APPLICATION FOR LICENSE FOR THE INDIAN POND PROJECT

FERC NO. 2142

FPL ENERGY MAINE HYDRO LLC

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Radio Telemetry Study on Flow-Related Movements, Spawning, and Seasonal Movements of Salmonids below Harris Station on the Kennebec River, Maine

Radio Telemetry Study
On Flow-Related Movements, Spawning, And Seasonal Movements of Salmonids Below Harris Station on the Kennebec River, Maine

For

The Indian Pond Project Relicensing
FERC No. 2142

Volume I

Submitted To:

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Executive Summary

E/PRO Engineering & Environmental Consulting, LLC (E/PRO) conducted a radio telemetry study on salmonids downstream of the Harris Station hydroelectric facility on the Kennebec River, Maine. The purpose of the study was to determine: 1) if the peaking operations at Harris Station are displacing brook trout (*Salvelinus fontinalis*) and landlocked salmon (*Salmo salar*); 2) what strategies and habitat features do brook tout and landlocked salmon utilize to adapt to flow changes; 3) where does salmonid spawning occur downstream of Harris Station, if at all; and 4) what seasonal movements salmonid species make in the Kennebec River downstream of Harris Station. For study purposes, the 19-mile river segment was divided into three reaches (upper, middle, and lower) based on river characteristics including gradient change, river width, and substrate make-up.

A total of 97 fish were tagged, of which 64 were landlocked salmon and 26 were brook trout. In addition, 1 rainbow trout (*Oncorhynchus mykiss*), 1 smallmouth bass (*Micropterus dolomieu*), 1 brown trout (*Salmo trutta*), 1 lake trout (*Salvelinus namaycush*), and 3 splake (*Salvelinus namaycush* X *Salvelinus fontinalis*) were also tagged.

During flows of 140 cfs, 300 cfs, 500 cfs, and 680 cfs, pools were the major aquatic habitat type utilized by landlocked salmon and brook trout in the upper and middle river reaches, while runs and pools were the prevalent habitat utilized in the lower river reach. During generation flows of 1,500 cfs–8,000 cfs, eddies were the most commonly used aquatic habitat in the upper and middle river reaches. Runs and pools were the most commonly used aquatic habitat in the lower river reach during generation flows.

The radio telemetry data collected during the four-month study period clearly demonstrates that salmonids are not being displaced downstream by the peaking operation of Harris Station. Salmonids utilized the numerous velocity refugia habitat in the river that varied according to river reach.

Brook trout and landlocked salmon are successfully reproducing in the Kennebec River and associated tributaries between Harris Station and Wyman Lake. Numerous juvenile brook trout were observed near the mouths of several tributaries and, to a much lesser degree, juvenile brook trout and landlocked salmon were also observed in the mainstem river. Spawning surveys conducted in the Kennebec River mainstem and tributaries revealed that salmonids are spawning below the Indian Pond Project. Approximately 58+ salmonid redds were documented in the river between Carry Brook and Holly Brook, and 6+ redds were discovered in Cold Stream approximately 100 yards from the confluence with the Kennebec River. All the documented redds were covered by at least four to twelve inches of water. The preference to construct redds at these depths is consistent with the size of the salmonids captured and observed in the study area. At least one study brook trout utilized Cold Stream for spawning purposes, indicating that river salmonids are successfully utilizing the associated tributaries to reproduce. During the surveys, which were conducted during the current minimum flow of 140 cfs from Harris Station, no dewatered redds were observed in the mainstem river.

Monitoring of seasonal movements throughout the summer and fall revealed that tagged landlocked salmon remained in the mainstem Kennebec River and brook trout utilized cooler water in the tributaries during the unusually dry summer months. As water temperatures dropped throughout the fall, spawning movements for both species were documented in late October and November. Aerial monitoring in mid-December revealed that out of 25 landlocked salmon currently tagged, five left the Kennebec River and were located in Wyman Lake, while eight had made significant movements (>1 mile) towards Wyman Lake, possibly for over-wintering purposes. Of the tagged salmonids remaining in the river, eleven salmon and four brook trout were found in pools throughout the river from Harris Station to Wyman Lake. Aerial monitoring will continue throughout the winter months to determine over-wintering areas of the tagged salmonids.

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1.0 Introduction

Harris Station at the Indian Pond Project (FERC No. 2142) is owned and operated by FPL Energy Maine Hydro, LLC (FPLE). The project is located in northwestern Maine in the upper portion of the Kennebec River basin, approximately 30 miles from the Canadian border, and approximately 114 miles above the river mouth at Popham Beach. Harris Station operates as a daily peaking facility, with daily flows ranging from the current minimum flow of 140 cfs to generating flows which typically range between 4,800-6,000 cfs.

Harris Station is FPLE's and Maine's highest capacity hydro facility, rated at 88 MW. Harris Station utilizes a spinning reserve system, enabling the station to come on-line almost instantaneously in the event of a major system failure on the New England power grid. It is also used for automatic generator control (AGC) that is necessary to balance system supply and demand on an instantaneous basis. This feature makes Harris Station a critical part of the FPLE's and the New England Power Pool's system.

Harris Station has exceptional rapid response rates during periods of peak electrical demand. Harris Station can produce 3 MW/minute in Automatic Control--three times faster than Maine's largest fossil unit in an emergency situation. Harris Station also possesses the unique ability to Black Start in the event of catastrophic system collapse. Utilizing flow through Unit #4 (the 140 cfs minimum flow turbine), Harris Station can generate its own internal power and begin transferring energy back onto the grid to reestablish system stability.

The FERC license for the Indian Pond Project expires on December 31, 2001. Submission of a final application to relicense the Project is required by December 31, 1999. During the relicensing of the Project, FPLE received comments from State and Federal agencies as well as non-governmental organizations regarding the effects the peaking operation had on the fishery resources of the Kennebec River below Harris Station. As part of the consultation process, FPLE formed a relicensing Flow Study

Team to address the issues raised. The Study Team was comprised of representatives from FPLE; the Maine Department of Inland Fisheries and Wildlife (MDIFW); the U.S. Fish and Wildlife Service (USFWS); the Appalachian Mountain Club (AMC); the Conservation Law Foundation (CLF); Trout Unlimited (TU); Maine Trout; Adventure Bound; and FPLE's consultants.

The Study Team identified four major questions regarding the operation of Harris Station.

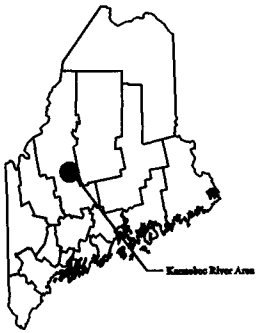
1. Are individual salmonid fish pushed downstream when generation flows are increased from base flows?
2. What strategies and habitat features do salmonid fish utilize to respond to flow changes and how will those strategies change under various flow regimes?
3. Where does salmonid spawning occur, if it does occur?
4. What sort of seasonal movements of salmonid species take place within the study area?

The Team reached consensus that a radio telemetry study was the most effective approach to address these issues. The result of the Study Team effort was the development of a radio telemetry study plan (FPLE 1999) which would serve as the foundation for the study.

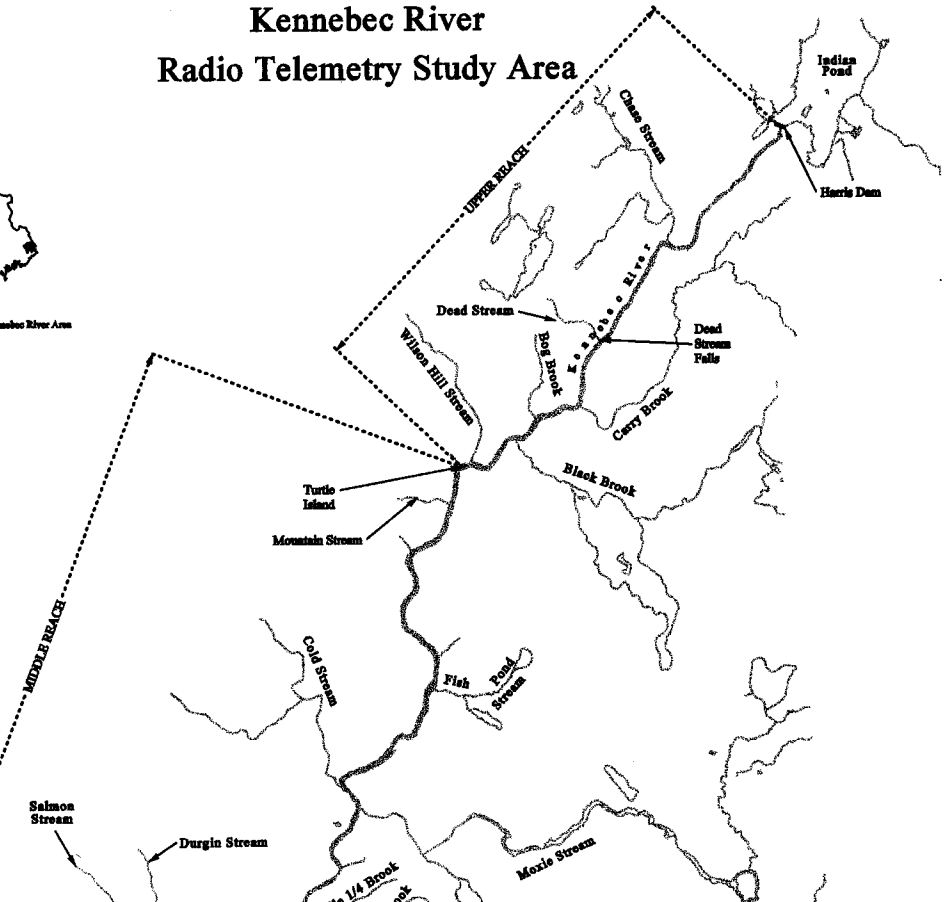
For study purposes, the Kennebec River from Harris Station to Wyman Lake was divided into three general reaches (upper, middle, and lower). A brief description of each study reach is provided below and Figure 1 provides a map of the study area.

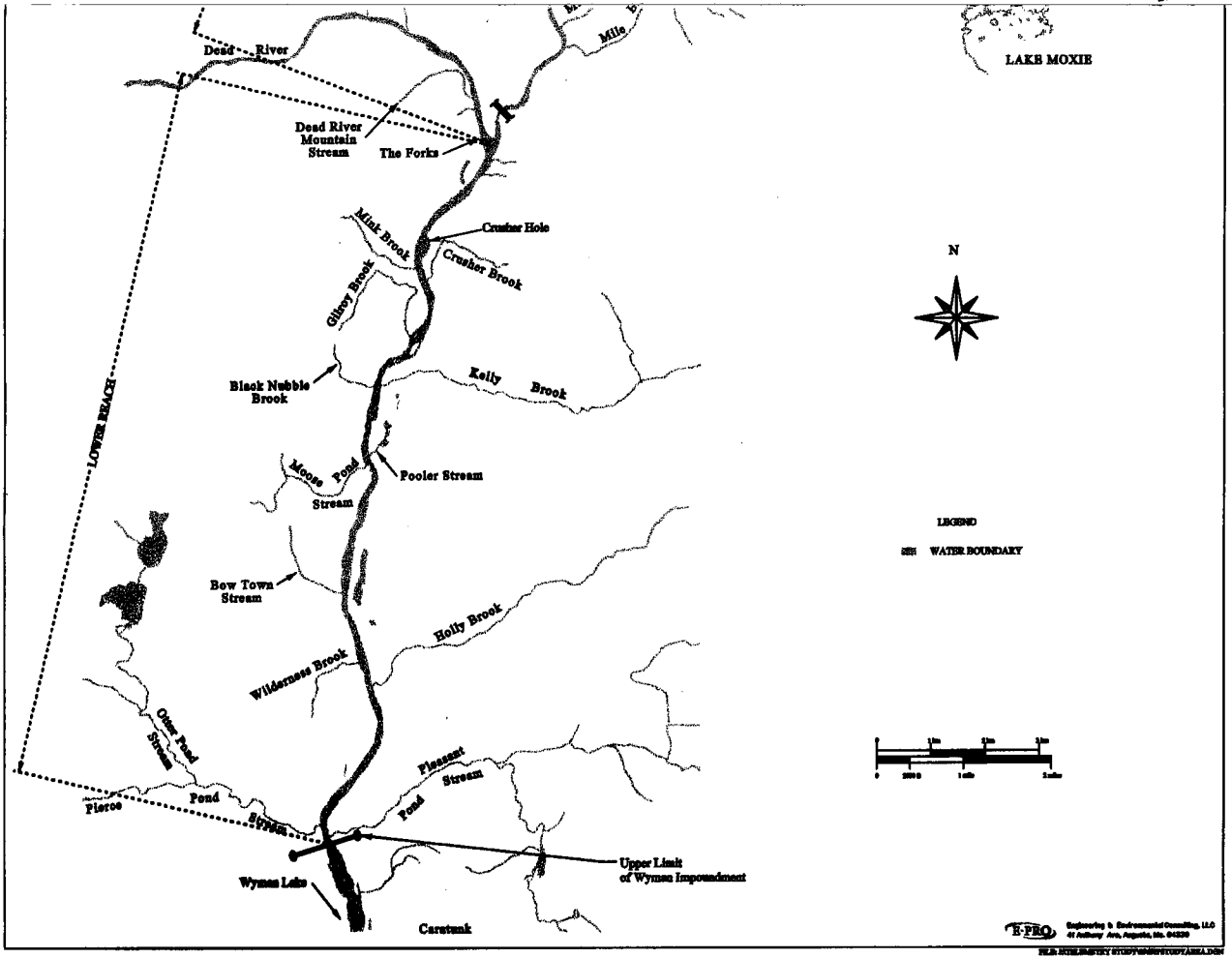
The upper reach between Harris Station and Turtle Island (approximately 5 miles) is characterized by high gradient (approximately 29 ft./mile), vertical gorge walls, and predominantly bedrock and large boulder substrate; this is considered the Kennebec Gorge. At the minimum flow of 140 cfs, aquatic habitats in the upper reach consist of

Figure 1
Kennebec River
Radio Telemetry Study Area



LOCATION DIAGRAM




Dead River
Dead River Mountain Stream
The Forks
Mink Brook
Crusher Hole
Crusher Brook
Gilroy Brook
Black Nubble Brook
Kelly Brook
LOWER REACH
Moose Pond Stream
Pooler Stream
Bow Town Stream
Holly Brook
Wilderness Brook
Otter Pond Stream
Pierce Pond Stream
Pleasant Pond Stream
Upper Limit of Wyman Impoundment
Wyman Lake
Caratunk
LAKE MOXIE
N
LEGEND
WATER BOUNDARY
E-PRO

approximately 1.5 miles of pools, 1.5 miles of run, 0.75 miles of riffles, and 2.25 miles of rapids.

The middle reach is the river segment between Turtle Island and the confluence with the Dead River at The Forks (approximately 7 miles), characterized by moderate gradient (approximately 20 ft./mile), steep forested shoreline, and boulder/cobble substrate. At the minimum flow of 140 cfs, aquatic habitats in the middle reach consist of approximately 1.6 miles of pools, 0.65 miles of runs, 5.25 miles of riffles, and 1.25 miles of rapids. Both the upper and middle river reaches are remote in nature, and river access is limited.

The lower reach from the confluence with the Dead River to Wyman Lake (approximately 7 miles) is characterized by relatively low gradient (approximately 17 ft./mile), moderately sloped riparian areas, and boulder/cobble substrate. The lower river reach is influenced by both flows from Harris Station and flows from the Long Falls Dam at the Flagstaff Project, about 24 miles upstream on the Dead River. Aquatic habitats in the lower reach consist of approximately 0.5 miles of pools, 0.5 miles of runs, 3.75 miles of riffles, and 2.25 miles of rapids. The lower reach is paralleled by US Route 201, and access to the river is more readily available.

The river reaches, especially the upper reach, change dramatically at higher flows. A well-established commercial whitewater rafting industry has developed around the daily generation releases from Harris Station. Plots of hourly flow releases during the study period are provided in Appendix 1.

2.0 Methodology

2.1 Species Selection

The Study Team selected two major target species for the study: brook trout (*Salvelinus fontinalis*) and landlocked salmon (*Salmo salar*). Although not included as species of

MDIFW management importance, rainbow trout (*Oncorhynchus mykiss*) and smallmouth bass (*Micropterus dolomieu*) were included as minor target species.

Brook trout were the primary target species identified by the team for the telemetry study because MDIFW is managing this river segment for a self-sustaining brook trout fishery. MDIFW placed greater emphasis on brook trout because they generally exhibit better growth rates in riverine environments than salmon do. Landlocked salmon were identified as lower priority, but the Study Team agreed to evaluate this species since it appeared to be the most commonly caught salmonid in the river below Harris Station. MDIFW annually stocks salmon (spring yearlings) in Indian Pond. It is apparent that some of these fish drop down into the river and mature (approximately 25% of salmon caught during the radio telemetry study had clipped left ventral fins, indicating that they had been stocked in Indian Pond).

Rainbow trout are also present in the study area and may be reproducing. The Study Team agreed that the rainbow's limited numbers and the lack of management interest from MDIFW eliminated it as a major target species for this study.

Smallmouth bass were illegally introduced into Indian Pond and have established themselves in large numbers in the Kennebec River down to Wyman Lake. Since MDIFW has expressed a desire to manage against this species, the Study Team thought it would be valuable to tag a small number of bass and monitor their movement.

2.2 Sampling Techniques

Several methods for sampling fish were evaluated, including use of active and passive gear, electro-fishing, and angling.

Use of passive gear includes setting nets that require daily tending. It was decided that this method was impractical for the study area for two reasons. First, the velocities in the Kennebec River at the generation flows are too high and would wash the nets down river.

Second, the Kennebec River experiences over 60,000 commercial/private whitewater boaters per year and any nets permanently installed in the river could pose safety problems.

Active gear was also initially used for sampling, but this method proved to be very inefficient. Active gear consists of any type of gear which sieves the fish from the water (Hayes 1983). This technique requires the weighted-end of the net to lie on the river bottom continuously, or its efficiency is greatly reduced. The substrate in the study area consists of large cobble/boulders, making it impossible to maintain bottom contact with the seines or nets.

The third sampling technique considered was electrofishing; however, both the low conductivity of the river water and the high water volume made this technique very impractical. As a result, angling proved to be the most effective and efficient sampling method.

Fish were collected by angling at various locations within the study area by local anglers and staff biologists. Angling efforts were concentrated during minimum flow periods from Harris Station, although many fish were caught during generation flows in all reaches of the river. Angling at the higher flows was more successful in areas containing velocity refugia (e.g., pools, eddies, etc.) for fish. Data was recorded from fish that were not suitable for tagging (too small or non-target species) and they were released immediately (see Appendix 2).

2.3 Radio Tracking Equipment

The radio transmitter tags were 12-hour programmable salmonid tags made by Lotek Engineering, Inc. Two (2) different-sized tags were used (3.7g and 6.7g) to allow tagging of a wide range of fish sizes likely to be encountered in the river. Tag weights varied depending on battery size; as a result, smaller tags had a shorter life span (76 days) than the larger tags (158 days).

Before tagging events, tags were programmed to cycle on between 5:00 AM and 5:00 PM and run for a period of approximately 12 hours. This was done to maximize battery life and to take advantage of available daylight hours for fieldwork. In addition, tag antennae were cut in half for two reasons. First, the shorter antennae caused less drag (and therefore less stress) and lessened the chance of the antennae being snagged on underwater obstructions. Second, by removing one-half of the antennae, the overall weight of the tag was reduced allowing smaller target species to be tagged. According to the manufacturer, cutting the antennae in half would not significantly affect the transmitting ranges of the tags.

Advanced Telemetry Systems, Inc., (ATS) Model R2000 receivers and Lotek Yagi directional antennas were used for all location monitoring. The upper reach of the study area, consisting of steep gorge walls, caused some reduced reception range of radio signals. Since these receivers work on the principle of "line-of-sight", care was taken to monitor the entire river by raft, canoe, and aircraft, and to conduct complete scans at each bend in the river to lessen the chance of missing signals. During the study, signals were effectively picked up within one-quarter to one-half mile of the location of the tag during river tracking events, and within one to two miles during aerial surveys.

The remote, extremely rugged nature of the study area presented major logistical challenges during tracking events. Due to the limited access to the river in the upper and middle reaches, most of the tracking was accomplished by traveling down the river in whitewater crafts. Whitewater rafts were used to track fish during generation flows as the river, particularly in the upper reach, is extremely turbulent with numerous rapids. Whitewater canoes were used for tracking during the minimum flows.

2.4 Surgical Procedure

During the development of the study plan, the Study Team agreed that surgical implantation of radio tags was the preferred method. Stomach tags were discussed and dismissed since they disrupt feeding activities and increase mortalities (Winter 1983).

Each target species caught was weighed and measured to determine if it was large enough for a transmitter. Following standard convention, tags could not exceed approximately 2% of the fish's body weight (Winter 1983). Accordingly, fish needed to have a minimum weight of approximately 125 grams to receive a small transmitter, while the minimum fish weight for a large transmitter was approximately 225 grams.

Fish large enough to tag were anesthetized using Finquel® brand MS-222 (tricaine methanesulfonate). Fish were anesthetized in a solution of approximately five gallons of fresh river water and approximately 50mg/L of MS-222. Since MS-222 can greatly lower the pH of the water, a buffer solution of approximately 12-15mg/L of sodium bicarbonate was added to maintain the river water pH[1] (pH readings ranging from 6.2 to 6.8 were recorded in this segment of the Kennebec River). Buffering the solution with sodium bicarbonate reduced the risk of fish mortality due to acidosis.

Once anesthetized, fish were placed in a piece of PVC pipe that was cut in half lengthwise, which served as an operating table. Wet cotton rags were placed between the fish and the operating table to prevent injury and loss of the fish's protective slime coat. The head of the table was slightly elevated at one end to allow irrigation water to flow through the gills and away from the fish. Irrigation of the gills was accomplished with the buffered MS-222 water flowing from an elevated 5-gallon bucket, through a 5/16-inch flexible hose into the fish's mouth and over its gills. The water kept the fish both anesthetized and oxygenated throughout the surgical procedure. All sutures, surgical tools, and tags were sterilized in isopropyl alcohol.

[1] Buffering information provided by Rick Simmons, Normandeau Associates, Inc.

An incision of ½-inch to ¾-inch long was made on the ventral side of the fish, slightly forward and dorsal of the pelvic girdle. Careful attention was required to prevent puncturing the internal organs while opening the peritoneum. Once the incision was made, the selected transmitter was implanted through the incision into the body cavity. A 16-gauge catheter was used to run the antennae out of the skin approximately 1-inch posterior to the incision. Three to six sutures were required to close the incision. See Photos 1-4.

After surgery, the fish were placed into a recovery bucket of fresh river water aerated by a battery-powered aerator. The fish were released into the river when, through a biologist's visual assessment, the fish had recovered from the effects of the anesthesia. Catch location, species, length, weight, and permanent marks were recorded for most of the tagged fish. Scale samples were also taken from each fish tagged and sent to the MDIFW Regional Headquarters in Strong, Maine, for age analysis.

2.5 Radio Tracking Methodologies

During the study, three methods of monitoring were implemented to document fish movements:

1. Intensive Monitoring Events. This method entailed tracking the movement of a particular fish or multiple fish from a particular location on the river through changing flows (minimum flow to generating flow). The purpose of the intensive tracking events was to monitor individual fish behavior and habitat use in response to flow increases from Harris Station. This method resulted in documentation of fish behavior and use of velocity refugia during peaking situations. Fish movements were tracked every 10 to 30 minutes prior to and during generation flows. Canoes were used to track fish at the lower flows, but tracking from shore was necessary at the generation flows.

Photo 1: Surgical Incision in a Brook Trout

Photo 2: Brook Trout with Inserted Tag

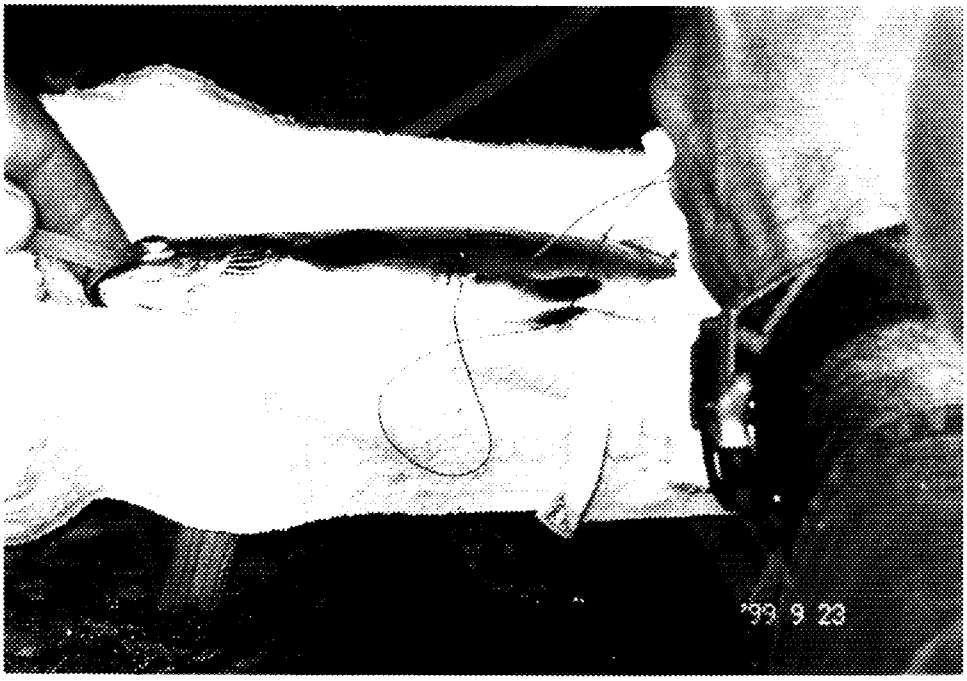


Photo 3: Landlocked Salmon during Surgery

Photo 4: Landlocked Salmon Immediately Following Surgery

2. Peaking Cycle Location Checks. This method involved floating down the river by canoe, raft, or cataraft and locating tagged fish throughout the entire study area. All fish that were located were recorded on a map. This method of locating fish was conducted during minimum flow, immediately followed by locating fish during the subsequent generating flow, and then locating the fish the following morning at the minimum flow. The study fish were located once for each of the flows. The purpose of the Peaking Cycle Location Checks was to identify where fish were holding within the study area and to document overall fish movement and use of habitat. This method allowed for complete coverage of the study area and tributaries (within the range of the receiver) during a 24-hour cycle of changing flows from Harris Station.

3. Supplemental monitoring. In addition to the above methods, supplemental tracking data was collected throughout the season. Numerous "spot checks" were performed while FPLE was conducting concurrent studies in the river. The team walked tributaries on several occasions in an attempt to locate fish that may have moved out of the main stem river. Aerial tracking by floatplane was also used to locate fish in the study area, as well as fish that had moved out of the reception range of the receiver while working in the main stem river.

3.0 Results

Between June 22, 1999, and September 25, 1999, over 290 fish were caught and recorded during the telemetry study. Species are broken down in Table 3.1. Approximately two dozen more fish, mainly non-target species, were caught but not recorded in the field.

Of the 290 fish caught, 112 were landlocked salmon and 48 were brook trout. A total of 97 fish were tagged during the course of the telemetry study. Of the 97 fish tagged, 64 were salmon, 26 were brook trout, three were splake, and one each of rainbow trout, lake trout, brown trout, and smallmouth bass. Reasons for not tagging all of the captured

target species included the fish were too small to tag, the fish were foul-hooked, or that the fish appeared too stressed. Although splake were not identified as a target species of

Table 3.1
Fish Captured during Telemetry Study

Species	Scientific Name	No. Captured	% of Total
Landlocked salmon	*Salmo salar*	112	38.6
Fallfish	*Semotilus corporalis*	64	22.1
Brook trout	*Salvelinus fontinalis*	48	16.6
Smallmouth bass	*Micropterus dolomieui*	39	13.4
White perch	*Morone americana*	11	3.8
White sucker	*Catostomus commersoni*	6	2.1
Splake	*Salvelinus namaycush X Salvelinus fontinalis*	4	1.4
Rainbow trout	*Oncorrhynchus mykiss*	3	1.0
Brown trout	*Salmo trutta*	2	0.7
Lake trout	*Salvelinus namaycush*	1	0.3
Totals:		**290**	**100.0**

Note: Approximately +/-24 more fish were caught during the study that were not recorded in the field.

the study, four were caught during the study and it was felt that it was worthwhile to tag the fish as it might provide useful information. Three of the four splake had both of their ventral fins clipped, indicating that MDIFW had stocked them earlier in the year at Wyman Lake (personal communication with Forrest Bonney, MDIFW). The lake trout, while presumed to have dropped down from Indian Pond, was also tagged to gather useful information. The brown trout, which are established in the Kennebec River, was tagged for the same reason. Table 3.2 provides information on the fish ID, the radio tag frequency, species of fish captured, length, weight, condition factor, age class of the fish, and the tagging date and location of capture. Salmonids that were too small to tag, as well as non-target species that were captured during tagging efforts, are included in Appendix 2.

During the course of the study, numerous tagged salmonids fell out of the sample population due to fish mortality or tag loss, or from the fish moving out of the study area. As a result, only a percentage of the total sample population was tracked in the river at any given time during the study. Section 3.5 provides more information on mortality and tag loss.

Table 3.2
Tagged Fish during Course of Telemetry Study

Sp. = species; L = total length; Wt = weight;
C.F. = Fulton-type Condition Factor: weight (g) X 100,000/(length)^3 (Anderson and Gutreuter 1983)

ID	Frequency	Sp.	L (mm)	Wt (g)	C.F.	Age Class	Tag Date	Catch Location
1LLS	148.710	LLS	344	460	1.130	3+	09/25/99	Crusher Hole
2LLS	148.720	LLS	420	820	1.107	4+	09/25/99	Standup Rips
3LLS	148.750	LLS	305	420	1.480	3+	09/24/99	Standup Rips
4LLS	148.880	LLS	247	140	0.929	2+	09/25/99	Crusher Hole
5SPL	148.890	SPL	275	145	0.697	1+	09/25/99	Crusher Hole
6BKT	148.910	BKT	245	150	1.020	2+	09/24/99	Standup Rips
7LLS	148.930	LLS	274	225	1.094	2+	09/24/99	Standup Rips
8LLS	148.950	LLS	na[1]	350	na	3+	07/21/99	1st Pool above Magic Falls
9BKT	148.960	BKT	na	145	na	2+	07/01/99	Mud Hole
10LLS	148.970	LLS	295	220	0.857	3+	09/22/99	Tailrace
11LLS	148.980	LLS	257	220	1.296	2+	09/23/99	Ballfield
12BKT	148.990(a)[2]	BKT	242	152	1.073	2+	07/22/99	Swimmer's Eddy
13LLS	148.990(b)	LLS	291	190	0.771	3+	08/26/99	Tailrace
14BKT	149.000	BKT	242	152	1.073	2+	07/14/99	Handicap Fishing Access
15LLS	149.010	LLS	240	235	1.700	2+	07/21/99	1st Pool above Magic Falls
16SMB	149.020	SMB	na	na	na	6+	07/14/99	Chase Stream Sluice
17LLS	149.030	LLS	290	230	0.943	2+	07/07/99	4th Pool downstream from Dam
18LLS	149.040	LLS	334	300	0.805	2+	07/21/99	1st Pool above Magic Falls
19LLS	149.050(a)	LLS	255	140	0.844	2+	07/08/99	Chase Stream Sluice
20BKT	149.050(b)	BKT	235	160	1.233	2+	07/22/99	Handicap Fishing Access
21LLS	149.050(c)	LLS	266	180	0.956	2+	08/26/99	Gilroy Pool
22LLS	149.060	LLS	na	na	na	na	07/07/99	Carry Brook
23BKT	149.070	BKT	230	147	1.208	2+	07/01/99	Northern Outdoors Campground
24LLS	149.080(a)	LLS	292.1	250	1.003	2+	07/01/99	Mud Hole
25LLS	149.080(b)	LLS	267	175	0.923	2+	09/02/99	Tailrace
26BKT	149.090(a)	BKT	245	150	1.020	2+	07/08/99	Viking Beach
27LLS	149.090(b)	LLS	273	240	1.180	3+	09/23/99	Ballfield
28BKT	149.100(a)	BKT	240	180	1.302	2+	07/09/99	Viking Beach
29BKT	149.100(b)	BKT	242	152	1.073	2+	07/22/99	Swimmer's Eddy
30LLS	149.100(c)	LLS	295	240	0.935	2+	08/25/99	Gilroy Pool
31LLS	149.200	LLS	300	224	0.830	2+	06/23/99	Carry Brook
32LLS	149.210	LLS	310	328	1.101	2+	06/23/99	Carry Brook
33LLS	149.220	LLS	261	191	1.074	2+	06/30/99	Moxie
34BKT	149.230	BKT	245	155	1.054	2+	07/08/99	Viking Beach
35BKT	149.240	BKT	290	235	0.964	2+	06/23/99	Gilroy Pool
36LLS	149.250	LLS	272	211	1.049	2+	06/24/99	Gilroy Pool
37LLS	149.260(a)	LLS	275	194	0.933	2+	06/23/99	Carry Brook
38LLS	149.260(b)	LLS	300	210	0.778	3+	09/22/99	China Beach

ID	Frequency	Sp.	L (mm)	Wt (g)	C.F.	Age Class	Tag Date	Catch Location
39LLS	149.270	LLS	290	250	1.025	2+	07/08/99	Chase Stream Sluice
40BKT	149.280	BKT	na	124	na	2+	06/24/99	Tailrace
41BKT	149.290	BKT	225	137	1.203	2+	06/24/99	Gilroy Pool
42BKT	149.300	BKT	252	207	1.294	2+	06/30/99	Moxie
43BKT	149.310	BKT	270	185	0.940	2+	07/02/99	Hole In The Wall
44LLS	149.320	LLS	290	216	0.886	2+	06/23/99	Ballfield
45BKT	149.340	BKT	262	210	1.168	2+	06/30/99	Ballfield
46LLS	149.360	LLS	375	510	0.967	4+	07/22/99	Dam
47LLS	149.380	LLS	331	365	1.006	3+	07/21/99	1st Pool above Magic Falls
48LLS	149.400(a)	LLS	335	296	0.787	na	06/22/99	Tailrace
49LLS	149.400(b)	LLS	356	380	0.845	2+	09/03/99	Standup Rips
50BKT	149.420	BKT	275	235	1.130	1+	07/08/99	Viking Beach
51BKT	149.440(a)	BKT	305	320	1.128	2+	07/09/99	Viking Beach
52LLS	149.440(b)	LLS	305	290	1.024	2+	09/03/99	Standup Rips
53LLS	149.460	LLS	410	na	na	na	06/22/99	Tailrace
54LLS	149.480	LLS	323	275	0.816	2+	07/23/99	Crusher Hole
55LLS	149.500	LLS	na	380	na	3+	07/01/99	Mud Hole
56BKT	149.520	BKT	280	278	1.266	2+	06/24/99	Hole In The Wall
57LLS	149.540	LLS	365	370	0.761	3+	07/08/99	Chase Stream Sluice
58BKT	149.560	BKT	380	755	1.376	3+	07/09/99	Viking Beach
59LLS	149.580(a)	LLS	310	320	1.074	2+	07/21/99	Cathedral Eddy
60LLS	149.580(b)	LLS	327	340	0.972	3+	09/22/99	False Chase
61LLS	149.600(a)	LLS	279	280	1.289	2+	07/02/99	Standup Rips
62LLS	149.600(b)	LLS	339	375	0.963	2+	09/22/99	Ballfield
63LLS	149.600(c)	LLS	490	1000+	0.850	5+	09/25/99	Ballfield
64LLS	149.620	LLS	245	182	1.238	2+	06/23/99	Carry Brook
65BKT	149.640(a)	BKT	288	256	1.072	2+	06/30/99	Ballfield
66LLS	149.640(b)	LLS	365	440	0.905	3+	08/25/99	Gilroy Pool
67LLS	149.660	LLS	345	600	1.461	3+	06/23/99	Carry Brook
68LLS	149.680	LLS	295	245	0.954	2+	06/30/99	Ballfield
69BKT	149.700(a)	BKT	285	280	1.210	2+	07/09/99	Viking Beach
70LLS	149.700(b)	LLS	366	455	0.928	3+	08/26/99	Gilroy Pool
71LLS	149.720(a)	LLS	315	287	0.918	2+	06/30/99	Standup Rips
72LLS	149.720(b)	LLS	368	400	0.801	4+	09/03/99	Standup Rips
73RBT	149.740(a)	RBT	345	454	1.106	3+	06/23/99	Ballfield
74BKT	149.740(b)	BKT	267	290	1.529	2+	09/02/99	Tailrace
75LLS	148.650	LLS	285	240	1.037	na	12/01/99	Tailrace*

ID	Frequency	Sp.	L (mm)	Wt (g)	C.F.	Age Class	Tag Date	Catch Location
76BNT	148.670	BNT	394	510	0.834	na	11/24/99	Ballfield
77LLS	148.680	LLS	303	410	1.474	na	11/23/99	Tailrace*
78LKT	148.690	LKT	430	670	0.843	na	11/23/99	Tailrace*
79LLS	148.700	LLS	421	760	1.019	na	11/23/99	Tailrace*
80BKT	148.730	BKT	276	190	0.904	na	12/01/99	Tailrace*
81BKT	148.740	BKT	275	185	0.890	na	12/01/99	Tailrace*
82LLS	148.760	LLS	276	230	1.094	na	11/24/99	Tailrace*
83SPL	148.770	SPL	332	270	0.738	na	12/01/99	Tailrace
84LLS	148.780	LLS	300	230	0.852	na	11/24/99	Tailrace*
85LLS	148.790	LLS	280	150	0.683	na	12/01/99	Tailrace*
86LLS	148.800	LLS	290	240	0.984	na	12/01/99	Tailrace*
87LLS	148.810	LLS	290	240	0.984	na	12/01/99	Tailrace*
88LLS	148.820	LLS	320	320	0.977	na	12/01/99	Tailrace*
89LLS	148.830	LLS	300	240	0.889	na	12/01/99	Tailrace*
90LLS	148.840	LLS	305	245	0.864	na	12/01/99	Tailrace*
91BKT	148.850	BKT	280	190	0.866	na	11/24/99	Ballfield*
92LLS	148.860	LLS	300	380	1.407	na	11/24/99	Tailrace*
93SPL	148.870	SPL	260	150	0.853	na	12/01/99	Tailrace
94BKT	148.920	BKT	263	170	0.935	na	12/01/99	Tailrace*
95LLS	148.940	LLS	250	180	1.152	na	12/01/99	Tailrace*
96LLS	149.010(b)	LLS	250	140	0.896	na	12/01/99	Tailrace*
97LLS	149.680(b)	LLS	350	450	1.050	na	12/01/99	Tailrace*

* Captured post-spawning
[1] na = not available
[2] Letters designate tags that were used again after retrieval.

BKT = brook trout
BNT = brown trout
LKT = lake trout
LLS = landlocked salmon
RBT = rainbow trout
SMB = smallmouth bass
SPL = splake

3.1 Effects of Generation Flows on Salmonids

The first major question addressed in the study plan was, "Are individual salmonid fish pushed downstream when generation flows are turned on from base (minimum) flows?" In order to answer this question, Intensive Monitoring Events and Peaking Cycle Location Checks were utilized. For reporting purposes, fish movements were described as follows: a significant move was defined as a move upstream or downstream out of a specific riffle/run/pool complex where the study fish was initially located during the both the Intensive Monitoring Events and Peaking Cycle Location Checks. An insignificant move was defined as movement within the same specific riffle, run, or pool or riffle/run/pool complex the study fish was initially located in. In either case, study fish location and habitat type were noted.

Individual fish were located during the increase from minimum flows to generation flows during the Intensive Monitoring Events. For the purposes of this report, each event is defined as monitoring one fish during flow changes on a particular date. Fish were monitored during the current minimum flow of 140 cfs, and also under three potential minimum flows: 300 cfs, 500 cfs, and 680 cfs[2]. Generating flows varied from approximately 4,600 cfs to 8,000 cfs.

A total of 18 fish were monitored during 61 Intensive Monitoring Events throughout the course of the study. Seventeen (94.4%) of the fish were landlocked salmon, and one (5.6%) was a brook trout. The data collected from the single brook trout and associated five monitoring events is comparatively less data than the salmon data. However, the data is sufficient to document brook trout behavior in response to changes in flow. The lack of additional brook trout study fish was due to the high water temperatures experienced in 1999, which severely limited the ability to successfully tag more fish.

[2] 300 cfs, 500 cfs, and 680 cfs are evaluation flows being discussed for boatability, angling and angler safety; and for consistency, they are also being evaluated for purposes of this study.

Also, most of the tagged brook trout moved into tributaries for thermal refuge and, as a result, responses to changing flows from Harris Station could not be monitored.

Fourteen Intensive Monitoring Events were conducted in the upper reach: five at 140 cfs-to-generation flows; four at 300 cfs-to-generation flows; and five at 680 cfs-to-generation flows. Forty events were done in the middle reach: eight at 140 cfs-to-generation flows; eleven at 300 cfs-to-generation flows; and twenty-one at 680 cfs-to-generation flows. Seven events were conducted in the lower reach: three at 140 cfs-to-generation flows; two at 300 cfs-to-generation flows; and two at 680 cfs-to-generation flows. Intensive Monitoring Events during 140 cfs-to-generation flows were conducted on August 6 and 11, September 24, and on October 14 and 15. Intensive Monitoring was conducted at 300 cfs-to-generation flows on September 25 and 30, and October 1. Intensive Monitoring was conducted at 680 cfs-to-generation flows on August 18, September 10, and on October 7 and 8. Fish location and habitat use was documented every 10 to 30 minutes prior to and throughout the flow changes during Intensive Monitoring Events.

Data collected during Intensive Monitoring Events indicates that movement in response to flows was minimal. None of the fish monitored made significant moves upstream or downstream in response to the increase in flow. Complete summaries of fish movement documented during the Intensive Monitoring Events are provided in Appendix 3.

Complete Peaking Cycle Location Checks were conducted on five separate occasions: July 15/16, July 29/30, August 5/6, August 19/20, and September 8/9. An additional Peaking Cycle Location Check was done for one brook trout, #69BKT, on July 14/15, to ensure that tracking equipment was functioning properly. Several fish were located during Day One of the tracking event during the low flow and high flow periods, but were not located on Day Two. Possible explanations for not locating a fish on Day Two included tag malfunction, movement of the fish out of the study area, movement of the fish into tributaries out of reception range, or human error. There were also several fish which were only located during one of the flows in a Peaking Cycle Location Check.

These locations are not discussed in this section because they do not demonstrate response to flow. However, use of habitat at that particular flow was recorded.

Data collected during the Peaking Cycle Location Checks indicates overall movement between flows was minimal. Although several individual fish moved significant distances over the course of the study, Peaking Cycle Location Checks documented that most moved insignificant distances and were located in the same general area during flow changes from Harris Station.

Out of 15 fish located during Peaking Cycle Location Checks, 13 fish (86.7%) had insignificant movements and stayed in the same general area during a 24-hour cycle of peaking operations at Harris Station. Two fish (13.3%) made significant upstream movements during the tracking events, and none of the tagged fish moved downstream significant distances during the Peaking Cycle Location Checks. Locations of fish documented throughout the study are graphically represented in Appendix 4.

3.1.1 Results of Intensive Monitoring Events

Intensive Monitoring Events allowed for more thorough documentation of fish behavior in response to changes in flow. None of the tagged fish monitored during the changes in flow moved a significant distance upstream or downstream in response to increases in flows. However, fish frequently moved upstream, downstream and laterally to different parts of the pool, run, or rapid they were holding in when the flows increased to generation flows. Summaries and maps of fish locations monitored during the Intensive Monitoring Events are provided in Appendix 3.

Landlocked Salmon Movements

Sixteen landlocked salmon were monitored during increases from minimum flows to generation flows: #67LLS, #22LLS, #17LLS, #60LLS, #61LLS, #7LLS, #72LLS, #49LLS, #52LLS, #3LLS, #63LLS, #27LLS, #1LLS, #2LLS, #4LLS, and #11LLS. The

Intensive Monitoring Events documented that none of these fish moved up or downstream a significant distance in response to increases in flows.

Upper Reach

Four landlocked salmon were located in the upper reach of the river.

#67LLS was monitored in the Carry Brook area on August 6 at 140 cfs-to-4,600 cfs; and then on August 11 at 140 cfs-to-4,800 cfs; and then on August 18 at 680 cfs-to-4,800 cfs; and then on September 10 at 680 cfs-to-8,000 cfs; and September 24 at 140 cfs-to-6,000 cfs; and then on September 25 at 300 cfs-to-6,000 cfs.

#22LLS was monitored in the Carry Brook area on August 11 at 140 cfs-to-4,800 cfs; and then on August 18 at 680 cfs-to-6,000 cfs; and then on September 10 at 680 cfs-to-8,000 cfs; and then on September 24 at 140 cfs-to-6,000 cfs; and then on September 25 at 300 cfs-to-6,000 cfs.

#17LLS was monitored in the False Chase Stream Sluice area on September 10 at 680 cfs-to-8,000 cfs; and then on September 30 at 300 cfs-to-6,000 cfs.

#60LLS was monitored in the False Chase Stream Sluice area on September 30 at 300 cfs-to-6,000 cfs.

Intensive Monitoring Events documented that none of the tagged salmon moved upstream or downstream a significant distance in response to increases in flow; however, some of the fish did move around in the riffle/run/pool complex during the flow.

Middle Reach

Ten landlocked salmon were located in the middle reach of the river.

#7LLS was located at Standup Rips on September 24 at 140 cfs-to-6,000 cfs; and then on September 25 at 300 cfs-to-6,000 cfs; and then on October 1 at 300 cfs-to-6,000 cfs; and then on October 7 and October 8 at 680 cfs-to-6,600 cfs.

#72LLS was located at Standup Rips on September 10 at 680 cfs-to-8,000 cfs; and then on September 24 at 140 cfs-to-6,000 cfs; and then on September 25 at 300 cfs-to-6,000 cfs; and then on October 8 at 680 cfs-to-6,600 cfs.

#49LLS was located at Standup Rips on September 10 at 680 cfs-to-8,000 cfs; and then on September 24 at 140 cfs-to-6,000 cfs; and then on September 25 at 300 cfs-to-6,000; and then on October 1 at 300-to-6,000 cfs; and then on October 7 and 8 at 680 cfs-to-6,600 cfs.

#3LLS was located at Standup Rips on September 25 at 300 cfs-to-6,000 cfs; and then on October 7 and 8 at 680 cfs-to-6,600 cfs.

#52LLS was located at Standup Rips on September 10 at 680 cfs-to-8,000 cfs.

#2LLS was located at Standup Rips on October 7 and 8 at 680 cfs-to-6,600 cfs.

#63LLS, #27LLS, and #11LLS were all located at the Ballfield on September 24 at 140 cfs-to-6,000 cfs; and then on September 30 at 300 cfs-to-6,000 cfs; and then on October 7 and 8 at 680 cfs-to-6,600 cfs.

#61LLS was located at Sandbar Eddy on August 11 at 140 cfs-to-4,800 cfs. On August 18, it was located at Sandbar Eddy during a 680 cfs flow; it then moved downstream to Swimmer's Eddy, 15 minutes prior to the arrival of the generation flow of 4,800 cfs.[3]

Intensive Monitoring Events documented that none of these fish moved upstream or downstream a significant distance in response to increases from minimum to generation flows.

Lower Reach

Two salmon were located in the lower reach of the river.

#1LLS was located in the Crusher Hole area on October 1 at 300 cfs-to-6,000 cfs; and then on October 7 and October 8 at 680 cfs-to-6,600 cfs; and then on October 14 at 140 cfs-to-6,100 cfs.

#4LLS was located in the Crusher Hole area on October 1 at 300 cfs-to-6,000 cfs; and then on October 14 at 140 cfs-to-6,100 cfs.

[3] During subsequent monitoring, #61LLS continued to move further downstream and became stationary approximately 1 mile below The Forks. The tag was retrieved (absent the fish) from this location on August 28. It is hypothesized that #61LLS was dead or wounded and subsequently drifted downstream.

Intensive Monitoring Events documented that none of these fish moved upstream or downstream a significant distance in response to increases from the minimum to generation flows.

Brook Trout Movements

Data collected on brook trout during Intensive Monitoring Events is limited to only one fish. This fish was monitored on five days at three different minimum-to-generation flows. The data collected from the single brook trout and associated five monitoring events is comparatively less data than the salmon data. However, the data is sufficient to document brook trout behavior in response to changes in flow. The lack of additional brook trout study fish was due to the high water temperatures experienced in 1999, which severely limited the ability to successfully tag more fish. In addition, most of the tagged brook trout moved into tributaries for thermal refuge. More information on brook trout movements into tributaries is provided in Section 3.5.

One brook trout was located in the middle reach of the river.

> #6BKT was monitored at Standup Rips on September 24 at 140 cfs-to-6,000 cfs; and then on September 25 at 300 cfs-to-6,000 cfs; and then on October 1 at 300 cfs-to-6,000 cfs; and then on October 7 and October 8 at 680 cfs-to-6,600 cfs. Each of the intensive tracking events documented insignificant movement by the fish in response to increasing flows.

Miscellaneous Species Movements

One splake was located in the lower reach of the river.

> #5SPL was monitored at Crusher Hole on October 1 at 300 cfs-to-6,000 cfs. This intensive tracking event documented insignificant movement by the fish in response to increasing flows.

3.1.2 Results of Peaking Cycle Location Checks

Landlocked Salmon Movements

Eleven landlocked salmon were located during the Peaking Cycle Location Checks: #17LLS, #22LLS, #31LLS, #39LLS, #48LLS, #52LLS, #57LLS, #59LLS, #61LLS, #67LLS, and #72LLS. During each tracking event, one fish (#31LLS) moved a significant distance upstream, one fish (#61LLS) moved a significant distance downstream, and the remaining nine stayed in the same general area.

Upper Reach

Six landlocked salmon were located in the upper reach of river during Peaking Cycle Location Checks and are broken down as follows:

#17LLS was located at False Chase Stream Sluice on July 29/30, August 5/6, August 19/20, and September 8/9.

#22LLS was located in the Carry Brook area on July 29/30, August 5/6, August 19/20, and September 8/9.

#39LLS was located at Chase Stream Sluice on July 15/16; on August 5/6, August 19/20, and September 8/9, it was located further upstream in the Harris Station tailrace.

#57LLS was located at Chase Stream Sluice on July 15/16; on August 5/6, August 19/20, and September 8/9, it was located further upstream in the Harris Station tailrace.

#59LLS was located at Elevator Eddy on July 29/30.

