Preliminary observations on the spawning and early life history of channel catfish from the lower Wisconsin River with recommendations for further study. Report 166 [1995]

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Preliminary Observations on the Spawning and Early Life History of Channel Catfish From the Lower Wisconsin River With Recommendations for Further Study

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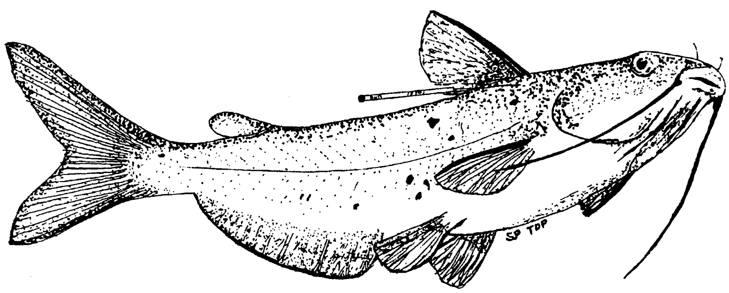

Abstract

A comprehensive study of the catfishes of the Lower Wisconsin River was begun during the summer of 1983. While initial efforts (1983-86) concentrated on adult catfish, incidental catches of juveniles, along with data collected in 1984 during tests of specially designed miniature hoop nets, provided preliminary information on the distribution and size of fingerling and yearling catfishes in the Lower Wisconsin River and adjacent waters of the Mississippi River. Most notably, it was evident that (1) juvenile catfish can be located in deeper water than might be expected based on literature reports and (2) first summer's growth of channel catfish in the areas sampled was at least as good as that in the rest of Wisconsin.

In May of 1986, 7 adult channel catfish (*Ictalurus punctatus*) were captured from the Lower Wisconsin River near the village of Lone Rock and implanted with radio transmitters. Activities of 4 of these fish (1 female and 3 males) were monitored through July of that year. During much of June, these fish were located in or near deep-cut banks or bank holes with some structure such as logs or well-developed sandwaves. Water temperatures were in the low to mid-70's (°F), less than what is considered optimum for spawning. The data suggest that these 4 fish spawned between 10 and 20 June 1986, and that the 3 males guarded the nests for 6 to 10 days until the eggs hatched. Subsequently, the 3 males moved to shallower water where they remained, presumably with their young charges, for an extended period of time.

Management of the important sport and commercial catfish species in large rivers requires a better understanding of their biology and ecology in these systems. Integral to this is understanding the early life histories of these species. To this end, a research proposal is appended.

Contents

Introduction

The Lower Wisconsin River is arguably the most important inland fishery resource in southwest Wisconsin and catfishes are considered by many to be the most important sport fish in that system. Fisheries managers from the Wisconsin Department of Natural Resources (DNR) Southern District, therefore, consider the management of the 2 largest species of the catfish family found in Wisconsin, the channel catfish *(Ictalurus punctatus)* and the flathead catfish (*Pylodictis olivaris*), a high priority. But in order to manage a species, particularly in the context of its ecological place in a complex community, it is necessary to have an understanding of all of its life stages.

In 1983 DNR Fish Researchers and Fisheries Managers from the Southern and Western Districts, began a comprehensive study of the catfishes of the Lower Wisconsin River. Field efforts from 1983 through 1986 concentrated on the movement and structure of the adult and adolescent segments of these catfish populations.

Fingerling and yearling catfish were collected incidental to these first efforts, and in 1984, a limited effort to test the effectiveness of specially designed miniature hoop nets provided additional information on the size and distribution of these juveniles. These data, along with the descriptions provided by Becker (1983), constituted about all that was known of the biology and behavior of young-of-the-year (YOY) catfish in Wisconsin. Additionally, specific information on spawning behavior and success was lacking for Wisconsin's river populations.

By 1986, Fish Researchers and Southern District Fisheries Managers were ready to implement studies to identify spawning and nursery habitats within the Lower Wisconsin River, and to describe the growth and distribution of YOY catfish. The immediate tasks facing the research team were to identify data needs and design a comprehensive study to document the spawning activity and early life history of Lower Wisconsin River channel catfish. Study segments were to include radio-tracking of adult fish to spawning grounds, documenting spawning activity, egg deposition and hatching success, and evaluating growth and distribution of channel catfish from larval (sac fry) through fall fingerling stages.

As originally written, the research objective for the spawning and early life history investigations was, "To provide the study design, data analyses, technical support and project coordination for Fisheries Management Project FM083-early life history segment." A major prerequisite to completing this outline was to develop and test equipment and techniques which could adequately sample these river populations and provide reliable data.

Due to budget cutbacks, however, Fisheries Management Project FM083 was terminated before any field work began (an action which invalidated the above objective). Budget cuts not withstanding, a limited effort was initiated in the spring of 1986 to develop and test equipment and techniques in preparation for an early life history study. These efforts were continued and expanded upon during that summer. As a result it became necessary to redefine the research objectives as follows:

1. Develop and test equipment and techniques for the collection of data on the early life history of channel catfish in the Lower Wisconsin River.
2. Develop a detailed study proposal for the evaluation of the early life history of channel catfish in the Lower Wisconsin River.

The information obtained from work on Objective 1, along with relevant data on fingerling catfish collected from 1983 through 1985, are contained in the main body of this report. Objective 2 is contained in Appendix A and includes a review of the literature concerning the spawning and early life history of catfish, and a review of sampling gear which could be employed in a study dealing with these aspects of catfish biology and ecology.

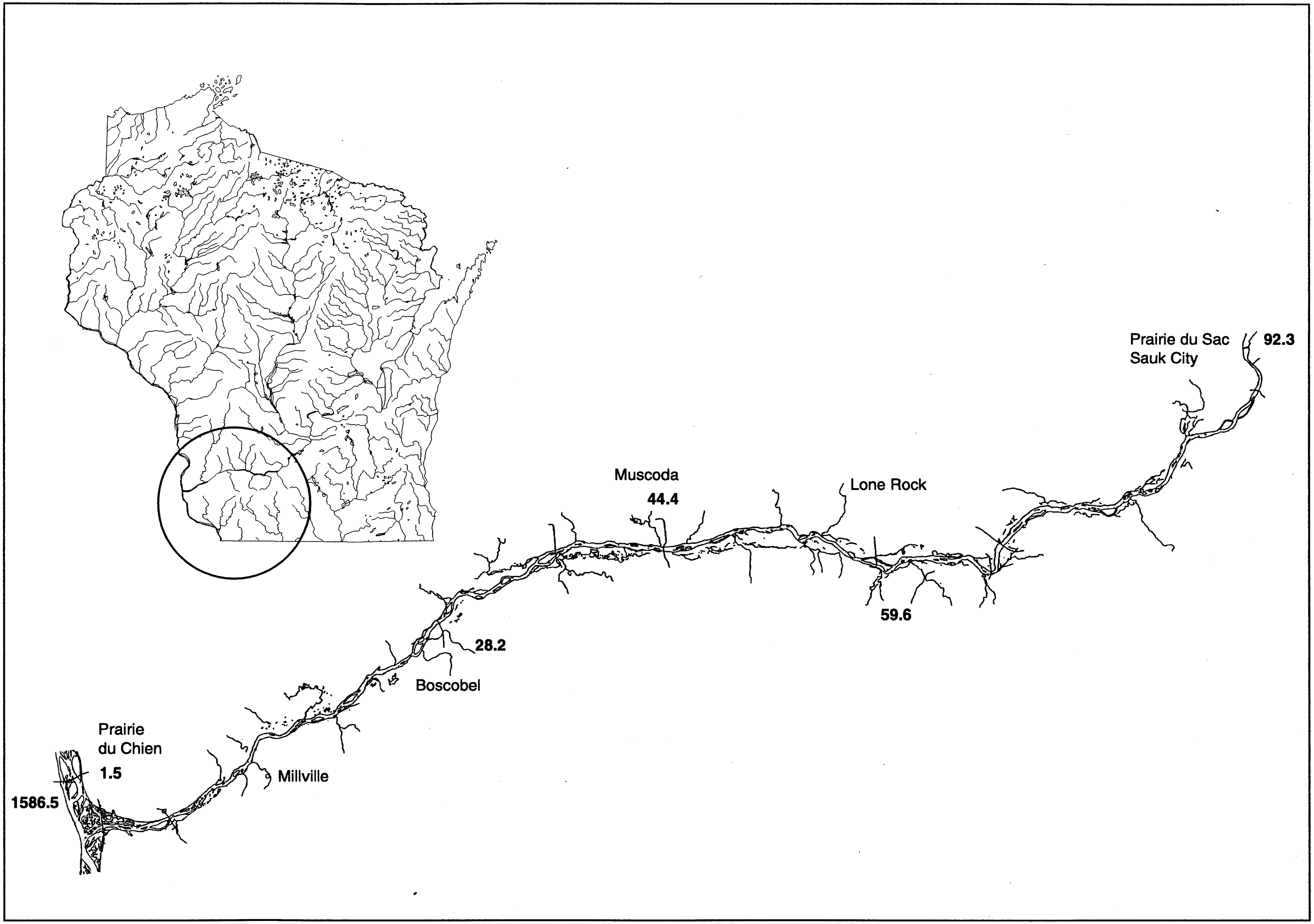

Figure 1. *Lower Wisconsin River study area including sampled portions of Pool 10 of the Upper Mississippi River. Selected river miles are listed. For definition of "river mile," see Fago (1988).*

Study Area

The Wisconsin River is 430 miles long and drains an area of some 12,000 square miles; it is the largest river wholly contained within the boundaries of the State of Wisconsin. It has its origins in Lac Vieux Desert, located on the state border with Michigan, from which it flows southward through the Northern Highlands (Upper Wisconsin River) and the Central Plains (Central Wisconsin River). Near Wisconsin Dells, the river turns east until it reaches Portage where it makes an abrupt change to the southwest (USDA 1979).

The river becomes the Lower Wisconsin River at river mile 92.3 as it breaks through the terminal moraine at Prairie du Sac into the driftless Western Uplands. This point of departure from "Central" to "Lower" is now occupied by the Prairie du Sac dam, a hydropower dam which marks the lowest reaches of Lake Wisconsin and which is also the last dam on the Wisconsin River. Here, where the Lower Wisconsin River begins its westwardly flow to the Mississippi, the flood plain is in excess of 4 miles wide (Martin 1965).

As the shallow channels meander from shore to shore and braid their way among numerous vegetated island and shifting sandbars, the sometimes strong, but always turbulent, currents undercut sand bars and shorelines creating the occasional "cut bank" or "bank hole" up to 15 ft deep. The river channel remains much the same over its course of more than 92 miles (Fig. 1) but the sandbars shift and the bank holes are cut and refilled with unpredictable frequency.

The flood plain, on the other hand, becomes increasingly narrow as the river flows west. At Muscoda, some 40 miles west of the Prairie du Sac Dam, the flood plain is 2 miles across; it becomes less than 0.5 miles wide at Bridgeport, just 6 miles from the confluence with the Mississippi River (Martin 1965).

Beyond this point, the river begins to widen to form the confluence delta. As the Wisconsin River passes under the railroad bridge at river mile 1.6 (river miles are as defined by Fago 1988), it becomes nearly indistinguishable from the maze of side channels, islands, and river lakes that form the backwaters of the Upper Mississippi River.

Methods

Seven adult channel catfish were surgically implanted with radio transmitters (50-51 MHz range) in May of 1986. These fish were captured in baited hoop nets near the mouth of Otter Creek in the Lower Wisconsin River (river mile 59.6R 0.1), near the village of Lone Rock. One of the 7 catfish died shortly after tagging, 1 was last observed on 16 June at mile 43.0, and 1 moved far enough away from the study area so that tracking was not feasible. This third fish was caught by an angler 1 year later at river mile 92.2.

The remaining 4 catfish (3 males and 1 female) were located 2-3 times per week, from mid-May through July, with the aid of a portable scanning receiver. At each location, the following data were collected and recorded: depth, surface temperature, substrate type (qualitative), and current velocities at the surface, mid-column, and bottom. Observations of cover types were also noted. Additionally, hourly water temperatures were recorded by a continuous recording thermograph at river mile 44.4 near Muscoda Wisconsin during the study period. Mean daily temperatures were calculated from these data.

Depth records along transects were made at several locations with a chart recorder and these data were then transferred to river maps to describe bottom contours. A 3-dimensional computer graphics program (SAS-Graph) was used to depict the topography at 1 site.

Hoop nets used to capture adult channel catfish were of 2 types. Commercial "buffalo" nets were 3-throated nets, 16 ft long with nine 3.5-ft-diameter hoops and 1-inch bar-mesh netting. Experimental hoop nets were of similar construction but with 7 hoops 2.5 ft in diameter and 0.75-inch bar-mesh netting. Hoop nets were baited with soya cake held in plastic "onion" bags tied into the cod end of the net; some loose "bill" was added to enhance the disbursal of the bait trail. Nets were set as depicted in Figure 2, with the stake driver (also depicted) used to set the anchor rod into the substrate. Downstream anchors varied with current conditions and availability but 10-pound steel weights were the most frequently used items.

