estuary has some game fish and large but variable populations of black bullheads and young-of-the-year yellow perch. Some carp were caught in the estuary. Sampling in the lower part of the estuary indicated that good populations of northern pike and walleyes and young-of-the-year perch were present. From below the Fond du Lac bridge to the Oliver Bridge some large beds of wild rice were observed. Some waterfowl were observed utilizing various parts of the estuary.

Figure 2. A long and wide boulder high gradient rapids in the Upper St. Louis near Skibo. There are several similar rapids above the mouth of the Partridge River.

Figure 3. Low area on the river bank where the St. Louis River meanders between the Partridge and Embarrass River. Note the brush in the river.

Figure 4. A typical straight reach of the St. Louis River with poor substrate and little cover.

Figure 5. A straight low gradient reach of the St. Louis in the bed of glacial Lake Upham with rocky bottom, but no pools or rapids are associated rocky soils.

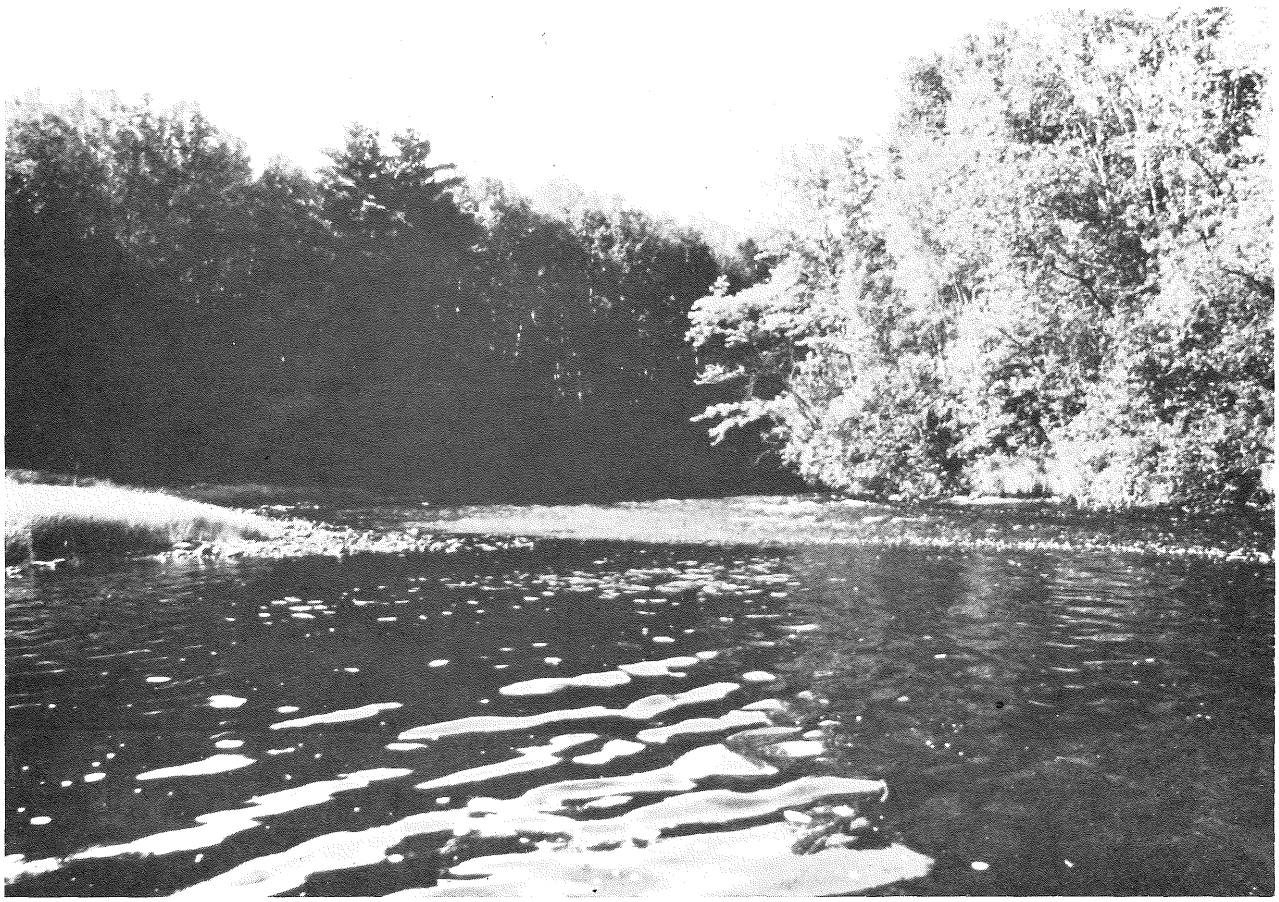

Figure 6. One of the few small rapids where the St. Louis River flow through the deposits of Glacial Lake Upham (upstream view).

Figure 7. Mouth of the Whiteface River near Floodwood.

Figure 8. A small falls between the Scanlon dam and Thomson dam.

Figure 9. Note the small amount of water in the St. Louis River in Jay Cooke State Park after the water has been diverted for hydroelectric power at the Thomson Reservoir.

Figure 10. Fond du Lac dam impoundment.

Figure 11. Fond du Lac dam.

Figure 12. Rock outcrops in the St. Louis River below the Fond du Lac dam tailwaters.

Introduction

One of the most unusual rivers in the state is the St. Louis River. Its source is about 60 miles north of its mouth and it flows 179 miles through forested land to its mouth in Lake Superior. Above Cloquet which is 20 miles from the estuary there are two towns on its banks, Brookston and Floodwood. Several of the Iron Range towns are located in the northern part of its watershed, but are not near the river. There are a few farms near the river, but most of the river's banks are wooded. Many of the farms are located in the western and southern part of the watershed near Meadowlands, Floodwood, and Brookston. There is a considerable amount of flat land in the central part of the watershed which was the bed of a glacial lake that drained into Glacial Lake Duluth. The St. Louis River uses the same outlet to drain into Lake Superior.

Except for the dam and impoundment near Forbes, the river's course has not been modified above Cloquet, but below Cloquet there are five impoundments that alter the physical characteristics of the St. Louis River. St. Louis Bay has been altered considerably by the construction of boat piers and other waterfront structures. The dams in and below Cloquet are used to produce electricity and wood processing industries are located near the river.

Several surveys have been conducted on the St. Louis River. The most extensive survey was completed by Moyle in 1947. Below Cloquet the river has had a long history of severe problems. The most extensive public health department investigation was completed in 1948 and since then there have been many investigations of special problems and the water quality samples have also been collected for many years.

In 1968 and in 1976-1977 the Department of Natural Resources surveyed the river, and this report summarizes the information collected. In 1968 information on water quality, fish by trapnetting, and river characteristics was collected. In 1976 and 1977 there was an extensive reconnaissance and an electrofishing survey of the river. This report summarizes the 1968 and 1976 - 1977 data collections. In 1974 the river was also seined with a 100 foot bag seine at several locations where it was seined in 1941, and the reservoirs

were also sounded in 1974. In 1968 the river was sampled with the type of trap-nets used in lake surveys, and in 1976 and 1977 the fish were sampled with Smith-Root type electrofishing gear.

In 1968 the water sent to the laboratory was analyzed for the nitrogen phosphorous sulphates, total alkalinity, Ph, and total iron. In 1976 and 1977 the conductivity, temperature, water transparency (secchi disc - ft.), and other physical measurements were made at several locations.

There is a considerable amount of public land in the rivers watershed, but much of the land near the river is privately owned. Most of the upper reach of the river is public land and within the Superior National Forest. There is some public land along the river between Cloquet and the Partridge River. Jay Cooke State Park is located on the St. Louis River below the Thomson Reservoir.

The river was divided into the 6 following reaches: A. The estuary which extends from the Fond du Lac bridge downstream, B. Sector I extends from the Fond du Lac highway 23 bridge to the highway 33 bridge in Cloquet, C. Sector II extends from Cloquet to the Junction of the Whiteface River, D. Sector III extends from the Whiteface River junction to the dam near Forbes, E. Sector IV extends from the dam near Forbes to the junction of the Partridge River, and F. Sector V extends from the Junction of the Partridge River to the Rivers source of Seven Beaver Lake. The river miles were numbered upstream from the Fond du Lac bridge, because there was no general agreement as to the distance the river flows from the Fond du Lac bridge to Lake Superior.

Access

Between Highway 53 and Cloquet there are 8 designated access points, mostly used by canoes. The river is accessable to some degree at most road crossings. Above highway 53 there is a designated access at the Norway Point campgrounds. At the Fond du Lac Bridge there is a park. Only portions of the river can be navigated by canoe above the mouth of the Partridge River. Except for a portage around the dam near Forbes the St. Louis River is navigable by canoe from the mouth of the Partridge River to Highway 33 at Cloquet. Below Cloquet only the impoundments and river pools can be navigated by boat. From the Fond du Lac bridge downstream the river is navigable by boat. Above Cloquet power boats can only be used in restricted areas. (See Table 2).

Table 1. Land Use Along the St. Louis River Corridor in 1977

Location	Sector No.	Farmland	Woodland	Marsh	Other
Estuary to Cloquet	1		70	15	15[1/]
Cloquet to Whiteface R.	2	8	90		
Whiteface R. to Forbes Dam	3	10	90		
Forbes Dam to Partridge R.	4	5	90		5[2/]
Partridge R. to Seven Beaver Lake	5				
Below Skibo Mill site			95	5	
Above Skibo Mill site			30	5	60[3/]

1/ Towns

2/ Misc.

3/ Shrub bog

Table 2. Access Points on the St. Louis River

Miles From Fond du Lac Bridge	Location		Quality of Access
	T.R.S.	Description	
0	48-15-7	State Highway No. 23	Good
6.3	48-16-9	Fond du Lac State Park swinging bridge off State Highway No. 39	Fair
8.5	48-16-5	Thomson Bridge parking lot at County State Aid Highway No. 1	Poor
11.4	49-16-30	U.S. Highway No. 61	Fair
14.5	49-17-14	Park, picnic area with boat landing in Cloquet - State Highway No. 33	Good
27.7	50-18-2	Canoe access - U.S. Highway No. 2	Good
30.9	51-18-27	Brookston boat landing and park on County State Aid Highway 31	Good
38.3	51-19-28, 29	County Road 844 at Poupores	Fair
48.6	51-20-8	Historic wayside park at U.S. Highway No. 2 via Savanna River	Good
48.8	51-20-5	Floodwood City Park via Floodwood River	Good
49.1	51-20-5	County State Aid Highway 8 Bridge	Fair
54.0	52-20-24	Canoe access off Highway 29	Good
56.5	52-20-13	County State Aid Highway 29 Bridge	Fair
62.1	53-19-17, 20	County State Aid Highway 133	Poor
64.9	53-19-5	County Road No. 156	Fair
68.8	54-19-8	Designated canoe access - County State Aid Highway 52	Good
72.7	55-19-29	County Road No. 92	Fair
78.3	55-19-10	County Road No. 436	Fair
85.1	56-18-29	County State Aid Highway 27	Fair

Table 2 Continued.

Miles From Fond du Lac Bridge	Location		Quality of Access
	T.R.S.	Description	
88.3	56-18-19	County Road 312	Fair
96.8	56-18-3	Designated canoe access - County State Aid Highway 7 south of Forbes	Good
98.6	56-18-2	Designated access below dam	Fair
102.7	56-17-4, 5	Designated public boat landing at end of County Road No. 387	Good
105.6	56-17-2	County Road No. 957	Fair
112.4	57-16-21	County State Aid Highway 95	Fair
114.8	57-16-15	County State Aid Highway 108	Fair
117.8	57-16-12	County State Aid Highway 4	Fair
121.1	58-16-36	County Road No. 657	Fair
127.5	58-15-22	County State Aid Highway 100	Fair
127.8	58-15-22	Side road off of County State Aid Highway 100	Good
	58-14-33	County Road 346	Good
137.2	57-14-8	Norway Point Campground road from County Road No. 346	Good
144.8	58-13-30	Skibo Lookout Road	Good
151.7	58-13-36	Skibo Mill Road from Skibo	Fair

Physical Characteristics of the River and its Watershed

General Characteristics

Most of the St. Louis River Basin is located in the southern part of St. Louis County and smaller portions are located in Lake, Itasca, Aitkin, and Carlton counties in Minnesota. Part of the estuary is located in Douglas County in Wisconsin. Since very high ranges of hills of igneous rock covered with red glacial drift are present on the watersheds boundary to the east and north, the river flows in a circuitous course to its outlet in Lake Superior at Duluth in the southeastern part of the watershed. At its source in the hills in the northeast part of the watershed, the St. Louis River flows westward out of the red glacial drift into the gray drift which contains the bed of Glacial Lake Upham. Then the St. Louis River flows through the glacial lake bed near its northern and western sides and turns eastward near Floodwood. Below Floodwood it enters a well defined valley which winds through red drift morains and rock outcrops to its mouth near the southern end of the eastern range of hills.

The St. Louis River drops 1067 feet from its source at Seven Beaver Lake, elevation 1669 feet, and flows 179 miles to the estuary at Lake Superior, elevation 602 feet. There is 21 miles of channel which winds through the estuary to the rivers normal outlet between Minnesota and Wisconsin Points. From its source to the estuary the river has an overall gradient of 6.0 feet per mile. The highest gradients occurred between Seven Beaver Lake and the Partridge River, 8.4 feet per mile in 34.5 miles, and between Cloquet and the estuary, 29.1 feet per mile in 19.9 miles. About 81 percent of the river's decrease in elevation occurs in 30 percent of its course. Over 59 percent of its length the river has a gradient of 1.8 feet per mile. Above its junction with the Whiteface River, 10 percent of its length, the river has a low gradient of 0.6 feet per mile. (Table 3).

Where dams are present there is a reduction in the streams gradient. When the height of the dams is deducted from the total elevation decrease, the river's gradient from the Partridge River to the dam near Forbes is reduced from 2.1 to 1.5 feet per mile, and from 29.1 to 13.8 feet per mile from Cloquet to the estuary. (Table 4).

Throughout its length there are a variety of river channel characteristics that are related to the differences in topography. Where the river flows south in the bed of Glacial Lake Upham the river has a low sinuosity, gradient, a deep valley, few riffles and rapids, and clay soils dominate the uplands. In contrast where the river flows west through the glacial lake the river has a higher sinuosity and gradient, is entering the deep narrow valley, and has a number of riffles and rapids.

The source of the St. Louis River, Seven Beaver Lake, is a collecting basin for several streams. The St. Louis River then flows downstream from Seven Beaver Lake to the mouth of the Partridge River over a series of boulder rapids and through several large pools. The river winds westward through gaps in a series of ridges 100 to 150 feet high on their western slopes. The ridges gradually decrease in elevation westward and have rocky surface soils derived from the red glacial drift. Between the ridges there is a considerable amount of low wet marsh and forest. The longest boulder rapids are located where the river goes through ridges, and the large pools (natural impoundments) are located in the flat land between the ridges.

Between the rapids above the mouth of the Embarrass River and two miles below the mouth of the Partridge River, the St. Louis River has a very low gradient, and meanders through a sandy flood plain about 20 feet deep and 2000 feet wide containing oxbow ponds. The adjacent relatively flat land has soils derived from the gray glacial drift. The river's channel is sandy and meanders through a flat countryside to the mouth of the Embarrass River. Downstream from the mouth of the Embarrass River to the dam at Forbes, the river doesn't meander, but much of the channel is quite sandy.

From below the dam at Forbes to the mouth of the East Swan River, the river's channel meanders considerably and has several riffles and rapids. Between the mouths of the East Swan River to the mouth of the Whiteface River, there are few bends in the river and it flows through the clay deposits of a glacial lake bed. Shores tend to be sandy on inside bends and clay on outside bends. The river's channel is a series of bends, rapids, and long straight reaches from the mouth of the Whiteface River to Cloquet.

From Cloquet to the estuary the river flows over rocky ledges, through five reservoirs, around the end of the igneous rocks that form the eastern edge of the watersheds boundary, and decends rapidly in a valley that becomes deeply entrenched into bedrock composed of layers of sandstone and shale. Between the Thomson Reservoir and the Fond du Lac Reservoir the river is very narrow where it flows through a gap in the bedrock and a very wide rapids where it flows over bedrock in Jay Cooke State Park.

Flow Characteristics

The average flow in the St. Louis River at Scanlon is 2284 c.f.s. and the median flow is 1250 c.f.s. The ordinary median low flow at Scanlon is about 465 c.f.s. or about 20 percent of average flow, and the ordinary high flow is about 6.4 times higher than the average flow. At Forbes above the junction of several large tributaries such as the Cloquet and Whiteface Rivers, the average flow is 567 c.f.s. Near Aurora below the mouth of the Partridge River the average flow is 247 c.f.s. (median 91 cfs), the ordinary low flow is about 21 c.f.s. or 8 percent of average flow, and the ordinary high flow is about 5.3 times higher than average flow. The drainage area of the major tributaries combined (Cloquet and Whiteface Rivers) is about 1400 square miles which have an average flow about 900 to 1000 c.f.s. which is regulated by reservoirs. Niether of these rivers has a gauging station. (Table 5).

At Scanlon the average 1976 flow was 64 to 69 percent of normal average flow, 39 to 51 percent of normal in July, 11 to 18 percent of normal in August, and 8 to 20 percent of normal in September. At Scanlon the effect of the late summer discharges from the reservoirs in the Whiteface and Cloquet River is evident. Flows at Scanlon in July were relatively lower and higher in August and September than they were at upstream gauging stations. The median low flow from 1909 to 1978 which includes data from several dry years was 20 percent at Scanlon and 8 percent near Aurora which is similar to the 1976 low data. (Table 6).

While only one dam breaks the free flowing character of the upper St. Louis River, at and below Cloquet, there are several large impoundments and some of the major tributaries have reservoirs that regulate and/or influence the rivers flow. The impoundments on the Cloquet and Whiteface River systems are used by the

Minnesota Power and Light Company to supply water to their hydroelectric plants on the St. Louis River below Cloquet. None of these plants have reservoirs with a large storage capacity. At average flow the average water retention time is less than one day, and at low flow its ordinarily less than 3 days. At low flow, sufficient water is released from the reservoirs on the Whiteface and Cloquet Rivers to generate power at the hydroelectric plants. At low flow there is very little water in the channel between the Thomson Dam and the Fond du Lac Reservoir.

The reservoirs that supply water to the hydroelectric plant have a combined storage capacity of 332,160 acre feet. The mining companies have 4 reservoirs associated with the Partridge River system. The minimum monthly flow in the St. Louis River below the Partridge River was in September 1976 and was 20 cfs, 8.1% of the average flow. In September 1976 the minimum monthly flow below the dam at Forbes was 49.1 cfs or 8.7% of average flow. At Scanlon the minimum monthly flow was in August at 18.4 percent of average flow, and the yearly average flow in the 1975-1976 water year was 69 percent of overall average flow.

Width and Depth Characteristics

In an ordinary section of channel from its source to the mouth, the width of the St. Louis River increases from about 60 feet to 260 feet. Significant increases in width were apparent at Forbes (width 100 feet), and below Floodwood (width 260 feet). In the channel the average depth increased from about 2 feet in the upper reaches to 3.7 feet above Cloquet. Only a short stretch of the river below Cloquet (between the Fond du Lac Dam and the estuary) approaches being an ordinary section of river channel, and has widths similar to these observed above Cloquet. Between its source and the mouth of the Partridge River, the river's width is quite variable, wide in the pools (natural impoundments) and narrow in the rapids and runs connecting the pools.

While the average depths increase going downstream the average maximum depths only varied from 4.1 to 4.8 feet with average maximum being 4.7 feet throughout its length in July 1977. About half (47.8% - range 42.9 to 57.9) of the maximum depth measurements ranged between 2.6 and 5.0 feet, 19.8 percent were less than 2.6 feet, 27.5 percent were 5.1 to 10 feet, and 4.9

percent were more than 10 feet. From Floodwood to Cloquet and Forbes to the E. Swan River the distribution of maximum depths was nearly normal, but above the impoundment at Forbes and between the E. Swan and Whiteface Rivers a considerable portion (27 to 29%) of the river was shallower than 2.6 feet. (Table 8).

Most of the riffles and/or rapids occur where stream gradients are high, and few rapids and riffles are present where gradients are low. The following equation expresses the relationship between river gradient and amount of riffles and rapids over short stretches of river where coarse substrate is present: $y=3.91x + 1.43$ at $r=0.97$, where $y=$ the percent riffle and rapids and $x=$ the rivers gradient expressed as feet per mile. The percentage of riffles and rapids is about four times the gradient, except where a large amount of rocks are present. Even where rocky substrates are present, rapids or riffles are absent if the river gradient is low and/or the river is wider in shallow areas. A narrowing of the channel to 75 percent (range 65 to 85) of its ordinary width was associated with the presence of riffle or rapids in shoals in July 1977.

Low gradient straight reaches of the St. Louis River have an unchanging appearance which is related to their low sinuosity. I contrast where there are many bends both shoals and deep river bend pools occur commonly, and where gradients are high, riffles, rapids, and pools occur. There are three basic relationships that apply to these observations; (1) the percentage of riffles and rapids is proportional to the rivers gradient $r=0.97$, (2) the depth is inversely proportional to the width $r=0.79$, and (3) the variation in depth increases as the sinuosity increases $r=0.81$.

Table 3. Physical characteristics of the various reaches of the St. Louis River (length, gradient, and width)

Location	Approximate Elevation Difference (Feet)	Vertical Drop at Dams (Feet)	Miles of River	River Gradient (ft./mile)		Width (Feet)	
				Original	Present	Channel	Natural or Artificial Impoundments
Seven Beaver Lake to Partridge R.	289	0	34.5	8.38	8.38	80-160	250-590
Partridge R. to dam near Forbes	75	20	36.0	2.10	1.53	80-145	90-128
Dam near Forbes to E. Swan River	60	0	28.7	2.09	2.09	80-135	---
E. Swan River to Whiteface River	11	0	18.4	0.60	0.60	75-140	---
Whiteface River to Cloquet (Hwy 33)	55	0	41.3	1.33	1.33	160-240	---
Cloquet (Hwy 33) to Estuary (Hwy 23)	577	184	19.9	29.1	13.8	80-1000 1/	153-3700 2/
Estuary	Nil	0	20.8 3/	Nil	Nil	360-480	500-8000
Total							

1/ 176 to 200 above estuary to Fond du Lac dam.

2/ In the Thomson Reservoir the maximum width is about 3700 feet. In other reservoirs the maximum width is about 800 feet.

3/ From the highway 23 bridge its 5.1 miles to Oliver Bridge, 12.8 miles to the Arrowhead Bridge, 15.7 miles to the outer harbor, and 20.8 miles to Minn.-Wisc. point entrance via the river channel.

Table 4. Length, gradient, amount of reservoir and soil characteristics of various reaches of the St. Louis River.

Location	Miles	Gradient (ft. mile) 3/	Riffles and Rapids (pct. coarse soils)	Pools, Runs, and Reservoirs				
				Reservoir (pct. of River reach)	Fine textured soils (sand, silt, clay as pct.)	Sand with boulders or rubble (pct.)	Coarse Soils (pct.)	Total (pct.)
Estuary	20.8	Nil	0.0	0.0	100	0.0	0.0	100
Estuary to bridge at Cloquet	19.9	29.1 (13.8)	48.1 1/	42.3	0.0	0.0	9.6	51.9
Cloquet to Whiteface R.	41.3	1.3	15.4	0.0	61.5	4.3	18.8	84.5
Whiteface R. to E. Swan R.	18.4	0.60	7.9	0.0	84.3	5.8	2.0	92.1
E. Swan River to dam near Forbes	28.7	2.09	29.6	0.0	70.0	0.0	1.4	71.4
Dam near Forbes to Partridge R.	36.0	2.10 (1.53)	8.9	23.2	66.1	1.8	0.0	91.1
Partridge R. to Seven Beaver Lake	34.5	8.38	37.5	0.0	-- 2/	--	--	62.5
Whole River	199.6	5.30 (3.73)	21.0	8.4	62.4	2.0	6.11	79.0

1/ Outcrops of bedrock present.

2/ A majority of the large pools have a layer of organic soils on the bottom. Sometimes the layer is thin. Small pools have rocky bottoms.

3/ Dams have reduced gradient to figure indicated by parenthesis.

Table 5, Flow characteristics of St. Louis River for years of record.

Location	Runoff (in.)	Average Flow C.F.S.		Drainage Area Sq. Mile	Extreme Discharges	
		Total	Sq. Mile		Minimum (cfs)	Maximum (cfs)
Below Partridge River	11.53	247	0.85	291	4	5,380
Near Forbes	---	567	0.80	713	25	5,610
Scanlon	9.04	2284	0.67	3,430	80	37,900

Table 6. Flow characteristics of St. Louis River in 1976, a low water year.

Location	Water Year (Oct. 1975 - Sept. 1976)						
	Runoff (in.)	Discharge as C.F.S. and percent ( ) of ordinary average					
		Maximum	Average	Minimum	July	August	September
Below Partridge River	8.78	1,980	166 (67)	16 (6.4)	127 (51)	27.6 (11.1)	20.1 (8.1)
Near Forbes	6.94	2,910	364 (64)	33 (5.7)	274 (48)	77.2 (13.6)	49.1 (8.7)
Scanlon	6.21	12,600	1589 (69)	260 (11.4)	893 (39.1)	422 (18.4)	478 (20.9)

Table 7. Widths, depths, and water velocity in St. Louis River at low flow, July 1976, by type of channel character (pool, sandy run, riffle, rapids)

Location	Volume		Velocity (ft./sec.)		Ave. Depth (ft.)	Width (ft.)	Channel Character
	C.F.S.	Pct. of Ave.	Max.	Ave.			
Below Partridge R.	127	51	0.5	0.47	3.6	75	Pool
	127	51	1.0	0.90	2.0	71	Sandy run
	127	51	1.5	1.35	2.0	46	Riffle
	127	51	2.2	1.76	1.5	48	Rocky rapids
Below Forbes	274	48	0.5	0.47	4.6	127	Pool
	274	48	1.0	0.90	3.0	102	Sandy run
	274	48	1.5	1.35	3.0	67	Riffle
	274	48	2.2	1.76	2.5	62	Rocky rapids
Above Cloquet	893	40	0.5	0.47	5.2	366	Pool
	893	40	1.0	0.90	3.7	258	Sandy run
	893	40	1.5	1.35	3.7	179	Riffle
	893	40	2.2	1.76	2.8	180	Rocky rapids

Table 8. Distribution of maximum river depths in the St. Louis River in July in 1978 from the source to Cloquet.

Maximum Depth Range Feet	Above Forbes	Forbes to E. Swan River	E. Swan R. to White-face River	Whiteface R. to Floodwood R.	Floodwood R. to Cloquet	Combined
1-2.5	27.2	24.0	28.8	2.6	18.1	19.8
2.5-5.0	54.6	44.8	46.5	42.9	57.9	47.8
5.1-7.5	18.2	13.0	16.5	23.4	12.0	15.8
7.6-10.0		12.3	5.5	23.4	8.4	11.7
10.1-13.0		5.8*	2.7	7.8	3.6	4.9
Mean-(Max.)	4.1	4.8	4.1	6.1	4.4	4.7

*Includes a 15 foot and 17 foot depth

Table 9. Physical characteristics of the St. Louis River in 1968 during the summer survey.

Location (Date)	Width (ft.)	Ave. Depth (ft.)	Surface Velocity (ft./sec.)	Temp (^{o}F) Air	Temp (^{o}F) H_2O	Time	Bottom	Remarks:
Below Thomson Dam (9-9-68)								
Pool	50	--	--	59	55	--	Ledge rock	Pool max. depth 17.2 ft.
Outlet	10	2.0	0.5					Note outflow is dam seepage, high water line 12 ft., 12.8 depth in channel, banks 50 ft. or more of ledge rock, channel ledge rock and boulders.
1.5 miles above Hwy 33 (8-30-68)	160	--	--	--	--	--	Sand rubble	Max. depth 8.1, backwater 2.3 ft., floating leaf pondweed, burreed, 6ft. banks.
Below White Pine R. (8-30-68)								
2.2 Miles	--	3.2	--	--	--	--	Sand rubble	River pondweed.
0.5 Miles	360	--	--	--	--	--		Maximum 6 ft.
Brookston (8-14-68)	200	5.0	--	63	68	--	Sand rubble	Color - dark brown, arrowhead, needle rush, claspingleaf pondweed, smartweed.
Paupores Rd. 844 (8-12-68)	190	4.5	0.2	69	71	1400	Sand rubble boulders	Arrowhead, claspingleaf pondweed, burreed, color - dark brown.

Table 9 Continued

Location (Date)	Width (ft.)	Ave. Depth (ft.)	Surface Velocity (ft./sec.)	Temp (^{o}F) Air	Temp (^{o}F) H_2O	Time	Bottom	Remarks:
Floodwood (8-8-68)	200	5.0	0.8	71	73	1145	Sand, some rubble	Arrowhead, color - dark brown
Bridge above jct. of Whiteface Hwy 29 (8-5-68)	145	1.5	2.2	76	71	1430	Boulder rubble	Arrowhead
Road 156 (8-9-68)	120	7.0	0.8	62	67	1100	Sand	Arrowhead, water dark brown
Road 52 West of Cotton (8-2-68)	130	1.0	2.2	72	69	1500	Rubble sand	Arrowhead, green algae
Road 92 East of Sax (7-31-68)	110	2.5	2.2	62	67	1430	Rubble sand	
Road 456 (7-28-68)	95	3.0	1.8	61	57	1430	Sand	Arrowhead
Road 27 (7-28-68)	95	2.5	2.2	64	65	1115	Rubble	Arrowhead, color - dark brown
Road 312 (7-24-68)	140	3.5	1.7	71	72	1600	Sand gravel	Arrowhead, cut grass
Above East Two Rivers	120	1.5	2.9	72	74	1400	Sand gravel	Arrowhead, cut grass
Hwy 7 Crossing	100	3.5	1.0	72	72	1300	Sand gravel	Arrowhead
300 Ft. below Forbes Dam	90	4.0	1.7	78	76	1200	Rubble	Arrowhead, water dark brown
Hwy 53 (7-12-68)	100	7	1.0	66	67	1400	Sand silt	Stage-high, water brown, Arrowhead present

Table 9 Continued

Location (Date)	Width (ft.)	Ave. Depth (ft.)	Surface Velocity (ft./sec.)	Temp (^{o}F) Air	Temp (^{o}F) H_2O	Time	Bottom	Remarks:
County Hwy 957 (7-12-68)	80	5	2.0	67	67	1120	Sand silt	Bank 20 ft., depth 4.5 to 5 ft. to Mudhen Creek stage high, color - dark brown, some suspended organic matter.
County Hwy 95 (7-11-68)	45	4.5	1.6	72	67	1015	Sand gravel	Bank 5 ft., arrowhead present, color - dark brown, stage-high
Road 108 (7-11-68)	80	4.0	1.6	69	62	1430	Sand silt	Arrowhead present, color-dark brown, stage high
Hwy 4 (7-8-68)	85	3.5	1.1	72	72	1445	Sand muck	Conditions similar
1.4 Miles above 657 (7-8-68)	60	4.5	2.5	78	72	1200	Sand	
Hwy 100 (6-28-68)	100	--	2.8	60	63	1000	Gravel boulder	Pool depth 8-12', color - dark brown, stage high
Below Road 346 (6-26-68)	200			61	65		Muck boulders	Pool below rapids, secchi disc 1.9 ft., color dark brown, yellow water lily, burreed, coontail, cattail
At Road 346 (6-14-68)	100	1.25	3.3	49	59	1010	Boulder	Rapids
Norway Point Campgrounds (6-12-68)								
Inlet	85	1.0	3.3				Boulder	
Pool	260	5.0	--	63	64		Muck	Water lily, bulrush present
Outlet	70	1.5	3.3				Boulder	

Table 9 Continued

Location (Date)	Width (ft.)	Ave. Depth (ft.)	Surface Velocity (ft./sec.)	Temp (°F) Air	Temp (°F) H_2O	Time	Bottom	Remarks:
Pool near Hush Creek (7-1-68)								
Inlet	75	3.0	--			1610	Boulder rubble	Aquatic veg. - wild celery, burreed, yellow water lily, arrowhead, floatingleaf pondweeds
Pool	300	3.0	--	54	57		Muck boulder	
Skibo Lookout Tower Road (6-14-68)	40	1.5	5.0	49	59	1400	Boulder rubble	Stage high, water dark brown
Site of Skibo Mill (6-17-68)								
Inlet	30	2.0	5.9				Boulder rubble	
Pool	100-200	8.0	--	65	61	1130	Muck	Water lilies, needle rush, sedge, bulrush
Outlet	80	1.5	5.0				Boulder rubble	

Table 10. Tributaries of the St. Louis River (S-2)

Name	Number	Length Miles	Location T. R. S.	Flow c.f.s.	Secchi	Temp. of Air	Temp. of H_2O	Date	Time
Silver Creek	S-2-8	4.0	48-16-15	19.5		72	56	8/19/68	1300
Otter Creek	S-2-9	16.5	48-16-8	24.0		82	68	7/18/68	1500
Midway Creek	S-2-10	16.9	48-16-5	14.5		59	62	7/31/68	1130
Crystal Creek	S-2-10.5		48-16-6	6.0		58	52	6/14/68	1350
Unnamed Creek	S-2-11	4.4	49-16-11	7.3		72	66	7/18/68	1130
Unnamed Creek	S-2-12	2.8	49-16-18	9.6		73	71	7/18/68	1500
Squaw Creek	S-2-13	5.6	49-17-4	3.0		68	61	8/30/68	
Section 4 Creek	S-2-13.1	1.4	49-17-4	13.65		72	52	6/17/68	
Unnamed Creek	S-2-13.4	1.7	50-17-33	0.0			55	8/30/68	1200
Maple Creek	S-2-13.8	2.5	50-17-26	0.0			62	8/30/68	1230
Pine River	S-2-14	12.8	50-17-26	44.0			59	8/30/68	1330
Simian Creek	S-2-15	12.3	50-17-22					8/30/68	1400
Cloquet River				54.0	Clear			8/12/77	
Kingburg Creek	S-2-22	4.0	51-19-28	1.2		69	63	8/12/68	1200
Ahmik River	S-2-27	4.9	51-20-36	198.0		60	58	8/12/68	1055
Savanna River	S-2-31	15.1	51-20-8	20.0		66	69	8/ 7/68	1125
					3.5			8/12/77	
Floodwood River	S-2-32	26.1	51-20-5			67	73	8/ 7/68	1145
					4.5			8/12/77	
Artichoke River				2.5	2.5			8/12/77	
Stoney Brook				15.0	Clear			8/12/77	
Whiteface River				15.0	Amber			8/ 1/77	
Unnamed Creek	S-2-35.5	*	52-19-7	0.8		82	67	8/ 5/68	1230

Table 10 Continued

Name	Number	Length Miles	Location T. R. S.	Flow c.f.s.	Secchi	Temp. of Air	Temp. of H_2O	Date	Time
Kirby Creek	S-2-38.4	*	54-19-32	1.6		62	55	8/ 9/68	1145
Sand Creek	S-2-39	10.5	54-19-17	19.2		74	59	8/ 2/68	1130
Unnamed Creek	S-2-39.5	*	54-19-17	5.4		69	62	8/ 2/68	1115
Swan River	S-2-41	40.8	55-19-31	72.0		61	62	7/31/68	1345
Stone River	S-2-42	13.7	55-19-29	10.0		59	61	7/31/68	1130
Unnamed Creek	S-2-42.1	0.4	55-19-29	0.25		60		7/31/68	1200
Unnamed Creek	S-2-44.7	1.9	56-19-35	0.24		72	65	7/26/68	1145
Unnamed Creek	S-2-45.3	1.4	56-18-31	0.4		71	62	7/26/68	1100
Unnamed Creek	S-2-45.5	1.8	56-18-20	0.0		66	64	7/28/68	1145
West Two River	S-2-46	29.8	56-18-18	68.0		72	70	7/24/68	1300
East Two River	S-2-47	31.2	56-18-18	31.5		72	62	7/24/68	1340
Elbow Creek	S-2-48	13.6	56-18-9	12.0		71	62	7/22/68	
Borg Creek	S-2-48.5	2.0	56-18-3	1.0		72	65	7/22/68	1500
Otter Creek	S-2-49	10.4	56-18-1	2.1		80	72	7/18/68	1430
Tony Creek	S-2-49.2	1.4	56-17-6	0.0		82	74	7/18/68	1400
Unnamed Creek	S-2-49.4	1.3	56-17-5	0.0		82	70	7/18/68	1330
Unnamed Creek	S-2-49.6	1.2	56-17-5	0.0		82	73	7/18/68	1310
Half Moon Creek	S-2-49.8	0.6	56-17-4	0.0		71	61	7/12/68	1345
Mud Hen Creek	S-2-50	24.5	56-17-2	45.0		67	66	7/12/68	1315
Ely Creek	S-2-51	5.1	57-17-26	52.5		69	64	7/12/68	1145
Hay Creek	S-2-51.5	2.3	57-16-30	0.0		71	62	7/11/68	1200
Heikkala Creek	S-2-51.7	0.8	57-16-30	0.0		72	61	7/11/68	1130
Embarrass River	S-2-52	51.5	57-16-30	120.0		72	67	7/10/68	1110
Cedar Creek	S-2-52.8	1.1	57-16-28	0.0		68	69	7/11/68	1230

Table 10 Continued

Name	Number	Length Miles	Location T. R. S.	Flow c.f.s.	Secchi	Temp. of Air	Temp. of H_2O	Date	Time
Unnamed Creek	S-2-53	1.2	57-16-21	0.0		71	64	7/11/68	1340
Unnamed Creek	S-2-54.5	4.5	57-16-15	4.8		69	65	8/10/68	1210
Frying Pan Creek	S-2-55	7.4	57-16-14	7.2		69	57	8/10/68	1300
Unnamed Creek	S-2-55.5	3.0	57-16-12	0.6		69	54	7/10/68	1430
Twin Lake Creek	S-2-56	6.3	57-16-12	8.4		69	60	7/10/68	1500
Unnamed Creek	S-2-56.3	1.2	58-16-36	1.05		78	64	7/ 8/68	1400
Partridge River	S-2-57	37.8	58-15-22	412.5		54	59	7/ 1/68	1100
Whitewater Creek	S-2-58	0.8	58-15-25			51	54	7/ 1/68	1245
Hush Creek	S-2-58.5	0.5	58-14-35			54	55	7/ 1/68	1600
Unnamed Creek	S-2-58.6	1.2	58-14-36	0.0		73	58	7/ 2/68	1330
Laird Creek	S-2-59	1.9	58-13-27	20.0		71	51	6/24/68	1100
Stone Creek	S-2-61	1.6	58-12-31	14.85		58	62	6/24/68	1200

Table 11. Characteristics of Reservoirs in the St. Louis River System on Tributaries

Reservoir	Date Constructed	Ownership	Area Acres	Max. Depth (Feet)	Capacity (Acre Feet)	Remarks:
Fish Lake	1911	M.P.L.	3260	35	39,680	Privately owned public utility
Wild Rice Lake	1909	M.P.L.	2133	12	9,600	Privately owned public utility
Orchard-Island	1909	M.P.L.	8280	62	171,520	Privately owned public utility
Boulder-Otter	1920	M.P.L.	4450	22	29,440	Privately owned public utility
Whiteface	1920	M.P.L.	4980	35	81,920	Privately owned public utility
Minntac	1920	U.S. Steel	1213	27		Privately owned utility
Colby Lake	--	Erie Mining	534	14		Privately owned utility
Whitewater Lake	--	Erie Mining	1210	73		Privately owned utility

Table 12. Physical characteristics of the six reservoirs on the St. Louis River.