#67LLS was located near the Down East Lunch Site on July 29/30; on August 5/6, August 19/20, and September 8/9, it was located further upstream in the Carry Brook area.

Although some of the fish made upstream movements *between* the Peaking Cycle Location Checks, all six made insignificant movements and stayed in the same general area *during* the tracking events.

Middle Reach

Five landlocked salmon were located in the middle reach of river during the Peaking Cycle Location Checks and are broken down as follows:

#49LLS, #72LLS, and #52LLS were located in the Standup Rips area on September 8/9.

#67LLS was located near the Down East lunch site on July 29/30; it was located further upstream in the Carry Brook area on August 5/6, August 19/20, and September 8/9.

#61LLS was located at Sandbar Eddy on August 5/6. On August 19, it was located near Cold Stream during the Day One minimum flow tracking event. During the subsequent generation flow tracking event on August 19, it was located further downstream near Mudhole. During the Day Two minimum flow tracking event, #61LLS was located approximately 3 miles further downstream. The tag, minus the fish, was then retrieved from this location on August 28, indicating that the fish had died.

During the tracking events, only one fish (#61LLS) moved downstream a significant distance; however, this fish was either dead or dying during the tracking events.

Lower Reach

Only one salmon was located in the lower reach.

#31LLS was located in the lower reach of river during a Peaking Cycle Location Check on July 15 just above Gilroy Pool. The fish was not located during the second day of the tracking event.

Brook Trout Movements

Three brook trout (#50BKT, #69BKT, and #74BKT) were located during Peaking Cycle Location Checks. Of these three brook trout, one moved upstream a significant distance

between flows, while the remaining two made insignificant movements and stayed in the same general area.

Upper Reach

Brook trout #50BKT was located at Chase Stream Sluice on July 15/16 and remained in the same area when the existing 140 cfs minimum flow was increased to a generation flow of 3,800 cfs. #50BKT was located in the middle reach on July 29/30. The fish had moved downstream approximately 9.5 miles between tracking events to just below the Moxie Lunch Site. It also remained in the same general area during that tracking event.

Middle and Lower Reaches

Brook trout #74BKT moved upstream from the lower reach to the middle reach during the increase from the existing 140 cfs minimum flow to a generation flow of 6,000 cfs on September 8/9. Initially, this fish made significant moves upstream from the minimum flow location at Gilroy Pool on September 8. At the generation flow of 6,000 cfs on the same day, the fish had moved upstream above Crusher Hole, a distance of approximately one mile. On September 9, the second day of tracking at minimum flow, the fish had moved further upstream to the Fishing Ledges in the middle reach, a distance of approximately six miles.

Brook trout #69BKT was located in the lower reach of river on July 14/15 near the mouth of Pleasant Pond Stream at the upper limit of Wyman Lake. #69BKT stayed in the same general area during the increase from the existing 140 cfs minimum flow to the generation flow of 6,000 cfs.

Miscellaneous Species Movements

One smallmouth bass was located in the upper reach of the river.

#16SMB was located at Chase Stream Sluice on July 29/30; it was then located downstream at Cathedral Eddy on the August 19/20 and September 8/9 tracking events.

During the tracking events, the bass remained in the same general area between flows.

3.2 Salmonid Strategies and Habitat Use Under a Peaking Flow Regime

The second major question addressed in the study plan was "What strategies and habitat features do salmonid fish utilize to adapt to flow changes and how will those strategies change under various flow regimes?"

Salmonid strategies for coping with changing flow conditions were noted early in the study during capture events. Both landlocked salmon and brook trout were caught during generation flows as well as at minimum flows. Fish captured during minimum flows were captured in a variety of habitats (pool, run, riffle, rapid). Fish captured in rapids during minimum flows were generally found using large boulders for velocity refuge. The most productive use of refugia during generating flows was in eddies found throughout the upper and middle reaches of the study area. This is typical salmonid behavior--lying in wait in velocity refuge and seizing prey in nearby swift currents. This allows the fish to spend less energy positioning itself, and more energy capturing food (Butler 1991). In addition to the major target species, other fish caught in eddies during generating flows included: smallmouth bass, fallfish, white perch, and white sucker.

The most effective methods to evaluate strategies and habitat use by both target species were the Intensive Monitoring Events and Peaking Cycle Location Checks. Due to time constraints and logistics, the precision at which fish were located was limited during the Peaking Cycle Location Checks. Depth, coupled with increased velocities, made precise positioning difficult when tracking fish by boat during generation flows. Intensive Monitoring Events proved to be the most effective method of the two, as individual fish were closely monitored as flow changes occurred. The results of the habitat-use data can be seen in Tables 3.2 - Table 3.5. Approximately 69.8% of the flow refugia utilized by brook trout and landlocked salmon in the upper and middle reaches was comprised of eddy/pool habitat; 28.2% of flow refugia was riffle, rapid, and run habitat. This varies dramatically from the lower reach of the river where eddy/pool habitat usage represents only 38.6%, while riffle, rapid, and run habitat usage increased to 59.6%.

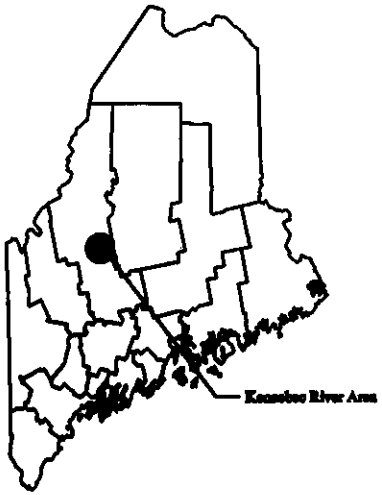
In addition to the habitat-use tables identified above, Figure 2 was developed to demonstrate the amount and comparative sizes of the numerous velocity refugia found in the study area during a flow of approximately 6,000 cfs. The majority of the refugia identified represent eddies; however, there are scattered pools and structures mapped as well. It should also be noted that significant velocity refugia also exist behind boulders along the riverbed that are not visible on the surface.

During baseline flow studies in 1998, velocity data was gathered at five representative transects throughout the radio tracking study area (Central Maine Power Company 1998c). These data clearly show that velocities decrease from mid-channel to bottom and that the physical structure in the river creates many areas with negative velocities (water flow contrary to the main current) that provide ideal holding areas for salmonids.

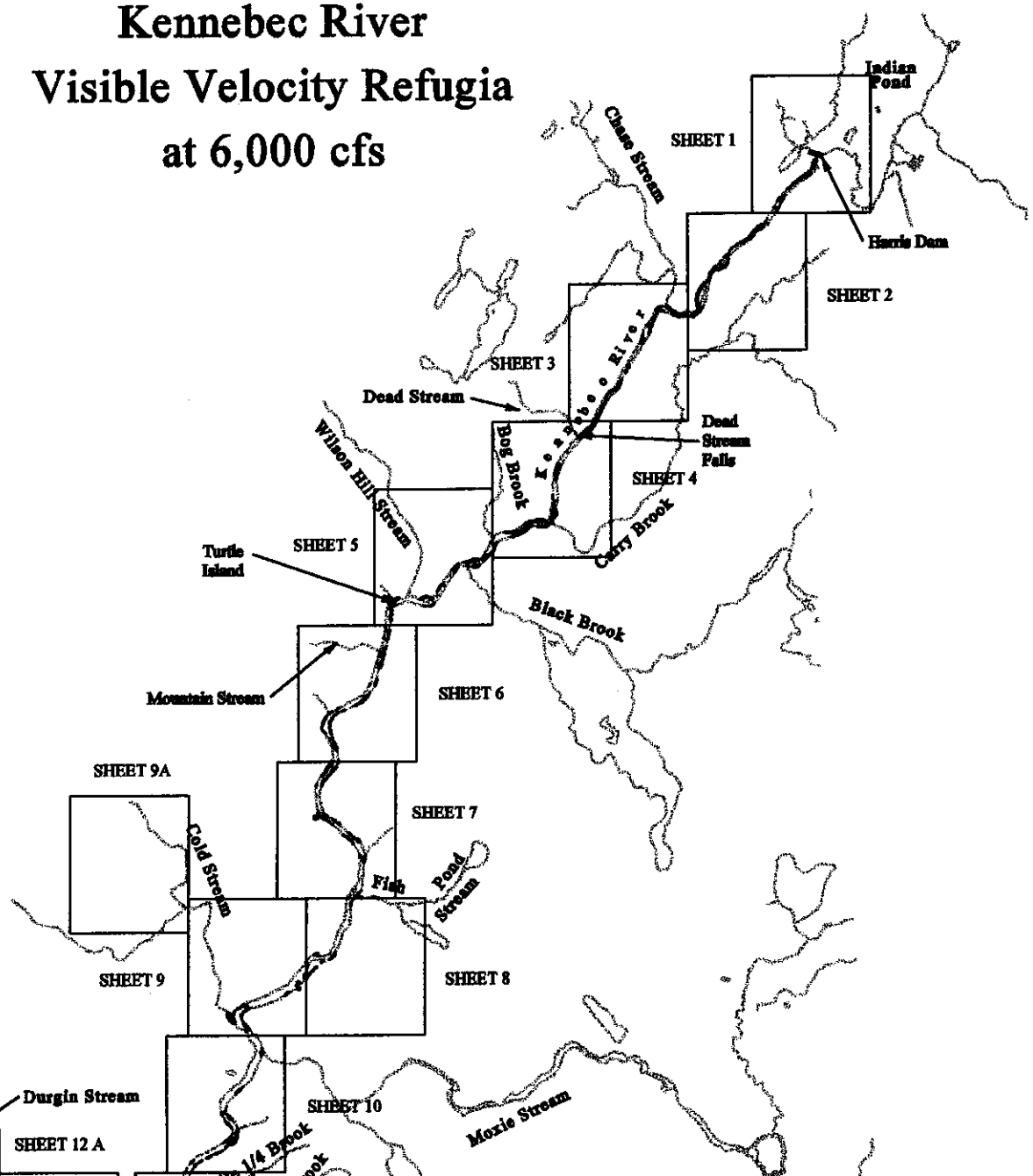
Upper Reach

The upper reach of the study area is comprised mostly of large embedded boulders and ledge substrate, interspersed with smaller areas of small boulder/cobble and pockets of depositional gravel (Central Maine Power Company 1998b). The steep nature of this section creates many micro and macro habitat transitions from rapids to pool (Central Maine Power Company 1998a). Visible velocity refugia during the 140 cfs minimum flow (and at other low flows evaluated) are found in deep pools, and behind the many large boulders (>600 mm Brusuen Substrate Code, Bovee 1982) and ledge found throughout this reach. As seen in Table 3.3, there were no significant differences in refugia use between the current minimum flow and the other evaluation flows (300 cfs, 500 cfs, 680 cfs).

Figure 2
Kennebec River
Visible Velocity Refugia
at 6,000 cfs



LOCATION DIAGRAM



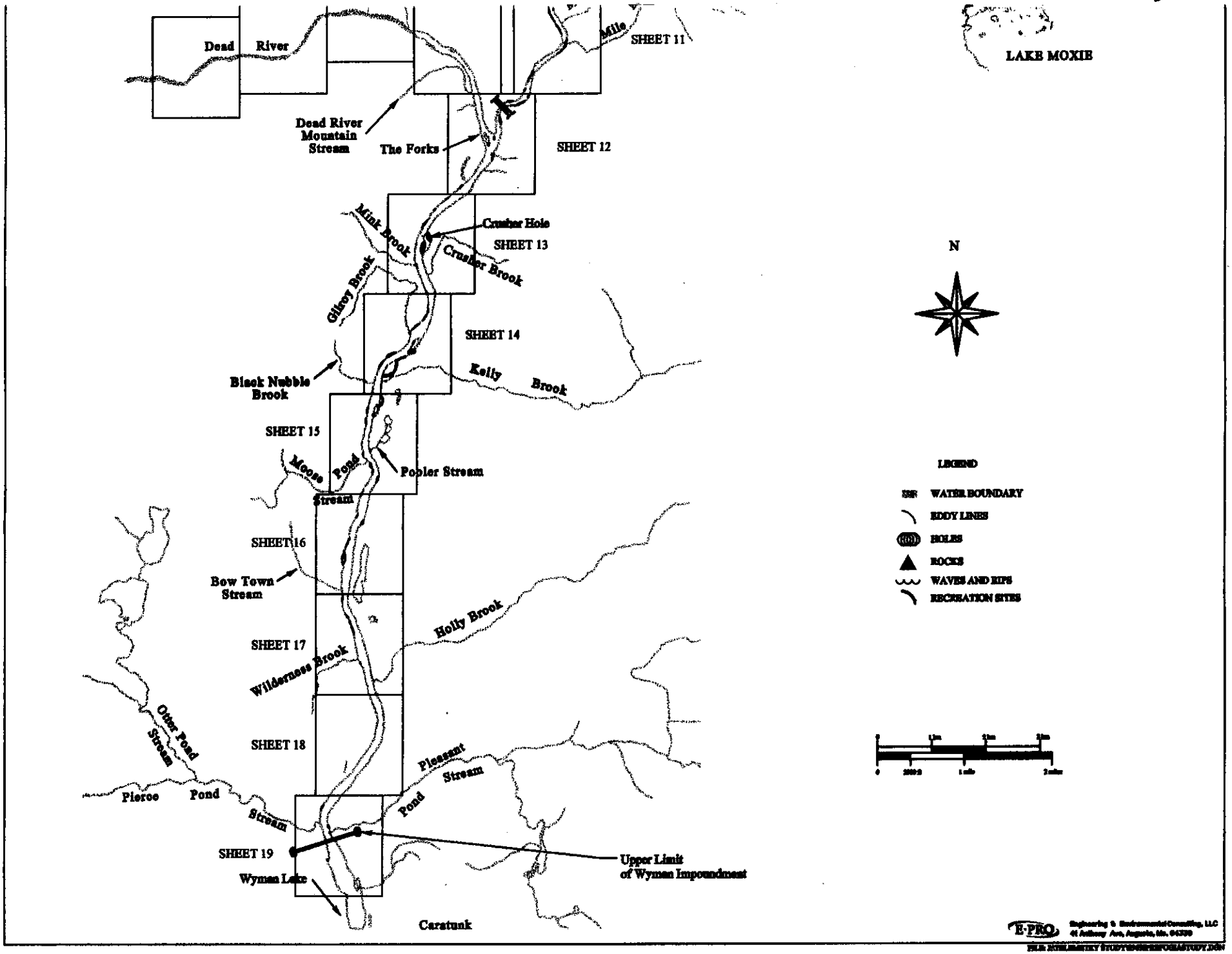

Dead River
Mile
SHEET 11
LAKE MOXIE
Dead River Mountain Stream
The Forks
SHEET 12
Mink Brook
Crusher Hole
SHEET 13
Crusher Brook
Gilroy Brook
SHEET 14
Black Nubble Brook
Kelly Brook
SHEET 15
Moose Pond
Stream
Popler Stream
SHEET 16
Bow Town Stream
Holly Brook
SHEET 17
Wilderness Brook
Otter Pond Stream
SHEET 18
Pleasant Stream
Pond
Pierce Pond
Stream
SHEET 19
Upper Limit of Wyman Impoundment
Wyman Lake
Caratunk
N
LEGEND
WATER BOUNDARY
EDDY LINES
HOLES
ROCKS
WAVES AND RIPS
RECREATION SITES

Table 3.3
Habitat Use in the Upper Reach

Species	River Flow (cfs)	Habitat	Data Count	Percent of Habitat
BROOK TROUT	140	POOL	3	100.0%
			TOTAL= 3	100.0%
	GENERATION FLOW	EDDY	1	100.0%
			TOTAL= 1	**100.0%**
LANDLOCKED SALMON	140	POOL	76	77.6%
		RIFFLE	8	8.2%
		RAPID	4	4.1%
		EDDY	3	3.1%
		RUN	7	7.1%
			TOTAL= 98	**100.1%**
	300	RIFFLE	4	44.4%
		POOL	3	33.3%
		RUN	2	22.2%
			TOTAL= 8	**99.7%**
	500	POOL	7	87.5%
		EDDY	1	12.5%
			TOTAL= 5	**100.0%**
	680	POOL	6	40.0%
		RUN	8	53.3%
		EDDY	1	6.7%
			TOTAL= 15	**100.0%**
	GENERATION FLOWS	EDDY	84	54.2%
		RUN	35	22.6%
		POOL	16	10.3%
		RIFFLE	12	7.7%
		RAPID	8	5.2%
			TOTAL= 155	**100.0%**

Most of the velocity refugia seen during lower flows are not visible during generation flows, although many still remain functional. Fish located in run habitat during generation flows are most likely utilizing the same features (e.g., boulders) that create visible velocity refugia during low flows. In some instances, the characteristics of the low-flow habitat may change at higher flows, but be of no less value as velocity refuge. For example, many of the pools found during lower flows become eddies or larger pools at higher flows.

Middle Reach

The nature of the river changes in the middle reach of the study area. This section has less gradient than the upper reach, with substrate composed of various-sized materials (sand to large boulder). This section contains mostly riffle habitat with intermittent runs and pools at lower flows. As flow increases, riffle habitat transforms into run habitat. Eddies and pools are also present. Despite the different nature of this river section, fish were found using similar velocity refugia as in the upper reach: eddies, deep pools, and boulders (see Table 3.4). No significant difference in refugia was seen when examining the various low flows. Fish located during generation flows were found utilizing eddies for velocity refuge.

Lower Reach

The composition of the lower reach of the study area changes dramatically over that of the upper and middle reaches--the river has less gradient and widens significantly. The lower reach has mostly small boulder/cobble substrate and lacks the amount of deep pools and eddies found in the upper and middle reaches. Subsequently, the major habitat use documented at low and high flows consisted of runs. Pools were secondary use at the low flows (see Table 3.5).

Although large boulder structure is lacking in the lower reach, the river widens and allows the volume of water to spread out, resulting in lower overall relative velocities.

As described in section 3.1 of this report, both brook trout and landlocked salmon appear to stay within the same general area when changes in velocity take place. No major difference in use of velocity refuge occurred when comparing the current minimum flow to the other evaluation flows. Although fish stayed in the same general area, velocity refuge use does change when comparing lower flows to generation flows. Intensive

Table 3.4
Habitat Use in the Middle Reach

Species	River Flow (cfs)	Habitat	Data Count	Percent of Habitat
BROOK TROUT	140	POOL	11	42.3%
		TRIBUTARY	2	34.6%
		RAPID	2	7.6%
		RIFFLE	2	7.6%
		RUN	9	7.6%
			TOTAL= 26	**99.7%**
	300	RIFFLE	1	33.3%
		RUN	1	33.3%
		RIFFLE/RUN	1	33.3%
			TOTAL= 3	**99.9%**
	680	RAPID	1	50.0%
		RIFFLE/RUN	1	50.0%
			TOTAL= 2	**100.0%**
	GENERATION FLOWS	EDDY	16	47.1%
		RUN	7	20.6%
		RAPID	6	17.6%
		TRIBUTARY	3	8.8%
		POOL	2	5.9%
			TOTAL= 34	**100.0%**
LANDLOCKED SALMON	140	POOL	37	78.7%
		RIFFLE	4	8.5%
		RUN	3	6.4%
		EDDY	1	2.1%
		RAPID	1	2.1%
		RIFFLE/RUN	1	2.1%
			TOTAL= 47	**99.9%**
	300	POOL	13	72.2%
		RUN	2	11.1%
		RIFFLE	1	5.6%
		RIFFLE/RUN	1	5.6%
		EDDY	1	5.6%
			TOTAL= 18	**100.1%**
	680	POOL	10	45.5%
		RUN	7	31.8%
		RIFFLE	2	9.1%
		RIFFLE/RUN	1	4.5%
		EDDY	1	4.5%
		BEHIND ROCK	1	4.5%
			TOTAL= 22	**99.9%**
	GENERATION FLOWS	EDDY	110	52.1%
		POOL	52	24.6%
		RUN	43	20.4%
		RIFFLE	3	1.4%
		RIFFLE/RUN	1	0.5%
		BEHIND ROCK	1	0.5%
		RAPID	1	0.5%
			TOTAL= 211	**100%**

Table 3.5
Habitat Use in the Lower Reach

Species	River Flow (cfs)	Habitat	Data Count	Percent of Habitat
BROOK TROUT	140	POOL	2	66.7%
		RIFFLE	1	33.3%
			TOTAL= 3	100.0%
	GENERATION FLOWS	RUN	3	50.0%
		POOL	2	33.3%
		TRIBUTARY	1	16.7%
			TOTAL= 6	100.0%
LANDLOCKED SALMON	140	POOL	6	66.7%
		RIFFLE	2	22.2%
		RUN	1	11.1%
			TOTAL= 9	100.0%
	300	POOL	3	42.9%
		RUN	4	57.1%
			TOTAL= 7	100.0%
	680	RUN	7	100.0%
			TOTAL= 7	100.0%
	GENERATION FLOWS	RUN	16	64.0%
		POOL	5	20.0%
		EDDY	4	16.0%
			TOTAL= 25	100.0%

Monitoring Events demonstrated that the study fish generally changed from using boulder and pool refugia, to utilizing eddies created within the same general area. This pattern can be seen in Tables 3.3 through Table 3.5 above. Both landlocked salmon and brook trout favored the pool habitat during minimum flows, moving to eddies during generation flows. Salmonids typically utilize velocity refuge for feeding purposes. This was evident during all different minimum/evaluation flow-to-generation flow combinations. Specific examples are shown in the by-catch data provided in Appendix 2.

3.3 Results of Salmonid Spawning Surveys

During the Indian Pond Project relicensing meetings, the Flow Study Team raised concerns regarding the lack of observed spawning activity in the Kennebec River below Harris Station. A spawning survey conducted in November 1998 documented the presence of suitable spawning substrate within the study area; however, no evidence of

salmonid spawning was observed. The large size of the study area (approximately 19 miles of river along with associated tributaries) coupled with poor viewing conditions due to overcast weather and the timing of the survey (i.e. early November) were possible explanations for not documenting redds during the 1998 surveys.

During the radio telemetry and other concurrent relicensing studies in 1999, numerous young-of-year brook trout were observed at the mouths of several small brooks below The Forks. Several specimens were collected and sent to MDIFW fishery biologists for age analyses. Results of the age analyses are provided in Table 3.6.

Observations of juvenile brook trout in the mouths of the tributaries, as well as the limited observations of both brook trout and landlocked salmon juveniles in the mainstem river during the fish community surveys (Eco-Analysts 1999) indicated that salmonids were likely spawning within the study area.

Table 3.6
Juvenile Brook Trout Captured within the Study Area, Summer 1999

Date	Length (mm)	Weight (g)	Age	Capture Location
07/08/99	275	235	1+[1,2]	Handicap Access Area
07/28/99	75	4	0+	Marshall Stream
07/28/99	55	3	0+	Marshall Stream
07/28/99	50	3	0+[2]	Mink Brook
07/29/99	59	na	0+	Wilderness Brook
07/29/99	68	na	0+	Wilderness Brook
09/08/99	na	46	1+[2]	Chase Stream
9/15/99	171	50	1+[2]	Cold Stream
9/15/99	203	87	1+[2]	Cold Stream

[1] Hatchery Fish
[2] Juvenile brook trout captured by Eco-Analysts, 1999

Aerial monitoring of tagged salmonids continued into the fall of 1999 in an attempt to document fall movements and to locate potential spawning activity. Aerial monitoring proved to be the most efficient method to gather data on general fish locations. Aerial surveys covered the entire river between Harris Station and Wyman Lake, as well as surveying the Dead River and up into Spencer Stream, and all the tributaries between.

This allowed for coverage of any large movements made by tagged salmonids. General locations of tagged salmonids were documented and later field examined for signs of spawning (i.e., redds).

In late October, study fish began to make noticeably different movements from their "normal" summer locations. The timing, as well as the temperature of the river water, indicated that these moves were likely spawning related. Due to high river flows from heavy fall rain events, the river and tributaries could not be waded. As a result, no salmonids were visually observed in spawning activities. However, locations of tagged fish were identified and later revisited during lower flows in mid-November to determine if suitable spawning habitat or redds could be located.

During the week of November 16 through November 18, 1999, an intensive, systematic redd survey was conducted in the Kennebec River and its tributaries below Harris Station. Flow releases from the Indian Pond and Flagstaff Projects, as well as from the Moxie dam (privately owned) were reduced to their respective minimum flows (140 cfs, 200 cfs, and 25 cfs, respectively) to enhance the effectiveness of the spawning surveys. In addition, the weather during the 1999 survey was much clearer than during the 1998 survey, allowing for better viewing conditions.

The Kennebec River was surveyed from the Harris Dam tailrace to The Forks, and from The Forks to Holly Brook in the lower river reach. Approximately 58+ salmonid redds were documented during the 3-day survey. All of the redds were watered (i.e. no dewatered redds were found) and located in areas protected from the main flow of the river. In addition, 6+ redds were documented at the tail of the first pool up Cold Stream. Due to time constraints, a more thorough survey of Cold Stream was not conducted. However, previous stream surveys conducted during the telemetry study identified numerous areas with suitable spawning habitat, while electrofishing during concurrent tributary studies (Eco-Analysts 1999) documented many young-of-year brook trout. It is probable that additional spawning is occurring further upstream. To substantiate this claim, #6BKT was located approximately ½ mile up Cold Stream during an aerial survey

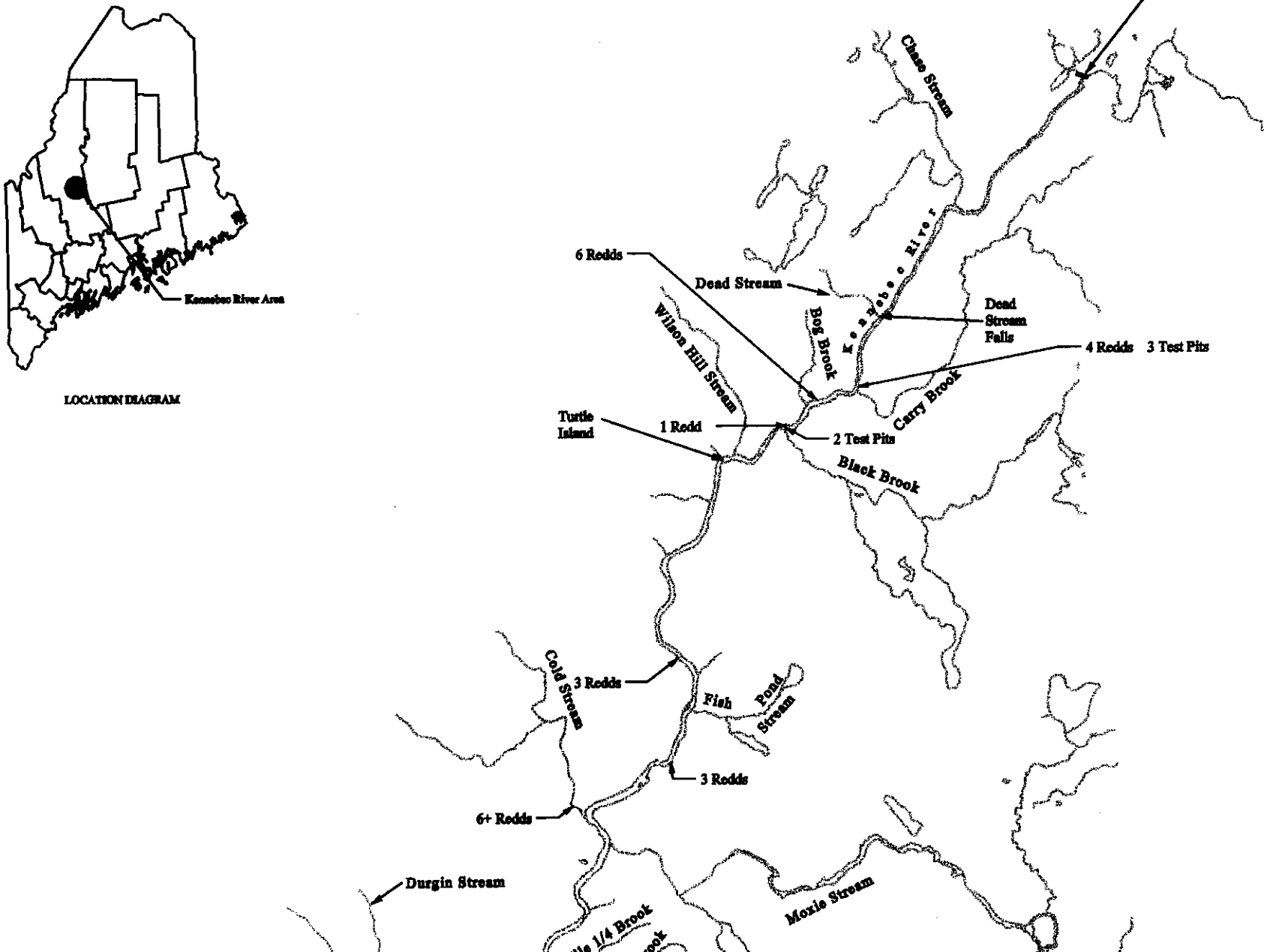
on November 9. During both the previous survey on November 4 and subsequent survey on November 18 this fish was located near the United States Geological Survey (USGS) Gage Station at The Forks, indicating that this large movement was spawning-related. The breakdown of the locations of redds documented during the 1999 spawning surveys are provided in Table 3.7 below. The locations of the redds are provided in Figure 3.

Some redds were discovered in extremely small patches of gravel. For example, the single redd discovered below Wilderness Brook was found in a 1 ft^2 patch of gravel surrounded by large cobble. There are many areas in the river comprised of cobble with interspersed gravel. However, due to the large size of the study area (19 miles of river), every square foot of substrate could not be viewed during the survey and it is probable that all of the redds in the river were not identified.

During the three days that the spawning surveys were conducted, the river flow, as measured at the USGS Gage Station at The Forks, did not go below 425 cfs. This flow represents the 140 cfs minimum flow from Harris Station and natural tributary inflow between the dam and the gage. As mentioned previously, flows were reduced to the minimum from Harris Station, the Moxie dam, and the Long Falls Dam at the Flagstaff Project for the purpose of conducting the spawning surveys. These low flows not only aided the biologists during the survey, but were representative of extreme low flow conditions. This allowed the survey team to document where spawning was occurring, and to document if redds were being dewatered at the existing 140 cfs minimum flow.

All documented redds were covered by at least four to twelve inches of water. The construction of redds at these depths is consistent with the size of the salmonids captured and observed in the study area. Salmonids generally require water deep enough (2 inches to about 10 feet) to cover the fish itself during spawning (Bjornn 1991); a requirement that each of the observed locations met. Additionally, spawning surveys conducted by MDIFW on other rivers in Maine reveals that depths of four to twelve inches over redds is common (personal comm. With Scott Roy, Forrest Bonney, and Dave Boucher, MDIFW).

Figure 3
Locations of Redds Documented During the 1999 Salmonid Spawning Survey



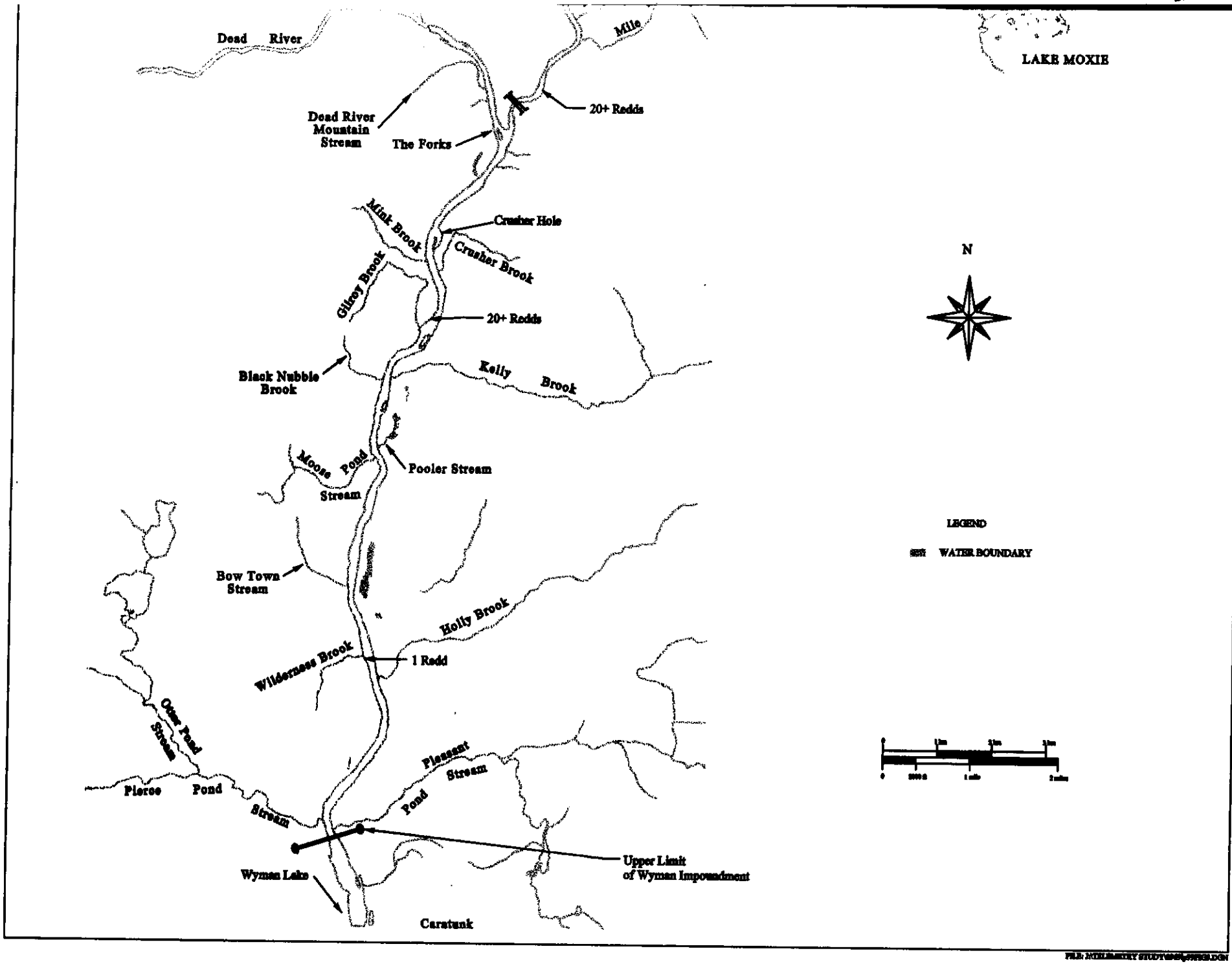

Dead River
Mile
LAKE MOXIE
Dead River Mountain Stream
The Forks
20+ Redds
Mink Brook
Crusher Hole
Crusher Brook
Gilroy Brook
20+ Redds
Black Nubble Brook
Kelly Brook
Moose Pond Stream
Pooler Stream
N
LEGEND
WATER BOUNDARY
Bow Town Stream
Holly Brook
Wilderness Brook
1 Redd
Otter Pond Stream
Pleasant Stream
Pierce Pond Stream
Pond
Upper Limit of Wyman Impoundment
Wyman Lake
Caratunk

Table 3.7
Locations of Salmonid Redds Documented during 1999 Spawning Surveys

River Reach	Location	No. of Redds	Condition of Eggs
Upper	Near the eddy just above Carry Brook (Kennebec Gorge)	4+	4+ viable/ 3 test pits
Upper	Just above Bog Brook (Kennebec Gorge)	6	Viable
Upper	Tail of pool near Black Brook on river-right	1	Test pit
Middle	Between Sandbar Eddy and Swimmer's Eddy, on river-right	3	Viable
Middle	Tail of 1st pool up Cold Stream	6+	Viable
Middle	Just above the Storm Channel	3	Viable
Middle	Just above the Ballfield on river-left	20+	Viable
Lower	River-right across from Gilroy Pool	20+	Viable
Lower	Below Wilderness Brook on river-right	1	Viable

In addition to documenting salmonid redds, approximately twelve fallfish nests where discovered in two separate areas below The Forks. One area was located on river-right below the Crusher Hole area, while another area was located on river-right above the Northern Outdoors campground in Caratunk. All of these nests were watered during the survey.

3.4 Seasonal Movements of Salmonids under a Peaking Flow Regime

During relicensing consultation, the Study Team requested information about seasonal movements of salmonids below Harris Station. Specifically, the Team was concerned whether the peaking operations of the Project impacted the expected seasonal movement patterns that are typically observed in salmonids. As a result, monitoring of tagged salmonids continued throughout the fall of 1999 in an attempt to define seasonal movements.

Brook Trout

The Kennebec River Basin, as well as most of Maine and the eastern states, experienced a severe drought in 1999, the driest in about 100 years recorded on the Kennebec River (personal communication with Wes Hallowell, FPLE). The lack of precipitation

combined with the high daily air temperatures created high water temperatures in the Kennebec River. Water temperatures recorded throughout the course of the study showed that river temperatures reached and sustained readings in the lower to mid-70s in July, August, and September.

Throughout the summer season, tagged brook trout utilized tributaries for temperature refuge. Of the available population of 7 tagged brook trout, 4 brook trout were located in tributaries found within the study area. These include two fish in Cold Stream, one fish in Moxie Stream, and one fish found in Salmon Stream on the Dead River. These movements were most likely temperature driven as mainstem river temperatures warmed into the lower 70s, while tributary temperatures utilized by the tagged brook trout averaged in the mid-to upper 60s. Although brook trout can tolerate temperatures in the 70s, they typically seek out colder water such as springs, deep pools, etc. (Warner and Havey 1985). The upper lethal temperature for brook trout is 77° F (Behnke 1991). The cooler water in the tributaries provided temperature refugia for the fish during the drought in July and August.

Due to tag loss and mortality associated with abnormally high water temperatures in 1999, only one brook trout (#6BKT) was available for tracking during the fall season. The fish was captured in the middle reach on September 24, and remained in the same general area between Standup Rips and the USGS gage station at The Forks during subsequent surveys. However, during an aerial survey on November 9, the fish was located approximately one-quarter mile up Cold Stream. Subsequent field examination of Cold Stream on November 16 showed that salmonids are utilizing this tributary for spawning as six redds were discovered at the tail of a large pool approximately 100 yards upstream from its confluence with the Kennebec River. On November 18, #6BKT had moved back into the Kennebec River and was again located near the USGS gage station. The timing of the movement indicates that spawning was the most likely reason for the temporary movement into Cold Stream. During this period, water temperatures had dropped into the mid-40s, and daily photoperiod was steadily diminishing. These seasonal environmental changes cause increased hormone levels in salmonids, bringing

about spawning activity (Butler 1991). The movement of the brook trout into Cold Stream correlates with this seasonal change.

Landlocked Salmon

During the summer months, individual study salmon tended to stay within a general area. During summer months, landlocked salmon tolerate and apparently thrive in water temperatures exceeding 70°F (Warner and Havey 1985). None of the tagged landlocked salmon were located in tributaries during tracking events.

The limited movements are normal behavior for landlocked salmon. Warner and Havey, 1982, stated that most landlocked salmon movements take place during the spring and fall and are triggered by physiological and environmental factors. The tagged study salmon remained in their same respective general areas through October 15. However, during an aerial survey on October 21, five of the sixteen tagged salmon had moved out of the areas they were usually found in during the summer and fall months. During this same time period, temperatures in the mainstem river were in the mid-40s. The combination of decreased water temperature and diminished photoperiod were likely triggering the urge to spawn. This is the most likely reason for the sudden movement of the salmon within the study population. Biologists followed and marked the locations that salmon moved to, and conducted spawning surveys in the same general areas where these fish were last located. These spawning surveys, conducted between November 16 and 18, revealed that salmonids were spawning in all three reaches of the study area, including tributaries.

Winter Movements of Salmonids

Salmonids are known to make a series of movements later in the calendar year, from summer feeding areas to spawning grounds, and from spawning grounds to wintering areas (Warner and Havey, 1985). Salmon and brook trout typically prefer slower moving water during the winter months, allowing the fish to use less energy positioning itself.

According to MDIFW Fisheries Research Biologist Ken Warner, salmonids in the West Branch of the Penobscot River have been documented moving from spawning grounds into deep deadwater areas for wintering (personal communication with Ken Warner, November 8, 1999). The Kennebec River below Harris Station has several deep pools that salmonids may use for over-wintering areas. In addition, salmonids may also utilize Wyman Lake. Due to slowed metabolism and preference for lower velocities at colder water temperatures, Mr. Warner stated that Wyman Lake could be a preferred wintering area for salmonids. An aerial survey conducted on December 9, 1999 documented that of the 25 landlocked salmon in the tagged study population, five had moved into Wyman Lake. Of the remaining 20 salmon, eight had made significant movement (>1 mile) toward Wyman Lake since the previous aerial survey on November 30, 1999. In addition, two salmon were located in the Dead River.

To date, it is not clear if brook trout or landlocked salmon utilize deep sections of the Kennebec River for over-wintering purposes. However, the December 9 aerial survey documented that 18 salmon and 5 brook trout were still holding in the mainstem Kennebec River. Eleven salmon and four brook trout were found in pools throughout the river from Harris Station to Wyman Lake. Of these fish, four salmon and two brook trout were still in the tailrace of Harris Station, which is a deep (10-20 ft.) pool, even at the 140 cfs minimum flow. During generating flows, a large pool/eddy is formed below the spillway of the dam that provides a deeper holding area for all species of fish. Radio telemetry data collected in 1999 documented that salmonids utilize this pool/eddy at minimum and generating flows throughout the summer and into the winter months.

As evidenced by recent aerial surveys, it appears salmonids are utilizing Wyman Lake for over-wintering purposes while others prefer to inhabit the many areas in the river between Harris Station and the Wyman Impoundment. Based on data collected through December 1999, it appears salmonids are utilizing many habitat features within the study area as wintering areas. Radio telemetry data collected through December 1999 also indicates that salmonids are freely moving throughout the study area at both generating flows and the current minimum flow. Some additional salmonids were tagged in

December 1999, and the locations of study fish will continue to be monitored throughout the winter for the life of the tags.

3.5 General Observations Documented During the Kennebec River Telemetry Study

Many observations were documented during the course of the study. The observations are important in understanding the overall quality of the Kennebec River. General observations documented during the course of the study are provided in Table 3.6.

Study-related Angling Observations

Non-target salmonid species caught by angling during the study were rainbow trout, brown trout, and splake. None of these species appeared to be as abundant as landlocked salmon and brook trout.

Juvenile and adult smallmouth bass were observed and caught throughout the river from the tailrace to Wyman Lake. They were especially prevalent in the upper reach of the study area. White perch were observed and caught in the study area, but they were only found in the upper reach. Fallfish were commonly caught and observed in all reaches of the study area. Several large schools of white suckers were observed in all reaches while angling, snorkeling, and tracking. Several white suckers were also caught during the study. Minnows were also observed in the study area. Species identified were black-nosed dace (*Rhinichthys atratulus*), pearl dace (*Margariscus margarita*), and common shiner (*Luxilus cornutus*). Slimy sculpins (*Cottus cognatus*) were also observed throughout the study area.

Table 3.6
General Observations

Date	Location	Water Temp. (F)	Flow (cfs)	Approx. Time	Observations
07/28/99	Marshall Stream Culvert	62	na	8:21 AM	Observed 4-6 juvenile BKT (with parr marks) in 4'x4'x8" pool. Collected 1 BKT for age class identification (L=75mm, wt.=4g)
07/28/99	RL culvert above "Joe Bruce Camp"	60	na	9:00 AM	Observed 1 juvenile BKT in small pool (2'x2'x3")--L=55mm, wt = approx. 3g
07/28/99	Mink Brook	65	na	10:50 AM	Observed approximately 2 dozen juvenile BKT in first 50 ft. of small, cascading tributary. Collected 1 BKT (L=50mm, wt = approx. 3g)
07/28/99	Culvert, RL, upper Gilroy Pool	na	na	AM	Small trickle of water, can't support fish. Congested with debris at outlet.
07/28/99	Culvert, RL, lower Gilroy Pool	na	na	AM	Small trickle of water, can't support fish. Congested with debris at outlet.
07/28/99	Kelly Brook	na	na	11:30 AM	Dry, except for small pool approximately 60 ft. from Kennebec. 1-2 ft. deep. Observed 1 BKT, approximately 3" long.
07/28/99	Moose Pond Stream	na	na	AM	Observed several blacknose dace
07/28/99	Schoolhouse Pool	na	140	AM	Potential spawning habitat near river right, near ledges
07/28/99	Holly Brook	na	na	12:38 PM	Completely dry at confluence.
07/28/99	Downstream of AT crossing	na	140	PM	Pockets of potential spawning habitat.
07/28/99	Pierce Pond Stream	76	na	1:20 PM	No fish observed
07/28/99	Pleasant Pond Stream	76	na	1:30 PM	Observed blacknose dace
07/29/99	Wilderness Brook	na	na	PM	Observed 12-15 juvenile BKT. Collected 2 BKT for age identification.
08/05/99	Salmon Stream (Dead River)	64	na	AM	No fish located. Fisherman caught 24 inch, 4lb. BNT just above Salmon Stream near old bridge.
08/05/99	Durgin Brook (Dead River)	61	na	AM	Observed juvenile BKT in culvert (61°F). BKT also observed in North Durgin Brook.
08/06/99	Cold Stream	60	140	AM	Note: Rained .5 to 1", increased flow in tributaries and river.
08/06/99	Fishing Ledges	67	140	AM	Note: Rained .5 to 1", increased flow in tributaries and river.
08/06/99	Ballfield	69	140	AM	Note: Rained .5 to 1", increased flow in tributaries and river.
08/09/99	Kelly Brook	na	na	PM	Water flowing in brook (dry on 8/6)
08/09/99	Riffles below Carry Brook	na	na	PM	Observed 1 juvenile SMB
08/10/99	False Chase Pool	na	140	1:30 PM	Observed 4 LLS (up to 14"), 1 sunfish, 6 SMB (10-12")
08/10/99	Elevator Eddy Beach	70	140	2:47 PM	Two anglers "worming"--released 10" LLS with torn gill rakers--dead
08/10/99	Pool above Magic	70	140	3:00 PM	Same two anglers caught 3 small LLS within 15 min. Did not handle fish very carefully. Had 14" LLS on stringer.
08/10/99	Magic Safety Eddy	na	140	3:30 PM	Strong current. Observed 2 LLS, 2 SMB (juvenile), 1 sculpin, 1 crayfish
08/10/99	Pool above Swimmer's Rips	71	140	4:35 PM	Observed 6 YOY SMB
08/11/99	Sandbar Eddy	69	140	11:35 AM	Observed 5 white suckers while snorkeling
08/20/99	Mouth of Chase Stream	na	140	8:30 AM	Beaver observed swimming in river across from mouth of Chase stream.
08/26/99	Carry Brook	68	140	9:10 AM	While angling, caught 1 LLS that had tagging scar with 2 suture scars. Wound completely healed. Tag had fallen out.
08/27/99	Marshall Culvert	na	na	9:00 AM	Almost completely dry, no signs of life.
08/27/99	Wilderness Brook	na	63	11:24 AM	Observed several BKT juveniles

Four salmon that died during radio tag implantation had their stomach contents briefly analyzed. General examinations revealed that the stomachs contained numerous aquatic insects, mainly caddisflies (Order *Trichoptera*) and stoneflies (Order *Plecoptera*). No forage fish species were observed in any of the stomach contents.

Non Study-related Angling

Anglers were observed throughout the study area from the Harris Station tailrace to Wyman Lake. Fishing techniques observed were fly-fishing, fishing with artificial lures, and fishing with live bait. Fishing with live bait (both shiners and worms) was the most common method observed. Popular fishing spots with easy access were the Harris Station tailrace, the area around Carry Brook, the area around Moxie Stream, the Ballfield, Crusher Hole, Gilroy Pool, Hole-in-the-Wall, Kelly Brook, and Holly Brook. Anglers were also observed at areas that are more difficult to access such as Chase Stream Sluice, Cathedral Eddy, Elevator Eddy (mouth of Chase Stream), pools above and below Magic Falls, Fish Pond Stream, and Standup Rips.

Anglers at the tailrace were observed fishing from the parking lot area that is approximately thirty feet above the tailrace pool. Many anglers fishing from the parking lot caught and dragged the hooked fish up the cement retaining wall. Fish released from the parking lot were simply dropped over the side, and many fish were observed to be foul-hooked. It should also be noted that many fish angled from the parking lot area at the tailrace for study-related purposes were foul-hooked and could not be used for the telemetry study. During snorkeling and SCUBA diving for stationary tags in the tailrace on July 29, biologists retrieved approximately 30 artificial lures from the bottom. Many hooks and lead sinkers were seen on the bottom, as were many yards of monofilament line.

On August 10, biologists observed two anglers fishing in the upper reach at the pool at Z-Turn Rapid. At the same time, the biologists found a freshly killed 10-in. landlocked

salmon floating in the pool that had a ripped gill raker. Later, the same two anglers were observed just above Magic Falls. In approximately fifteen minutes, they caught and released 3 small landlocked salmon and had a 14-inch salmon on a stringer. FPLE employees also observed two anglers keep three adult male salmon at the tailrace pool on October 14. Two of the fish were large and had well-developed kypes.

Fishing regulations are more liberal in this stretch of the Kennebec River than in other noted landlocked salmon and brook trout waters, such as the Rapid, Magalloway, Allagash, Roach, and West Branch of the Penobscot Rivers. For example, anglers in this segment of the Kennebec River can fish with live bait and can keep legal-sized fish until the end of October. The minimum length limits on brook trout and salmon are 10 inches and 12 inches, respectively; while the daily bag limit on brook trout and salmon is two in the aggregate (including lake trout). Much stricter regulations apply to the other mentioned rivers. For example, regulations on the Rapid River restrict anglers to fly-fishing only; all brook trout must be released alive at once throughout the season; and salmon must be released alive at once between August 16 and September 30. The Rapid River is closed to the taking of brook trout and salmon during the month of October. Also, the minimum length on salmon is 14 inches with a daily bag limit of one fish.

Kennebec River Water Temperatures

Water temperatures were presumed to be an especially critical factor during the study. Brook trout and salmon are not only intolerable to warmer temperatures, but warmer temperatures greatly increase the risk of infections, particularly after surgery (Winter 1983). The Kennebec River Basin, as well as most of Maine and the eastern states, experienced a severe drought in 1999, the driest in about 100 years recorded on the Kennebec River. The lack of precipitation combined with the high daily air temperatures created high water temperatures in the Kennebec River. Water temperatures recorded throughout the course of the study showed that river temperatures reached and sustained readings in the lower to mid-70s in July, August, and September. A few dead salmonids (non-tagged) were observed floating in the river during this period, indicating that water temperature caused significant stress to the fishery.