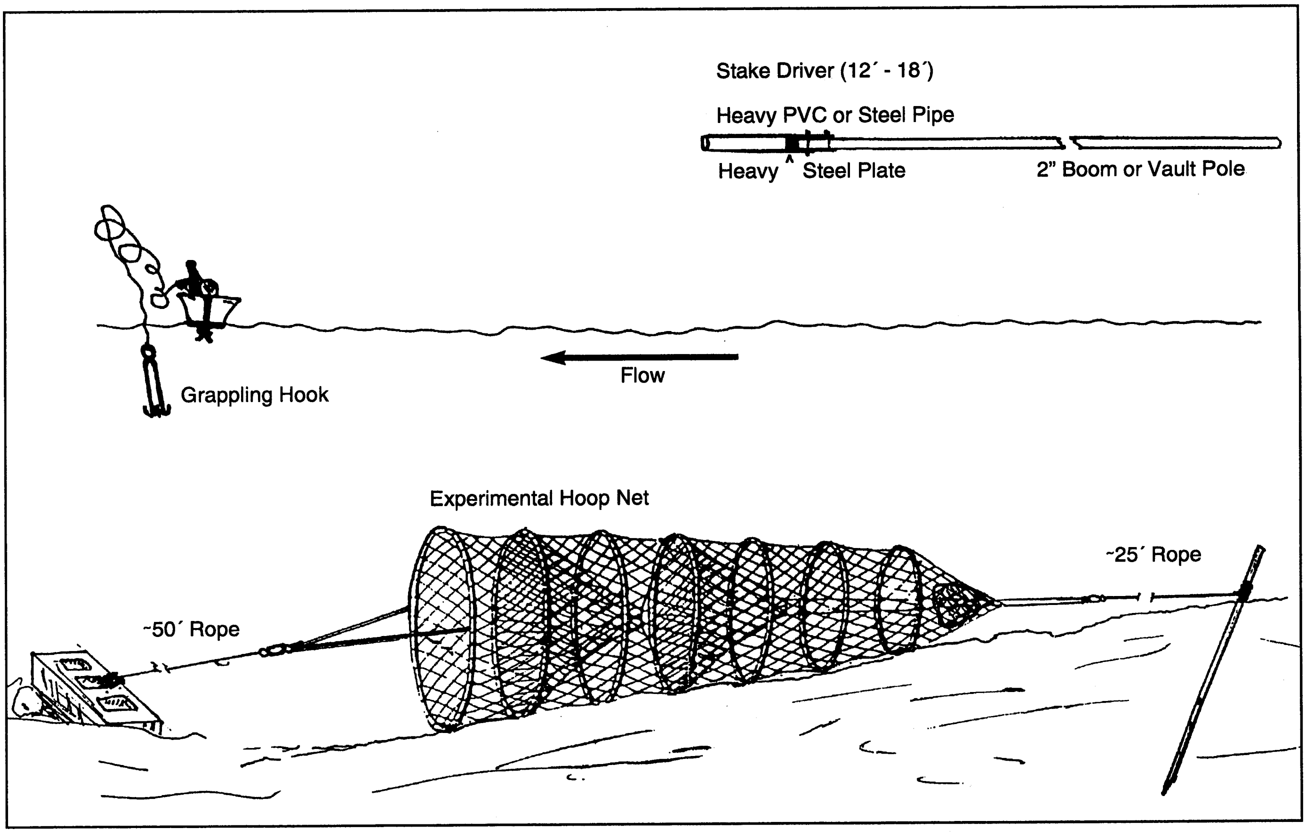

Figure 2. *Typical hoop net set, stake driver, and retrieval gear. Slat traps were sometimes set in place of the downstream anchor. When used, miniature hoop nets were fished in tandem with large hoop nets and placed between the net mouth and the anchor.*

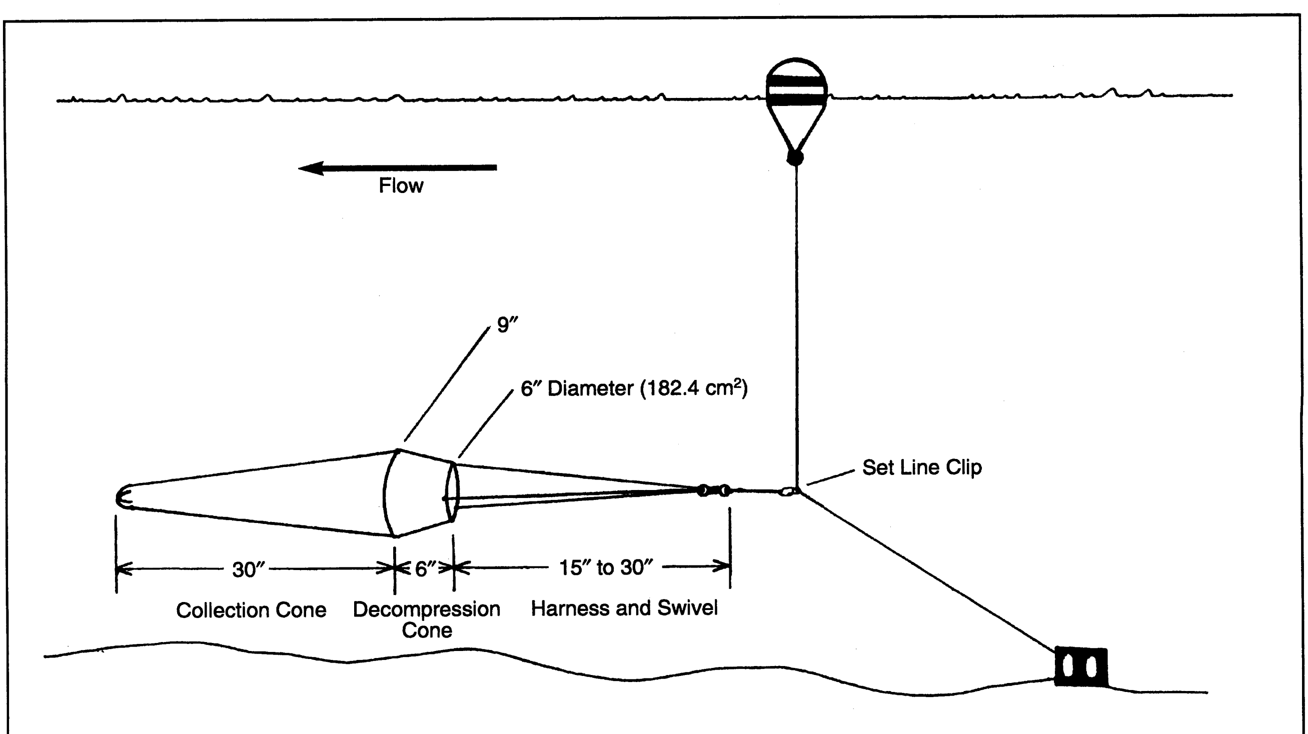

Figure 3. *Experimental drift net design and deployment.*

Miniature hoop nets were constructed by DNR Southern District Fisheries Management staff and tested in 1984. These nets were about 8 ft long, had only 1 throat, and 3 hoops, each 1 ft in diameter. The webbing used was 1/4-inch minnow seine, and wooden slate (1.25 inches x 0.25 inches) were spaced 1 inch apart across the mouth of each net. Miniature hoop nets were usually added at the downstream end of a hoop net set.

In 1983, the first year of the catfish investigations, several YOY and yearling catfish were caught in standard hardwood slat traps baited with soya cake. These traps were 12 inches square and 48 inches long. Gaps between slats were approximately 0.25 inches and the throat slats tapered to a 1.25-inch opening. Traps were set in the same manner as were the hoop nets or, more frequently, added at the downstream end of a hoop net set replacing the steel anchor.

Miniature drift nets were designed and constructed as a method of collecting quantitative and statistically valid (i.e., sufficient sample size) drift samples which could include larval catfish that may stray from the school or be swept away by changing and unpredictable currents. These nets were constructed as shown in Figure 3. Hoops, swivels, and set line clips were stainless steel, the harnesses were made from nylon coated, braided steel cable, the decompression cones were canvas and the collection cone was made of 500- or 750-µm NITEX nylon bolting cloth. Preliminary tests were run on these nets to determine "fishability" but no effort was made to quantify the drift samples collected during these tests.

Standard bag seines were also evaluated for collecting larval and fingerling specimens. These nets ranged from 20 to 40 feet in length and were made of 1/16-inch Ace weave or 1/8 and 1/4-inch Diamond weave netting.

Based on the results obtained from the above activities, which relate to revised Study Objective 1, and on an extensive literature review, a detailed research proposal (Appendix A) was developed to study the early life histories of channel and flathead catfish in the Lower Wisconsin River. This satisfies and expands on revised Study Objective 2.

Results and Discussion

Adult Catfish

Standard radio telemetry techniques proved effective for locating adult channel catfish during this study. Tyus et al. (1984) found similar techniques to be very effective for collecting habitat data on Colorado squawfish (*Ptychocheilus oregonensis*) and further concluded that "radiotelemetry observations appear to avoid some of the bias" that may be inherent in observations made using more conventional collection techniques such as electroshocking. Gerhardt and Hubert (1990) use radio telemetry techniques to evaluate channel catfish spawning habitat in the Powder River system of Wyoming and Montana. Additionally, they found that movements of male catfish "declined sharply" 6 days before the first larval catfish were observed in drift nets.

In the current study, radio-tagged catfish could be approached by motor boat to within a few ft of their actual position, depending on water depth, without disturbing them. Fish in shallow water (<3 ft) generally abandoned their position when approached by boat, while fish in deeper water (>5 ft) often remained stationary even when the boat passed directly over them. Although not used in this study, a highly directional antenna system could be used to triangulate the location of radio-tagged fish in shallow water.

Catfish 1

(Female; radio frequency 50.992 MHz, length 20 inches, weight 4.1 lb): The only female catfish observed in this study is designated Catfish 1 for the purposes of this report. This fish was caught at river mile 60.2, radio tagged, and released at river mile 59.6 R 0.1. on 15 May 1986. She was observed on 29 May in 10.6 ft of water at river mile 61.2; the surface water temperature was 69°F at the time of observation. She was located in the same general area on 4 more occasions, the last being 11 June. By 16 June, she had moved across the channel to another deep hole but stayed only a day or so before moving to an area of shallower water approximately 0.5 mile downstream where she remained until 27 June when radio contact was lost (Fig. 4). The surface water temperature during this period was in the low to mid-70's (Table 1).

Catfish 1 could have spawned at 1 of 2 sites during this time (the site where she was first observed and where she remained for approximately 2 weeks, or the site on the north shore where she stayed for only a short time). Overhangs and snags were observed at the first site and this could have provided cover for the nest. However, according to Harlan and Speaker (1951), the female is driven away from the nest by the male after spawning. It is more likely that spawning took place on or about 16 June at the second site where she stayed only 1 or 2 days and then departed for better feeding grounds.

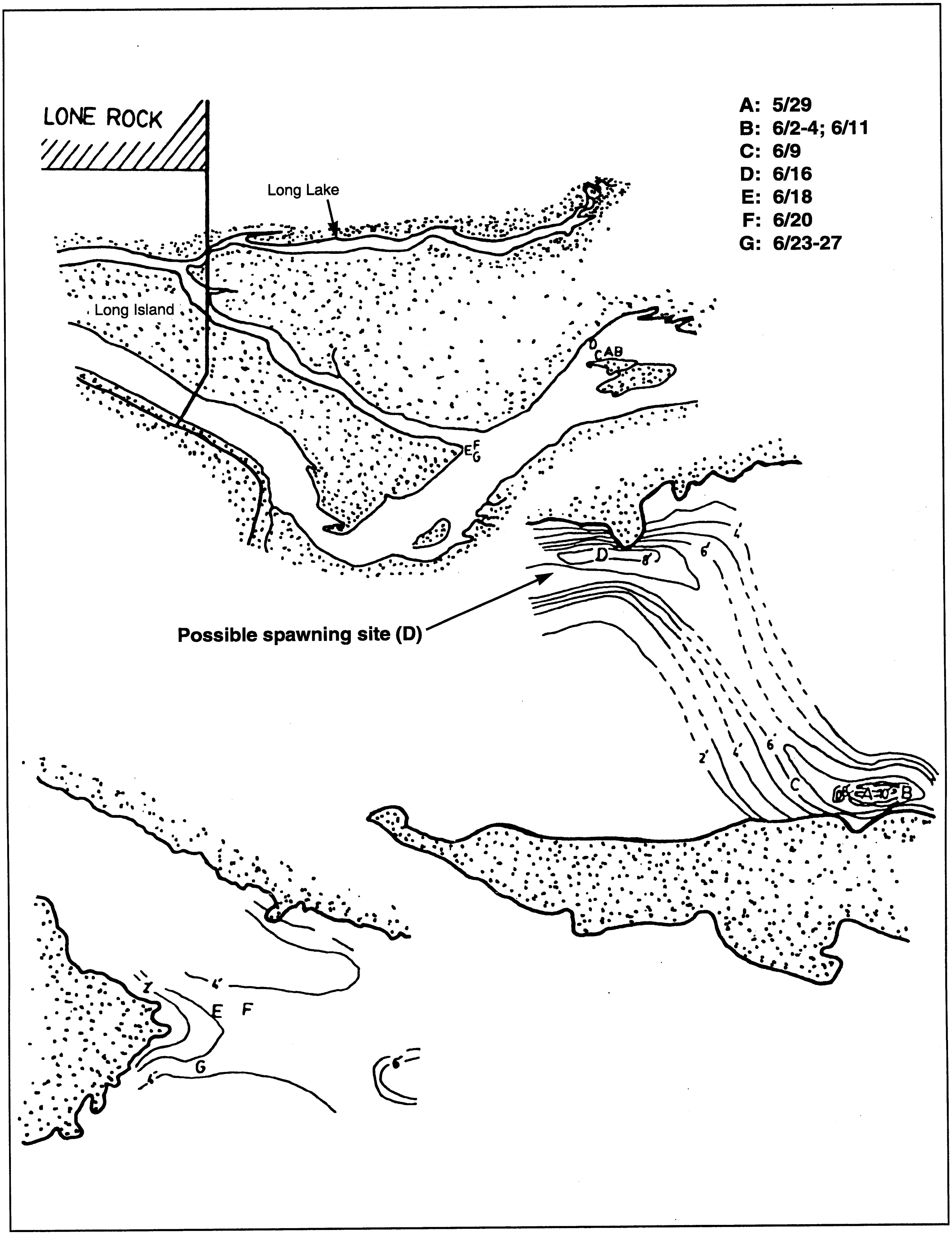

Figure 4. *Observed locations for a female channel catfish (radio frequency 50.992 MHz) between 29 May and 27 June 1986 and stream channel contours at those locations (from data in Table 1).*

Catfish 2

(Male; radio frequency 50.294 MHz, length 19 in., weight 2.3 lb): Catfish 2 was caught at river mile 57.8, tagged, and released at river mile 59.2 R 0.1 on 15 May 1986. He immediately moved downstream to near Muscoda and on 13 June was located at river mile 42.8 on the upstream end of McCary Island in less than 4 ft of water. He had moved 16.5 miles downstream from where he had been tagged and remained in this general area for at least 10 days before moving another 0.5 mile downstream into the side channel behind that island (Fig. 5). Five days later Catfish 2 was located back at the upstream end of the island, and on 11 July, he was located 1.4 miles upstream where he remained until monitoring efforts were discontinued.

It would be difficult to speculate on where and when, if at all, Catfish 2 might have spawned; general conditions and temperatures seemed favorable in all cases (Table 2) and he could have remained at all 3 principal sites for the 6 to 10 days required for the eggs to hatch (Harlan and Speaker 1951). If Catfish 2 did spawn, however, it is likely that he did so at the head of McCary Island sometime around 13 to 18 June, or in the side channel sometime between 23 and 27 June.

Catfish 3

(Male; radio frequency 50.082 MHz, length 25 in., weight 7.1 lb): This fish, tagged on 6 May 1986 and released at river mile 59.6 R 0.1, was the most frequently observed fish and also the most mobile, tending to roam over a stretch of the river between river mile 61.2, where he was first located on 29 May, to river mile 60.0 (Table 3). Two periods of relative inactivity were noted for Catfish 3. The first occurred in mid-June when he spent at least 5 days at river mile 60.6 in about 3.5 ft of water. The second was the last half of July where he spent at least 2 weeks in a shallow side channel at the upstream end of a small island on the south shore of the river (Fig. 6). Unless spawning occurred late in May, it is likely that Catfish 3 spawned during the first inactive period and that the second and longer inactive period was a time of recuperation and feeding after a long and active period of brood guarding.