Name	Location of Dam (T) (R) (S)	Area (Acres)	Shoreline Miles	Depth		% Under 15 Feet (Lit. Area)	Retention Time (days)
				Med.	Max.		
Ford (Forbes)	(56,57) (18) (1,36)	7.1	0.7	7.5	15	98.6	--
Cloquet	(49) (17) (13,14)	238	8.5	5	38	95.0	0.26
Knife Falls	(49) (17) (13)	60.5	2.6	25	49	29.3	0.33
Scanlon	(48) (16) (18)	62.9	4.7	8	65	71.6	0.11
Thomson	(48) (16) (5-6)	339	9.0	5	24	83.5	0.45
Fond du Lac	(48) (15) (6)	217	6.5	14	60	51.6	0.67

Chemical and Physical Characteristics of the Water

Water in the St. Louis River ranges from being soft, total alkalinity 18 ppm to hard 107 ppm (average 44 to 76 ppm in various years), has a sulphate content of 0.5 to 12.5 ppm (average 3 to 5 ppm), has total phosphorous content of 0.03 to 0.17 ppm (average 0.03 to 0.08 ppm), a total nitrogen content ranging from 0.8 to 1.1 ppm (1968), a P.H. ranging from 6.9 in the softer waters to 7.2 in the harder waters, and a variable iron content (average about 0.7 ppm). Above Cloquet the secchi disc transparency ranges from 1.7 to 5.8 feet. In 1977 the water was about 1.3 feet clearer than it was in 1976. Through the middle part of its course the average transparency was 2.7 feet in 1976 and 4.0 feet in 1977.

While there is quite a bit of change from its source to the mouth, ordinarily the St. Louis is a brown stained soft water river. From Seven Beaver Lake and continuing to the mouth of Partridge River, the St. Louis has a dark brown stain, a secchi disc transparency less than 2 feet, a total alkalinity ranging from 18 to 28 ppm, and a conductivity ranging from 60 to 110 mmho/cm. After the river flows out of the red drift below the Partridge River the water becomes harder. Below the mouth of the Partridge River to the dam near Forbes the brown stain is less intense, the secchi disc transparency increases from 4 to 7 feet, the total alkalinity increases to 38 to 42 ppm, and the conductivity 195 to 220 mmho/cm. From Forbes to the mouth of the Whiteface River the St. Louis River flows through the clay deposits in the beds of Glacial Lake Upham, and the river is not as clear (secchi disc transparency 2.6 to 4.8 feet), the water is harder (the alkalinity usually near 55 ppm), and the conductivity range is 175 to 262 mmho/cm. Below the Whiteface River several large tributaries enter the St. Louis. There are two towns and a railroad yard next to the river. The main difference in the water is that the conductivity is slightly higher, 212 to 272 mmho/cm.

Below Cloquet in 1977, the transparency decreased from 3.9 to 0.8 feet and the conductivity increased from 210 to 850 mmho/cm, and the water temperature increased from 67^{o} F to 75^{o} F below the paper plant. The effluent from the paper plant had a transparency of 0.5 feet and a conductivity of 2900 mmho/cm, and the effluent had a temperature of 97^{o} F. River conditions had improved at Fond du Lac, the transparency increased to 2.2 feet, and the con-

ductivity decreased to 365 mmho/cm. In the St. Louis River estuary the transparency was about 2.2 feet and the conductivity was 290 mmho/cm. (Table 14).

Results of Water Quality Sampling

From 1968 through 1971, the difference between the water samples taken throughout the year at Brookston and Fond du Lac was that the dissolved oxygen was not below 5 ppm at Brookston and was below 5 ppm in 22.5 percent of the Fond du Lac samples, that the median B.O.D. was 2.2 at Brookston and 4.8 ppm at Fond du Lac, and that the median turbidity was 3.9 at Brookston and 6.9 at Fond du Lac. At Brookston and Fond du Lac the pH was 7.2 and 6.9 respectively, the sulfates were 3.0 and 3.8 ppm respectively, the chlorides were 4 and 10 ppm respectively, the total alkalinity was 44 and 48 ppm respectively, the iron was about 0.6 ppm, the total phosphorous was 0.6 ppm, and the total nitrogen was about 1.3 ppm. (Table 13).

The 1968 DNR summer samples showed similar results between the Brookston and Fond du Lac sampling stations, total alkalinity 52 and 45 ppm, total phosphorous 0.049 and 0.054 ppm, total nitrogen 0.98 and 1.06 ppm, pH 7.1 and 7.0, and total iron 0.61 and 0.63 ppm respectively, but between Brookston and Fond du Lac a considerable amount of change occurred. From Brookston to Fond du Lac the sulphates increased from 2.7 to 6.0 ppm, the total phosphorous increased from about 0.05 ppm at Brookston to a peak of 0.169 ppm below Scanlon and then decreased to about 0.05 ppm at Fond du Lac. Peak pH and total alkalinity values of 7.3 and 54 ppm were reported below the Thomson dam 1.7 miles above the Fond du Lac sampling station in 1968. (Table 14).

A similar set of conditions was observed during the 1977 river reconnaissance. On August 13th and 16th, 1977, above Cloquet the river had a secchi transparency of 3.9 feet, a conductivity of 210 mmho/cm at 20° C. Above the Scanlon dam below the paper plant discharges the water transparency was 0.8 feet, the conductivity was 850 at 24° C on the surface and sludge and gas bubbles were visible. Below the Scanlon (3rd dam) conditions had improved slightly, secchi disc transparency 1.1 feet, conductivity 590 at 20.5° C. The next day in the Thomson Dam Reservoir the conductivity was 425 at 17.5° C. In Fond du Lac Reservoir the secchi disc transparency was 2.2 feet and the conductivity 325 at 19.5° C. Note that at Fond du Lac the conductivity was higher and the transparency was lower (turbidity higher) than it was upstream from Cloquet during the 1977 reconnaissance and in the 1968 to 1971

samples and that river conditions were worst near Scanlon. The conductivity of the paper plants primary effluent was 2900 at 36° C and the transparency was 0.5 feet.

In 1941 and 1942 Moyle (1942) investigated the chemical characteristics of the water of the St. Louis River at several locations throughout its course. At a set of stations similar to those investigated in 1968 the total alkalinity was 62 and 44 ppm in 1941-42 and 1968 respectively, the sulphates were 3.0 and 4.7 ppm, the total phosphorous was 0.06 ppm and 0.05, and the total iron was 0.8 and 0.7 ppm respectively. The only practical difference between these two sets of data is that the total alkalinity was higher in the 1941-1942 data. A closer examination of the total alkalinity data showed that the total alkalinity in 1941 was 26 ppm higher at similar sampling stations, and that the total alkalinity in 1942 (51 ppm) was close to the average total alkalinity in the 1968 samples (44 ppm).

When the 1968 to 1971 alkalinity data at Brookston was compared with the monthly flows, there was a correlation between flow and total alkalinity ($r=0.63$). At Fond du Lac in the same time period the correlation was $r = 0.53$. At Fond du Lac when the flow decreases 100 cfs the total alkalinity will increase about 1 ppm.

In the St. Louis River at Brookston the total suspended solids (average 11.2 mg/l.) is correlated with the turbidity ($r=0.76$), 1.27 mg/l of total suspended solids is equal to 1 ppm of J.T.U. turbidity. About 10 percent of organic matter is nitrogen so if the total suspended solids is organic matter the organic nitrogen should be about 1.1 ppm. The amount of organic nitrogen in this set of samples was 1.3 ppm, confidence limits 0.9 to 1.7 ppm, which is similar to the calculated 1.1 ppm.

Water Temperatures

Water temperatures were lowest in the winter from December through February (32° F) and increased in the spring (range 33 to 56° F) and early summer to 68° in July (maximum observed 80° F) and decreases to the winter minimum in the fall (range 33 to 68° F). In the summer the daily variation in water temperature (maximum about 8° F) is low (rate of increase per hour less than 1.4° F). In the spring water temperatures increase about 0.25° F per day, and 0.4° F in June. In July and August the maximum observed yearly

water temperatures have varied from 73 to 80° F. There was no correlation between water temperatures and air temperatures during the day. In 1976 when the maximum temperatures were observed the water temperatures were approximately equal to the average air temperature.

In the PCA samples taken at Brookston from 1968 through 1971 and from December through February water temperatures ranged from 31 to 33° F (median 32° F), from March through May water temperatures ranged from 33 to 56° F (median 50° F), from June through August water temperatures ranged from 62 to 75° F (median 68° F), and from September through November the water temperatures ranged from 33 to 68° F (median 51° F). (Table 13)

In 1968 a series of water and air temperatures taken the length of the river on June 3rd from 9:35 AM to 1:55 PM, water temperatures ranged from 54 to 60° F (mean 56.5° F, standard deviation 2.29° F) and the air temperatures ranged from 56 to 74° F (mean 70.6° F, standard deviation 3.00° F). In another series taken on July 8, 1968 from 9:30 AM to 3:35 PM, water temperatures ranged from 71 to 74° F (mean 72.8° F standard deviation 1.22° F), and the air temperatures ranged from 74 to 81° F (mean standard deviaiton 3.6° F). In a third series taken on August 5, 1968 from 9:30 AM to 3:38 PM, water temperatures ranged from 65 to 73° F (mean 70° F, and the air temperatures ranged from 60 to 80° F (mean 73.9° F, standard deviation 6.18° F). (Table 17)

In the 1976 survey data collected from July 19 to 27, the water temperatures ranged from 72 to 80° F (mean 76.8° F, standard deviation 2.43° FO, and the air temperatures ranged from 68 to 82° F (mean 75.9° F, standard deviation 5.01° F). In the 1977 survey data collected from July 30 to August 19 the water temperatures ranged from 65 to 73° F (mean 67.4° F, standard deviation 3.04° F) and the air temperatures ranged from 64 to 72° F (mean 68.6° F, standard deviation 1.69° F).

Seasonal Variations

Averages do not indicate the magnitude of the variations which can occur in many of the chemical parameters throughout the year. The 1968-1971 data indicates that in the winter at Brookston when the water temperatures and river flows are low (about 32° F and 1,400 cfs respectively) the water is clear (median turbidity 3.6 ppm), the dissolved oxygen is highest (10.3 ppm), B.O.D. is 2.2 ppm, the total phosphorous is highest (0.16 ppm) and the total nitrogen is about 1.43 ppm. The organic nitrogen is about 1.0 ppm and the inorganic forms, ammonia, nitrates, and nitrites, are 0.43 ppm or 30% of the total nitrogen.

In the spring from March through May when water temperatures range from 36 to 60° F (median 50°) and the stream flows are highest (median 4,300 cfs, monthly average - maximum about 12,700 cfs) and the water is most turbid (median 7.3 ppm), the dissolved oxygen is about 8.9 ppm, B.O.D. is 2.5 ppm, the total phosphorous is low (0.09 ppm), and the median total nitrogen is about 1.34 ppm. Organic nitrogen comprises 1.0 ppm of the total nitrogen, and the inorganic forms are 0.34 ppm or 25 percent of the total nitrogen.

In the summer from June through August when water temperatures are highest (median 68° F, range 62-75° F), river flows are low (about 1900 cfs) and the water had a median turbidity of 3.6 ppm, the dissolved oxygen is 7.3 ppm (range 6.1 to 8.6), the B.O.D. is 2.1 ppm, the total phosphorous is higher (median 0.11 ppm) than in the spring or fall, and the median total nitrogen is 1.14 ppm. Organic nitrogen comprised 0.93 ppm of the total nitrogen, and the inorganic forms are 0.21 ppm or 18 percent of the total nitrogen.

In the fall from September through November when the water temperatures are cooler (median 51° F) and the water flows are somewhat higher (median 2,100 cfs) and the median turbidity is 4.2 ppm, the median dissolved oxygen (9.8 ppm) is higher than it is in the summer, the B.O.D. is 2.1 ppm, the total phosphorous is lowest 0.08 ppm and similar to the spring concentration of 0.09 ppm, and the total nitrogen is 1.06 ppm. Organic nitrogen comprises 0.86 ppm of the total, and the inorganic forms are 0.20 ppm, or 20 percent of the total. Note that the inorganic forms stay at the same level in the spring and summer and decrease from winter to summer and that the organic nitrogen decreases from winter to the fall.

Table 13 Summary of water chemistry in St. Louis River from December 1967 through November 1971. PPM unless otherwise noted.

	Median	Median by Season				Median by Years*				No. Samples
		Winter	Spring	Summer	Fall	67-68	68-69	69-70	70-71	
Temperature °F										
Brookston	50	32	50	68	51	52	48	52	44	38
Fond du Lac	50	32	42	70	46	50	52	52	44	40
Turbidity (JTU)										
Brookston	3.9	3.6	7.3	3.6	4.2	14.0	4.0	3.5	3.8	39
Fond du Lac	6.9	5.7	12.6	6.9	6.5	16.0	5.6	5.8	7.2	39
Residue										
Brookston	6	5	9	7	5	9	7	5	6	39
Fond du Lac	11	6	13	12	11	12	9	8	23	40
B.O.D.										
Brookston	2.2	2.2	2.5	2.1	2.1	3.2	2.5	2.2	1.6	38
Fond du Lac	4.8	15.0	4.1	4.8	7.3	4.7	8.5	6.6	4.0	39
Dissolved Oxygen										
Brookston	9.1	10.3	8.9	7.3	9.8	8.7	9.0	8.8	8.9	37
Fond du Lac	8.6	9.2	9.7	5.1	6.9	6.8	6.9	7.0	9.1	40
T. Alkalinity										
Brookston	44	54	42	46	46	42	43	60	48	39
Fond du Lac	48	56	40	43	46	40	50	55	52	40
Iron										
Brookston	0.620	0.630	0.750	0.550	0.560	0.780	0.585	0.360	0.795	33
Fond du Lac	0.590	0.525	0.840	0.525	0.515	0.730	0.480	0.430	0.660	37
Chlorides										
Brookston	4	6	4	2.5	1	1	1.5	5	4	39
Fond du Lac	10	10	7	11	11	10	10.5	10.0	10.0	39
T. Phosphorous										
Brookston	0.110	0.160	0.090	0.110	0.080	0.080	0.070	0.120	0.120	39
Fond du Lac	0.105	0.100	0.105	0.120	0.100	0.100	0.105	0.100	0.130	40
Organic - N										
Brookston	1.000	1.000	1.000	0.925	0.860	1.200	0.930	0.810	1.150	37
Fond du Lac	1.000	0.980	1.050	0.990	1.000	1.000	0.915	0.980	1.100	39
Ammonia - N										
Brookston	0.090	0.110	0.130	0.050	0.080	0.080	0.075	0.100	0.160	39
Fond du Lac	0.135	0.220	0.125	0.080	0.120	0.090	0.075	0.180	0.200	40
Nitrate - N										
Brookston	0.160	0.300	0.190	0.140	0.100	0.180	0.155	0.115	0.290	39
Fond du Lac	0.130	0.080	0.175	0.050	0.100	0.120	0.150	0.10	0.160	38
Flow (cfs)		1442	4285	1948	1843	2488	1851	1496	1843	

*December to November of next year.

Table 14. Summary of the water chemistry samples, average of 3 samples per sampling station, taken the entire length of the St. Louis River in 1968.

Location (T., R., S.)	Total Alk.	SO_4	Total P	Total N	pH	Total Iron	Miles Upstream from last Station
Fond du Lac (48-15-81)	45	6.0	0.054	1.06	7.0	0.63	0.0
Below Thomson Dam (48-16-8)	54	5.4	0.112	1.02	7.3	0.71	7.7
Scanlon at Highway 61 (49-16-30)	47	3.8	0.169	1.02	7.0	0.67	4.0
Cloquet Highway 33, N channel (49-17-14)	47	2.1	0.049	0.97	7.2	0.77	2.5
Brookston (51-18-27)	52	2.7	0.056	0.98	7.1	0.61	16.3
Floodwood (51-20-5)	52	3.2	0.060	0.87	7.1	1.00	17.0
Meadowlands Bridge (53-19-20)	53	3.8	0.072	0.91	7.1	0.64	14.8
Toivola Bridge (54-19-8)	53	5.9	0.063	0.77	7.2	0.70	6.7
Zim Bridge (west) (56-18-29)	43	4.2	0.049	0.77	7.2	0.60	16.3
Forbes Dam (56-18-2)	41	5.5	0.083	0.82	7.2	0.54	11.7
U.S. 53 Bridge (56-17-4)	39	5.0	0.030	0.85	7.2	0.68	6.2
Highway 57 Bridge (56-17-2)	39	4.4	0.031	0.81	7.2	0.66	2.6
Highway 95 Bridge (57-16-28)	41	5.8	0.032	0.82	7.2	0.83	6.7
Highway 4 Bridge (57-16-12)	38	6.4	0.027	0.89	7.2	0.84	5.5
Highway 100 - Aurora (58-15-22)	38	7.1	0.022	0.83	7.2	0.63	9.9
Highway 346 - SE of Hoyt Lakes (58-14-33)	18	3.2	0.027	0.81	6.9	0.68	21.3

Table 15. Water transparencies (secchi disc - ft.) in the St. Louis River in 1976 and 1977.

Location	1976	1977
Norway Point Campgrounds	1.7	--
Above Highway 53	5.8	--
Impoundment near Frobes	4.0	--
Near Toivola	2.6	4.0
Near Meadowlands	--	3.5 - 4.0
Above Whiteface River	--	4.8
Below Whiteface River	2.9	--
Above Paupores	2.1	4.3
Near Brookston	2.5	--
Below Mouth of Cloquet River	2.8	3.5
Above Cloquet		3.8
At Cloquet	3.3	--
Below N.W. Paper Discharge	--	0.8
Interstate 35 Crossing	--	1.3
Thomson Reservoir	--	2.5
Fond du Lac Reservoir	--	2.2
Near Highway 23	3.1	--
Oliver Bridge	--	2.2

SUMMARY

Above Partridge	1.7	--
Reservoir	4.0	--
Swan River to Cloquet		
Mean ($\bar{x}$)	2.7	4.0
S.E $\bar{x}$	0.23	0.07
Confidence limits	2.1-3.3	3.8-4.2
Cloquet to Estuary		
Mean $\bar{x}$	3.1	1.82
S.E. $\bar{x}$	--	0.15
Confidence limits	--	1.4-2.2

Table 16. Water transparencies, temperatures, and conductivities in the St. Louis River from Cloquet to the estuary on 8-15-77 to 8-16-77.

Location	Temperature (°C.)	Conductivity mmho/cm	Secchi Disc Transparency (ft.)	Remarks
Above Cloquet	20		3.9	8-15-77
Conwed Plant				
Above		272		
Adjacent				Not operating
Cloquet Highway 33		282		
N W Paper Co.				
Ditch runoff		1100		
Below 1st dam	19.5	590	3.0	
Below 2nd dam	19.0	475		
Effluent	36.0	2900	0.5	
0.5 mi. downstream	--	--	0.8	Gas & sludge
Depth 1 ft.	24.0	850		
Depth 9 ft.	21.0	475		
Below Scanlon Dam				
Mid channel				
8-15-77	20.5	590	1.1	
8-16-77	19.5	675		No dis. oxygen
Thomson Reservoir	17.5	425	2.5	8-16-77
Fond du Lac Res.	19.5	325	2.2	8-16-77
Highway 23	21	365		8-16-77
Upper St. Louis Bay	19.5	290	2.2	8-16-77, near Sargent Cr.

Table 17. Summer air and water temperature profiles of the St. Louis River in 1968.

Location (T.R.S.)	Temperature °F					
	6-3-68		7-8-68		8-5-68	
	Water/Air	Time	Water/Air	Time	Water/Air	Time
Fond du Lac (48-15-8)	59/67	10:45	71/82	12:15	70/60	0930
Below Thomson Dam (48-16-8)	59/68	11:15	72/81	1350	65/64	1000
Scanlon-4561 (49-16-30)	59/68	11:45	71/80	1450	70/68	1015
Cloquet-Hwy 33 (49-17-14)	58/71	12:00	72/74	1535	69/68	1030
Brookston (51-18-27	54/66	9:35	72/?	0930	69/71	1100
Floodwood (51-20-5)	54/67	10:15	72/?	--	69/74	1135
Meadowlands Br. (53-19-20)	54/72	10:55	72/?	--	70/76	1245
Toivola Br. (54-19-8)	55/72	11:15	72/?	--	71/77	1310
Zim Br. (56-18-29)	55/73	11:50	74/?	--	70/79	1345
Forbes Dam (56-18-2)	55/74	12:40	74/?	--	71/80	1410
US 53 Br. (56-17-4)	54/73	13:00	74/?	--	70/80	1430
957 Br. (56-17-2)	55/74	13:10	74/?	--	71/80	1445
Hwy 95 Br. (57-16-28)	59/74	13:35	74/?	--	71/79	1510
Hwy 5 Br. (57-16-12)	58/74	13:55	74/?	--	70/79	1530
Aurora Hwy 100 (58-15-22)	60/68	9:45	74/80	955	71/74	9:55
Hwy 346 (58-14-33)	58/72	11:15	72/75	1120	73/74	11:15

Table 18. Water temperatures and conductivities of the St. Louis River and tributaries in 1977.

Date	Location	Conductivity (mmho/cm)	Water Temp (^{o}C)	Remarks:
7/26	Skibo Mill	60		
7/27	N.F.D. to Skibo L.O.	65		
7/27	Norway Point Public Access			
7/29	Partridge River - CSAH 110	450		
7/29	CSAH 100	220		
7/29	CSAH 4	215		
7/29	CSAH 108	195		
7/29	Trib. from Lost Lake - CSAH 108	145		
7/29	CSAH 95 - Embarrass River	200		
8/1	County Road 957	192		
8/1	CSAH 16 - Mud Hen Creek	152	14.5	
8/1	U.S. 53	191	18.0	
8/3	Forbes Dam Tailwaters	200	19.0	Dark org. stain
8/3	1 mile above Co. Rd. 312 Bridge	205	23.0	
8/1	County Road 312 Bridge	211	19.3	
8/1	Co. Rd. 661 Bridge - W. Two Rivers	202	19.0	
8/2	CSAH 27 & Co. Rd. 313 junc. - E. Two Rivers	550	19.0	V. turbid & green
8/2	Co. Rd. 101 E. Two Rivers - W. of Eveleth	620	19.9	Relatively clear
8/2	Co. Rd. 102 E. Two Rivers - E. of Leonidas	620	19.9	
8/2	Outlet from Mashkenode L. - E. Two Rivers	325	20.0	Relatively clear
8/2	Outlet from Manganika L. - E. Two Rivers	620	19.0	Turbid & green
8/2	CSAH 37 - W. Two Rivers	205	19.6	
8/3	County Road 436	175	19.0	V. turbid
8/3	CSAH 83 - Stone River	170	21.7	Clean but highly stained
8/3	Co. Rd. 230 - above new bridge	235	19.5	Brown stain
8/3	Co. Rd. 230 - below new bridge	235	19.5	
8/10	Co. Rd. 750 - Swan River	408	20.5	Mod. silt load

Table 18 Continued

Date	Location	Conductivity (mmho/cm)	Water Temp (°C)	Remarks:
8/10	CSAH 5 at Toivola - Sand Creek	95	18.5	Mod. silt load
8/10	CSAH 52	260	23.5	
8/11	End of Co. Rd. 226 - Whiteface River	150	21.5	Light silt load, heavy brown stain
8/11	CSAH 29	258	21.5	
8/11	Canoe access below Whiteface River	228	19.5	
8/12	CSAH 8	221	19.0	
8/12	Hwy 73 - Floodwood River	202	19.0	Light silt load, mod. brown stain
8/12	U.S. 2 - Savannah River	108	19.5	Heavy brown stain
8/14	CSAH 31 - Brookston	212	20.0	
8/14	CSAH 31 - Brookston - Stony Brook	121	18.8	Light silt load, mod. stain
8/14	Co. Rd. 866 - Artichoke River	240	20.0	" " "
8/14	End of County Road 867	210	20.0	
8/18	Hwy 33 - White Pine River	180	10.0	Light silt, mod. stain
8/15	Above Conwed Corp.	272		
8/15	Hwy 33	282		
8/15	Runoff from N.W. Paper yard below 1st dam	1100		
8/15	Midchannel below 1st dam	590		
8/15	N.W. Paper discharge canal - 2nd dam	500	19.5	
8/15	Midchannel below 2nd dam	475	19.0	
8/15	N.W. Paper primary effluent	2900	36.0	
8/15	½ mile below primary effluent	850	24.0	1' depth
8/15	½ mile below primary effluent	475	21.0	9' depth
8/15	Midchannel below 3rd dam	590	20.5	
8/16	CSAH 61	675	19.5	
8/16	Above dam - Thompson Res.	425	17.5	
8/17	½ mile above Thompson Hydro Plant	325	19.5	Dark amber color
8/17	Above Thompson Hydro Plant	325	19.5	
8/18	Hwy 23	365	21.0	
8/18	St. Louis Bay at Saergent Creek	290	19.5	

Table 19

Chemical and Physical Properties of the Water Samples collected by the Minnesota Department of Health in the St. Louis River on May 21, 1958.

Determinations*	Station Description							
	Upper Bridge in Cloquet	Northwest Paper Co. Dam	Scanlon Bridge	Below Thomson Dam	Thomson Hydro Plant	Fond du Lac Bridge	Oliver Bridge	Arrowhead Bridge
Time Collected	12:45 PM	1:00 PM	2:00 PM	2:20 PM	2:45 PM	3:00 PM	4:15 PM	4:45 PM
Temperature (^{o}F)	62	62	62	65	62	64	62	62
Total Solids	160	160	220	230	240	240	230	200
Total Volatile Matter	83	97	140	120	140	130	130	110
Turbidity (scale units)	7	10	16	8	7	9	10	8
Dissolved Oxygen	6.8	5.5	2.6	4.9	1.9	0.0	0.0	4.9
Biochemical Oxygen Demand (5-Day)	2.5	9.8	25.	6.0	9.5	9.0	8.0	3.8

*Expressed as milligrams per liter unless otherwise noted.

Table 20

Five day period of oxygen supply in the St. Louis River at Fond du Lac in 1958.

Date	Flow	DO/BOD
5/7/58	1,040	0.65 (5.3/8.1)
5/8/58	1,110	1.68 (6.6/4.1)
5/14/58	770	0.18 (1.4/7.9)
5/15/58	810	1.04 (5.2/5.0)
5/21/58	852	0.01 (0.1/7.8)
5/28/58	730	0.01 (0.1/8.0)

Note: In this data r = 0.66 and DO/BOD = 0.001 times the flow minus 0.24.

Table 21

Oxygen Supply (Dissolved Oxygen/B.O.D.) in the St. Louis River at Brookston and Fond du Lac from 1968 to 1971.

Season	Temp. (median)	Oxygen Supply (DO/BOD)		Median Flow (c.f.s.)
		Brookston	Fond du Lac 1/	
Winter	32	4.7	0.6	1442
Spring	50	3.6	2.4	4285
Summer	68	3.5	1.1	1948
Fall	51	4.7	0.9	1843
All Seasons		4.1	1.8	1851

1/ Correlation between flow and DO/BOD is r = + 0.99, DO/BOD = 0.0006 (flow) - 0.20.

Aquatic Vegetation

In the St. Louis River filamenteous green algae was well distributed throughout the length of the river; it was frequently observed in long clumps or strands attached to rocks and submerged branches. Submerged vegetation which occurred commonly was narrow leaf pondweed, river pondweed, Canada waterweed, wild celery, claspingleaf pondweed, and/or coontail. These species were likely to be restricted to the streams margin or other areas where the water velocity was lower. Emergent vegetation consisting of common cattail, burreed, arrowhead, sedge, and reed canary grass was restricted to the quieter waters and damp soils along the rivers margin. Floating leaf vegetation such as duckweeds, yellow water lily, white water lily and water stonewort were sometimes present in quieter waters. Some species such as spikerush, wild rice, and swamp horsetail were locally abundant in restricted parts of the river.

Where the rivers current was fast filamenteous algae was the only type of plant life visible and sometimes occurring in long clumps or strands oscillating in the current wherever there was a place of attachment. On sandy river bottoms where the water velocity is frequently high, sometimes filamenteous algae is present late in the summer if the sand is not eroding. Between Floodwood and Brookston, frequently there are heavy beds of water celery and claspingleaf pondweed near the shore that are not visible at ordinary and high water stages, because the river has a dark brown stain.

Above the mouth of the Partridge River, the St. Louis River has a distinct sequence of pools and rapids that are not found in the lower portions of the river, the rapids are a sea of boulders nearly void of vegetation except for filamenteous algae. The pools frequently are large enough so that they have some of the aquatic vegetation characteristics of small lakes and ponds. At the Norway Point Campground there is a long pool where the vegetation is well developed and the commonest vegetation is arrowhead, spikerush, waterlilies, bushy pondweed, and water celery. Upstream from the campground where a forest road crosses the river an occasional strand of water celery was present in a small pool. South of Skibo where the railroad crosses the St. Louis River no vegetation was observed in the boulder rapids, but some water lilies were observed in a small pool. Upstream from the railroad crossing at the landing

at the old lumber mill site, the pool which extends upstream a considerable distance on fine substrates the pool has good stands of wild rice and burreed along the upper part of the pools margin. Downstream from Seven Beaver Lake the source of the St. Louis River to the upper extent of the wild rice stands some water lilies and burreed occurs along the river's margin.

Except for a few short, rocky riffles located at the upper end, the portion of the St. Louis River between the mouth of the Partridge River and the dam near Forbes has a sandy bottom where eroding banks occur frequently. In this reach there was little aquatic vegetation except where water velocities are low enough to allow the growth of filamenteous algae on the sandy bottom. The species of aquatic vegetation that were present were arrowhead, smartweed, white water lily, claspingleaf pondweed, and water starwort.

From the dam near Forbes to the mouth of the Whiteface River, the St. Louis River flows through a narrow valley that is relatively deep and that has a variety of substrates. The only aquatic plant life commonly found was filamenteous algae where suitable attachments such as rocks in rapids occurred, and arrowhead and sedge along the river's margin. Other aquatic plants present were Canada waterweed, burreed, claspingleaf pondweed, water stonewort and whitestem pondweed.

Above and below the mouth of the Whiteface River for a few miles, the valley is absent and clay soils dominate except where sand is deposited. Since clay soils are not as erodable as sandy soils, aquatic plants are sometimes abundant where the water velocity is less extreme (0.3 ft. sec.). At an access point where clay banks were eroding, there was a dense growth of whitestem pondweed confined to a narrow two foot wide band along the river's margin. Along banks where there was spring seepage, horsetail and scattered arrowhead plants were present.

At Floodwood the St. Louis River becomes wider and flows through a fairly broad valley that becomes quite deep several miles downstream at Cloquet. In this portion of the river several dense beds of aquatic vegetation were observed in pools and other locations where the water velocity was low. In one pool there were some dense beds of arrowhead, water celery, Canada waterweed, and river pondweed. At other locations only water celery was present. Sometimes claspingleaf pondweed was present in the beds of water celery. The species of aquatic plants observed in this section of the river were arrowhead, common cattail, star duckweed, claspingleaf pondweed, water celery, river pondweed,

Canada waterweed, sago pondweed, floatingleaf burreed, and whitestem pondweed. None of the plants occurred in a continuous fringe along the river's margin, but occurred in scattered beds or as occasional plants along the margin.

From Cloquet to the upper part of the St. Louis River estuary below the Highway 23 bridge, the river drops rapidly through a series of reservoirs and rapids in a deep valley where rocky outcrops are prevalent and frequently form the river's margin. Normally dense growths of aquatic plants are absent, but arrowhead, river pondweed, claspingleaf pondweed, and water celery were observed as being present in the river near Cloquet and river pondweed, arrowhead, coontail, and narrowleaf pondweed were noted as being present in the river above the estuary and below the Fond du Lac dam.

In the estuary below the Highway 23 bridge, above the industrialized area, beds of wild rice are present in the shallow waters adjacent to the river channel. Yellow water lilies, white water lilies, coontail, water milfoil, narrowleaf pondweed, river pondweed, arrowhead, duckweeds, and common cattail were also present. (See Tables 22 and 23 for species lists).

Table 22. General List of Aquatic Plants of the St. Louis River

19 July 1976 - 30 July 1976

1. *Ceratophyllum demersum* (coontail)
2. *Elodea canadensis* (Canada waterweed)
3. *Myriophyllum exalbescens* (water milfoil)
4. *Nymphaea tuberosa* (white waterlily)
5. *Nuphar variegatum* (yellow waterlily)
6. *Pontederia cordata* (pickerelweed)
7. *Sagittaria latifolia* (arrowhead)
8. *Sagittaria rigida* (stiff wapato)
9. *Sparganium eurycarpum* (giant burreed)
10. *Vallisneria Americana* (wild celery)
11. *Typha latifolia* (broadleaf cattail)
12. *Zizania aquatica* (wild rice)
13. *Potamogeton pectinatus* (sago pondweed)
14. *Potamogeton zosteriformis* (flatstem pondweed)
15. *Potamogeton Richardsonii* (claspingleaf pondweed)
16. *Potamogeton nodosus* (river pondweed)
17. *Scirpus subterminalis* (submerged bulrush)
18. *Spirudela polyrhiza* (greater duckweed)
19. *Equisetum Fluviatile* (swamp horsetail)

Table 23. Species of aquatic plants found in the St. Louis River during the 1976 - 1977 survey.

Species		Sector				
Common Name	Scientific Name	5	4	3	2	1
Filamentous green algae	*Chlorophyceae*		P	O	P	
Muskgrass	*Chara spp.*	O				
Water moss	*Drepanocladus*				P	
Floatingleaf burreed	*Sparganium fluctuans*	A		O	O	
Narrowleaf pondweed	*Potamogeton spp.*	C			P	P
Floatingleaf pondweed	*Potamogeton natans*			O	O	
River pondweed	*Potamogeton nodosus*	P			P	P
Sago pondweed	*Potamogeton pectinatus*				O	
Claspingleaf pondweed	*Potamogeton Richardsonii*	O	S	O	O	
Wild celery	*Vallisneria americana*	C			O	
Duckweed	*Lemna spp.*			O		P
Pickerelweed	*Pontederia cordata*	P				
Coontail	*Ceratophyllum demersum*		A		P	C
White waterlily	*Nymphaea tuberosa*	C	S			P
Yellow waterlily	*Nuphar variegatum*	C				P
Water starwort	*Callitriche palustris*	O	S	O		
Water milfoil	*Myriophyllum exalbescens*	O				P
Water horehound	*Lycopus americanus*	O				
Canada waterweed	*Elodea canadensis*			O	O	C
Bladderwort	*Utricularia spp.*	O				
Swamp horsetail	*Equisetum fluviatile*	A	P			
Common cattail	*Typha latifolia*	O		S	C	C
Greenfruited burreed	*Sparganium chlorocarpum*					
Giant burreed	*Sparganium eurycarpum*	O				
Arrowhead	*Sagittaria spp.*	O	O	C	C	C
Wild rice	*Zizania aquatica*	C				O
Reed canary grass	*Phalaris arundinacea*		C	O	O	
Cane grass	*Phragmites communis*	O				
Sedge	*Carex spp.*	A	P	C		
Spikerush	*Eleocharis palustris*	C				

Table 23 Continued

Species		Sector				
Common Name	Specific Name	5	4	3	2	1
Smartweed	*Polygonum spp.*		O	O		
Hardstem bulrush	*Scirpus acutus*			S		O
Softstem bulrush	*Scirpus validus*	O	P			
Sweetflag	*Acorus calamus*	O				
Dock	*Rumex spp.*		P			
Water parsnip	*Sium suave*	O	P			

Invertebrates

Moyle (1947) notes that in the St. Louis drainage system there were 52 invertebrates per square foot in warm water streams. On course and fine substrate the density was 67.3 and 18.6 organisms per square foot respectively. Excluding the data for the tributary streams there were 94.0 invertebrates per square foot (Sx = 84.5) at the sampling stations in the St. Louis River. In the 1947-1948 Minnesota Department of Health report the mean invertebrate density was similar (103.3 per square foot, Sx - 48.0) in four samples taken in the St. Louis River at Brookston at various times of the year.