Water temperatures were also recorded at several tributaries to the Kennebec River. Temperature data was limited in July; however, substantial temperature data was recorded for August and September. Tributary temperatures were lower than river temperatures. From August 1 to October 7, Chase Stream averaged approximately 2.5°F cooler then the Kennebec River; Carry Brook averaged 7.8°F cooler; Cold Stream averaged 4.3°F cooler; and Moxie Stream averaged 3.3°F cooler.

The lower reach experiences significant flow and temperature influence from the Dead River. Habitat-use data is limited for the lower reach as water temperatures reached the upper 70's and fish tagging was discontinued; however, salmonids were still caught despite the high temperatures. This caused a lack of study population during portions of the summer of 1999. Tracking documented that some of the fish moved out of the lower main stem river into tributaries with cooler water temperatures. Some of the tagged fish could have dropped down into the deeper portions of Wyman Lake, completely out of the study area.

Tributary Use by Tagged Fish

Of the available population of 7 tagged brook trout, 4 brook trout were located in tributaries found within the study area. This movement was most likely temperature driven as main stem river temperatures warmed into the lower 70's. The upper lethal temperature for brook trout is 77°F (Behnke 1991). A temperature of 77°F was documented in the main stem of the river on July 28 near Crusher Hole. Brook trout prefer water temperatures in the range of 59°F to 68°F for optimum health and growth (Behnke 1991). River temperatures from August 10 through September 9 averaged 71.2°F. Water temperatures of Moxie Stream from August 11 through September 9 averaged 70.6°F. Water temperatures documented in Cold Stream from August 6 through September 9 averaged 65.8°F. #50BKT moved into both Moxie Stream and Cold Stream during the study. The week of August 5, #50BKT was found in Moxie Stream, which had a temperature of 69°F, compared to the main stem of the river which

was 70°F. #50BKT was then located in Cold Stream on August 11, where it remained until mid-September. Four other study fish, #12BKT, #14BKT, #51BKT, and #69BKT also entered Cold Stream during July and August. #51BKT later left Cold Stream and moved down the Kennebec River into the Dead River, and then entered Salmon Stream (where it was later found dead on the shore with a hook in its mouth). It is believed that all five of these fish entered the tributaries for a thermal refuge, as the average water temperatures in the tributaries were lower than those found in the main stem of the river. None of the landlocked salmon were located in tributaries during tracking events. During summer months, landlocked salmon tolerate and apparently thrive in water temperatures exceeding 70°F. Brook trout can be found at these temperatures, although they usually seek out colder water (springs, deep pools, etc.) (Warner and Havey 1985).

4.0 Discussion/Conclusions

Flow-Induced Movements

The results of the study indicate that salmonids tagged and tracked within the study area did not significantly move downstream or upstream in response to generation flows. The exception was one landlocked salmon located during a Peaking Cycle Location Check that exhibited downstream movement (see Section 3.1). The remainder of the fish located during Peaking Cycle Location Checks stayed in the same general area during the events. Short-range movements within the same general area were documented. Fish located during Intensive Monitoring Events also stayed in the same general area. None of the fish monitored during these events moved upstream or downstream out of the general area in response to generation flows. Fish were noted moving laterally and upstream and downstream within the same riffle/run/pool complex.

Each of the tracking methods showed that both target species located in the upper and middle reaches primarily used pool habitat during lower flows. During generation flows, the primary habitat used as velocity refugia in the upper and middle reaches by both species were eddies. Fish in the lower reach primarily used run habitat during lower flows, and pools were next in preference. Run habitat was the primary habitat used

during generation flows in the lower reach. This information indicates that velocity refuge is available to salmonids within the run habitats (see Section 3.2). The difference in habitat use at generation flows between the upper, middle, and lower reaches of the river is a function of habitat availability and river morphology.

Sample Size

A total of 97 fish were tagged during this telemetry study. Out of this total, 64 landlocked salmon, 26 Brook trout, 1 rainbow trout, 1 brown trout, 1 lake trout, 3 splake and 1 smallmouth bass were tagged. At no time during this study were all 97 fish in the water at the same time. The number of fish in the water on any given date varied from 8 to 23 fish.

Out of the 26 brook trout, 8 were tagged and never located again, and 11 tags were recovered or became stationary over the course of the study. Tags that remained stationary were removed from the data set. Data was gathered from some of the fish before the tags became stationary and was considered useful. As a result, data was utilized from only 7 brook trout. While the sample population of brook trout was small, data collected from the locations and habitat use by these 7 fish is useful in determining strategies in coping with high flow conditions.

Of the 64 tagged salmon, 4 were tagged and never located again, and 18 tags were recovered or became stationary over the course of the study. Data collected before a tag became stationary was considered useful and is included in the results discussion of this report.

Typical mobile telemetry studies used to evaluate migration patterns incorporate a maximum sample population of 20 to 40 individual fish (Winter 1983). Telemetry studies dealing with animal behavior generally deal with a smaller sample size, allowing for more intensive monitoring of individuals (Winter 1983). The sample population for brook trout and landlocked salmon satisfies these parameters. It should be noted that as

described in Section 3.5, river water temperatures during 1999 were abnormally high. Biologists made the decision to stop tagging fish when it became evident that the fish would not recover from the stress associated with high river water temperatures and tagging. Otherwise, more fish would have been tagged.

Condition Factors

To address concerns raised by fisheries agencies and fisheries interest groups regarding the health and condition of the Kennebec River salmonid fishery, condition factors of the study fish were calculated. Condition factors are used when comparing the overall health and condition of fish of the same species (Anderson and Gutreuter 1983). The condition factors of the Kennebec River study fish were compared to condition factors for brook trout and landlocked salmon catch data collected by MDIFW from the Cupsuptic, Kennebago, Rapid, and Swift Rivers in western Maine. The MDIFW fish consisted of a total of 88 brook trout and 68 landlocked salmon. Fulton-type condition factors for the MDIFW fish were calculated and are provided in Table 3.7. Fulton-type condition factors are a weight to length ratio, multiplied by an arbitrary scaling constant that varies with units of measure (Anderson and Gutreuter 1983). Fulton-type condition factors for the Kennebec River study fish are provided in Table 3.8. Condition factors of post-spawning salmonids (4 brook trout, 15 landlocked salmon) were not used to calculate overall condition factors of the radio telemetry study fish (see Table 3.2 above).

Since the minimum-tagged study fish was 240 mm (9-in. size class), only condition factors from the MDIFW 9-in.+ classes were used for comparison purposes. The average condition factors for both brook trout and landlocked salmon study fish in the Kennebec River were higher than the average condition factors for the same species from the Cupsuptic, Kennebago, Rapid, and Swift Rivers. The overall average Fulton-type condition factor for 9-in.+ Kennebec River landlocked salmon (n = 42) was 0.998, compared to 0.799 for the MDIFW salmon of the same size classes (n = 63). The overall average Fulton-type condition factors for 9-in.+ Kennebec River brook trout (n = 20) was 1.163, compared to 1.008 for the MDIFW brook trout (n = 62).

Table 3.7
Condition Factors for Brook Trout and Landlocked Salmon Collected by MDIFW from the Cupsuptic, Kennebago, Rapid, and Swift Rivers in Western Maine

Brook Trout

Size Class (in)(mm)	N =	Max	Min	Mean
9-in.	5	140 g	95 g	112.6 g
(8.6-9.5)(216-241)	CF =	1.026	0.822	0.914
10-in.	11	250 g	130 g	180.0 g
(9.6-10.5)(242-267)	CF =	1.422	0.736	1.067
11-in.	12	270 g	170 g	207.9 g
(10.6-11.5)(268-292)	CF =	1.154	0.809	0.945
12-in.	10	310 g	240 g	273.5 g
(11.6-12.5)(293-318)	CF =	1.056	0.864	0.960
13-in.	13	470 g	285 g	362.7 g
(12.6-13.5)(319-343)	CF =	1.251	0.823	1.018
14-in.	4	500 g	410 g	470.0 g
(13.6-14.5)(344-368)	CF =	1.166	0.998	1.086
15-in.	5	690 g	465 g	554.0 g
(14.6-15.5)(369-394)	CF =	1.163	0.861	1.008
16-in.	1	990 g	990 g	990.0 g
(15.6/16.5)(394-419)	CF =	1.336	1.336	1.336
17-in.	0			
(16.6-17.5)(420-445)				
18-in.	1	1410 g	1410 g	1410.0 g
(17.6-18.5)(446-470)	CF =	1.358	1.358	1.358
19-in.	0			
(18.6-19.5)(471-495)				
20-in.	0			
(19.6-20.5)(495-521)				
				Overall
		Ave. Max	Ave. Min	Mean
	Total	CF	CF	CF
	62	1.215	0.956	1.008

Landlocked Salmon

Size Class (in)(mm)	n =	Max	Min	Mean
9-in.	2	100 g	70 g	85.0 g
(8.6-9.5)(216-241)	CF =	0.801	0.575	0.688
10-in.	6	150 g	105 g	139.2 g
(9.6-10.5)(242-267)	CF =	0.983	0.697	0.880
11-in.	7	175 g	120 g	147.1 g
(10.6-11.5)(268-292)	CF =	0.848	0.590	0.685
12-in.	1	200 g	200 g	200.0 g
(11.6-12.5)(293-318)	CF =	0.698	0.698	0.698
13-in.	4	375 g	260 g	292.5 g
(12.6-13.5)(319-343)	CF =	1.063	0.737	0.845
14-in.	10	510 g	330 g	380.5 g
(13.6-14.5)(344-368)	CF =	1.112	0.749	0.832
15-in.	20	570 g	310 g	449.6 g
(14.6-15.5)(369-394)	CF =	0.983	0.612	0.799
16-in.	10	800 g	450 g	556.5 g
(15.6/16.5)(394-419)	CF =	1.136	0.672	0.836
17-in.	1	675 g	675 g	675.0 g
(16.6-17.5)(420-445)	CF =	0.837	0.837	0.837
18-in.	0			
(17.6-18.5)(446-470)				
19-in.	1	675 g	675 g	675.0 g
(18.6-19.5)(471-495)	CF =	0.599	0.599	0.599
20-in.	1	900 g	900 g	900.0 g
(19.6-20.5)(495-521)	CF =	0.687	0.687	0.687
				Overall
		Ave. Max	Ave. Min	Mean
	Total	CF	CF	CF
	63	0.886	0.678	0.799

Source: Maine Department of Inland Fisheries & Wildlife

Table 3.8
Condition Factors for Brook Trout and Landlocked Salmon Collected for the Kennebec River Telemetry Study, 1999

Brook Trout

Size Class (in)(mm)	n =	Max	Min	Mean
9-in.	4	180 g	137 g	147 g
(8.6-9.5)(216-241)	CF =	1.302	1.020	1.183
10-in.	8	290 g	150 g	199 g
(9.6-10.5)(242-267)	CF =	1.529	1.020	1.190
11-in.	6	280 g	185 g	245 g
(10.6-11.5)(268-292)	CF =	1.266	0.940	1.097
12-in.	1	320 g	320 g	320 g
(11.6-12.5)(293-318)	CF =	1.128	1.128	1.128
13-in.	0			
(12.6-13.5)(319-343)				
14-in.	0			
(13.6-14.5)(344-368)				
15-in.	1	755 g	755 g	755 g
(14.6-15.5)(369-394)	CF =	1.376	1.376	1.376
16-in.	0			
(15.6/16.5)(394-419)				
17-in.	0			
(16.6-17.5)(420-445)				
18-in.	0			
(17.6-18.5)(446-470)				
19-in.	0			
(18.6-19.5)(471-495)				
20-in.	0			
(19.6-20.5)(495-521)				

Total	Ave. Max CF	Ave. Min CF	Overall Mean CF
20	1.320	1.097	1.163

Landlocked Salmon

Size Class (in)(mm)	n =	Max	Min	Mean
9-in.	1	235 g	235 g	235 g
(8.6-9.5)(216-241)	CF =	1.700	1.700	1.700
10-in.	7	220 g	140 g	174 g
(9.6-10.5)(242-267)	CF =	1.296	0.844	1.004
11-in.	8	250 g	190 g	220 g
(10.6-11.5)(268-292)	CF =	1.180	0.771	0.985
12-in.	10	420 g	210 g	273 g
(11.6-12.5)(293-318)	CF =	1.480	0.778	0.983
13-in.	6	375 g	275 g	325 g
(12.6-13.5)(319-343)	CF =	1.006	0.787	0.892
14-in.	7	600 g	370 g	444 g
(13.6-14.5)(344-368)	CF =	1.461	0.761	0.976
15-in.	1	510 g	510 g	510 g
(14.6-15.5)(369-394)	CF =	0.967	0.967	0.967
16-in.	0			
(15.6/16.5)(394-419)				
17-in.	1	820 g	820 g	820 g
(16.6-17.5)(420-445)	CF =	1.107	1.107	1.107
18-in.	0			
(17.6-18.5)(446-470)				
19-in.	1	1000 g	1000 g	1000.0 g
(18.6-19.5)(471-495)	CF =	0.850	0.850	0.850
20-in.	0			
(19.6-20.5)(495-521)				

Total	Ave. Max CF	Ave. Min CF	Overall Mean CF
42	1.275	0.952	0.998

Tag Retrieval, Missing Fish, and Fish Mortality

During the course of the study, 30 tags (11 brook trout, 18 landlocked salmon, and 1 rainbow trout) were recovered or located in a stationary position in the river. Table 3.9 provides a list of recovered tags, as well as tags not recovered but verified as stationary.

Two of the twenty-nine brook trout and landlocked salmon tags were recovered from fish that had been killed and/or picked up by osprey. #58BKT was found at an osprey nest across the river from Fish Pond Stream, and #66LLS was found at river's edge beneath another osprey nest near the Fishing Ledges. Six of the twenty-nine were either confirmed killed by fisherman, or the evidence points strongly to that conclusion (i.e., hooks in mouth, fish tossed into the woods). It is important to note that despite the surgical procedure and tag implantation, the fact that anglers caught them indicates that the fish had resumed normal feeding habits. Examination of at least one angled fish indicated that the tagging incision was healing properly. On September 25, a fly fisherman was observed to catch and kill a salmon that had been tagged only three days prior. Before removing the tag, biologists noted that the fish appeared healthy and that the incision was in the healing process.

The remaining 21 of the 29 tags were found without corresponding fish. Seventeen of these were recovered, while four could not be recovered due to deep water, current, or substrate. It cannot be determined whether these 21 tags were released as the result of the mortality of the fish, or from tag loss. At least two were confirmed to have resulted from tag loss. Two salmon caught by angling had visible surgical scars and no tags. One was caught on August 26 by a biologist and the other by a non-study fisherman on October 8. Both fish had a healed incision and suture scars. These fish likely lost their tags as a result of poor suturing. If mortality was involved in any of the lost tags, it may have resulted from stress from angling and surgery, high water temperatures, predators (e.g., osprey) and mortality from recapture by non-study angling.

During the course of the study, 12 fish (12.4%) out of the total sample size of 97 were tagged, released, and never located again. Possible explanations include fish moving out of the study area (including in angler creels), moving into deep water (i.e., Wyman Lake), movement into areas where the signal could not be easily located, battery failure or tag malfunction. Tag malfunctions were observed by biologists with the tags in their possession. These malfunctions included tags not turning back on during the 12-hour

Table 3.9 1999 Kennebec River Telemetry Study Recovered Tags/Mortality

No.	Sp.	Tagging Date	Catch Location	Recovery Date	Recovery Location/ Stationary Signal Location	Notes
#8LLS	LLS	07/21/99	1st pool above Magic Falls	nr	Pool below Z-Turn Rapid	Could not retrieve tag from 1-4 ft. deep pool with broken shale/gravel bottom below Z-Turn Rapid.
#9BKT	BKT	07/01/99	Mud Hole	07/15/99	Wyman Lake	Retrieved tag from Wyman Lake across from Dan Hanson's camp.
#12BKT	BKT	07/22/99	Swimmer's Eddy	08/05/99	Cold Stream	Retrieved tag from first pool 100 yd. up Cold Stream.
#14BKT	BKT	07/14/99	Handicap Fishing Access	nr	Cold Stream	Stationary tag located approximately 0.8 miles up Cold Stream. Could not retneve tag.
#15LLS	LLS	07/21/99	1st pool above Magic Falls	08/10/99	Upstream of Swimmer's Rips	Retrieved tag on river-left, approximately 100 yd. upstream of Swimmer's Rips.
#19LLS	LLS	07/08/99	Chase Stream Sluice	07/15/99	The Forks	Retrieved tag at The Forks.
#20BKT	BKT	07/22/99	Handicap Fishing Access	07/29/99	Downstream of AT crossing	Retrieved tag from east shore south of AT trail crossing.
#24LLS	LLS	07/01/99	Mud Hole	07/30/99	Fishing Ledges	Retrieved tag from dead fish, mid-channel at end of Fishing Ledges. Slight eye injury.
#26BKT	BKT	07/08/99	Viking Beach	07/30/99	Upstream of Turtle Island	Retrieved tag from base of riffle above Turtle Island.
#28BKT	BKT	07/09/99	Viking Beach	07/09/99	Viking Beach	Died on operating table, retrieved tag. Second hook recovered from gill raker.
#29BKT	BKT	07/22/99	Swimmer's Eddy	08/19/99	Mouth of Kelly Brook	Retrieved tag from dewatered bank at mouth of Kelly Brook.
#31LLS	LLS	06/23/99	Carry Brook	07/30/99	Across from Carry Brook	Retneved tag directly across from Carry Brook Stairs.
#36LLS	LLS	06/24/99	Gilroy Pool	nr	Wyman Lake	Located stationary tag in 40 ft. of water in Wyman Lake on 7/14, south of Henhawk Island. Could not retrieve tag.
#37LLS	LLS	06/23/99	Carry Brook	08/10/99	Tailrace	Retrieved tag at base of rafters put-in at tailrace of dam.
#46LLS	LLS	07/22/99	Tailrace	07/30/99	Upstream of Black Brook Rapids	Retrieved tag from above Black Brook Rapids.
#47LLS	LLS	07/21/99	1st pool above Magic Falls	nr	Upstream of Magic Safety Eddy	Tag in 2-3 feet of swift water above Magic Safety Eddy. Can not retrieve due to current.
#48LLS	LLS	06/22/99	Tailrace	07/29/99	Tailrace	Retrieved tag from river-right in tailrace.
#51BKT	BKT	07/09/99	Viking Beach	07/30/99	Salmon Stream, Dead River	Retrieved tag from dead fish at Salmon Stream on Dead River. Angled, killed, and tossed on shore
#58BKT	BKT	07/09/99	Viking Beach	07/29/99	Osprey nest west of Fish Pond Stream	Dead. Located tag in or around osprey nest near Fish Pond Stream on 7/29 (did not retrieve tag).
#59LLS	LLS	07/21/99	Cathedral Eddy	08/10/99	Mouth of Chase Stream	Retrieved tag from mouth of Chase Stream.
#61LLS	LLS	07/02/99	Standup Rips	08/27/99	Downstream of The Forks	Dead, probably due to angling. Retrieved tag on east bank of river approximately 200 yd. upstream of Joe Bruce camp
#62LLS	LLS	09/22/99	Ballfield	09/25/99	Ballfield Rips	Angled and killed by fly fisherman. Angler killed the fish despite seeing the antenna--tag was removed and reused.
#64LLS	LLS	06/23/99	Carry Brook	08/10/99	False Chase Pool	Retrieved tag from False Chase Pool.
#65BKT	BKT	06/30/99	Ballfield	07/15/99	Wyman Lake	Retrieved tag from dead fish at pool across from Dan Hanson's camp on Wyman Lake.
#66LLS	LLS	08/25/99	Gilroy Pool	after 08/27/99	Osprey nest near Fishing Ledges	Drifted 1 mile downstream after release, probably dead or near dead. Retrieved tag at base of osprey nest downstream of Fishing Ledges
#68LLS	LLS	06/30/99	Ballfield	07/16/99	Near Northern Outdoors campground	Retneved tag from river-left near Northern Outdoors campground
#69BKT	BKT	07/09/99	Viking Beach	07/30/99	Cold Stream	Retneved tag from dead fish near first pool on Cold Stream, fisherman had tossed fish on shore
#70LLS	LLS	08/26/99	Gilroy Pool	09/08/99	In mouse hole downstream of Gilroy Pool	Retneved tag from hole on western shore, downstream of Gilroy Pool. Fish did not look to good at release
#71LLS	LLS	06/30/99	Standup Rips	07/30/99	Standup Rips	Retrieved tag from river-right at base of Standup Rips
#73RBT	RBT	06/23/99	Ballfield	07/29/99	Ballfield pool	Retneved tag from in front of launch at Ballfield (probable angling mortality)

nr = not recovered

Unknown /can not confirm mortality
Confirmed/strongly suspected angled
Predated
Died during surgery

on/off cycle and switches sticking in the off position. Discussion with the tag manufacturer indicated that only a very small percentage (<1%) of the tags should have malfunctioned.

Two additional fish were initially tracked, but eventually were lost bringing the total fish that could not be located to fourteen. #34BKT was caught and released on July 8 at Viking Beach. It was located on July 24 near Mud Hole and was never located again. On July 1, #55LLS was caught, tagged, and released near Mud Hole. It was located near the Ballfield on July 13, 15, and 24, but has not been located since. The fate of these fish is unknown.

Finally, one fish was located sporadically throughout the study, only to disappear late in the study. On June 23, #35BKT was tagged at Gilroy Pool, in the lower reach of the river. It was next located near the upper limits of Wyman Lake on July 14. On July 29, it was located in the middle reach of the river at Mud Hole. The fish was not located again until September 8, when it was located immediately downstream of the Appalachian Trail crossing. Its location appeared to be on the west ridge of Wyman Lake near Pierce Pond Stream. On September 25, the fish was located by aerial survey near the mouth of Pleasant Pond Stream. On September 30 and October 1, the fish was located in Pleasant Pond Stream near Rte. 201. The fish has not been located since, and it is believed that the battery has expired. This fish is an example of study fish moving into areas where they were difficult to locate.

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Radio Telemetry Study
On Flow-Related Movements, Spawning, And Seasonal Movements of Salmonids Below Harris Station on the Kennebec River, Maine

For

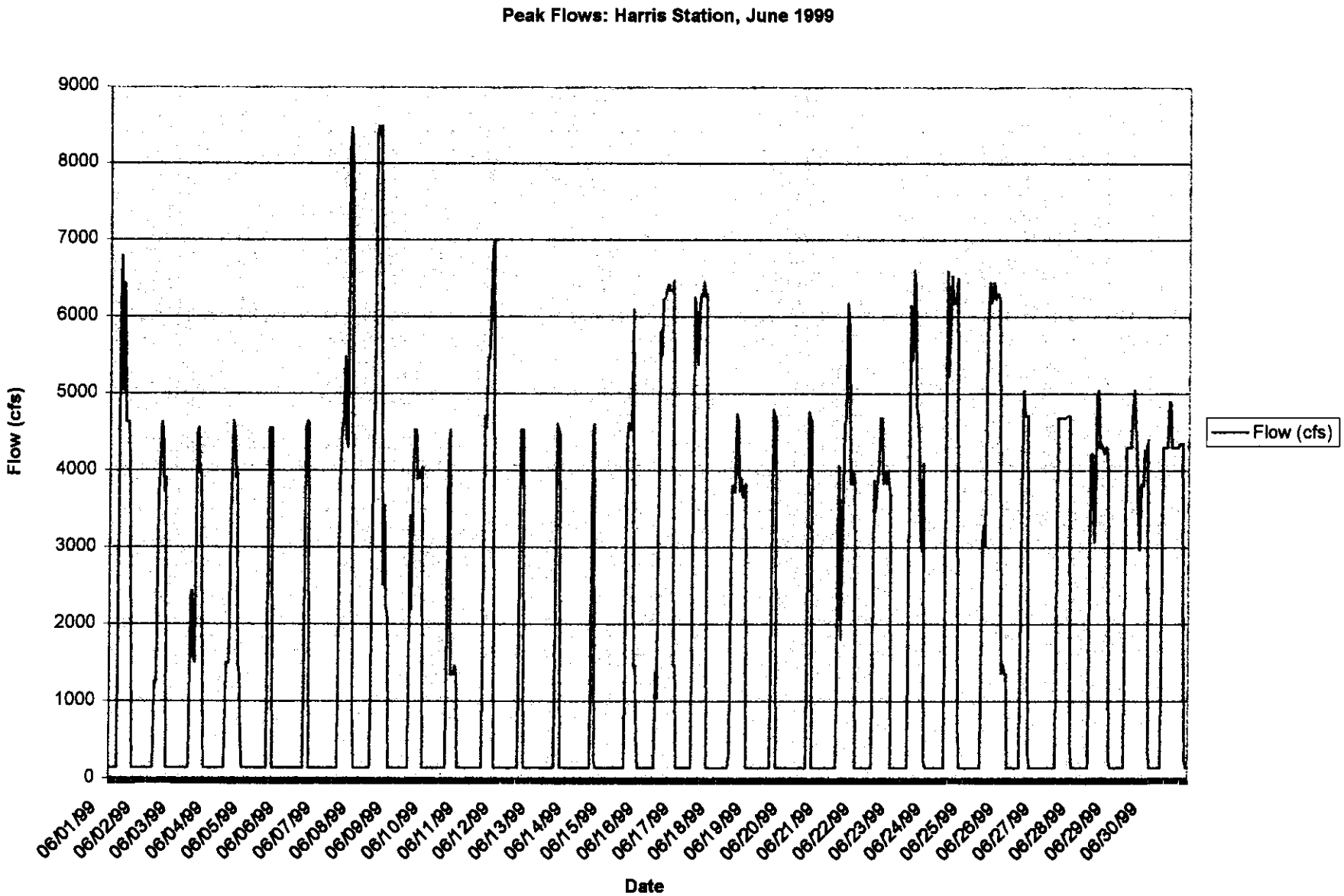
The Indian Pond Project Relicensing
FERC No. 2142

Volume II

Appendices

Appendix 1

Harris Station Flow Releases, June 1-September 30, 1999


Peak Flows: Harris Station, June 1999
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7000
6000
5000
4000
3000
2000
1000
0
Flow (cfs)
Flow (cfs)
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06/02/99
06/03/99
06/04/99
06/05/99
06/06/99
06/07/99
06/08/99
06/09/99
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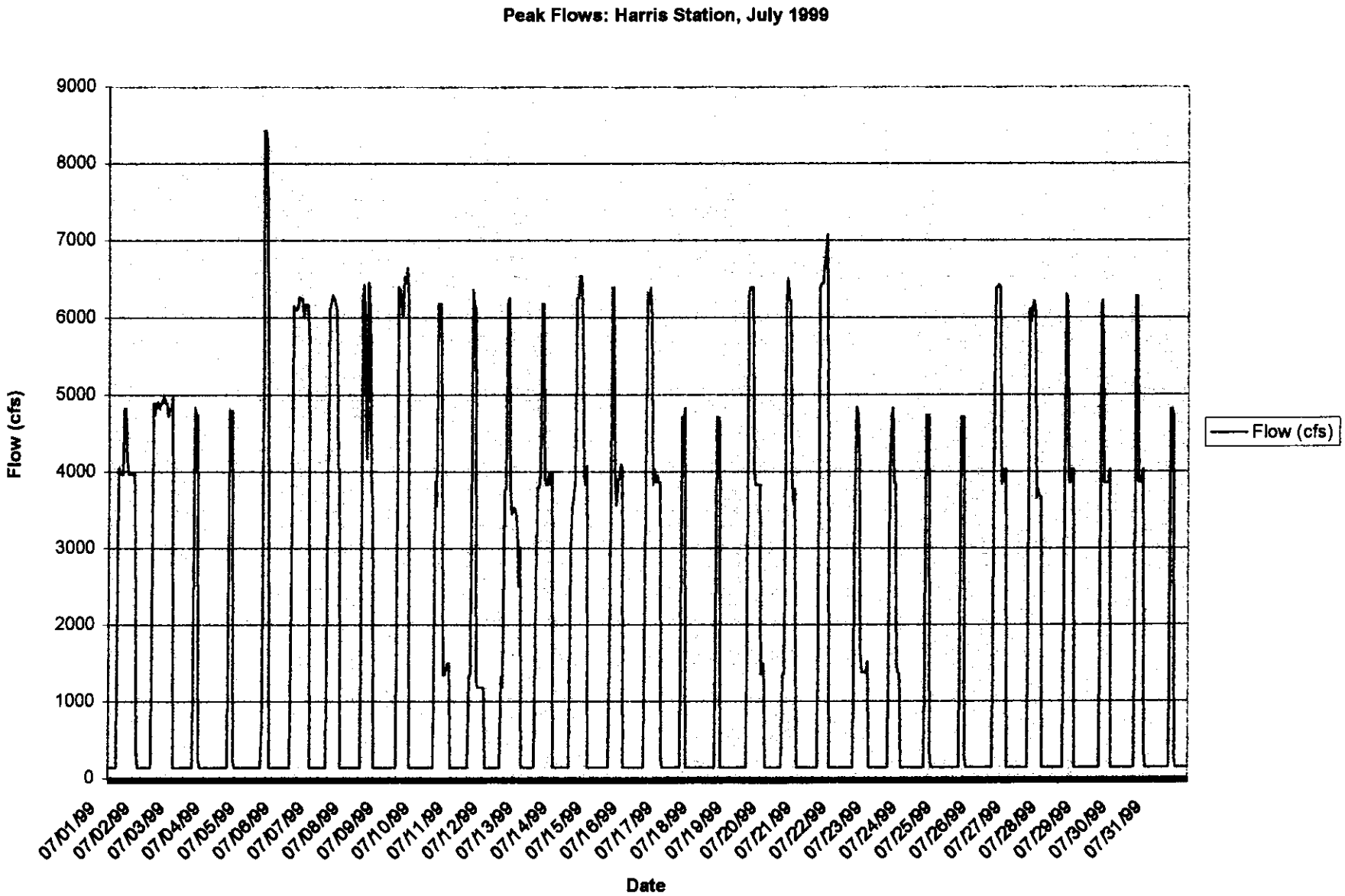
Date


Peak Flows: Harris Station, July 1999
Flow (cfs)
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8000
7000
6000
5000
4000
3000
2000
1000
0
07/01/99
07/02/99
07/03/99
07/04/99
07/05/99
07/06/99
07/07/99
07/08/99
07/09/99
07/10/99
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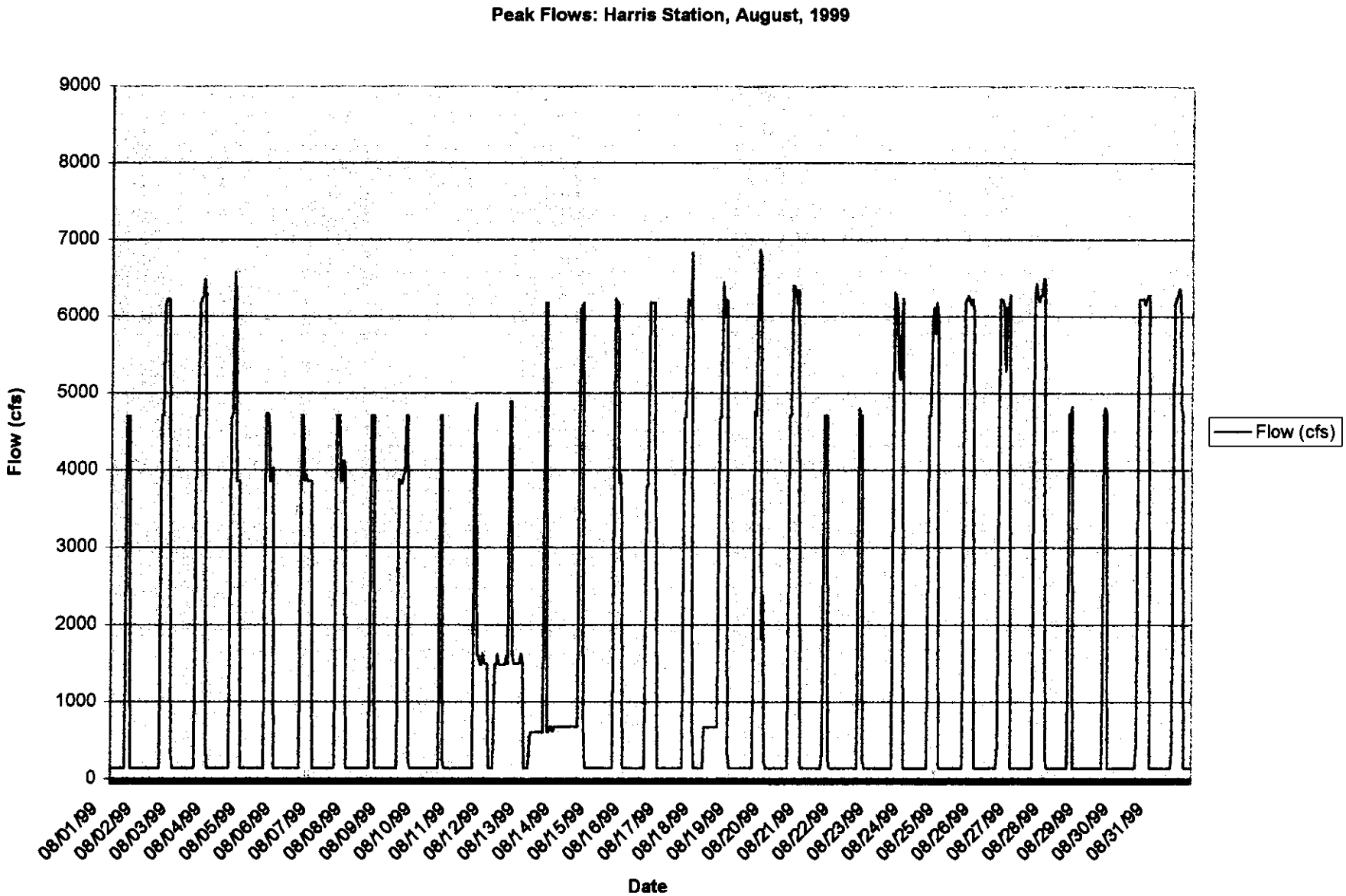
07/30/99
07/31/99
Date
Flow (cfs)


Peak Flows: Harris Station, August, 1999
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8000
7000
6000
5000
4000
3000
2000
1000
0
Flow (cfs)
Flow (cfs)
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08/02/99
08/03/99
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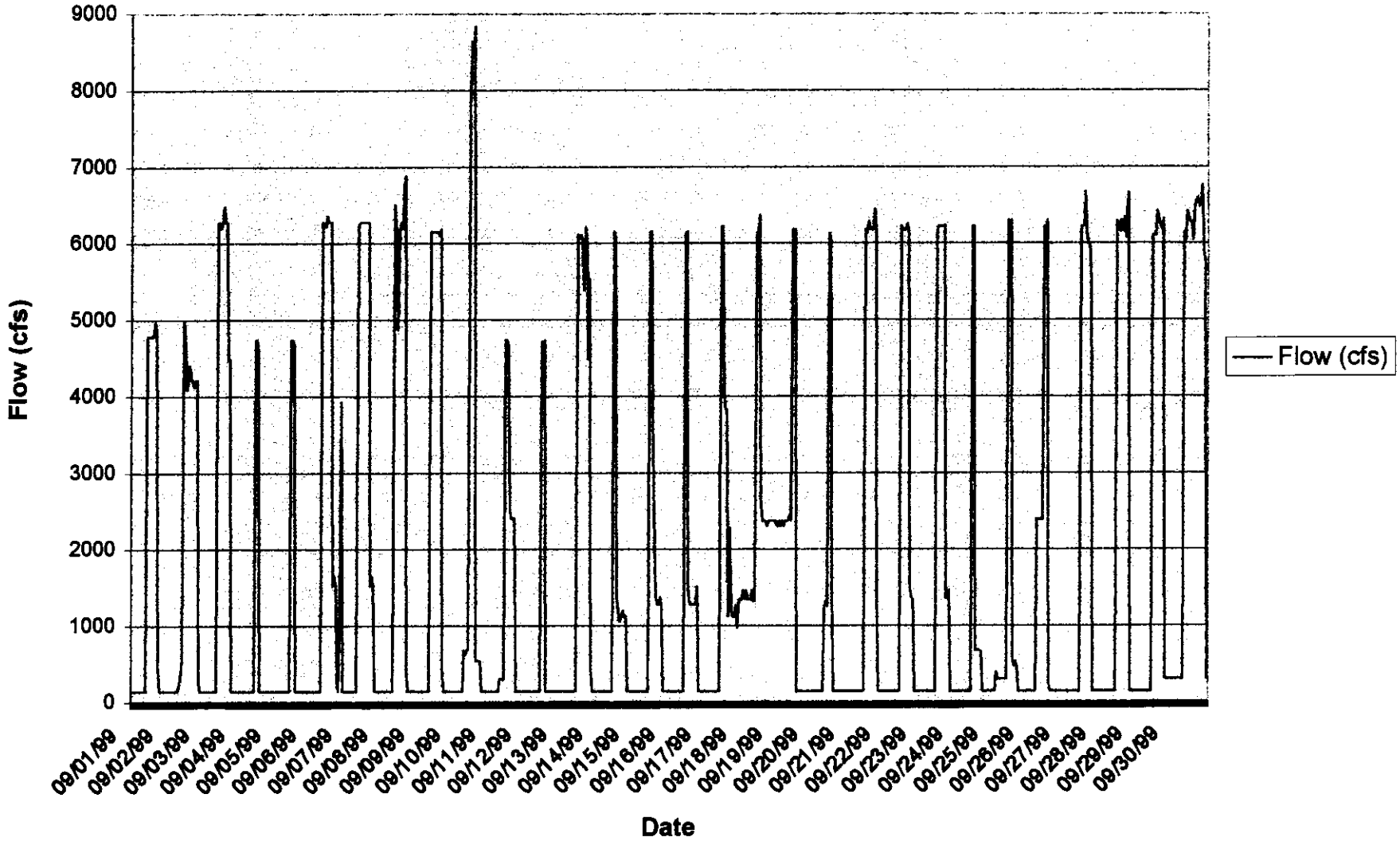
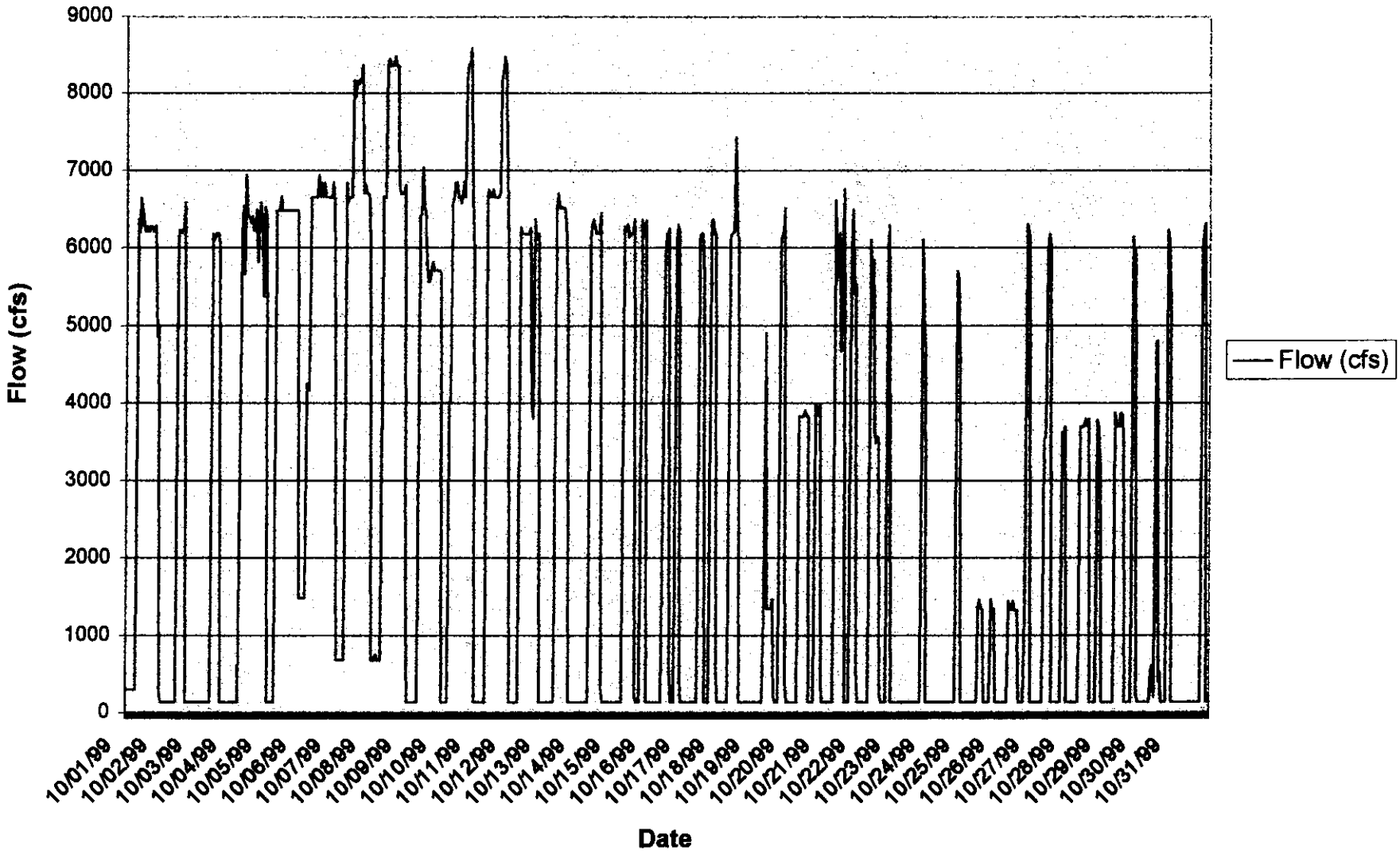
08/30/99
08/31/99
Date

Peak Flows: Harris Station, September 1999



Peak Flows: Harris Station, October 1999



Appendix 2

1999 Kennebec River Telemetry Study By-catch Data

1999 Kennebec River Radio Telemetry Study By-catch Data

LLS = landlocked salmon
BKT = brook trout
SPL = splake
RBT = rainbow trout
SMB = smallmouth bass
WHP = white perch
FLF = fallfish
WHS = white sucker
BNT = brown trout

Date	Location	Habitat	Sp	L* (mm)	Wt (g)	# of Fish	Permanent Marks	Water Temp. (F)	Flow (cfs)	Approx. Time	Notes
6/22	Harris Tailrace	eddy/pool	LLS	na	na	33	25% of fish had clipped LV	na	140 - 3,800	all day	
6/22	Harris Tailrace	eddy/pool	SMB	na	na	14	no	na	140 - 3,800	all day	
6/22	Harris Tailrace	eddy/pool	WHP	na	na	4	no	na	140 - 3,800	all day	
6/23	Gilroy	riffle	BKT	na	na	5	no	na	140	AM	
6/23	Ballfield	pool	FLF	na	na	10	no	na	140	AM	
6/23	Gilroy	riffle	BKT	na	na	1	no	na	140	PM	
6/23	Gilroy	pool	LLS	na	na	1	no	na	140	AM	
6/23	Gilroy	pool	SMB	na	na	1	no	na	140	AM	
6/23	Ballfield	pool	FLF	na	na	4	no	na	140	PM	
6/23	Ballfield	pool	WHS	na	na	3	no	na	140	PM	
6/23	Ballfield	riffle	BKT	na	na	2	no	na	140	PM	
6/23	Ballfield	riffle	LLS	na	na	2	no	na	140	PM	
6/23	Ballfield	riffle/pool	SMB	na	na	4	no	na	140	PM	
6/24	Hole-in-the-Wall	pool	FLF	na	na	4	no	na	140	AM	
6/24	Gilroy	pool	FLF	na	na	5	no	na	140	AM	
6/24	Gilroy	riffle/pool	BKT	na	na	5	no	na	140	AM	
6/24	Gilroy	riffle	LLS	na	na	1	no	na	140	AM	
6/24	Holly	pool	FLF	na	na	1	no	na	140	AM	
6/24	Hole-in-the-Wall	pool	BKT	na	na	1	no	na	140	AM	
6/24	Hole-in-the-Wall	pool	RBT	na	na	1	no	na	140	AM	
7/7	Third pool from dam	pool	SMB	200	na	1	no	na	140	16:30	
7/7	Third pool from dam	pool	SMB	230	na	1	no	na	140	16:30	
7/7	Fourth pool from dam	pool	SMB	200	na	1	no	70	140	17:30	
7/7	Fifth pool from dam	pool	BKT	230	na	1	both ventrals clipped	na	140	18:00	
7/8	Viking Beach	eddy	BKT	200	na	2	no	na	4,100 - 6,400	AM	
7/8	Viking Beach	eddy	SMB	200	na	5	no	na	4,100 - 6,400	AM	
7/8	Viking Beach	eddy	FLF	200	na	2	no	na	4,100 - 6,400	AM	
7/8	Viking Beach	eddy	FLF	305	na	2	no	na	4,100 - 6,400	AM	
7/8	Viking Beach	eddy	WHS	380	na	1	no	na	4,100 - 6,400	AM	
7/9	Viking Beach	eddy	BKT	240	180	1	no	na	6,000	AM	Died, tag recovered
7/21	Cathedral Eddy	eddy	FLF	na	na	5	no	70	140	07:00-08:00	
7/21	Cathedral Eddy	eddy	LLS	na	na	1	no	70	140	07:00-08:00	
7/21	Cathedral Eddy	eddy	WHP	na	na	5	no	70	140	07:00-08:00	

*Lengths are approximate

1999 Kennebec River Radio Telemetry Study By-catch Data

7/21	Cathedral Eddy	eddy	SMB	na	na	2	no	70	140	07:00-08:00	
7/21	Below Cathedral Eddy	pool	FLF	na	na	2	no	70	140	07:00-08:00	
7/21	Below Cathedral Eddy	pool	WHP	na	na	2	no	70	140	07:00-08:00	
7/21	Below Cathedral Eddy	pool	SMB	na	na	2	no	70	140	07:00-08:00	
7/21	First Pool above Magi	pool	LLS	330	na	1	no	na	140	17:00-18:30	
7/22	Handicap Access	pool/riffle	FLF	150-305	na	12	no	74	140	AM	
7/22	Handicap Access	pool	SMB	305	680	1	no	74	140	AM	
7/22	Gilroy Pool	pool	SMB	305	na	1	no	na	140	AM	
7/22	Gilroy Pool	pool	FLF	254	na	1	no	na	140	AM	
7/22	Gilroy Pool	pool	WHS	330	na	1	no	na	140	AM	
7/22	Swimmers Eddy	run	BKT	216	120	1	no	na	140	7:00-11:30	too small, released
7/23	Swimmers Eddy	run	BKT	178	na	1	no	na	140	7:00-11:31	too small, released
7/22	Swimmers Eddy	eddy/pool	SMB	178	na	1	no	na	140	7:00-11:30	
7/22	Swimmers Eddy	eddy/pool	FLF	356	na	1	no	na	140	7:00-11:30	
7/22	Swimmers Eddy	eddy/pool	FLF	127	na	1	no	na	140	7:00-11:30	
7/22	Swimmers Eddy	eddy/pool	LLS	305	na	1	no	na	140	7:00-11:30	hooked in the eye, released
7/21	Tailrace	run	LLS	200	na	1	no	na	1,400	3:00- 5:00	released
7/22	Tailrace	run	LLS	254	na	1	no	na	1,400	3:00- 5:00	released
7/23	Tailrace	run	LLS	305	na	2	no	na	1,400	3:00- 5:00	released
7/24	Tailrace	run	LLS	254	na	1	no	na	1,400	3:00- 5:00	released
7/22	Tailrace	run	SMB	150	na	4	no	na	1,400	3:00- 5:00	released
7/23	Tailrace	run	FLF	150	na	1	no	na	1,400	3:00- 5:00	released
8/26	Gilroy Pool	pool	FLF	254	na	1	no	65	140	8:40 AM	
8/26	Gilroy Pool	pool	FLF	305	na	1	no	65	140	8:43 AM	
8/26	Gilroy Pool	pool	FLF	254	na	1	no	65	140	8:44 AM	
8/26	Gilroy Pool	pool	FLF	254	na	1	no	65	140	8:46 AM	
8/26	Gilroy Pool	pool	WHS	406	na	1	no	65	140	8:50 AM	
8/26	Gilroy Pool	pool	FLF	305	na	1	no	65	140	8:55 AM	
8/26	Gilroy Pool	pool	FLF	200	na	1	no	65	140	9:55 AM	
8/26	Gilroy Pool	pool	FLF	254	na	1	no	65	140	10:10 AM	
8/26	Gilroy Pool	pool	FLF	200	na	1	no	68	140	10:41 AM	
8/26	Gilroy Pool	pool	FLF	127	na	1	no	69	140	11:13 AM	
8/26	Gilroy Pool	pool	FLF	254	na	1	no	69	140	11:15 AM	
8/26	Gilroy Pool	pool	FLF	200	na	1	no	69	140	11:17 AM	
8/26	Gilroy Pool	pool	FLF	200	na	1	no	69	140	11:20 AM	
8/26	Carry Brook	pool	LLS	230	na	1	no	68	140	8:30 AM	
8/26	Carry Brook	pool	LLS	305	na	1	healed tag incision near RV	68	140	9:10 AM	Tagging scar with 2 suture scars, healed. No tag.
9/22	Ballfield	riffle	BNT	305	na	1	no	na	140	AM	Released, not tagged
9/22	Ballfield	riffle	RBT	305	na	1	no	na	140	AM	Hooked deep, not tagged
9/23	Holly Brook	eddy	FLF	254	na	1	no	61	140	1:00 PM	

*Lengths are approximate

1999 Kennebec River Radio Telemetry Study By-catch Data

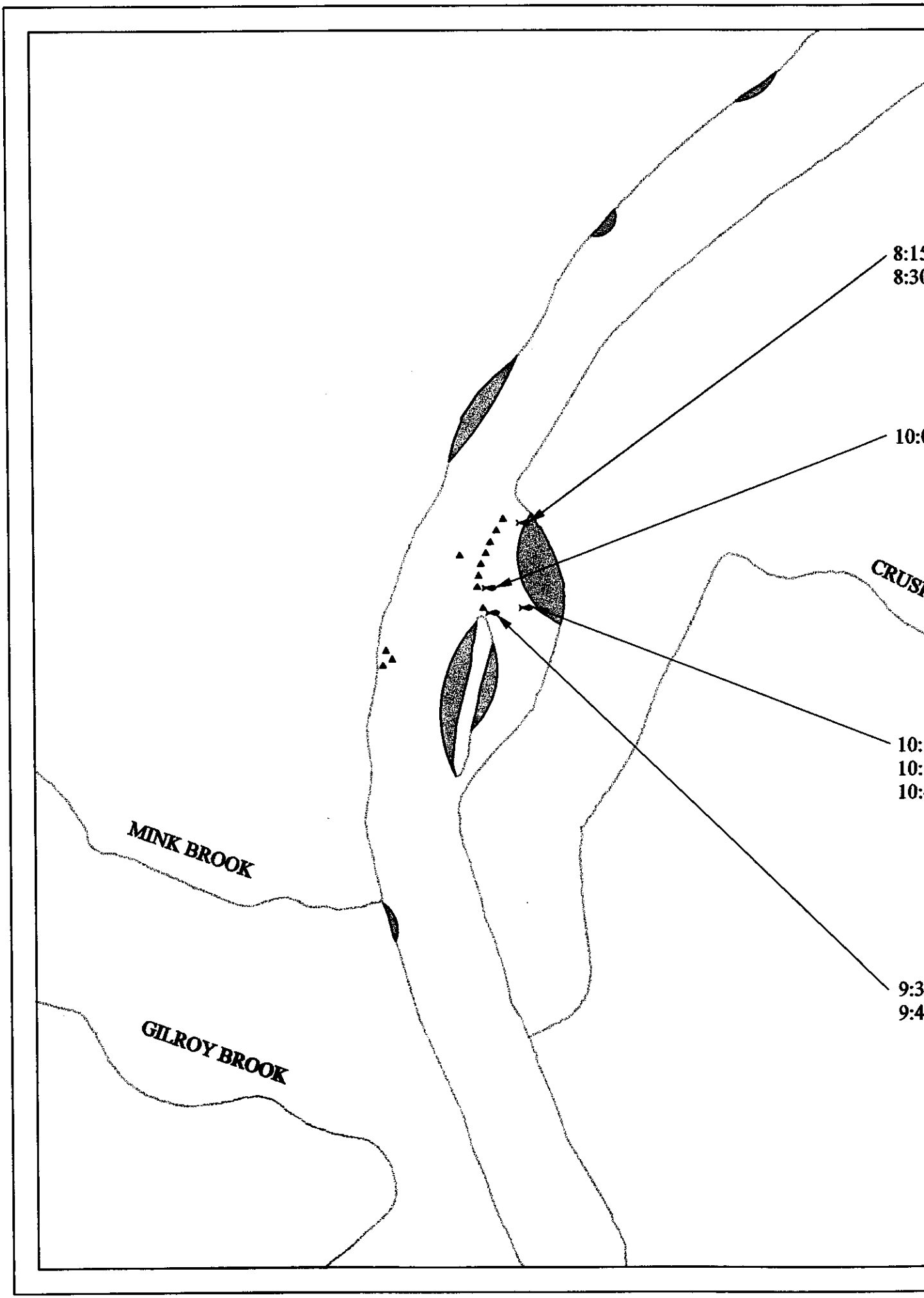
9/23	Carry Brook	riffle	LLS	na	na	1	no	61	140	9:00 AM	Tagged, but died immediately after surgery. Retrieved tag.
9/23	Ballfield	run	BKT	230	130	1	no	61	140	10:30 AM	Too small to tag
9/24	Ballfield	run	BKT*	200	na	1	both ventrals clipped	na	680	3:30 PM	Released.