Catfish 4

(Male; radio frequency 50.851 MHz, length 21 in., weight 4.1 lb): Catfish 4 was caught at river mile 57.8 on 15 May 1986, tagged, and released at river mile 59.6 R 0.1. The first boat observations of this fish were made on 2 June at river mile 56; he was in 3.3 ft of water (Table 4). The water temperature at the time of observation was 68° F. Two days later he was observed 0.1 miles upstream and in 5 ft of water. The surface water temperature at the time of observation was 72° F; the mean temperature for that day at river mile 44.4 was 70° F (Table 5). Catfish 4 was observed in this same general location through 23 June at depths up to 8 ft (Fig. 7). The substrate in this area was hard sand with rock and at least 1 submerged log at a depth of 6 ft. The surface water temperature at

Table 1. *Observed locations and physical habitat characteristics for a female channel catfish (radio frequency 50.992 MHz, length 20 inches, weight 2.9 lb) between 29 May and 27 June 1986 (see Fig. 4).*

Observ. date	River mile[a] and (site)	Depth (ft)	Current velocity (ft/sec)			Water temp.(°F)	Substrate	Comments
			Surface	Midwater	Bottom			
05/29/86	61.2(A)	10.6	–	–	–	69	Sand	Overhangs
06/02/86	61.2(B)	8.0	–	–	–	66	Sand	Overhangs/ snags
06/04/86	61.2(B)	7.0	–	–	–	72	Sand	
06/09/86	61.1(C)	6.5	1.5	1.5	–	69	Sand	
06/11/86	61.2(B)	8.0	1.0	1.6	–	73	Sand	
06/16/86	61.1(D)	8.5	–	–	–	72	Sand	
06/18/86	60.5(E)	3.2	2.2	–	0.6	75	Sand	
06/20/86	60.6(F)	3.9	2.1	–	0.9	73	Sand	
06/23/86	60.5(G)	4.8	2.7	–	0.7	76	Sand	
06/25/86	60.5(G)	–	–	–	–	–	Sand	
06/27/86	60.5(G)	–	–	–	–	–	Sand	

[a]River mileage as defined by Fago (1988).

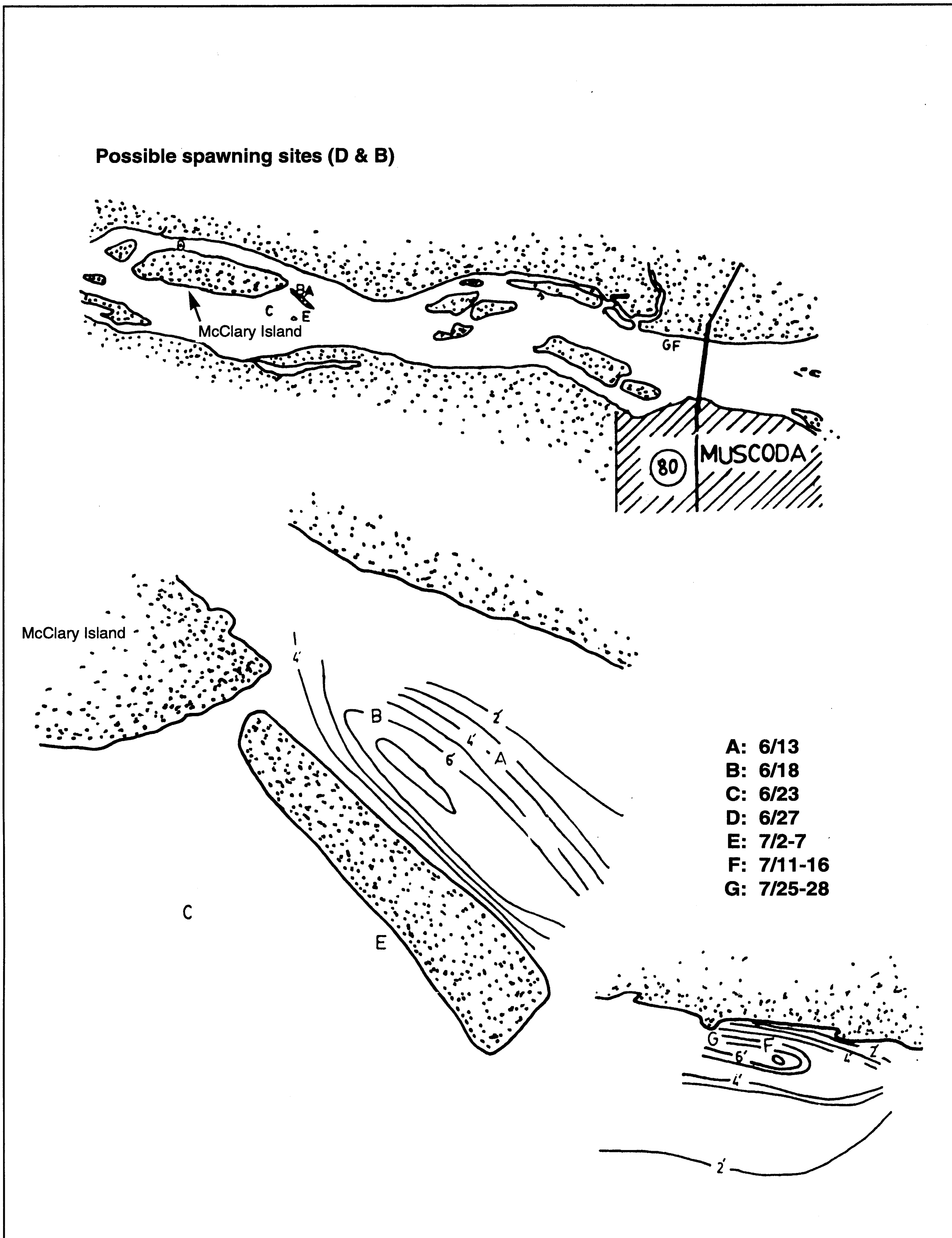

Figure 5. *Observed locations for a male channel catfish (radio frequency 50.294 MHz) between 13 June and 28 July 1986 and stream channel contours at 4 of those locations (from data in Table 2).*

the observed fish locations reached 77° F during this period and the mean water temperature at river mile 44.4 reached 74° F on 19 June and a June peak of 76° F 2 days later.

Given the favorable temperatures and substrates described here, it is quite possible that Catfish 4 spawned sometime between 9 and 18 June. Figure 8 depicts a partially buried log which could have served as spawning cover for Catfish 4. On 25 June, Catfish 4 had moved to shallower water and, over the next several days, was observed in a variety of locations. The last observation was on 17 July in a small side channel about 1.5 miles from the presumed spawning site.

In general, then, radio-tagged catfish were located in or near deep cut banks or bank holes with some structure such as overhanging trees, logs, rocks, or well-developed sandwave formations during much of June 1986. While no attempt was made to determine if these were spawning fish, these locations fit the descriptions of preferred spawning habitat given by Harlan and Speaker (1951) who considered the channel catfish selective in its breeding habits, preferring "overhanging rock ledges, deeply undercut banks, underwater muskrat runs, hollow logs and even large tin cans, tile, and other similar objects..." as places to deposit eggs. Therefore, it is plausible that these fish did spawn at those sites suggested above.

Likewise, it is generally accepted that channel catfish spawn in late spring or early summer when water temperatures reach about 70° F with 85° F being the upper limit and 80° F being the apparent optimum temperature (Clemens and Sneed 1957). While mean daily water temperatures at river mile 44.4 were less than optimum during mid-June, they were within the above specified limits. Given, however, that much of the literature on catfish spawning activity comes from studies of populations from more southerly climates, it is reasonable to suspect that the optimum spawning temperature for catfish of the Lower Wisconsin River might be somewhat lower than those generally reported in the literature. Therefore reasonable hypotheses may state that the single female observed (Catfish 1) spawned on or about 16 June, and that the 3 males observed spawned during the period 10 to 20 June and proceeded to guard the nest for from 6 to 10 days until the eggs hatched.

As with most Ictalurids, larval channel and flathead catfish remain under male guard for a period of time immediately post-hatch. These fish, juveniles and guarding male, may maintain and move in schools for from several days to a few weeks (Becker 1983). It is interesting to note that, as the water temperature increased over time, the 3 male catfish in this study moved to areas of shallower water (Figs. 5-7 and Tables 2-4) where they remained, presumably with their young charges, for an extended period of time. I postulate that this behavior would (1) position the young in suitable nursery habitats when the schools broke up, and (2) place the males on adequate feeding grounds to allow them to most quickly recover from the energy deprivation incurred during these arduous spawning and parenting activities.

Table 2. *Observed locations and physical habitat characteristics for a male channel catfish (radio frequency 50.294 MHz, length 19 inches, weight 2.3 lb) between 13 June and 28 July 1986 (see Fig. 5).*

Observ. date	River mile[a] and (site)	Depth (ft)	Current velocity (ft/sec) Surface	Midwater	Bottom	Water temp.(°F)	Substrate	Comments
06/13/86	42.8(A)	3.9	2.1	2.0	1.3	70	Sand	
06/18/86	42.7(B)	6.0	2.8	2.7	–	73	Sand	
06/23/86	42.6(C)	2.0	2.3	2.2	1.2	78	Sand	Sandwaves
06/27/86	42.1L 0.2(D)	4.1	1.0	0.8	1.3	76	Sand	Below sand cut
07/02/86	42.8(E)	2.0	–	–	–	71	Sand	Sandwaves
07/07/86	42.8(E)	2.3	2.4	2.3	1.3	75	Sand	Sandwaves
07/11/86	44.2(F)	3.8	2.0	1.8	0.6	70	Sand	
07/16/86	44.2(F)	3.9	2.0	1.6	1.2	79	Sand	
07/25/86	44.2(G)	5.0	2.6	2.6	0.9	81	Sand	
07/28/86	44.2(G)	–	–	–	–	79	Sand	

[a]River mileage as defined by Fago (1988).

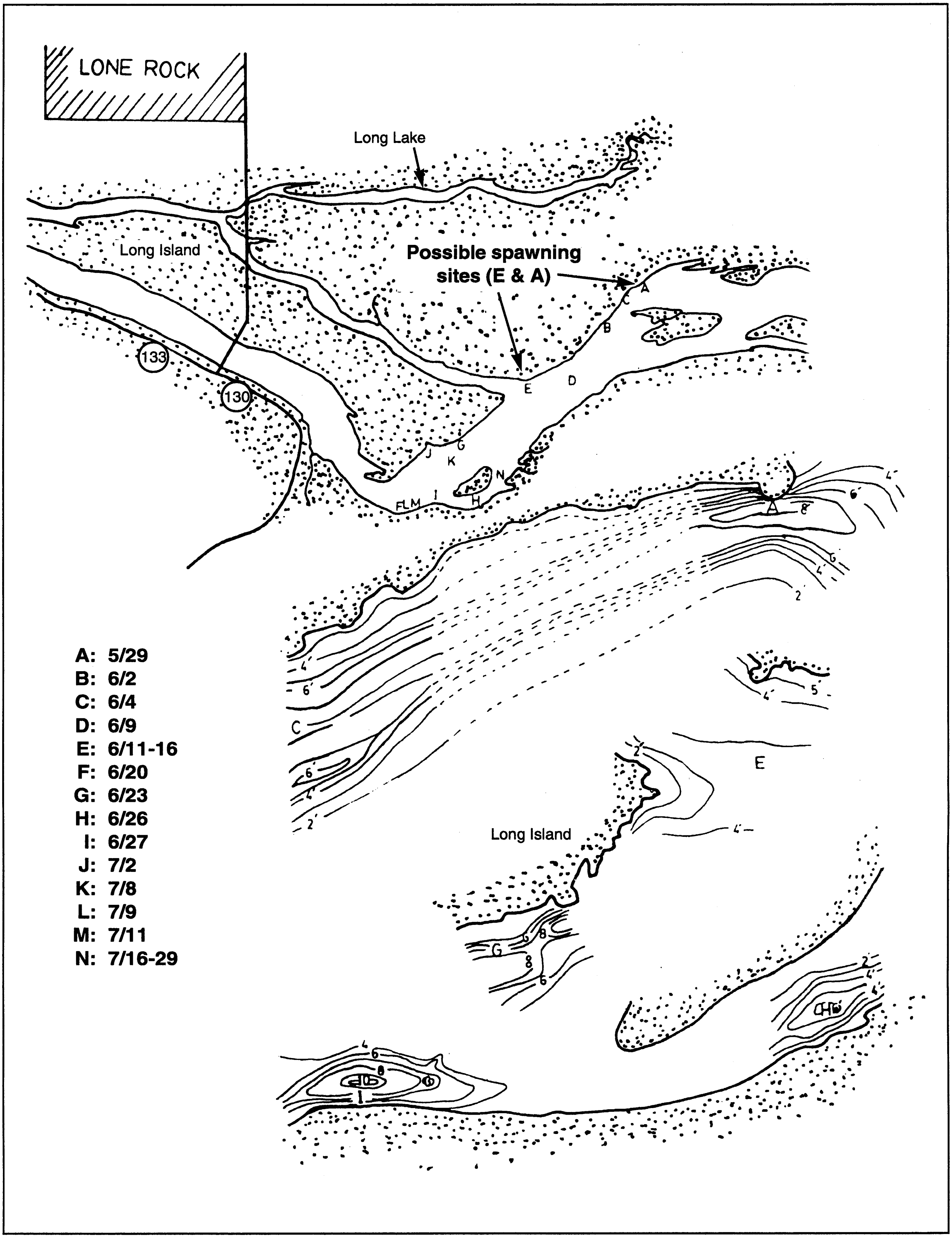

Figure 6. *Observed locations for a male channel catfish (radio frequency 50.082 MHz) between 29 May and 29 July 1986 and stream channel contours at 6 of those locations (from data in Table 3).*

Table 3. *Observed locations and physical habitat characteristics for a male channel catfish (radio frequency 50.082 MHz, length 25 inches, weight 7.1 lb) between 29 May and 29 July 1986 (see Fig. 6).*

Observ. date	River mile[a] and (site)	Depth (ft)	Current velocity (ft/sec)			Water temp.(°F)	Substrate	Comments
			Surface	Midwater	Bottom			
05/29/86	61.2(A)	8.3	–	–	–	68	Sand	Strong current
06/02/86	61.0(B)	8.0	–	–	–	68	Sand	
06/04/86	61.1(C)	6.0	–	–	–	71	Sand	
06/09/86	60.8(D)	5.0	0.7	0.7	0.6	72	Sand	Approx. location
06/11/86	60.6(E)	–	–	–	–	73	Sand	
06/16/86	60.6(E)	3.6	–	–	–	72	Sand	
06/20/86	60.0(F)	3.3	2.3	2.2	1.0	75	Sand	
06/23/86	60.3(G)	6.9	3.0	2.7	–	76	Sand	
06/25/86	60.2R 0.1(H)	6.3	0.3	0.7	0.4	75	Sand/detritus	Near snag
06/27/86	60.1(I)	6.7	0.7	1.3	–	77	Firm clay	
07/02/86	60.2(J)	5.0	3.2	3.1	1.4	70	Sand	
07/08/86	60.3(K)	3.2	1.7	1.6	0.5	72	Sand	Sandwaves
07/09/86	60.0(L)	–	–	–	–	–	Sand	
07/11/86	60.0(M)	–	–	–	–	–	Sand	
07/16/86	60.2R 0.2(N)	4.0	–	–	–	81	Sand/detritus	
07/17/86	60.2R 0.2(N)	–	–	–	–	–	Sand/detritus	
07/22/86	60.2R 0.2(N)	–	–	–	–	–	Sand/detritus	
07/25/86	60.2R 0.2(N)	–	–	–	–	–	Sand/detritus	
07/28/86	60.2R 0.2(N)	1.6	–	–	–	78	Sand/detritus	
07/29/86	60.2R 0.2(N)	2.5	–	–	–	–	Sand/detritus	Fish moved

[a]River mileage as defined by Fago (1988).