Below Cloquet the invertebrate density, mostly Tuberficedae, was much higher and more variable (July $\overline{X}$ = 7,700 and Sx = 13,531). At Brookston the diversity index ranged from 2.89 to 3.73 or about normal, and the BOD ranged from 1.4 to 1.7 p.p.m. Below Cloquet the diversity index for invertebrates ranged from a low of 0.67 to 0.72 at above the Scanlon Dam to a maximum of 2.47 to 3.10 near the Oliver Bridge. Below a diversity index of 1.0 rivers can be regarded as polluted and partly recovered when the index is between 2 and 3. (Table 25).

There was a negative correlation (r = -0.60) between diversity index and the BOD. (Diversity index = 11.83 minus 2.77 times the BOD). This equation indicates that the BOD is less than 3.2 where the diversity index is normal (over 3.0). Tuberficidae which are an indicator of degraded waters were less than 11 percent of the samples at Brookston and over 80 percent of the organisms in a sample from the most polluted areas above the Oliver Bridge.

Table 24. Summary of the Minnesota Department of Health invertebrates sampling in February and July 1948 in relationship to the BOD and percent of Tuberficidae present.

Location	Diversity Index		Number Square Foot		Percent Tuberficidae		B.O.D.	
	Feb.	July	Feb.	July	Feb.	July	Feb.	July
Brookston	2.89	3.73	54.9	138.6	0.0	10.4	1.4	1.7
Cloquet above Dam	--	0.88	--	6,405.6	--	87.7	4.2	5.6
Above Scanlon Dam	0.72	0.67	308.1	640.0	98.3	97.2	18.0	13.0
Above Fond du Lac Dam	--	1.45	--	32,297.3	--	99.8	12.0	4.2
Fond du Lac Bridge	--	1.88	--	6,333.6	--	82.5	11.0	4.5
Oliver Bridge	3.10	2.47	76.5	409.4	43.4	42.1	9.5	3.7
Spirit Lake outlet	0.34	1.56	504.1	533.3	75.1	62.5	9.6	4.4

Table 25. Summary of the 1948 summer invertebrate sampling and the associated diversity indexes and BOD.

Location	Diversity Index	Number Square Yard	Tuberficidae Percent	B.O.D.	
				July	Feb.
Brookston	3.73	1,247 (138.6)	10.4	1.7	1.4
Cloquet (above Knife Falls)	0.88	57,650 (6,405.6)	87.7	5.6	4.2
Above Scanlon Dam	0.67	5,760 (640.0)	97.2	13.0	18.0
Above Fond du Lac Dam	1.45	290,676 (32,297.3)	99.8	4.2	12.0
Fond du Lac Bridge	1.88	57,002 (6,333.6)	82.5	4.5	11.0
Oliver Bridge	2.47	3,685 (409.4)	42.1	3.7	9.5
Spirit Lake outlet	1.56	4,800 (533.3)	62.5	4.4	9.6

Reptiles and Amphibians

No exhaustive sampling survey was undertaken, but during the reconnaissance seven species of reptiles and amphibians were observed. Several wood turtles (Clemmys insculpta) were first observed in the St. Louis River between Highway 100 south of Aurora and Highway 53. (See Table 26).

The eastern garter snake, snapping turtle, western painted turtle, mink frog, leopard frog, and wood frog were also observed.

Table 26. Species of reptiles and amphibians observed along the St. Louis River during the 1976 - 1977 survey.

Species		Sector				
Common Name	Scientific Name	5	4	3	2	1
Snapping turtle	*Chelydra serpentina*			X		
Wood turtle	*Clemmys insculpta*		X			
Western painted turtle	*Chrysemys picta belli*		X			
Eastern garter snake	*Thamnophis sirtalis sirtalis*					X
Mink frog	*Rana septentriaonalis*		X			
Northern leopard frog	*Rana pipiens pipiens*			X		
Wood frog	*Rana sylvatica*			X		

Fisheries

Of the total number of larger sized fish species caught (54.5 fish per hour) in the St. Louis River in 1976 and 1977, yellow perch, northern redhorse, white suckers, black bullheads, black crappies, walleyes, smallmouth bass and northern pike were more than two percent of the catch and comprised 95.3 percent of the electrofishing catch. These species were 85.3 percent of the total weight. Channel catfish and rock bass were 1.4 percent of the catch. Carp, silver redhorse, burbot, largemouth bass, bluegills, and pumpkinseeds were less than 1.0 percent of the total catch. The crappies and yellow perch were small and were 1.9 percent of the total catch by weight. Channel catfish and carp were large sized fish and comprised a large portion, 9.5 and 4.1 percent of the total catch by weight. (Table 30).

Excluding small sized fish species such as minnows and darters, 11.6 percent (6.4 per hour) of the fish sampled with electrofishing gear in 1976 and 1977 were game fish such as walleye, smallmouth bass, northern pike and channel catfish; 42.7 percent were large sized rough fish such as redhorse, white sucker, and carp; 8.9 percent were sport fish such as crappies and rock bass, and other fish (mostly yellow perch) were 36.8 percent of the catch. By weight 11.6 percent of the catch was game fish, 83.0 percent was large rough fish, 0.4 percent was sport fish, and 5.0 percent was other fish.

In the upper reaches above the mouth of the Partridge River the species caught electrofishing were walleye, smallmouth bass, yellow perch, rock bass, white suckers, northern redhorse, and black bullheads. Below the mouth of the Partridge River to the Forbes Dam; northern pike, northern redhorse, white suckers, rock bass, and yellow perch were the commonly caught species (more than two percent of the catch), and walleye and burbot were also present. From the Forbes Dam to the mouth of the Whiteface River; northern redhorse, white suckers, smallmouth bass, and walleyes were the primary constituents, two percent or more of the catch; channel catfish and northern pike were also present. Between the mouth of the Whiteface River and Cloquet, northern pike, northern redhorse, white suckers, channel catfish, smallmouth bass, black crappies (young-of-the-year), yellow perch, and walleye were the primary constituents (over two percent) of the electrofishing catches.

From Cloquet downstream the characteristics of the fish population change considerably. At the point where it was severely degraded near Scanlon only white suckers and a few minnows were found where dissolved oxygen was present (usually below riffles and dams), but farther downstream where local conditions were somewhat better (including river mouths, rapids, and riffles) other species commonly found in the St. Louis River system were present, but not abundant (less than 10 percent of the total catch). Below the Fond du Lac Dam and in the estuary, and St. Louis Bay, yellow perch (mostly young-of-the-year), white suckers, and black bullheads comprised 91 to 97 percent of the electrofishing catches in variable combinations from sample to sample. In St. Louis Bay game fish were a small portion of the catch, 3.3 percent, but the rate of catch was high, 11.3 fish per hour, and was similar to the catch rate of 9.3 game fish per hour above Cloquet. Between St. Louis Bay and the Fond du Lac Dam the game fish catch rate varied from 1.2 to 2.1 fish per hour. (Table 35).

In 1941 the St. Louis was seined at several places throughout its course and 20 species of fish were caught. In 1974 many of these seining stations were resampled and 19 species of fish were caught. Thirteen species of fish were caught both years, and they comprised the bulk of the catch both years, 88 percent in 1941 and 95 percent in 1974. The species caught both years were rock bass, tadpole madtom, northern pike, yellow perch, Johnny darter, longnose dace, trout perch, white sucker, redhorse, black bullhead, long perch, common shiner, and blacknose shiner. (Table 36).

During the electrofishing survey small sized species of fish were caught at a rate of 36.4 fish per hour, they were central mudminnow, longnose dace, hornyhead chub, pearl dace, fathead minnow, emerald shiner, mimic shiner, common shiner, spotfin shiner, spottail shiner, blacknose dace, trout perch, log perch, Johnny darter, brook stickleback, and mottled sculpin. Of these the emerald shiner, common shiner, spottail shiner, blacknose dace, trout perch, and log perch were the species which occurred most commonly (more than two percent of the catch of small sized species).

In 1968 the St. Louis River was sampled extensively with trap nets. The species of fish that occurred commonly (more than two percent of the catch) were white sucker, northern redhorse, channel catfish, black bullhead, northern pike, walleye, rock bass and black crappie. Black bullheads, yellow bullheads,

tadpole madtom, yellow perch, smallmouth bass, pumpkinseed, bluegill, and burbot comprised 10 percent of the total catch. As in 1977 yellow perch occurred most commonly in the lower part of the river. Since trapnets don't catch young-of-the-year fish, the total catch of smallmouth bass and perch was low. In 1968 channel catfish were found throughout the entire length of the river, but in 1978 they were only caught in the part of the river from below the dam near Forbes to Cloquet. White suckers dominated the catch below Cloquet and were less abundant in the other portions of the river. (Table 39).

A considerable portion of the river was electrofished in 1976 when the water levels were low. The field notes state that the highest catches of fish were obtained in deep areas where rocks and boulders were present, in pools below rapids, and where there were brush and logs along the edge of the river. Few to no fish were caught in the long straight sections of river channel. In all the 1976 samples of fish above Cloquet the average catch rate was 35 $\pm$ 5.7 fish per hour. When the samples were separated by substrate and type of cover, the catches on boulder bottoms with logs was highest (83 fish per hour), catches over boulder bottoms without logs and in a pool below a rapids were intermediate (39 fish per hour), and fish were caught at 23 fish per hour (significantly lower than average) over sandy bottoms when logs and brush were lodged in the river. Note the catches over sandy bottoms were lowest. After the data was separated by habitat it was noted that there was a correlation ($r = 0.91$) between the catch rate and the secchi disc water transparency. It appears that the catch increased about 5.1 fish per hour for every foot of increase of transparency. (Table 40)

The variation of the diversity index for the various reaches of the river above Cloquet is an indication of the quality of the habitat. Between Forbes and the mouth of the Partridge River much of the river's channel is sandy and the diversity index was 1.68 for the larger sized fish species. The diversity index was highest for the reach above the mouth of the Partridge River and above Cloquet to the mouth of the Whiteface River (2.35 and 2.68 respectively). Between Forbes and the Whiteface River junction the value was intermediate (2.06), and the channel was about half pool and rapids, and half a straight relatively shallow sandy-clay channel. (Table 41)

Conditions Related to Fish Kills

Reports of fish kills and low dissolved oxygen occur frequently upstream in, and downstream from Thomson Reservoir. A 1964 letter to the Director of Fish and Wildlife summarizes the problem as follows: "Dissolved oxygen is chronically at low levels or at times absent in parts of the St. Louis River below Cloquet due primarily to wastes from the Northwest Paper Company and the Wood Conversion Company at Cloquet." The fish kills recorded in the files are as follows:

1. July and August, 1956
2. May 1958
3. August 1969
4. August 1970
5. September 1971
6. July 1973

In addition to the low dissolved oxygen, the 1956 report notes that the water color was grayish, the water was quite turbid, gas bubbles were observed over the entire Thomson Reservoir surface, the odor of hydrogen sulphide, was present, and the concentration of sulphites and sulphides was 18 p.p.m. in the reservoir and 4 p.p.m. in the inflowing water. These concentrations of sulphides are sufficient to kill fish. Sulphites are rapidly converted to sulphates and remove dissolved oxygen from the water.

In 1958 there was an extensive fish kill on the St. Louis from the Fond du Lac Dam to one block below the Oliver Bridge on May 19, 1958. The dissolved oxygen was 0.3 p.p.m. and 1,218 dead suckers and redhorse and 295 walleye were counted and additional dying fish were observed. Some dead fish were observed as early as May 11 and became very numerous before May 19. On May 21 water samples were anlyzed from a number of locations from Cloquet to St. Louis Bay: by the Department of Health, and several BOD and dissolved oxygen samples were taken at various dates by the Duluth Water, Gas and Sewage Department near Fond du Lac. At that time the BOD ranged from 6 to 25 p.p.m. from the Northwest Paper Co. Dam in Cloquet to the Oliver Bridge. On May 21, 1958 the dissolved oxygen ranged from 5.5 ppm at the Northwest Paper Co. Dam to 0.0 ppm at the Fond du Lac and Oliver Bridges. Above the Problem area the BOD was 2.5 ppm and the dissolved oxygen was 6.8 ppm. (Table 19)

To determine to what extent and how the parameters (total solids, total volitile matter, turbidity, dissolved oxygen, and biochemical oxygen demand) used in the water analysis were related, the correlation coefficients and the equations for the line were calculated. There was little correlation between the dissolved oxygen and the biochemical oxygen demand (BOD) (r= -0.36), but there was a good correlation between turbidity and BOD (r= +0.92) with the equation being y = 2.19 x -11.37; where y is the BOD and x is the turbidity.

The 1968-1971 turbidity and BOD data for Brookston was analyzed to ascertain if there was a similar correlation. In the Brookston data there was a correlation (r= +0.70), the intercept of the line (1.68) was smaller, and the slope of the line (0.11) was smaller than it was for the data below Cloquet. At Fond du Lac the 1968-1971 data was erratic, r = 0.22 (note that the slope of the line in 1958 was higher than it was in the 1968-1970 data) and that at Brookston at zero turbidity (lines intercept) the BOD was 1.68 to 1.7 p.p.m.

Hutchinson (1941) notes that in lake water where particulate matter is excluded the oxygen declines at a rate of 0.2 to 0.28 p.p.m. per day, about 1 to 1.4 p.p.m. in 5 days which is similar to the rate found in the St. Louis River at Brookston. Since the maximum turbidity in 1958 was 16 p.p.m. a normal BOD would have been about 3.5 p.p.m., 1.7 + 16 (0.11), instead of the 25 p.p.m. observed. The BOD was partially correlated with total volitile matter (r= +0.59) equation; y= 1.77 x + 102.42, where y= total volitile matter and x= BOD. Apparently the total volitile matter starts to be a problem when it exceeds 102 mg./l.

There were only three other correlations in the 1958 data that were significant, a correlation coefficient of r= +0.91 between total solids and total volitile matter, a correlation coefficient of r= -0.81 between total volitile matter and dissolved oxygen. From the foregoing it appears that part of the decrease in oxygen occurred rapidly before the BOD was determined in the laboratory.

Dissolved oxygen data and biochemical oxygen demand data can be combined to determine the number of 5-day periods of oxygen supply by dividing the dissolved oxygen by the BOD. This was correlated with river flow at Fond du Lac (r= +0.99), and poorly correlated with flow at Brookston (r= -0.61). The 1958 investigation suggested that low river flows were related to the fish kill. On May 14, 1958 a 5-day oxygen supply (DO divided by the BOD) was 1.4/7.9 or 0.18 and the supply calculated from a flow of 770 cfs was 0.26. Apparently the pollutants were too concentrated at low flow. (Tables 20-21)

Table 27. Species of fish caught electrofishing in the St. Louis River during the 1976 - 1977 survey.

Species		Sector				
Common Name	Scientific Name	5	4	3	2	1
Northern pike	*Esox lucius*		X	X	X	X
Carp	*Cyprinus carpio*					X
Northern redhorse	*Moxostoma macrolepidetum*	X	X	X	X	X
Silver redhorse	*Moxostoma anisurum*					X
White sucker	*Catostomus commersoni*	X	X	X	X	X
Channel catfish	*Ictalurus punctatus*			X	X	
Black bullhead	*Ictalurus melas*	X				X
Burbot	*Lota lota*		X	X	X	
Largemouth bass	*Micropterus salmoides*				X	
Smallmouth bass	*Micropterus dolomieui*	X		X	X	
Rock bass	*Ambloplites rupestris*	X	X	X	X	X
Bluegill	*Lepomis macrochirus*			X	X	X
Pumpkinseed	*Lepomis gibbosus*			X	X	
Black crappie	*Pomoxis nigromaculatus*				X	X
Yellow perch	*Perca flavescens*	X	X		X	X
Walleye	*Stizostedion vitreum vitreum*	X	X	X	X	X
Central mudminnow	*Umbra limi*		X			
Longnose dace	*Rhinichthys cataractae*		X	X		
Hornyhead chub	*Nocomis biguttatus*					X
Pearl dace	*Semotilus margarita*					X
Fathead minnow	*Pimephales promelas*					X
Emerald shiner	*Notropis atherinoides*					X
Mimic shiner	*Notropis volucellus*			X		
Common shiner	*Notropis cornutus*	X		X	X	X
Spotfin shiner	*Notropis spilopterus*		X			
Spottail shiner	*Notropis hudsonius*	X			X	X
Blacknose shiner	*Notropis heterolepis*	X			X	
Trout-perch	*Percopsis omiscomaycus*	X	X	X	X	
Log perch	*Percina caprodes*		X	X	X	X

Table 27 Continued

Species		Sector				
Common Name	Scientific Name	5	4	3	2	1
Johnny darter	*Etheostoma nigrum*		X	X		X
Brook stickleback	*Culaea inconstans*				X	
Mottled sculpin	*Cottus bairdi*			X		

Table 28. Length-frequency distributions of the electrofishing catches in 1976-77.

Total Length in Inches	Species and Numbers of Fish in Length Groups								
	Northern Pike	Carp	Northern Redhorse	Silver Redhorse	White Sucker	Channel Catfish	Black Bullhead	Burbot	Largemouth Bass
					13			1	4
3.0 - 3.4					7				
3.5 - 3.9					4				
4.0 - 4.4					1				
4.5 - 4.9			2		1				
5.0 - 5.4			15		2				
5.5 - 5.9			16		3				
6.0 - 6.4			9		6		2	1	
6.5 - 6.9					6		15	2	
7.0 - 7.4			3		6		67	1	
7.5 - 7.9			2		2		28	1	
8.0 - 8.4			6		3		9		
8.5 - 8.9			11		2		1		
9.0 - 9.4			5		2				
9.5 - 9.9	1		7		4				
10.0 - 10.4			12		8				
10.5 - 10.9			8		6	2			
11.0 - 11.4			13		14	1			
11.5 - 11.9	2		6		11	3			
12.0 - 12.9	4		17		31	2			
13.0 - 13.9	3		30	1	26	1			
14.0 - 14.9	4		48		39				
15.0 - 15.9	4		47		48	1			
16.0 - 16.9	2		42		37	2			
17.0 - 17.9	2		24		29	2			
18.0 - 18.9	1	1	18	2	21	2			
19.0 - 19.9		1			8	4			
20.0 - 20.9	3		1	1		1			
21.0 - 21.9	3	3				1			
22.0 - 22.9						1			
23.0 - 23.9		3							
24.0 - 24.9	1	2							
25.0 - 25.9	1								
26.0 - 26.9									
27.0 - 27.9	1	1							
28.0 - 28.9		1							
29.0 - 29.9									
30.0 - 30.9		1							
31.0 - 31.9									
32.0 - 32.9									
33.0 - 33.9									
34.0 - 34.9									
35.0 - 35.9									
36.0 - 36.9									
TOTALS	32	13	342	4	340	23	122	6	4

Table 28. Length-frequency distributions of the electrofishing catches in 1976-77.

Total Length in Inches	Species and Numbers of Fish in Length Groups								
	Small-mouth Bass	Rock Bass	Bluegill	Pump-kin seed	Black Crappie	Yellow Perch	Walleye		
	21	7	1		94	382	2		
3.0 - 3.4	10	3				14	5		
3.5 - 3.9	2	1							
4.0 - 4.4	1	4		1	1	8	1		
4.5 - 4.9	1	3	1			18	2		
5.0 - 5.4	1	1				18	5		
5.5 - 5.9	4					8	4		
6.0 - 6.4	3				1	6	1		
6.5 - 6.9	1			1		3	4		
7.0 - 7.4	5		1		1	6	1		
7.5 - 7.9	3				1	3	3		
8.0 - 8.4	4				3	4	1		
8.5 - 8.9	2					3	2		
9.0 - 9.4	1	2				5	3		
9.5 - 9.9		2				3	8		
10.0 - 10.4						5	1		
10.5 - 10.9	1					1	2		
11.0 - 11.4	1					1	2		
11.5 - 11.9						2	2		
12.0 - 12.9							3		
13.0 - 13.9	2						4		
14.0 - 14.9							1		
15.0 - 15.9							3		
16.0 - 16.9							2		
17.0 - 17.9							5		
18.0 - 18.9									
19.0 - 19.9									
20.0 - 20.9							1		
21.0 - 21.9									
22.0 - 22.9									
23.0 - 23.9									
24.0 - 24.9									
25.0 - 25.9									
26.0 - 26.9									
27.0 - 27.9									
28.0 - 28.9									
29.0 - 29.9									
30.0 - 30.9									
31.0 - 31.9									
32.0 - 32.9									
33.0 - 33.9									
34.0 - 34.9									
35.0 - 35.9									
36.0 - 36.9									
TOTALS	63	23	3	2	101	490	68		

Table 29. Length-frequency distributions of the 1968 trapnet catches in the St. Louis River.

Total Length in Inches	Species and Numbers of Fish in Length Groups								
	White Sucker	No. Red-horse	Channel Catfish	Black Bull-head	Yellow Bull-head	No. Pike	Yellow Perch	Walleye	Small-mouth Bass
3.0 - 3.4									
3.5 - 3.9									
4.0 - 4.4							1		
4.5 - 4.9									
5.0 - 5.4							2		
5.5 - 5.9				1			1		
6.0 - 6.4					1			1	
6.5 - 6.9	1				1		2		
7.0 - 7.4			1				3		1
7.5 - 7.9	1	1					2		
8.0 - 8.4	2	2	1				2	1	2
8.5 - 8.9	2	2		2			1	2	
9.0 - 9.4	3		6			2	2		
9.5 - 9.9	3		5			1	2	3	
10.0 - 10.4	5	1	2	1		2	1	1	
10.5 - 10.9	2			2	1	8	1	2	1
11.0 - 11.4	3	2	2		3	6		5	
11.5 - 11.9	4	6	1					4	1
12.0 - 12.9	15	16	6	2	2	2		3	3
13.0 - 13.9	19	28	12			3		3	1
14.0 - 14.9	55	22	7			4		2	
15.0 - 15.9	62	70	8			5		1	
16.0 - 16.9	35	51	11			4		1	
17.0 - 17.9	44	29	19			2			
18.0 - 18.9	45	10	19			3		2	
19.0 - 19.9	24	6	16			1			
20.0 - 20.9	7	3	4			2			
21.0 - 21.9	1		9			3			
22.0 - 22.9	1		3			1			
23.0 - 23.9	1		7			1			
24.0 - 24.9			1			1			
25.0 - 25.9						1			
26.0 - 26.9			1			1			
27.0 - 27.9						1			
28.0 - 28.9			1			1		1	
29.0 - 29.9									
30.0 - 30.9									
31.0 - 31.9									
32.0 - 32.9									
33.0 - 33.9									
34.0 - 34.9									
35.0 - 35.9									
36.0 - 36.9						1			
44.5						1			
TOTALS	335	249	142	8	8	57	20	32	9

Table 29 Continued

Species and Numbers of Fish in Length Groups

Total Length in Inches	Pumpkinseed	Bluegill	Rock Bass	Black Crappie	Burbot				
3.0 - 3.4									
3.5 - 3.9			1	1					
4.0 - 4.4		1	1	2					
4.5 - 4.9				2					
5.0 - 5.4	2	1		7					
5.5 - 5.9		2	1	2					
6.0 - 6.4		1		3					
6.5 - 6.9		1	2	2					
7.0 - 7.4	2	6	1	3					
7.5 - 7.9		3	1	1					
8.0 - 8.4		3	3	2					
8.5 - 8.9	1	1	5						
9.0 - 9.4			8						
9.5 - 9.9		1	2	1					
10.0 - 10.4			3	1	1				
10.5 - 10.9				2					
11.0 - 11.4				1					
11.5 - 11.9				2					
12.0 - 12.9					1				
13.0 - 13.9					1				
14.0 - 14.9					1				
15.0 - 15.9									
16.0 - 16.9									
17.0 - 17.9									
18.0 - 18.9					2				
19.0 - 19.9									
20.0 - 20.9									
21.0 - 21.9									
22.0 - 22.9									
23.0 - 23.9									
24.0 - 24.9									
25.0 - 25.9									
26.0 - 26.9									
27.0 - 27.9									
28.0 - 28.9									
29.0 - 29.9									
30.0 - 30.9									
31.0 - 31.9									
32.0 - 32.9									
33.0 - 33.9									
34.0 - 34.9									
35.0 - 35.9									
36.0 - 36.9									
TOTALS	5	20	28	32	6				

Table 30. The species composition and rate of catch (fish/hr.) in the St. Louis River, 1976-77 electrofishing catches (30.04 hrs. fished, 31.92 miles shocked).

Species	No.	Percent of Catch	Weight (lbs.)	Percent by Weight	Fish/hr.
Northern pike	32	2.0	39.0	3.5	1.1
Carp	13	0.8	105.8	9.5	0.4
Northern redhorse	342	20.9	390.9	35.0	11.4
Silver redhorse	4	0.2	11.5	1.0	0.1
White sucker	340	20.8	418.4	37.5	11.3
Channel catfish	23	1.4	45.7	4.1	0.8
Black bullhead	122	7.5	31.4	2.8	4.1
Burbot	6	0.4	1.5	0.1	0.2
Largemouth bass	4	0.2	--	--	0.1
Smallmouth bass	63	3.8	11.1	1.0	2.1
Rock bass	23	1.4	3.9	0.3	0.8
Bluegill	3	0.2	0.5	--	0.1
Pumpkinseed	2	0.1	0.4	--	0.1
Black crappie	101	6.2	1.6	0.1	3.4
Yellow perch	490	29.9	20.1	1.8	16.3
Walleye	68	4.2	33.7	3.0	2.3
Subtotals	1636	100.0	1115.5	100.0	54.5
Central mudminnow	3	0.3			0.1
Longnose dace	6	0.5			0.2
Hornyhead chub	6	0.5			0.2
Pearl dace	3	0.3			0.1
Fathead minnow	3	0.3			0.1
Emerald shiner	78	7.1			2.6
Mimic shiner	12	1.1			0.4
Common shiner	48	4.4			1.6
Spotfin shiner	1	0.1			--
Spottail shiner	682	62.4			22.7
Blacknose dace	75	6.9			2.5
Trout perch	51	4.7			1.7
Log perch	108	9.9			3.6

Table 30. The species composition and rate of catch (fish/hr.) in the St. Louis River, 1976-77 electrofishing catches (30.04 hrs. fished, 31.92 miles shocked), continued.

Species	No.	Percent of Catch	Weight (lbs.)	Percent by Weight	Fish/hr.
Johnny darter	15	1.4			0.5
Brook stickleback	1	0.1			--
Mottled sculpin	1	0.1			--
Subtotals	1093	100.0			36.4
Totals	2729	100.0			90.8

Table 31. The species composition and catch rate (fish/hr.) in the St. Louis River electrofishing catches (2.35 hrs. fished, 0.86 miles shocked) from the Partridge River to Seven Beaver Lake in 1976-77.

Species	No.	Percent of Catch	Weight (lbs.)	Percent by Weight	Fish/hr.
Northern redhorse	3	9.4	3.2	28.3	1.3
White sucker	5	15.6	2.4	21.2	2.1
Black bullhead	3	9.4	0.6	5.3	1.3
Smallmouth bass	3	9.4	1.6	14.2	1.3
Rock bass	4	12.5	0.6	5.3	1.7
Yellow perch	6	18.7	0.9	8.0	2.5
Walleye	8	25.0	2.0	17.7	3.4
Subtotals	32	100.0	11.3	100.0	13.6
Common shiner	23	21.5			9.8
Spottail shiner	1	0.9			0.4
Blacknose shiner	72	61.3			30.6
Trout perch	11	10.3			4.7
Subtotals	107	100.0			45.5
Totals	139	100.0			59.1

Table 32. The species composition and catch rates (fish/hr.) in the St. Louis River electrofishing catches (5.60 hrs. fished, 5.95 miles shocked) from the dam near Forbes to Partridge River in 1976 and 1977.

Species	No.	Percent of Catch	Weight (lbs.)	Percent by Weight	Fish/hr.
Northern pike	5	3.1	4.5	2.0	0.9
Northern redhorse	89	54.9	118.8	54.2	15.9
White sucker	52	32.1	93.5	42.7	9.3
Burbot	3	1.8	0.4	0.2	0.5
Rock bass	5	3.1	0.2	0.1	0.9
Yellow perch	5	3.1	0.5	0.3	0.9
Walleye	3	1.8	1.2	0.5	0.5
Subtotals	162	100.0	219.1	100.0	28.9
Central mudminnow	3	7.5			0.5
Longnose dace	2	5.0			0.4
Common shiner	5	12.5			0.9
Spotfin shiner	1	2.5			0.2
Trout perch	14	35.0			2.5
Log perch	7	17.5			1.2
Johnny darter	8	20.0			1.4
Subtotals	40	100.0			7.1
Totals	202	100.0			36.1

Table 33. The species composition and catch rate (fish/hr.) in the St. Louis River electrofishing catches (2.03 hrs. fished, 1.95 miles shocked) from the Whiteface River to dams near Forbes in 1976 and 1977.

Species	No.	Percent of Catch	Weight (lbs.)	Percent by Weight	Fish/hr.
Northern pike	2	0.9	7.2	3.8	1.0
Northern redhorse	89	42.0	69.9	37.0	43.8
White sucker	68	32.1	85.3	45.2	33.5
Channel catfish	3	1.4	8.0	4.2	1.5
Burbot	2	0.9	0.1	--	1.0
Smallmouth bass	30	14.1	4.3	2.3	14.8
Rock bass	2	0.9	--	--	1.0
Bluegill	1	0.5	0.1	--	0.5
Pumpkinseed	1	0.5	0.1	--	0.5
Walleye	14	6.6	13.7	7.3	6.9
Subtotals	212	100.0	188.7	100.0	104.4
Longnose dace	4	4.3			2.0
Common shiner	1	1.1			0.5
Mimic shiner	12	13.0			5.9
Trout perch	4	4.3			2.0
Log perch	68	73.9			33.5
Johnny darter	2	2.2			1.0
Mottled sculpin	1	1.1			0.5
Subtotals	92	100.0			45.3
Totals	304	100.0			149.7

Table 34. The species composition and catch rate (fish/hr.) in the St. Louis River electrofishing catches (11.67 hrs. fished, 15.57 miles shocked) from Cloquet to the Whiteface River mouth in 1976 and 1977.

Species	No.	Percent of Catch	Weight (lbs.)	Percent by Weight	Fish/hr.
Northern pike	17	3.9	12.4	3.4	1.5
Northern redhorse	156	35.6	190.2	52.4	13.4
White sucker	56	12.8	102.1	28.1	4.8
Channel catfish	20	4.6	37.7	10.4	1.7
Burbot	1	0.2	1.0	2.7	0.1
Largemouth bass	4	0.9	--	--	0.3
Smallmouth bass	30	6.8	5.2	1.4	2.6
Rock bass	7	1.6	2.5	6.9	0.6
Bluegill	1	0.2	0.4	0.1	0.1
Pumpkinseed	1	0.2	0.3	0.1	0.1
Black crappie	100	22.8	1.6	0.4	8.6
Yellow perch	12	2.7	1.0	2.7	1.0
Walleye	33	7.5	8.3	2.3	2.8
Subtotals	438	100.0	362.7	100.0	37.5
Common shiner	7	1.7			0.6
Spottail shiner	347	85.9			29.7
Blacknose shiner	3	0.7			0.3
Trout perch	22	5.4			1.9
Log perch	24	5.9			2.1
Brook stickleback	1	0.2			0.1
Subtotals	404	100.0			34.6
Totals	842	100.0			72.1

Table 35. Change in catch rate and composition in the lower St. Louis River from Highway 2 to St. Louis Bay near the Arrowhead Bridge in 1976 and 1977.

Location	Percent of Catch					Total Catch Per Hr.	Catch Per Hr. Excluding Perch and Bullheads
	White Sucker	Yellow Perch	Other Fish	Game Fish			
				All	NP & WA		
Hwy 2 to Hwy 23 in Cloquet	2.3	2.3	71.7	23.7	11.3	40.2	39.3
Above Hwy 61 at Scanlon	100.0[1/]	0	0	0	0	20.7	20.7
Upper Fond du Lac Reservoir	90.9	2.0	7.9	0	0	124.9	122.0
Fond du Lac Dam to Hwy 23	28.1	53.4	14.6[2/]	3.9	3.9	53.4	19.7
Estuary Below Hwy 23	4.3	56.9	37.1[3/]	1.7	1.7	70.9	4.9
St. Louis Bay (No. of Arrowhead Bridge)	4.0	87.2	5.5	3.3	3.3	343.5	43.9

1/ In a 0.43 mile stretch of river with good substrate covered with sphaerotilus fish and were only caught in the upper ¼ with oxygen suppled from the dams tailwaters pool. The lower 3/4 was degraded and anaerobic.

2/ Bullheads 9.7 percent.

3/ Bullheads 36.2 percent.

Table 36

Catches of fish in seine hauls in 1941 and 1974 in the St. Louis River above Cloquet.

Species	1941	1974
Spottail shiner	49	
Rock bass	37	7
Tadpole madtom	84	22
Northern pike	10	2
Yellow perch	52	4
Johnny darter	309	26
Longnose dace	93	2
Golden shiner	27	
Trout perch	91	33
White sucker	9	
Black bullhead	32	7
Log perch	1	3
Black crappie	5	
Redhorse	9	48
Sand shiner	214	
Creek chub	1	
Walleye	1	
Burbot	1	
Common shiner	45	20
Blacknose shiner	1	35
Smallmouth bass		2
Largemouth bass		1
Iowa darter		2
Blackchin shiner		4
Sculpin		1
Bluegill		3
Totals	1071	221
Hauls	21	35

Table 37. Catches of fish in the Thomson and Fond du Lac Reservoirs in 4 trapnet sets per reservoir in 1968.

Species*	THOMSON				FOND DU LAC			
	Total Number	Number per Set	Total Pounds	Pounds per Set	Total Number	Number per Set	Total Pounds	Pounds per Set
White sucker	340	85.00	386.3	92.08	187	46.75	130.8	32.70
Brown bullhead	2	0.50	0.7	0.18				
Northern pike	1	0.25	1.0	0.25				
Yellow perch	2	0.50	0.4	0.10				
Burbot	2	0.50	1.1	0.28				
Walleye					1	0.25	0.1	0.03
Totals	347	86.75	371.5	92.9	188	47.00	130.9	32.73
Water Temp. (sur.)	53° F				65° F			
Secchi Disc (ft.)	2				2			
Dissolved oxygen in ppm at Surface	8.0				5.0			
Date	September 5-6, 1968				September 12-13, 1968			
Total Alk. ppm	40				40			

*List species in phylogenetic order.

Table 38. Catches of fish in gillnets in the Thomson and Fond du Lac Reservoirs in 2 sets in each reservoir in September 1968.

Species*	THOMSON				FOND DU LAC			
	Total Number	Number per Set	Total Pounds	Pounds per Set	Total Number	Number per Set	Total Pounds	Pounds per Set
White sucker	441	220.5	480.0	240.00	217	108.5	95.0	47.50
Northern redhorse	1	0.5	1.7	0.85				
Brown bullhead	1	0.5	1.0	0.50				
Northern pike	25	12.5	13.1	6.55	3	1.5	1.3	0.65
Yellow perch	11	5.5	2.9	1.45				
Walleye	4	2.0	1.9	0.95				
Rock bass	1	0.5	0.3	0.15				
Totals	484	242.0	520.9	250.45	220	110.0	96.3	48.15

Table 39. In St. Louis River comparative abundance and percentage composition of catch in trapnets in 1968.

Species	Whole River			Sector - Catch Per Set				
	No. of Fish	Catch Per Set	Percent Composition	I	II	III	IV	V
White sucker	319	3.89	34%	8.17	2.38	2.19	0.33	4.75
Northern redhorse	242	2.95	26%	0.89	2.75	5.06	1.83	3.95
Channel catfish	143	1.74	15%	0.83	1.56	5.19	0.33	0.80
Black bullhead	9	0.11	1%		0.13	0.31	0.08	0.05
Yellow bullhead	8	0.10	1%			0.06		0.35
Tadpole madtom	1	0.01	1%					0.05
Northern pike	56	0.68	6%	0.61	0.38	0.25	0.42	1.50
Yellow perch	20	0.24	2%	0.22	0.06		0.08	0.70
Walleye	30	0.37	3%	0.39	0.19	0.81	0.50	0.05
Smallmouth bass	9	0.11	1%		0.38	0.19		
Pumpkinseed	5	0.06	1%	0.11		0.06		0.10
Bluegill	20	0.24	2%	0.39	0.13	0.19		0.40
Rock bass	27	0.33	3%	0.33	0.56	0.25		0.40
Black crappie	32	0.39	3%	0.44	0.50	0.19	0.75	0.20
Burbot	4	0.05	1%	0.11				0.10
Total Catch Set		11.3		12.5	9.0	14.8	4.3	13.4
Total No. Fish	925			225	144	236	52	268
Total No. Sets		82		18	16	16	12	20

Table 40. Catch rate in electrofishing samples in 1976 by type of habitat and the catch rate adjusted for water transparency in ( ) 1/. Little water velocity and depths 3 to 5 feet.