*Lengths are approximate

Appendix 3

Intensive Monitoring Events

This appendix contains representative computer-generated maps of fish movements documented during the radio telemetry study. Additional maps will be provided by FPLE upon request.


8:15
8:30
10:0
CRUSI
10:
10:
10:
9:3
9:4
MINK BROOK
GILROY BROOK

AM 300 cfs
AM 300 cfs

0 AM 6,000 cfs

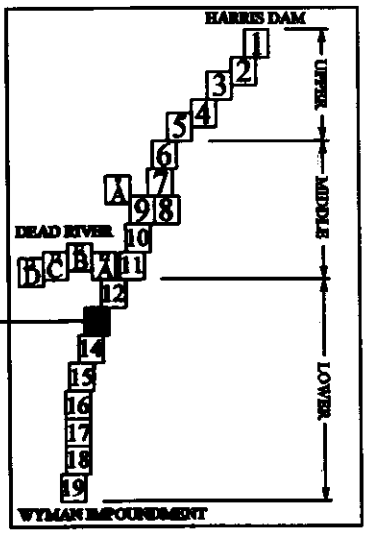
ER BROOK

5 AM 6,000 cfs
0 AM 6,000 cfs
5 AM 6,000 cfs

AM 300 cfs
AM 6,000 cfs

Intensive Monitoring Event for #1LLS, October 1, 1999

SHEET 13



LOCATION DIAGRAM

N

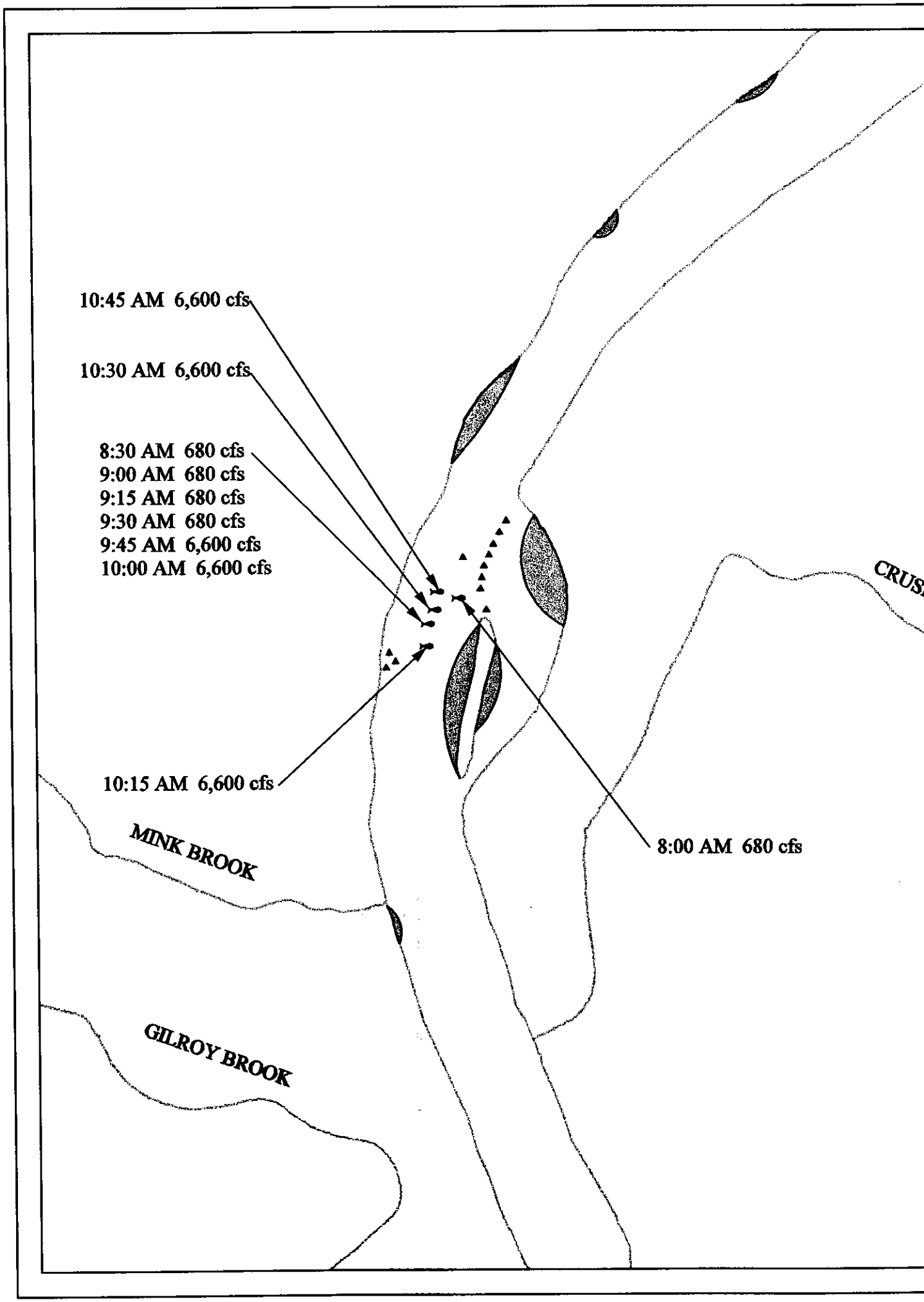
LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

On October 1, 1999, monitoring was conducted between the hours of 8:15 AM and 10:45 AM. The minimum flow was 300 cfs at Harris Station until 8:00 AM. The generating flow was approximately 6,000 cfs at Harris Station from 8:00 AM until 10:00 PM.

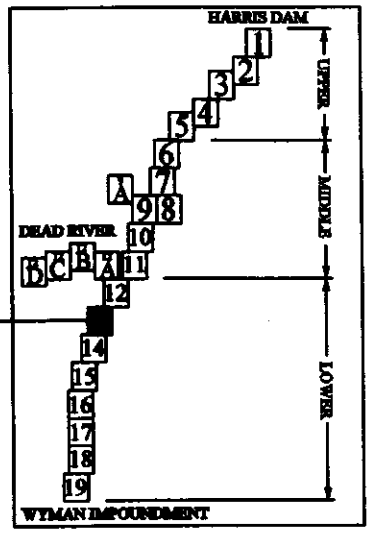
At 8:15 AM, the fish was located near the head of Crusher Hole pool. At 9:30 AM, the fish moved down the pool and was situated near the head of Crusher Island. The generating flow arrived at 9:43 AM. At 9:45 AM, the fish was in the same location as it was at 9:30 AM. At 10:00 AM, the fish was located approximately 50 feet up river from the 9:30 and 9:45 AM location. At 10:15 AM, the fish was located in the middle of Crusher Hole. The fish was checked every 15 minutes and stayed in the middle of the pool for the remainder of the monitoring event.

200 100 0 200 400 600 YARDS


10:45 AM 6,600 cfs
10:30 AM 6,600 cfs
8:30 AM 680 cfs
9:00 AM 680 cfs
9:15 AM 680 cfs
9:30 AM 680 cfs
9:45 AM 6,600 cfs
10:00 AM 6,600 cfs
10:15 AM 6,600 cfs
8:00 AM 680 cfs
MINK BROOK
GILROY BROOK
CRUS

Intensive Monitoring Event for #1LLS, October 8, 1999

SHEET 13



LOCATION DIAGRAM

N

LEGEND

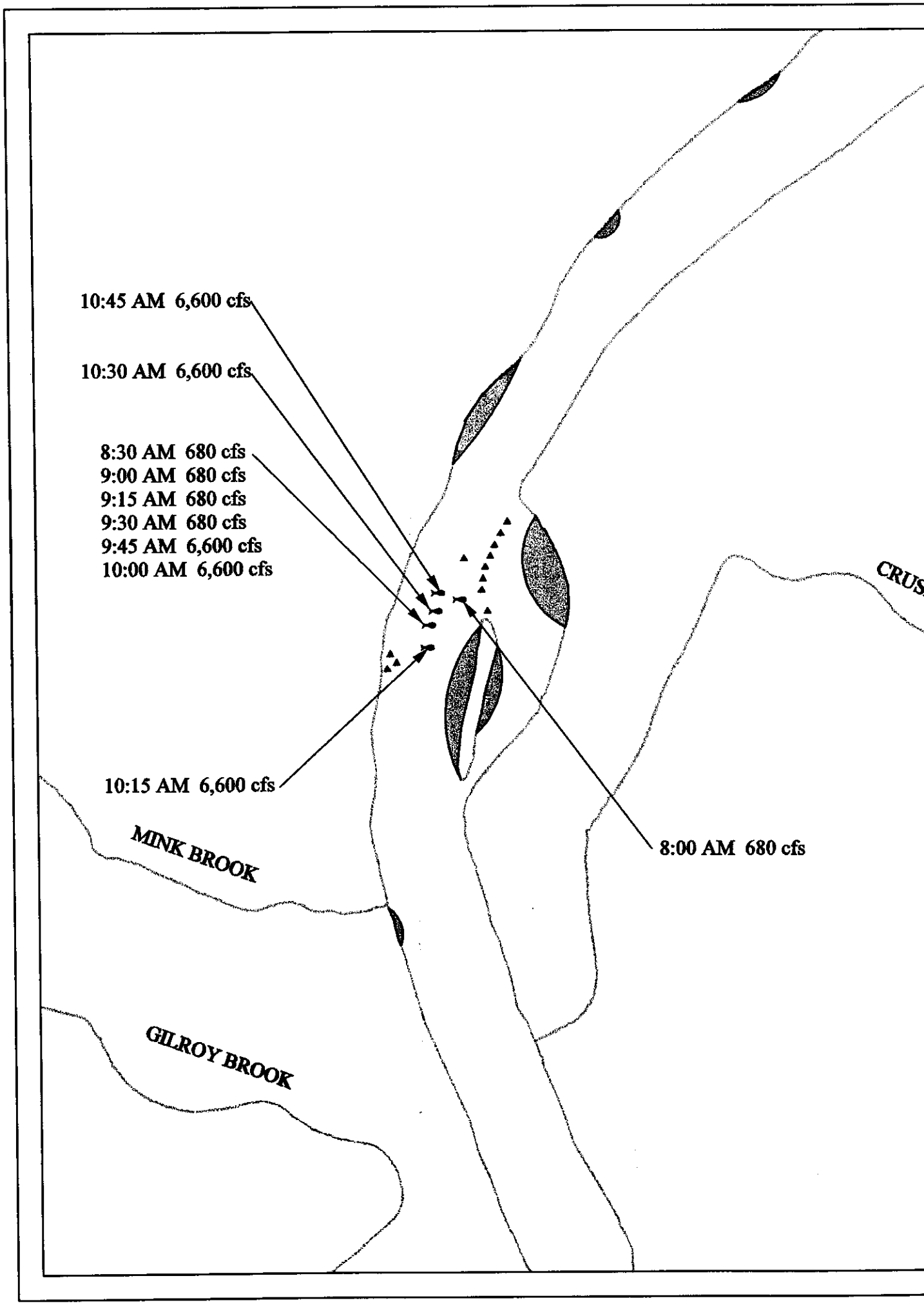
- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

On October 8, 1999, monitoring was conducted between the hours of 8:00 AM and 10:45 AM. The minimum flow was 680 cfs at Harris Station until 7:00 AM. The generating flow was approximately 6,600 cfs at Harris Station for the remainder of the day.

At 8:00 AM, the fish was located river left in the main stem of the river. At 8:30 AM, the fish was located in the main stem of the river, in run habitat, even with the head of Crusher Island. The fish held in this location throughout the 680 cfs flow. The generating flow arrived at 9:32 AM. The fish remained in the same general area until 10:15 AM, when it was located down river approximately 50 feet. At 10:30 AM, the fish had moved up river from the 10:15 AM location. At 10:45 AM, the fish was located up river from the 10:30 AM location. The fish remained in the run habitat throughout the monitoring event.

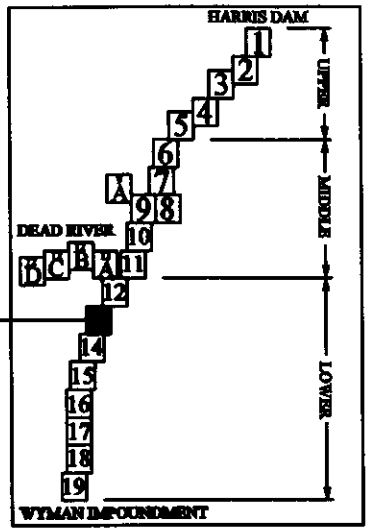
200 100 0 200 400 600 YARDS

E-PRO


10:45 AM 6,600 cfs
10:30 AM 6,600 cfs
8:30 AM 680 cfs
9:00 AM 680 cfs
9:15 AM 680 cfs
9:30 AM 680 cfs
9:45 AM 6,600 cfs
10:00 AM 6,600 cfs
10:15 AM 6,600 cfs
8:00 AM 680 cfs
MINK BROOK
GILROY BROOK
CRUS

Intensive Monitoring Event for #1LLS, October 8, 1999

SHEET 13



LOCATION DIAGRAM

N

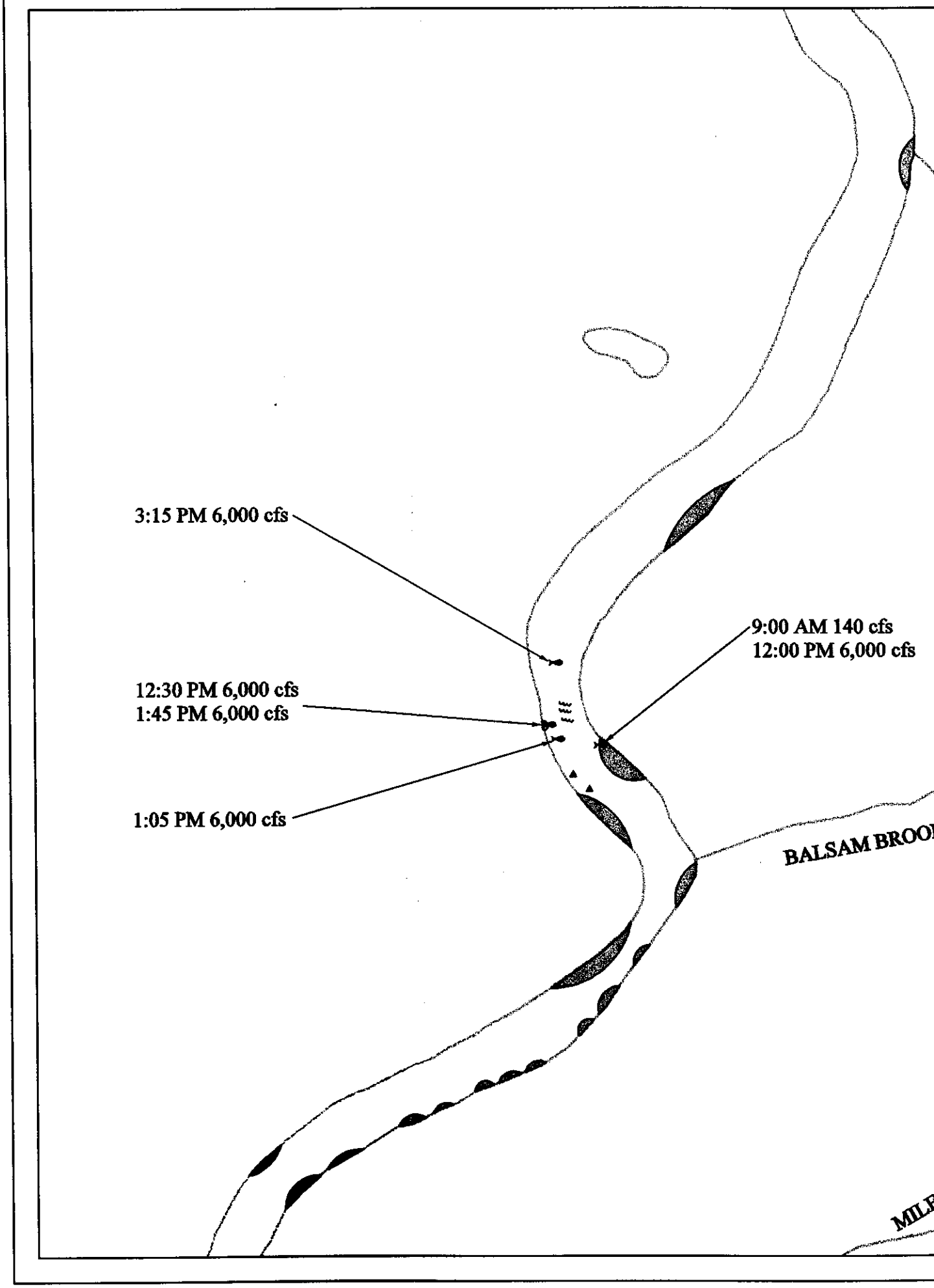
LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

On October 8, 1999, monitoring was conducted between the hours of 8:00 AM and 10:45 AM. The minimum flow was 680 cfs at Harris Station until 7:00 AM. The generating flow was approximately 6,600 cfs at Harris Station for the remainder of the day.

At 8:00 AM, the fish was located river left in the main stem of the river. At 8:30 AM, the fish was located in the main stem of the river, in run habitat, even with the head of Crusher Island. The fish held in this location throughout the 680 cfs flow. The generating flow arrived at 9:32 AM. The fish remained in the same general area until 10:15 AM, when it was located down river approximately 50 feet. At 10:30 AM, the fish had moved up river from the 10:15 AM location. At 10:45 AM, the fish was located up river from the 10:30 AM location. The fish remained in the run habitat throughout the monitoring event.

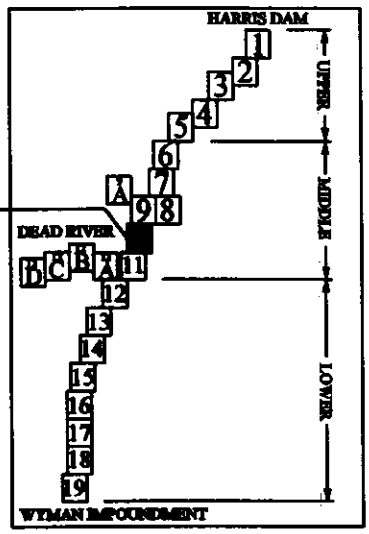
200 100 0 200 400 600 YARDS


3:15 PM 6,000 cfs
9:00 AM 140 cfs
12:00 PM 6,000 cfs
12:30 PM 6,000 cfs
1:45 PM 6,000 cfs
1:05 PM 6,000 cfs
BALSAM BROO
MIL

Intensive Monitoring Event for #6BKT, September 24, 1999

MOXIE STREAM

SHEET 10



LOCATION DIAGRAM

N

LEGEND

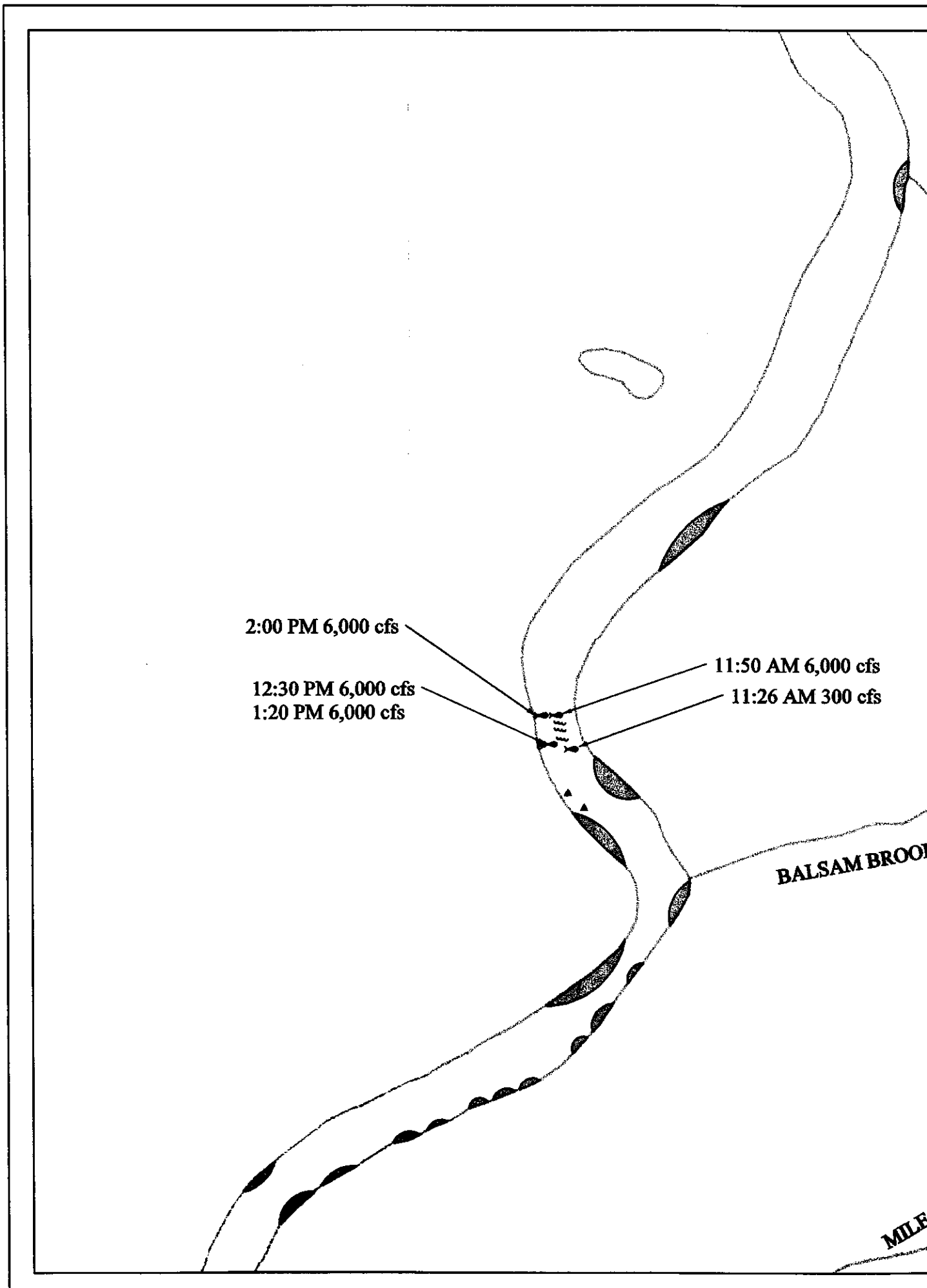
- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

On September 24, 1999, monitoring was conducted between the hours of 9:00 AM and 3:15 PM. The minimum flow was 140 cfs at Harris Station until 10:00 AM. The generating flow was 6,000 cfs at Harris Station from 10:00 AM to 12:00 PM. From 12:00 PM to 7:00 PM the minimum flow went down to 680 cfs.

At 9:00 AM, the fish was caught and tagged on river-left, across from the third ledge, up from the campsite. After recovering, the fish was released at the capture site. The generating flow arrived at 11:53 AM. At 12:00 PM, the fish was located in the eddy on river-left, across from the third ledge. At 12:30 PM, the fish was located on river-right in the eddy between the third and fourth ledge. At 1:05 PM, it was located on river-right, above the second ledge. At 1:45 PM, it was located back in the same area as the 12:30 PM check. At 3:15 PM, the fish was located at mid-channel, upstream from the fourth ledge.

1/4 BROOK

200 100 0 200 400 600 YARDS

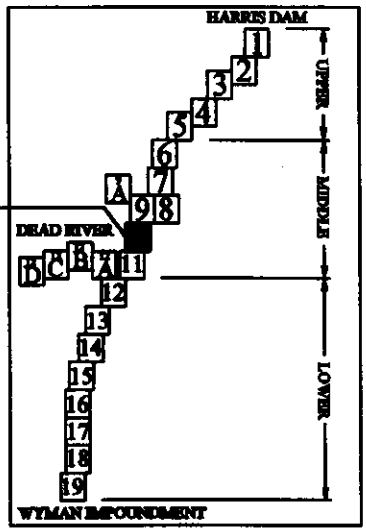

2:00 PM 6,000 cfs
12:30 PM 6,000 cfs
1:20 PM 6,000 cfs
11:50 AM 6,000 cfs
11:26 AM 300 cfs
BALSAM BROO
MILF

Intensive Monitoring Event for #6BKT, September 25, 1999

MOXIE

STREAM

SHEET 10



LOCATION DIAGRAM

N

LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

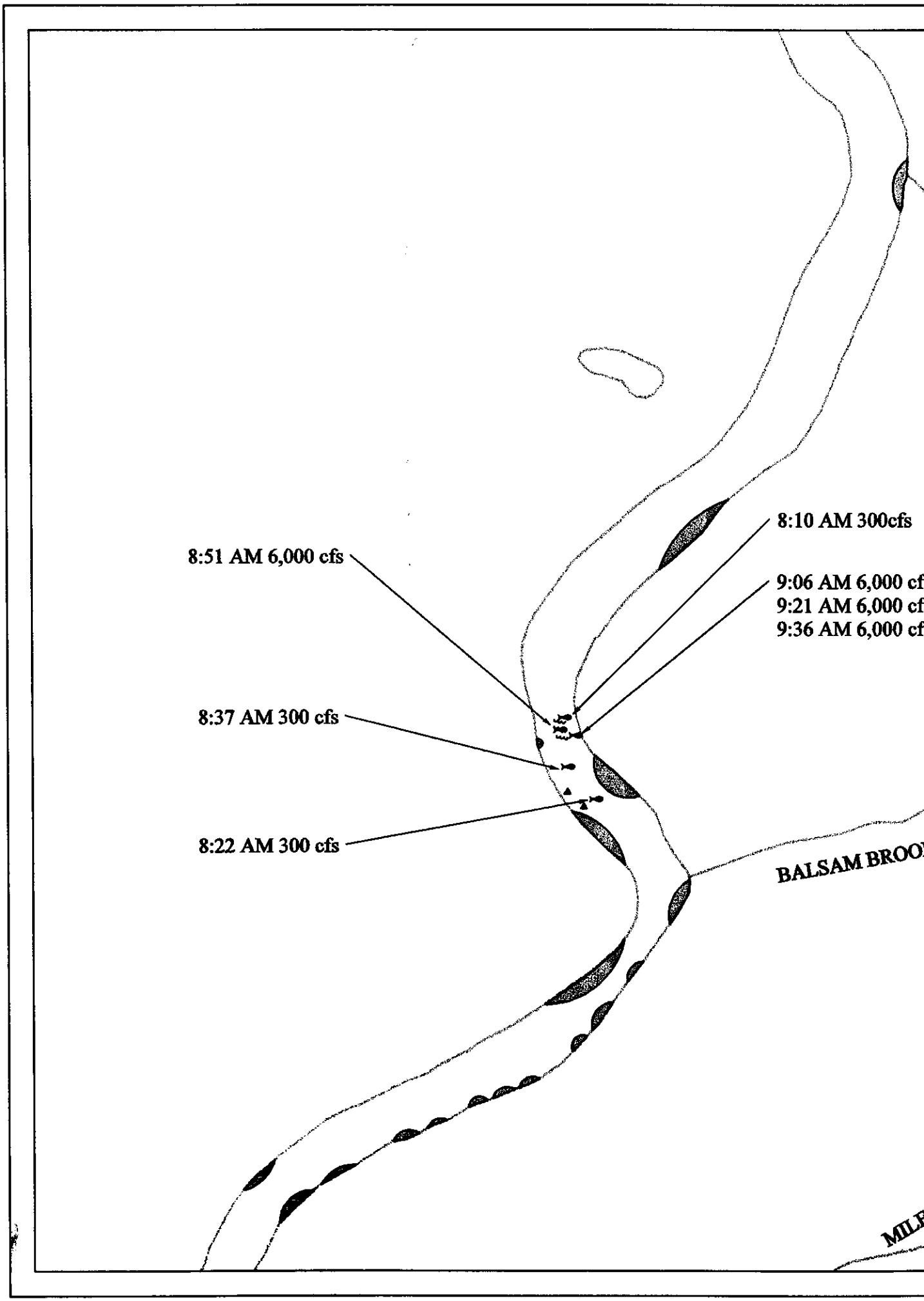
On September 25, 1999, monitoring was conducted between the hours of 11:26 AM and 2:00 PM. The minimum flow was 300 cfs at Harris Station until 10:00 AM. The generating flow was approximately 6,000 cfs at Harris Station from 10:00 AM to 12:00 PM.

At 11:26 AM, the fish was located at the tail end of the riffle/small rapid at the head of the pool. The generating flow arrived at 11:50 AM. At 11:50 AM, the fish was located upstream, mid-channel across from the fourth ledge. At 12:30 PM, the fish moved to river-right into the eddy between the third and fourth ledge. The fish held here until 2:00 PM when it moved up river in front of the fourth ledge.

/4 BROOK

200 100 0 200 400 600 YARDS

E·PRO

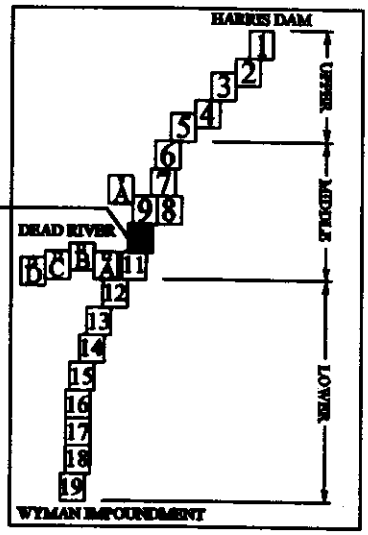

8:10 AM 300cfs
8:51 AM 6,000 cfs
9:06 AM 6,000 cf
9:21 AM 6,000 cf
9:36 AM 6,000 cf
8:37 AM 300 cfs
8:22 AM 300 cfs
BALSAM BROO
MIL

Intensive Monitoring Event for #6BKT, October 1, 1999

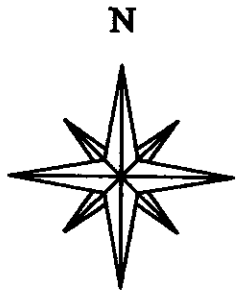
MOXIE

STREAM

SHEET 10



LOCATION DIAGRAM



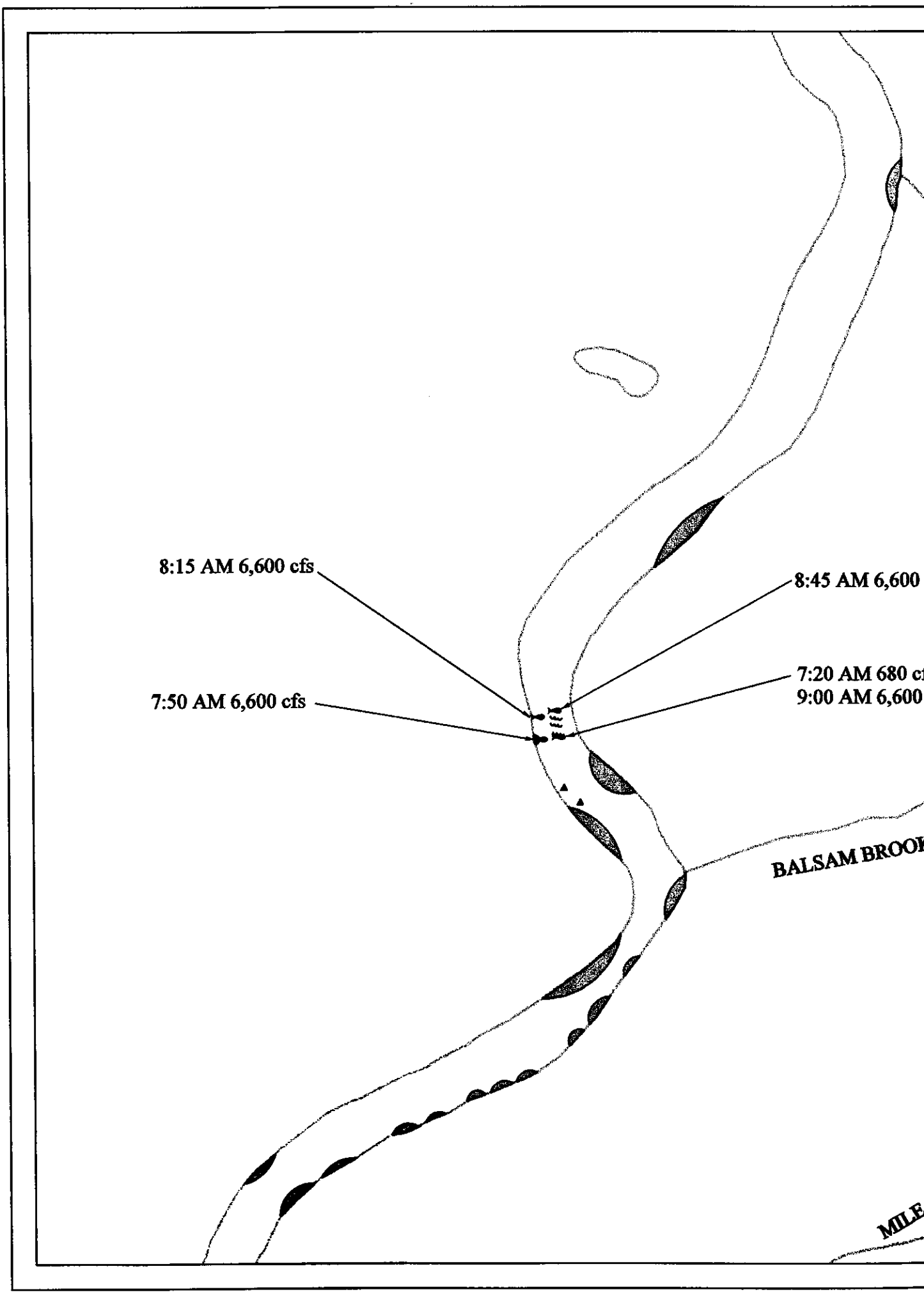
LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

On October 1, 1999, monitoring was conducted between the hours of 8:10 AM and 9:36 AM. The minimum flow was 300 cfs at Harris Station until 8:00 AM. The generating flow was 6,000 cfs at Harris Station for the remainder of the day.

At 8:10 AM, the fish was located in the rapid on river-left of Standup Rips. At 8:22 AM, the fish was moving around the pool. At 8:37 AM, the fish moved upstream 50 feet in the run habitat at the head of the pool. The generating flow arrived at 8:39 AM. At 8:51 AM, the fish moved up river 150 feet into the rapid. At 9:06 AM, the fish had moved river-left into the head of the eddy where it stayed for the remainder of the monitoring event.

4 BROOK

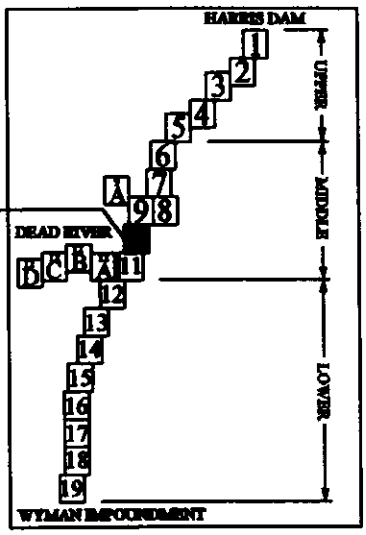

8:15 AM 6,600 cfs
8:45 AM 6,600
7:20 AM 680 cf
9:00 AM 6,600
7:50 AM 6,600 cfs
BALSAM BROOK
MILE

Intensive Monitoring Event for #6BKT, October 7, 1999

MOXIE

STREAM

SHEET 10



LOCATION DIAGRAM

N

LEGEND

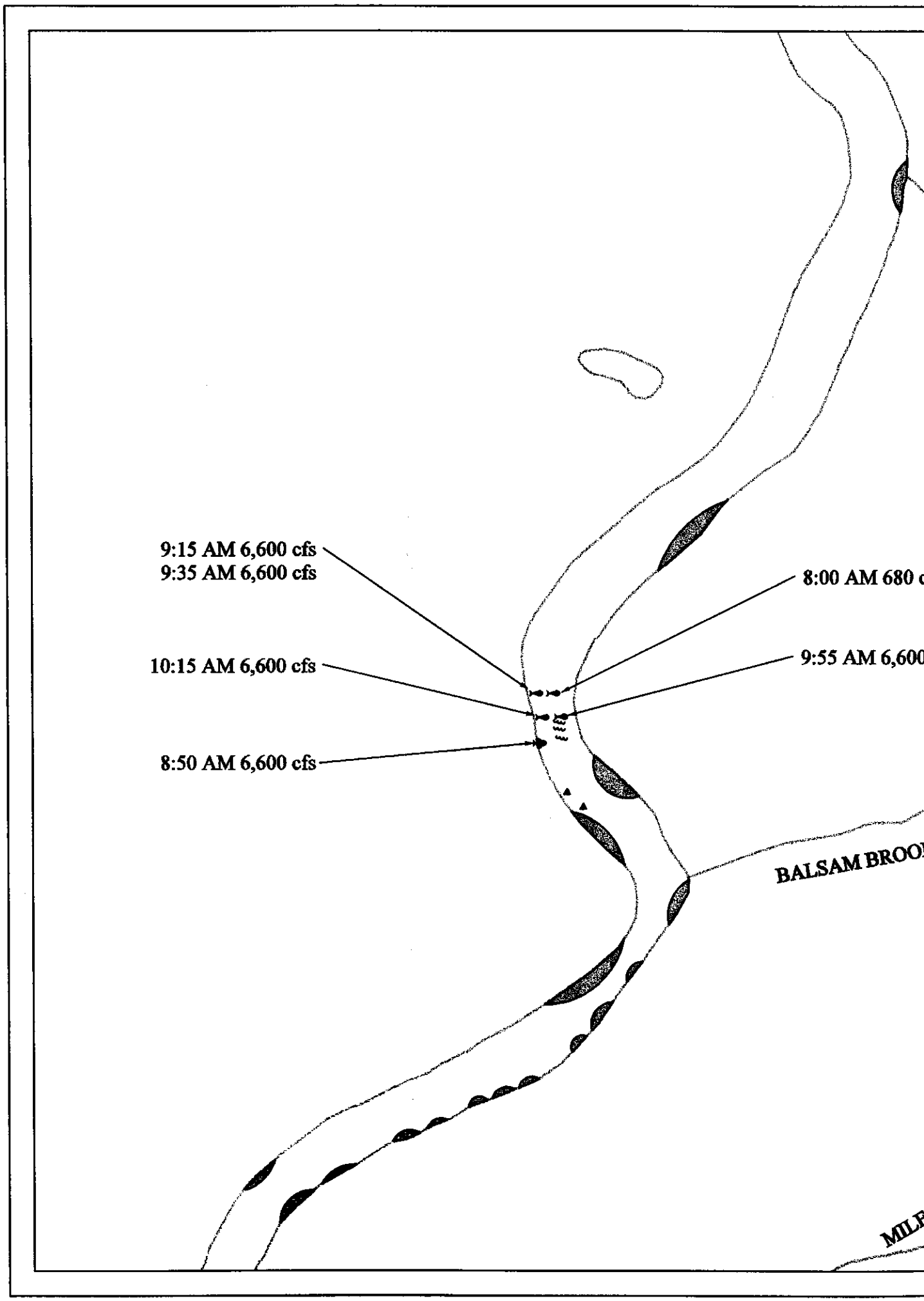
- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

On October 7, 1999, monitoring was conducted between the hours of 7:20 AM and 9:00 AM. The minimum flow was 680 cfs at Harris Station until 6:00 AM. The generating flow was 6,600 cfs at Harris Station for the remainder of the day.

At 7:20 AM, the fish was located at mid-channel, in the rips. The generating flow arrived at 7:45 AM. At 7:50 AM, the fish moved river-right into the eddy at the fourth ledge. At 8:15 AM, the fish moved upstream, above the fourth ledge at mid-channel. At 8:45 AM, the fish was located across from the fourth ledge. At 9:00 AM, the fish was back at mid-channel in the rips.

200 100 0 200 400 600 YARDS

E-PRO

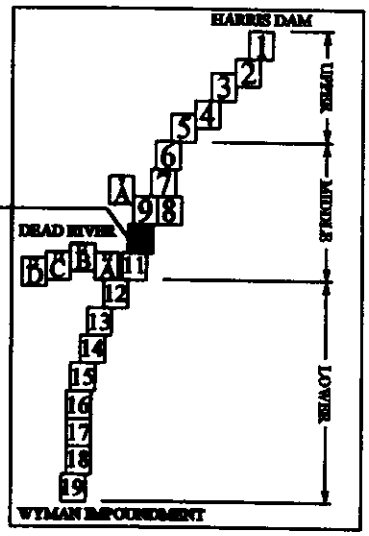

9:15 AM 6,600 cfs
9:35 AM 6,600 cfs
10:15 AM 6,600 cfs
8:50 AM 6,600 cfs
8:00 AM 680
9:55 AM 6,600
BALSAM BROO
MIL

Intensive Monitoring Event for #6BKT, October 8, 1999

MOXIE

STREAM

SHEET 10



LOCATION DIAGRAM

N

LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

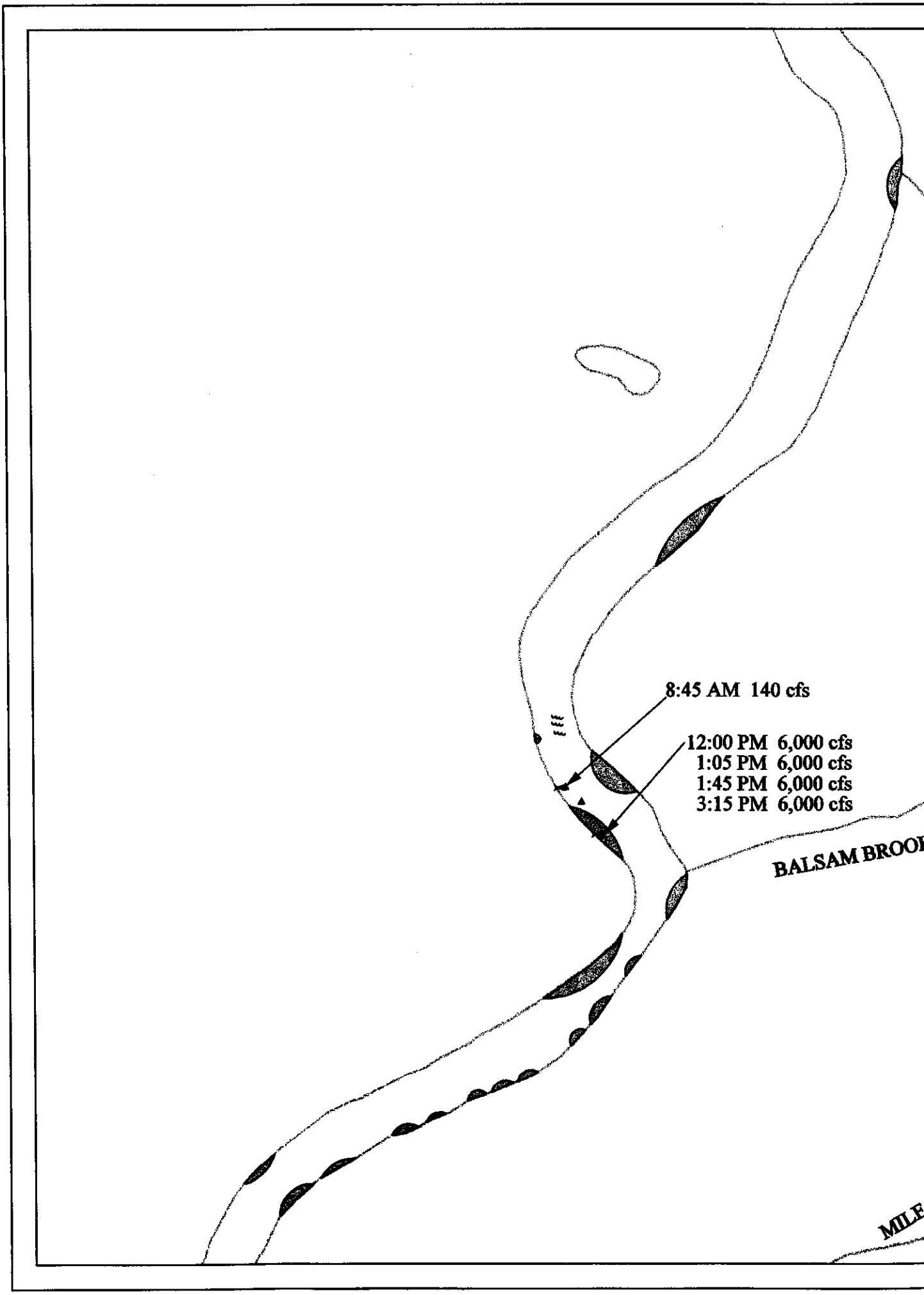
On October 8, 1999, monitoring was conducted between the hours of 8:00 AM and 10:15 AM. The minimum flow was 680 cfs at Harris Station until 6:00 AM. The generating flow was 6,600 cfs at Harris Station for the remainder of the day.

At 8:00 AM, the fish was located in rapids, mid-channel above the fourth ledge. The generating flow arrived at 8:45 AM. At 8:50 AM, the fish was located on river-right, in the between the third and fourth ledge. At 9:15 AM and 9:35 AM, the fish was located on river-right approximately 100 yards upstream from the fourth ledge. At 9:55 AM, the fish had moved to river-left into the run across from the fourth ledge. At 10:15 AM, the fish had moved to river-right, into the eddy by the fourth ledge.