Table 4. *Observed locations and physical habitat characteristics for a male channel catfish (radio frequency 50.851 MHz, length 21 inches, weight 4.1 lb) between 2 June and 17 July 1986 (see Fig. 7).*

Observ. date	River mile[a] and (site)	Depth (ft)	Current velocity (ft/sec)			Water temp.(°F)	Substrate	Comments
			Surface	Midwater	Bottom			
06/02/86	56.7(A)	3.3	–	–	–	68	Sand	Sandwaves
06/04/86	56.7(A)	–	–	–	–	72	Sand	
06/09/86	56.8(B)	5.0	3.0	2.5	2.5	72	Sand	
06/11/86	56.8(C)	–	–	–	–	73	Sand	
06/18/86	56.8(C)	8.0	4.2	2.0	–	75	Sand/rock	Hard bottom
06/20/86	56.8(C)	6.0	2.6	1.5	–	77	Sand	Log on bottom
06/23/86	56.7(D)	4.0	2.8	2.5	1.6	77	Sand	
06/25/86	57.1(E)	5.0	1.6	1.5	0.6	75	Sand	
06/27/86	57.9L 0.2(F)	–		–	–	–	–	Located by air
07/02/86	56.7(A)	3.6	2.6	2.5	1.3	71	Sand	
07/09/86	57.9(G)	3.5	–	–	–	–	Sand	
07/11/86	57.9(G)	–	–	–	–	–	Sand	
07/16/86	57.9L 0.4(H)	3.0	2.2	–	1.5	81	Sand	
07/17/86	57.9L 0.4(H)	3.0	2.2	–	1.5	–	Sand	

[a]River Mileage as defined by Fago (1988).

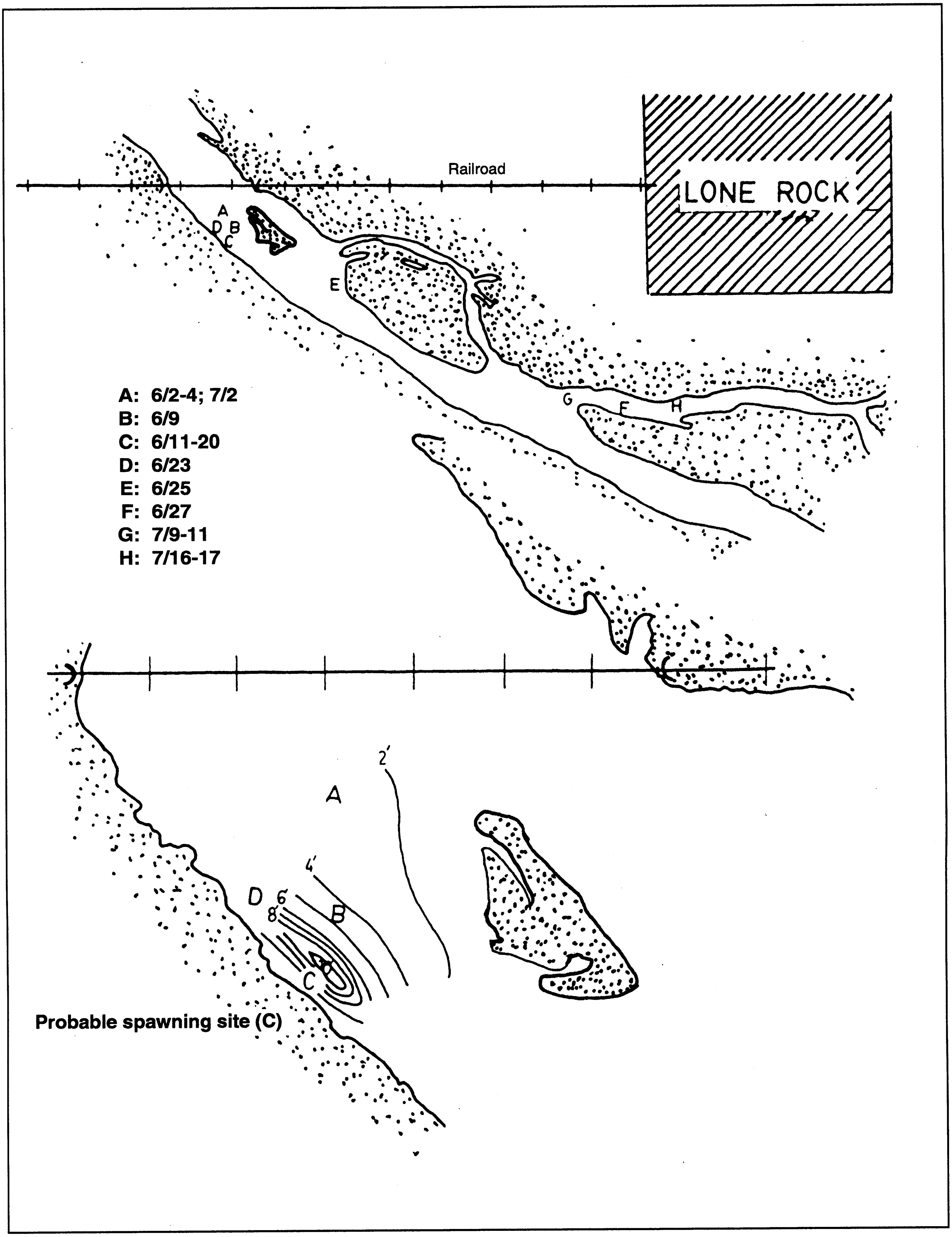

Figure 7. *Observed locations for a male channel catfish (radio frequency 50.851 MHz) between 2 June and 17 July 1986 and stream channel contours at 2 of those locations (from data in Table 4).*

Table 5. *Mean daily water temperatures (°F), recorded at river mile[a] 44.4 (Muscoda, Wis.) of the Lower Wisconsin River with a continuously recording thermograph, compared to surface temperatures recorded at time of location of four radio-tagged channel catfish between 29 May and 31 July 1986.*

Date recorded		River mile 44.4	Catfish 1[b]	2	3	4
May	29	68	69		68	
	30	69				
	31	72				
June	1	72				
	2	66	66		68	68
	3	66				
	4	70	72		71	72
	5	66				
	6	64				
	7	65				
	8	70				
	9	70	69		72	72
	10	69				
	11	71	73		73	73
	12	65				
	13	68		70		
	14	66				
	15	66				
	16	70	72		72	
	17	70				
	18	70	75	73		75
	19	74				
	20	75	73		75	77
	21	76				
	22	73				
	23	72	76	78	76	77
	24	72				
	25	71			75	75
	26	73				
	27	75		76	77	
	28	74				
	29	74				
	30	72				

Date recorded		River mile 44.4	Catfish 1	2	3	4
July	1	69				
	2	70		71	70	71
	3	73				
	4	75				
	5	77				
	6	78				
	7	74	75			
	8	72		72		
	9	75				
	10	73				
	11	70			70	
	12	74				
	13	75				
	14	74				
	15	77				
	16	78		79	81	81
	17	81				
	18	83				
	19	81				
	20	79				
	21	79				
	22	80				
	23	80				
	24	81				
	25	79			81	
	26	79				
	27	79				
	28	78			79	78
	29	79				
	30	79				
	31	79				

[a]River mile as described by Fago (1988).
[b]Numbers correspond to fish depicted in Tables 1-4 and Figures 4-7; catfish number 2 was located near Muscoda, Wis.

Juvenile Catfish

No attempts were made to collect channel catfish eggs or larvae during this study. However, tests were run on a variety of newly developed and standard gears to determine if they might be useful in obtaining these samples.

Evaluation of Sampling Equipment and Techniques

Miniature Drift Nets

As a result of the budget cutbacks and staff limitations, no serious effort was spent on the testing of the miniature drift nets designed and constructed for this study (Fig. 3). These nets were set on 1 occasion in the summer of 1986 to determine the ease of their deployment, if they would maintain a desired position in the current, and if they could effectively collect drifting organisms and debris. While no larval fish were captured, these nets show some promise as a method of collecting these samples when properly deployed at the appropriate times and locations. There will, however, need to be extensive testing of these nets to determine the most effective way to deploy them, as extensive "sanding in" was a problem in the trials mentioned above.

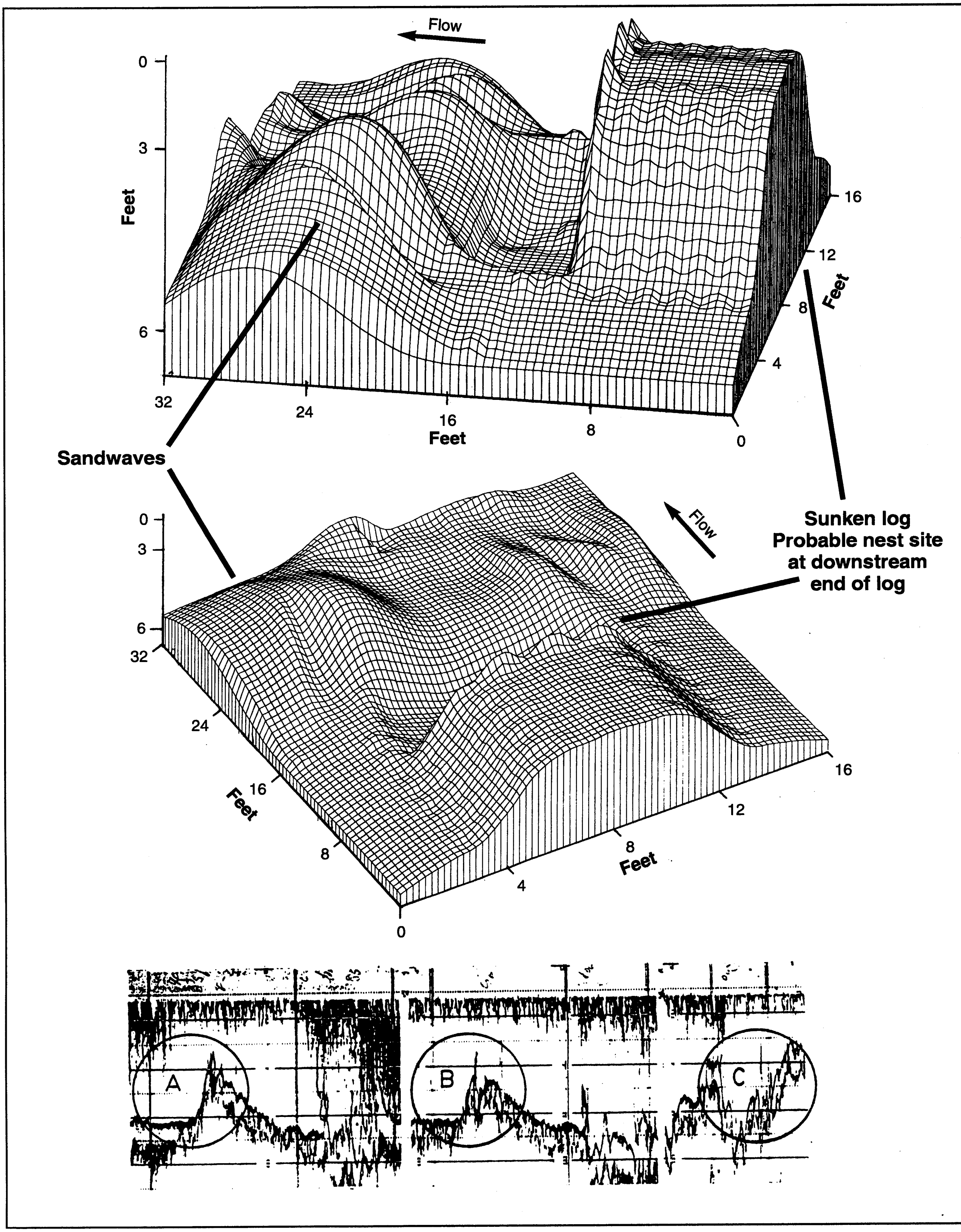

Figure 8. *Computer simulation of a hypothetical spawning site selected by a male channel catfish (radio frequency 50.851 MHz) and selected segments of the sonar graph recording upon which this model is based. Transects A and B are upstream recordings (west to east) and transect C is a recording made perpendicular from the shoreline (north to south). This site corresponds to site C of Figure 7.*

Conventional wisdom suggests that, because larval Ictalurid broods are guarded by the male, these fish are less susceptible to drifting than most other fish species. Gerhardt and Hubert (1990), however, used the presence of larval channel catfish in the drift to identify the time of spawning for this species in the Powder River system of Wyoming and Montana. Brown and Armstrong (1985) were very successful in capturing Ictalurid prolarvae and channel and flathead catfish alevins with drift samplers (15 x 15 x 80 cm; mesh = 0.4 mm) set along transects at the upstream end of riffles in the Illinois River, Arkansas.

In their study, Brown and Armstrong (1985) identified 18 larval fish taxa from drift samples. Of these, channel catfish "alevins were by far the most abundant, comprising 57% of the catch" and flathead catfish larvae accounted for 12% of the total fish drift. These are exceptionally high percentages, given the fact that channel catfish were considered only common in the river and flathead catfish were considered uncommon, while related species such as slender madtoms (*Noturus exilis*) and black bullheads (*Ictalurus melas*) (which were considered more abundant in the study area) were not found in the drift. Prolarval Ictalurids were collected with drift nets between 9 and 23 June 1981. Channel catfish alevins were collected between 16 June and 26 August with the majority captured between 23 June and 22 July. Flathead alevins were collected from 7 July through 26 August with the majority collected in mid July. Nearly all drifting fish were collected at night with a few collections made at dusk and dawn. Peak drift periods were 2300 hr and 0300 hr (Brown and Armstrong 1985). In Wisconsin, drifting of catfish larvae would most likely occur 2 to 3 weeks later than was observed in Arkansas.