	Overall Catch Rate	Habitats Separated		
		Boulder, log	Boulder + Rapids Pool	Sand, Logs & Brush
Catch Per Hour				
Mean	35.0 (33.8)	82.8 (83.8)	39.2 (39.4)	23.0 (20.4)
Conf. Limits	5.7 (5.8)	--	±10.6 (12.0)	±5.7 (2.2)
Standard Dev.	22.1 (22.6)	--	7.4 (8.4)	10.2 (4.0)
Number Samples	9	1	3	5
Secchi Transparency				
Mean	3.0	2.6	2.8	3.3
Standard Dev.	1.29	--	0.31	1.85

1/ Over sand bottoms r= 0.91 for catch vs secchi disc in feet (catch per hour = (secchi disc ft.) (5.1) + 6.12) so the crude rate was adjusted to a transparency of 2.8 ft. as follows: adjusted rate = crude rate + 5.1 (obs. secchi - 2.8).

Table 41. Species diversity of electrofishing catches fish populations in the St. Louis River.

Location	Large Sized Fishes Only	All Species
Cloquet to Hwy 23	d < 1.00*	---
Cloquet to Whiteface River	2.68	2.80
Whiteface River to Dam near Forbes	2.06	2.73
Dam near Forbes to Partridge River	1.68*	2.55
Partridge River to Seven Beaver Lake	2.35	2.62
Whole River	1.57**	2.36

*Low varies considerably from area to area

**Low includes estuary and catches between Cloquet and estuary

Terrestrial Vegetation

The trees that occurred in four of the five river sectors were balsam fir, white spruce, red pine, white pine, white cedar, balsam poplar, aspen, paper birch, American elm, basswoods, box elder, silver maple, black ash, and green ash. Of these aspen, paper birch, American elm, box elder, and green ash occurred commonly in four of the five sectors. Aspen and paper birch are characteristic of the second growth upland forest covering much of the watershed. The other trees occur more commonly along waterways in varying combinations, but are usually mixed with aspen and/or birch where the dryer uplands are close to the river bank. Willow, alder, hazel, wild rose, red-osier dogwood, and high bush cranberry were the shrubs that were observed most frequently. (Table 42)

Above the junction of the Partridge River in the dryer portions of the uplands, aspen and birch are the dominant tree species with spruce, fir, and pine being present in variable combinations. Hazel brush occurs commonly in dense stands. Along the higher river banks black ash occurs commonly with varying amounts of spruce, fir, cedar, birch, and larger trees lean over the river. Shrubs that occur commonly along the river banks are dogwood, alder, and mountain maple. Where the river is slower and wider, usually there is a wide and low lying flood boggy flood plain which has variable combinations of sedge and willow with a fringe of black spruce between the flood plain and the uplands.

Below the mouth of the Partridge River a hardwood forest with variable species combinations and some conifers bordered the river. In some areas dead elms were present. Near the middle of this reach of river soils were very sandy, much natural bank erosion is present and the river meanders considerably and the principal tree species present were silver maple and box elder.

Above the area where the river meandered several species were present, the most important being aspen, birch, black and green ash, silver maple, and box elder, with some spruce and fir being present. The lower end of the reach of river above the dam near Forbes has a similar vegetation except that some white pine and white cedar are present.

From the dam near Forbes to the junction of the Swan River the river flows through a well entrenched narrow valley where hardwood trees dominate and various species of coniferous trees occur commonly. The tree species that occurred most commonly were aspen, balsam poplar, white birch, silver maple, basswood, fir, spruce, and white pine. The shrubs were red osier dogwood, alder, hazel, rose, poison ivy, and gooseberry. From below the junction of the Swan River to the junction of the Whiteface River 10 percent of the land along the river corridor was pastured. The commonest trees were silver maple, box elder, black ash, balsam poplar, and American elm; with willow, alder, and dogwood being the commonest shrubs.

From below the junction of the Whiteface River where the river is wider and there is a distinct river valley to Cloquet. Ten percent of the land is open farmland and residential area, and 90 percent of the land is covered with a hardwood forest primarily composed of aspen, white birch, American elm, box elder, balsam poplar, and basswood trees. Willows, red osier dogwood, and alder are the most commonly occurring shrubs.

Below Cloquet rock outcrops occur commonly, there is a considerable amount of marshland in the river's estuary, residential and commercial land are present adjacent to the river. The bulk of the land (70%) is wooded, and the commonest trees are aspen, white birch, balsam poplar, basswood, American elm, box elder, and ash. Willow and red osier dogwood are the commonest shrubs.

Table 42. Species of woody plants (trees, shrubs, vines) observed during the 1976 - 1977 survey of the St. Louis River.

Species		Sector				
Common Name	Scientific Name	5	4	3	2	1
Balsam fir	*Abies balsamea*	C	C	O	O	
Tamarack	*Larix laricina*	C				
White spruce	*Picea glauca*	O	C	C	O	P
Black spruce	*Picea mariana*	C	O			
Jack pine	*Pinus banksiana*	O			P	P
Red pine	*Pinus resinasa*		O	O	O	O
White pine	*Pinus strobus*	O	O	O	O	O
White cedar	*Thuja occidentalis*	O	O	O	O	
Balsam poplar	*Populus balsamifera*	O	O	C	C	C
Trembling aspen	*Populus tremuloides*	C	C	C	C	C
Big-toothed aspen	*Populus grandidentata*				O	
Yellow birch	*Betula lutea*			S		
Paper birch	*Betula papyrifera*	C	C	C	C	C
Northern red oak	*Quercus borealis*					P
Bur oak	*Quercus macrocarpa*		S	S	O	
American elm	*Ulmus americana*		C	C	C	C
Red elm	*Ulmus rubra*				O	P
Mountain ash	*Sorbus decora*				S	
Basswood	*Tilia americana*		O	C	C	C
Box elder	*Acer negundo*		C	C	C	C
Red maple	*Acer rubrum*					S
Silver maple	*Acer saccharinum*		C	C	O	O
Sugar maple	*Acer saccharum*		S			
Black ash	*Fraxinus nigra*	C	C	O	O	O
Green ash	*Fraxinus pennsylvanica*	O	C	C	C	C
Willow	*Salix spp.*	A	C	C	C	C
Green and speckled alder	*Alnus crispa, A. rugosa*	A	C	C	C	O
American and beaked hazelnut	*Corylus americana and C. Cornuta*	C	O	C	C	

Table 42 Continued

Species		Sector				
Common Name	Scientific Name	5	4	3	2	1
Currant or Gooseberry	*Ribies spp.*	O		O		
Juneberry	*Amelanchier spp.*	O	P			P
Hawthorn	*Crataegus spp.*	O			O	P
Wild plum	*Prunus americana*				S	
Chokecherry	*Prunus virginiana*	O	C			P
Prickly and smooth wild rose	*Rosa ocicularis and R. blanda*	O	C	C	O	
Blackberry, raspberry	*Rubus spp.*	O		O		P
Poison ivy	*Rhus radicans*		P	C		
Sumac	*Rhus spp.*					O
Mountain maple	*Acer spicatum*	O	O			
Red-osier dogwood	*Cornus stolonifera*	C	C		C	C
Blueberry	*Vaccinium angustifolium*	O				
Honeysuckle	*Lonicera spp.*					P
High-bush cranberry	*Viburnum*		O	O	O	O
Dogbone	*Apocyn*	S				
Virginia creeper				C		

Wildlife

Deer, ducks, and ruffed grouse are the principal game animals; and the beaver, muskrat, mink, fox, and otter are the main furbearing animals that occur in the watershed.

The species of shorebirds and gulls observed were spotted sandpiper, solitary sandpiper, greater yellowlegs, less yellowlegs, herring gull, ring-billed gull, common tern, killdeer, common snipe, great blue heron, and American bittern. Seven species of birds of prey were observed, and they were great-horned owl, red-tailed hawk, broad winged hawk, bald eagle, marsh hawk, and osprey. Bald eagles are commonly sighted near Fond du Lac reservoir in Jay Cook State Park. (Table 44).

Of the 48 species of smaller birds observed, the species observed most commonly were the blue jay, common raven, common crow, black-capped chickadee, cedar waxwing, common yellowthroat, goldfinch, and the white-throated sparrow.

River habitat for wildlife in the St. Louis River varies considerably from its source to its mouth. River banks are forested and occasional farms are present in the forested uplands, especially below Forbes. In the very soft water zone between the Seven Beaver Lake and the mouth of the Partridge River there are many pools resembling shallow marshes and ponds that have extensive bog brush lowlands adjacent to them, and good stands of wild rice occur in some places. There was no distinct valley adjacent to the high gradient sections and the forest started on the river bank. Several kinds of aquatic plants were found in the pools, and very few plants were present in the high gradient sections.

From the mouth of the Partridge River to the impoundment near Forbes the river channel is sandy, shallow, and frequently has eroding sandy banks. Few aquatic plants were present and forest land borders the river. From the dam near Forbes to the Whiteface River, forest land covers the high banks that are deeply incised into the relatively flat wooded countryside. Few aquatic plants were present in the many pools and riffles between Forbes and the mouth of the Swan River and the relatively straight featureless channel between the mouths of the Swan and Whiteface Rivers. From the mouth of the Whiteface River to Cloquet the river widens, flows through a distinct valley, and several beds of

submerged aquatic plants are present. Below Cloquet the rivers course and banks consist of rocks and boulders and impoundments to the estuary. Few aquatic plants are present above the estuary except in Thomson Reservoir which is quite shallow. In the upper part of the estuary, extensive stands of wild rice are present in the shallow adjacent to the main channel.

Waterfowl

Mallards, black ducks, blue-winged teal, wood ducks, and red-breasted mergansers were observed at more than one location. Canada geese, ring-necked ducks, and a green-winged teal were observed in the river below Cloquet. Three broods of red-breasted mergansers were also observed. Most of the ducks were observed above the mouth of the Partridge River in the larger river pools and between Floodwood and Cloquet and in the Thomson Reservoir near the extensive beds of aquatic plants. Of the 100 to 200 waterfowl observed, about 20 were seen between the mouth of the Partridge River and the mouth of the Whiteface River where beds of aquatic plants were absent, mergansers occurred most commonly there.

Mammals

Near the river signs of otter, raccoon, and beaver were observed. One or more of the following mammals were observed during the survey; black bear, white-tailed deer, beaver, woodchuck, red squirrel, chipmunk, and Franklins ground squirrel, and muskrat. Beaver dams and lodges were observed from the source to Highway 53. Below Highway 53 a few beaver trails were observed. (Table 43).

Table 43. Species of mammals observed along the St. Louis River during the 1976 - 1977 survey.

Species		Sector				
Common Name	Scientific Name	5	4	3	2	1
Woodchuck	*Marmota monax*	X	X	X		
Franklin's around squirrel	*Citellus franklinii*					X
Eastern chipmunk	*Tamias striatus*		X			
Red squirrel	*Tamiascirus hudsonicus*		X			X
Beaver	*Castor canadensis*	X	X	X	X	X
Muskrat	*Ondatra zibethica*			X	X	X
Porcupine	*Erethizon dorsatum*		X		X	
Black bear	*Ursus americanus*		X	X	X	
Raccoon	*Procyon lotor*			X	X	X
Mink	*Mustela vison*	X	X			
Otter	*Lutra canadensis*		X	X		
White-tailed deer	*Odocoileus virginianus*	X	X	X	X	X

Table 44. Species of birds observed along the St. Louis River during the 1976 - 1977 survey.

Species		Sector				
Common Name	Scientific Name	5	4	3	2	1
Common loon	*Gavia immer*	X				
Pied-billed grebe	*Podilymbus podiceps*	X				
Great blue heron	*Ardea herodias*	X	X	X	X	X
Green heron	*Butorides virescens*				X	X
American bittern	*Botaurus lentiginosus*		X		X	
Canada goose	*Branta canadensis*					X
Mallard	*Anas platyrhynchos*	X	X	X	X	X
Black duck	*Anas rubripes*	X			X	X
Green-winged teal	*Anas crecca*					X
Blue-winged teal	*Anas discors*			X	X	X
Wood duck	*Aix sponsa*	X	X	X		X
Ring-necked duck	*Aythya collaris*	?		X		
Common goldeneye	*Bucephala clangula*				X	
Red-breasted merganser	*Mergus serrator*		X	X		X
Red-tailed hawk	*Buteo jamaicensis*	X	X			
Broad-winged hawk	*Buteo platypterus*			X		
Bald eagle	*Haliaeetus leucocephalus*					X
Marsh hawk	*Circus cyaneus*				X	
Osprey	*Pondion haliaetus*			X		
American kestrel	*Falco sparverius*			X	X	
Ruffed grouse	*Bonasa umbellus*			X		
Killdeer	*Charadrius vociferus*				X	
Common snipe	*Capella gallinago*				X	
Spotted sandpiper	*Actitis macularia*	X	X	X	X	X
Solitary sandpiper	*Tringa solitaria*		X	X		
Greater yellowlegs	*Tringa melanoleucus*				X	
Lesser yellowlegs	*Tringa flavipes*		X		X	
Herring gull	*Larus argentatus*				X	X
Ring-billed gull	*Larus delawarensis*					X
Common tern	*Sterna hirundo*					X

Table 44 Continued

Species		Sector				
Common Name	Scientific Name	5	4	3	2	1
Mourning dove	*Zenaida macroura*				X	
Black-billed cuckoo	*Coccyzus erythropthalmus*		X			
Great horned owl	*Bubo virginianus*			X		
Chimney swift	*Chaetura pelagica*			X		
Ruby-throated hummingbird	*Archilochus colubris*			X		
Belted kingfisher	*Megaceryle alcyon*	X	X	X	X	X
Common flicker	*Colaptes auratus*	X	X	X		
Pileated woodpecker	*Dryocopus pileatus*			X		
Red-headed woodpecker	*Melanerpes erythrocephalus*			X	X	
Yellow-bellied sapsucker	*Sphyrapicus varius*		X			
Hairy woodpecker	*Dendrocopos villosus*		X			
Eastern kingbird	*Tyrannus tyrannus*	X	X	X	X	X
Great crested flycatcher	*Myiarchus crinitus*	X	X	X		
Eastern phoebe	*Sayornis phoebe*		X		X	X
Least flycatcher	*Empidonax minimus*		X			
Eastern wood pewee	*Contopus virens*		X	X		
Tree swallow	*Iridoprocne bicolor*	X				
Barn swallow	*Hirundo rustica*	X		X		
Cliff swallow	*Petrochelidon pyrrhonota*		X		X	
Purple martin	*Progne subis*		X			
Blue jay	*Cyanocitta cristata*	X	X	X	X	
Common raven	*Corvus corax*	X		X		X
Common crow	*Corvus brachyrhynchos*			X	X	X
Black-capped chickadee	*Parus atricopillus*	X	X	X		
White-breasted nuthatch	*Sitta carolinensis*		X	X		
Red-breasted nuthatch	*Sitta canadensis*		X			
Gray catbird	*Dumetella carolinensis*	X	X			
Brown thrasher	*Toxostoma rufum*	X				
American robin	*Turdus migratorius*		X	X		
Wood thrush	*Hylocichla mustelina*		X			
Cedar waxwing	*Bombycilla cedrorum*	X	X	X	X	X
Red-eyed vireo	*Vireo olivaceus*		X			
Philadelphia vireo	*Vireo philadelphicus*		X			

Table 44 Continued

Species		Sector				
Common Name	Scientific Name	5	4	3	2	1
Yellow warbler	*Dendroica petechia*	X				
Chestnut-sided warbler	*Dendroica pensylvanica*		X			
Ovenbird	*Seiurus aurocapillus*			X		
Common yellowthroat	*Geothlypis trichas*	X	X		X	
Wilson's warbler	*Wilsonia pusilla*		X			
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*				X	
Red-winged blackbird	*Agelaius phoeniceus*	X	X			
Common grackle	*Quiscalus quiscula*		X			
Scarlet tanager	*Piranga olivacea*			X		
Evening grosbeak	*Hesperiphena vespertina*		X			
Purple finch	*Carpodacus purpureus*		X	X		
Pine siskin	*Spinus pinus*					X
American goldfinch	*Spinus tristis*	X	X		X	
LeConte's sparrow	*Ammospiza leconteii*		X			
White-throated sparrow	*Zonotrichia albicollis*	X	X	X		
Song sparrow	*Melospiza melodia*		X	X		

DISCUSSION

At the present time the portion of the St. Louis River channel extending from its source to Cloquet has not been significantly modified and has problems largely related to the topography of the adjacent land. For example, in the reach below the Partridge River the river has unstable sandy soils, is continually meandering, and has poor fish habitat. The best fish habitat is present where the river channel is relatively stable and a wide variation of depths is present, and the habitat is poorest where the river channel is straight and a minimum variation in depth is present. The best fish habitat was located where depth variation was highest, where the stream gradient was highest and where the percent of riffles and rapids with rocky substrates was high. The straightest reach with the least habitat occurred between the mouth of the Whiteface and Swan Rivers where river channel soils are unstable frequently sand overlaying clay or clay from eroding banks.

Where bottom soils were stable and beds of submerged aquatic plants were present several flocks of waterfowl were observed. These beds of aquatic plants were found where water velocities were low. The pools of the upper river (above the Partridge) frequently had beds of aquatic plants where waterfowl concentrate. Waterfowl concentrations were also observed near the beds of aquatic plants that occurred commonly between Floodwood and Cloquet and in Thompson Reservoir.

There were problems associated with pollution and low river flows from Cloquet downstream. Pollution from Cloquet masked many problems associated with the river, but it was noted that at low flow most of the river's water was diverted from Thomson Reservoir around Jay Cooke State Park to the power plant at the upper end of Fond du Lac Reservoir. At low flow very little water is present in the river in Jay Cooke State Park. In the most polluted segment of the river some white suckers were only present below dams and rapids where the dissolved oxygen was higher. The establishment of the new sanitary district and sewage disposal facilities should improve conditions in this section of the river, but only future sampling can determine the degree of recovery.

In the estuary conditions for fish survival were somewhat better. Only a few game fish (northern pike and walleye) were present in the upper part of the estuary, but good populations were present in the area much further downstream.

Since there is an effort to improve conditions in the lower part of the river, additional gauging stations should be established near the mouths of the Cloquet, Whiteface, Floodwood, and Savanna Rivers so that the effect of water flow regulations on fish and wildlife can be established. Between the Thompson and Fond du Lac Reservoirs there is a severe low flow problem. A program of establishing good fish populations between Cloquet and Fond du Lac should be undertaken when it can be established that the oxygen levels can be maintained. This will require additional studies.

Note the catch of 55 large sized fish per hour was low as compared with the statewide average of 110, but the water in the St. Louis is soft so a lower density of fish would be expected. Most of the time the water temperature in the St. Louis River is below 75^{o} F above Cloquet, but may be 80^{o} F or more when river flows are low. Many tributary streams have water temperatures low enough to support cold water fishes (trout).

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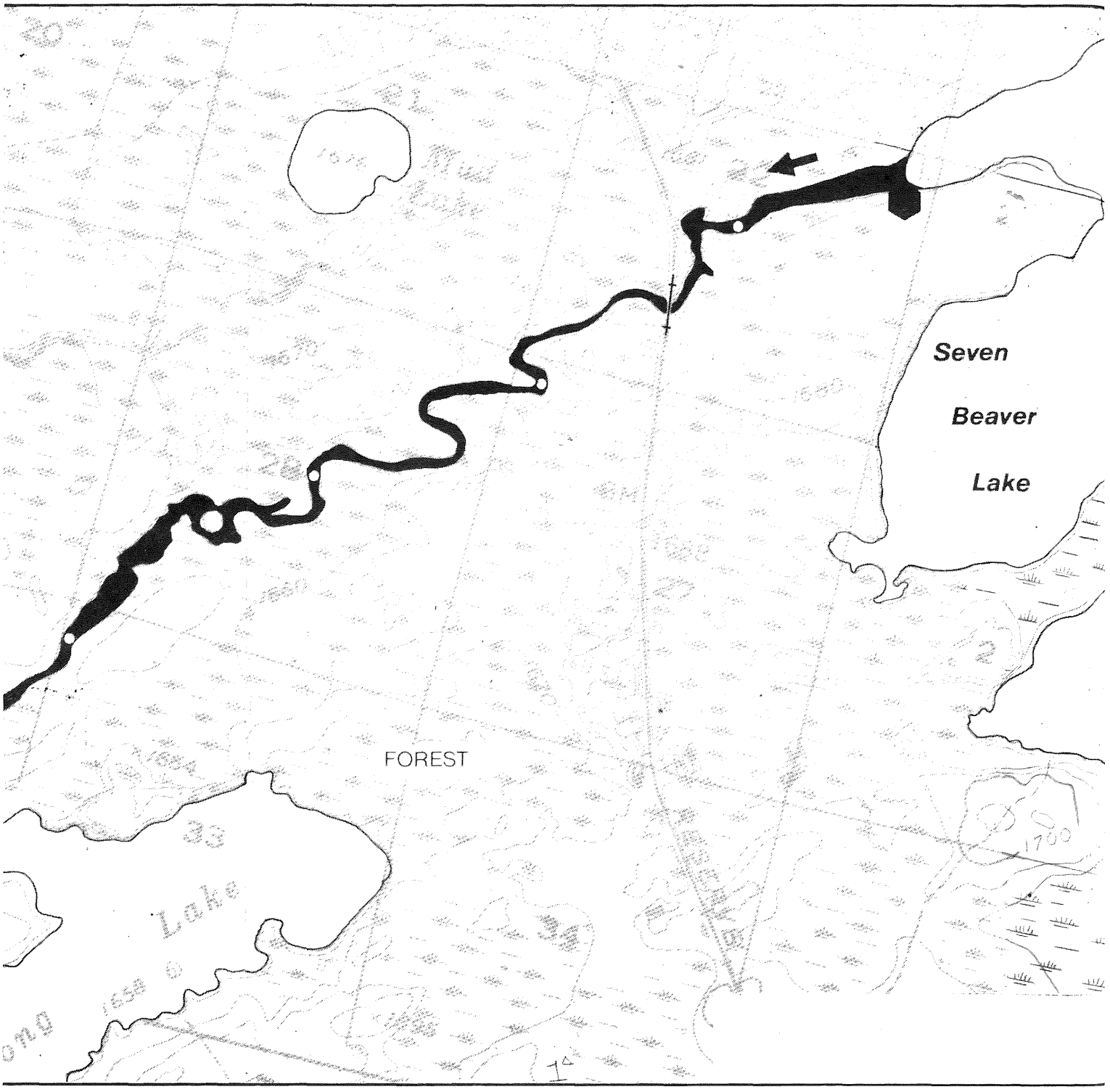


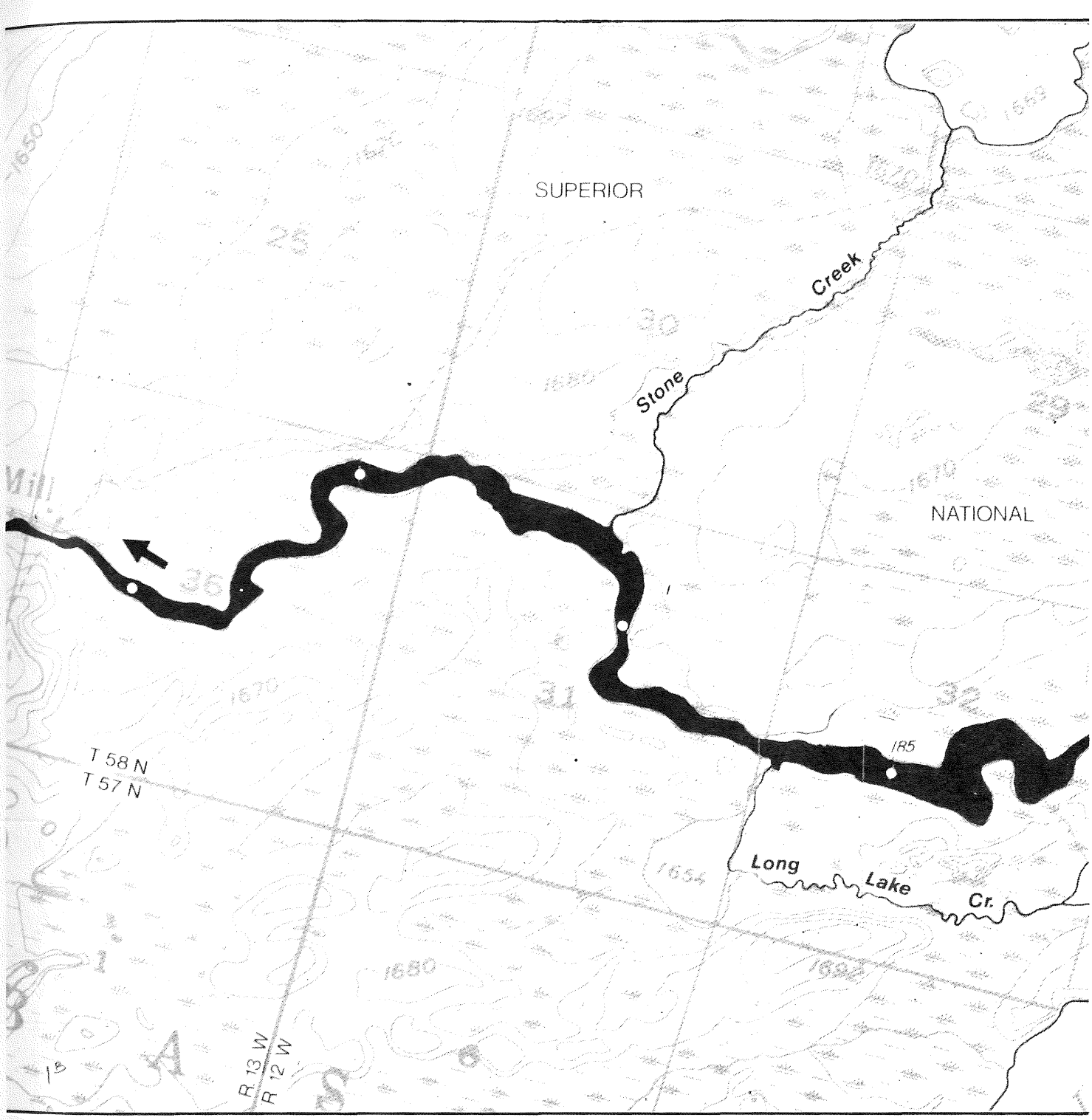
LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: #1
of 48

N

Scale: 1" = 2000'



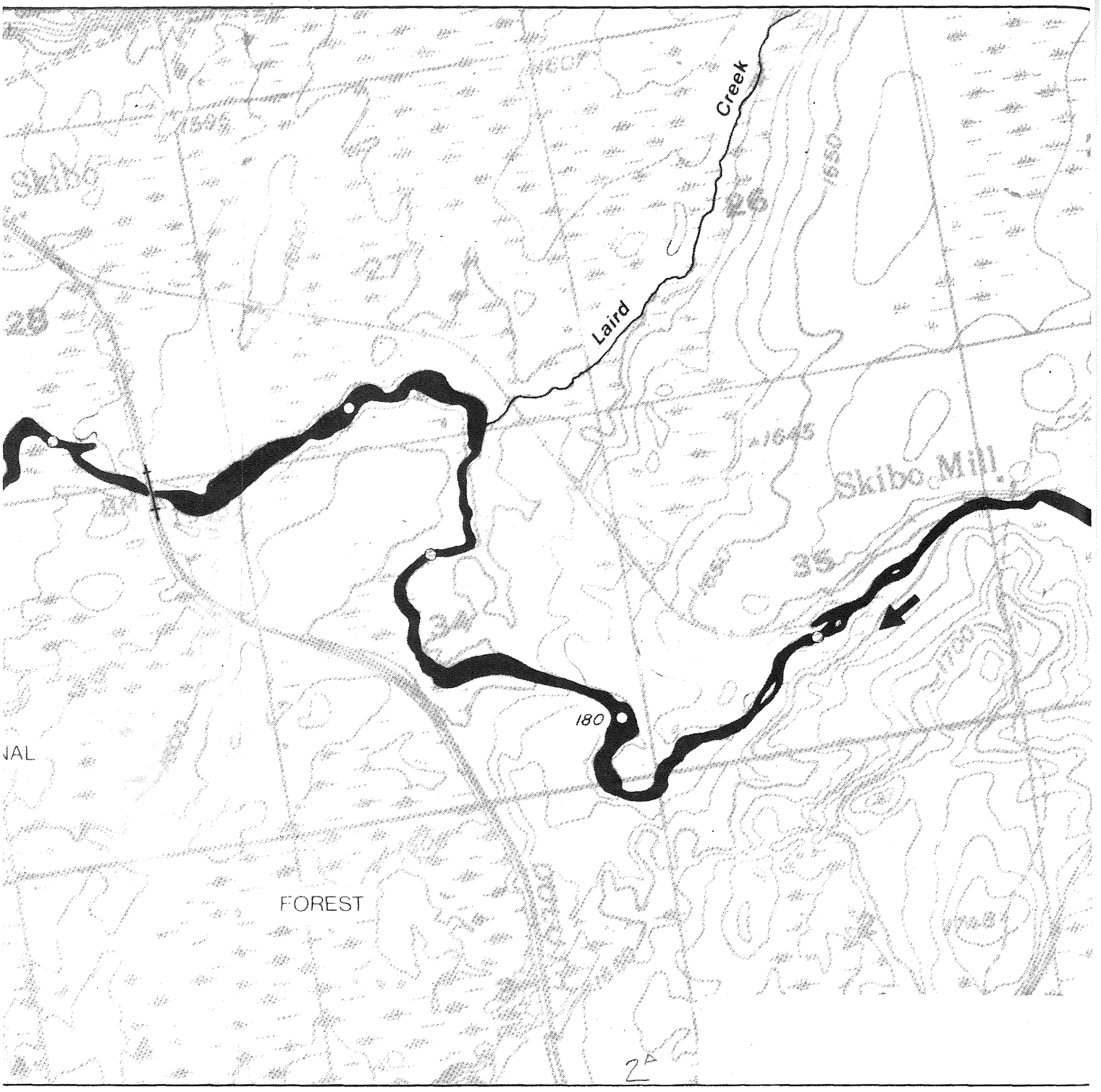
LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: # 2
of 48

N

Scale: 1" = 2000'



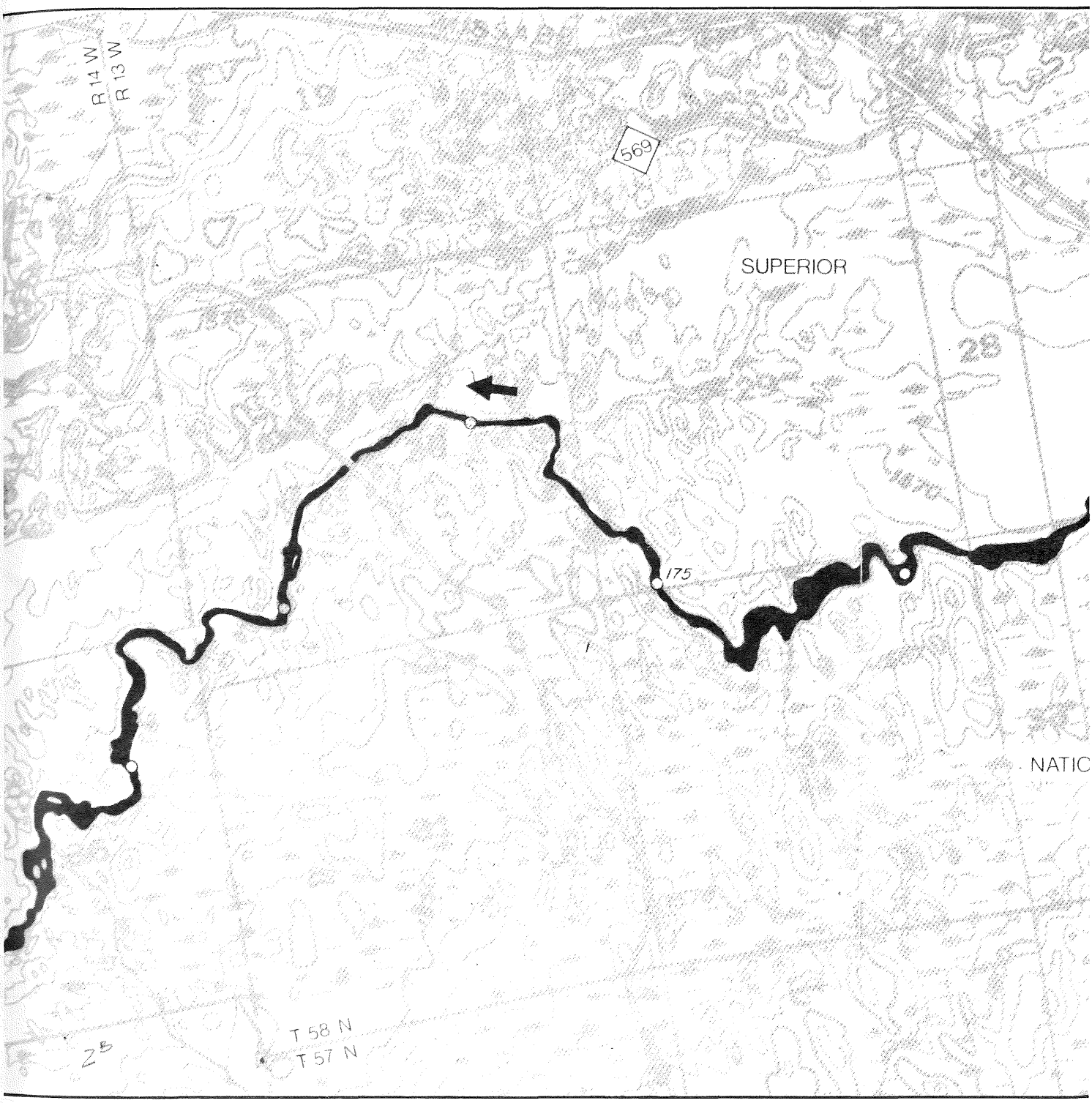
LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: #3
of 48

N

Scale: 1" = 2000'



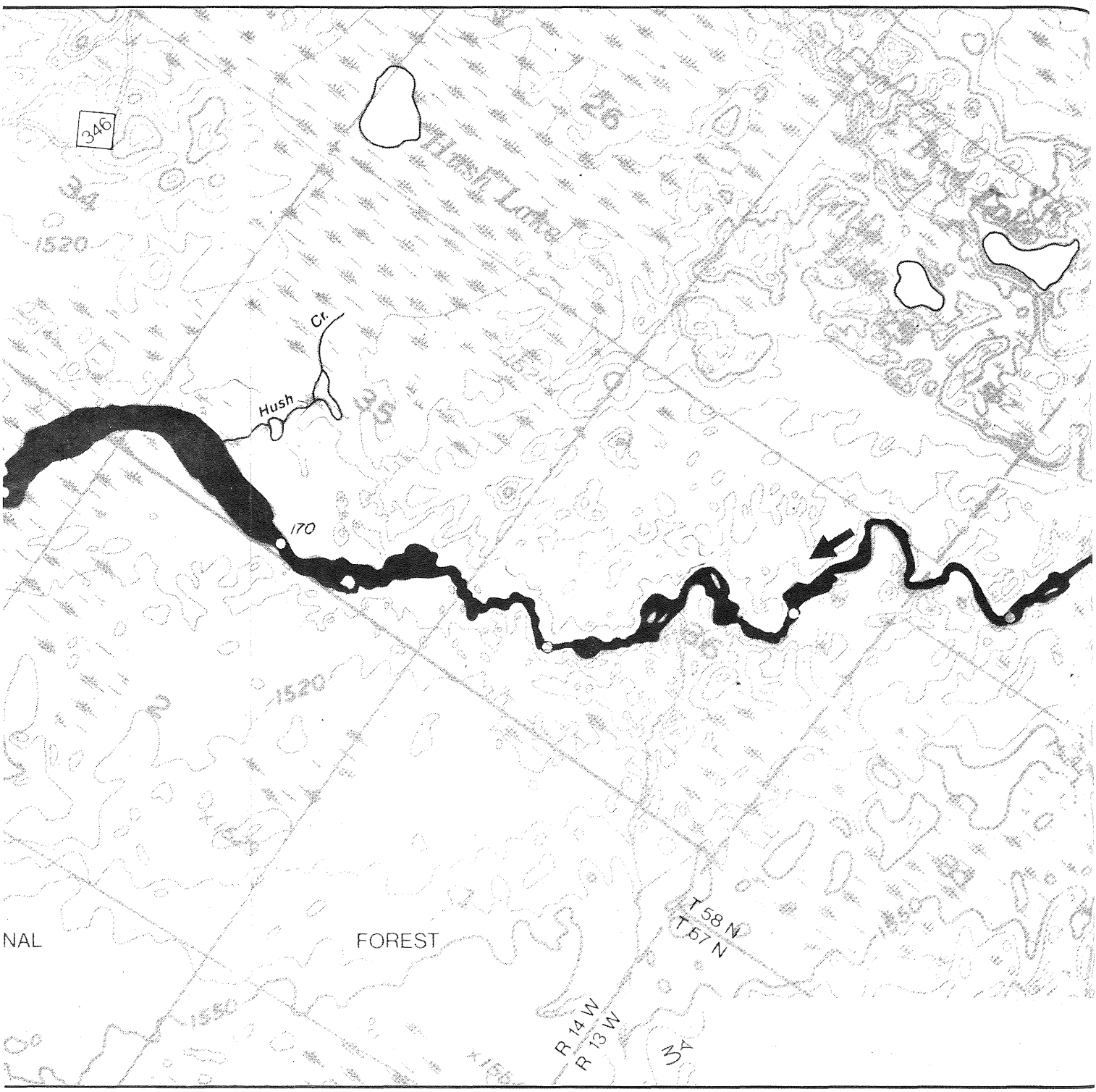
LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: #4
of 48