200 100 0 200 400 600 YARDS

fs

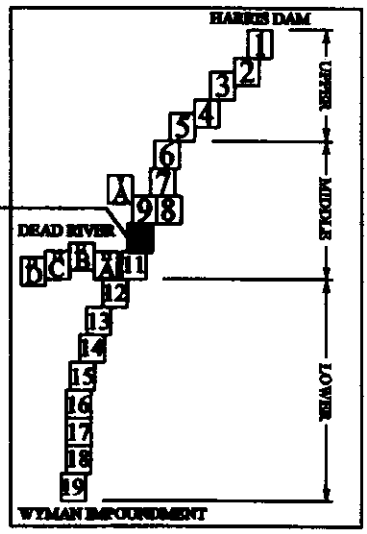
4 BROOK


8:45 AM 140 cfs
12:00 PM 6,000 cfs
1:05 PM 6,000 cfs
1:45 PM 6,000 cfs
3:15 PM 6,000 cfs
BALSAM BROOK
MILE

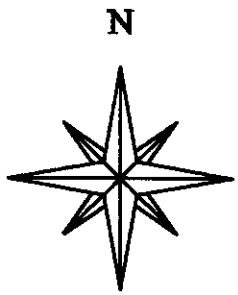
Intensive Monitoring Event for #49LLS, September 24, 1999

MOXIE STREAM

SHEET 10



LOCATION DIAGRAM



LEGEND

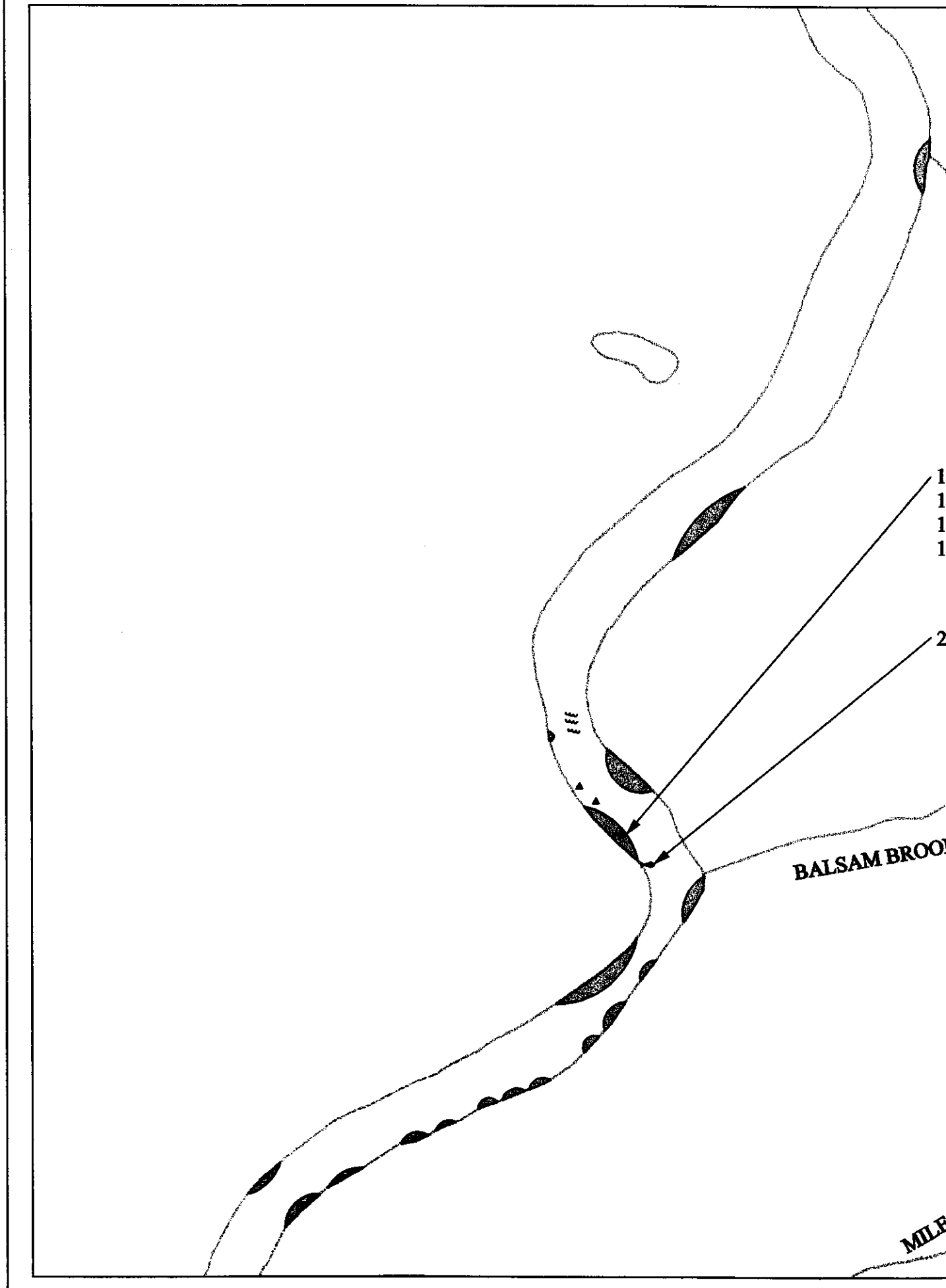
- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

On September 24, 1999, monitoring was conducted between the hours of 8:45 AM and 3:15 PM. The minimum flow was 140 cfs at Harris Station until 10:00 AM. The generating flow was 6,000 cfs at Harris Station from 10:00 AM until 12:00 PM, when it dropped to 680 cfs until 7:00 PM.

At 8:45 AM the fish was first located in the pool between the first and second ledges near river-right. The generating flow arrived at 11:53 AM. At 12:00 PM the fish moved downstream into the eddy on river-right, where it remained for the duration of the monitoring event. The river flow also remained near 6,000 cfs at the monitoring location for the duration of the event.

4 BROOK

200 100 0 200 400 600 YARDS

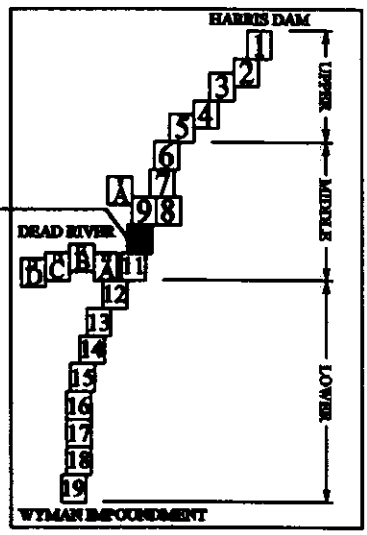

1
1
1
1
2
BALSAM BROO
MIL

Intensive Monitoring Event for #49LLS, September 25, 1999

MOXIE

STREAM

SHEET 10



LOCATION DIAGRAM

N

26 AM 300 cfs
50 AM 6,000 cfs
30 PM 6,000 cfs
0 PM 6,000 cfs

0 PM 6,000 cfs

LEGEND

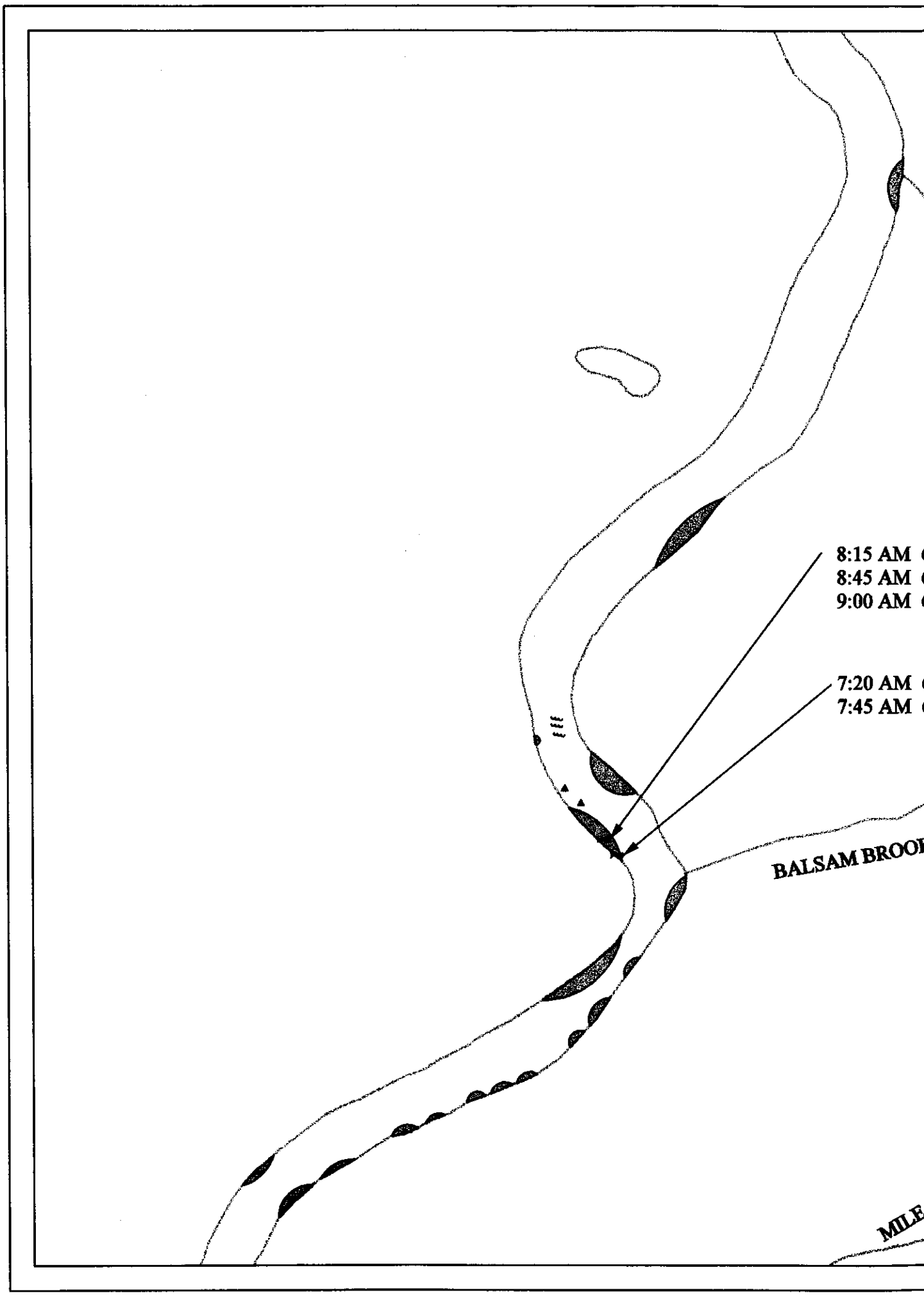
- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

On September 25, 1999, monitoring was conducted between the hours of 11:26 AM and 2:00 PM. The minimum flow was 300 cfs at Harris Station until 10:00 AM. The generating flow was 6,000 cfs at Harris Station from 10:00 AM until 12:00 PM, when it dropped to 680 cfs until 7:00 PM.

At 11:26 AM, the fish was located near Standup Rips on river-right, in the pool (an eddy at generation flow) in front of the campsite. The generating flow arrived at 11:50 AM. The fish was located in the same location until 2:00 PM when it was located in the riffle below the campsite on river-right.

BROOK

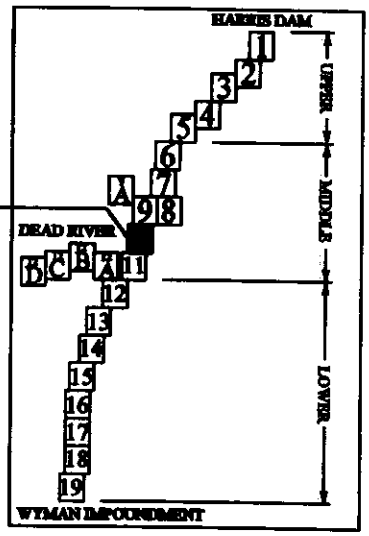
200 100 0 200 400 600 YARDS


8:15 AM
8:45 AM
9:00 AM
7:20 AM
7:45 AM
BALSAM BROOK
MILE

Intensive Monitoring Event for #49LLS, October 7, 1999

MOXIE STREAM

SHEET 10



LOCATION DIAGRAM

N

LEGEND

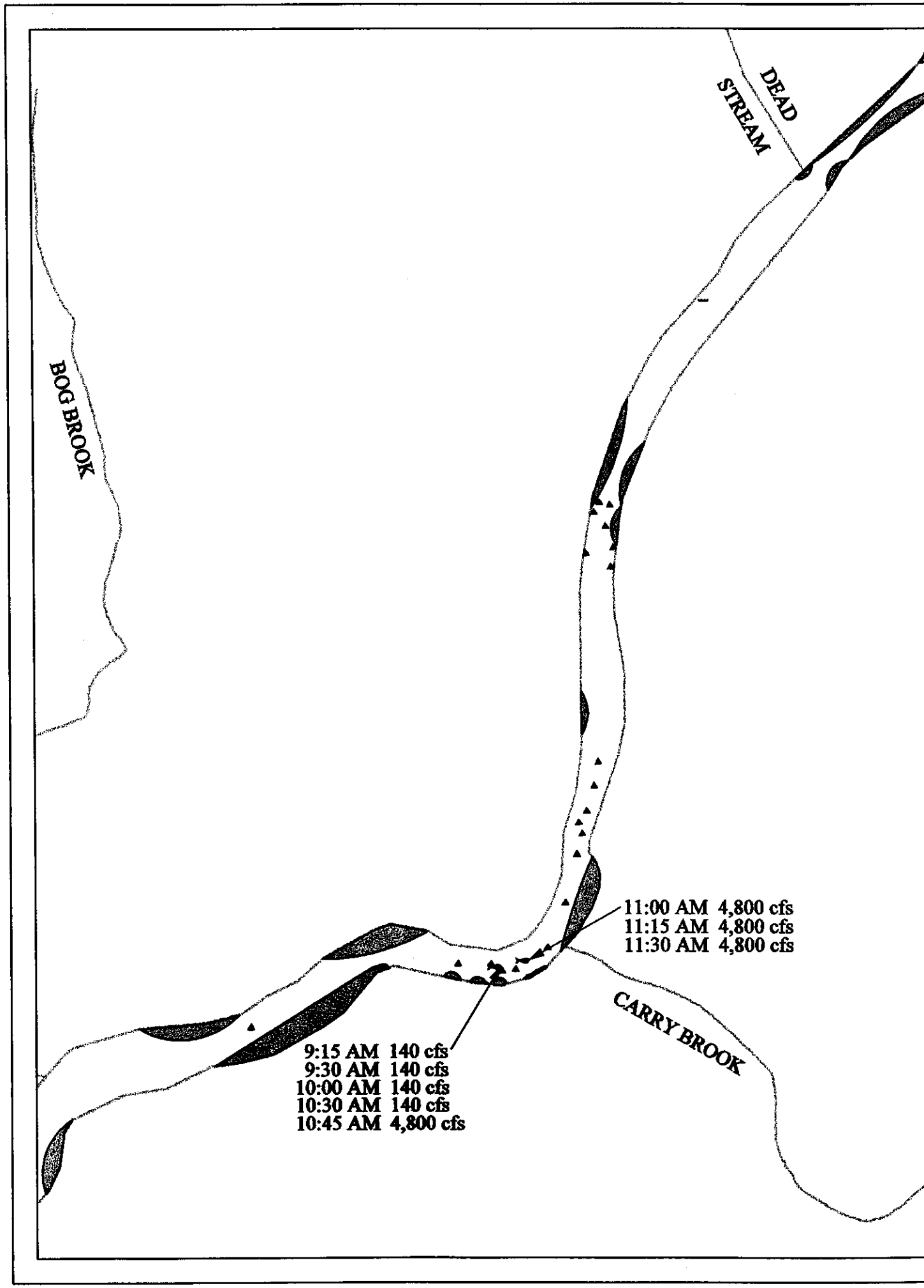
- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

On October 7, 1999, monitoring was conducted between the hours of 7:20 AM and 9:00 AM. The minimum flow was 680 cfs at Harris Station until 6:00 AM. The generating flow was 6,600 cfs at Harris Station from 6:00 AM for the remainder of the day

At 7:20 AM, the fish was located near Standup Rips on river-right, 100 feet below the campsite, in the riffle habitat. The generating flow arrived at 7:45 AM. The habitat changed from riffle to run once the generation flow arrived. The fish stayed in the same area as the 7:20 AM location. At 8:15 AM, the fish moved slightly up river, to the eddy in front of the campsite. The fish held this spot for the remainder of the monitoring event.

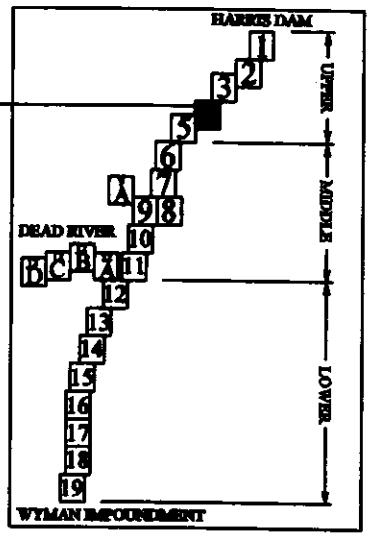
200 100 0 200 400 600 YARDS

00 cfs
00 cfs
00 cfs
) cfs
00 cfs
BROOK


DEAD STREAM
BOG BROOK
11:00 AM 4,800 cfs
11:15 AM 4,800 cfs
11:30 AM 4,800 cfs
CARRY BROOK
9:15 AM 140 cfs
9:30 AM 140 cfs
10:00 AM 140 cfs
10:30 AM 140 cfs
10:45 AM 4,800 cfs

Intensive Monitoring Event for #67LLS, August 11, 1999

SHEET 4



LOCATION DIAGRAM

N

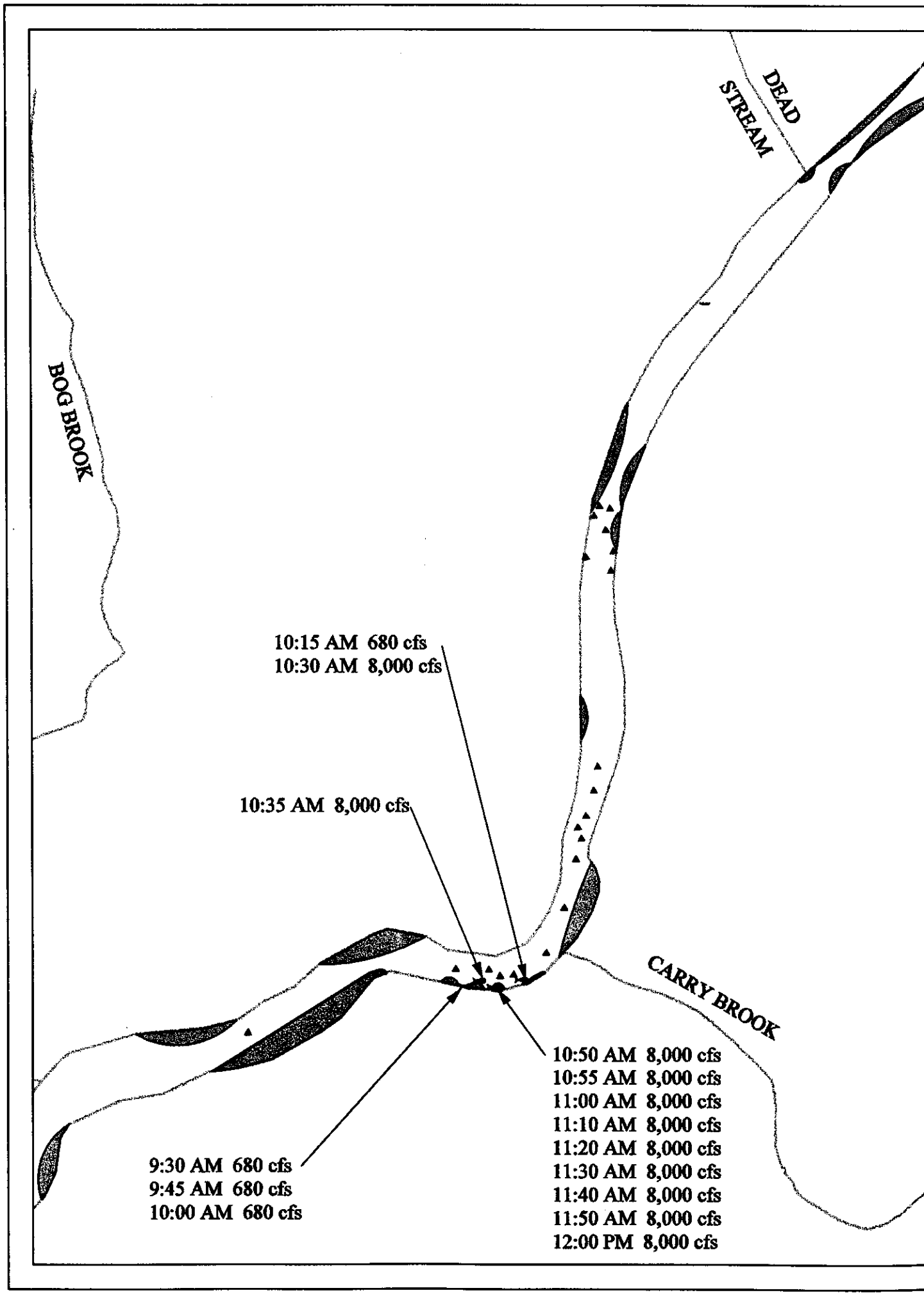
LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

On August 11, 1999, monitoring was conducted between the hours of 9:15 AM and 11:30 AM. The minimum flow was 140 cfs at Harris Station until 10:00 AM. The generating flow was 4,800 cfs at Harris Station from 10:00 AM until 12:00 PM.

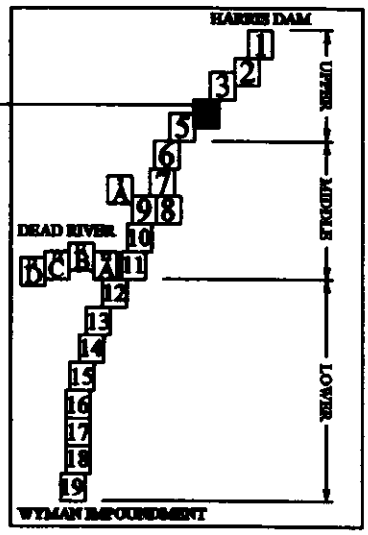
At 9:15 AM, the fish was first located at the tail end of the riffles across from the Northern Outdoors lunch site. The fish remained in this general location until the generating flow arrived at 10:45 AM. At that time, the fish moved upstream approximately 50 feet into boulder/eddy refugia located near river-left. The fish remained in this general location for the duration of the monitoring event.

200 100 0 200 400 600 YARDS


DEAD STREAM
BOG BROOK
10:15 AM 680 cfs
10:30 AM 8,000 cfs
10:35 AM 8,000 cfs
CARRY BROOK
10:50 AM 8,000 cfs
10:55 AM 8,000 cfs
11:00 AM 8,000 cfs
11:10 AM 8,000 cfs
11:20 AM 8,000 cfs
11:30 AM 8,000 cfs
11:40 AM 8,000 cfs
11:50 AM 8,000 cfs
12:00 PM 8,000 cfs
9:30 AM 680 cfs
9:45 AM 680 cfs
10:00 AM 680 cfs

Intensive Monitoring Event for #67LLS, September 10, 1999

SHEET 4



LOCATION DIAGRAM

N

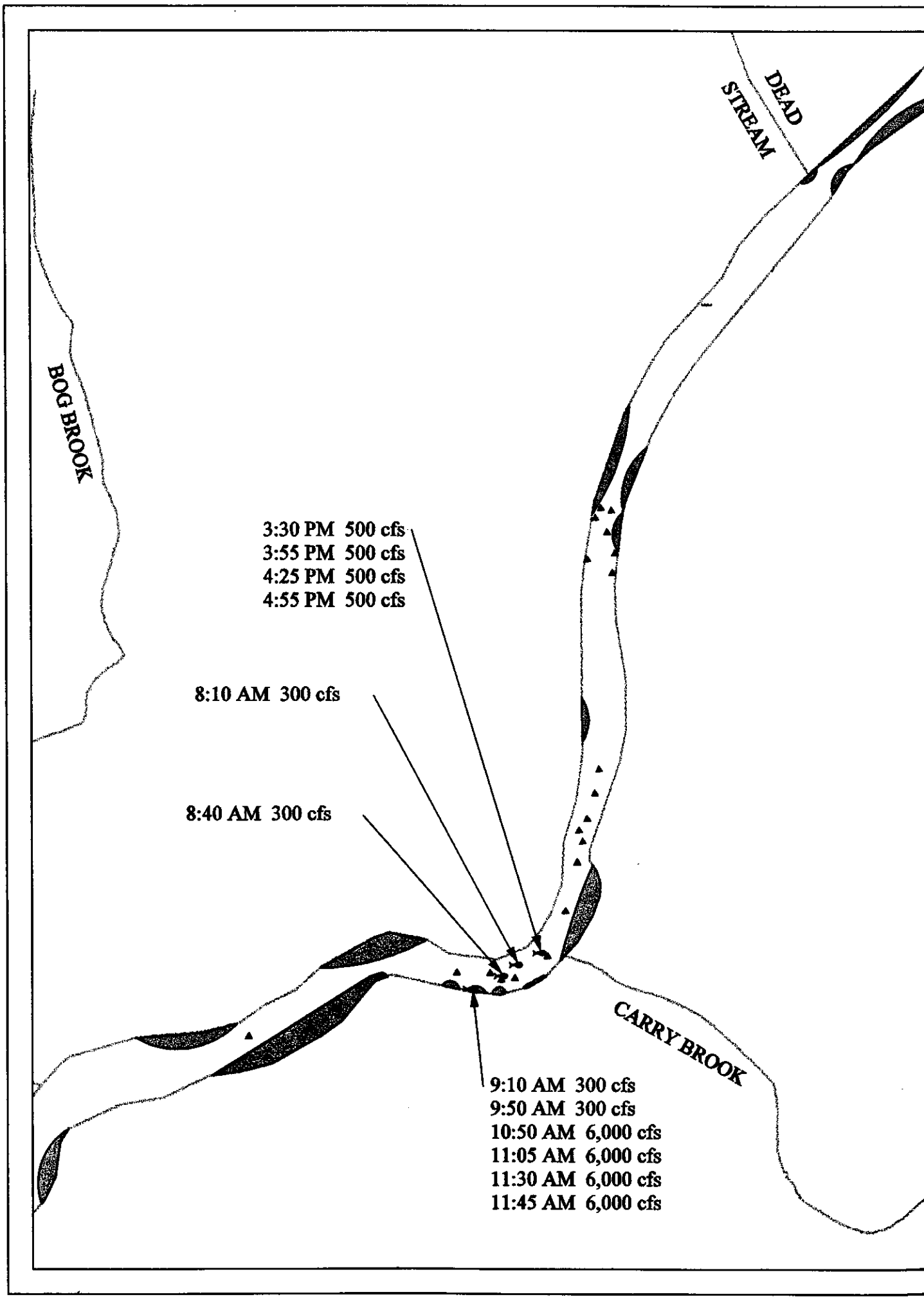
LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

On September 10, 1999, monitoring was conducted between the hours of 9:30 AM and 12:00 PM. The minimum flow was 140 cfs at Harris Station until 7:00 AM. From 7:00 AM to 10:00 AM, the minimum flow increased to 680 cfs at Harris Station. The generating flow was 8,000 cfs at Harris Station from 10:00 AM until 2:00 PM.

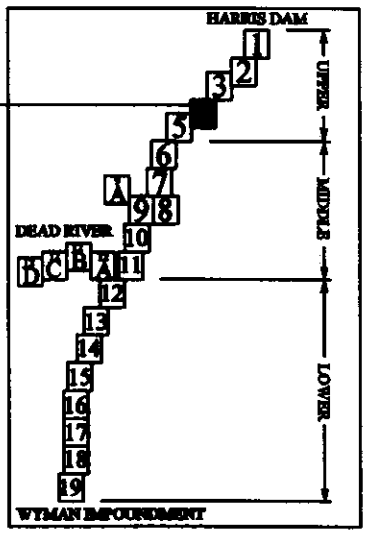
At 9:30 AM, at a flow of 680 cfs, the fish was located below Carry Brook on river-left at the second ledge across from Northern Outdoors lunch site. The fish held in this location until 10:15 AM, when it moved up river to the head of the pool on river-left. The generation flow of 8,000 cfs arrived at 10:25 AM. The fish was located at 10:30 AM in the same location as 10:15 AM. At 10:35 AM the fish moved down river about 50 feet on river-left. At 10:50 AM, the fish had moved up river, on river-left, into the eddy near the first ledge where it stayed for the remainder of the monitoring event.

200 100 0 200 400 600 YARDS

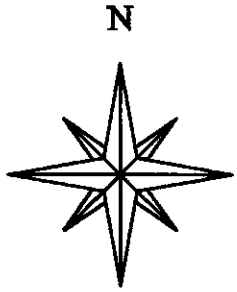

DEAD STREAM
BOG BROOK
3:30 PM 500 cfs
3:55 PM 500 cfs
4:25 PM 500 cfs
4:55 PM 500 cfs
8:10 AM 300 cfs
8:40 AM 300 cfs
CARRY BROOK
9:10 AM 300 cfs
9:50 AM 300 cfs
10:50 AM 6,000 cfs
11:05 AM 6,000 cfs
11:30 AM 6,000 cfs
11:45 AM 6,000 cfs

Intensive Monitoring Event for #67LLS, September 25, 1999

SHEET 4



LOCATION DIAGRAM

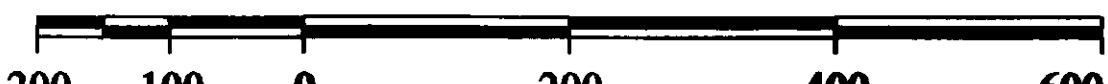


LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

On September 25, 1999, monitoring was conducted between the hours of 8:10 AM and 4:55 PM. The minimum flow was 300 cfs at Harris Station until 10:00 AM. The generating flow was 6,000 cfs from 10:00 AM until 12:00 PM. From 12:00 PM until 4:00 PM, the minimum flow was approximately 500 cfs at Harris Station.

At 8:10 AM the fish was located at the head of pool at Northern Outdoors lunch site. At 8:40 AM the fish had moved into a riffle opposite Northern Outdoors lunch site. At 9:10 AM the fish had moved into the eddy opposite the Northern Outdoors lunch site. The generation flow arrived at approximately 10:35 AM. The fish remained in the eddy through 11:45 AM. At 3:30 PM, during the 500 cfs flow, the fish moved into the pool at the base of the Carry Brook stairs where it stayed for the duration of the monitoring event.

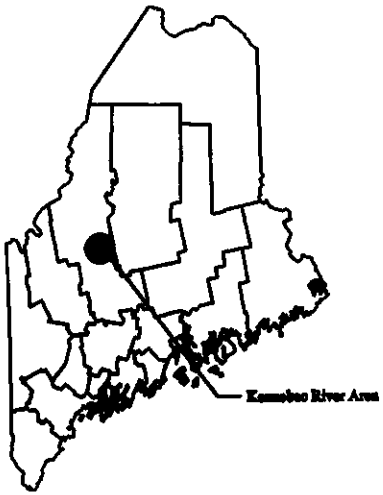


Appendix 4

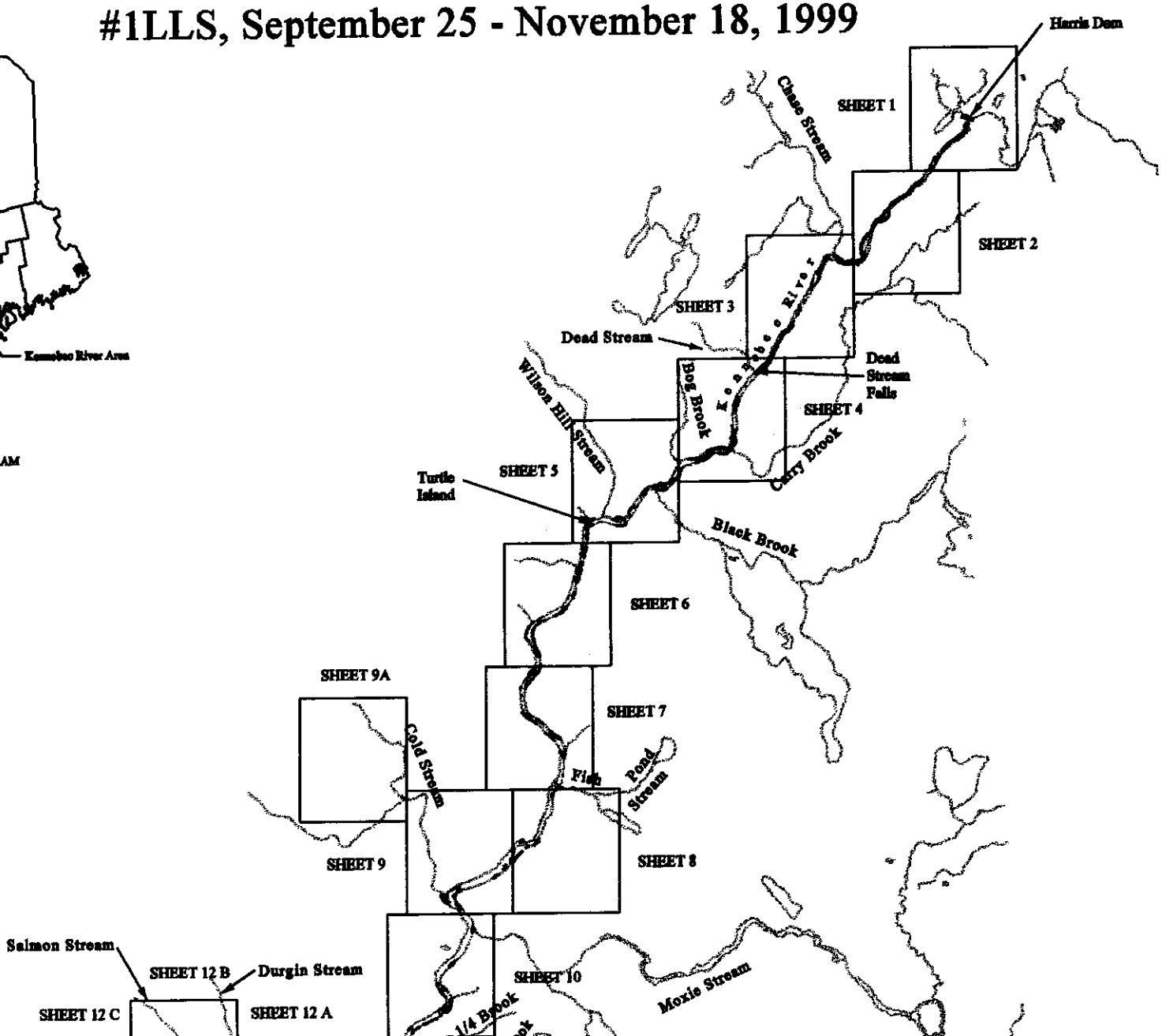
Fish Movements over the Course of the Radio Telemetry Study

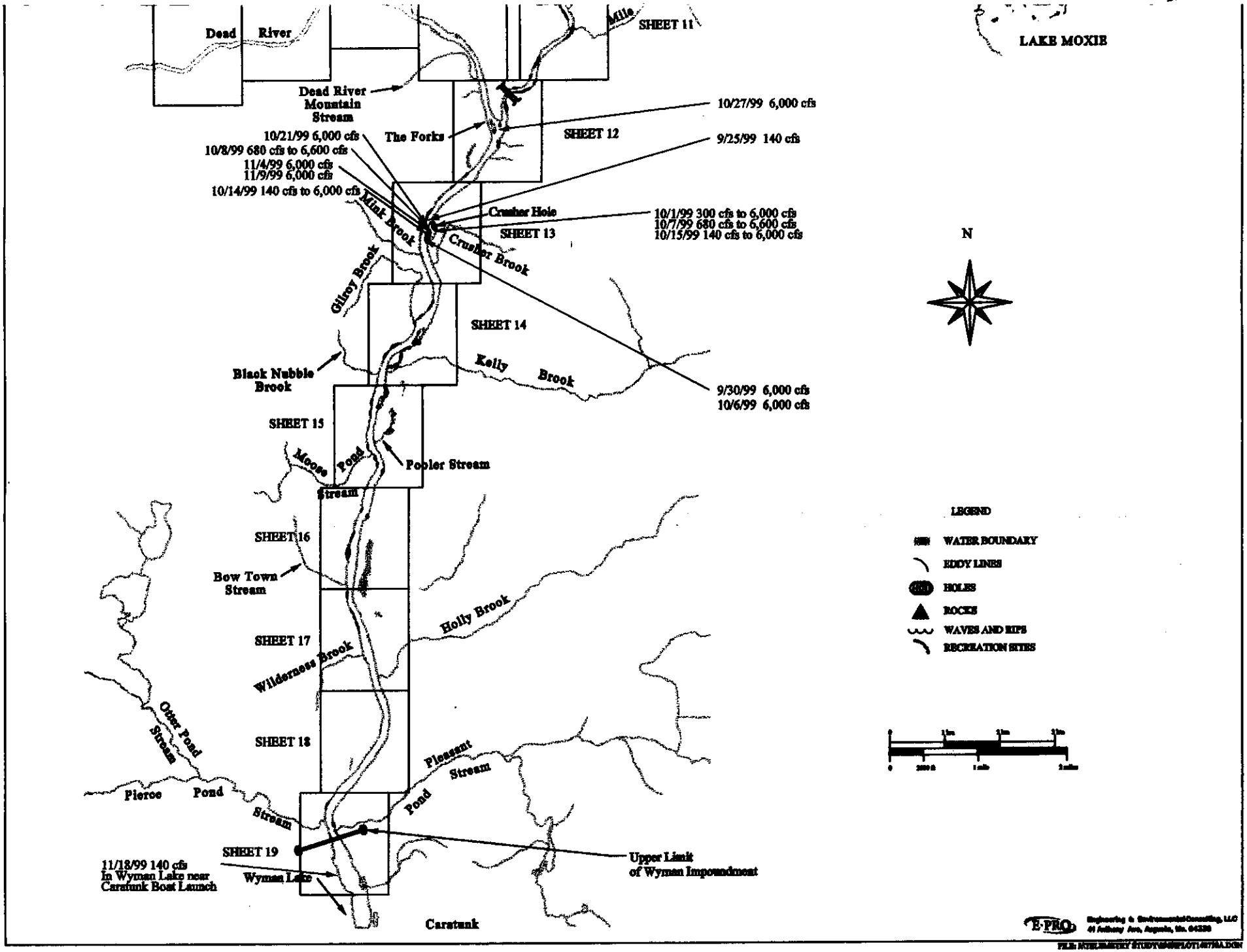
This appendix contains representative computer-generated maps of fish movements documented during the radio telemetry study. Additional maps will be provided by FPLE upon request.

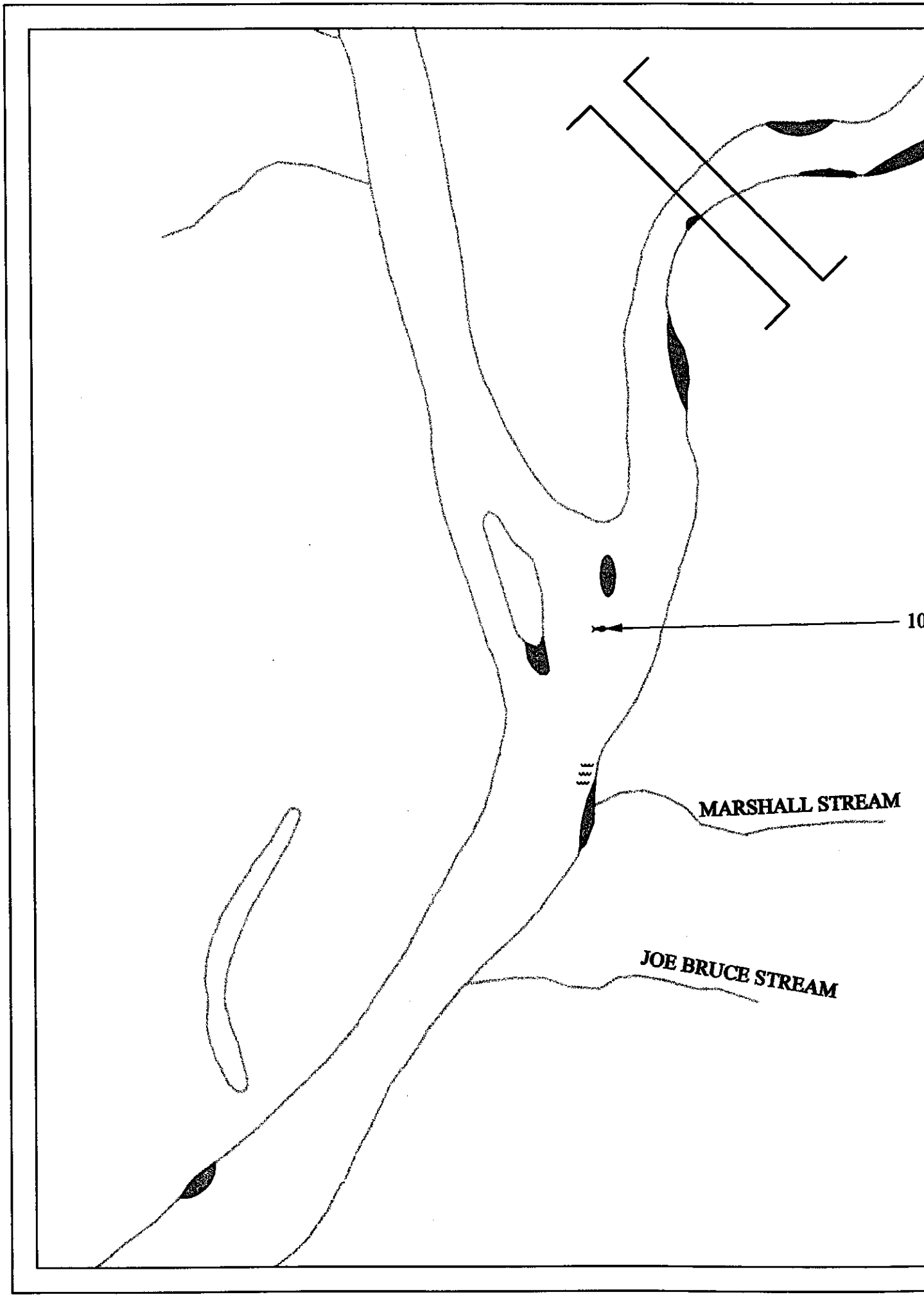
Fish Movement over the Course of the Radio Telemetry Study
#1LLS, September 25 - November 18, 1999



LOCATION DIAGRAM

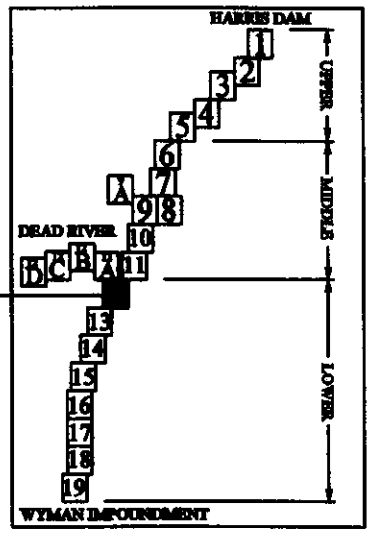



Dead River
SHEET 11
LAKE MOXIE
Dead River Mountain Stream
10/27/99 6,000 cfs
The Forks
SHEET 12
9/25/99 140 cfs
10/21/99 6,000 cfs
10/8/99 680 cfs to 6,600 cfs
11/4/99 6,000 cfs
11/9/99 6,000 cfs
10/14/99 140 cfs to 6,000 cfs
Mink Brook
Crusher Hole
10/1/99 300 cfs to 6,000 cfs
10/7/99 680 cfs to 6,600 cfs
10/15/99 140 cfs to 6,000 cfs
SHEET 13
Crusher Brook
Gilroy Brook
SHEET 14
Black Nubble Brook
Kelly Brook
9/30/99 6,000 cfs
10/6/99 6,000 cfs
SHEET 15
Moose Pond Stream
Pooler Stream
SHEET 16
Bow Town Stream
Holly Brook
SHEET 17
Wilderness Brook
Otter Pond Stream
SHEET 18
Pleasant Pond Stream
Pierce Pond Stream
SHEET 19
11/18/99 140 cfs in Wyman Lake near Carratunk Boat Launch
Wyman Lake
Upper Limit of Wyman Impoundment
Carratunk
N
LEGEND
WATER BOUNDARY
EDDY LINES
HOLES
ROCKS
WAVES AND RIPS
RECREATION SITES
E-PRO

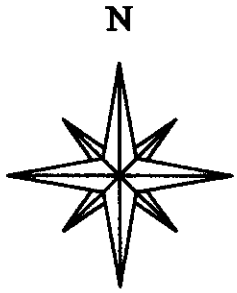

10
MARSHALL STREAM
JOE BRUCE STREAM

Fish Movement over the Course of the Radio Telemetry Study #1LLS, September 25 - November 18, 1999

SHEET 12



LOCATION DIAGRAM



LEGEND

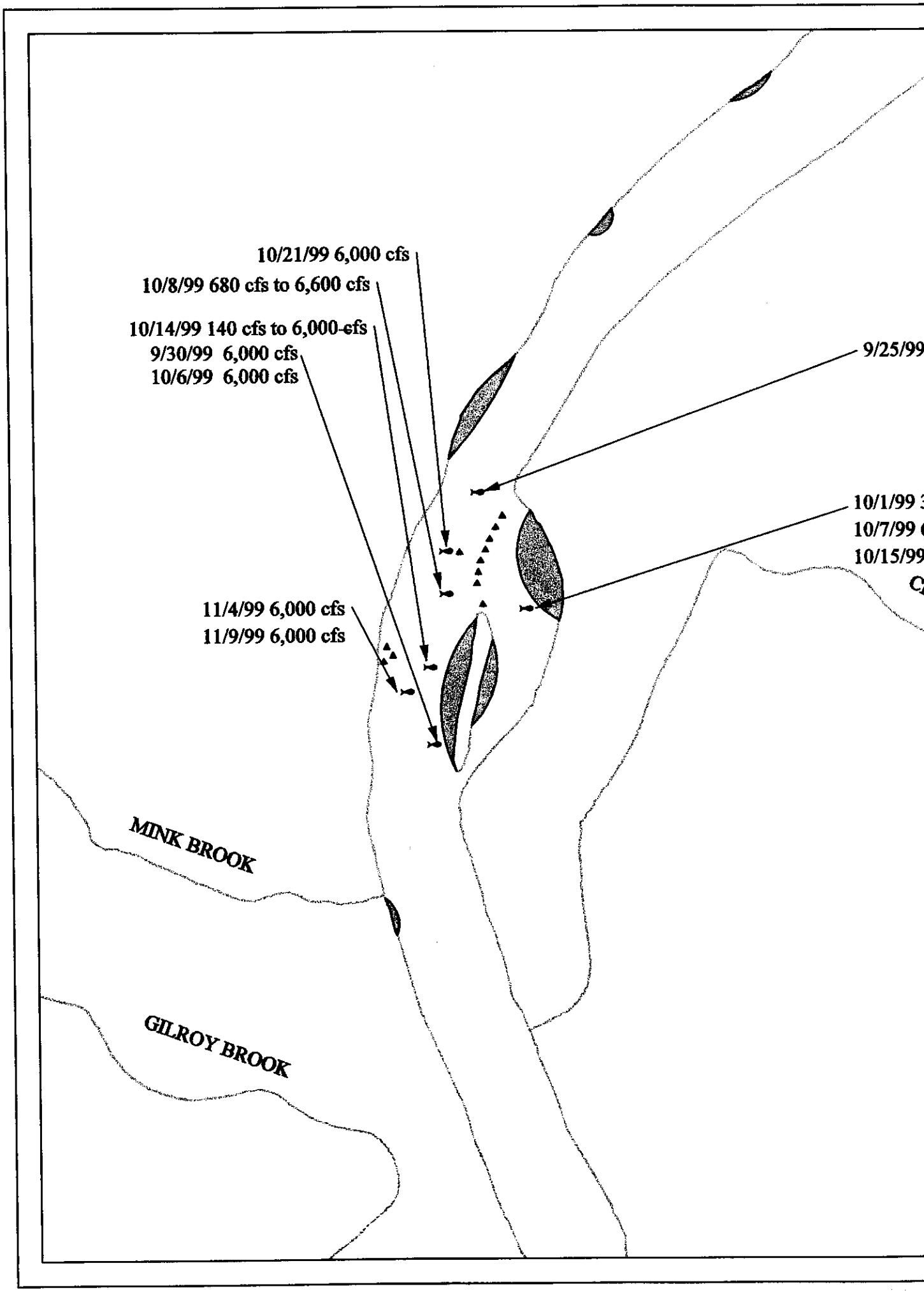
- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

7/99 6,000 cfs

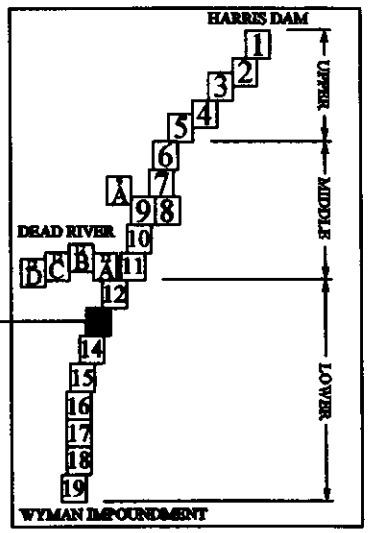
The fish was captured on September 25, 1999, near Crusher Hole. During a spot check on September 30, the fish was still located near Crusher Hole.

The fish was also the subject of five Intensive Monitoring Events. On October 1, the fish was the subject of an Intensive Monitoring Event during a 300 cfs minimum flow to 6,000 cfs generating flow in the Crusher Hole area. The fish was located again in the Crusher Hole area during a spot check on October 6. On both October 7 and October 8, the fish was monitored during a 680 cfs minimum flow to 6,600 cfs generating flow. On October 14 and 15, the fish was monitored during a 140 cfs minimum flow to 6,000 cfs generating flow. The fish remained in the same general area during all flow changes.

Five aerial checks were conducted during the fall of 1999. On October 21, at 6,000 cfs, the fish was located at Crusher Hole. On October 27, at 6,000 cfs, the fish had moved up river to The Forks area at the mouth of the Dead River. On November 4 and November 9, the fish was located in the Crusher Hole area. On November 18, the fish was located in Wyman Lake near the Caratunk boat launch.


10/21/99 6,000 cfs
10/8/99 680 cfs to 6,600 cfs
10/14/99 140 cfs to 6,000 cfs
9/30/99 6,000 cfs
10/6/99 6,000 cfs
9/25/99
10/1/99
10/7/99
10/15/99
11/4/99 6,000 cfs
11/9/99 6,000 cfs
MINK BROOK
GILROY BROOK

Fish Movement over the Course of the Radio Telemetry Study #1LLS, September 25 - November 18, 1999



LOCATION DIAGRAM

SHEET 13

N

LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

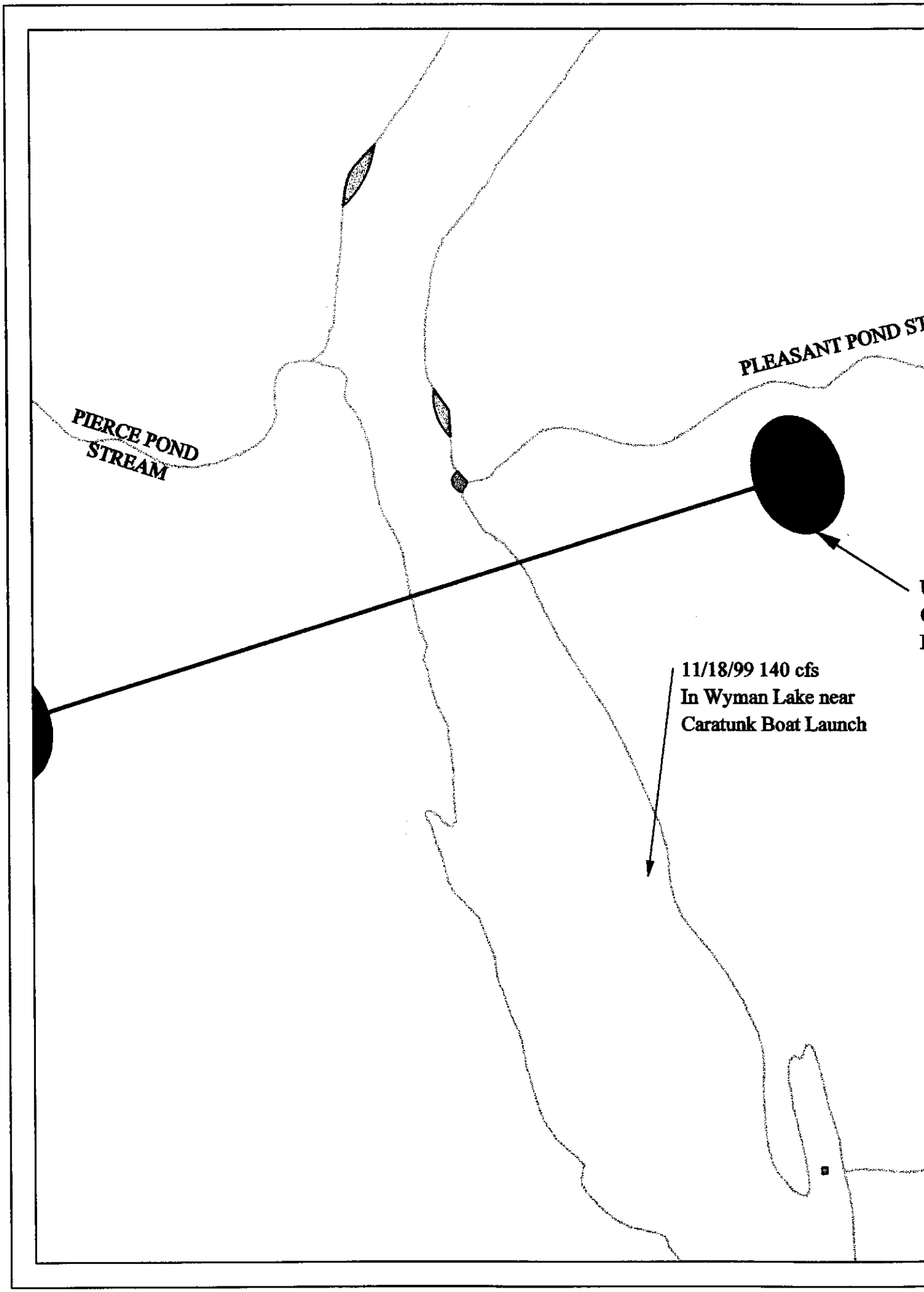
The fish was captured on September 25, 1999, near Crusher Hole. During a spot-check on September 30, the fish was still located near Crusher Hole.