Once effective deployment strategies are determined, the small size of the experimental drift nets designed for this study should permit the setting of several nets in a vertical and horizontal array. This will provide a more quantitative and statistically valid sample than is possible with conventional drift-net sampling techniques. One potential drawback to catching drifting larval and postlarval catfish is the small size of these experimental drift nets (6-inch mouth) which may allow these fish to detect the nets and escape capture or to escape the nets after entry. Brown and Armstrong (1985), however, did not find the small size of their square drift samplers to be a problem. Conversely, these nets may be looked upon as a "refuge" to small catfish, similar to the way hoop nets and slat traps are sometimes viewed by larger catfish.

As an alternative, stacked box or square drift nets could also be deployed. The larger size of this type of gear might reduce detection and escapement, and still allow for simultaneous collection of multiple samples. Kempinger (1988) was very successful in collecting larval lake sturgeon (*Acipenser fulvescens*) with this type of sampling gear.

Seines

As with the miniature drift nets, little effort was spent on determining the effectiveness of collecting juvenile catfish in the Lower Wisconsin River with seines. The purpose of the limited effort was to determine if seines could be used at all in the unpredictable and often strong currents of the Lower Wisconsin River, and what techniques would be most effective. These efforts confirmed the conventional wisdom that downstream seine hauls are most effective along shorelines bordering river channels and that large-mesh seines are easier to manipulate under these conditions than are small-mesh seines. Hauling small-mesh seines upstream through the shallow bays that often form at the lower ends of sandbars and islands was another effective technique for collecting small fish.

Holden and Stalnaker (1975) were successful in collecting Age 0 and I channel catfish from backwaters and areas of "gentle" current in the Middle and Upper Colorado River Basins, and Helms (1975), using a semicircular sweep technique, collected several hundred Age-0 channel catfish, ranging in total length from 1.6 to 3.4 inches, along Upper Mississippi River shorelines from August through October. Similar techniques to these, plus cross-channel seining (Kempinger In Press.), and downstream hauls should prove effective for collecting small catfish from Lower Wisconsin River shorelines, side channels, and sand and gravel bars during late summer and early fall.

Miniature Baited Hoop Nets

Miniature baited hoop nets were effective for collecting very small Ictalurids. These nets were tested in early August of 1984 at Lower Wisconsin River mile 14.6. On 2 August, 3 channel catfish, 2 measuring 1.9 inches and 1 measuring 2.2 inches total length, and a tadpole madtom (*Noturus gyrinus*), measuring 1.6 inch total length, were collected. Another channel catfish, 1.9 inches long, and 3 tadpole madtoms (not measured) were captured on 6 August (Table 6). These nets were set just off the south shore and on a bend in the river (Fig. 9). Although water depth and other habitat variables were not recorded, the location suggests that the nets were set in relatively swift and deep water.

Table 6. *Location, gear, and date of capture of juvenile channel and flathead catfish (<4.7 inches) from Pool 10 of the Upper Mississippi River and from the Lower Wisconsin River, 1983-85.*

Date	Length (inches)	River	Mile[a]	Depth (feet)	Surface Temp.(°F)	Gear Type
Channel catfish						
2 Aug 84	1.9	WR	14.6 (s)[b]			Mini hoop net
2 Aug 84	1.9	WR	14.6 (s)			Mini hoop net
2 Aug 84	2.2	WR	14.6 (s)			Mini hoop net
6 Aug 84	1.9	WR	14.6 (s)			Mini hoop net
23 Aug 83	2.6	WR	1.0 (n)	6.6	84	Slat trap
23 Aug 83	3.0	WR	1.0 (n)	6.6	84	Experimental hoop net
26 Aug 83	2.7	WR	1.0 (n)	9.8		Slat trap
26 Aug 83	3.3	WR	1.5 (s)	9.8		Experimental hoop net
26 Aug 83	3.7	WR	1.5 (s)	9.8		Slat trap
2 Sep 83	3.7	WR	12.3 (s)		79	Slat trap
9 Sep 83	3.8	WR	0.8 (n)		65	Experimental hoop net
13 Sep 83	3.4	MR	1586.1 (e)	10.5	70	Slat trap
13 Sep 83	3.6	MR	1586.1 (e)	10.5	70	Slat trap
14 Sep 83	3.8	WR	1.5 (s)	7.5	66	Slat trap
14 Sep 83	3.9	WR	1.5 (s)	7.5	66	Slat trap
14 Sep 83	4.1	WR	1.5 (s)	7.5	66	Slat trap
14 Sep 83	4.1	WR	4.8 (n)	10.8	66	Experimental hoop net
14 Sep 83	4.3	WR	1.5 (s)	7.5	66	Slat trap
14 Sep 83	4.3	WR	1.5 (s)	7.5	66	Slat trap
16 Sep 83	3.9	MR	1585.5 (w)	9.8	66	Slat trap
17 Sep 84	3.6	MR	1585.4 (e)	9.8	55	Experimental hoop net
17 Sep 83	3.8	WR	0.9 (n)	8.2	61	Experimental hoop net
18 Sep 83	3.8	MR	1591.3 (e)	13.1+	64	Experimental hoop net
20 Sep 83	3.1	WR	1.7 (n)	9.8	61	Slat trap
20 Sep 83	3.9	WR	1.5 (s)	9.8	61	Slat trap
20 Sep 83	3.9	WR	1.5 (s)	9.8	61	Slat trap
20 Sep 83	4.0	WR	1.7 (n)	8.5	61	Slat trap
20 Sep 83	4.1	WR	1.5 (s)	9.8	61	Slat trap
20 Sep 83	4.1	WR	1.5 (s)	9.8	61	Slat trap
20 Sep 83	4.3	WR	1.5 (s)	9.8	61	Slat trap
20 Sep 83	4.5	WR	2.2 (n)	10.2	61	Experimental hoop net
20 Sep 83	4.6	WR	1.5 (s)	9.8	61	Slat trap
21 Sep 83	3.7	MR	1589.1R 3.1 (w)	10.8	59	Slat trap
21 Sep 83	4.1	MR	1591.3 (e)	13.1+	59	Experimental hoop net
22 Sep 83	4.1	MR	1586.1 (e)	12.5	57	Slat trap
24 Sep 83	3.5	MR	1590.1 (w)	13.1+	55	Slat trap
24 Sep 83	3.7	MR	1590.1 (w)	13.1+	55	Slat trap
24 Sep 83	4.0	MR	1589.4 (e)	9.8	55	Slat trap

Date	Length (inches)	River	Mile[a]	Depth (feet)	Surface Temp.(°F)	Gear Type
24 Sep 83	4.2	MR	1591.3 (e)	13.1+	55	Experimental hoop net
24 Sep 83	4.3	MR	1589.4 (e)	9.8	55	Slat trap
24 Sep 83	4.5	MR	1589.1R 3.1 (w)	11.5	55	Slat trap
24 Sep 83	4.6	MR	1590.5 (e)	13.1	55	Experimental hoop net
26 Sep 83	3.7	WR	1.5 (s)	13.1	59	Slat trap
27 Sep 83	3.0	MR	1591.3 (e)	13.1+	59	Slat trap
27 Sep 83	3.5	MR	1589.4 (e)	10.8	59	Slat trap
27 Sep 83	3.5	MR	1591.3 (e)	13.1+	59	Experimental hoop net
27 Sep 83	4.1	MR	1589.1R 3.1 (w)	11.5	59	Slat trap
27 Sep 83	4.1	MR	1589.1R 3.1 (w)	11.5	59	Slat trap
27 Sep 83	4.3	MR	1591.3 (e)	13.1+	59	Experimental hoop net
28 Sep 83	3.5	WR	86.9 (e)	8.2	63	Slat trap
29 Sep 83	3.1	WR	4.8 (n)		65	Slat trap
29 Sep 83	3.3	WR	4.8 (n)		65	Slat trap
29 Sep 83	3.7	WR	1.7 (n)	6.6	65	Slat trap
10 Oct 85	4.3	WR	2.9 (m)		52	Experimental hoop net
14 Oct 83	3.6	WR	94.5 (w)	13.1+	54	Slat trap
14 Oct 83	3.9	WR	92.5 (w)	13.1+	54	Slat trap
14 Oct 83	4.1	WR	94.5 (w)	13.1+	54	Slat trap
17 Oct 83	2.8	WR	92.5 (w)	13.1+	54	Slat trap
17 Oct 83	3.5	WR	92.5 (w)	13.1+	54	Slat trap
19 Oct 83	3.0	WR	92.5 (w)	13.1+	54	Slat trap
19 Oct 83	3.3	WR	92.5 (w)	13.1+	54	Slat trap
26 Oct 84	3.2	WR	1.6 (m)		50	Experimental hoop net
28 Oct 83	4.1	WR	94.0 (w)	13.1+	50	Slat trap
29 Oct 84	3.5	WR	2.5 (n)		52	Experimental hoop net
5 Nov 84	3.5	WR	2.0 (n)		43	Experimental hoop net
5 Nov 84	3.8	WR	2.0 (n)		43	Experimental hoop net
7 Nov 83	4.1	WR	92.5 (w)		48	Slat trap
9 Nov 83	4.3	WR	94.3 (w)	13.1+	48	Experimental hoop net
16 Apr 84	4.2[c]	MR	1590.4 (e)		46	Experimental hoop net
2 May 84	3.5[c]	MR	1590.4 (e)	14.7+	50	Experimental hoop net
2 May 84	4.5[c]	MR	1585.4 (e)	13.8	50	Experimental hoop net
Flathead catfish						
16 Aug 83	2.4	MR	1584.0R 0.1 (e)	11.5	81	Slat trap
17 Aug 83	2.7	WR	10.8L 0.6 (n)		81	Slat trap
26 Aug 83	4.3	WR	1.0 (n)	9.8	75	Slat trap
14 Sep 83	4.6	WR	2.2 (n)	10.5	66	Slat trap

[a] As defined by Fago (1988).
[b] (x) indicates where in the channel a net was set: south, east, north, and west sides, and mid-channel.
[c] These 3 channel catfish were considered to be yearlings based on the time of the year and their size. They are included here to support the assumption that the other catfish listed in this table were young of the year.

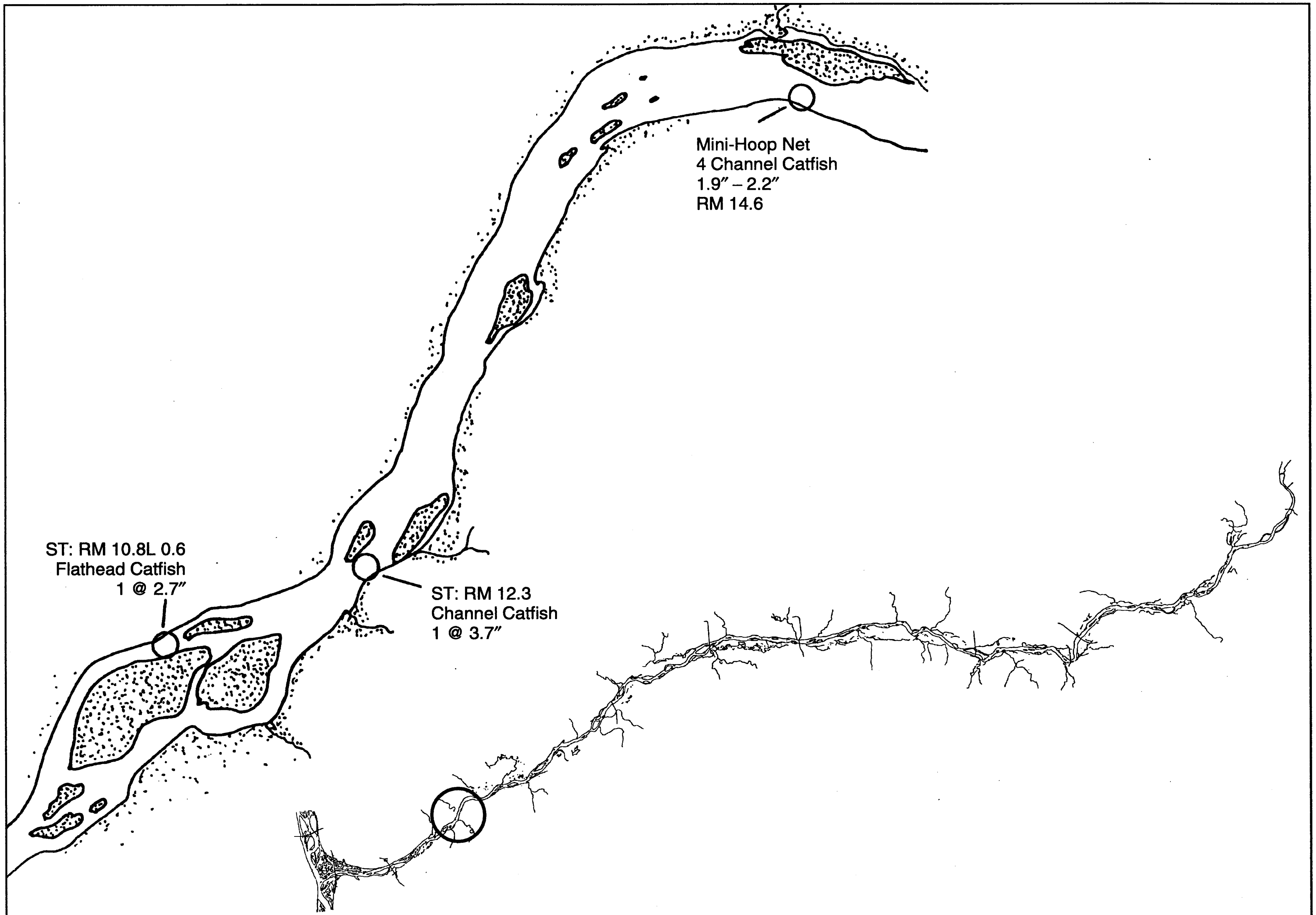

Figure 9. *Sample sites on the Lower Wisconsin River near the village of Millville where young-of-the-year catfish were collected in 1983 and 1984. RM = river mile as defined by Fago (1988); ST = slat trap.*

Experimental Hoop Nets and Slat Traps

While the 4 channel catfish and the madtoms mentioned above were the smallest Ictalurids collected, larger YOY and yearling catfish were collected in experimental hoop nets and slat traps on a number of occasions (Table 6). Forty-five of the 64 YOY channel catfish and all 4 YOY flathead catfish collected were caught in slat traps between 23 August and 9 November 1983. The remaining 19 YOY channel catfish were caught in experimental hoop nets; 13 between 23 August and 9 November 1983, 5 between 17 September and 4 November 1984 and 1 on 10 October 1985. The 3 yearling channel catfish listed in Table 6 were caught in experimental hoop nets in the spring of 1984.