N

Scale: 1" = 2000



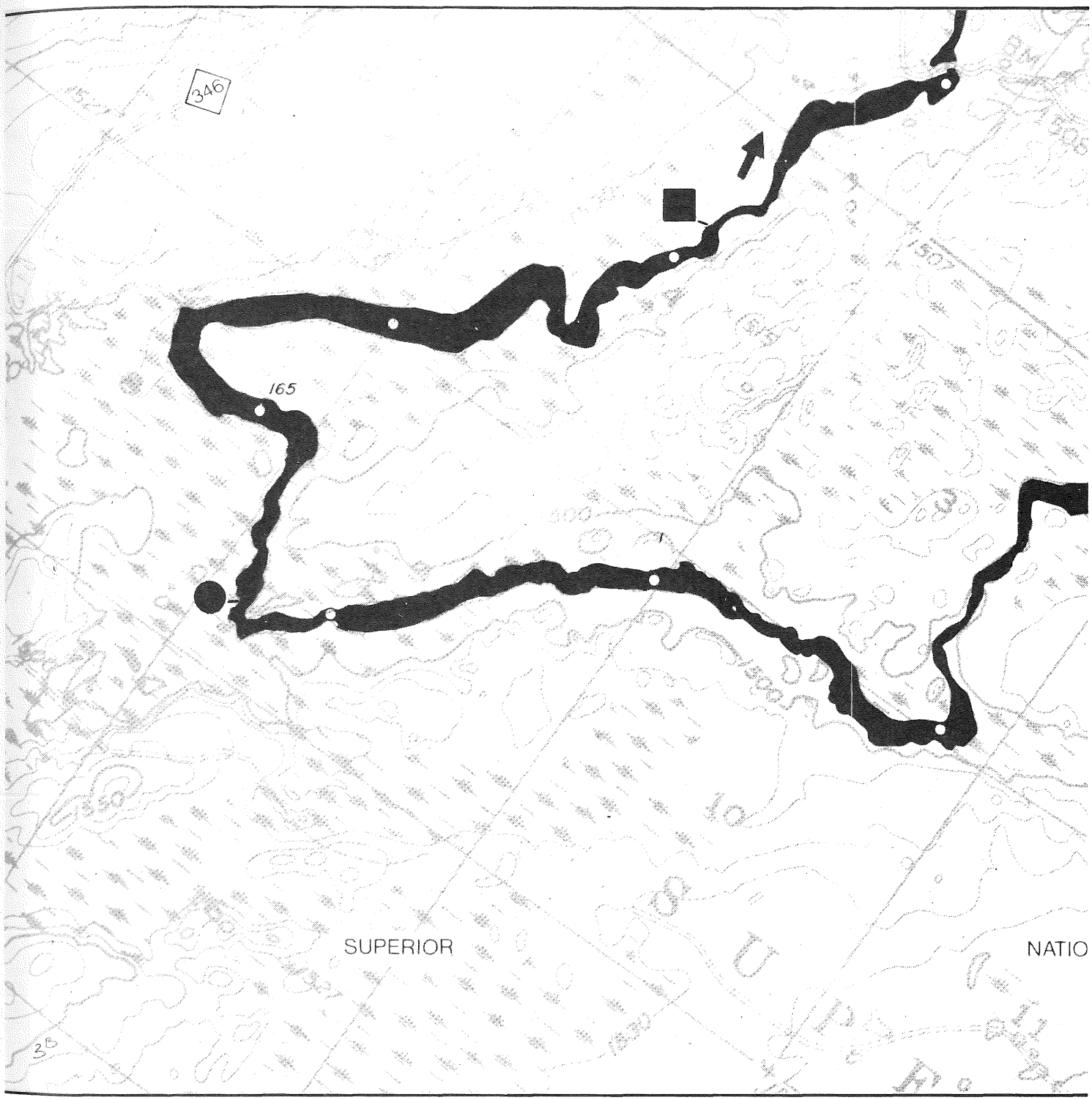
LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: #5
of 48

N

Scale: 1" = 2000'



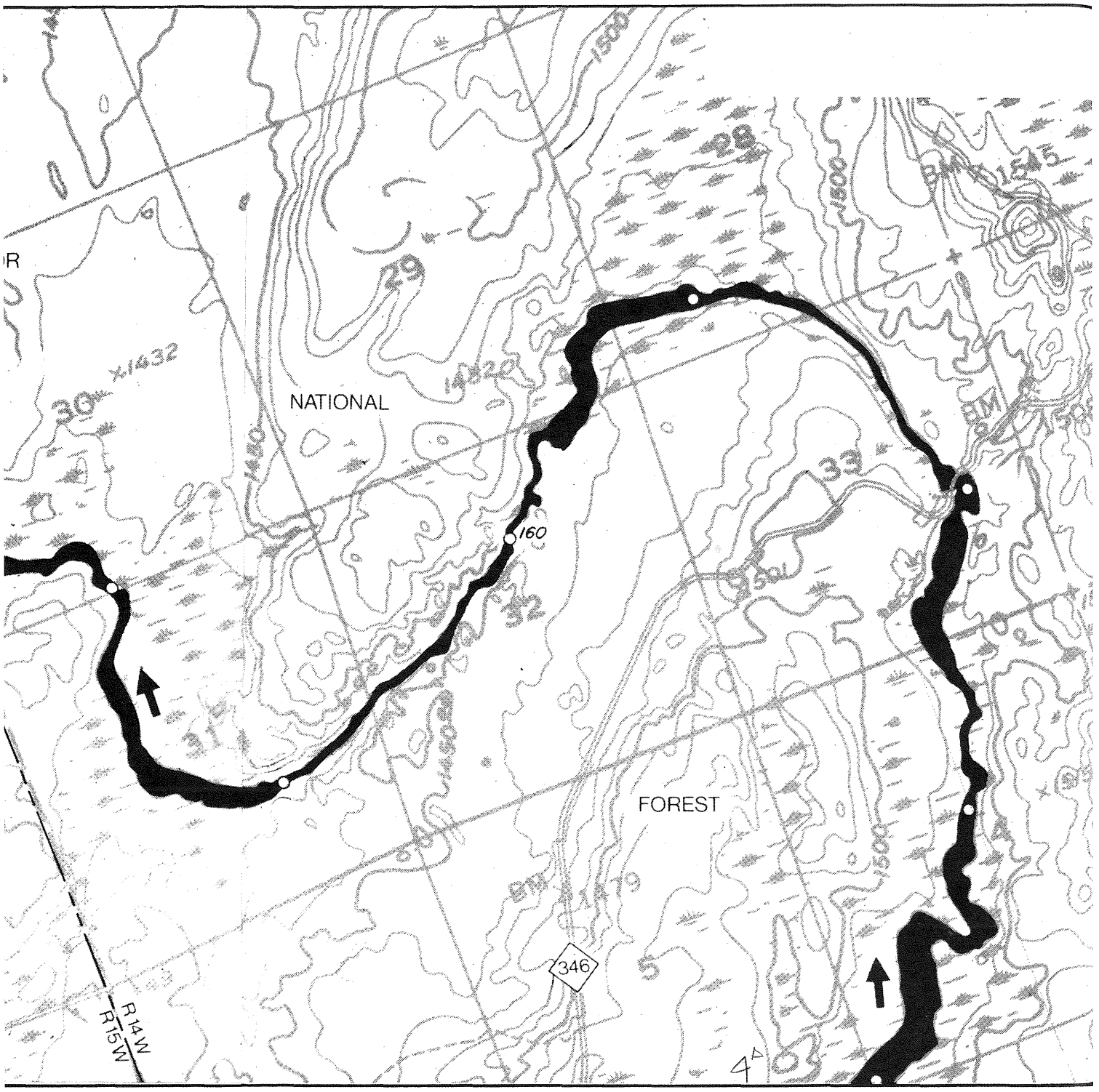
LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: # 6
of 48

N

Scale: 1" = 2000'

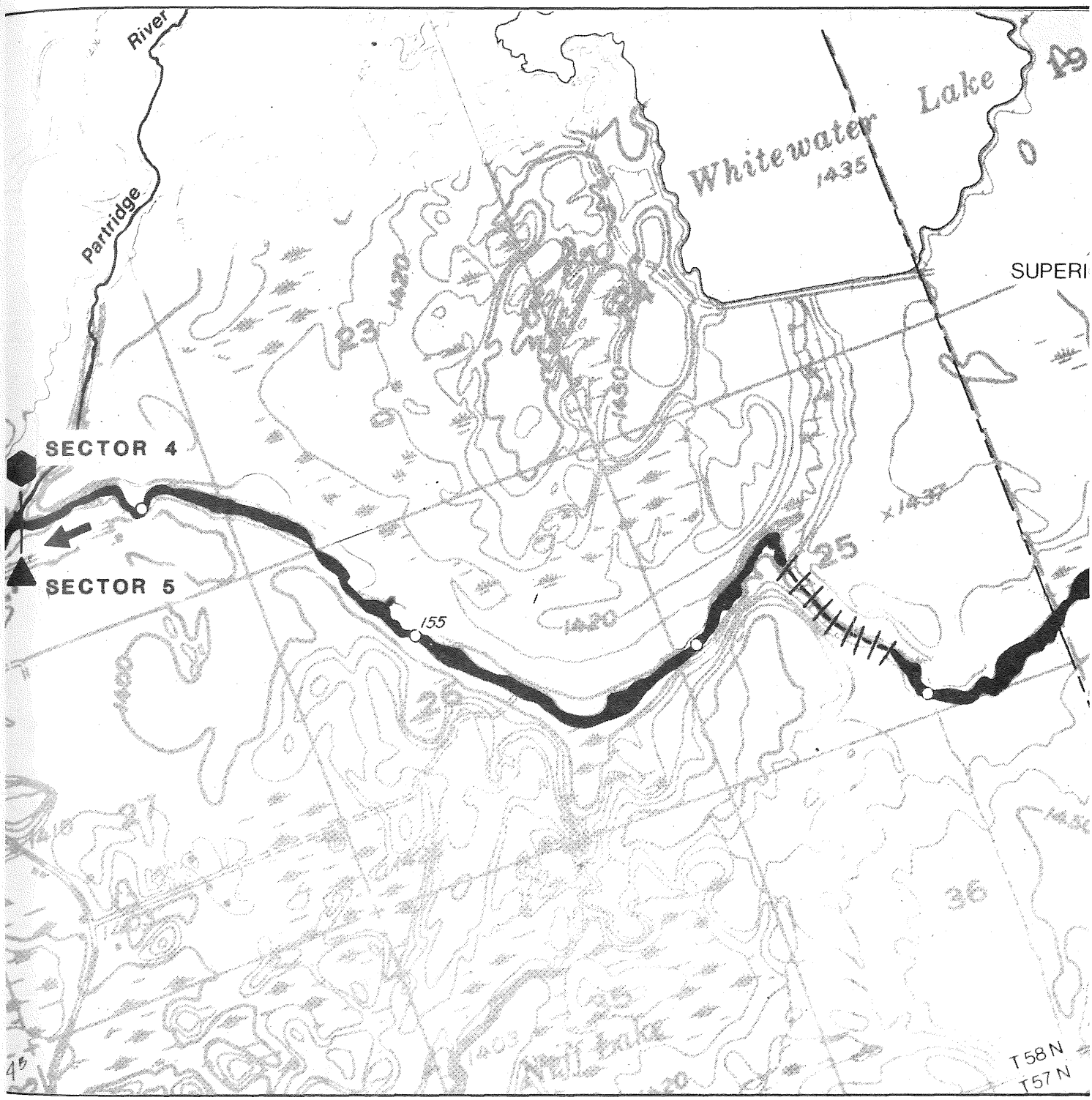


LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: #7
of 48

Scale: 1"=2000'



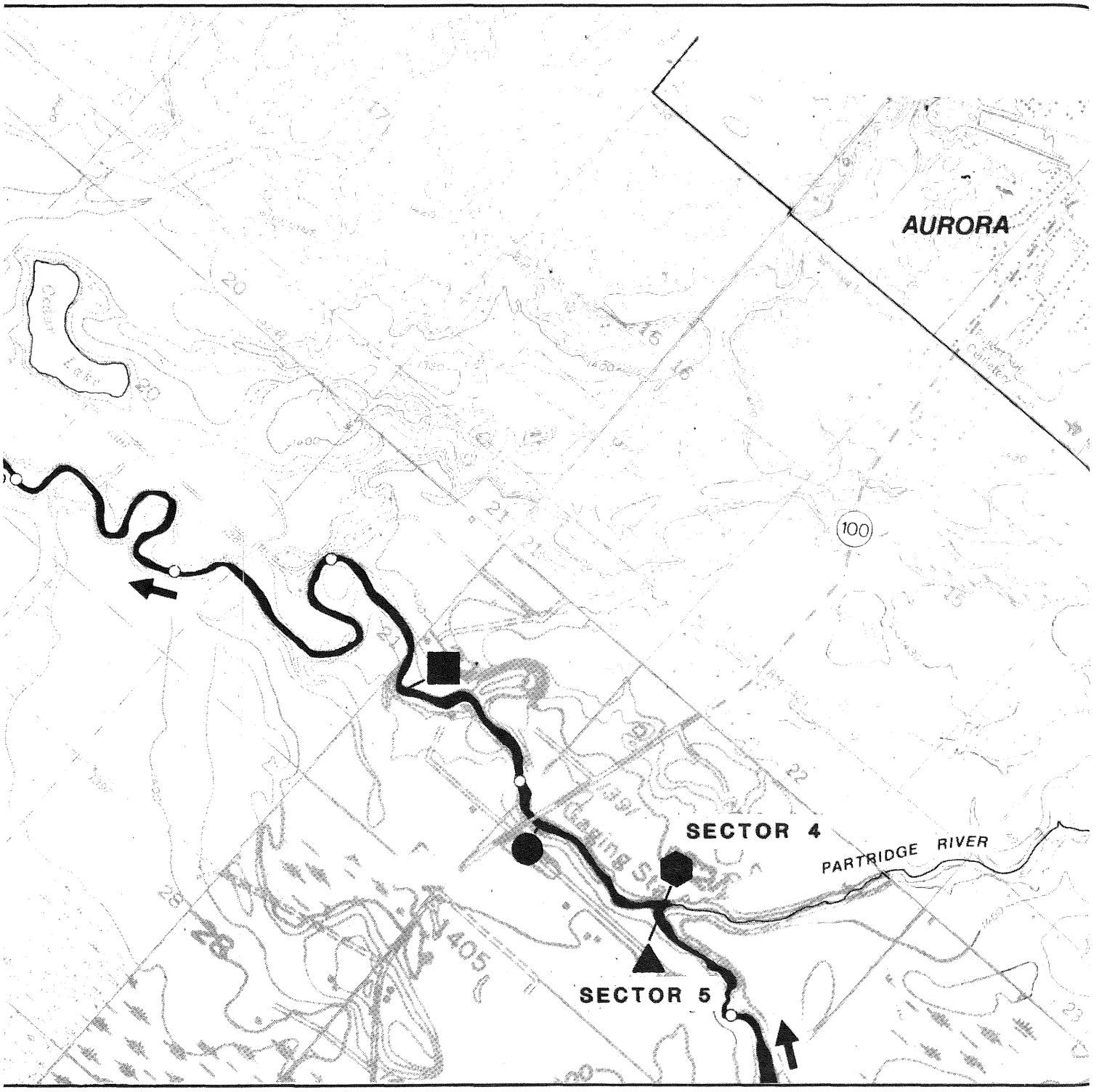
LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: # 8
of 48

N

Scale: 1"=2000'

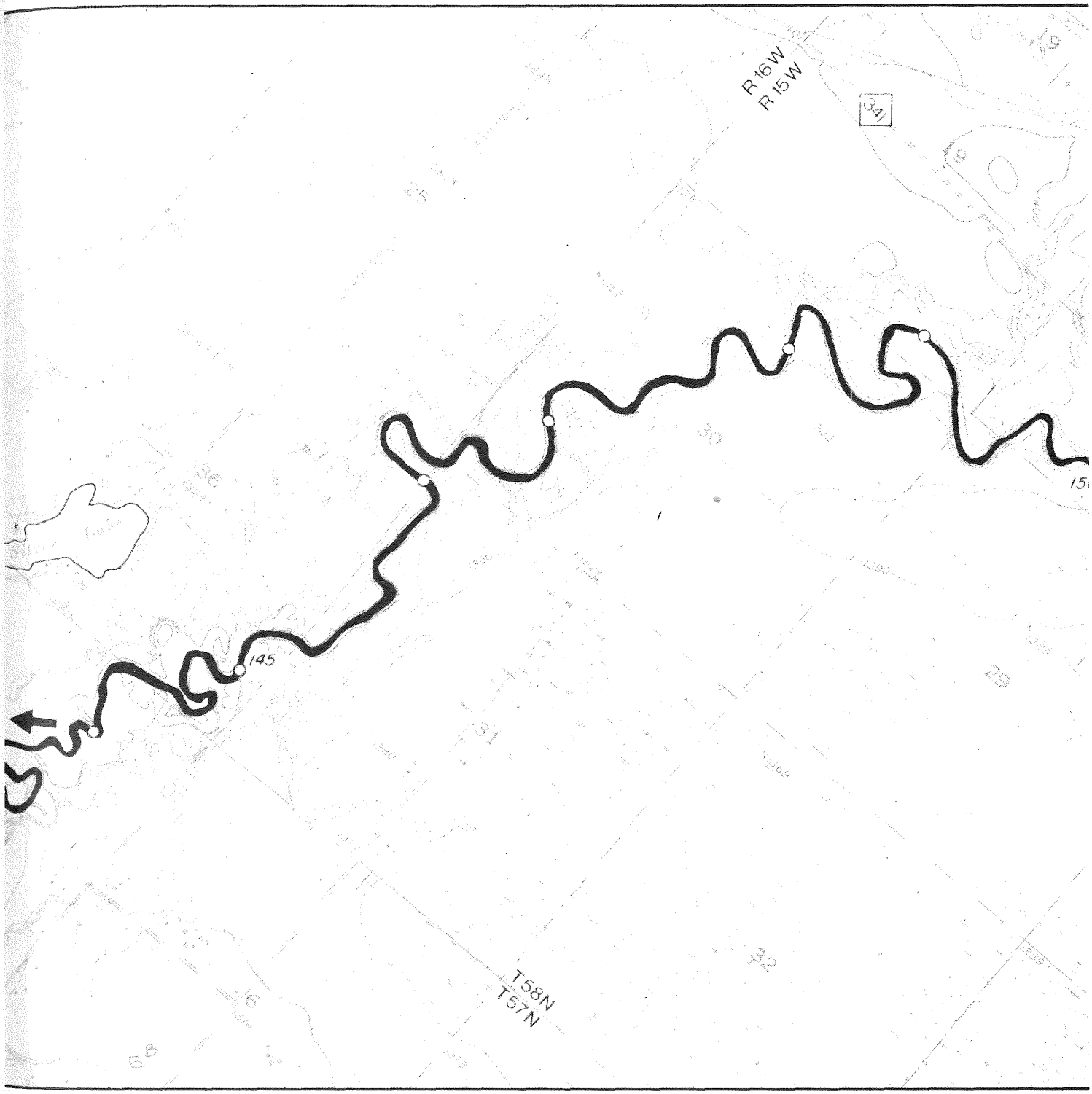


LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: #9
of 48

Scale: 1"=2000'



LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: # 10
of 48

N

Scale: 1" = 2000'

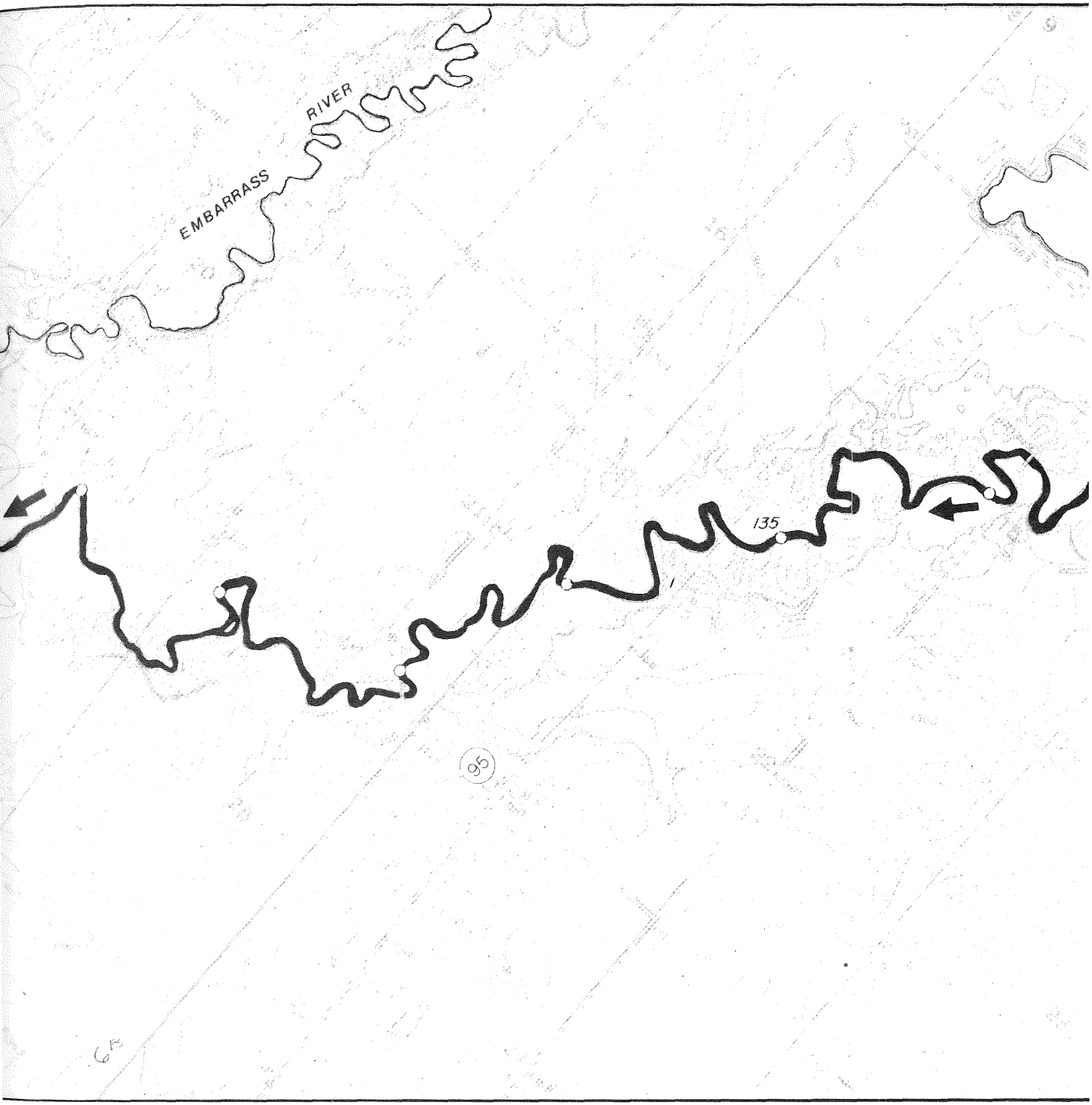
LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: #11
of 48

N

Scale: 1"=2000'



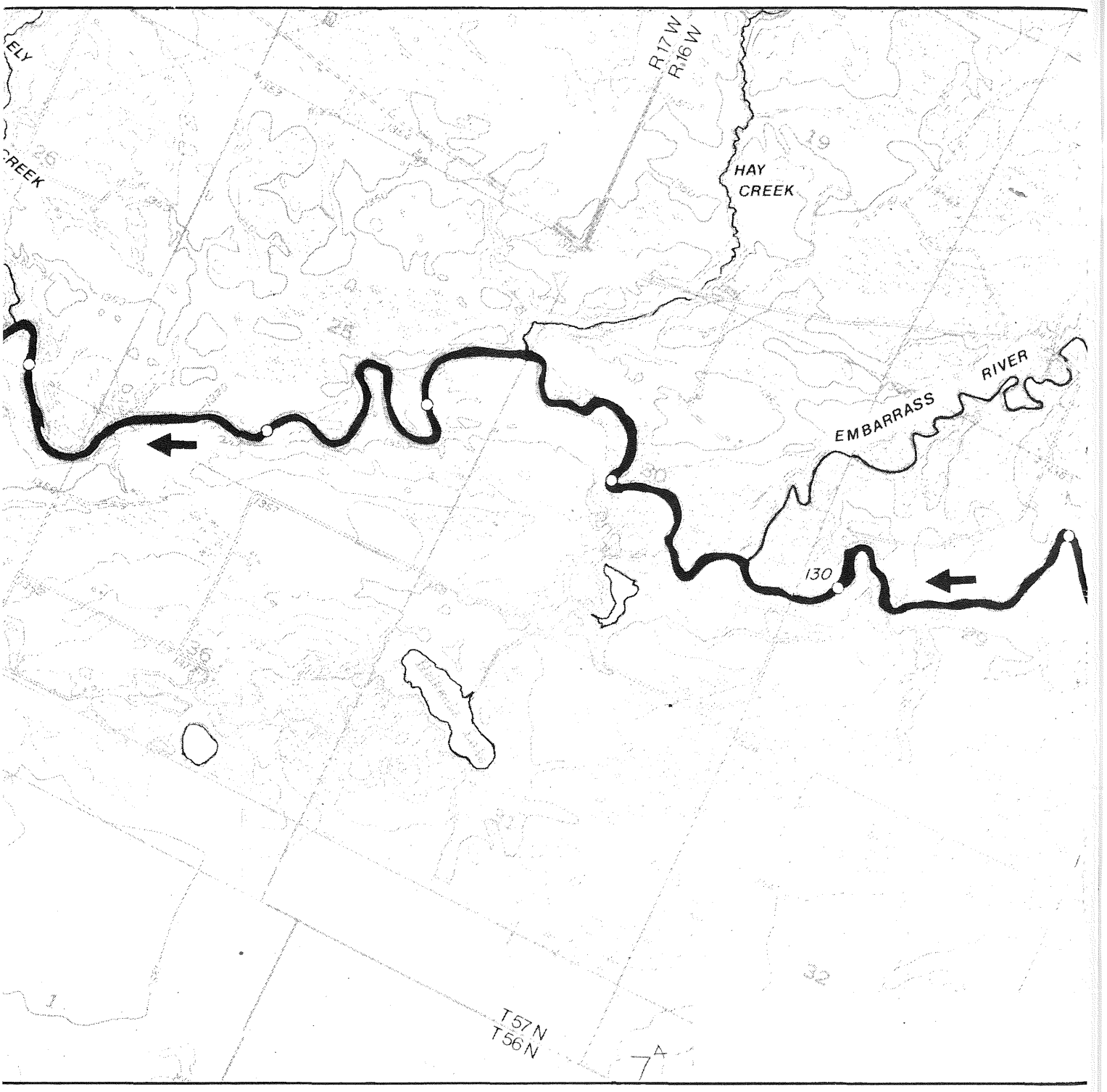
LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: # 12
of 48

N

Scale: 1" = 2000'



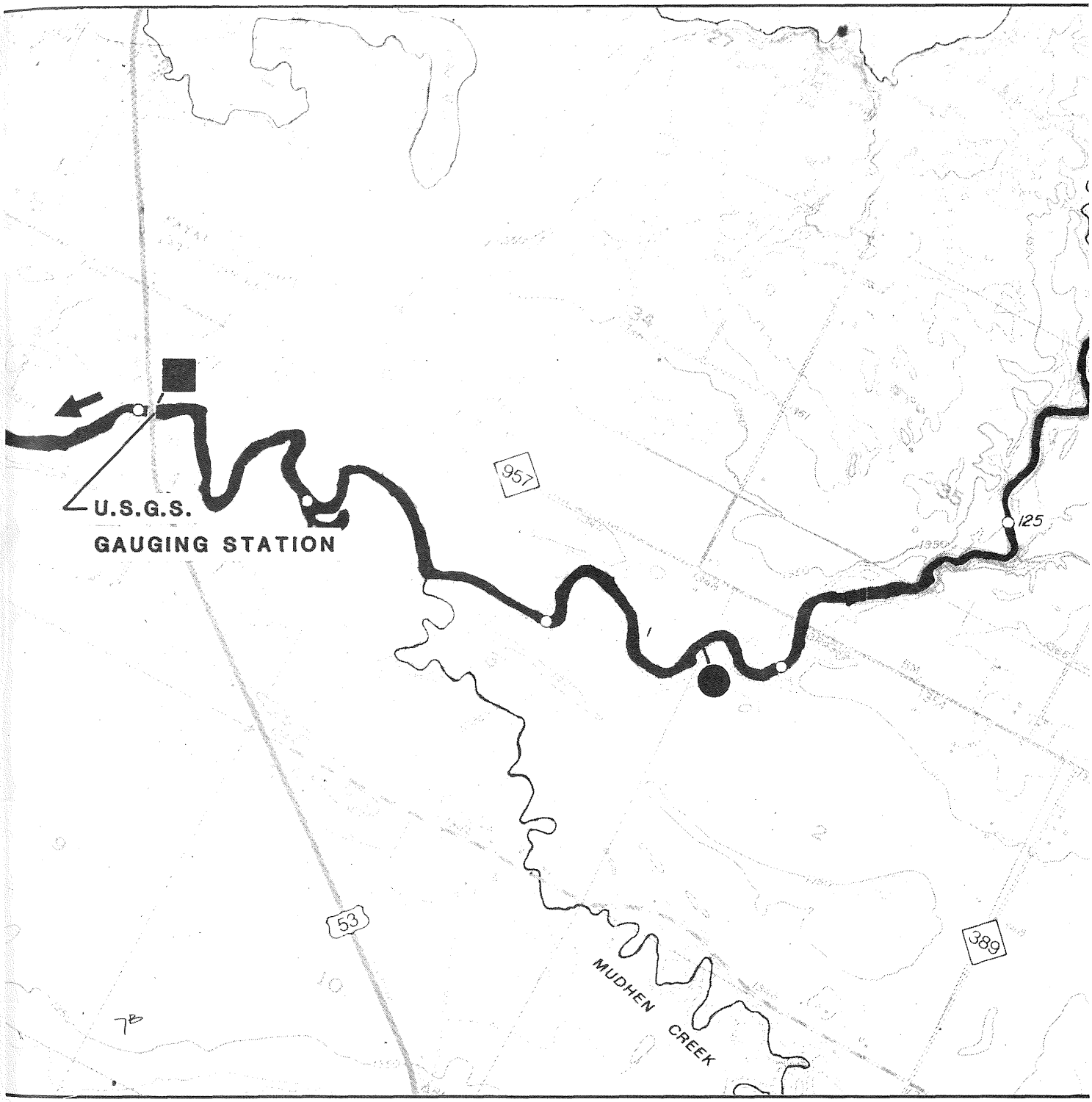
LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: # 13
of 48

N

Scale: 1" = 2000'



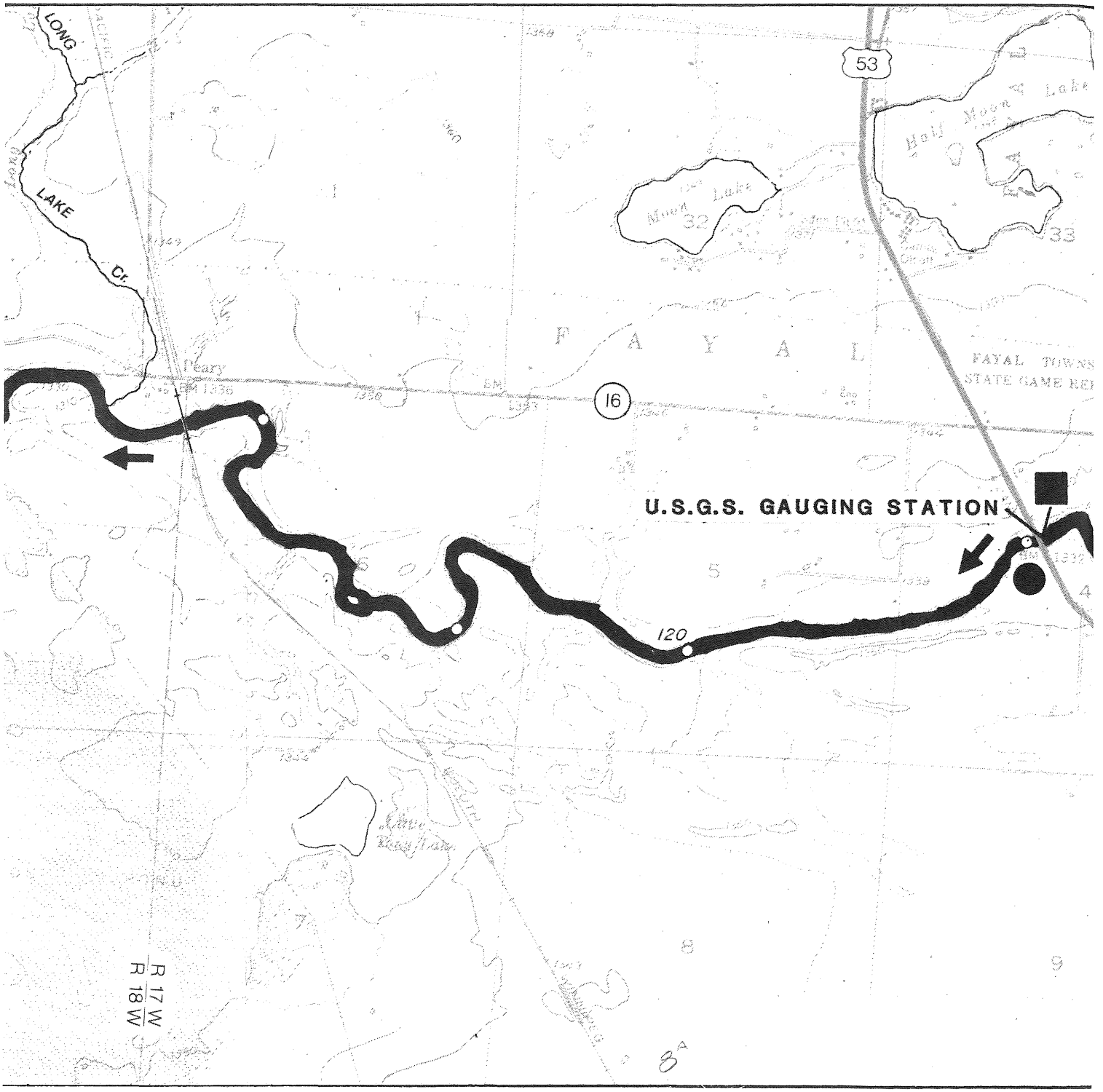
LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: # 14
of 48

N

Scale: 1" = 2000'



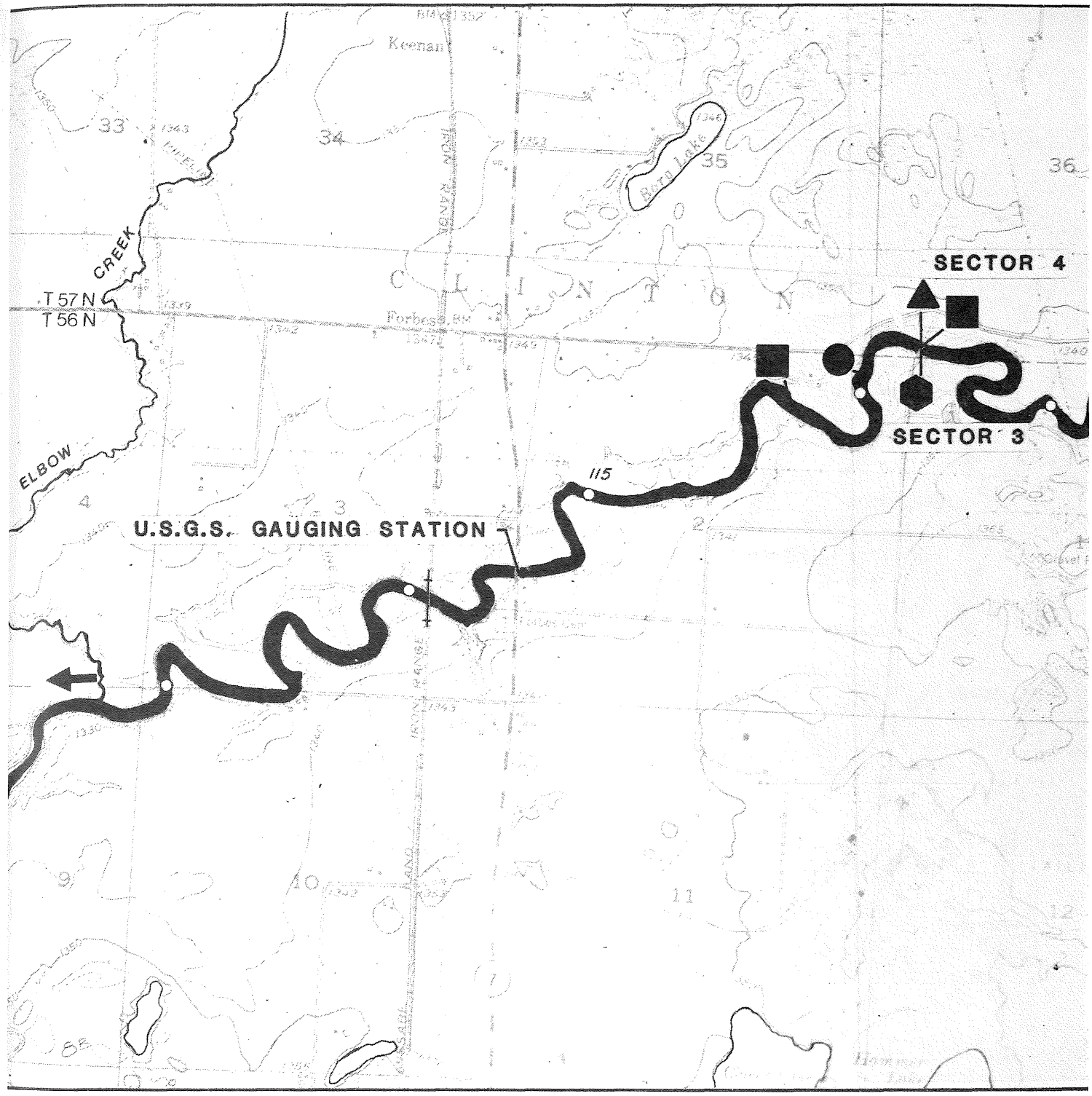
LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: #15
of 48