The fish was also the subject of five Intensive Monitoring Events. On October 1, the fish was the subject of an Intensive Monitoring Event during a 300 cfs minimum flow to 6,000 cfs generating flow in the Crusher Hole area. The fish was located again in the Crusher Hole area during a spot check on October 6. On both October 7 and October 8, the fish was monitored during a 680-cfs minimum flow to 6,600 cfs generating flow. On October 14 and 15, the fish was monitored during a 140 cfs minimum flow to 6,000 cfs generating flow. The fish remained in the same general area during all flow changes.

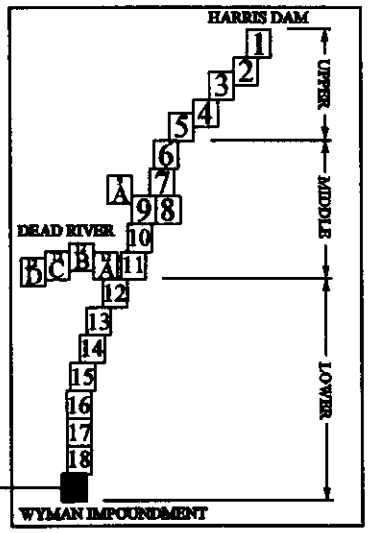
Five aerial checks were conducted during the fall of 1999. On October 21, at 6,000 cfs, the fish was located at Crusher Hole. On October 27, at 6,000 cfs, the fish had moved up river to The Forks area at the mouth of the Dead River. On November 4 and November 9, the fish was located in the Crusher Hole area. On November 18, the fish was located in Wyman Lake near the Caratunk boat launch.

200 100 0 200 400 600 YARDS

E-PRO Engineering & Environmental Consulting, LLC 41 Anthony Ave, Augusta, Me. 04330


PLEASANT POND ST
PIERCE POND
STREAM
11/18/99 140 cfs
In Wyman Lake near
Caratunk Boat Launch

Fish Movement over the Course of the Radio Telemetry Study #1LLS September 25 - November 18, 1999



LOCATION DIAGRAM

SHEET 19

N

LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

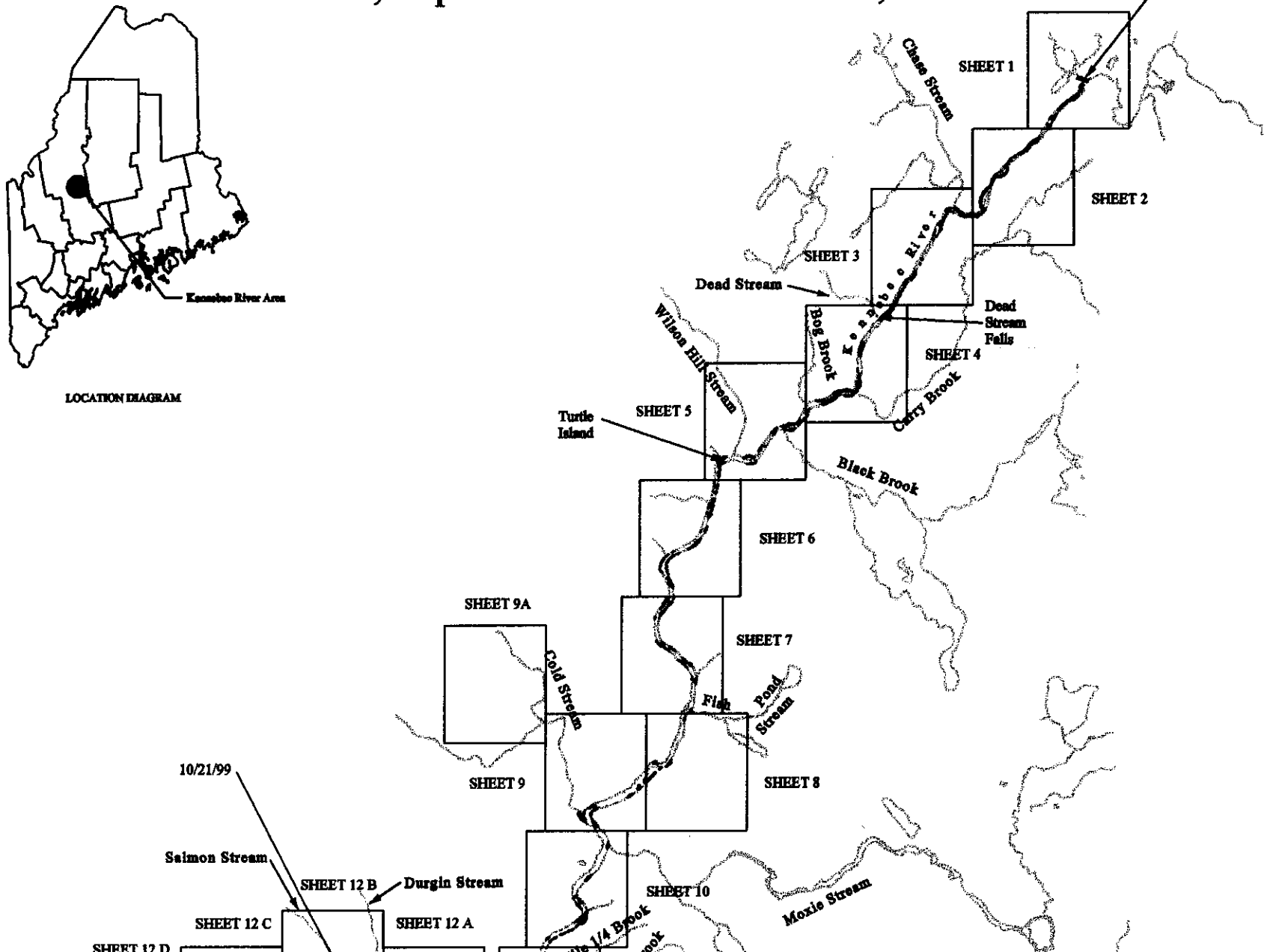
The fish was captured on September 25, 1999, near Crusher Hole. During a spot check on September 30, the fish was still located near Crusher Hole.

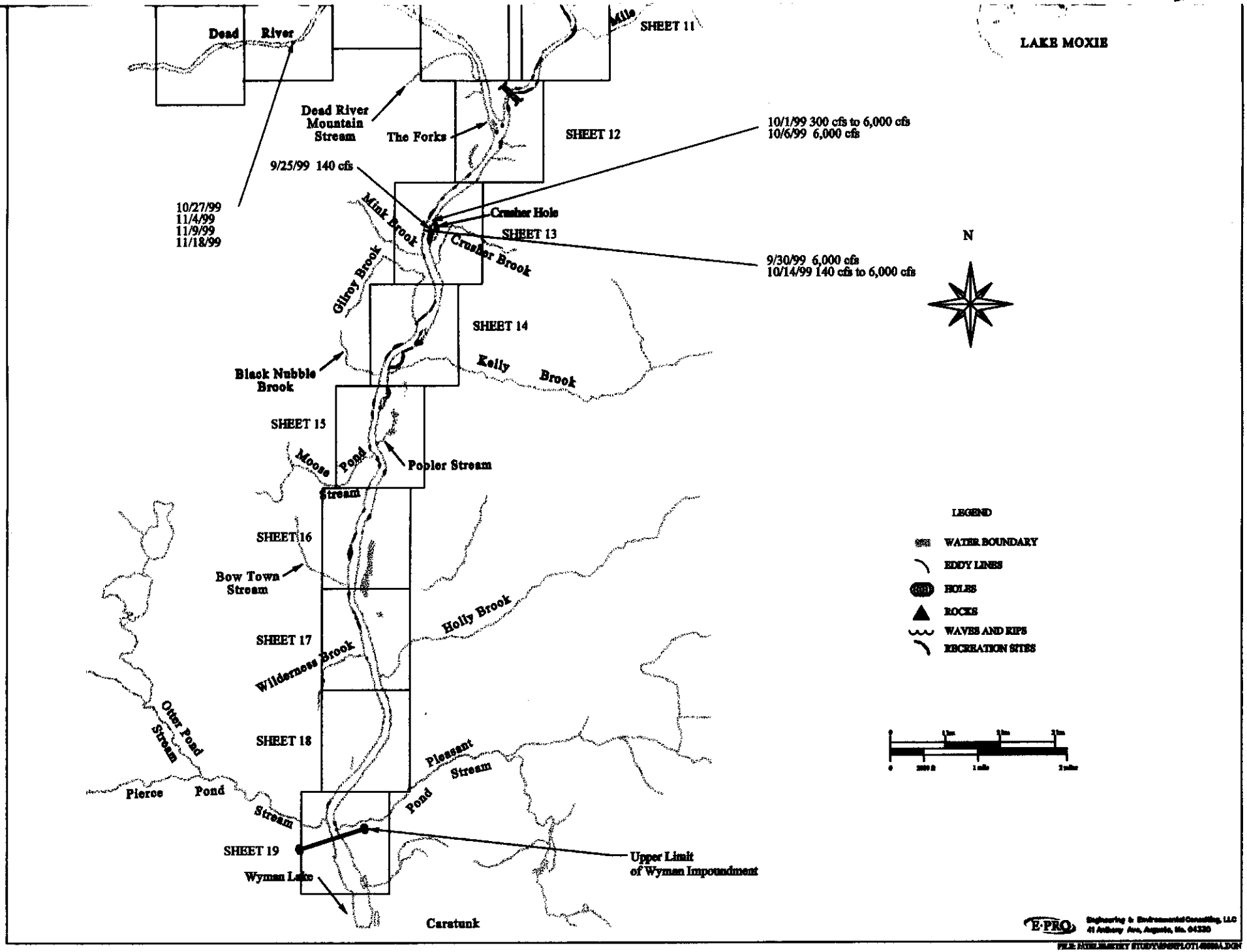
The fish was also the subject of five Intensive Monitoring Events. On October 1, the fish was the subject of an Intensive Monitoring Event during a 300 cfs minimum flow to 6,000 cfs generating flow in the Crusher Hole area. The fish was located again in the Crusher Hole area during a spot check on October 6. On both October 7 and October 8, the fish was monitored during a 680-cfs minimum flow to 6,600 cfs generating flow. On October 14 and 15, the fish was monitored during a 140 cfs minimum flow to 6,000 cfs generating flow. The fish remained in the same general area during all flow changes.

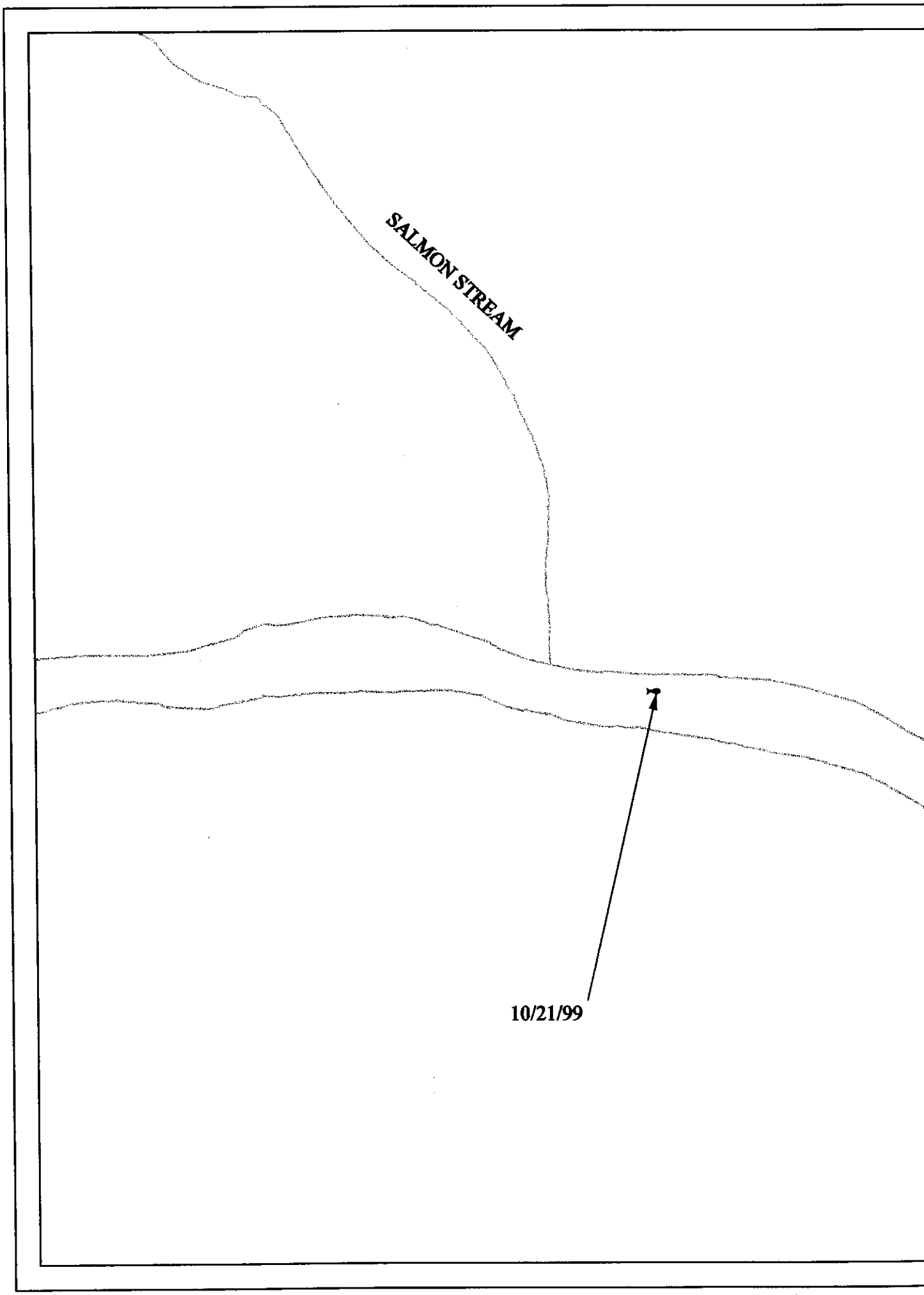
Five aerial checks were conducted during the fall of 1999. On October 21, at 6,000 cfs, the fish was located at Crusher Hole. On October 27, at 6,000 cfs, the fish had moved up river to The Forks area at the mouth of the Dead River. On November 4 and November 9, the fish was located in the Crusher Hole area. On November 18, the fish was located in Wyman Lake near the Caratunk boat launch.

200 100 0 200 400 600 YARDS

Fish Movement over the Course of the Radio Telemetry Study
#4LLS, September 25 - November 18, 1999



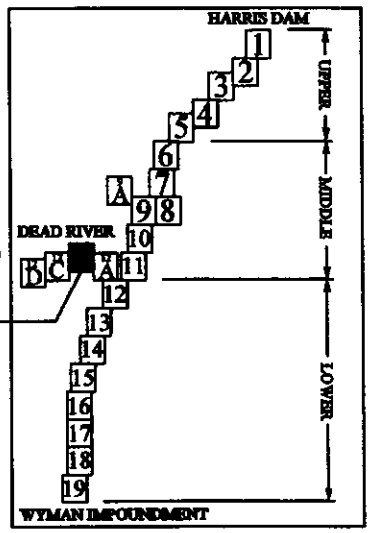

Dead River
SHEET 11
LAKE MOXIE
Dead River Mountain Stream
The Forks
SHEET 12
10/1/99 300 cfs to 6,000 cfs
10/6/99 6,000 cfs
9/25/99 140 cfs
10/27/99
11/4/99
11/9/99
11/18/99
Mink Brook
Crusher Hole
SHEET 13
Crusher Brook
9/30/99 6,000 cfs
10/14/99 140 cfs to 6,000 cfs
N
Gilroy Brook
SHEET 14
Kelly Brook
Black Nubble Brook
SHEET 15
Moose Pond
Stream
Popler Stream
SHEET 16
Bow Town Stream
Holly Brook
SHEET 17
Wilderness Brook
Otter Pond Stream
SHEET 18
Pleasant Stream
Pierce Pond
Stream
Pond
SHEET 19
Upper Limit of Wyman Impoundment
Wyman Lake
Carratunk
LEGEND
WATER BOUNDARY
EDDY LINES
HOLES
ROCKS
WAVES AND RIPS
RECREATION SITES
E-PRO


SALMON STREAM
10/21/99

Fish Movement over the Course of the Radio Telemetry Study #4LLS, September 25 - November 18, 1999

DURGIN STREAM

SHEET 12B



LOCATION DIAGRAM

N

LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on September 25, 1999, near Crusher Hole. During a spot check on September 30, it was located near Crusher Hole during a 6,000 cfs generating flow. On October 6, the fish was again located near Crusher Hole.

The fish was also the subject of two Intensive Monitoring Events. On October 1, the fish was monitored during a 300 cfs minimum flow to 6,000 cfs generating flow. On October 14, the fish was monitored during a 140 cfs minimum flow to 6,000 cfs generating flow.

Five aerial checks were conducted during the fall of 1999. On October 21, the fish was located up the Dead River about 100 yards down river from Salmon Stream. On October 27, the fish had moved further up the Dead River, approximately 1 mile above Salmon Stream. On November 4, November 9 and November 18, the fish was located in the Dead River, 100-200 yards upstream of the confluence with Gulf Stream.

200 100 0 200 400 600 YARDS

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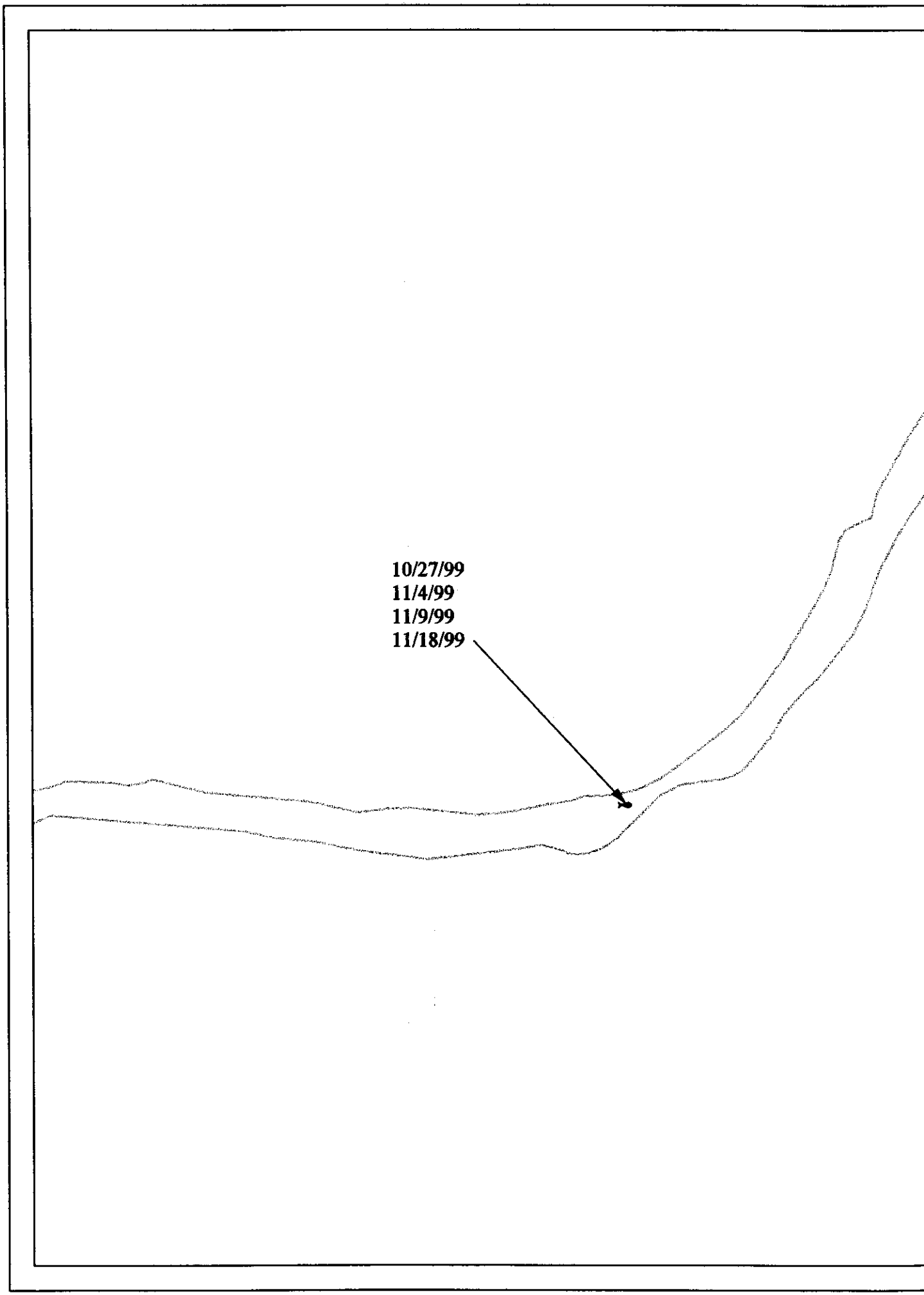
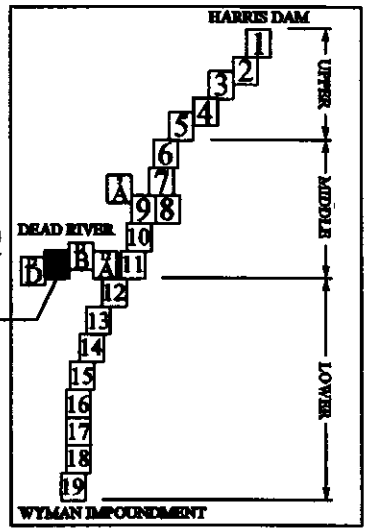

10/27/99
11/4/99
11/9/99
11/18/99

Fish Movement over the Course of the Radio Telemetry Study #4LLS, September 25 - November 18, 1999

SHEET 12C



LOCATION DIAGRAM

N

LEGEND

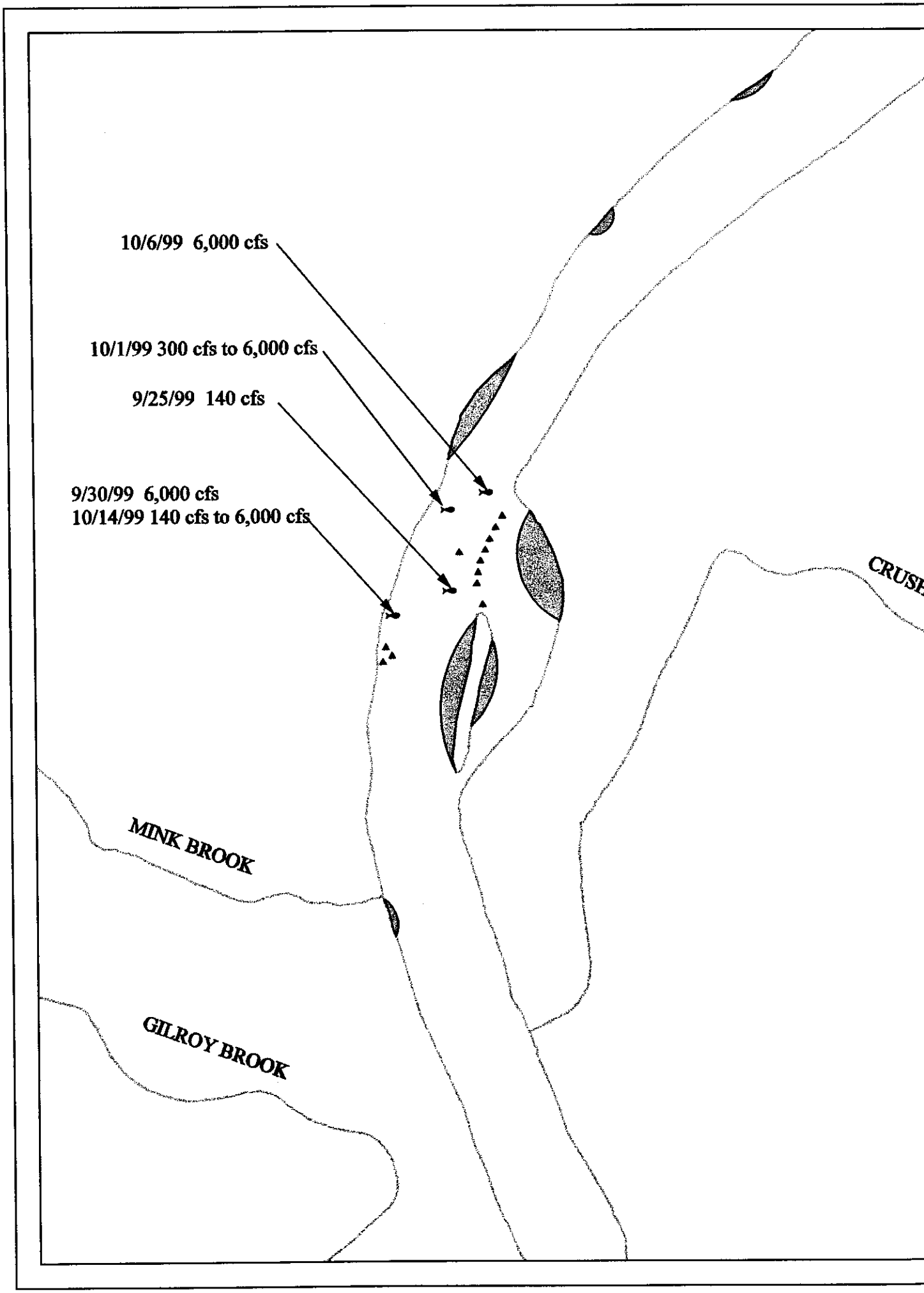
- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on September 25, 1999, near Crusher Hole. During a spot check on September 30, it was located near Crusher Hole during a 6,000 cfs generating flow. On October 6, the fish was again located near Crusher Hole.

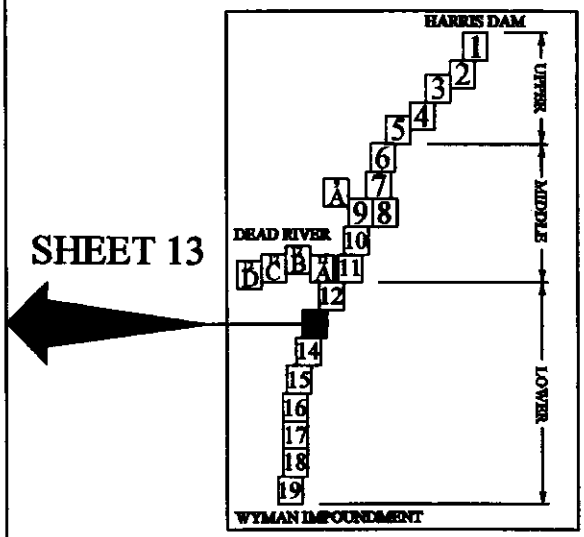
The fish was also the subject of two Intensive Monitoring Events. On October 1, the fish was monitored during a 300 cfs minimum flow to 6,000 cfs generating flow. On October 14, the fish was monitored during a 140 cfs minimum flow to 6,000 cfs generating flow.

Five aerial checks were conducted during the fall of 1999. On October 21, the fish was located up the Dead River about 100 yards down river from Salmon Stream. On October 27, the fish had moved further up the Dead River, approximately 1 mile above Salmon Stream. On November 4, November 9 and November 18, the fish was located in the Dead River, 100-200 yards upstream of the confluence with Gulf Stream.

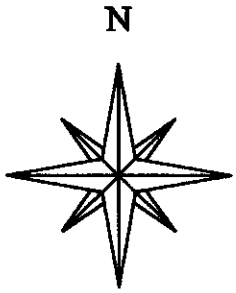
200 100 0 200 400 600 YARDS


10/6/99 6,000 cfs
10/1/99 300 cfs to 6,000 cfs
9/25/99 140 cfs
9/30/99 6,000 cfs
10/14/99 140 cfs to 6,000 cfs
MINK BROOK
GILROY BROOK

Fish Movement over the Course of the Radio Telemetry Study #4LLS, September 25 - November 18, 1999



LOCATION DIAGRAM



LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on September 25, 1999, near Crusher Hole. During a spot check on September 30, it was located near Crusher Hole during a 6,000 cfs generating flow. On October 6, the fish was again located near Crusher Hole.

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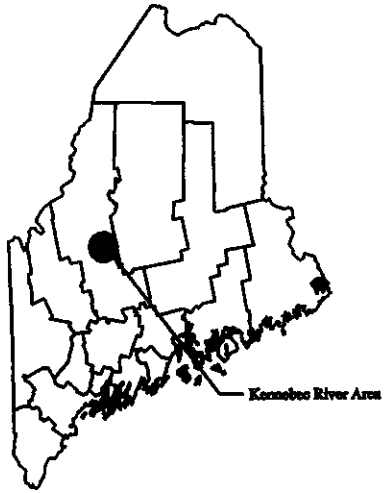
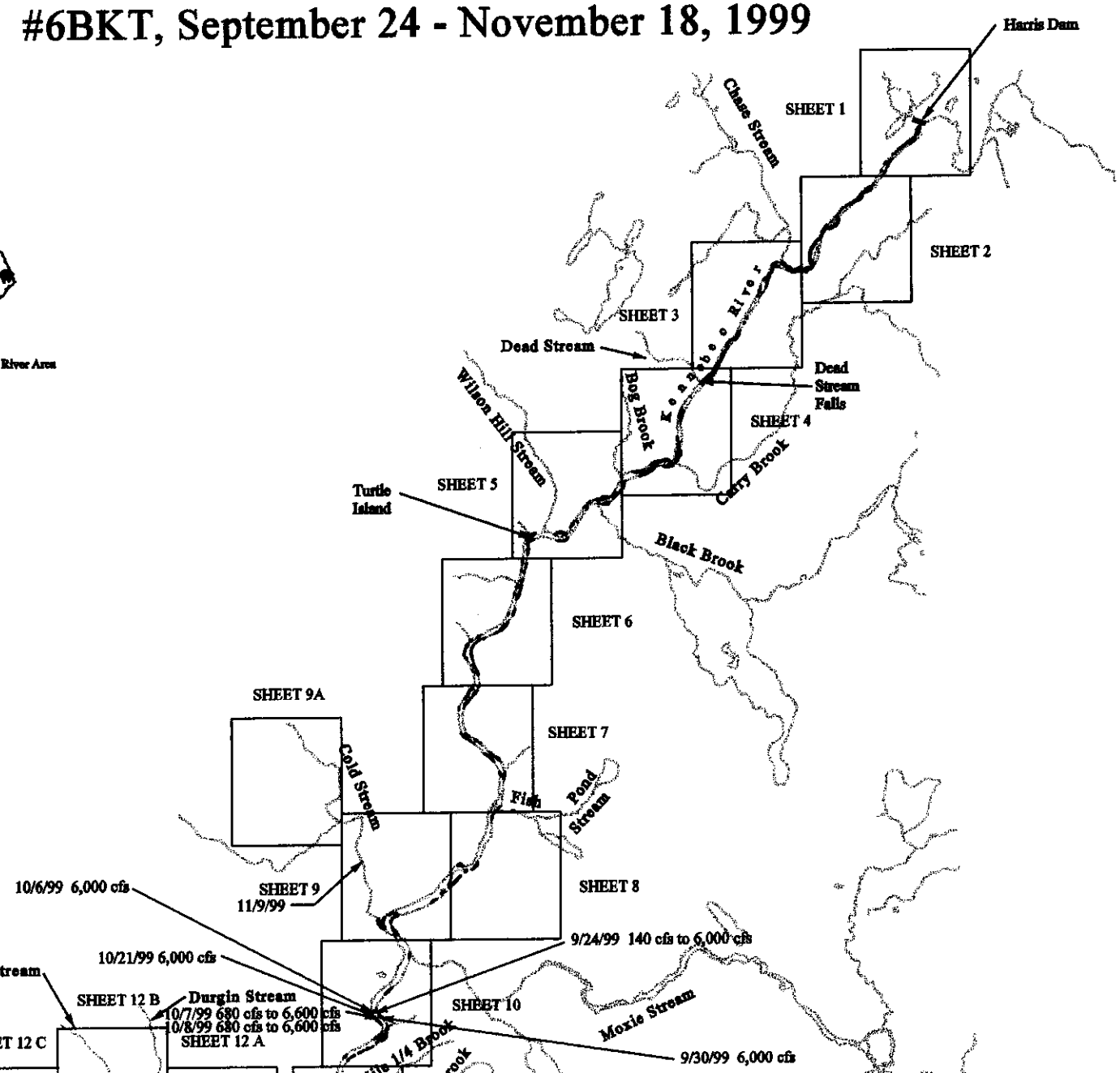
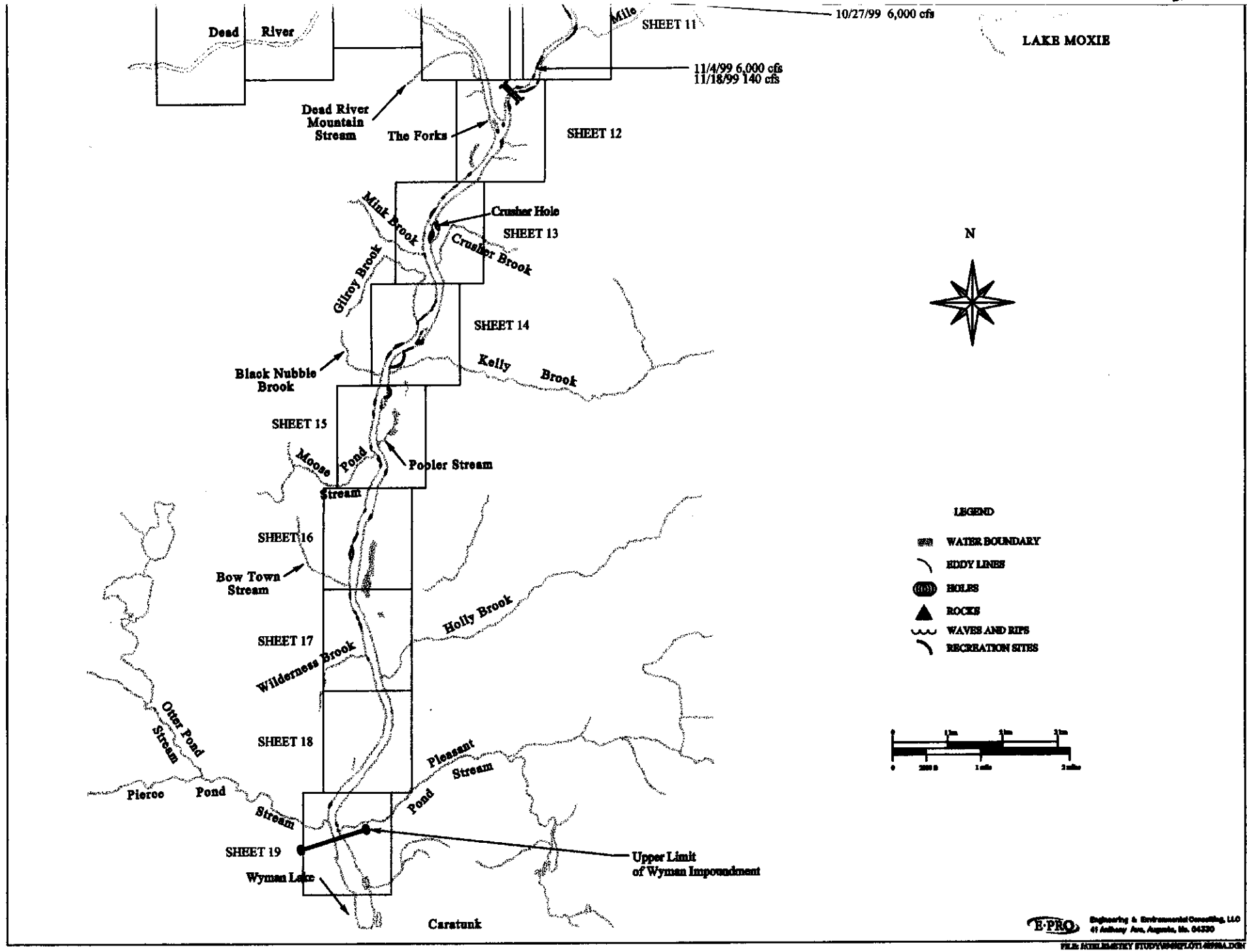
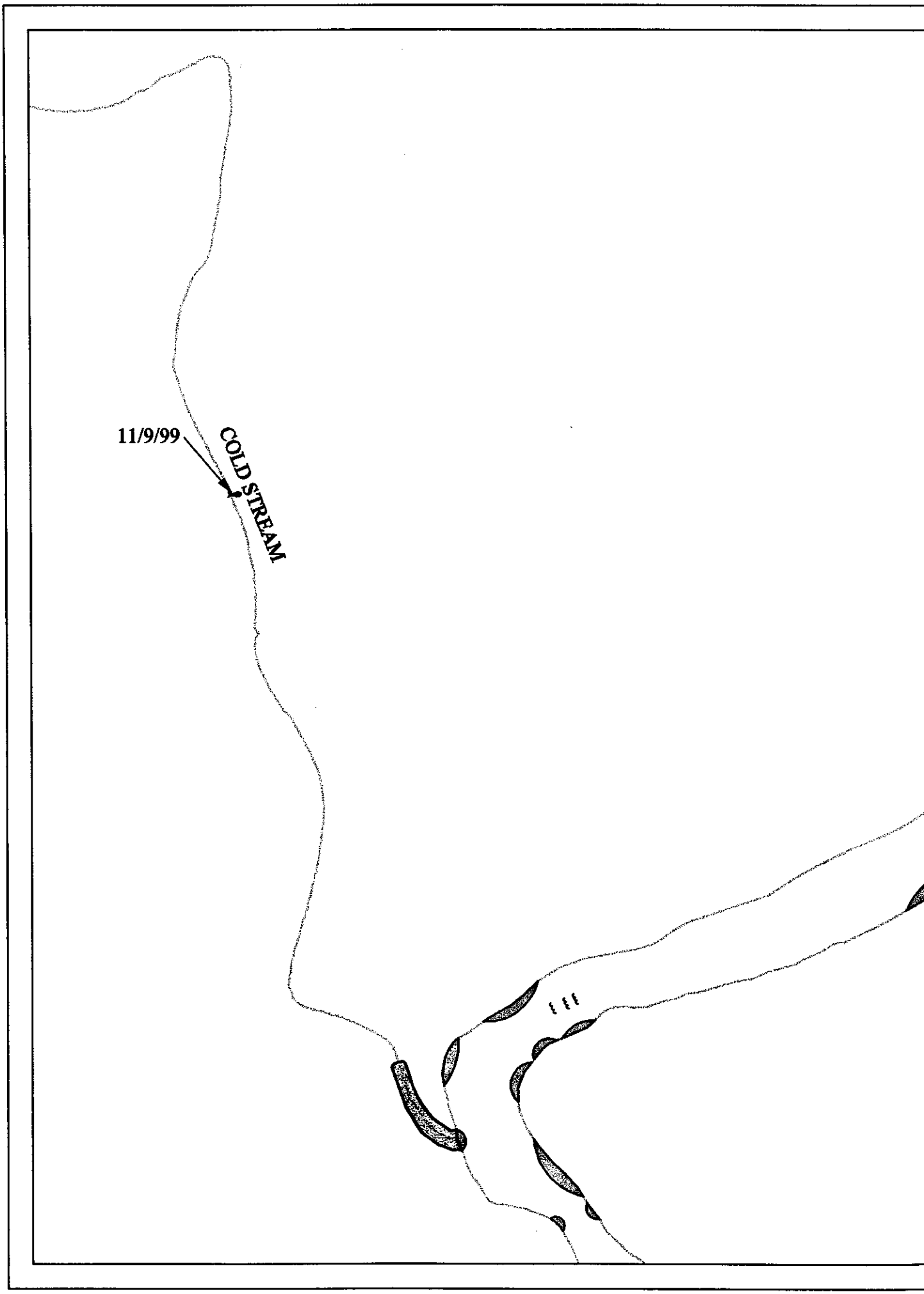
Fish Movement over the Course of the Radio Telemetry Study
#6BKT, September 24 - November 18, 1999



LOCATION DIAGRAM

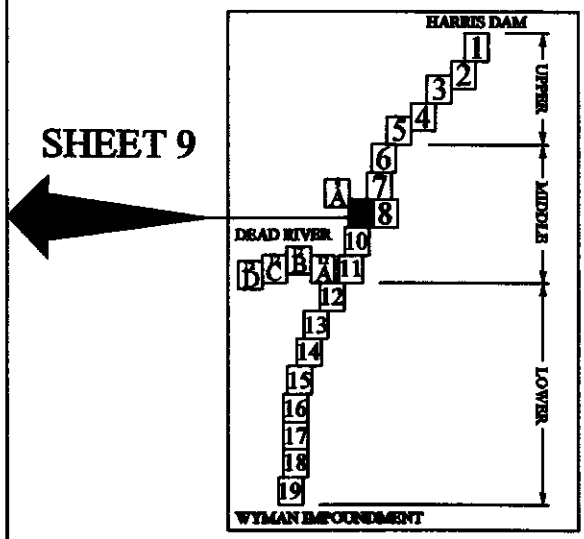



Dead River
Mile
SHEET 11
10/27/99 6,000 cfs
LAKE MOXIE
11/4/99 6,000 cfs
11/18/99 140 cfs
Dead River Mountain Stream
The Forks
SHEET 12
Mink Brook
Crusher Hole
SHEET 13
Crusher Brook
Gilroy Brook
SHEET 14
Kelly Brook
Black Nubble Brook
SHEET 15
Moose Pond
Stream
Pooler Stream
SHEET 16
Bow Town Stream
Holly Brook
SHEET 17
Wilderness Brook
Otter Pond Stream
SHEET 18
Pleasant Stream
Pierce Pond
Stream
Pond
SHEET 19
Upper Limit of Wyman Impoundment
Wyman Lake
Caratunk
N
LEGEND
WATER BOUNDARY
EDDY LINES
HOLES
ROCKS
WAVES AND RIPS
RECREATION SITES
E-PRO
Engineering & Environmental Consulting, LLC
41 Anthony Ave, Augusta, Me. 04330

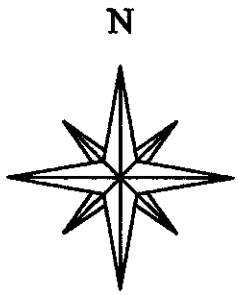

11/9/99
COLD STREAM

Fish Movement over the Course of the Radio Telemetry Study #6BKT September 24 - November 18, 1999

SHEET 9



LOCATION DIAGRAM



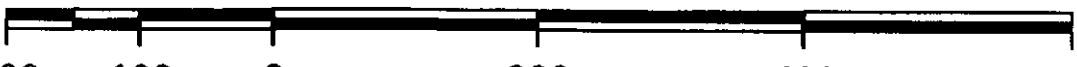
LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on September 24, 1999, at Standup Rips. Spot checks on September 30 and October 6, located the fish in the Standup Rips area.

The fish was also the subject of three Intensive Monitoring Events. On September 24, the fish was monitored during 140 cfs minimum flow to 6,000 cfs generation flow. On both October 7 and 8, the fish was monitored during a 680 cfs minimum flow to 6,600 cfs generating flow.

Five aerial checks were conducted during the fall of 1999. On October 21, at 6,000 cfs, the fish was located at Standup Rips. On October 27, at 6,000 cfs, the fish was located down river at Mudhole. On November 4, the fish was located at the gaging station. On November 9, the fish was located up Cold Stream. On November 18, the fish was located downstream in the mainstem of the river near the gaging station.



200 100 0 200 400 600 YARDS

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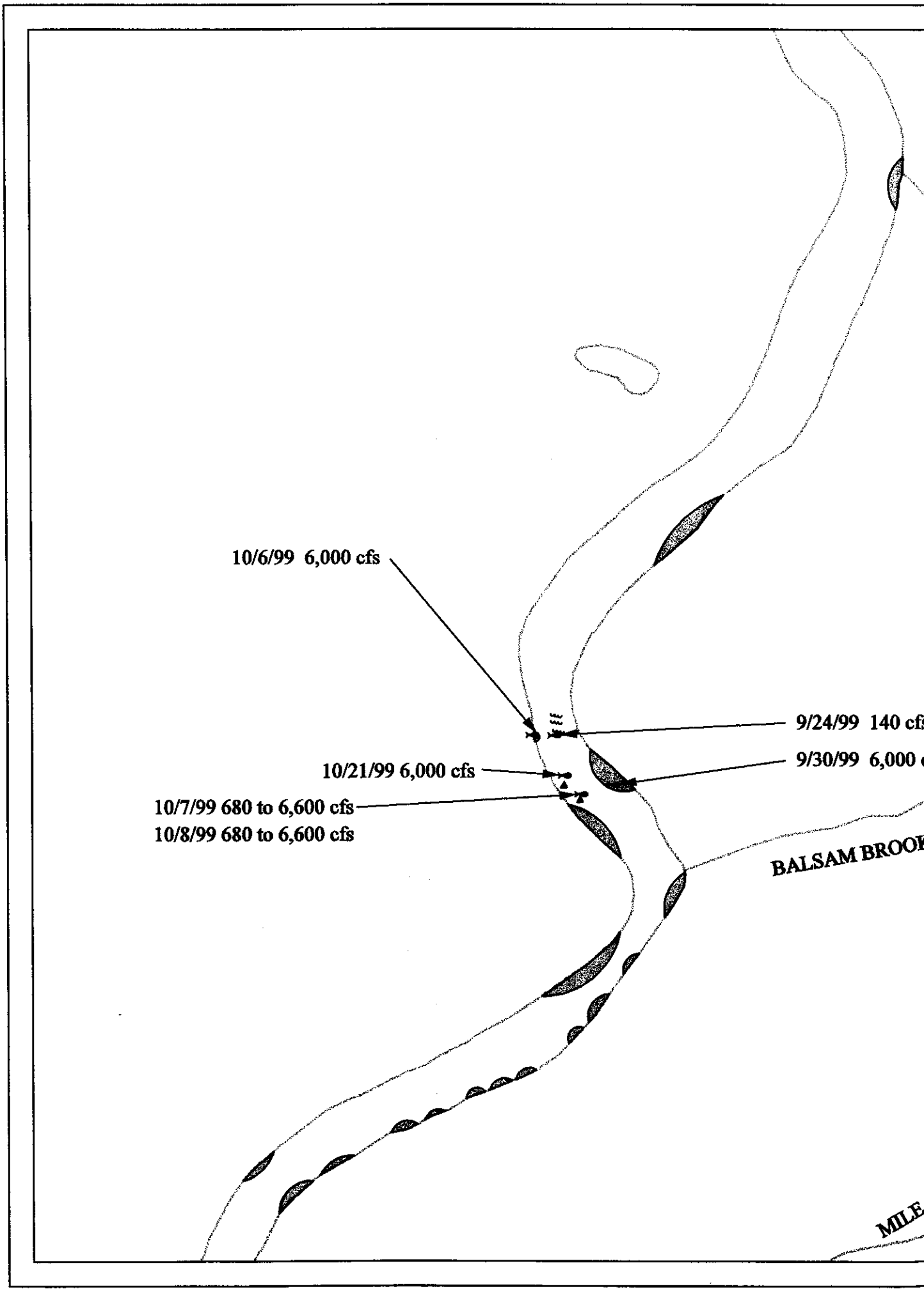
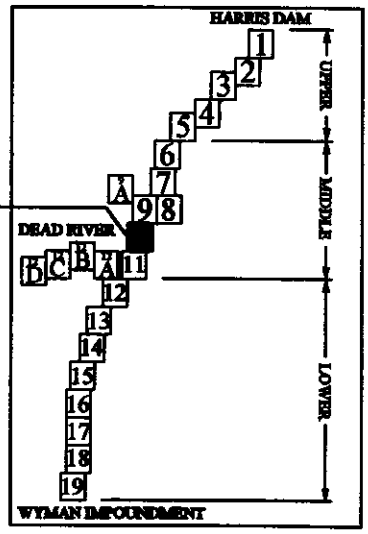

10/6/99 6,000 cfs
9/24/99 140 cfs
9/30/99 6,000
10/21/99 6,000 cfs
10/7/99 680 to 6,600 cfs
10/8/99 680 to 6,600 cfs
BALSAM BROOK
MILE

Fish Movement over the Course of the Radio Telemetry Study #6BKT September 24 - November 18, 1999

MOXIE STREAM

SHEET 10



LOCATION DIAGRAM

N

LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on September 24, 1999, at Standup Rips. Spot checks on September 30 and October 6, located the fish in the Standup Rips area.