YOY channel catfish caught in slat traps and experimental hoop nets were concentrated near the confluence of the Wisconsin and Mississippi rivers. Thirty-one of the 64 were collected from 11 sample sites between river miles 0.5 and 5.0 on the Lower Wisconsin River, and 21 were taken from 9 sites between river miles 1585 and 1592 in Pool 10 of the Upper Mississippi River (Fig. 10).

Most of the Lower Wisconsin River sites were on the north side of the main channel with several located in side channels (Fig. 10). Current velocity at these sites was estimated to be moderately high to high. The median water depth was 9.8 ft with the shallowest 6.6 ft and the deepest 13.1 ft.

Eight of the 9 Mississippi River sample sites were located on the main channel (3 downstream of the confluence and 5 upstream off Island 172). The most northerly site was in the East Channel (east of Island 172) at Prairie du Chien (Fig. 10). Median water depth for these 9 sites was 11.5 ft (9.8 ft to 13.1+ ft), and, as with the Wisconsin River sites, current velocity was estimated to be moderately high to high.

Only 2 other YOY channel catfish were collected in the Lower Wisconsin River below the Prairie du Sac dam. One was caught on 2 September 1983 at river mile 12.3 near Millville (Fig. 9) and the other was taken on 28 September 1983 in 8.2 ft of water at river mile 86.9 (Fig. 11). Both sites were located on the southeast side of the main channel in relatively swift water.

In addition to those listed above, 10 YOY channel catfish were caught above the Prairie du Sac dam between 14 October and 9 November 1983 (Fig. 11). Water depths at the 4 sites sampled were estimated at over 13 ft; current velocities were not estimated. All sites were on the western shore in the lower riverine reaches of Lake Wisconsin.

Three of the 4 YOY flathead catfish collected were taken near the confluence of the Wisconsin and Mississippi rivers, 1 in 11.5 ft of water in a side channel of the Mississippi River near Wyalusing and 2 in about 10 ft of water from side channels on the north shore of the Wisconsin River (Fig. 10). The fourth YOY flathead was caught in a side channel on the northwest side of Hacklin Island in the Lower Wisconsin River near Millville (Fig. 9).

The 3 yearling channel catfish listed in Table 6 were all caught in deep water (>13.5 ft) along the eastern shore of the main channel in the Mississippi River (Fig. 10). These fish, which were caught in spring of 1984, were between 3.5 and 4.5 inches long and are included here for size comparison to support the assumption that the other fish listed here were YOY.

YOY channel catfish in Wisconsin, according to Becker (1983), may reach 1.9 inches in length by mid-August and exceed 3 inches by October. Data reported here suggest that first summer's growth for channel catfish is at least as good in the Lower Wisconsin River as elsewhere in Wisconsin.

With the break-up of the schools, juveniles are reported to frequent shallow water areas over sand and gravel bars, rocks, or drift piles (Becker 1983). Based on observations made during the first years of this study (1983-85), however, one might conclude that this commonly held belief could be in error. I must point out here that netting sites were selected to catch adult catfish and not juveniles. Had the appropriate gear been set in "preferred" habitats, many more juvenile catfish might very likely have been collected. What is clear, however, is that juvenile catfish do frequent deeper water than might have been expected.

Management Implications

The suggestions, hypotheses, and postulations presented here are just that: suggestions, hypotheses and postulations. If the DNR truly wishes to manage these important sport and commercial catfish species in large rivers, it must gain a better understanding of their biology and ecology in these systems. Integral to this is the understanding of the early-life histories of these species and the physical and environmental requirements critical to their success.

To this end, I have prepared and appended a research proposal (Appendix A) which I feel adequately identifies these informational needs and which, if the research is funded, will provide the necessary insights to more effectively manage these important species. This proposal is aimed at the catfish of the Lower Wisconsin River but

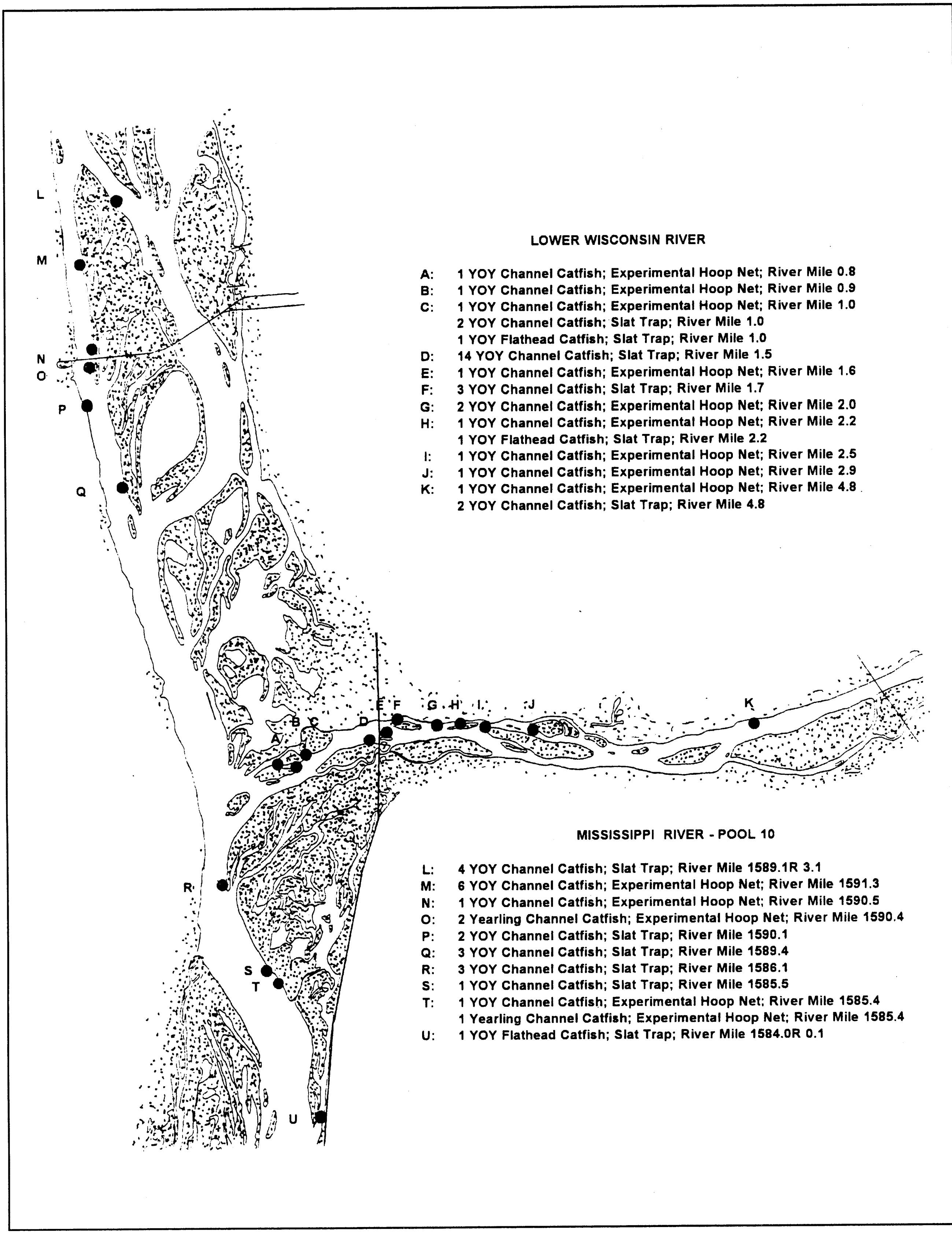

Figure 10. *Sample sites on the Lower Wisconsin River at the confluence and on the Upper Mississippi River where small catfish were collected from 1983 to 1985. YOY designates young-of-the-year. River miles are as defined by Fago (1988).*

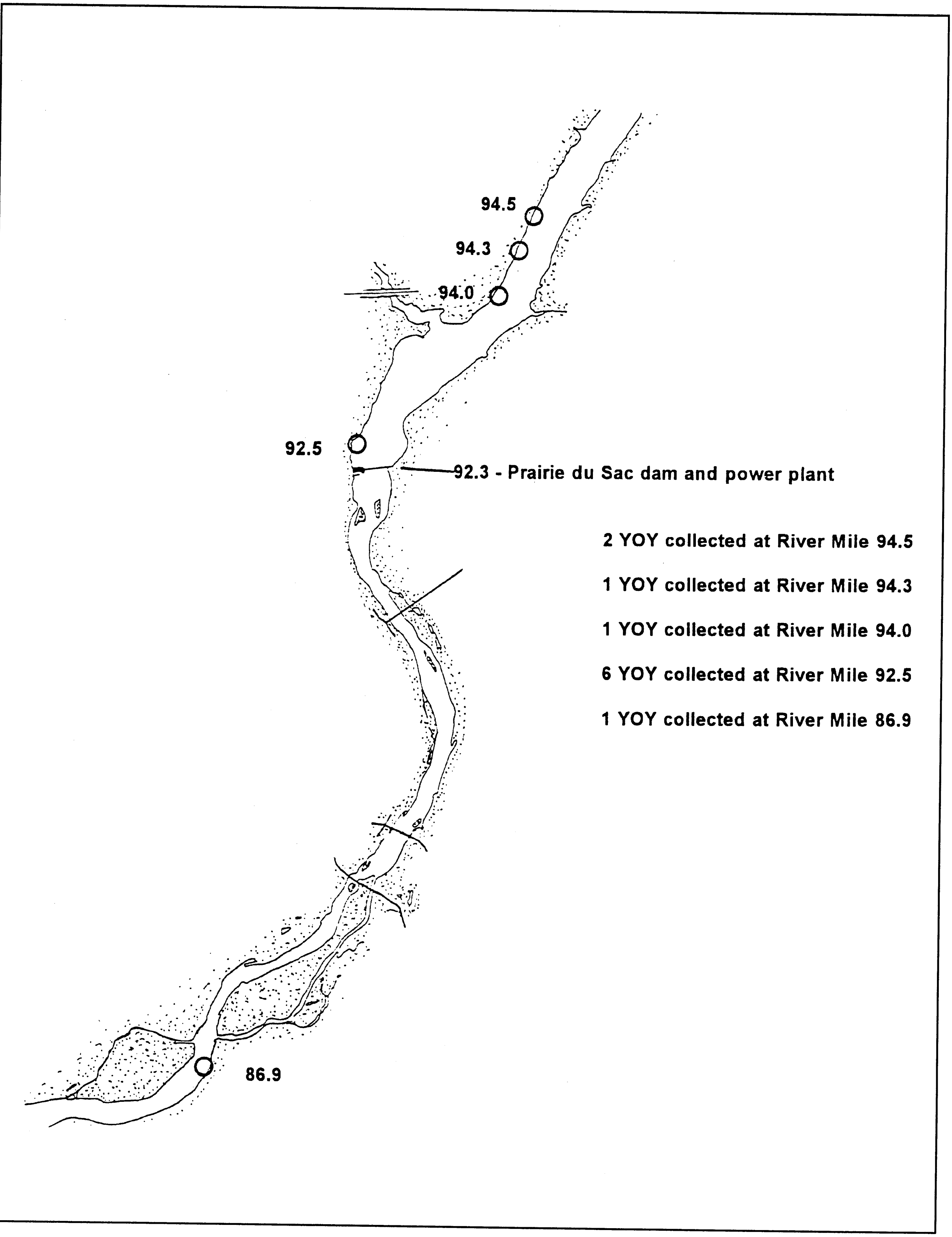

Figure 11. *Sample sites on the Lower Wisconsin River in the vicinity of the Prairie du Sac dam where young-of-the-year channel catfish were collected in slat traps during September and October of 1983. River miles are as defined by Fago (1988).*

would be equally applicable to other large river systems and, with appropriate modifications of gear and techniques, to other riverine species.

While the management implications of this study and the accompanying literature review are, for the most part, broad and non-specific, they are, however, significant in that they point out our limited understanding of large riverine ecosystems. Clearly, the most urgent needs are to develop tools and techniques for obtaining and analyzing quantifiable data on the fish populations of large rivers specifically, and on large-river ecology in general. Of equal importance is a genuine commitment on the part of the DNR to obtain these data and to apply the knowledge and insight gained to the holistic management of these complex ecosystems.

Summary

1. During much of June, the 4 radio-tagged adult catfish (1 female, 3 males) were generally located in or near deep-cut banks or bank holes with some structure such as overhanging trees, logs, rocks, or well developed sandwave formations (areas considered to be suitable spawning habitat).
2. Mean daily water temperatures at river mile 44.4 during mid-June 1986 were less than what is generally considered optimum for spawning, but were within the specified limits reported in the literature. Therefore, I suspect that the optimum spawning temperature for catfish in the Lower Wisconsin River and in other large, northern rivers might be somewhat lower than those reported for more southerly climates.
3. I hypothesize that these fish did spawn at the sites suggested in this report between 10 to 20 June, and that the 3 males observed proceeded to guard the nests for 6 to 10 days until the eggs hatched.
4. As the water temperature increased over time, the 3 male catfish observed in this study moved to areas of shallower water where they remained, presumably with their young charges, for an extended period of time. Reasons suggested for this behavior are (1) to position the young in suitable nursery habitats when the schools broke up and (2) to place the males on adequate feeding grounds to allow them to most quickly recover from the energy deprivation incurred during these spawning and parenting activities.
5. Juvenile catfish were collected in deeper water than might have been expected based on literature reports. Had "preferred" habitats been sampled, more juvenile catfish might have been collected.
6. First summer's growth of channel catfish in the Lower Wisconsin River is at least as good as elsewhere in Wisconsin.
7. The most urgent needs are to develop tools and techniques for obtaining and analyzing quantifiable data on the fish populations of large rivers specifically, and on large-river ecology in general.

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Appendix A: Research project proposal for the study of spawning and early life history of catfish in the Lower Wisconsin River.

FISHERIES RESEARCH SECTION
PROJECT SUMMARY

TITLE: Spawning and Early Life History of Catfish in the Lower Wisconsin River, Wisconsin.