N

Scale: 1"=2000'



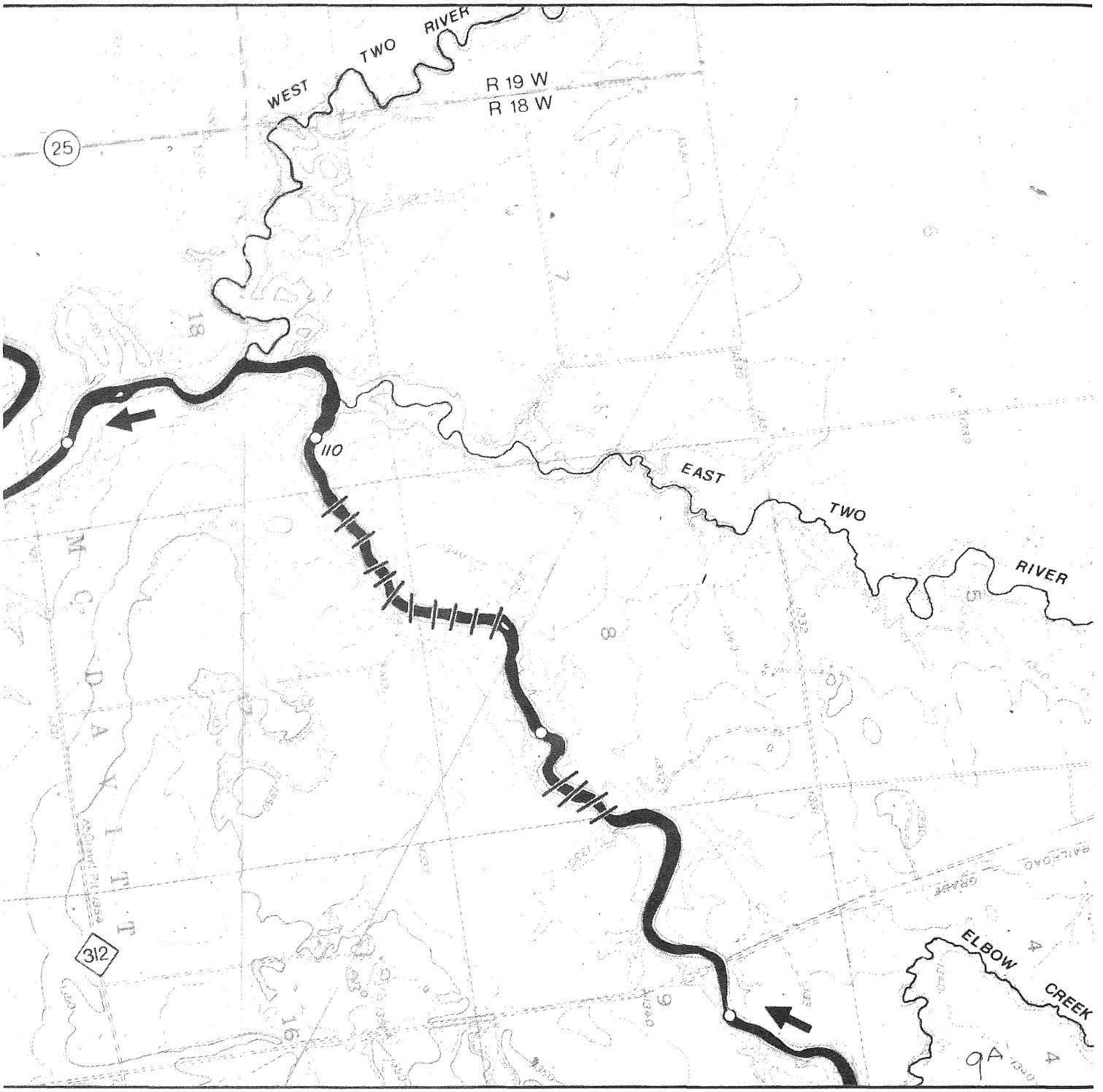
LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: #16
of 48

N

Scale: 1" = 2000'

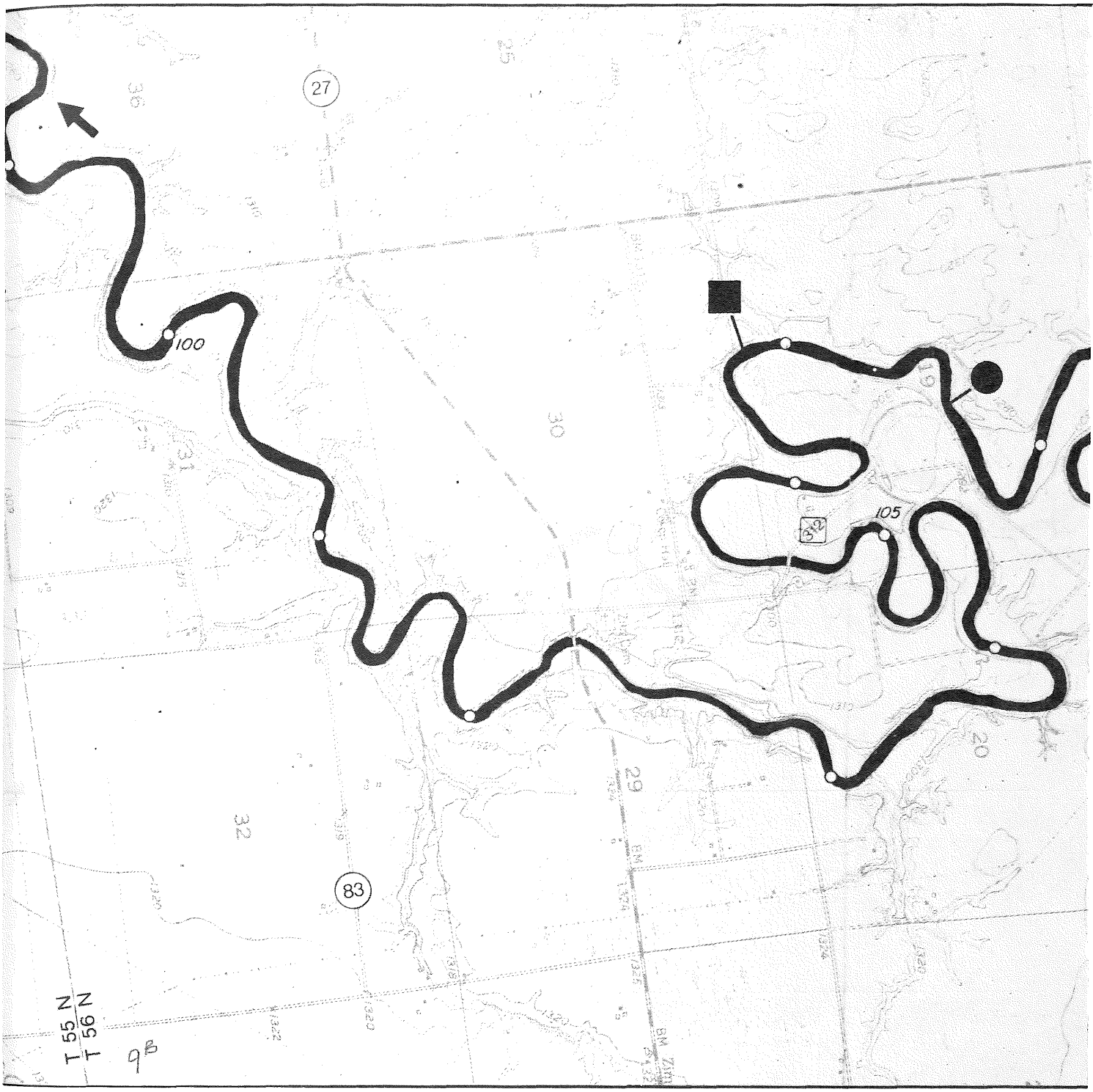


LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: #17 of 48

Scale: 1" = 2000'



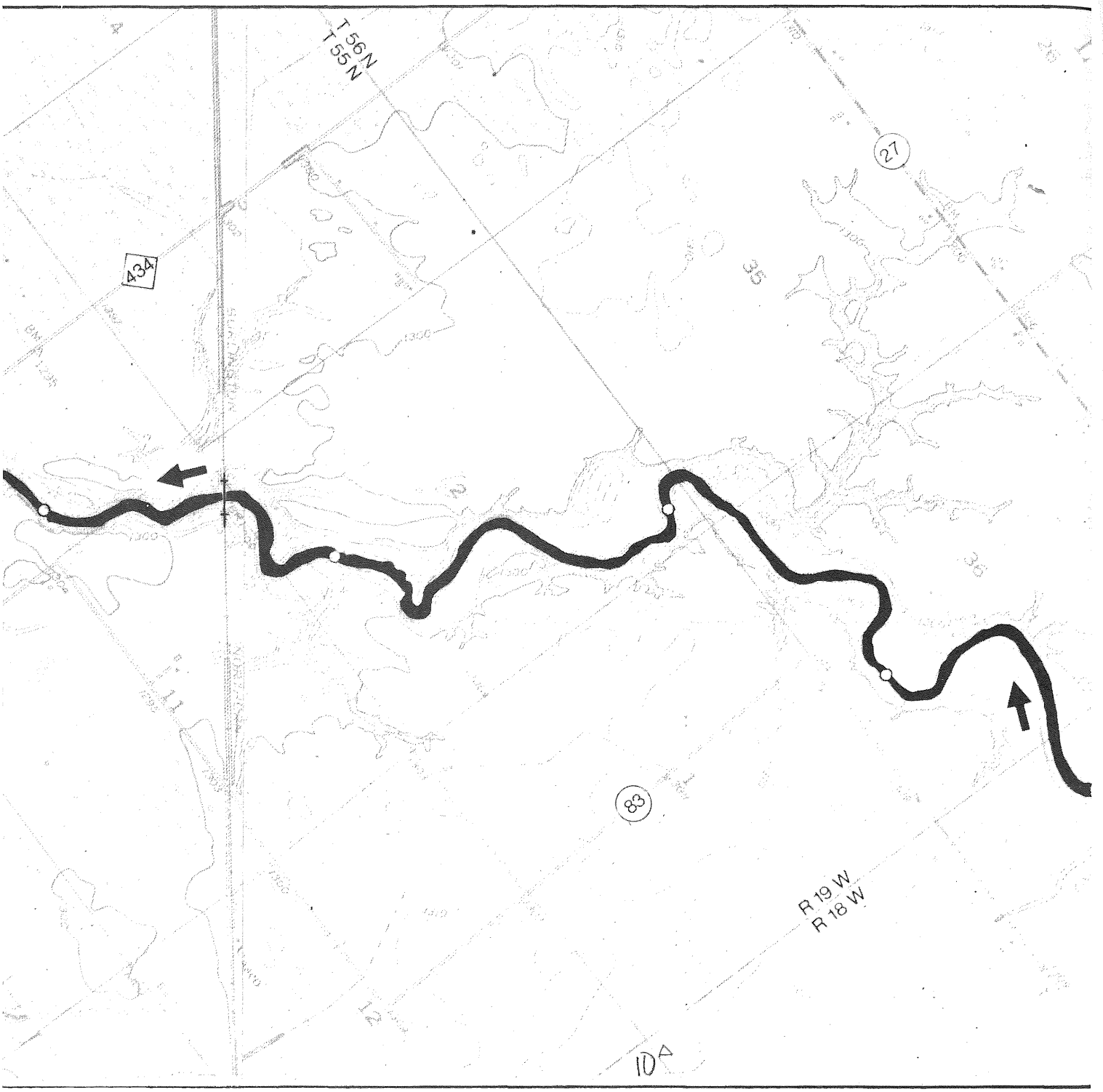
LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: #18
of 48

N

Scale: 1"=2000'



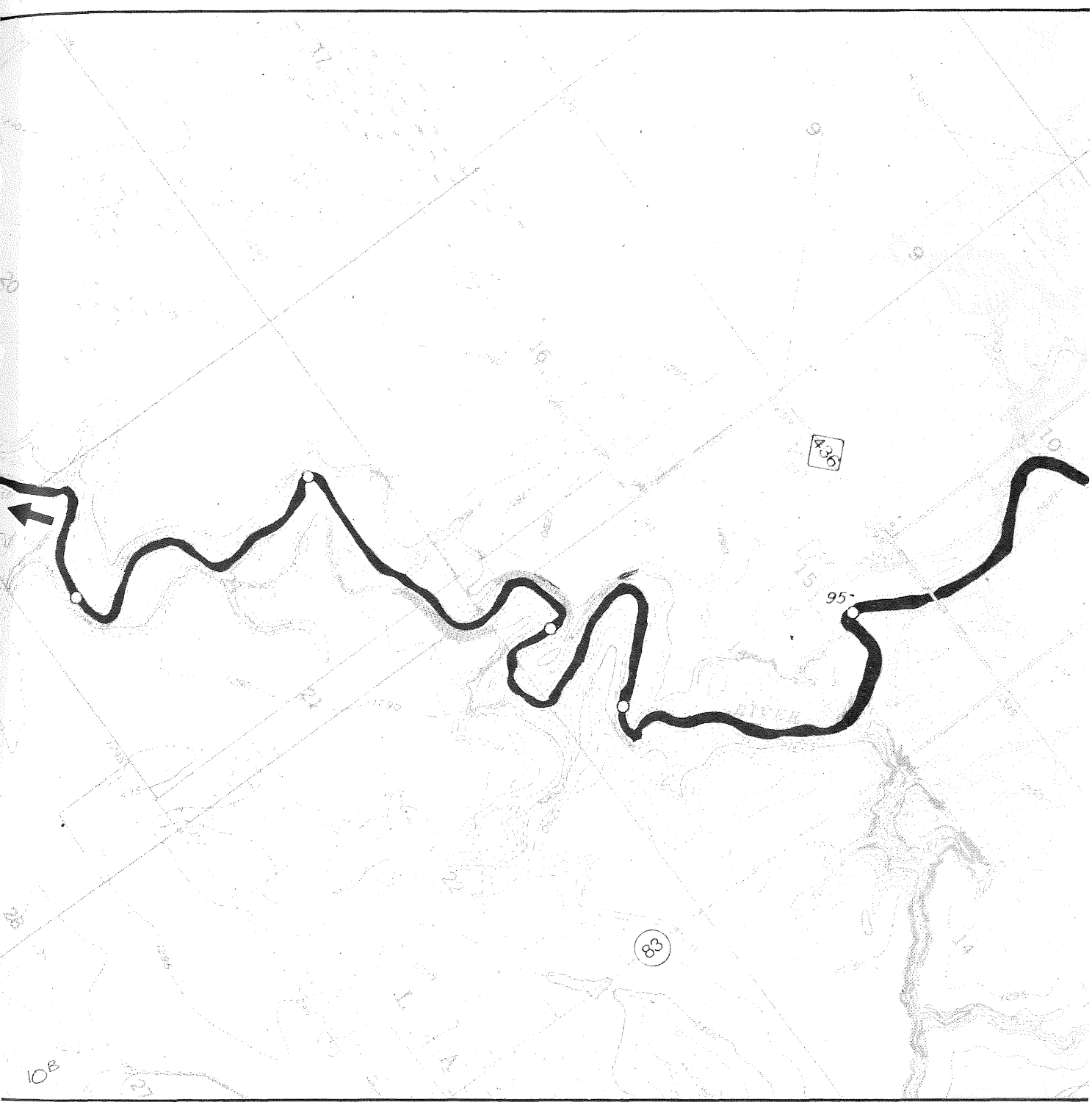
LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: # 19
of 48

N

Scale: 1" = 2000'

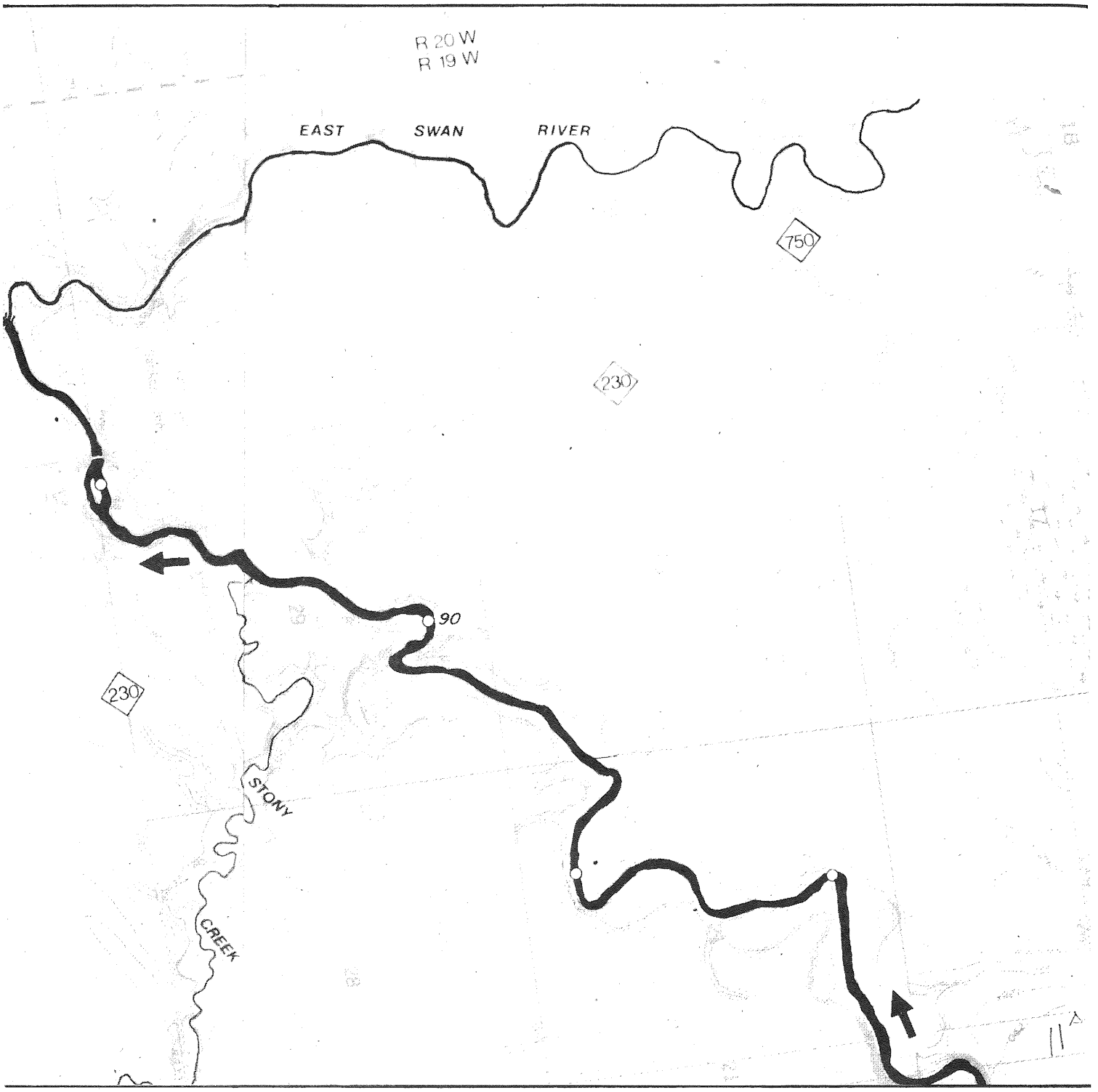


LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: # 20
of 48

Scale: 1" = 2000'

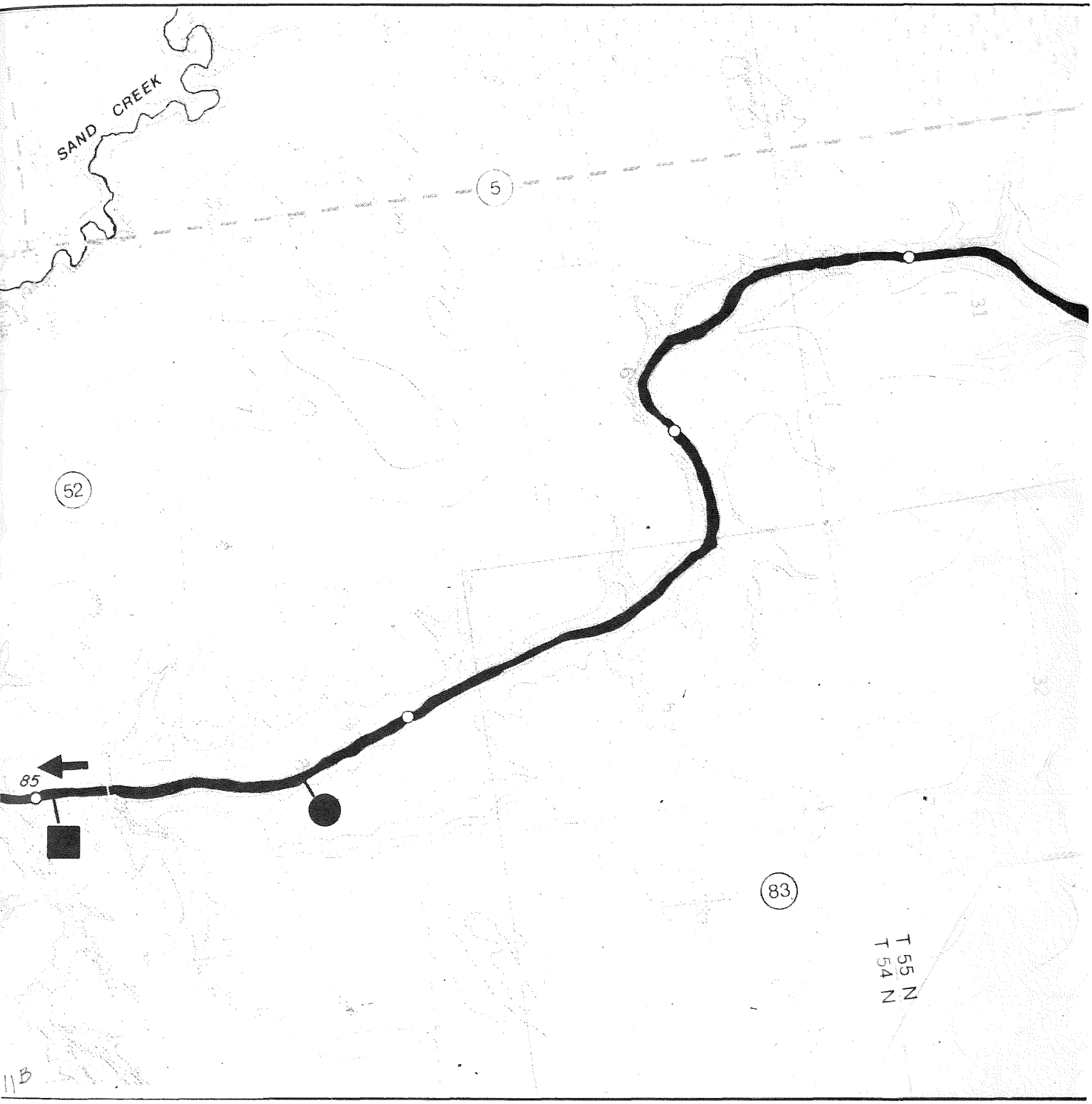


LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: # 21
of 48

Scale: 1" = 2000'



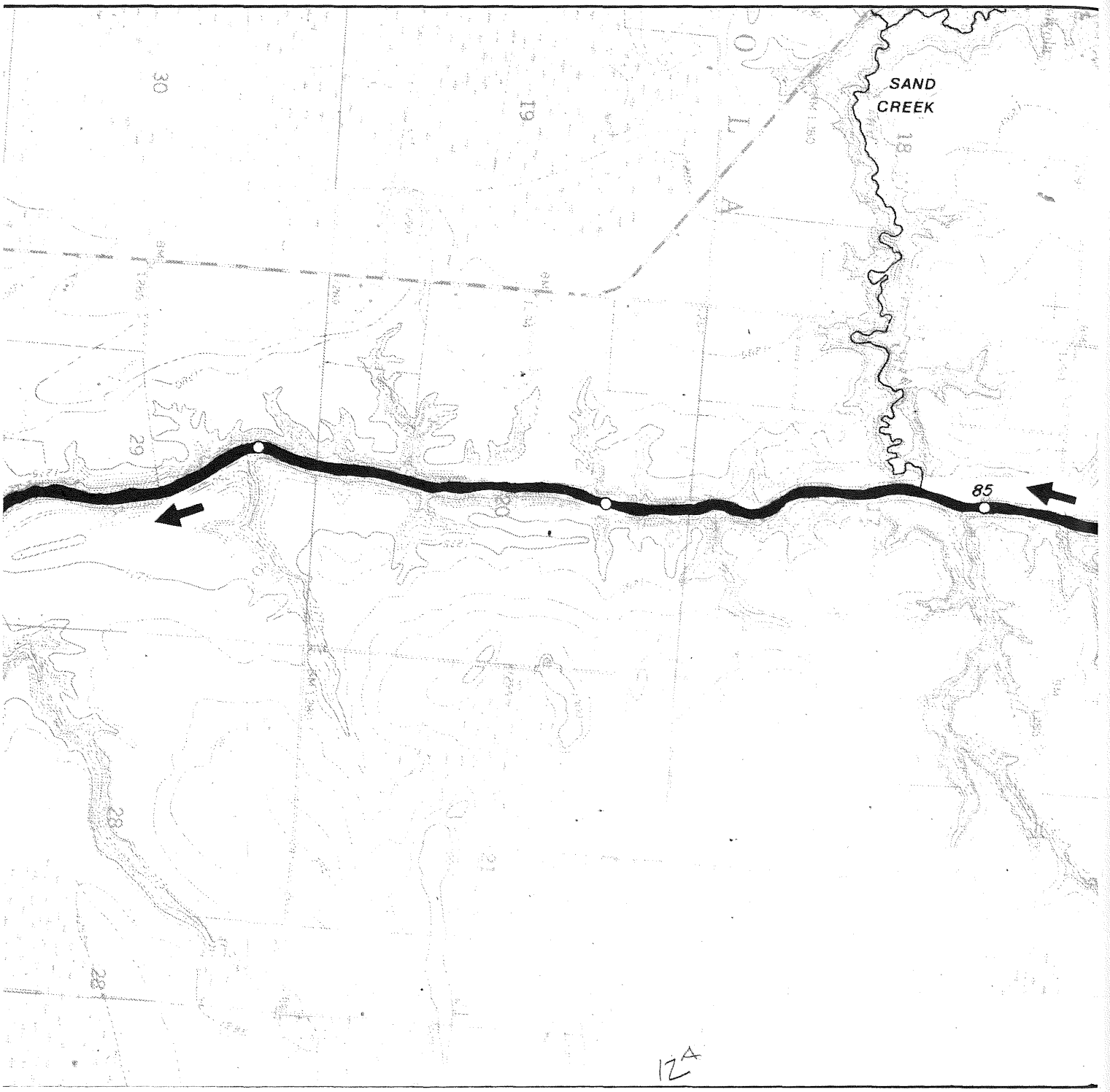
LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: # 22
of 48

N

Scale: 1" = 2000'



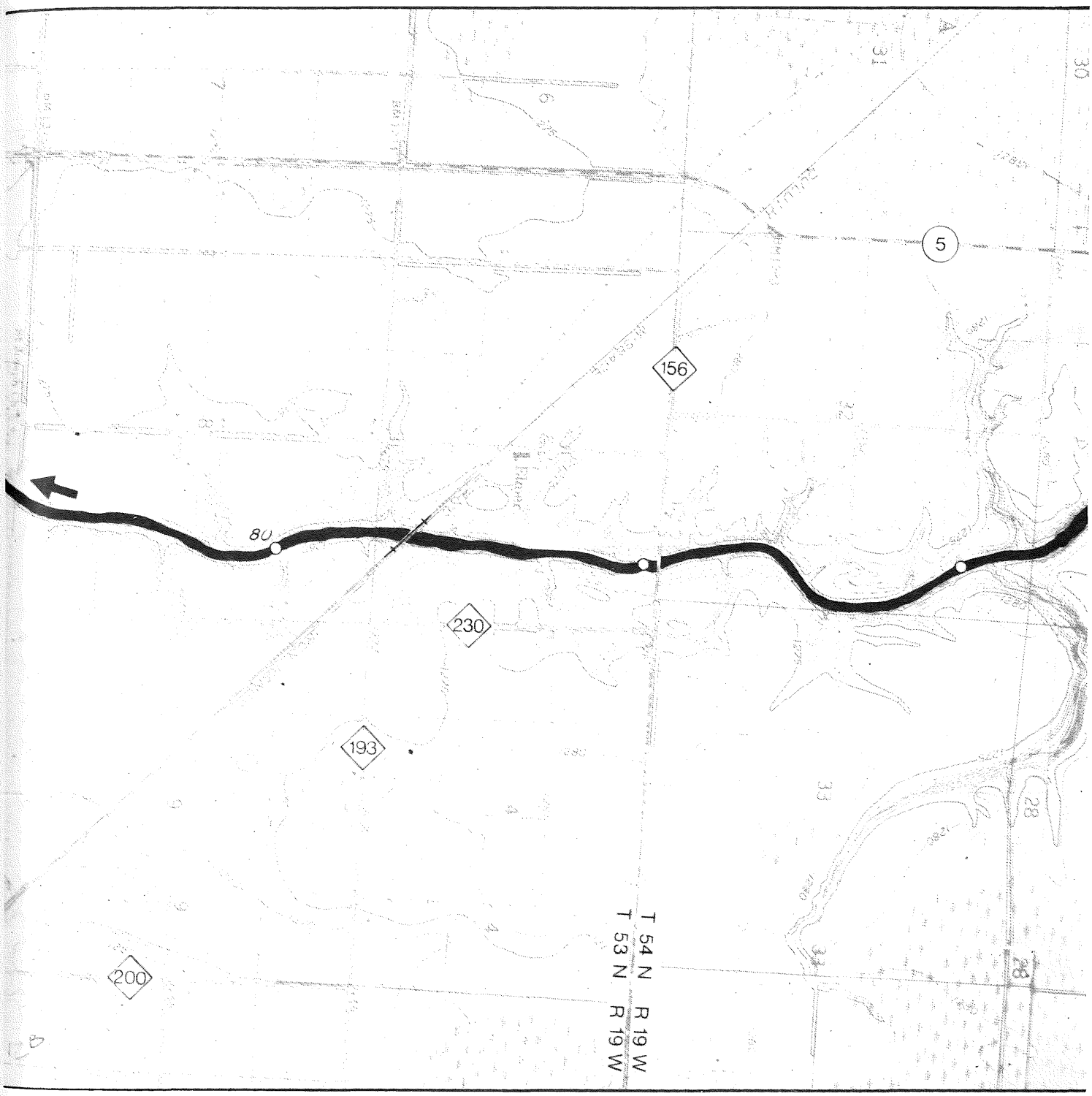
LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: #23
of 48

N

Scale: 1"=2000'

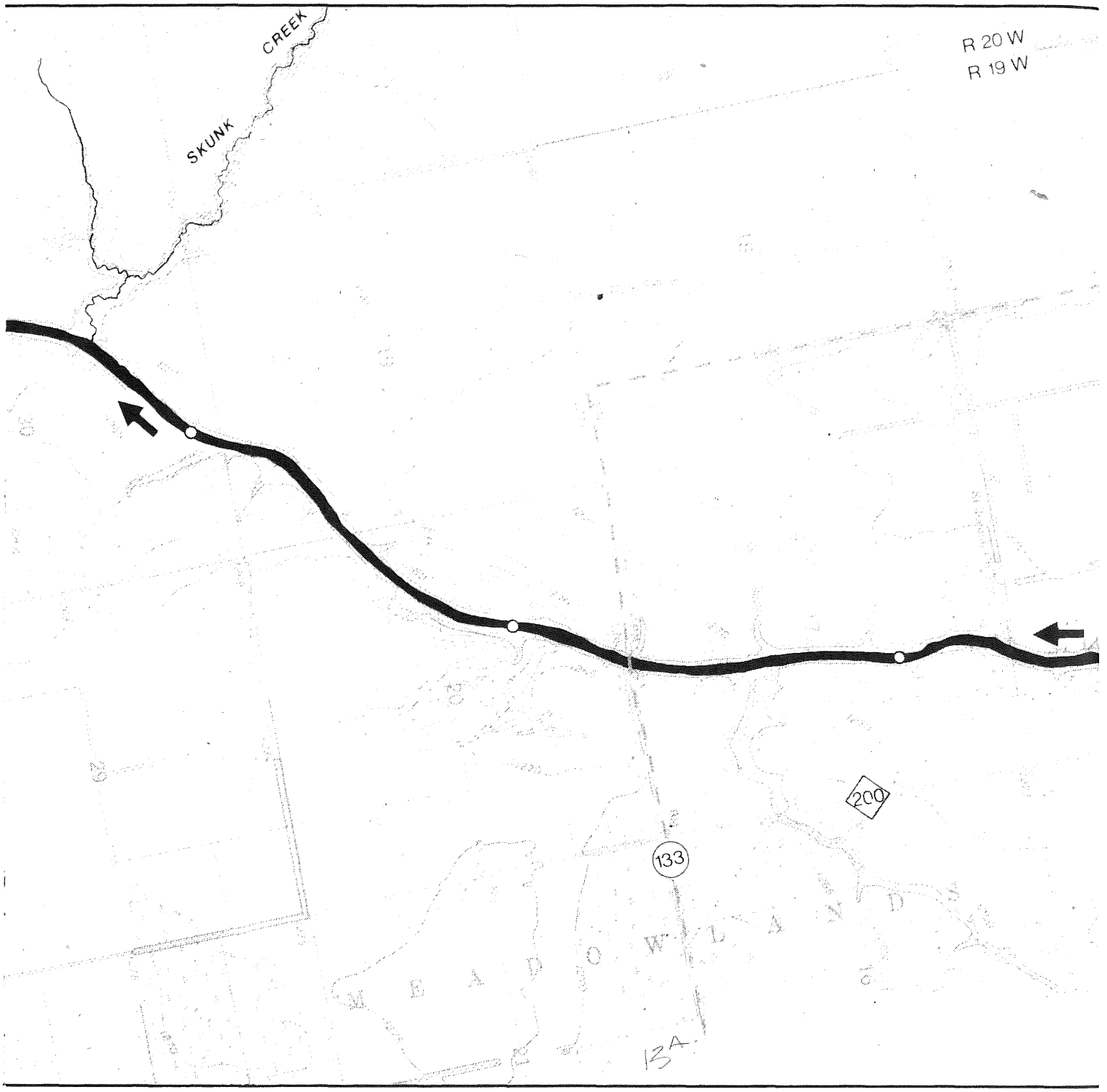


LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: #24 of 48

Scale: 1"=2000'

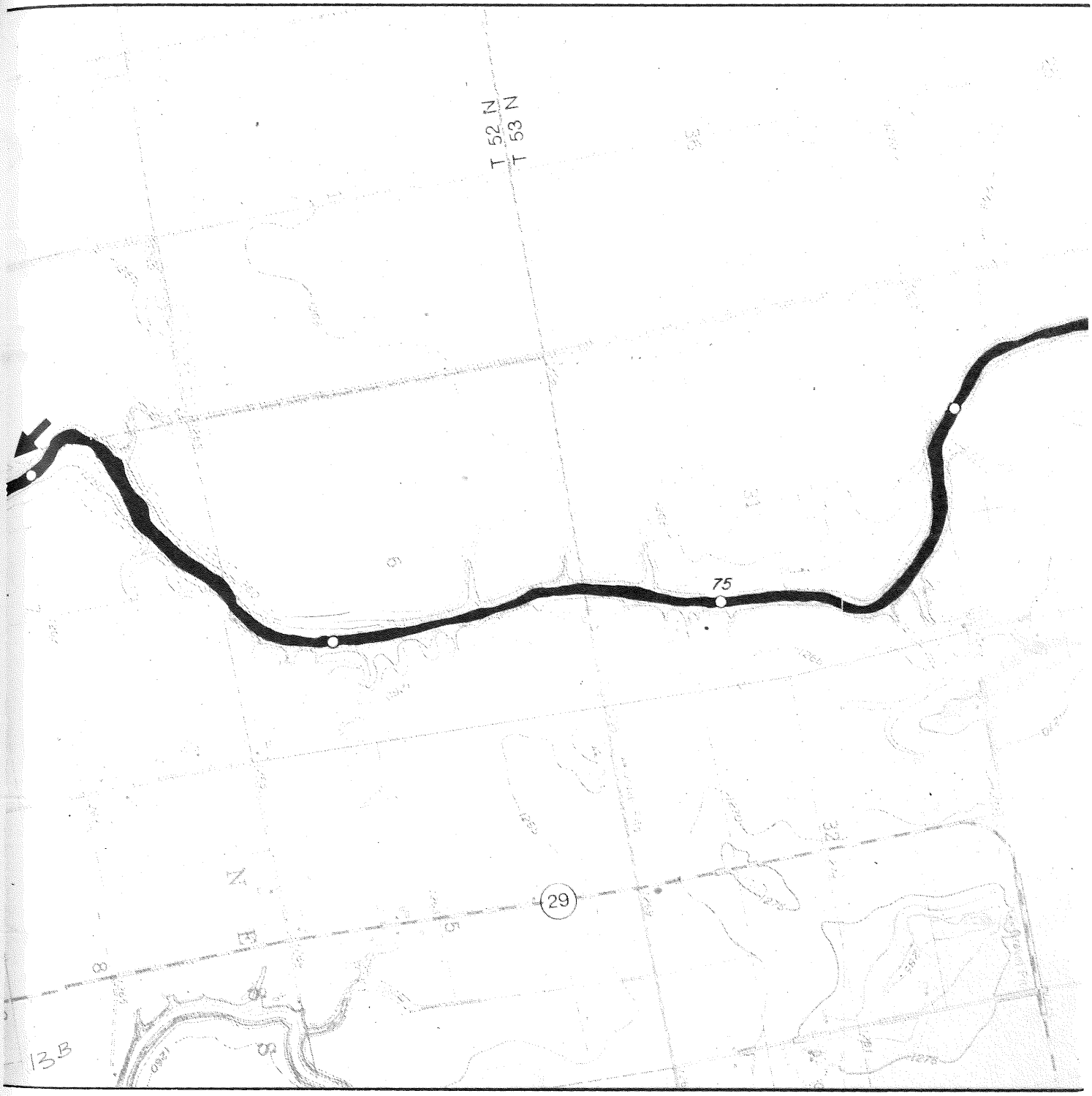


LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: #25
of 48

Scale: 1"=2000'