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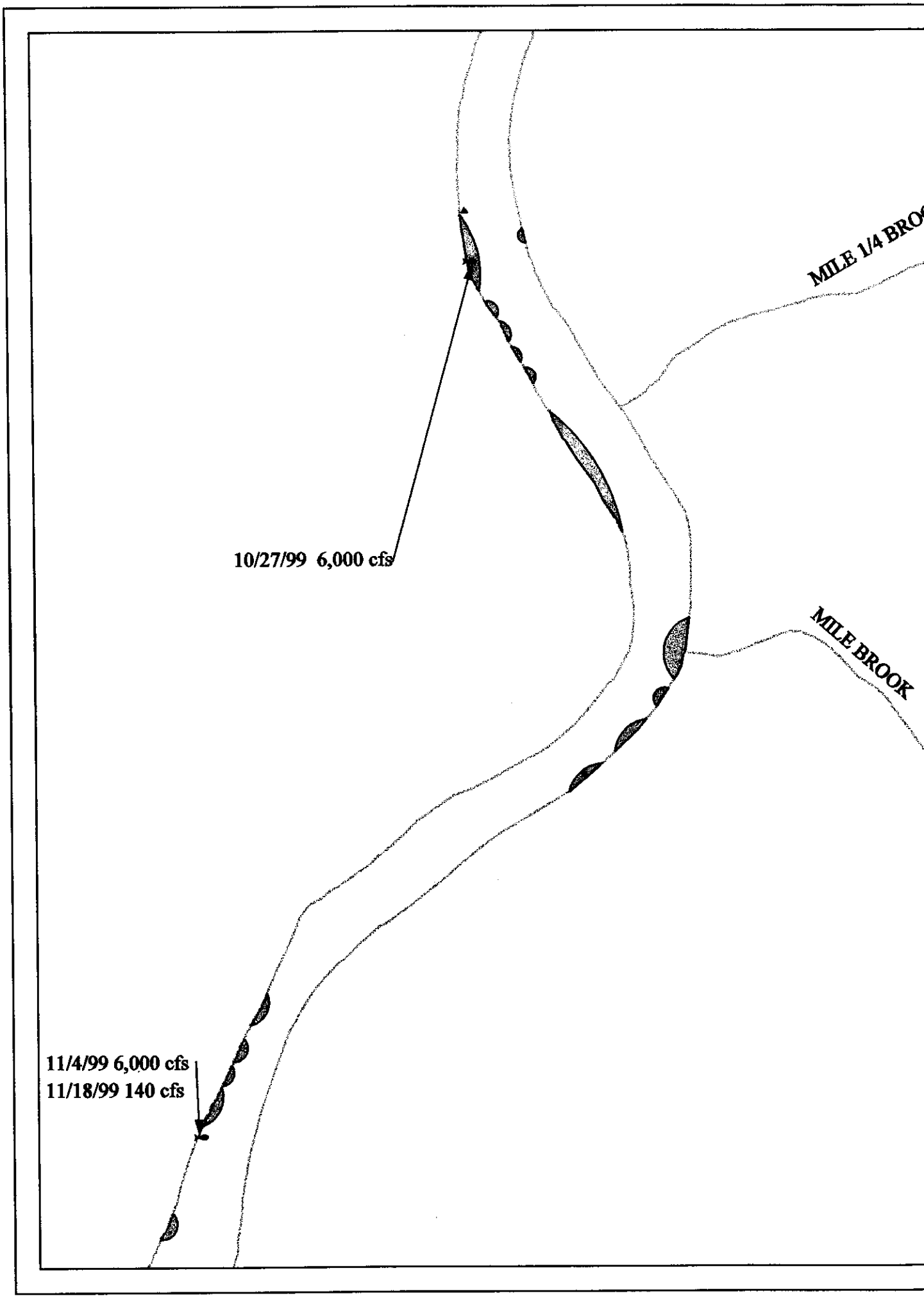
Five aerial checks were conducted during the fall of 1999. On October 21, at 6,000 cfs, the fish was located at Standup Rips. On October 27, at 6,000 cfs, the fish was located down river at Mudhole. On November 4, the fish was located at the gaging station. On November 9, the fish was located up Cold Stream. On November 18, the fish was located downstream in the mainstem of the river near the gaging station.

6,000 cfs

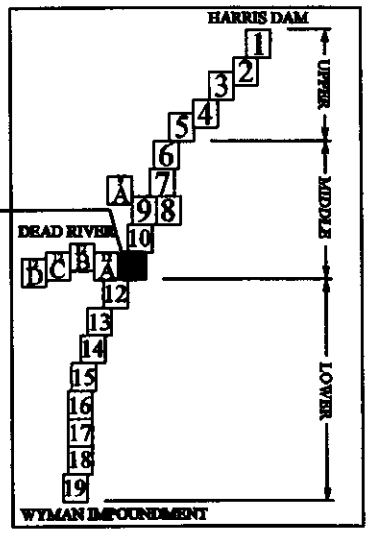
BROOK

200 100 0 200 400 600 YARDS


MILE 1/4 BRO
10/27/99 6,000 cfs
MILE BROOK
11/4/99 6,000 cfs
11/18/99 140 cfs

Fish Movement over the Course of the Radio Telemetry Study #6BKT September 24 - November 18, 1999

SHEET 11



LOCATION DIAGRAM

N

LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on September 24, 1999, at Standup Rips. Spot checks on September 30 and October 6, located the fish in the Standup Rips area.

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200 100 0 200 400 600 YARDS

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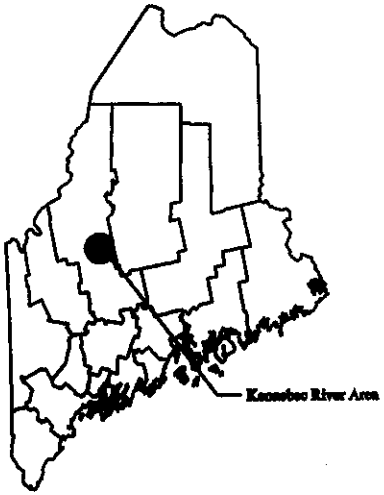
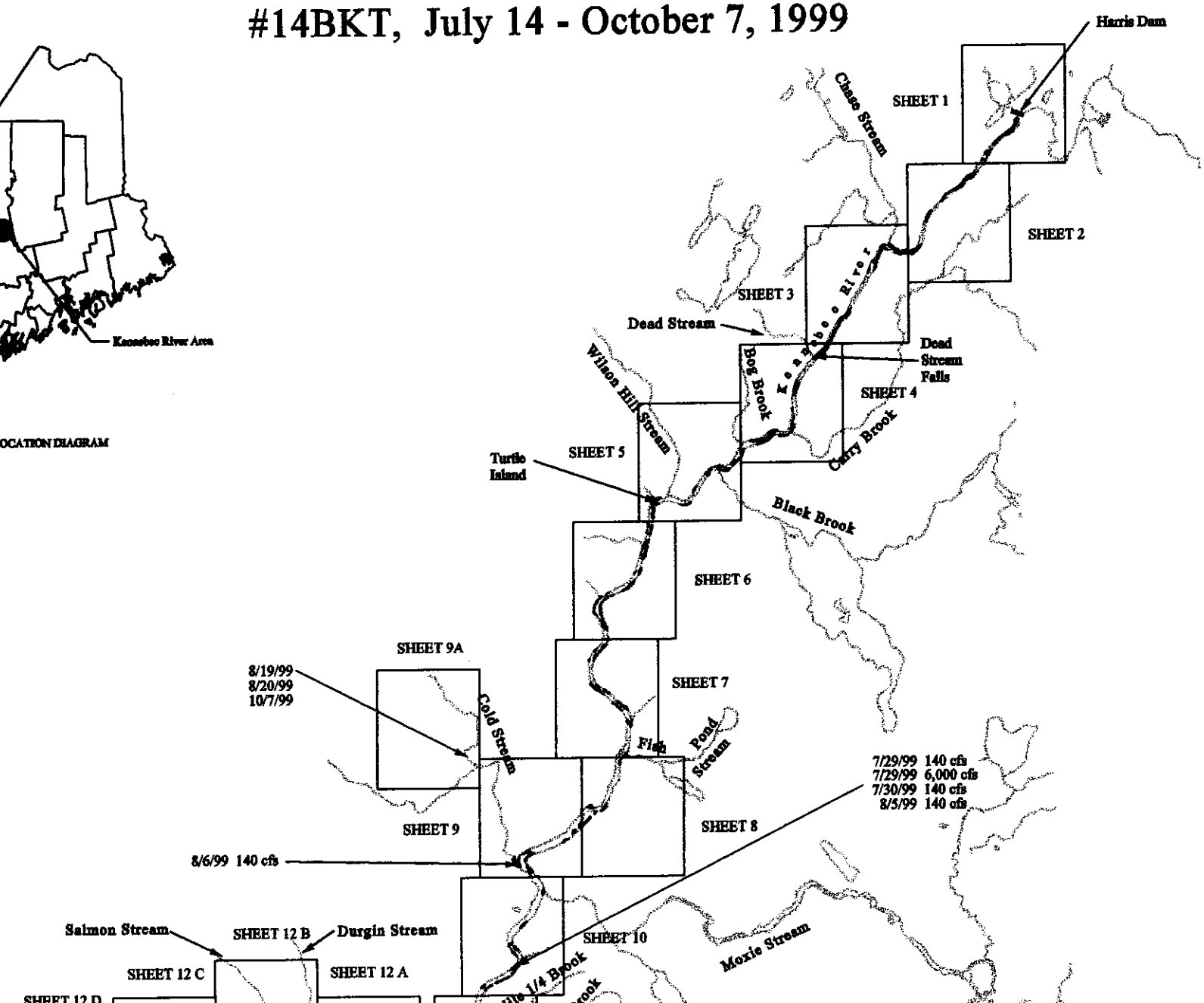
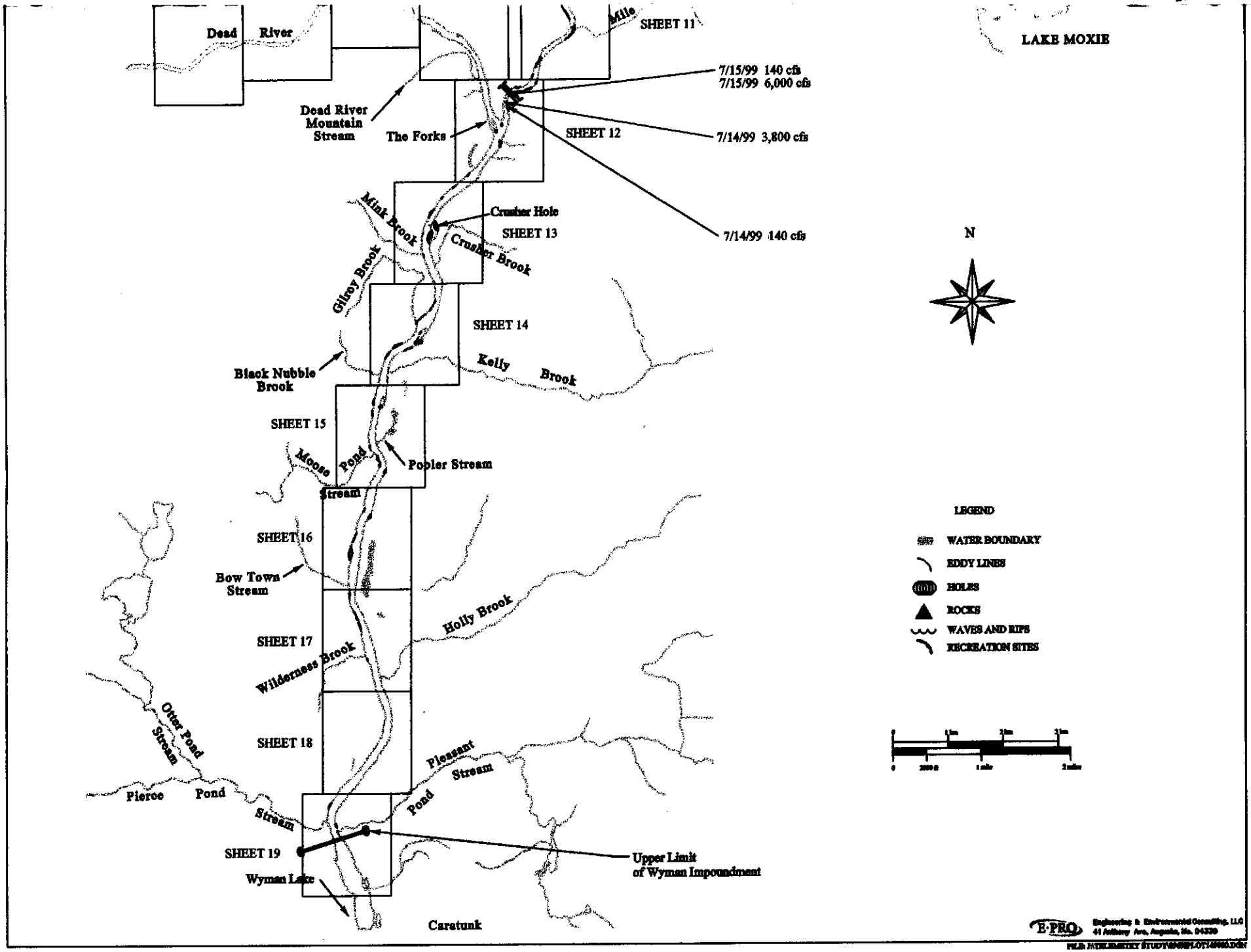
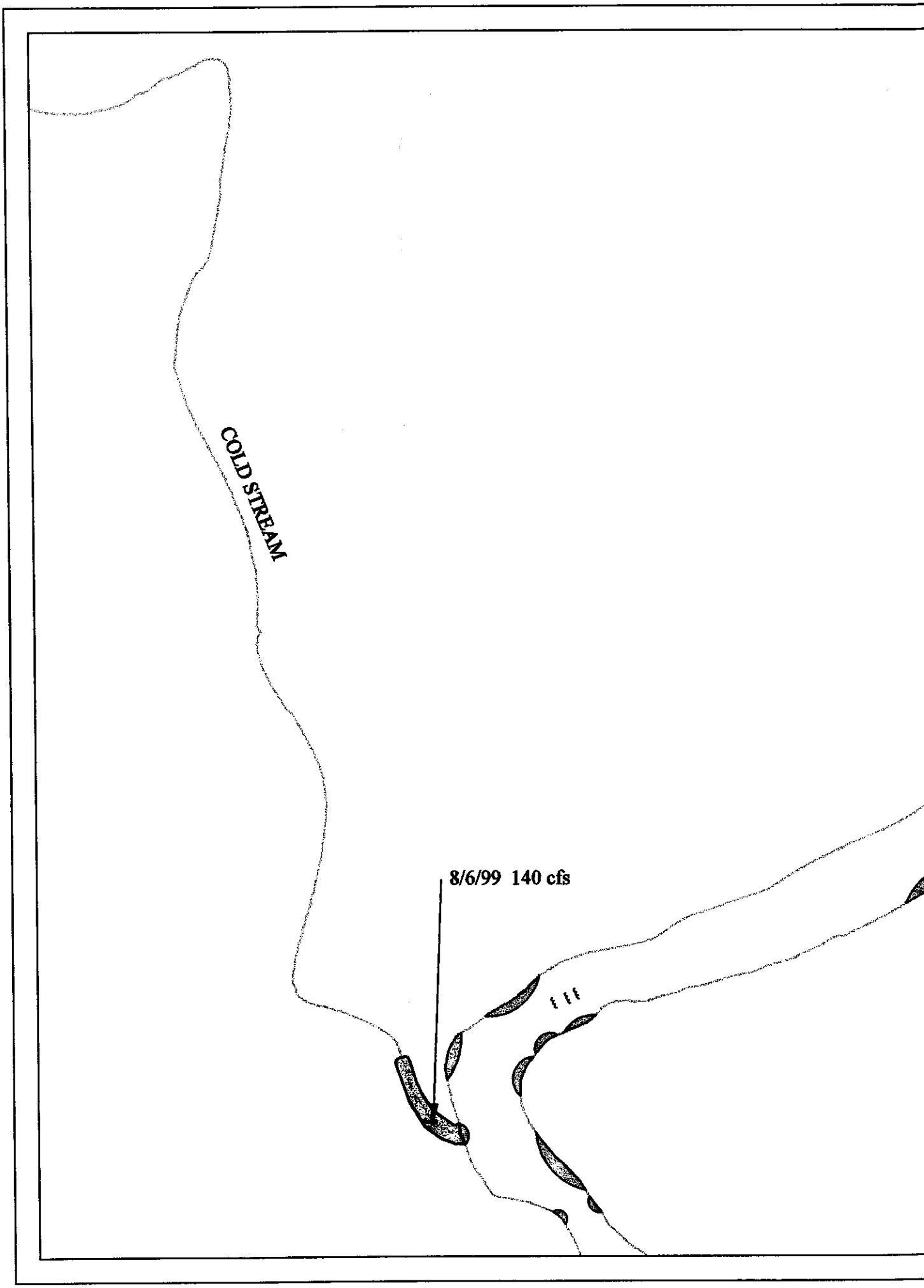
Fish Movement over the Course of the Radio Telemetry Study
#14BKT, July 14 - October 7, 1999



LOCATION DIAGRAM

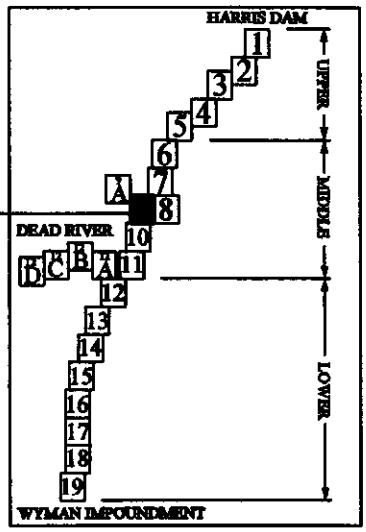



Dead River
Mile
SHEET 11
LAKE MOXIE
7/15/99 140 cfs
7/15/99 6,000 cfs
Dead River Mountain Stream
The Forks
SHEET 12
7/14/99 3,800 cfs
7/14/99 140 cfs
Crusher Hole
SHEET 13
Mink Brook
Crusher Brook
Gilroy Brook
SHEET 14
Black Nubble Brook
Kelly Brook
SHEET 15
Moose Pond
Stream
Popler Stream
SHEET 16
Bow Town Stream
Holly Brook
SHEET 17
Wilderness Brook
Otter Pond Stream
SHEET 18
Pleasant Stream
Pierce Pond
Stream
Pond
SHEET 19
Upper Limit of Wyman Impoundment
Wyman Lake
Caratunk
N
LEGEND
WATER BOUNDARY
EDDY LINES
HOLES
ROCKS
WAVES AND RIPS
RECREATION SITES


COLD STREAM
8/6/99 140 cfs

Fish Movement over the Course of the Radio Telemetry Study #14BKT, July 14 - October 7, 1999

SHEET 9



LOCATION DIAGRAM

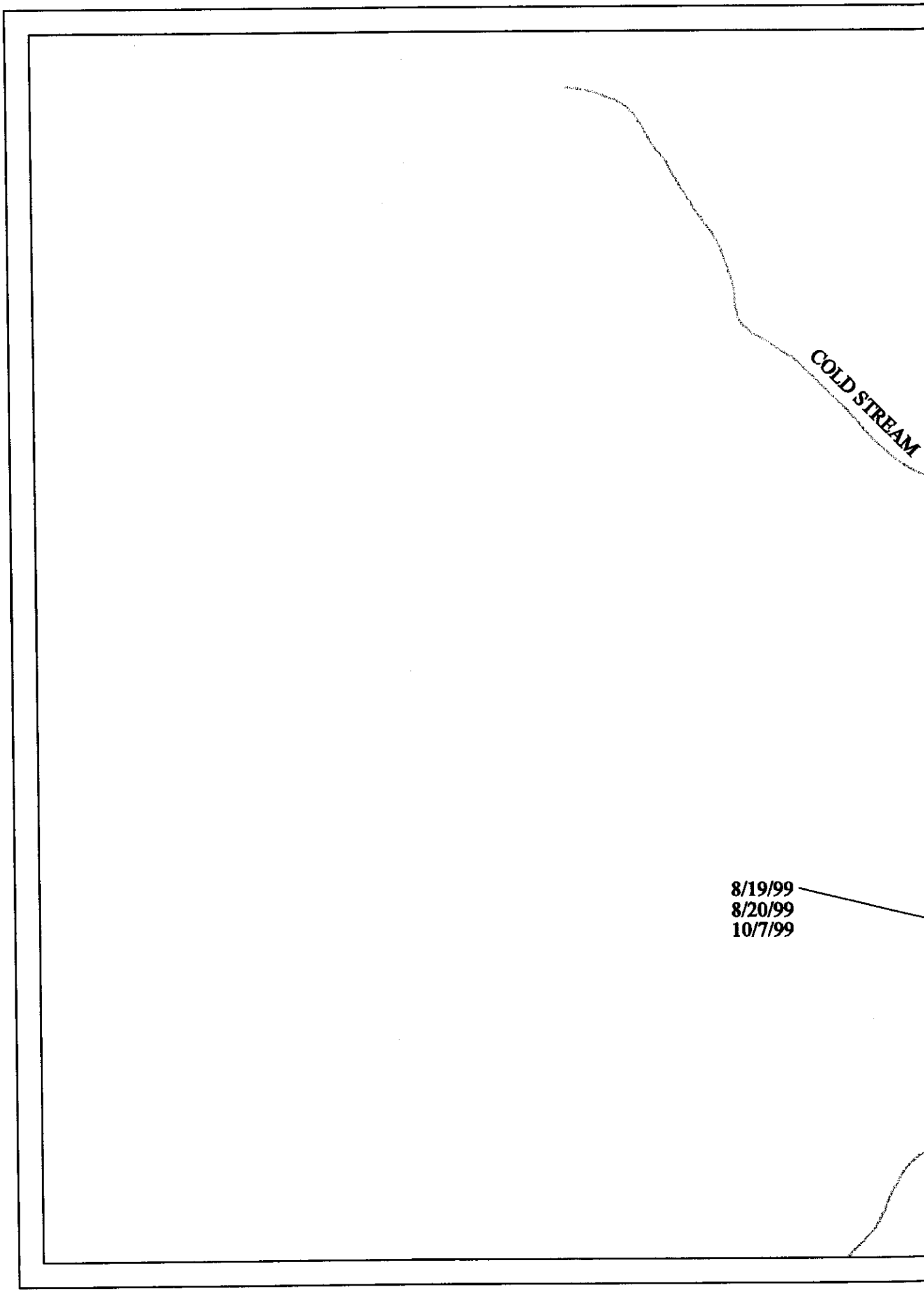
N

LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

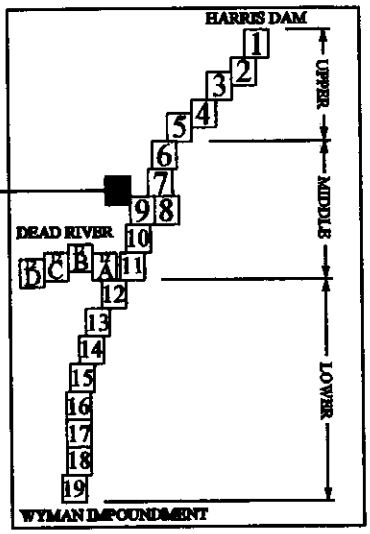
The fish was captured on July 14, 1999, near the Handicap Access below the Route 201 bridge. Later that day during the generating flow of 3,800 cfs, the fish was located upstream approximately 100 yards. On July 15, the fish was located in the run downstream of the Route 201 bridge during both minimum flow of 140 cfs and the generating flow of 6,000 cfs. On July 29, the fish was located in the riffles upstream of the Fishing Ledges during both the minimum flow of 140 cfs and the generating flow of 6,000 cfs. During the minimum flow of 140 cfs on the following day the fish was located in the pool at the Fishing Ledges. On August 5, the fish was still located near at the Fishing Ledges during the minimum flow of 140 cfs. On the following day the fish was located in Cold Stream, in the riffles above the confluence with the Kennebec River. On August 19, the fish was located an undetermined distance further upstream in Cold Stream. On August 20, the fish was located approximately .8 miles up Cold Stream. The fish remained in Cold Stream for the remainder of the summer. On October 7, E/PRO biologists located the position of the tag and determined it to be stationary. Attempts to retrieve the tag failed due to the fast current and large cobble substrate.

200 100 0 200 400 600 YARDS

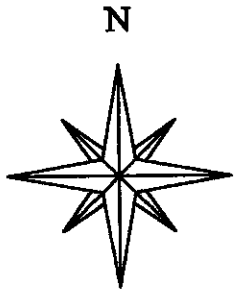

COLD STREAM
8/19/99
8/20/99
10/7/99

Fish Movement over the Course of the Radio Telemetry Study #14BKT, July 14 - October 7, 1999

SHEET 9A



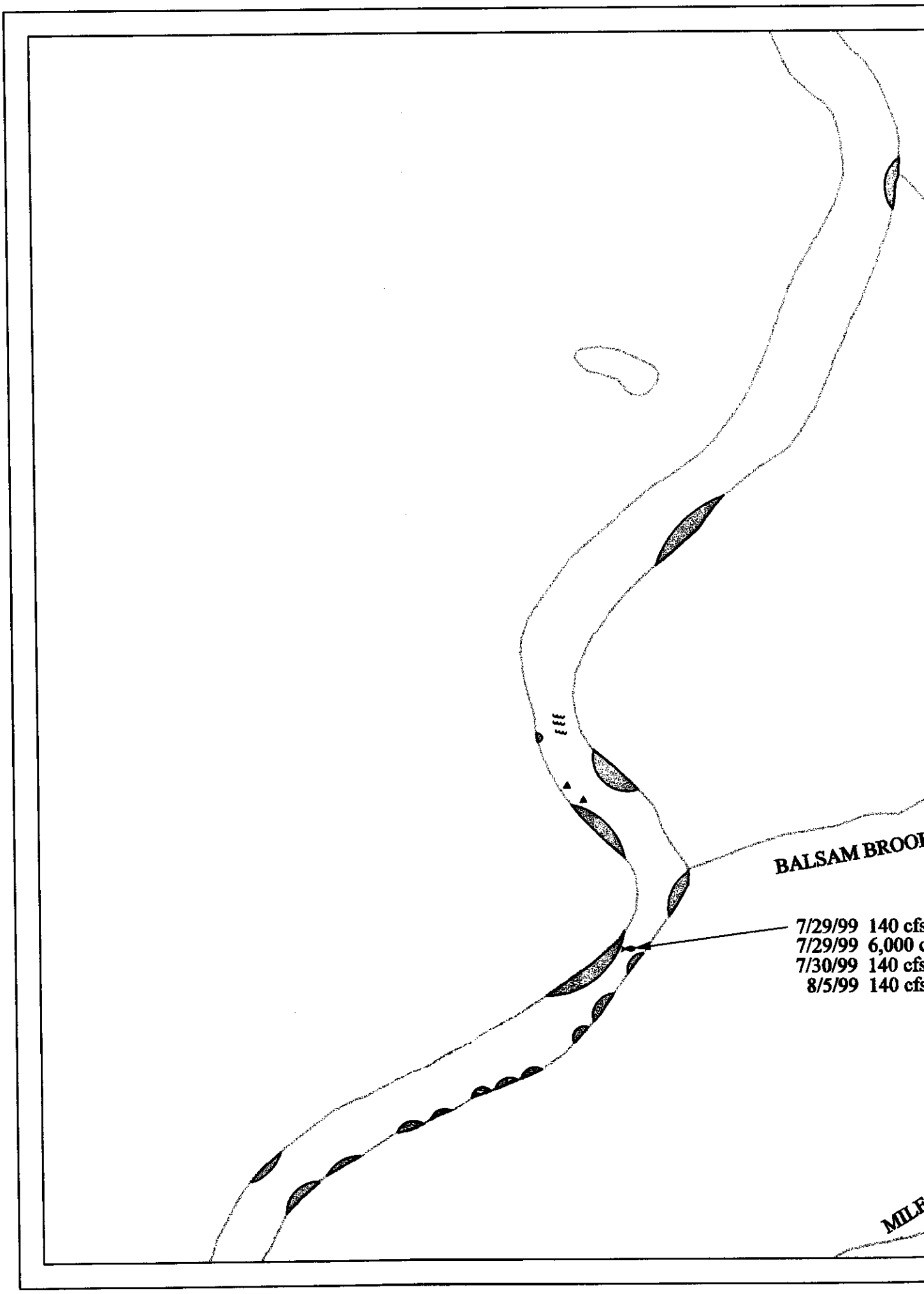
LOCATION DIAGRAM



LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

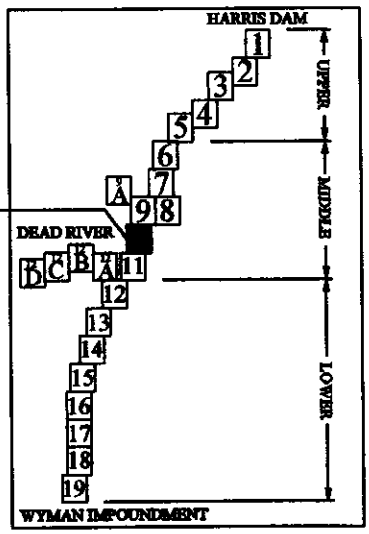
The fish was captured on July 14, 1999, near the Handicap Access below the Route 201 bridge. Later that day during the generating flow of 3,800 cfs, the fish was located upstream approximately 100 yards. On July 15, the fish was located in the run downstream of the Route 201 bridge during both minimum flow of 140 cfs and the generating flow of 6,000 cfs. On July 29, the fish was located in the riffles upstream of the Fishing Ledges during both the minimum flow of 140 cfs and the generating flow of 6,000 cfs. During the minimum flow of 140 cfs on the following day the fish was located in the pool at the Fishing Ledges. On August 5, the fish was still located near at the Fishing Ledges during the minimum flow of 140 cfs. On the following day the fish was located in Cold Stream, in the riffles above the confluence with the Kennebec River. On August 19, the fish was located an undetermined distance further upstream in Cold Stream. On August 20, the fish was located approximately .8 miles up Cold Stream. The fish remained in Cold Stream for the remainder of the summer. On October 7, E/PRO biologists located the position of the tag and determined it to be stationary. Attempts to retrieve the tag failed due to the fast current and large cobble substrate.


BALSAM BROOK
7/29/99 140 cfs
7/29/99 6,000 c
7/30/99 140 cfs
8/5/99 140 cfs

Fish Movement over the Course of the Radio Telemetry Study #14BKT, July 14 - October 7, 1999

MOXIE STREAM

SHEET 10



LOCATION DIAGRAM

N

LEGEND

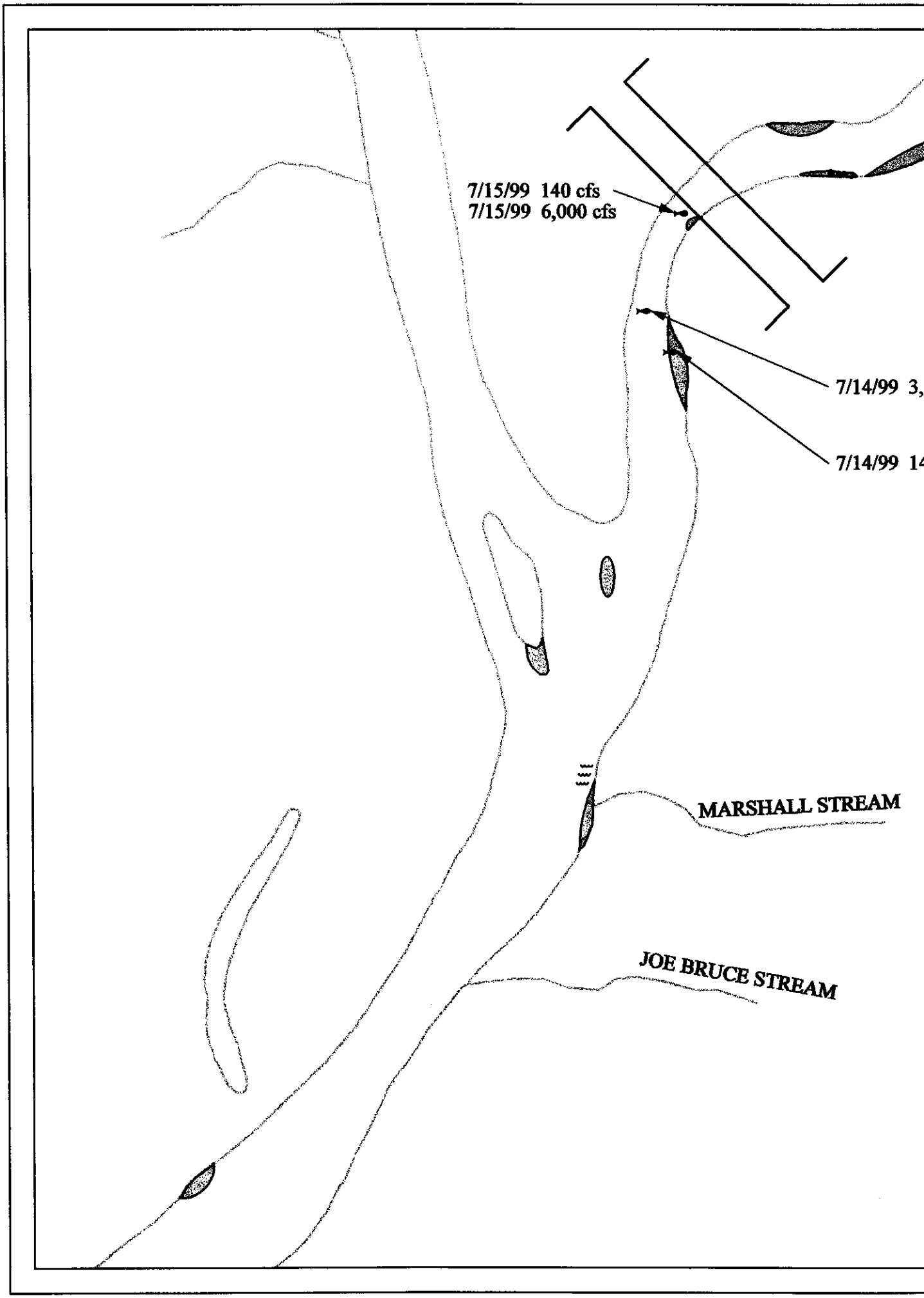
- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on July 14, 1999, near the Handicap Access below the Route 201 bridge. Later that day during the generating flow of 3,800 cfs, the fish was located upstream approximately 100 yards. On July 15, the fish was located in the run downstream of the Route 201 bridge during both minimum flow of 140 cfs and the generating flow of 6,000 cfs. On July 29, the fish was located in the riffles upstream of the Fishing Ledges during both the minimum flow of 140 cfs and the generating flow of 6,000 cfs. During the minimum flow of 140 cfs on the following day the fish was located in the pool at the Fishing Ledges. On August 5, the fish was still located near at the Fishing Ledges during the minimum flow of 140 cfs. On the following day the fish was located in Cold Stream, in the riffles above the confluence with the Kennebec River. On August 19, the fish was located an undetermined distance further upstream in Cold Stream. On August 20, the fish was located approximately .8 miles up Cold Stream. The fish remained in Cold Stream for the remainder of the summer. On October 7, E/PRO biologists located the position of the tag and determined it to be stationary. Attempts to retrieve the tag failed due to the fast current and large cobble substrate.

4 BROOK

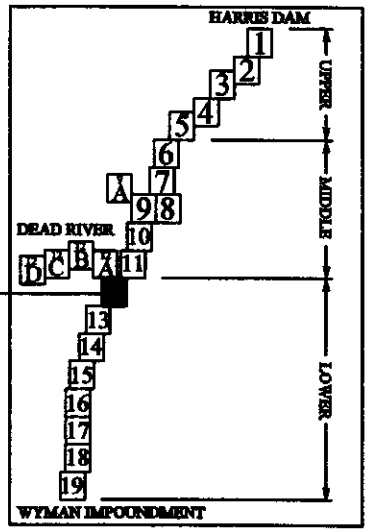
200 100 0 200 400 600 YARDS

E-PRO Engineering & Environmental Consulting, LLC
41 Anthony Ave, Augusta, Me. 04330

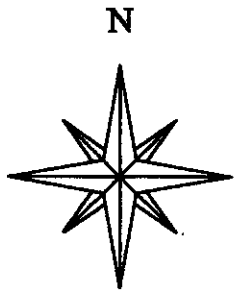

7/15/99 140 cfs
7/15/99 6,000 cfs
7/14/99 3,
7/14/99 14
MARSHALL STREAM
JOE BRUCE STREAM

Fish Movement over the Course of the Radio Telemetry Study #14BKT, July 14 - October 7, 1999

SHEET 12



LOCATION DIAGRAM



LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on July 14, 1999, near the Handicap Access below the Route 201 bridge. Later that day during the generating flow of 3,800 cfs, the fish was located upstream approximately 100 yards. On July 15, the fish was located in the run downstream of the Route 201 bridge during both minimum flow of 140 cfs and the generating flow of 6,000 cfs. On July 29, the fish was located in the riffles upstream of the Fishing Ledges during both the minimum flow of 140 cfs and the generating flow of 6,000 cfs. During the minimum flow of 140 cfs on the following day the fish was located in the pool at the Fishing Ledges. On August 5, the fish was still located near at the Fishing Ledges during the minimum flow of 140 cfs. On the following day the fish was located in Cold Stream, in the riffles above the confluence with the Kennebec River. On August 19, the fish was located an undetermined distance further upstream in Cold Stream. On August 20, the fish was located approximately .8 miles up Cold Stream. The fish remained in Cold Stream for the remainder of the summer. On October 7, E/PRO biologists located the position of the tag and determined it to be stationary. Attempts to retrieve the tag failed due to the fast current and large cobble substrate.

200 100 0 200 400 600 YARDS

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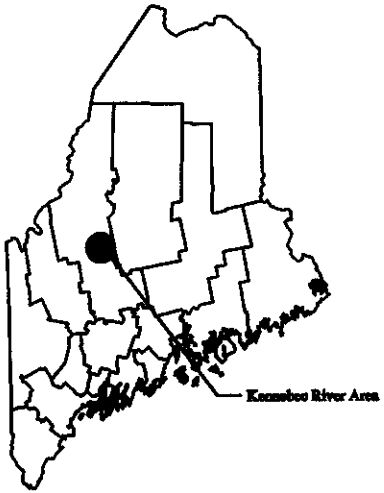
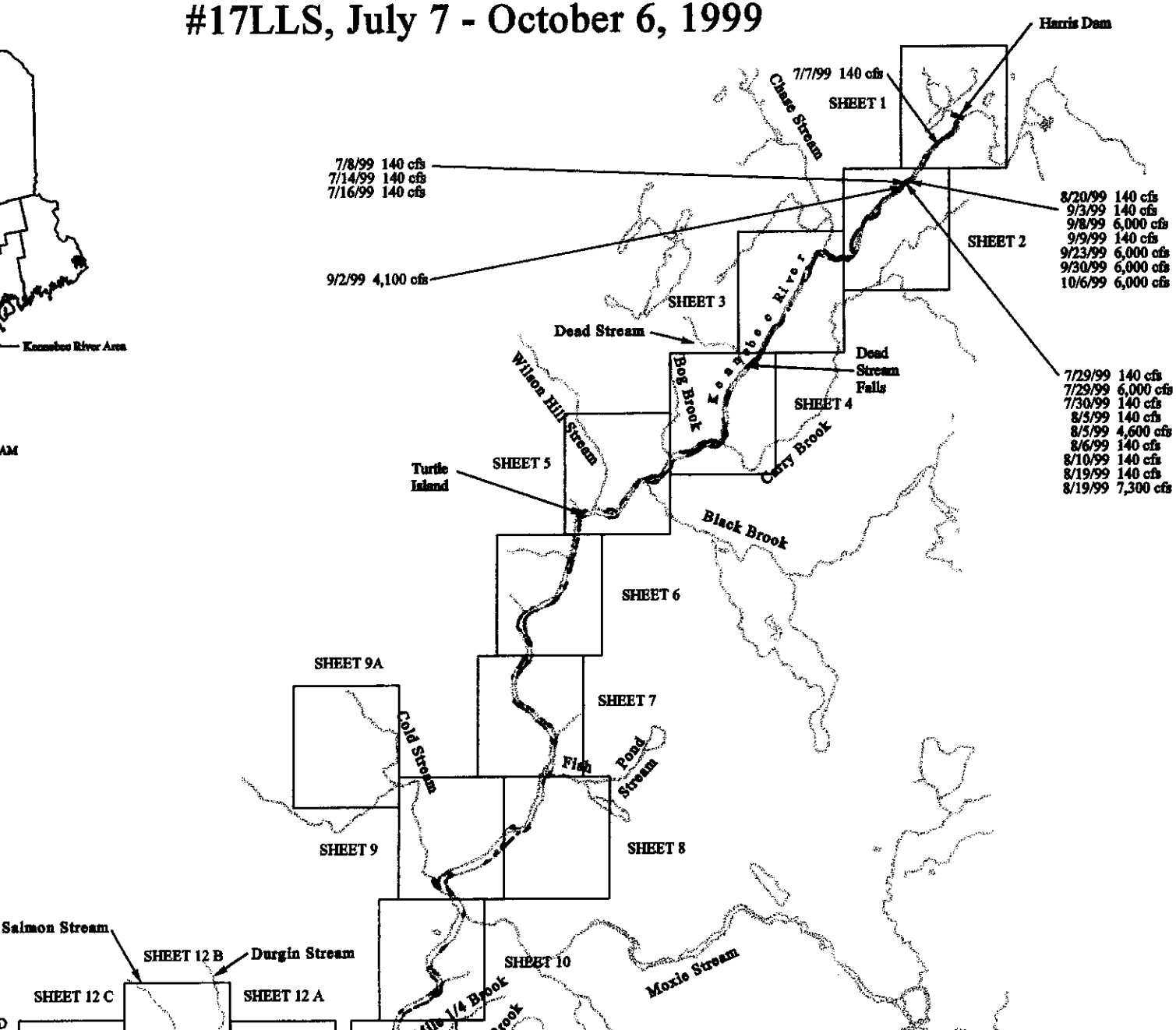
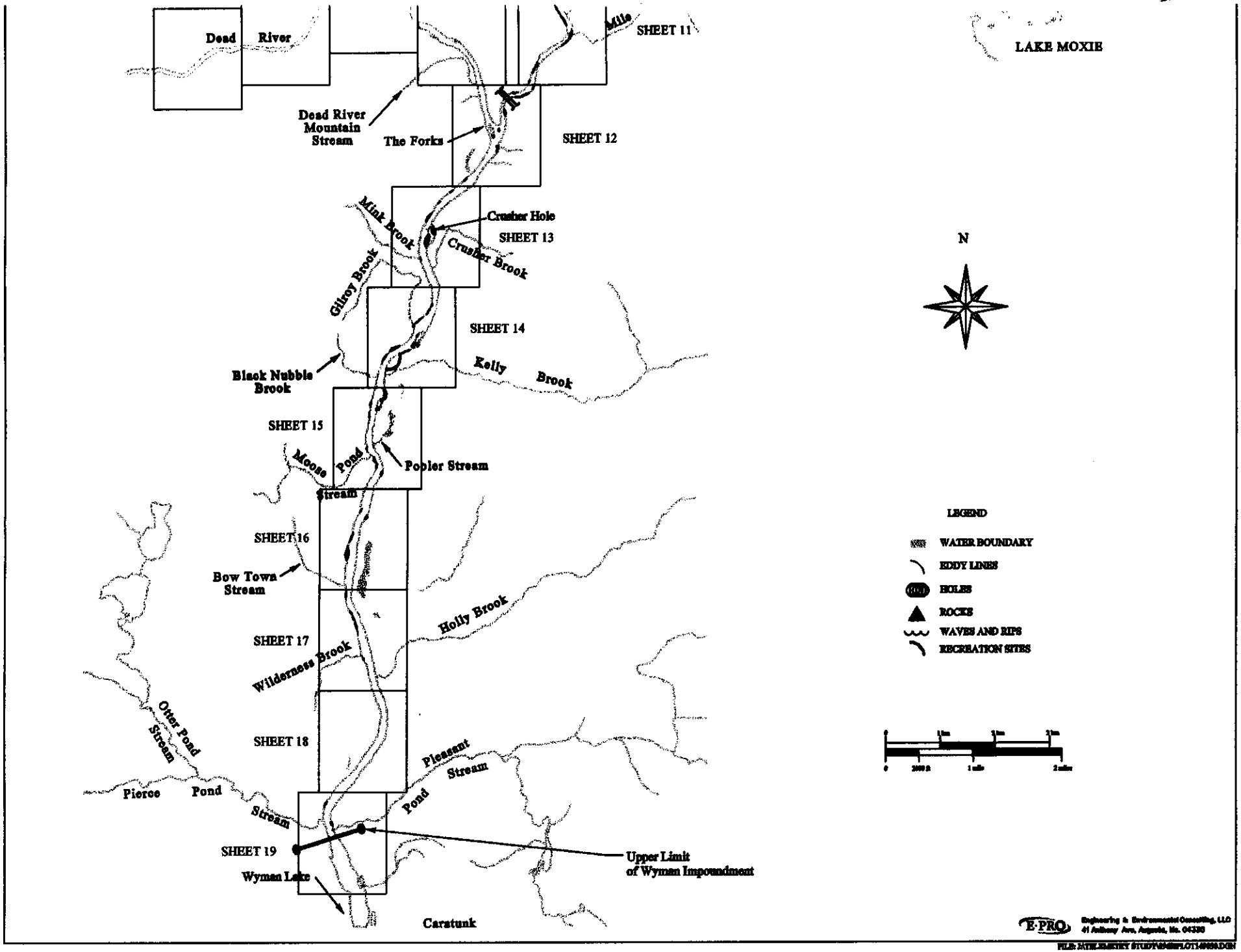
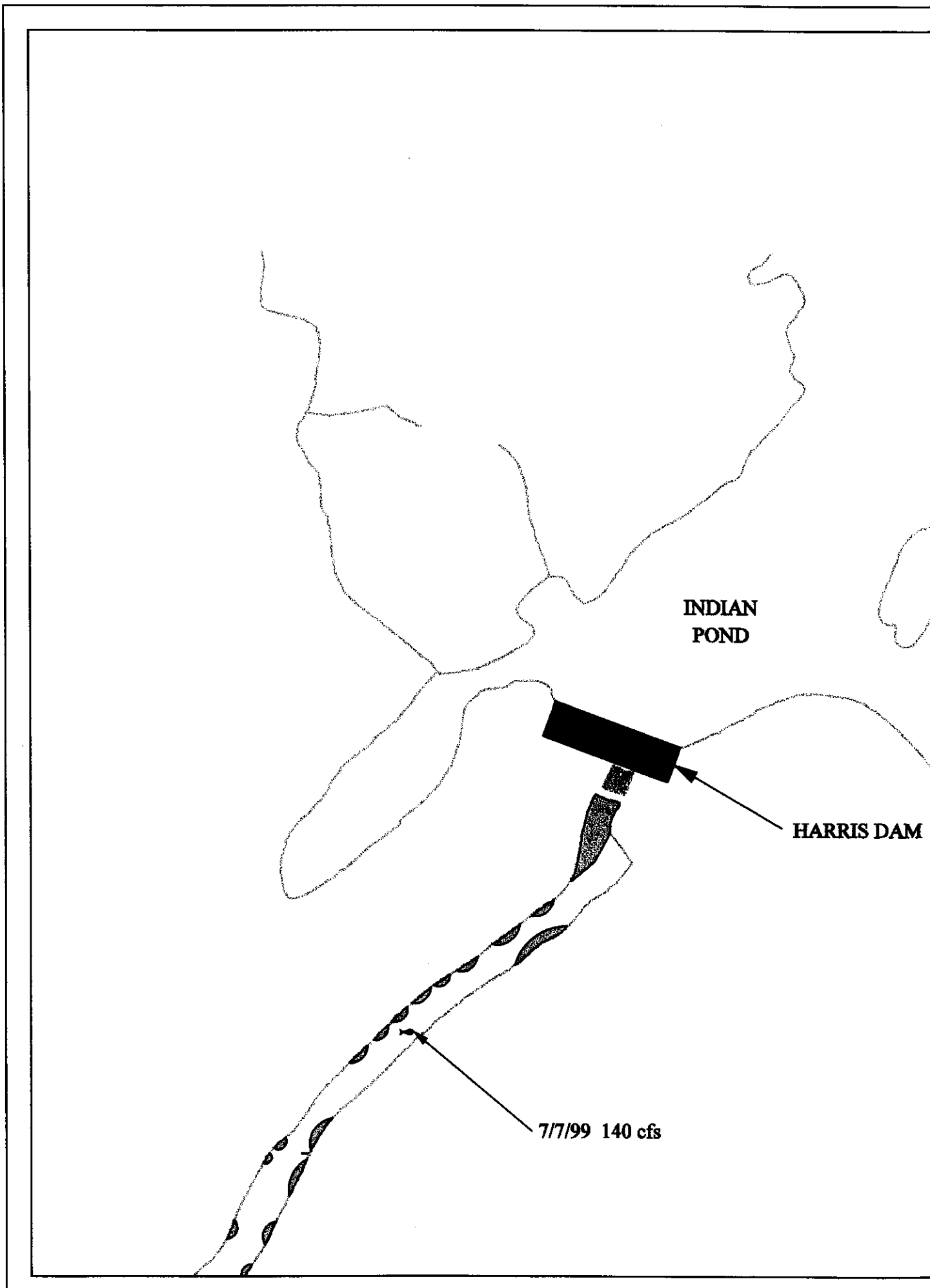
Fish Movement over the Course of the Radio Telemetry Study
#17LLS, July 7 - October 6, 1999



LOCATION DIAGRAM

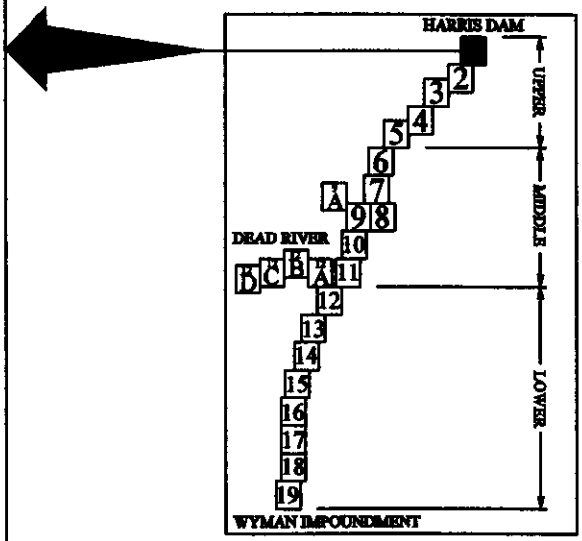



Dead River
SHEET 11
LAKE MOXIE
Dead River Mountain Stream
The Forks
SHEET 12
Mink Brook
Crusher Hole
SHEET 13
Crusher Brook
Gilroy Brook
SHEET 14
Kelly Brook
Black Nubble Brook
SHEET 15
Moose Pond
Stream
Popler Stream
SHEET 16
Bow Town Stream
Holly Brook
SHEET 17
Wilderness Brook
Otter Pond Stream
SHEET 18
Pleasant Stream
Pierce Pond
Stream
Pond
SHEET 19
Upper Limit of Wyman Impoundment
Wyman Lake
Caratunk
N
LEGEND
WATER BOUNDARY
EDDY LINES
HOLES
ROCKS
WAVES AND RIPS
RECREATION SITES
E-PRO

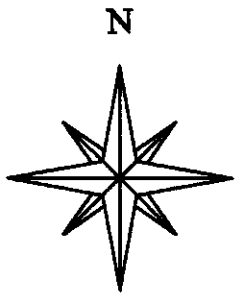

INDIAN
POND
HARRIS DAM
7/7/99 140 cfs

Fish Movement over the Course of the Radio Telemetry Study #17LLS, July 7 - October 6, 1999

SHEET 1



LOCATION DIAGRAM



LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on July 7, 1999, in a pool between the Throat and the Taster Wave in the Upper Reach. On July 8, the fish was located downstream in the pool at False Chase during the minimum flow of 140 cfs. It was located in this pool during subsequent checks on July 14, July 16, July 29, July 30, August 5, August 6, and August 10. Snorkeling checks by E/PRO biologists on August 10, verified that the fish was indeed alive. The fish moved as the divers approached (verified with the receiver); however, it was not seen. On August 19, the fish was again located in the False Chase pool during the minimum flow of 140 cfs. The fish was still located in the False Chase area during the generation flow of approximately 7,300 cfs later that day, although the fish was located in an eddy near river-left. On August 20, the fish was located back in the False Chase pool. On September 2, the fish was located downstream, just above Chase Stream Sluice, during the generating flow of 4,100 cfs. The next day, it was located back upstream in the False Chase pool. On September 8, the fish was located in the eddy on river-left, still in the False Chase area. On September 9, the fish was in the False Chase pool. The fish was still located in the False Chase area, in an eddy on river-right, during subsequent checks on September 23, September 30, and October 6.