ACTIVITY: ________

GRANT: Federal Aid in Sport Fish Restoration WI F-95-R

PRINCIPAL INVESTIGATOR: To be determined

PHONE: (608) 221-6336

STUDY NO.: _____

STUDY PERIOD: FY 1-6

TOTAL COST: $555,800 **CURRENT ANNUAL COST:** $121,200 **SFR FED:**

OBJECTIVES:
1. Describe the spawning behavior and early life history of channel catfish and flathead catfish population in the Lower Wisconsin River.
2. Identify critical spawning and nursery habitat for channel and flathead catfish, and quantify that critical habitat for the Lower Wisconsin River.

BENEFITS: With the knowledge gained through this study, the Department will be able to make better informed decisions concerning the management of river catfish populations specifically, and the management of large river ecosystems in general. The resource and the user public will benefit from management decisions based on a more complete understanding of the ecological of large rivers; this study will provide one more piece to the puzzle.

Years	Description of Research Activity
FY 1-3	1. Radio-tag and track mature pre-spawning male channel and flathead catfish.
FY 1-3	2. Determine fecundity and age structure of channel and flathead catfish spawning populations in the Lower Wisconsin River.
FY 1-3	3. Locate nest sites and describe biotic and abiotic characteristics of these sites.
FY 1-3	4. Determine egg deposition rate,larval abundance, and nest success, for channel and flathead catfish nest sites.
FY 1-4	5. Determine relative abundance and growth of post-larval young-of-the-year and yearling channel and flathead catfish.
FY 1-4	6. Determine habitat preference and use by post-larval young-of-the-year and yearling channel and flathead catfish.
FY 4-6	7. Complete necessary data analysis, write, review, edit and publish final report.

SPECIES: Channel Catfish (*Ictalurus punctatus*) and Flathead Catfish (*Pylodictis olivaris*).

CONGRESSIONAL DISTRICT(S): Two and Three

WISCONSIN DEPARTMENT OF NATURAL RESOURCES
P.O. BOX 7921
MADISON, WI 53707

State : Wisconsin

Project No.: F-95-P

Study No.: ____

Project Title: Spawning and Early Life History of Catfish in the Lower Wisconsin River.

Problem:

In order to manage a species or to define its place in the complex community in which it lives, it is necessary to have an understanding of all the life stages of that species. Recent studies have provided a wealth of information on adult and sub-adult catfish (*Ictalurus punctatus* and *Pylodictis olivaris*) in the Lower Wisconsin River. However, little is known about spawning behavior and nest success of these populations, or about the biology and behavior of young-of-the-year and yearling catfish. This information gap applies, not only to Lower Wisconsin River populations, but to catfish populations throughout Wisconsin.

Study Objectives:

1. Describe the spawning behavior and early life history of channel catfish and flathead catfish population in the Lower Wisconsin River.
2. Identify critical spawning and nursery habitat for channel and flathead catfish, and quantify that critical habitat for the Lower Wisconsin River.

Justification:

The Lower Wisconsin River is arguably the most important inland fisheries resource in southwest Wisconsin and catfish are considered by many to be the most important sport fish in that system. Southern District Fisheries Managers, along with many other Fisheries Managers throughout the State, have placed a high priority on these species. In order to provide effective management of these important sport and commercial species, whether in the Lower Wisconsin River, the Upper Mississippi River, the Wolf River, or any other large river, it is necessary to have an understanding of all of its life stages.

While there is a sizable repository of information on catfish spawning and early life history in the literature, the majority of it comes from more southerly regions of the continent (see Status, below). As suggested for spawning temperature in a preliminary study (Pellett 1995), some aspects of catfish biology and behavior may differ regionally. It is important, therefore, that this information be gathered from populations within the northern distribution of these species to complete the picture and provide relevant information to resource managers of this region.

This project will evaluate the early life history of both catfish species and will complement work done on older catfish in previous studies (Fago In Prep., Pellett et al. In Prep.). Specifically, it is intended to identify spawning and nursery habitats within the Lower Wisconsin River and to describe the growth and distribution of young-of-the-year and yearling catfish.

Status:

Lower Wisconsin River catfish populations are migratory. Both channel and flathead catfish overwinter in deep holes (Hawkinson and Grunwald, 1979), principally in the Upper Mississippi River or just below the dam at Prairie du Sac. In late March or early April, when water temperatures rise to around 55° F, those adult catfish that overwintered in the Mississippi River begin to stage at the mouth of the Wisconsin River in preparation for the annual spawning migration which may take them some 92 river miles upstream. Within days or weeks, depending on the distance traveled, these fish have settled into their "home" territories to feed and spawn. In the Lower Wisconsin River, channel catfish spawn in late June or early July (Pellett 1995).

Channel catfish adults are very mobile during spawning and, according to Trautman (1981), will "ascend surprisingly small streams for the purpose of spawning". Additionally, this species is described by Harlan and Speaker (1951) as being selective in its breeding habits, preferring "overhanging rock ledges, deeply undercut banks, underwater muskrat runs, hollow logs and even large tin cans, tile, and other similar objects .." as places to deposit eggs.

Clemens and Sneed (1957) report that spawning takes place when water temperatures reach about 70° F with 85° F being the upper limit and 80° F being the apparent optimum temperature. In the Lower Wisconsin River, and very likely throughout the northern distribution of this species, optimal temperatures for spawning are probably in the 70° to 75° F range (Pellett 1995). Helms (1975) reported that, in pools 9, 11, 13, and 18 of the Upper Mississippi River, initial spawning activity of channel catfish generally occurs in mid May to early June in water temperatures of about 65° F, and continues through late June or early July.

Females weighing from one to four pounds will produce about 4,000 eggs per lb of body weight (Clemens and Sneed 1957). The adhesive eggs average 3.2 mm in diameter. After spawning, the female is driven away by the male who then guards the eggs until they hatch (Harlan and Speaker 1951).

Hatching of eggs occurs within 6 to 10 days after spawning. At hatching, fry are greater than 6.3 mm total length, and develop through the pectoral finbud stage within 34 hours (Saksena et al. 1961). The male continues to protect the school of fry for a period of time after hatching (Harlan and Speaker 1951).

Larval and post-larval channel catfish under male guard may remain and move in schools for from several days to a few weeks. With the break up of these schools, juveniles tend to frequent shallow water areas over sand and gravel bars, rocks, or drift piles (Becker 1983). Young-of-the-year channel catfish in Wisconsin may reach 1.9 inches in length by mid-August and exceed 3 inches by October (Becker 1983).

Greenbank and Monson (1947) report that male channel catfish reach first maturity at 12 to 13 inches in the Upper Mississippi River and full maturity at length greater than 13 inches. Females reach first maturity at the same size but do not reach full maturity until over 14 inches long. Appelget and Smith (1951) concur with the length of maturity reported by Greenbank and Monson (1947), but state that the age of sexual maturity is 4 to 5 years. Mayhew (1972) states that Mississippi River channel catfish can reach a length of 13 inches at less than 3 years of age and, therefore, would be mature at about 3 to 4 years of age.

Lower Wisconsin River channel catfish populations near the confluence reflect the age, growth, and maturity patterns of Upper Mississippi River populations (Pellett unpubl. data). This agrees with data reported for Iowa tributaries of the Mississippi River (Schoumacher and Ackerman 1965). Populations further upstream appear to be slower growing and, consequently, may mature later than those that "home" near the confluence (Pellett unpubl. data).

Flathead catfish spawn in much the same manner as do channel catfish (Pflieger 1975). In Wisconsin, flatheads spawn in June and July at temperatures around 72-75° F (Becker 1983). They prefer spawning sites of "shelves with overhanging ledges, hollow logs, and well protected places" (Fontaine 1944). Male are very aggressive towards females and other intruders after spawning is completed (Henderson 1965). Males guard their nests after spawning and are very active in cleaning or "fluffing" and rearranging the eggs (Fontaine 1944). Nests may contain from a few thousand to tens of thousands eggs which range in size from 2.8 to 3.7 mm in diameter (Minckley and Deacon 1959, Summerfelt and Turner 1971). Eggs hatch in from 6 to 7 days at 75-82° F (Giudice 1965) to 9 days at 75-79° F (Snow 1959). Newly hatched flatheads are about 11 mm in length (Snow 1959).

Young flathead catfish frequent the shallow riffle areas (Smith 1979), where they remain until they reach about 2 to 4 inches in length. They become more evenly distributed throughout the stream and occupy a variety of habitats as they grow. At a size of 12 to 16 inches, they are most frequently associated with cover at intermediate depths (Minckley and Deacon 1959).

Flathead catfish of the Mississippi River attain sexual maturity when they reach a length of from 17 to 19 inches (Barnickol and Starret 1951). This translates to an age of about 4 years (Mayhew 1969).

Techniques and tools for collecting fish eggs, larvae, young-of-the-year, and yearlings in lotic systems have been developed and tested by numerous investigators. Snyder (1983) describes the design and use of many of these tools and summarizes advantages and disadvantages of the principal gear types.

Pumps of various designs can be used to collect eggs and larvae from benthic substrate and from around submerged structure. Other tools and techniques which could be used to sample catfish eggs include the use of dredges, grabs and corers, and the hydraulic dislodging of egg masses and substrate coupled with drift nets (Snyder 1983). Under favorable current and visibility conditions, eggs could be hand collected by SCUBA divers. Seines, constructed of 500-µm bolting mesh could be very effective for collecting larval fish off sand and gravel bars and along suitable shorelines (Leslie et al. 1983, Scheidegger 1990).

Methods of sampling open water ichthyoplankton are numerous and varied. Stacked or single drift nets (Kempinger 1988) and serially deployed stationary plankton nets (Dovel 1964) can be used in large river systems. Brown and Armstrong (1985) were successful in capturing Ictalurid prolarvae and channel and flathead alevins in drift samplers (15 x 15 x 80 cm, mesh = 0.4 mm) set along a transect at the upstream end of riffles in the Illinois River, Arkansas. "Of the 18 identifiable taxa that were collected in the drift, channel catfish (*Ictalurus punctatus*) alevins were by far the most abundant, comprising 57% of the catch. Flathead catfish (*Pylodictus olivaris*)....larvae accounted for 12%....of the total fish drift,.." This not withstanding that channel catfish were considered only common in the river and flatheads were considered uncommon.

Other gear which could be used to collect larval catfish in lotic systems are push nets (Miller 1973, Tarplee et al. 1979), towed nets (Dovel 1964, Smith and Richardson 1977), and torpedo-shaped high speed samplers (Fraser 1968, Noble 1970). Gale and Mohr (1978) used fixed nets, push nets and pumping techniques to collect channel catfish postlarvae. Continuous drift samplers (Anderwald et. al, 1991) could prove as effective for collecting larval catfish as did the drift samplers used by Brown and Armstrong (1985) and by Gerhardt and Hubert (1990).

Techniques and tools which could be employed for collecting young-of-the-year and yearling catfish more closely resemble those used for adults than those described above. The key appears to be miniaturization of gear.

Miniature baited hoop nets were successful in capturing juvenile channel catfish of about 1.9 inches total length and catfish as small as 2.4 inches and 3 inches were collected in standard slat traps and experimental hoop nets respectively (Pellett 1995). Similarly minnow traps, baited or unbaited, and miniaturized slat traps could be deployed in suitable habitat.

Seines could also be used to collect juvenile catfish. Holden and Stalnaker (1975) collected Age 0 and I channel catfish with seines from backwaters and areas of mild current in the Middle and Upper Colorado River Basins. Helms' (1975) technique was to make semicircular sweeps along shorelines with a 6 x 30 ft x 1/4 inch drag seine to collect young-of-the-year channel catfish from the Upper Mississippi River. Kempinger (In Press) was successful in collecting 33-97 mm lake sturgeon fingerlings from the Wolf River with standard minnow seines (0.25" and 0.5" mesh bag seines) by seining cross current from shore to shore. Similar equipment and techniques could by employed across suitable side channels, along sand bars and over gravel riffles.

Small otter trawls were used by Holland-Bartels and Duval (1988) to capture young-of-the-year channel catfish from Upper Mississippi River main channel and channel border habitats. Tows were made downstream for short intervals and at minimum headway speed. Similar gear could be employed, with great care, in main and side channels of the Lower Wisconsin River.

The use of electroshocking gear could be very effective on young-of-the-year and yearling catfish. Back pack and stream shockers, or prepositioned electroshocking grids could be employed along sand bars, over shallow riffles, and around shallow structures such as rock outcroppings, snags, and deadfalls. Deeper areas could be sampled with mini-boomshockers and even full sized boomshockers. In such cases, it may be necessary to deploy block nets downstream (for very short periods) or catch-boats which could pick up stunned fish downstream from the shocker boats.

In spring, 1986, a limited effort was initiated by Wisconsin Department of Natural Resources Researchers to develop and test equipment and techniques in preparation for a joint Fish Research/Fisheries Management study of the early life history of catfish in the Lower Wisconsin River. These preliminary efforts were continued and expanded upon during summer of that year but, due to budget cutbacks, the study was never fully implemented. Results of these efforts are reported in Pellett (1995).

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PROJECT BUDGET

TITLE: Spawning and Early Life History of Catfish in the Lower Wisconsin River, Wisconsin.

FUNDING SOURCE: Federal Aid in Sport Fish Restoration (SFR) and State Segregated Funds

STUDY NO.: ____

		FY-1	FY-2	FY-3	FY-4	FY-5	FY-6	TOTAL
Permanent Hours:								
NRR Supervisor	($22.00/hr):	300	200	100	100	200	100	1000
NRRS-Senior	($17.00/hr):	1040	1040	1040	1040	1040	1040	6240
Project Hours:								
NRRT-2	($11.00/hr):	2080	2080	2080	2080	1040	1040	10,400
Salary:		$47,100	$45,000	$42,800	$42,800	$33,500	$31,300	$242,500
Fringes @ 35.6%		$16,800	$16,000	$15,200	$15,200	$11,900	$11,200	$86,300
LTE Hours:		1040	2080	2080	2080	1040	1040	9360
LTE Salary	($8.00/hr):	$ 8,300	$16,700	$16,700	$16,700	$ 8,300	$ 8,300	75,000
Fringes @ 12%		$ 1,000	$ 2,000	$ 2,000	$ 2,000	$ 1,000	$ 1,000	$ 9,000
Total Sal & Fringe:		$ 73,200	$ 79,700	$ 76,700	$ 76,700	$ 54,700	$ 51,800	$421,800
Supplies/Services:		$ 25,000	$25,000	$25,000	$15,000	$20,600	$ 400	$111,000
Capital:		$ 23,000	–	–	–	–	–	$ 23,000
Total Costs:		$121,200	$104,700	$101,700	$ 91,700	$ 75,300	$ 52,200	$555,800
Project Total:		**$555,800**						

Estimates of Itemized Costs Other Than Salaries

Supplies and Services

Radio Transmitters	$ 15,000
Meal & Lodging	$ 10,000
Travel	$ 15,000
Boat Gas	$ 10,000
Nets & Gear	$ 15,000
Equip. Repair	$ 10,000
DOA Flights	$ 15,000
Office Supplies	$ 6,000
Publications	$ 15,000
Totals	**$111,000**

Capital (FY-1 ONLY)

Suction Dredge	$ 2,000
Directional Antenna	$ 1,000
Work Boat & Trailer	$ 2,500
40 Hp Outboard Motor	$ 3,000
15 Hp Outboard Motor	$ 1,500
Tempmentors (18)	$13,000
	$23,000

Project title: **Early Life History of Catfish in the Lower Wisconsin River**

State: Wisconsin

Project No.: F-95-P

Activity 1 Radio Telemetry

Objective: Radio-tag and track mature pre-spawning male channel and flathead catfish.