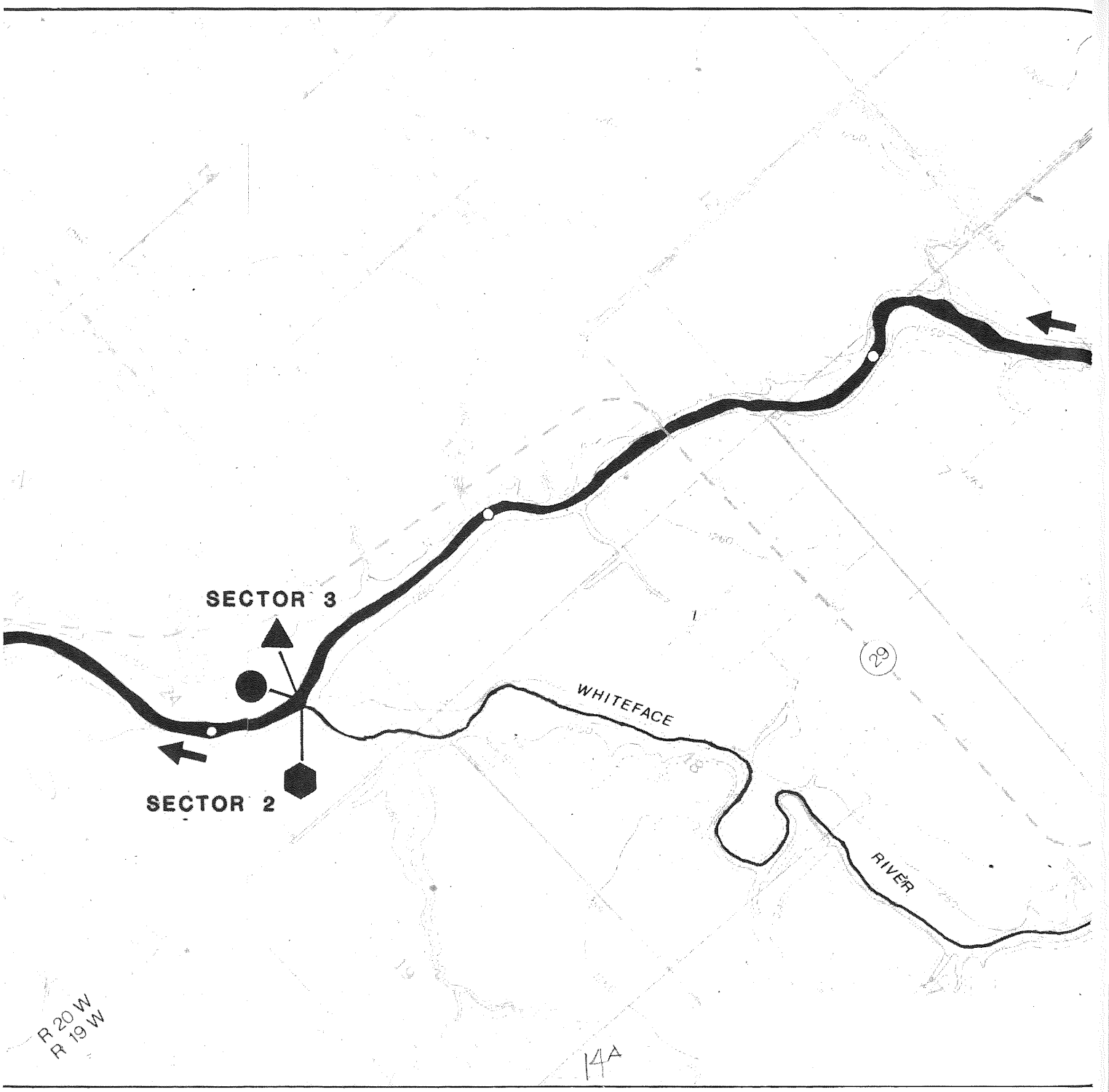
LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: # 26
of 48

N

Scale: 1" = 2000'

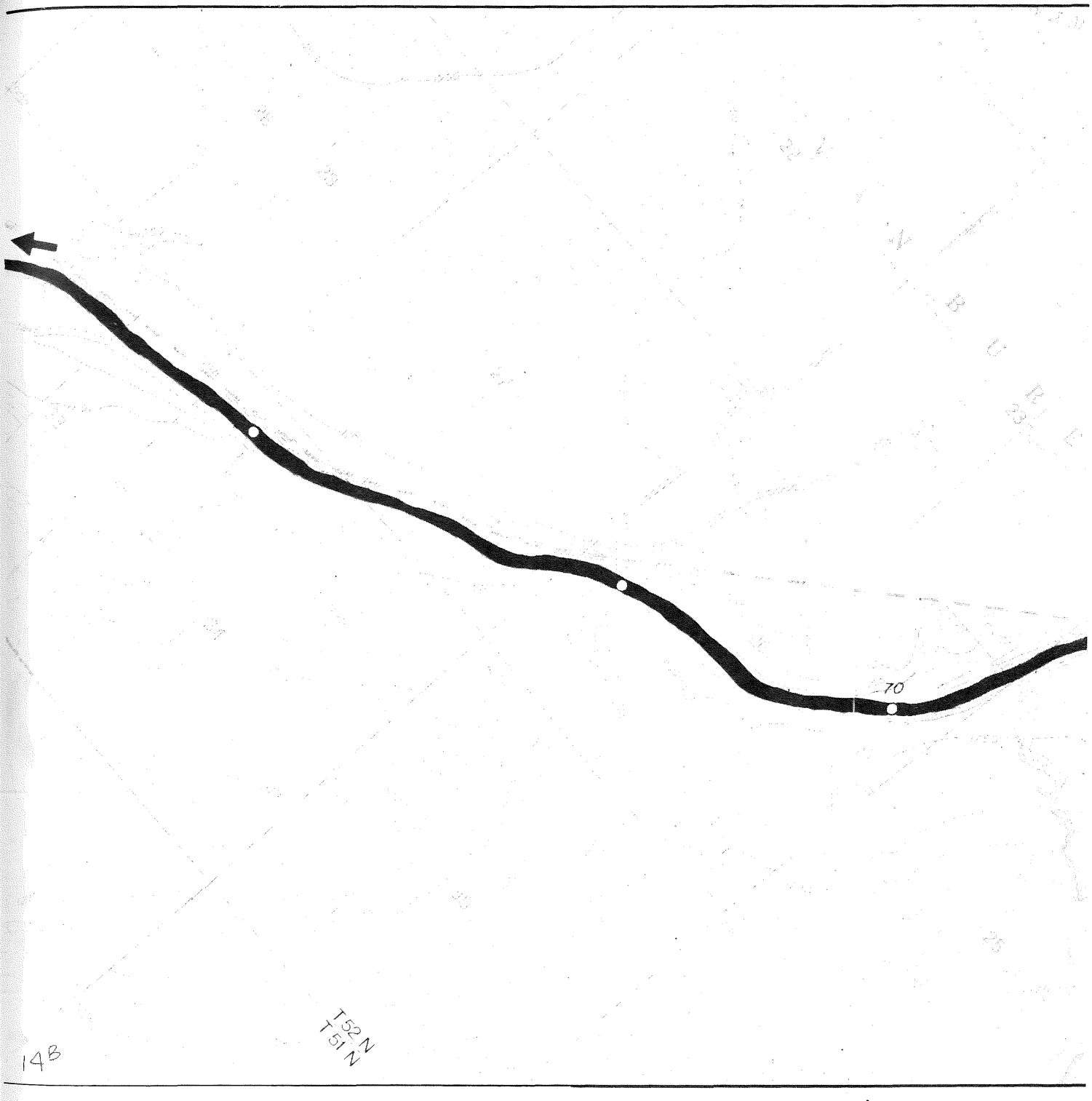


LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: #27 of 48

Scale: 1"=2000'

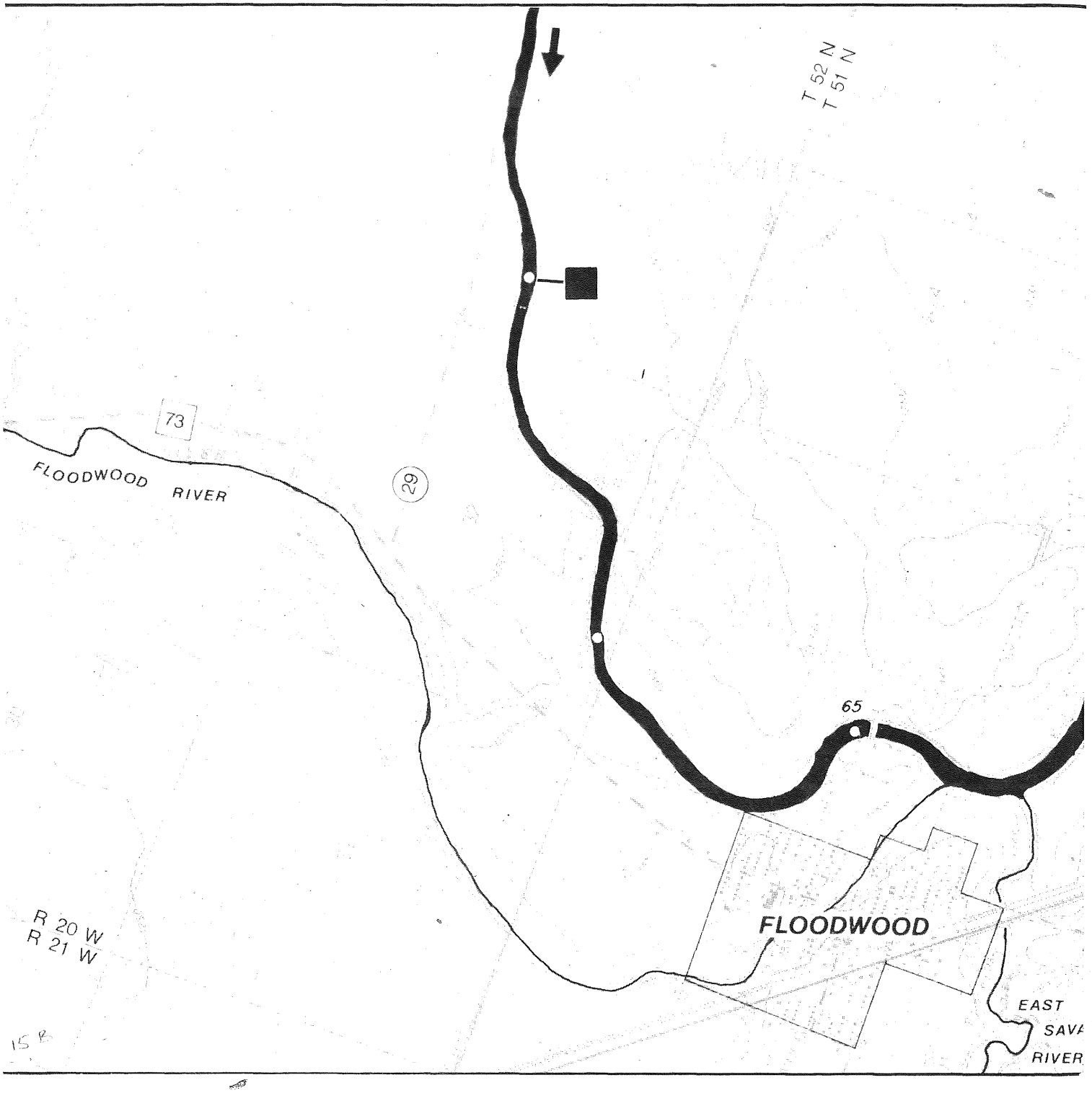


LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: #28
of 48

Scale: 1" = 2000'

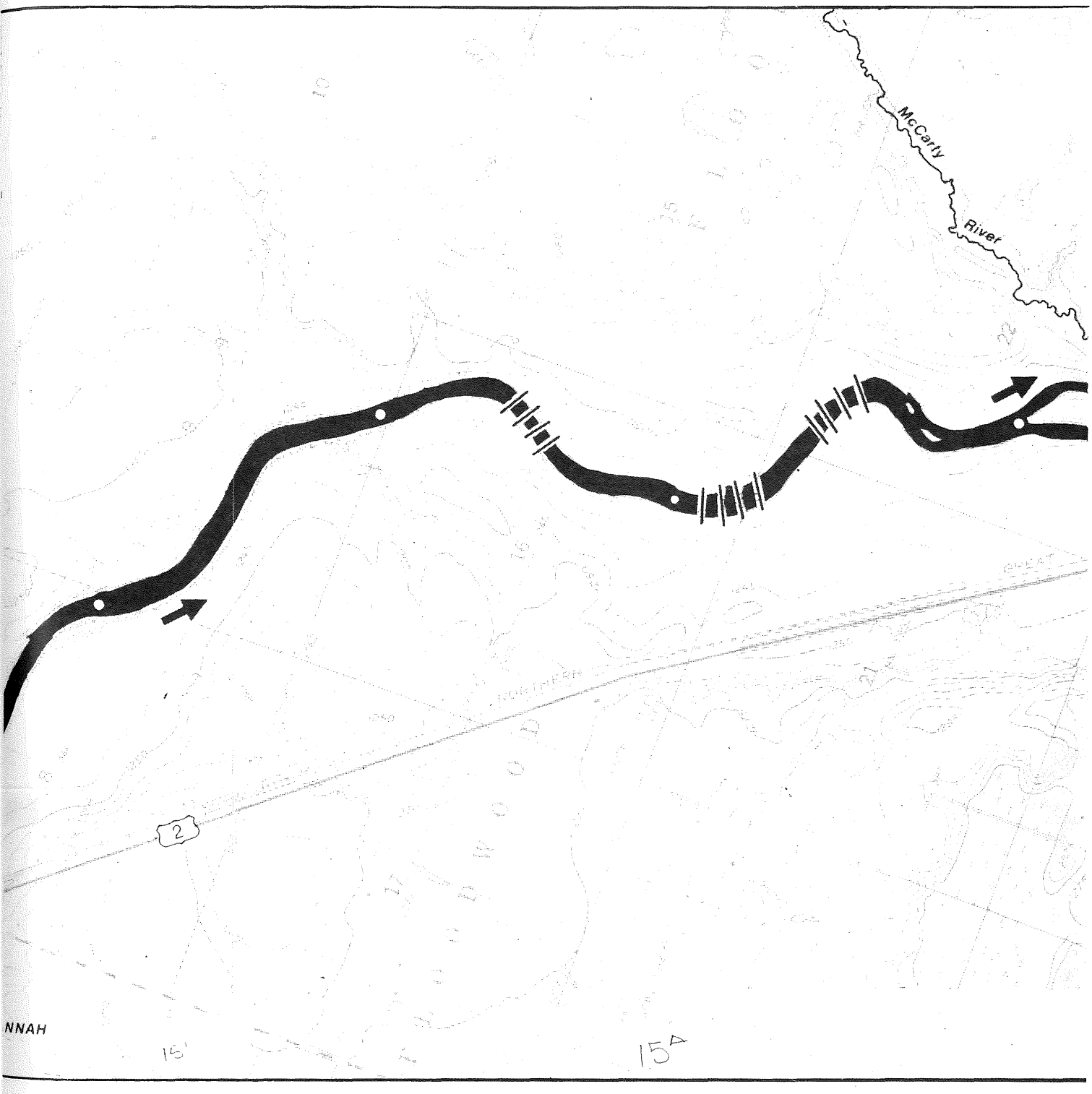


LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: # 29
of 48

Scale: 1"=2000'



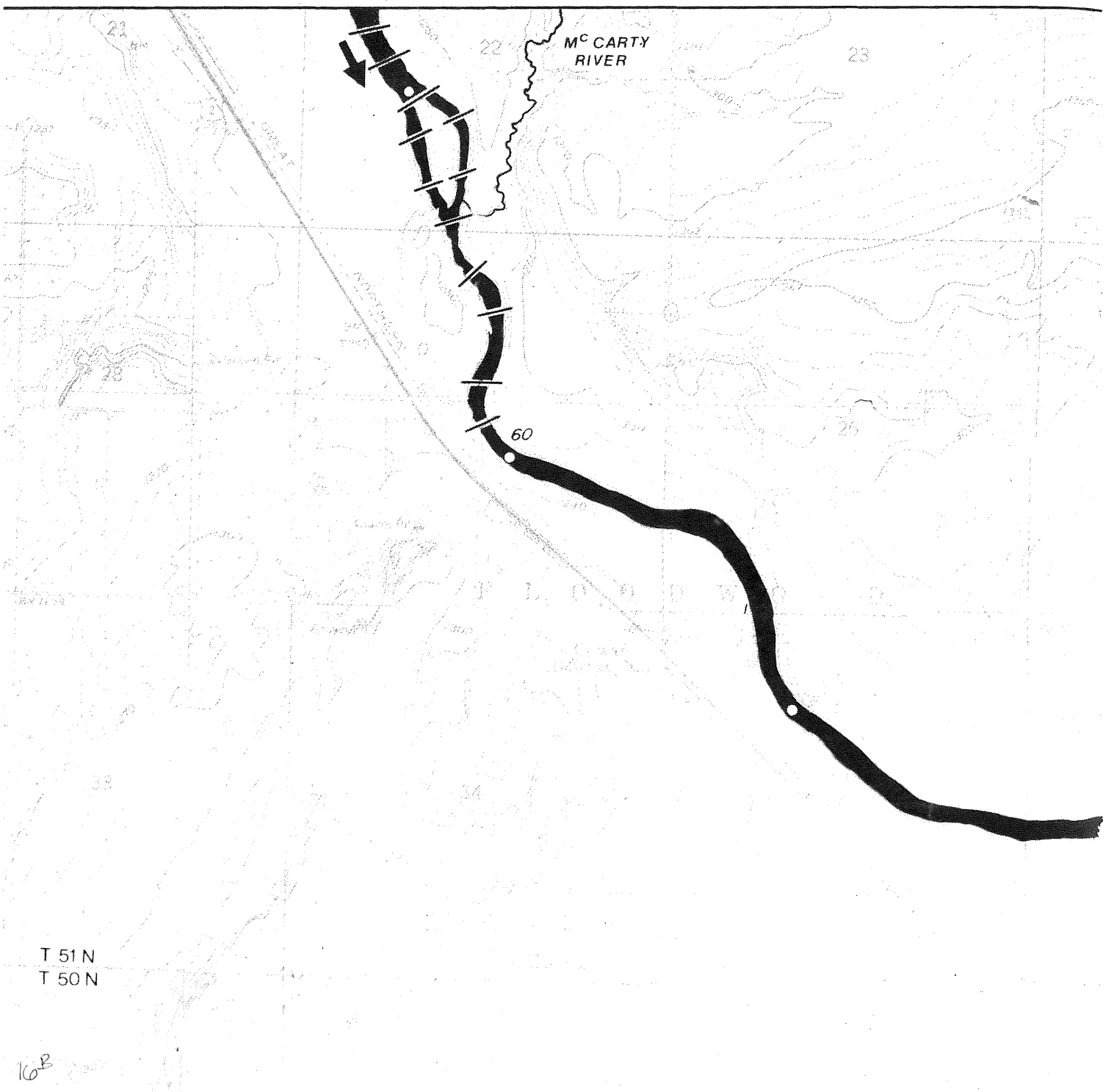
LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: # 30
of 48

N

Scale: 1" = 2000'



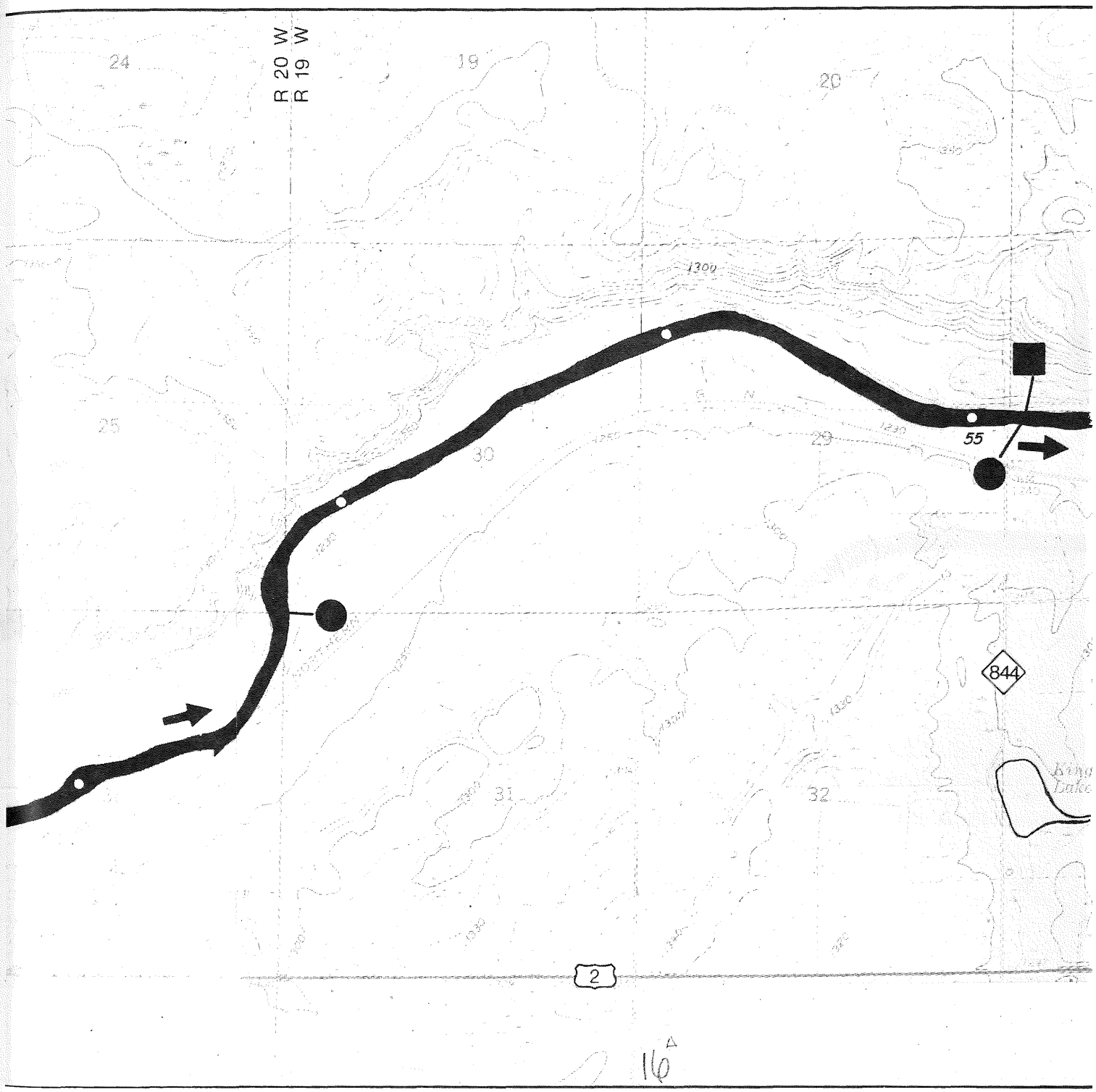
LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: #31
of 48

N

Scale: 1" = 2000'



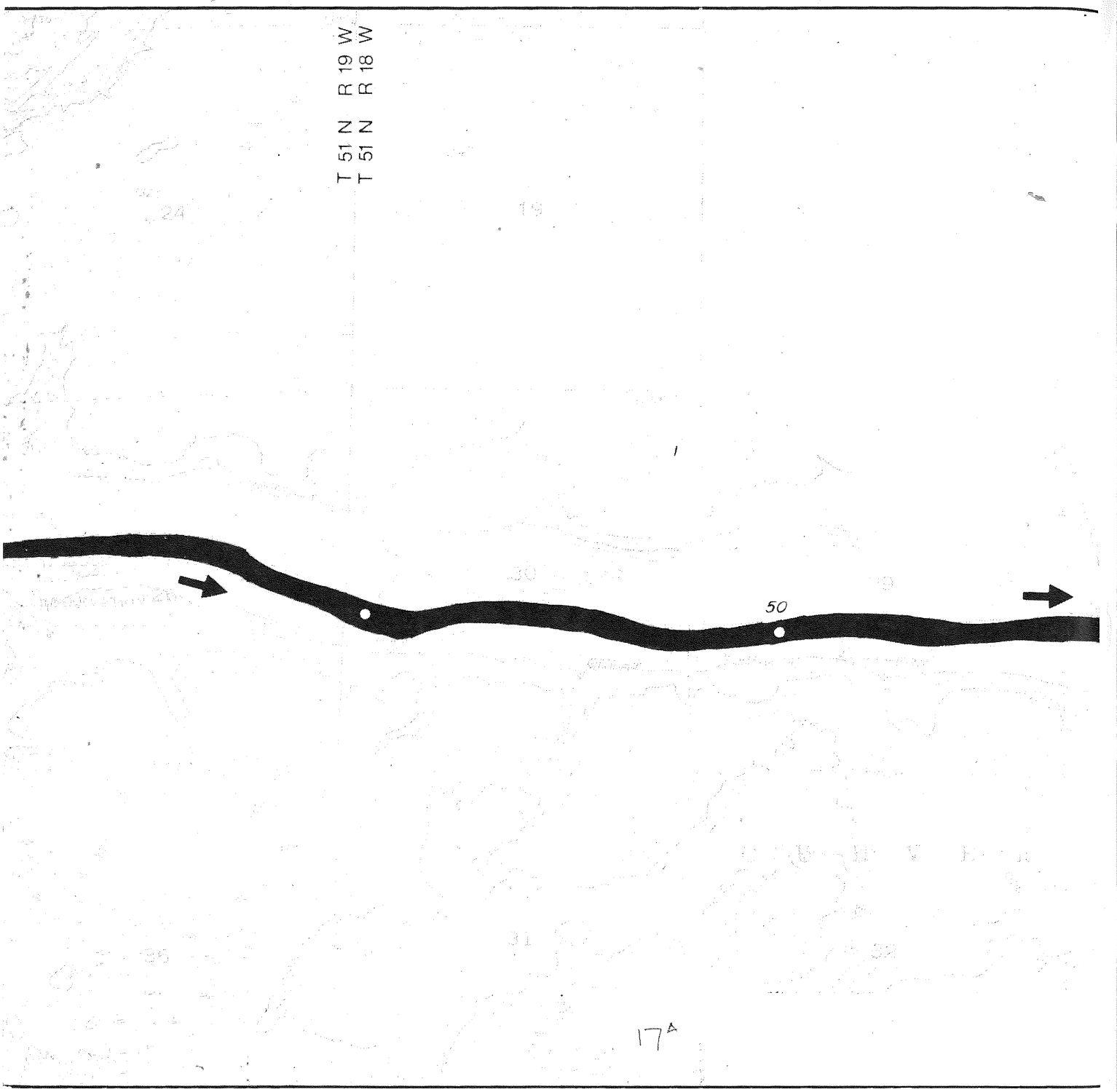
LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: # 32
of 48

N

Scale: 1" = 2000'



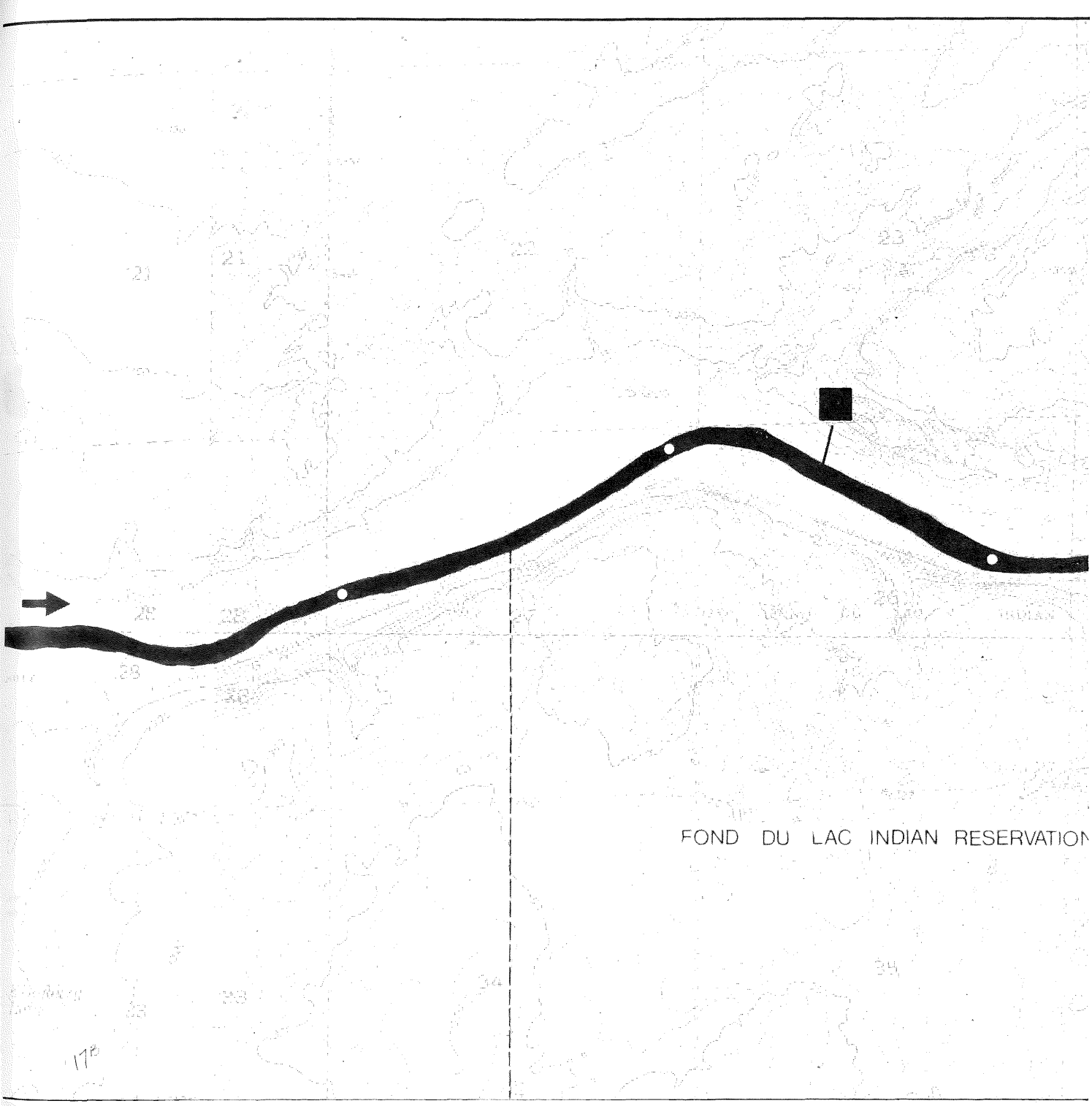
LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: #33
of 48

N

Scale: 1" = 2000'



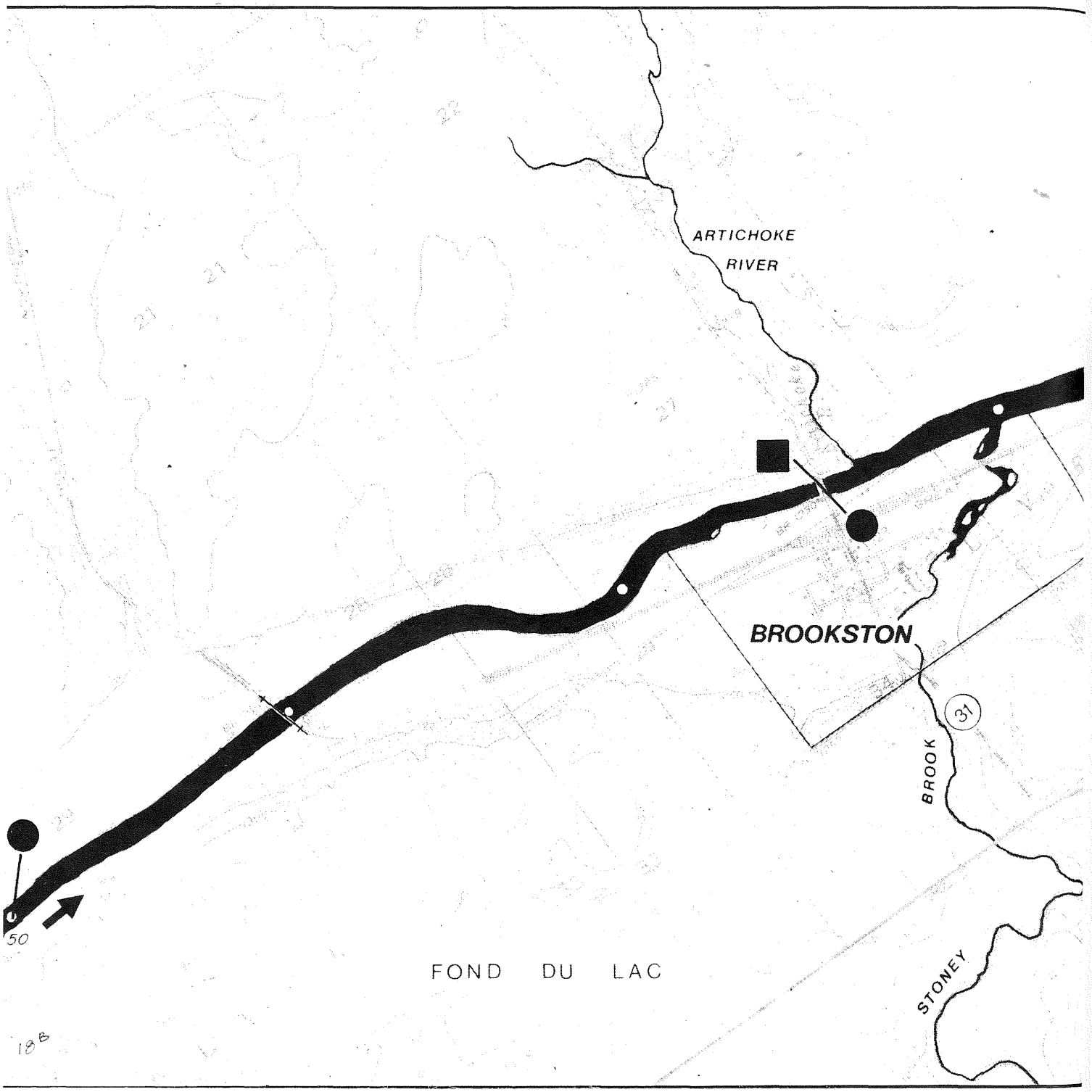
LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: #34
of 48

N

Scale: 1" = 2000'



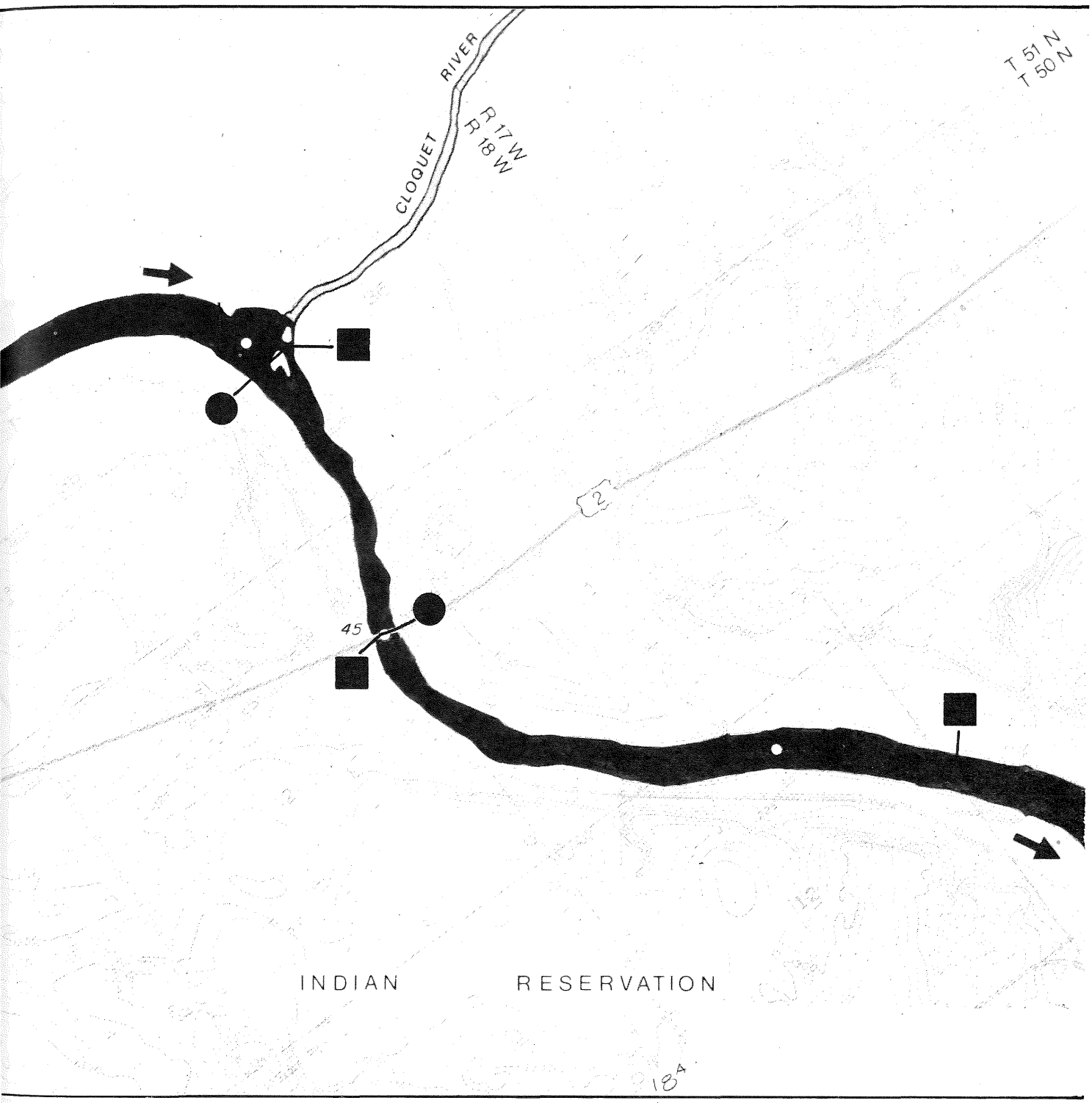
LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: # 35
of 48

N

Scale: 1" = 2000'



LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: # 36 of 48

Scale: 1" = 2000'

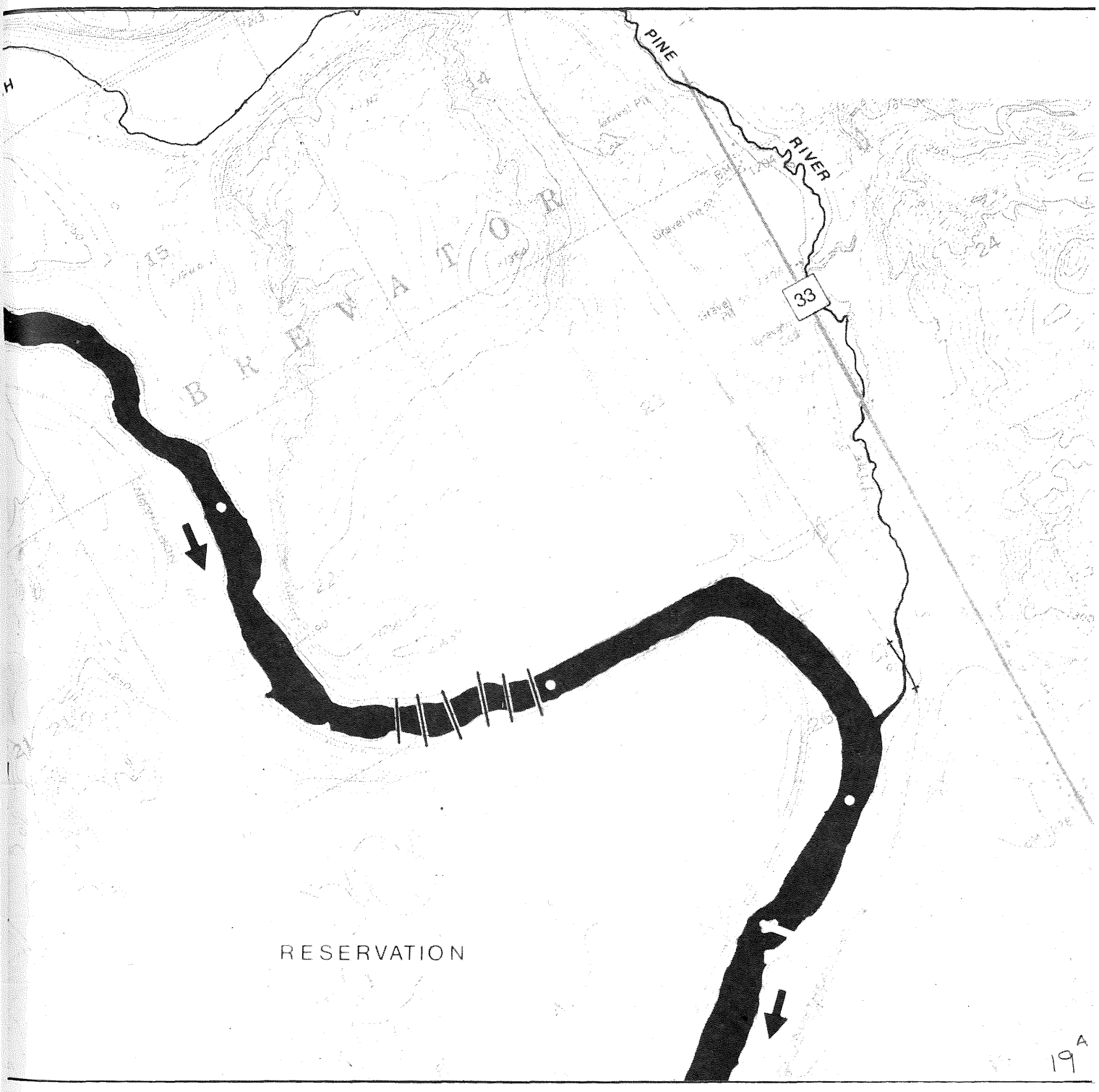
LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: # 37
of 48

N

Scale: 1" = 2000'



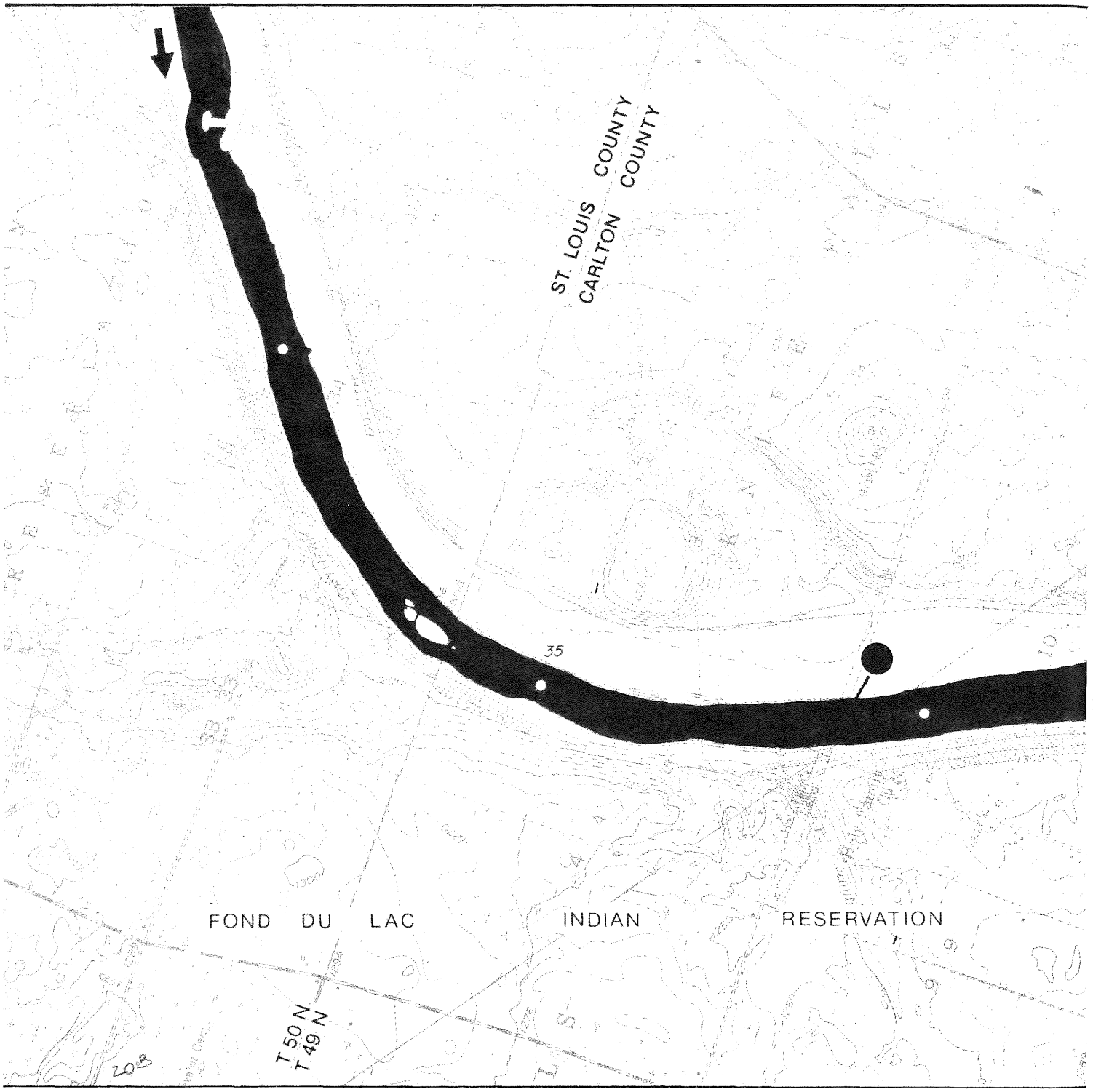
LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: #38
of 48

N

Scale: 1"=2000'



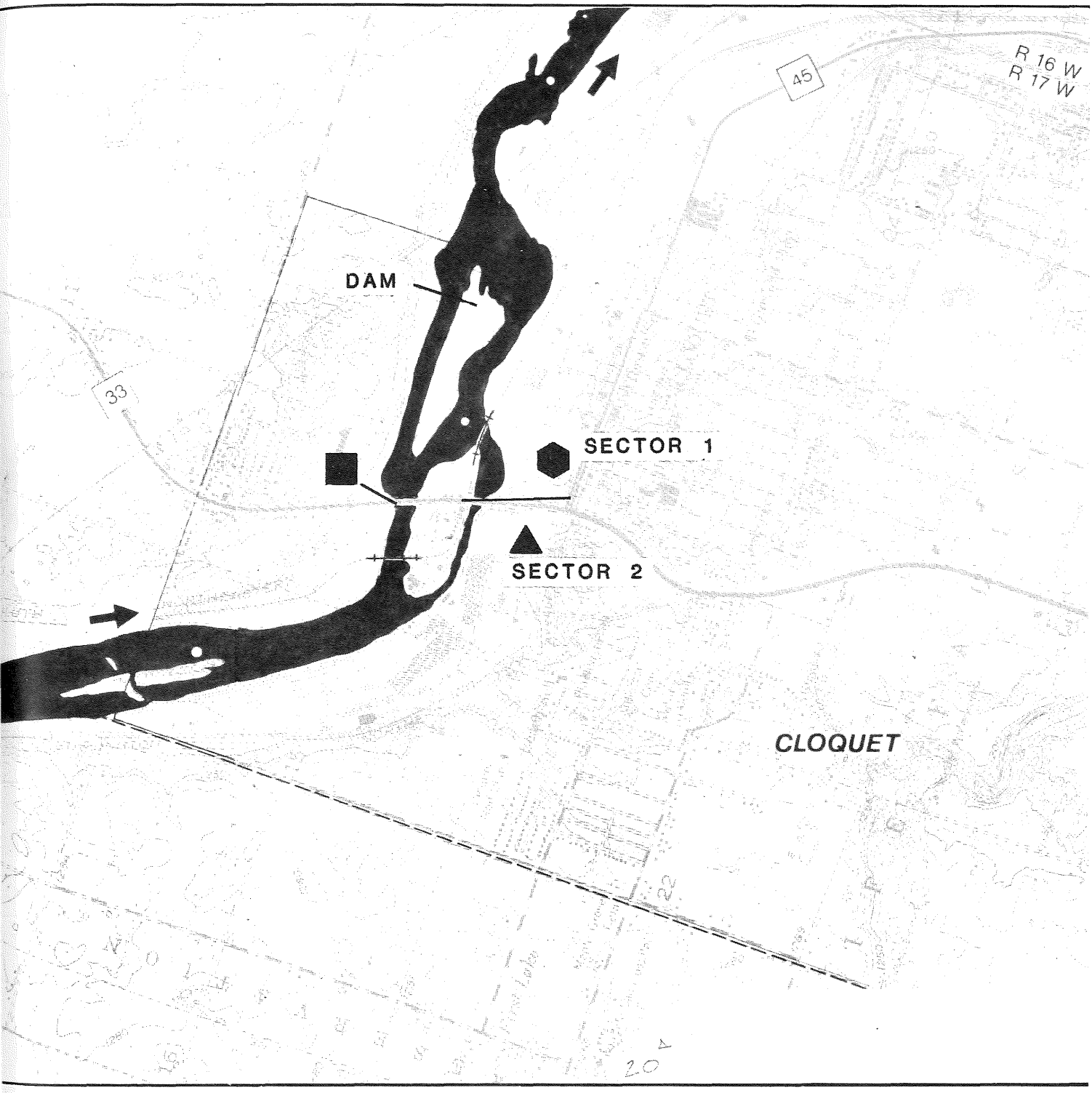
LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: # 39
of 48

N

Scale: 1"=2000'

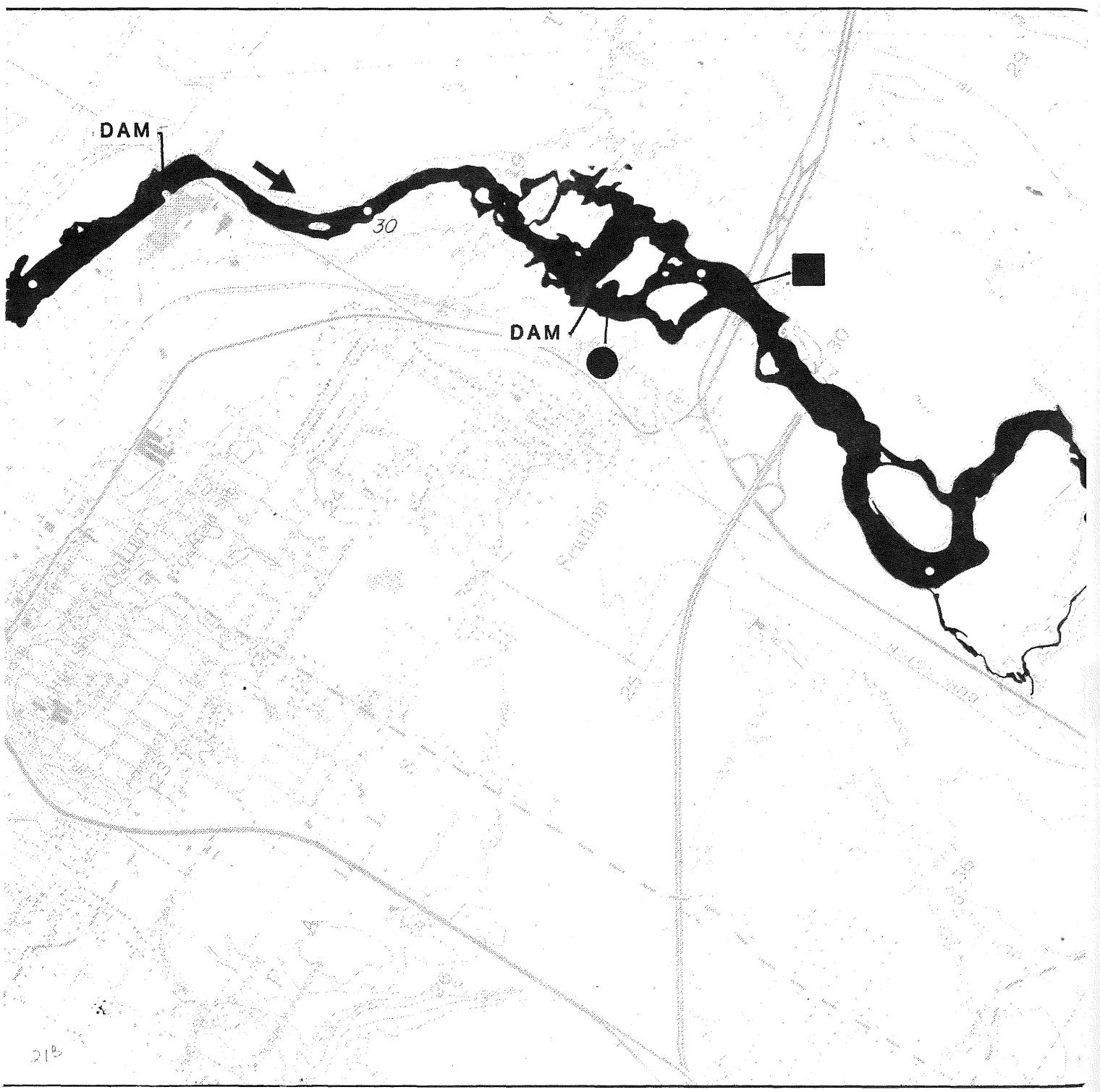


LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: #40
of 48

Scale: 1" = 2000'

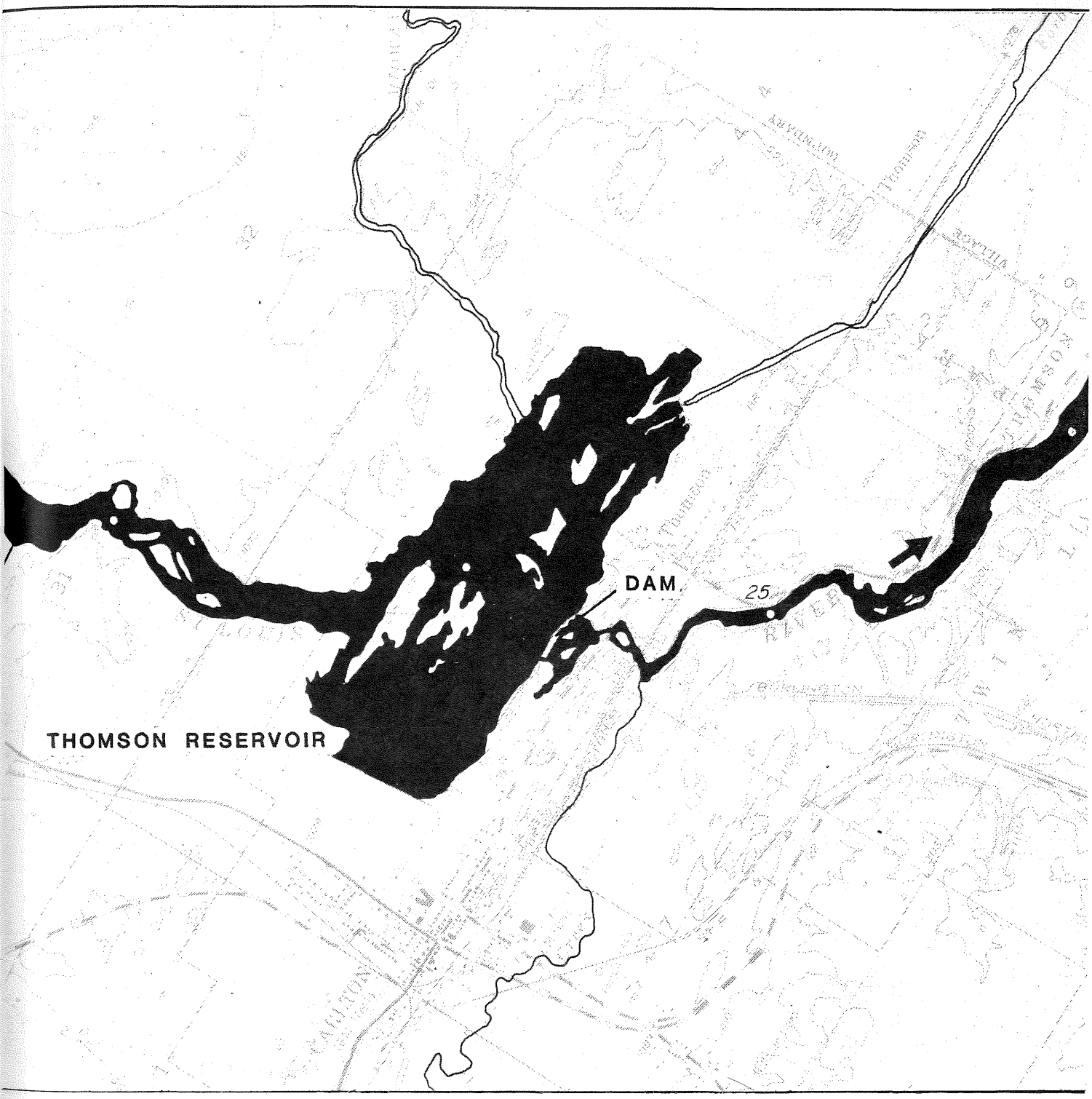


LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: # 41
of 48

Scale: 1" = 2000'

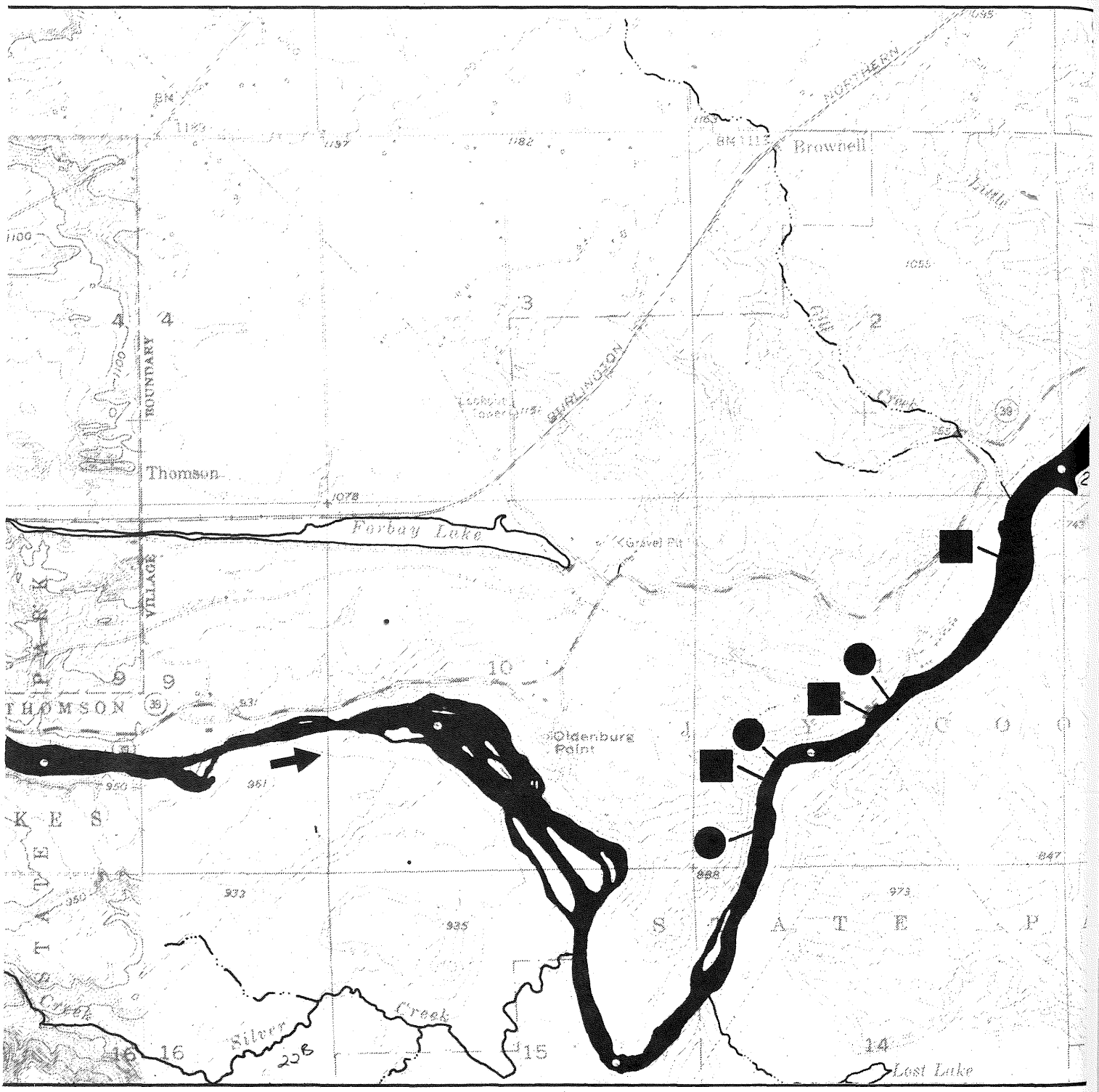


LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: # 42
of 48

Scale: 1" = 2000'



LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: # 43
of 48

N

Scale: 1" = 2000'

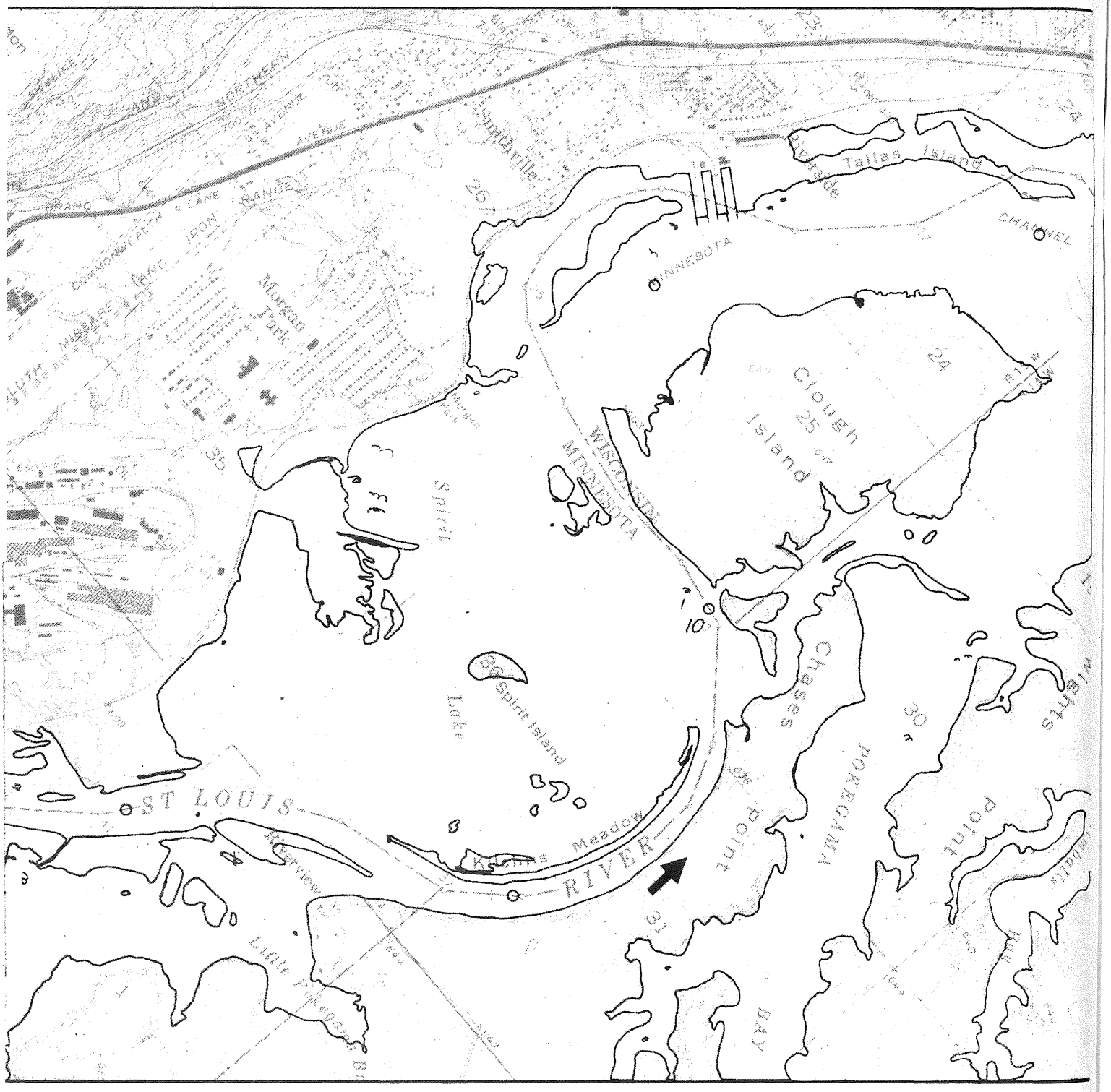
LEGEND

- Start of Electro Fishing Run
- End of Electro Fishing Run
- Beginning of Sector
- End of Sector

Plate: # 44
of 48

N

Scale: 1"=2000'



LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: # 45
of 48

N

Scale: 1" = 2000'

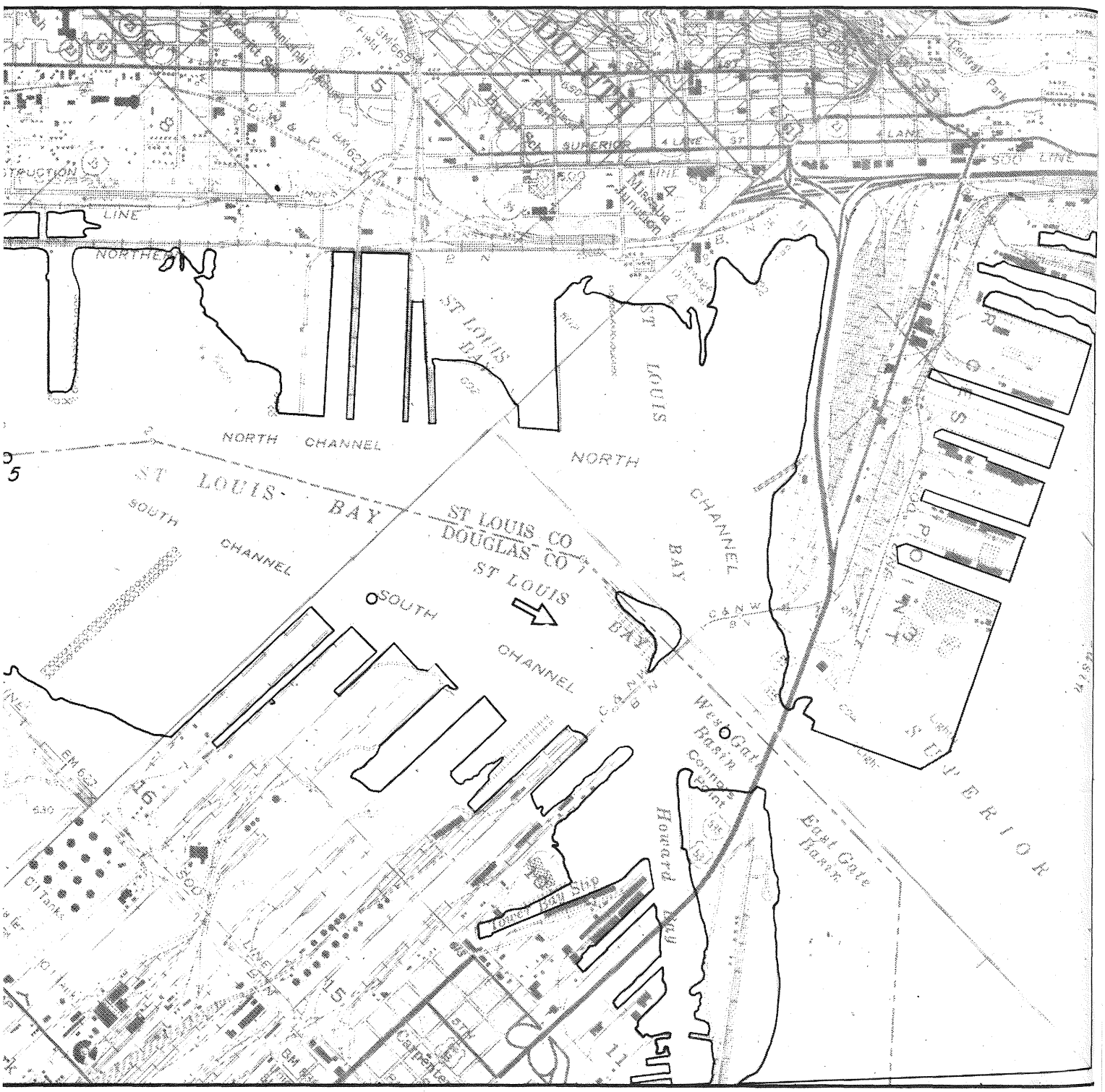
LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: #46
of 48

N

Scale: 1"=2000'

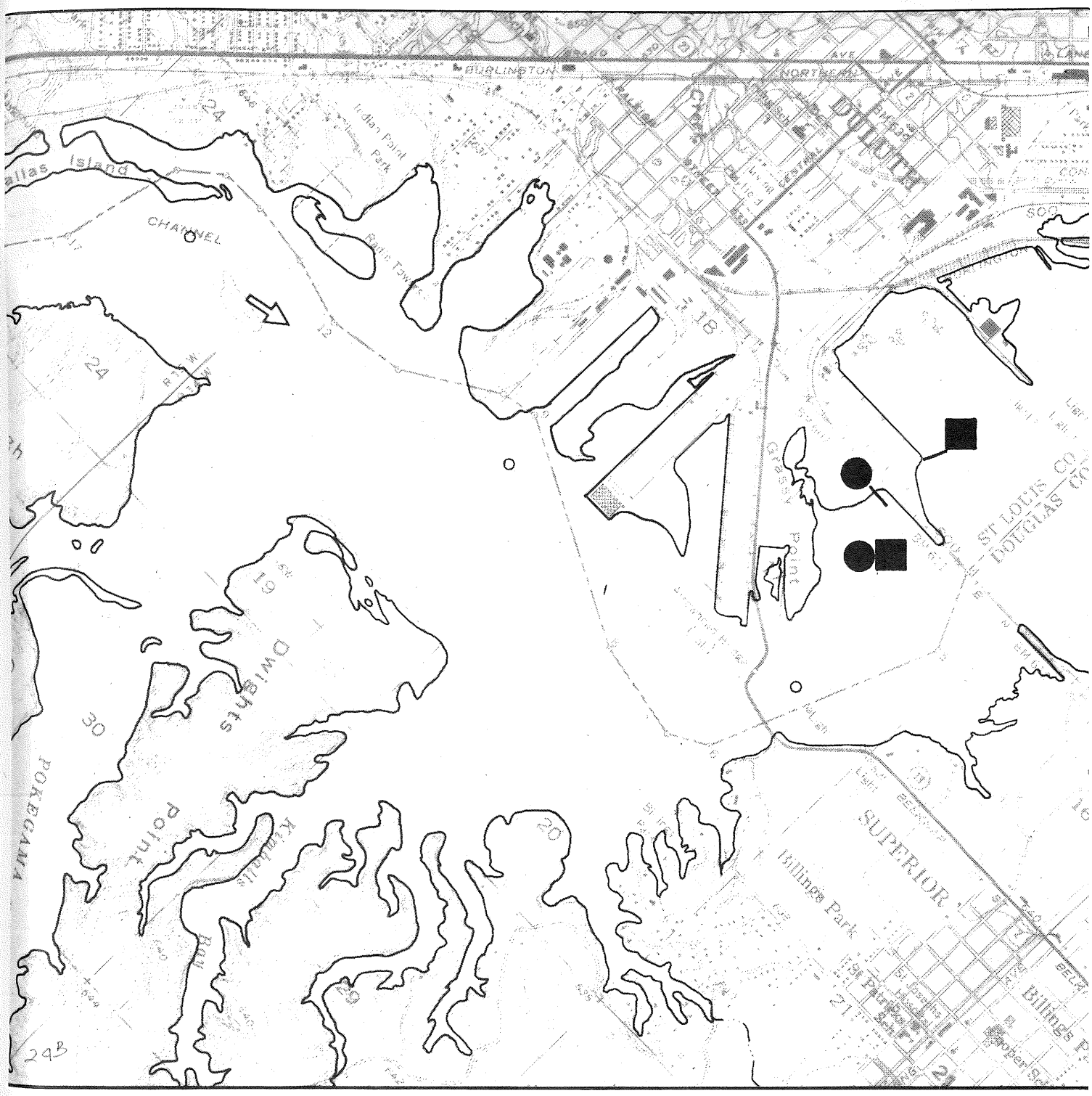


LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: # 47
of 48

Scale: 1" = 2000'



LEGEND

- ● Start of Electro Fishing Run
- ■ End of Electro Fishing Run
- ▲ Beginning of Sector
- ⬢ End of Sector

Plate: # 48
of 48

Scale: 1" = 2000'