Procedures: During autumn of the first year of the study, continuously recording temperature meters (Tempmentors (Tm) or equivalent) will be placed at mid-water depths in pre-migration staging areas within the Lower Wisconsin River just upstream of its confluence with the Mississippi River (e.g., the railroad bridge at mile 1.6) and just below the Prairie du Sac Dam (e.g., the Highway 60 bridge). A third unit should be place at some mid-point along the rivers course (e.g., the Highway 80 bridge at Muscoda). Units will be programmed to record hourly temperatures; data will be retrieved at 6-month intervals and downloaded to SAS computer files.

The following spring, and during spring of each sample year, adult male channel and flathead catfish will be collected from these pre-migration staging areas. Baited and unbaited hoop nets will be the principle collection gear; set lines and bank poles may be used if too few flatheads are captured in the hoop nets.

At each site, up to 40 male catfish of each species (not to exceed 100 total) will be surgically implanted with radio transmitter of unique frequencies in the 49-50 MHz range. Size of fish implanted will depend on transmitter weight requirements and size of fish available but all fish must be visibly mature with a reasonable expectation of spawning. Larger males are preferred because they can carry larger transmitters, will be less impeded by the transmitter and its antenna, and are most likely the principal spawners. Each transmittered fish will, in addition to the radio tag, be tagged with a uniquely numbered anchor tag and will have the right pectoral spine removed for age determination (see activity 2).

Scanning receivers will be used to track transmittered fish. Movements will be followed, via properly equipped aircraft, at least twice weekly until it appears that these fish have settled into their "home" territory. Local movements will be followed, thereafter, by boats. The number of tracking boats will depend on the distribution of the transmittered fish. If fish are widely distributed, at least 4 separate areas should be monitored along the full 93-mile course of the Lower Wisconsin River. Subsequently, these fish will be monitored from the air on a weekly basis until the transmitter fails, or they can no longer be located. Ideally, investigators will be able to follow some fish through more than one spawning cycle and thus determine if catfish spawn each year and if they return (i.e., home) to the same spawning sites.

Activity Duration: Fiscal Years 1-3

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Activity 2 Fecundity and Age Structure

Objective: Determine fecundity and age structure of channel and flathead catfish spawning population in the Lower Wisconsin River.

Procedures: Just prior to the onset of spawning, baited and unbaited hoop nets will be set in the general vicinity of apparent nesting sites located under Activity 1. Additional netting sites may be needed to adequately represent the distribution of spawning populations throughout the full reach of the study area. Nets should not be placed, however, within several hundred meters of the actual nesting sites.

Fecundity: Up to 10 females of each species (no more than 50 each in total) will be collected from an area within 5 km of each designated spawning site. These fish will be measured (standard length) and weighed in the field, then immediately placed on ice and, as soon as possible, delivered to the laboratory for processing. Each fish will be reweighed and measured. The ovaries will be surgically removed and each lobe weighed individually, after which each will be carefully split and preserved in modified Gilson's fluid for later analysis. Eggs from each pair of ovaries will be cleared from the remaining ovarian tissue and the fixative. All eggs containing yolk will be counted and the diameter of a subsample of eggs from each pair of ovaries will be measured. Comparison within and among sites for each species will be made for the following:

-Number of eggs per standard length increment of fish.

-Size of eggs per standard length increment of fish.

-Gonadosomatic index (GSI).

Age: The right pectoral spine will be removed, in the laboratory, from all females collected for fecundity analysis. All other catfish collected will be sexed and tagged with uniquely numbered anchor tags. An evaluation of maturity will be made on-site. The right pectoral spines will be removed from all mature catfish collected. Tagged fish that are subsequently recaptured will have the dorsal spine removed for comparison and verification. Each spine will be placed in an individual scale envelope upon which is recorded the date, species, standard length, weight, sex, capture location, and tag number. Spines will be sectioned, mounted, and aged in the laboratory. Age distribution and length at age of spawning catfish will be compared within and among sample sites for each species.

Activity Duration: Fiscal Years 1-3

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Activity 3 Locate and Describe Spawning Sites

Objective Locate and describe biotic and abiotic characteristics of nest sites.

Procedures: Male channel and flathead catfish will be tracked to spawning areas as described in Activity 1. Once these fish have settled into their "home" territory, individual fish will be tracked by boat and spawning sites located.

In deep water sites, actual location of the spawning sites may be possible by floating over the site and observing the radio signal strength. In shallow water sites, it will be necessary to employ directional antennas and triangulation techniques so as not to disturb the pre-nesting or nesting males. Location of nest sites will be marked on detailed maps as will land reference points to facilitate relocation. Where possible, enhanced GPS positions will be fixed.

Continuously recording temperature meters (Tempmentors$^{(Tm)}$ or equivalent) will be placed at or near each spawning site at a depth of approximately 0.5 to 1.0 m above the substrate. If multiple spawning sites are located within a 5-km stretch of the river, 1 centrally located site per 10 spawning sites will be selected for temperature meter placement. Once positioned, these instruments will be left in place year-round and data retrieved as in Activity 1 (above).

A chart recording depth finder will be used to describe the 3-dimensional configuration of the nest sites. Where conditions permit (i.e., deep water sites or where the nest is to be intentionally disturbed to collect other data) this will be done while the male is on the nest. In all other cases, these data will be collected after the male has vacated the site. SAS-graph computer programs and/or optical imaging technology will be used to create a 3-dimensional computer record and image of each site. These records will form the base of a computer-generated graphics model of each nest site.

During the nesting period, twice-weekly measurements of current velocity and temperature will be made at the surface, at midwater, and at the bottom. Precise dates and times of these measurements will be recorded. Temperature data will be compared with those collected form the continuously recording temperature meters (above). Additional measurements will be made after major storm events. All measurements will be made at or as near to the nest as possible without creating a major disruption of the nest. These same measurements will be made on selected nests without regard to the impact on the eggs, larvae, or male behavior. These data will be incorporated into the computer-generated graphics model of each nest site.

Structural components (i.e., logs, rocks, sunken boats, etc.) and attributes (i.e., undercut banks, rock ledges. etc.) of nest sites will be evaluated and quantified after depth data have been collected. Data recorded for these components will consist of size, texture, current orientation, and location within or near the nest site. These data will be incorporated into the computer-generated graphics model of each nest site.

In most cases, substrate samples will be collected after depth and structural data have been collected and after the male has vacated the nest site. Some substrate samples will be collected in conjunction with egg and larval collection made under Activity 4. Substrate samples will be collected with boat mounted suction dredges or pump samplers in most cases. Where conditions permit, SCUBA divers will collect various samples by hand. Substrate composition will be analyzed by conventional graduated screen methods. Percent composition by standard categories (cobble, gravel, sand, etc.) will be determined. These data will be incorporated into the computer generated graphics model of each nest site.

Activity Duration: Fiscal Years 1-3

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Activity 4 Egg Deposition, Larval Abundance, and Nest Success.

Objective: Determine egg deposition rate, larval abundance, and nest success, for channel and flathead catfish nest sites.

Procedures: Temperature data at each site will be collected as in Activity 3 (above). Eggs and nesting larvae will be sampled from selected nest sites. SCUBA divers will make these collections where conditions permit. Under less favorable conditions, suction dredges and/or pump samplers will be the principle collection gear.

Gravimetric and volumetric measurement of each egg mass will be made. A count of living and dead eggs will be made and the diameter of each measured. The stage of embryo development for living eggs will be noted.

The stage of development will be determined for each or a subsample of larvae collected from each nest site. All larvae from a nest site will be counted, and all or a subsample will be measured and weighed.

Drift nets will be periodically deployed downstream of disturbed and undisturbed nests and at randomly selected locations to determine spatial and temporal pre-dispersal drift patterns, health and mortality of pre-dispersal drifting larvae, and onset of post-larval dispersal from nest sites.

Activity Duration: Fiscal Years 1-4

Activity 5 Post-larval Y-O-Y and Yearling Catfish Abundance and Growth

Objective: Determine relative abundance and growth of post-larval young-of-the-year, and yearling channel and flathead catfish.

Procedures: In the context of this study, young-of-the-year (Y-O-Y) catfish are considered to be those juveniles which have dispersed from the nest, and which were hatched during the same calendar year in which they were collected or observed. Additionally, and for the purpose of data collection, post-larval Y-O-Y will be categorized as follows: Fry (free feeding under male guard and subject to significant drifting) and Fingerlings (not under male guard nor subject to significant drifting). Fingerlings will further be categorized by size and season (i.e., small, medium, large, early summer, late summer, fall, etc.). Yearling catfish are considered to be those juveniles which were hatched in the calendar year previous to the year they were collected or observed.

To determine the onset of post-larval dispersal, first from nest sites, and second, from male guardianship, the activities of transmittered parental male catfish will be monitored from boats at least twice weekly until it has been determined that the larvae are no longer under male guard.

Data will be compared within and among sites.

Abundance: Drift nets will be fished immediate downstream of transmittered parental males once they and their charges have left the nest sites and established nursery areas, and until it is determined that post-larval Y-O-Y are no longer subject to significant drifting. Drift nets will be of 2 types: large single or paired stacked nets, and small batteries of several nets per set. In addition, fry may be collected with seines, push nets, and modified shrimp trawls.

For fingerling and yearlings, sampling gear will be miniaturized hoop nets (baited and unbaited), modified slat and/or minnow traps, seines, shrimp trawls, and electroshocking gear. Differences in gear used to collect fingerlings (all sizes) and yearlings will be primarily in mesh size, as dictated by size of target fish, and modifications made to accommodate habitats occupied by the different sizes described above.

All fry and small fingerlings, and all or a subsample of larger fingerlings and yearlings collected will be sealed in plastic bags and immediately placed on ice for transport to the laboratory. Fish not so handled will be measured and weighted in the field and these data will be recorded on field data sheets which will indicate the date and site collected, gear used and other data relating to activity 6 (below). Fish brought back to the laboratory will be kept on ice and processed within 24 hours or will be frozen for processing at a later date. Fish processed in the laboratory will be measured (standard length in mm), weighed to the nearest gram, and have otoliths removed. Yearling catfish will also have the dorsal and right pectoral spines removed.

A subsample of these fish will be photographed and/or have similar image records made using optical-imaging technology.

Growth: Otoliths will be extracted from all or a subsample of fry and fingerlings collected. Otoliths will be dried and prepared for sectioning. Daily growth of fry and fingerlings will be analyzed and used to back calculate the date of hatching.

In addition to otoliths, dorsal and right pectoral spines will be removed from yearling catfish for age verification and for comparison of aging methodologies.

Activity Duration: Fiscal Years 1-4

Activity 6 Post-larval Y-O-Y and Yearling Habitat Preference

Objective: Determine habitat preference and use by post-larval young-of-the-year and yearling channel and flathead catfish.

Procedures: Data on habitat preference and use will be collected in conjunction with Activity 5 (above). At each site where post-larval Y-O-Y and yearling channel and flathead catfish are captured, detailed data on habitat will be recorded. These data include date, time, river mile, distance to main channel, cross sectional location, enhanced GPS coordinates, depth, substrate, structure (type and orientation), fish species assemblage, river stage, current velocity (surface, midwater, bottom), turbidity, water temperature (surface, midwater, bottom), dissolved oxygen, pH, conductivity, air temperature, and weather conditions. When possible, some of these variables will be monitored with continuously recording meters. These data will be used to construct Habitat Suitability Indices (HSI's) for these species and incorporated into a computer model of habitat preference.

A survey of the physical characteristic at 100 to 200 randomly selected river sites will be conducted along the 92+ miles of the study area. At each site, date, time, river stage, and river mile will be recorded. Three shore-to-shore transects, within 100 m of each other, will be made and the following data will be collected for each transect: river width, cross-sectional depth contours, structure (type, location & orientation) and enhanced GPS coordinates (beginning and end, and at 3 to 4 points along each transect). Upon completion of these transects, the following data will be collected along a fourth transect randomly located within the bounds of the 3 original transects, at points 1 m of each shore and at 3 to 4 locations across this fourth transect: enhanced GPS coordinates, substrate type, current velocity (surface, midwater, bottom), water temperature (surface, midwater, bottom), dissolved oxygen, pH, turbidity, and conductivity.

To determine the extent and distribution of suitable habitat for juvenile channel and flathead catfish, these data will be compared to those collected at the spawning sites, and incorporated into a computer generated graphics model of the availability and distribution of these preferred habitats throughout the Lower Wisconsin River.

Activity Duration: Fiscal Years 1-4

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Activity 7 Final Report

Objective: Complete data analysis, write, review, edit and publish the final report.

Procedures: Data from Activities 1 through 6 will be analyzed within and among sample sites and compared to data from other sources. One to several refereed journal articles will be published on various aspects of the early life history of channel and flathead catfish of the Lower Wisconsin River.

Activity Duration: Fiscal Years 4-6

Geographic Location: Lower Wisconsin River from river mile 0 to river mile 92.3 (confluence with the Mississippi River to the Prairie du Sac Dam).

Personnel: DNR research staff; contributing resource management staff and cooperating agencies and/or institutions.

Prepared by: Thomas D. Pellett—DNR Bureau of Research, Fish Research Section.

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Thomas D. Pellett is the Southern Warmwater Group Leader for the Fish Research Section of the Bureau of Research, DNR. Tom received a Bachelor of Science Degree in biology from the University of Wisconsin-La Crosse in 1968. Following a tour of duty in the United States Navy, Tom returned to La Crosse where he earned a Master of Science degree. His master's thesis dealt with the species composition, relative abundance, and distribution of fishes in Navigation Pool 8 of the Upper Mississippi River. In 1977, Tom enrolled in the Fisheries and Wildlife program at Virginia Polytechnic Institute and State University in Blacksburg, Virginia, where he continued his post-graduate education and conducted research on resource partitioning and competition among the native fishes of a small mountain stream. Tom accepted the position of station supervisor at the DNR Fisheries Management station in Sturgeon Bay in 1981. In 1983, he transferred to the Bureau of Research as the Special Projects Leader and was promoted to Group Leader in 1984. Tom's principal research interests are large river and small lake ecosystems.

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