200 100 0 200 400 600 YARDS

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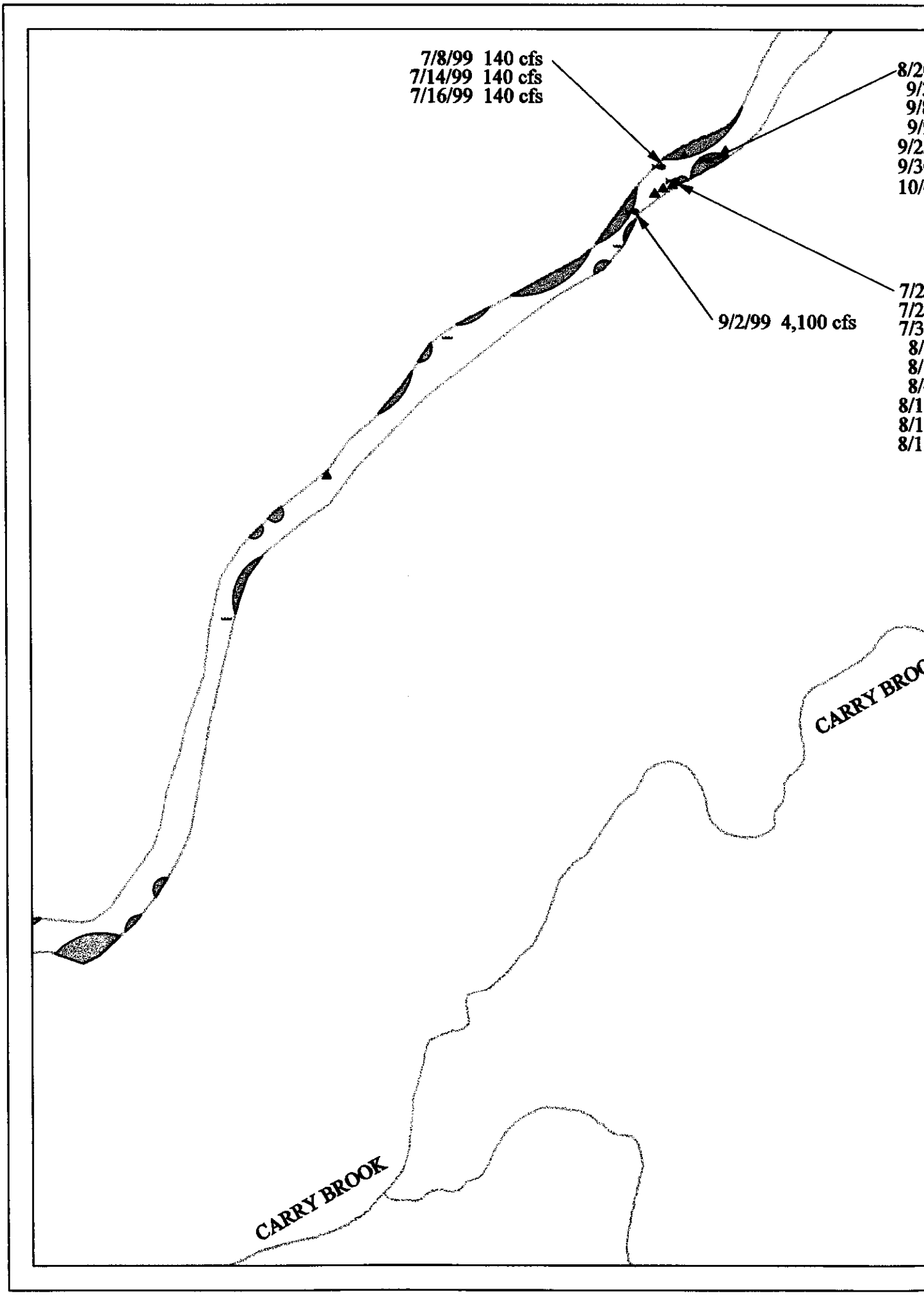
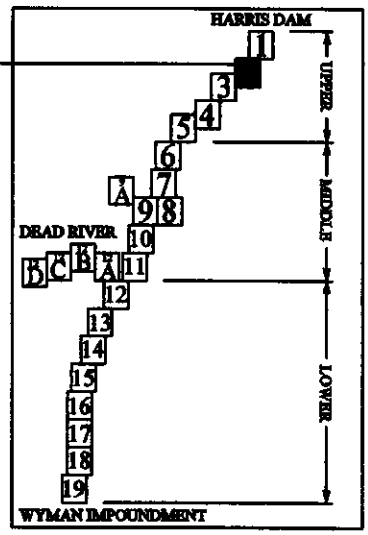

7/8/99 140 cfs
7/14/99 140 cfs
7/16/99 140 cfs
9/2/99 4,100 cfs
CARRY BROOK
CARRY BROOK

'99 140 cfs
'99 140 cfs
'99 6,000 cfs
'99 140 cfs
'99 6,000 cfs
'99 6,000 cfs
'99 6,000 cfs

'99 140 cfs
'99 6,000 cfs
'99 140 cfs
'99 140 cfs
'99 4,600 cfs
'99 140 cfs
'99 140 cfs
'99 140 cfs
'99 7,300 cfs

Fish Movement over the Course of the Radio Telemetry Study #17LLS, July 7 - October 6, 1999

SHEET 2



LOCATION DIAGRAM

N

LEGEND

WATER BOUNDARY

FISH LOCATION

EDDY AT GENERATION FLOWS

BOULDERS

WAVES AND RIPS

The fish was captured on July 7, 1999, in a pool between the Throat and the Taster Wave in the Upper Reach. On July 8, the fish was located downstream in the pool at False Chase during the minimum flow of 140 cfs. It was located in this pool during subsequent checks on July 14, July 16, July 29, July 30, August 5, August 6, and August 10. Snorkeling checks by E/PRO biologists on August 10, verified that the fish was indeed alive. The fish moved as the divers approached (verified with the receiver); however, it was not seen. On August 19, the fish was again located in the False Chase pool during the minimum flow of 140 cfs. The fish was still located in the False Chase area during the generation flow of approximately 7,300 cfs later that day, although the fish was located in an eddy near river-left. On August 20, the fish was located back in the False Chase pool. On September 2, the fish was located downstream, just above Chase Stream Sluice, during the generating flow of 4,100 cfs. The next day, it was located back upstream in the False Chase pool. On September 8, the fish was located in the eddy on river-left, still in the False Chase area. On September 9, the fish was in the False Chase pool. The fish was still located in the False Chase area, in an eddy on river-right, during subsequent checks on September 23, September 30, and October 6.

200 100 0 200 400 600 YARDS

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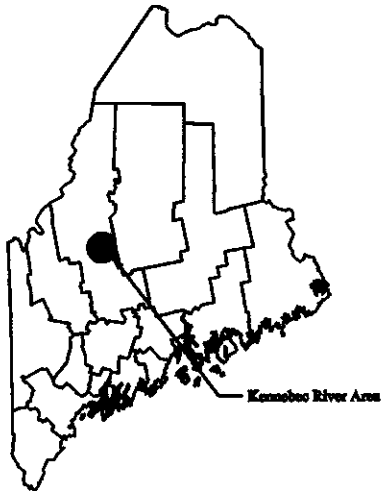
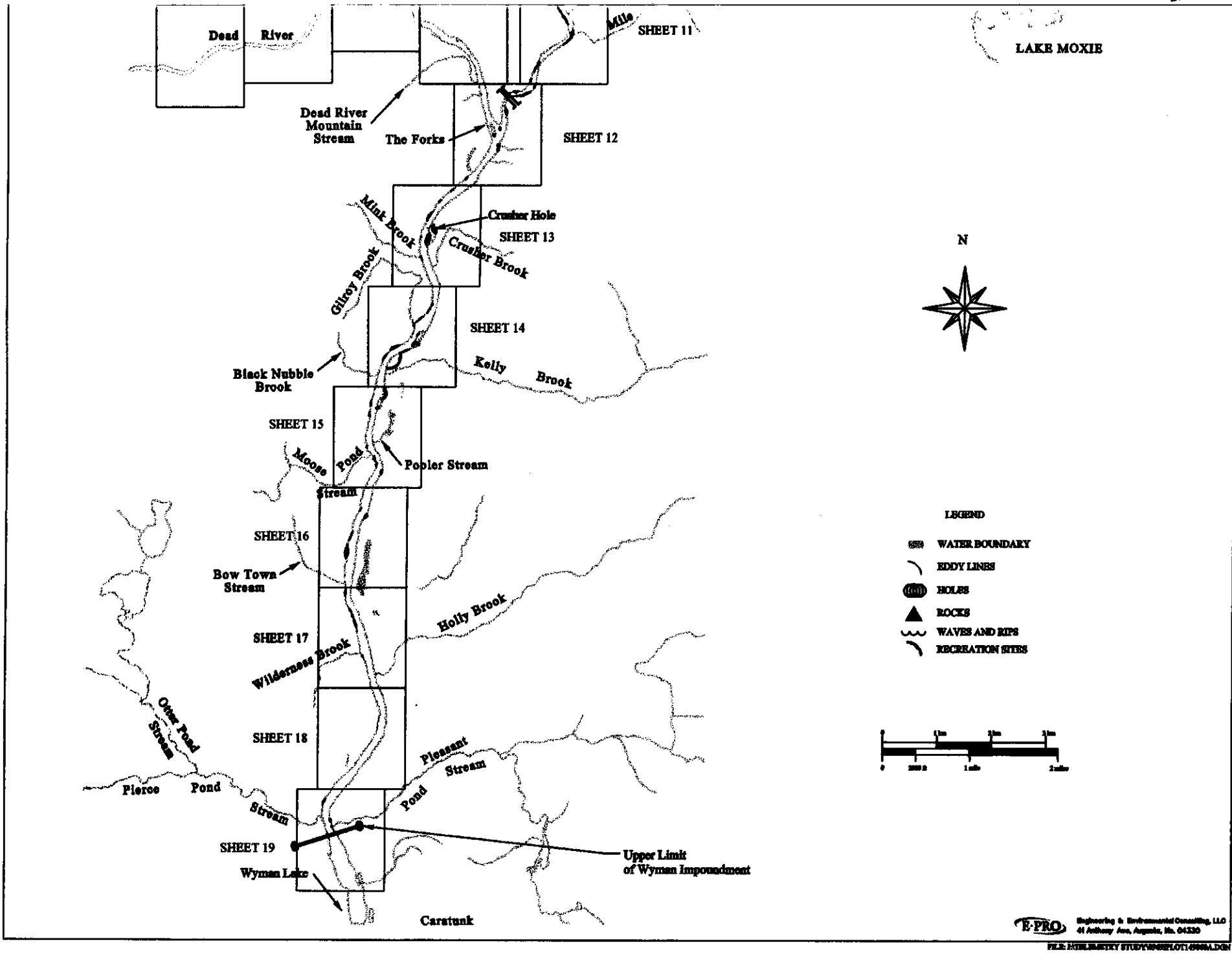
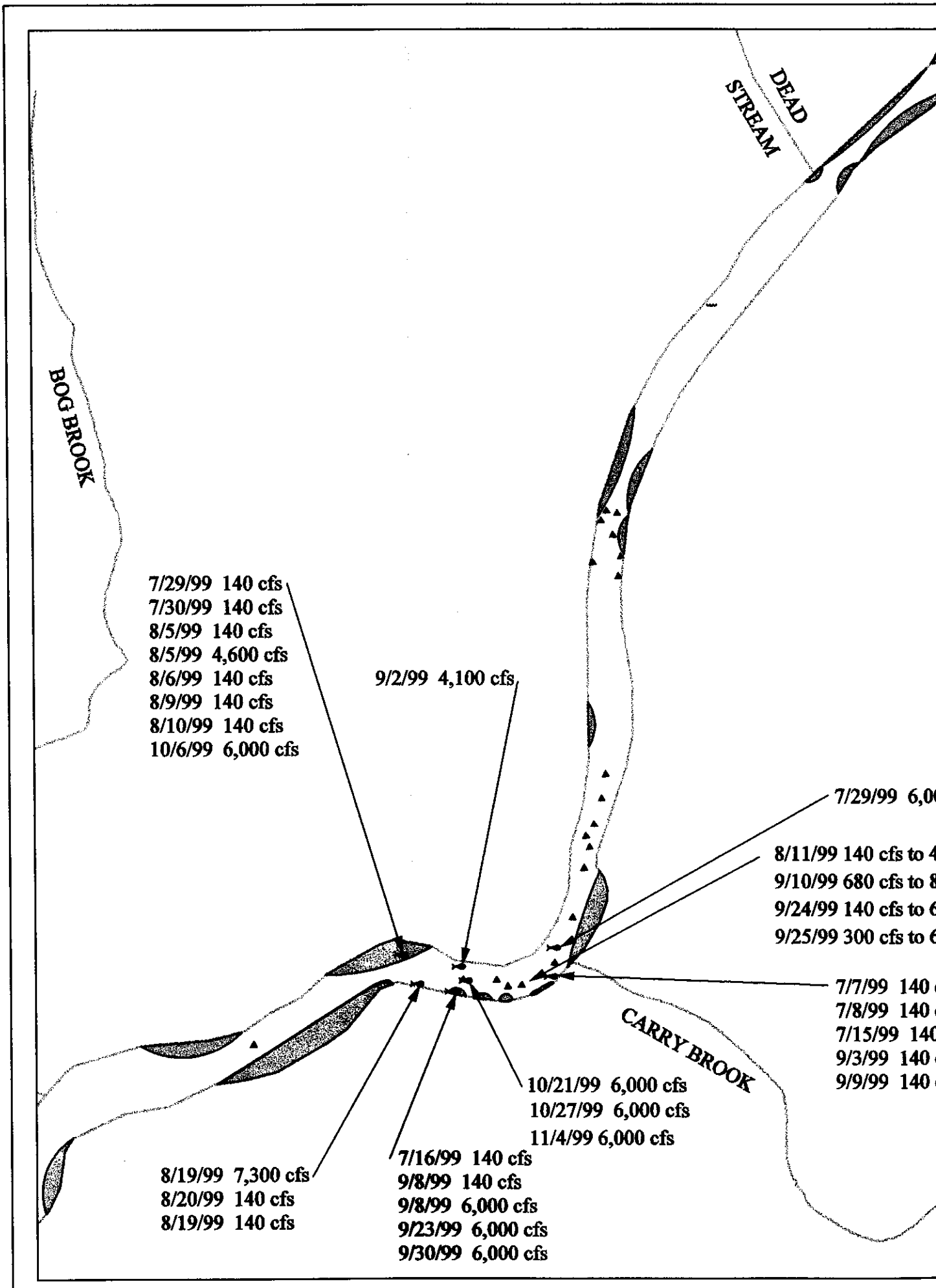
Fish Movement over the Course of the Radio Telemetry Study
#22LLS, July 7 - October 27, 1999



LOCATION DIAGRAM

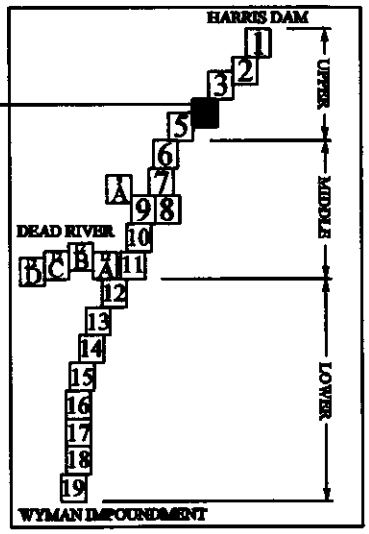
Harris Dam
Chase Stream
SHEET 1
9/2/99 4,100 cfs
SHEET 2
7/29/99 140 cfs
7/30/99 140 cfs
8/5/99 140 cfs
8/5/99 4,600 cfs
8/6/99 140 cfs
8/9/99 140 cfs
8/10/99 140 cfs
10/6/99 6,000 cfs
SHEET 3
Dead Stream
Kennebec River
Dead Stream Falls
7/29/99 6,000 cfs
8/11/99 140 cfs to 4,800 cfs
9/10/99 680 cfs to 8,000 cfs
9/24/99 140 cfs to 6,000 cfs
9/25/99 300 cfs to 6,000 cfs
Bog Brook
Wilson Hill Stream
SHEET 4
8/19/99 7,300 cfs
8/20/99 140 cfs
8/19/99 140 cfs
Turtle Island
SHEET 5
Curry Brook
7/7/99 140 cfs
7/8/99 140 cfs
7/15/99 140 cfs
9/3/99 140 cfs
9/9/99 140 cfs
Black Brook
SHEET 6
SHEET 9A
SHEET 7
Cold Stream
Fish Pond Stream
10/21/99 6,000 cfs
10/27/99 5,900 cfs
11/4/99 6,000 cfs
7/16/99 140 cfs
9/8/99 140 cfs
9/8/99 6,000 cfs
9/23/99 6,000 cfs
9/30/99 6,000 cfs
SHEET 9
SHEET 8
Salmon Stream
SHEET 12 B
Durgin Stream
SHEET 10
Moxie Stream
SHEET 12 C
SHEET 12 A
SHEET 12 D


Dead River
Mile
SHEET 11
LAKE MOXIE
Dead River Mountain Stream
The Forks
SHEET 12
Mink Brook
Crusher Hole
SHEET 13
Crusher Brook
Gilroy Brook
SHEET 14
Black Nubble Brook
Kelly Brook
SHEET 15
Moose Pond
Stream
Popler Stream
SHEET 16
Bow Town Stream
Holly Brook
SHEET 17
Wilderness Brook
Otter Pond Stream
SHEET 18
Pleasant Stream
Pierce Pond
Stream
Pond
SHEET 19
Upper Limit of Wyman Impoundment
Wyman Lake
Carratunk
N
LEGEND
WATER BOUNDARY
EDDY LINES
HOLES
ROCKS
WAVES AND RIPS
RECREATION SITES
E-PRO


DEAD STREAM
BOG BROOK
7/29/99 140 cfs
7/30/99 140 cfs
8/5/99 140 cfs
8/5/99 4,600 cfs
8/6/99 140 cfs
8/9/99 140 cfs
8/10/99 140 cfs
10/6/99 6,000 cfs
9/2/99 4,100 cfs
7/29/99 6,0
8/11/99 140 cfs to 4
9/10/99 680 cfs to 8
9/24/99 140 cfs to 6
9/25/99 300 cfs to 6
7/7/99 140
7/8/99 140
7/15/99 140
9/3/99 140
9/9/99 140
CARRY BROOK
10/21/99 6,000 cfs
10/27/99 6,000 cfs
11/4/99 6,000 cfs
8/19/99 7,300 cfs
8/20/99 140 cfs
8/19/99 140 cfs
7/16/99 140 cfs
9/8/99 140 cfs
9/8/99 6,000 cfs
9/23/99 6,000 cfs
9/30/99 6,000 cfs

Fish Movement over the Course of the Radio Telemetry Study #22LLS, July 7 - October 27, 1999

SHEET 4



LOCATION DIAGRAM

N

LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

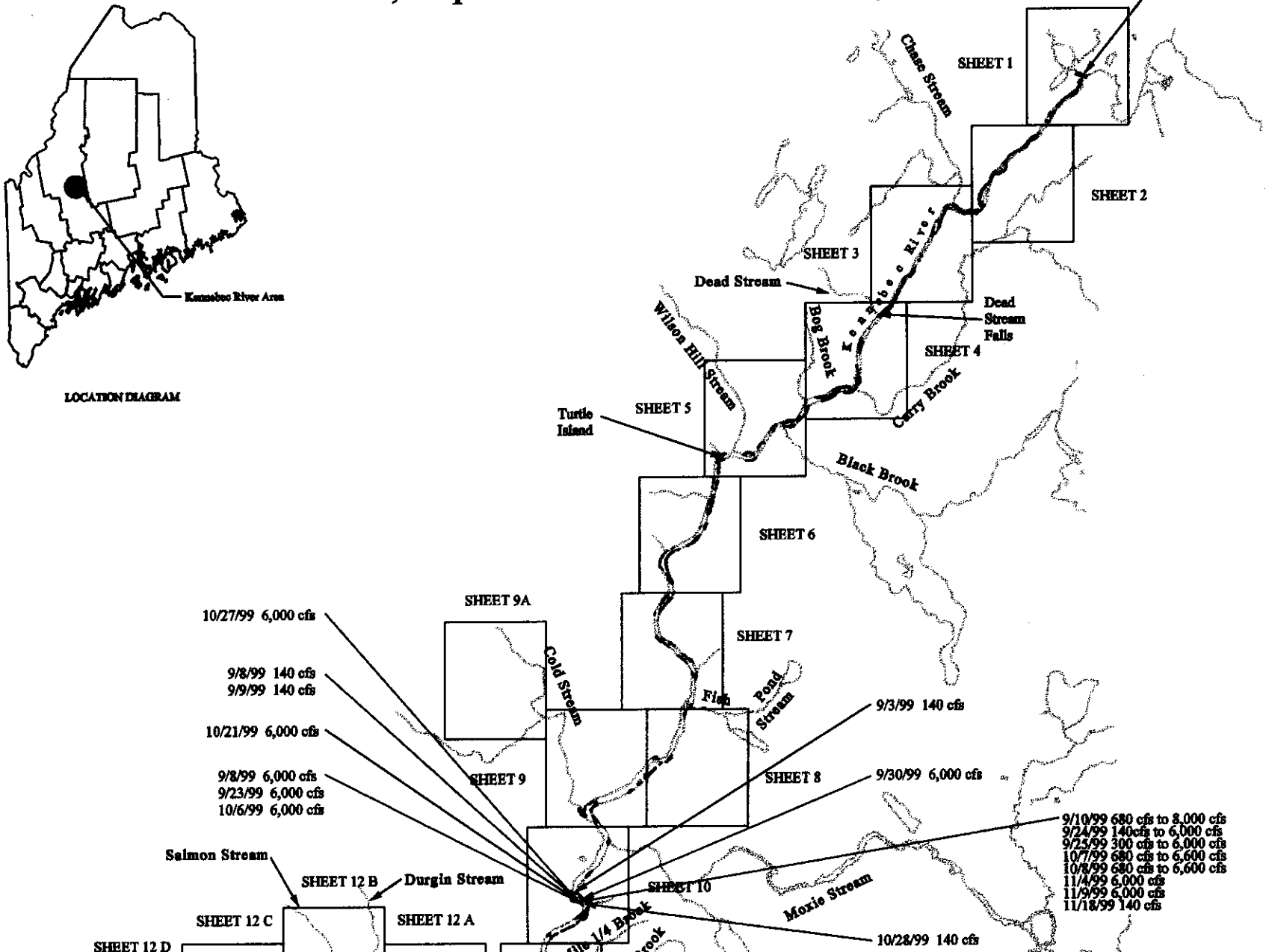
The fish was captured on July 7, 1999, in the Carry Brook area. The fish remained in this general area during all Peaking Cycle Checks and spot checks which were conducted on the following days: July 15, July 29, July 30, August 5, August 6, August 9, August 10, August 19, August 20, September 2, September 3, September 8, September 9. Spot checks were conducted on September 23, 30 and October 6.

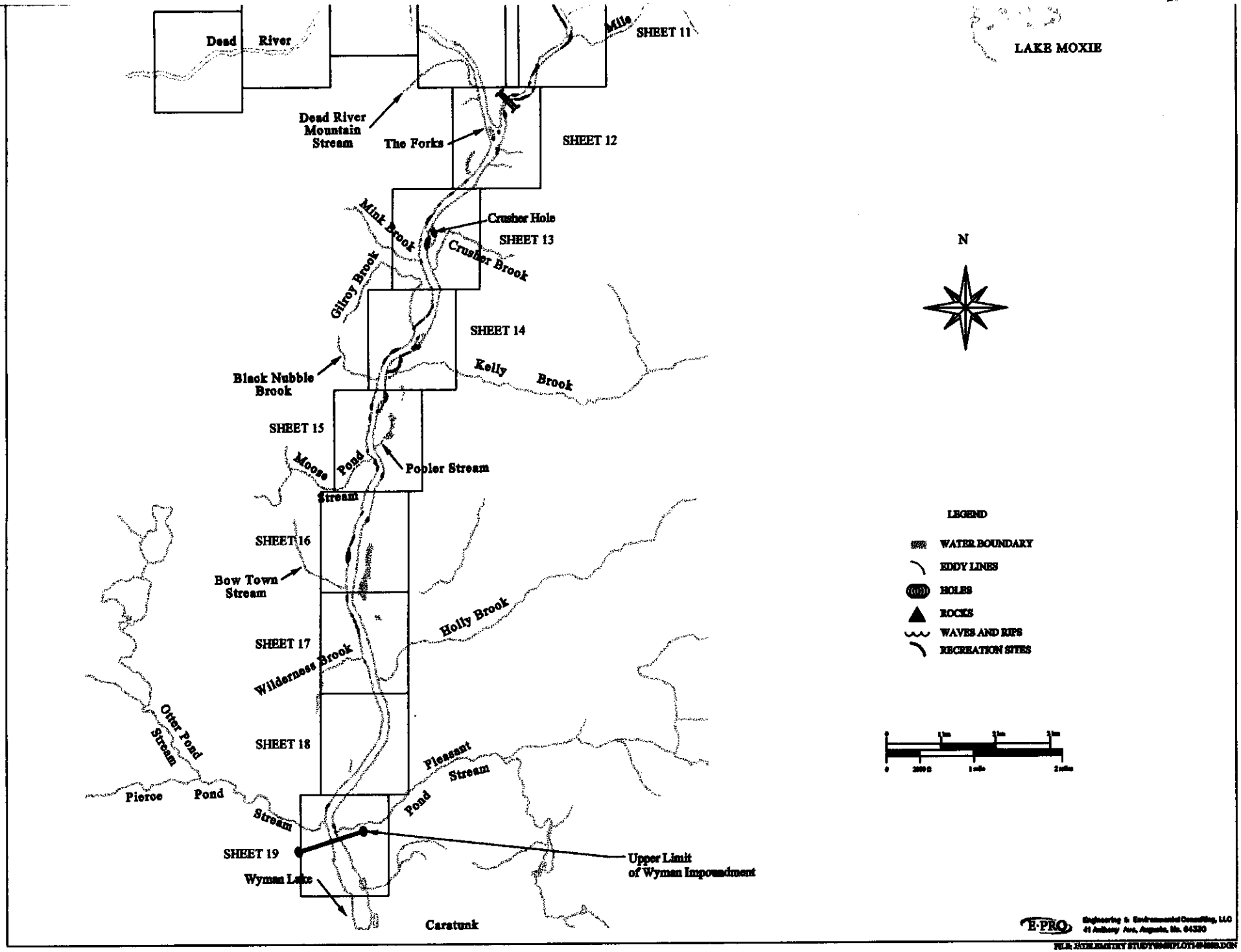
In addition to the Peaking Cycle Location Checks and spot checks, the fish was also the subject of four Intensive Monitoring Events. On August 11, the fish was monitored during a 140 cfs minimum flow to 4,800 cfs generating flow. On September 10, the fish was monitored during a 680 cfs minimum flow to 8,000 cfs generating flow. On September 24, the fish was monitored during a 140 cfs minimum flow to 6,000 cfs generating flow. On September 25, the fish was monitored during a 300 cfs minimum flow to 6,000 cfs generating flow.

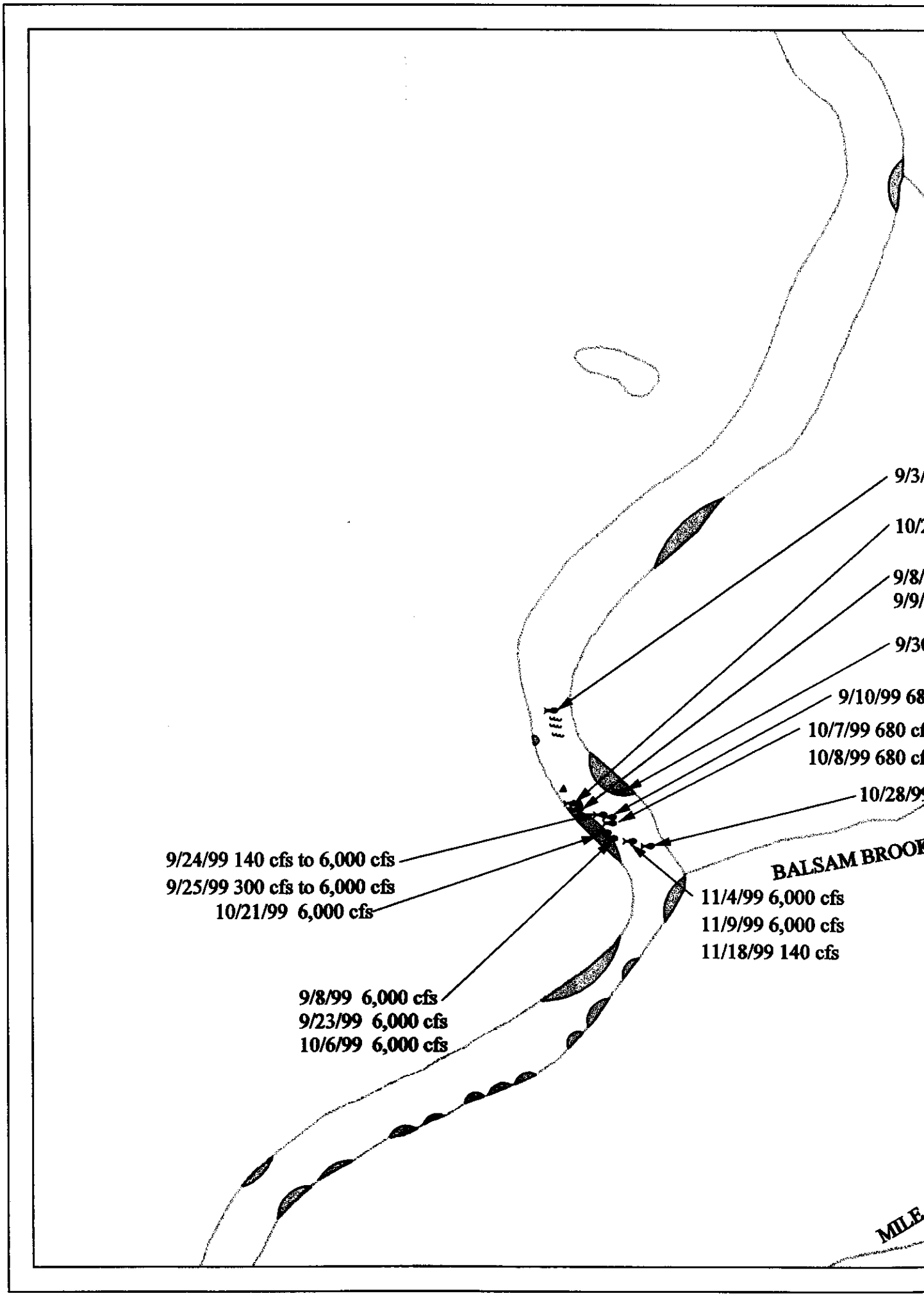
Five aerial checks were conducted during the fall of 1999. The fish was located on three of these events. On October 21, 27, and November 4 at 6,000 cfs, the fish was located in the Carry Brook area.

200 100 0 200 400 600 YARDS

Fish Movement over the Course of the Radio Telemetry Study
#49LLS, September 3 - November 18, 1999



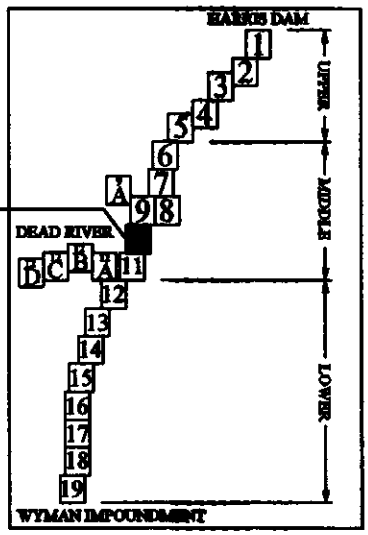

Dead River
SHEET 11
LAKE MOXIE
Dead River Mountain Stream
The Forks
SHEET 12
Mink Brook
Crusher Hole
SHEET 13
Crusher Brook
Gilroy Brook
SHEET 14
Kelly Brook
Black Nubble Brook
SHEET 15
Moose Pond
Stream
Pooler Stream
SHEET 16
Bow Town Stream
Holly Brook
SHEET 17
Wilderness Brook
Otter Pond Stream
SHEET 18
Pleasant Stream
Pond
Pierce Pond
Stream
SHEET 19
Upper Limit of Wyman Impoundment
Wyman Lake
Carratunk
N
LEGEND
WATER BOUNDARY
EDDY LINES
HOLES
ROCKS
WAVES AND RIPS
RECREATION SITES


9/3
10/
9/8/
9/9/
9/3
9/10/99 68
10/7/99 680 cf
10/8/99 680 cf
10/28/9
9/24/99 140 cfs to 6,000 cfs
9/25/99 300 cfs to 6,000 cfs
10/21/99 6,000 cfs
BALSAM BROOK
11/4/99 6,000 cfs
11/9/99 6,000 cfs
11/18/99 140 cfs
9/8/99 6,000 cfs
9/23/99 6,000 cfs
10/6/99 6,000 cfs
MILE

Fish Movement over the Course of the Radio Telemetry Study #49LLS, September 3 - November 18, 1999

MOXIE STREAM

SHEET 10



LOCATION DIAGRAM

N

LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on September 3, 1999, at Standup Rips. On September 8, the fish was located in the pool below Standup Rips during a 140 cfs minimum flow. Later that day during the subsequent generating flow of approximately 6,000 cfs, the fish was located in an eddy near river-right below Standup Rips. On September 9, the fish was located in the pool during the 140 cfs minimum flow. During spot checks on September 23, September 30, October 6 and October 28, the fish was located in the pool/eddy area below Standup Rips.

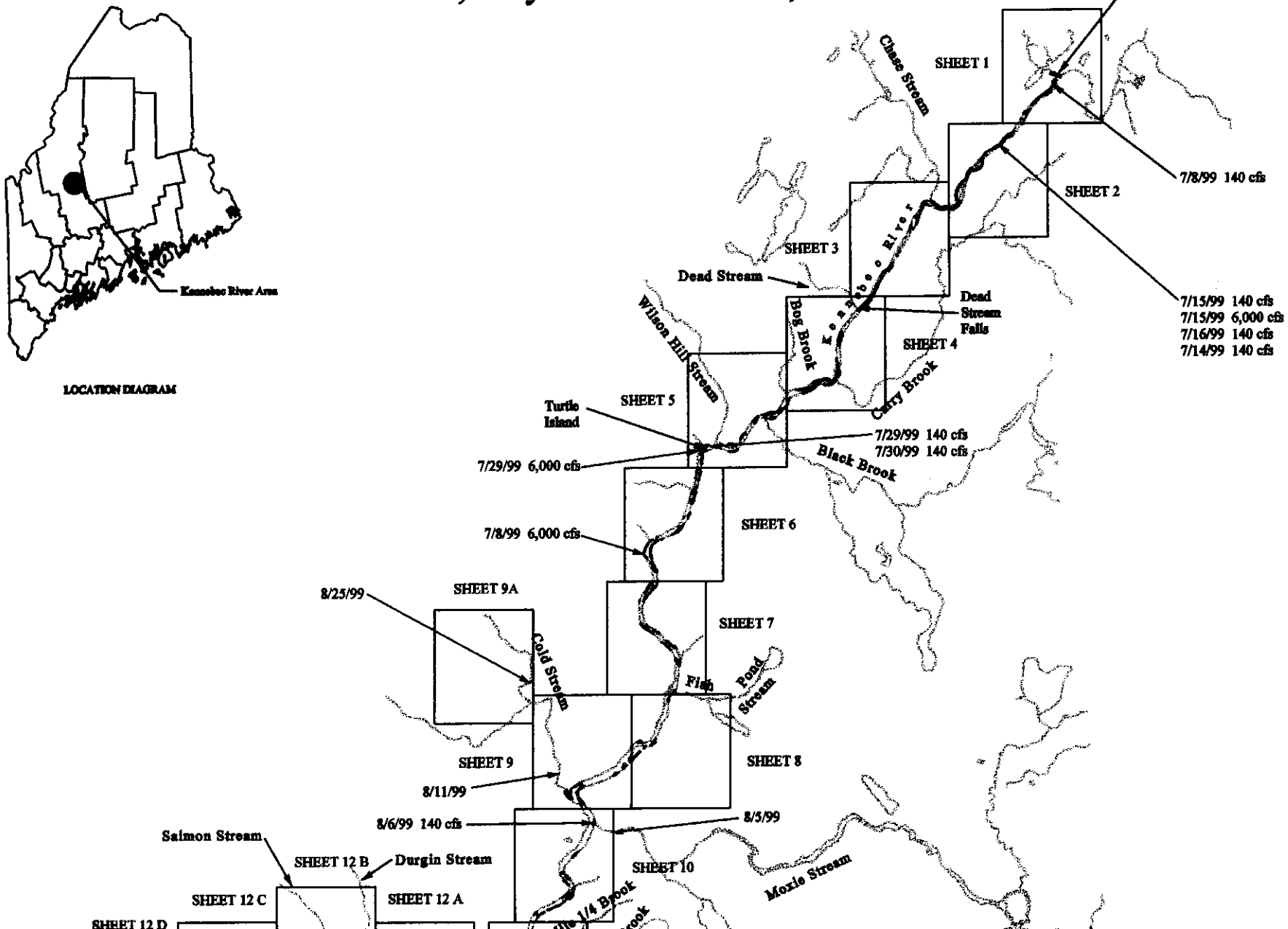
In addition to the Peaking Cycle Location Checks and spot checks, the fish was also the subject of five Intensive Monitoring Events. On September 10, the fish was monitored during a 680 cfs minimum flow to 8,000 cfs generating flow. On September 24, the fish was monitored during a 140 cfs minimum flow to 6,000 cfs generating flow. On September 25, the fish was monitored during a 300 cfs minimum flow to 6,000 cfs generating flow. On both October 7 and October 8, the fish was monitored during a 680 cfs minimum flow to 6,600 cfs generating flow.

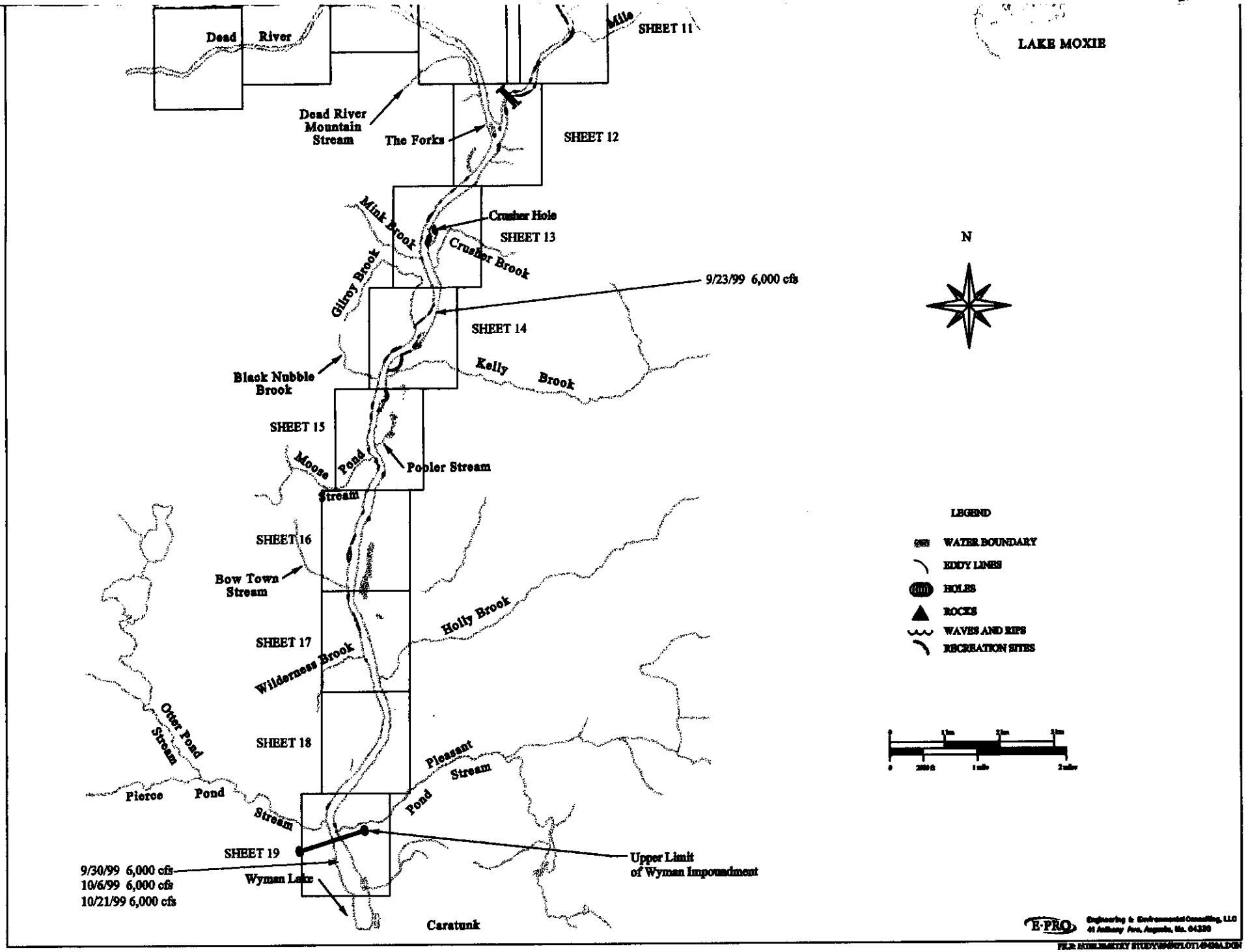
Five supplemental aerial checks were conducted during the fall of 1999. The fish was located on four of these events. On October 21, 27, and November 4 and 9, at 6,000 cfs, the fish was located in the Standup Rips area. On November 18, at 140 cfs, the fish was located in the Standup Rips area.

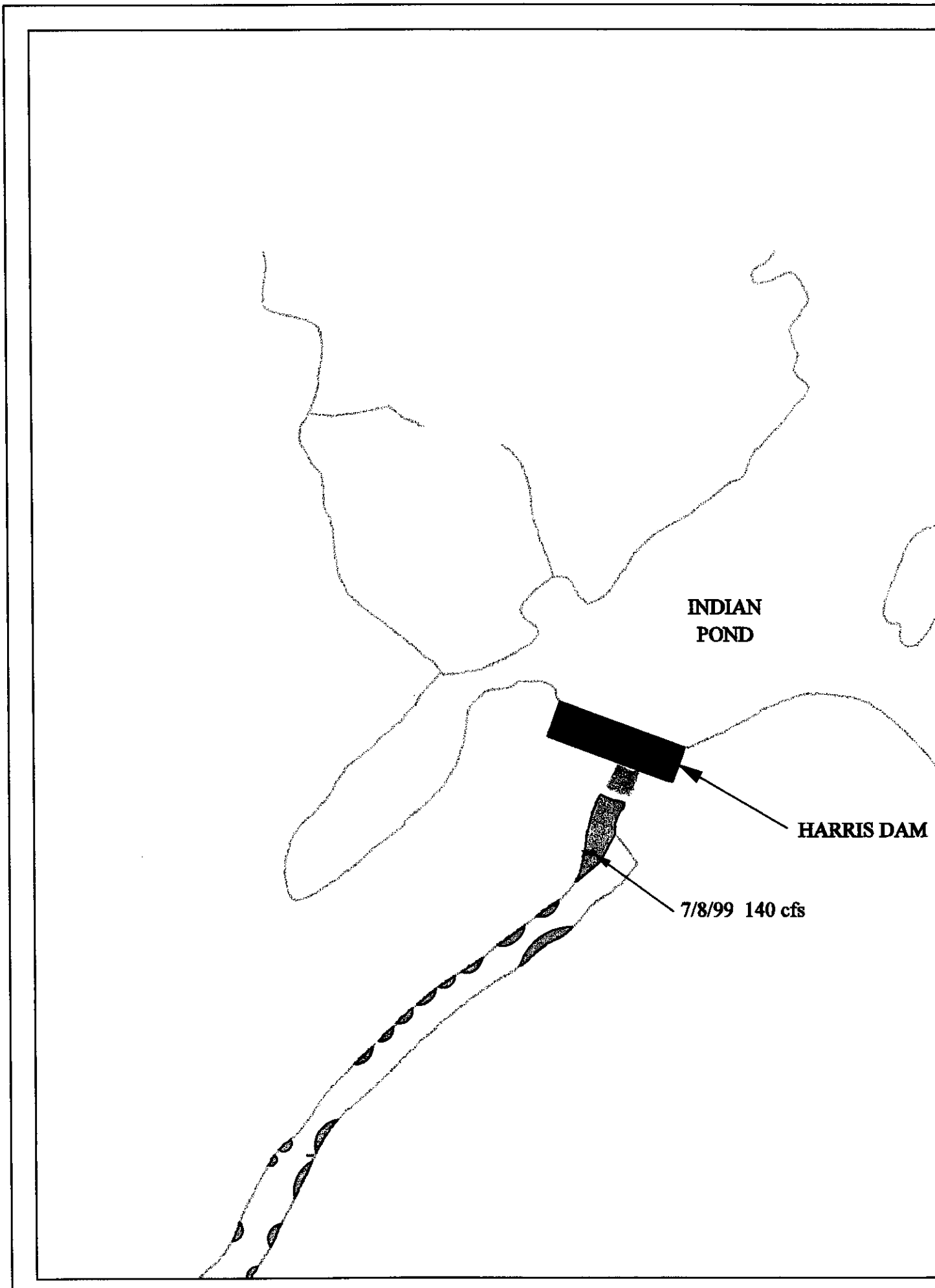
200 100 0 200 400 600 YARDS

E-PRO Engineering & Environmental Consulting, LLC 41 Anthony Ave, Augusta, Me. 04330

Fish Movement over the Course of the Radio Telemetry Study
#50BKT, July 8 - October 21, 1999

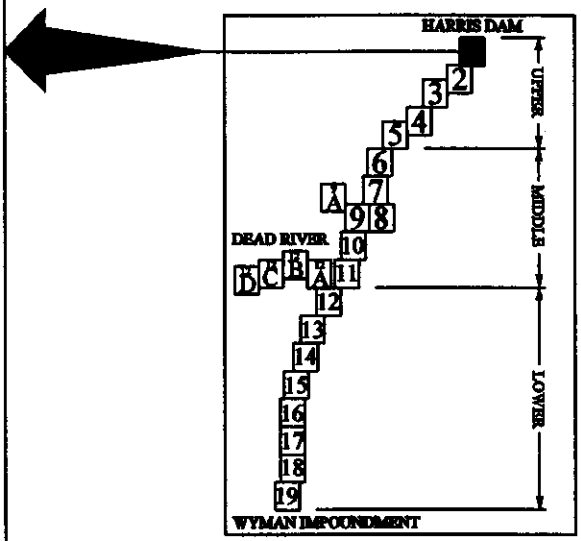



Dead River
Mile
SHEET 11
LAKE MOXIE
Dead River Mountain Stream
The Forks
SHEET 12
Mink Brook
Crusher Hole
SHEET 13
Crusher Brook
Gilroy Brook
9/23/99 6,000 cfs
SHEET 14
Black Nubble Brook
Kelly Brook
SHEET 15
Moose Pond
Stream
Popler Stream
SHEET 16
Bow Town Stream
Holly Brook
SHEET 17
Wilderness Brook
Otter Pond Stream
SHEET 18
Pleasant Stream
Pierce Pond
Stream
Pond
SHEET 19
Upper Limit of Wyman Impoundment
9/30/99 6,000 cfs
10/6/99 6,000 cfs
10/21/99 6,000 cfs
Wyman Lake
Caratunk
N
LEGEND
WATER BOUNDARY
EDDY LINES
HOLES
ROCKS
WAVES AND RIPS
RECREATION SITES
E-PRO
Engineering & Environmental Consulting, LLC
41 Anthony Ave, Augusta, Me. 04330

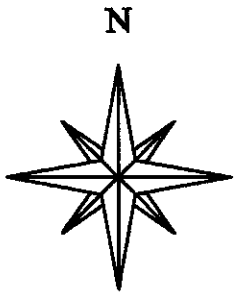

INDIAN
POND
HARRIS DAM
7/8/99 140 cfs

Fish Movement over the Course of the Radio Telemetry Study #50BKT, July 8 - October 21, 1999

SHEET 1



LOCATION DIAGRAM



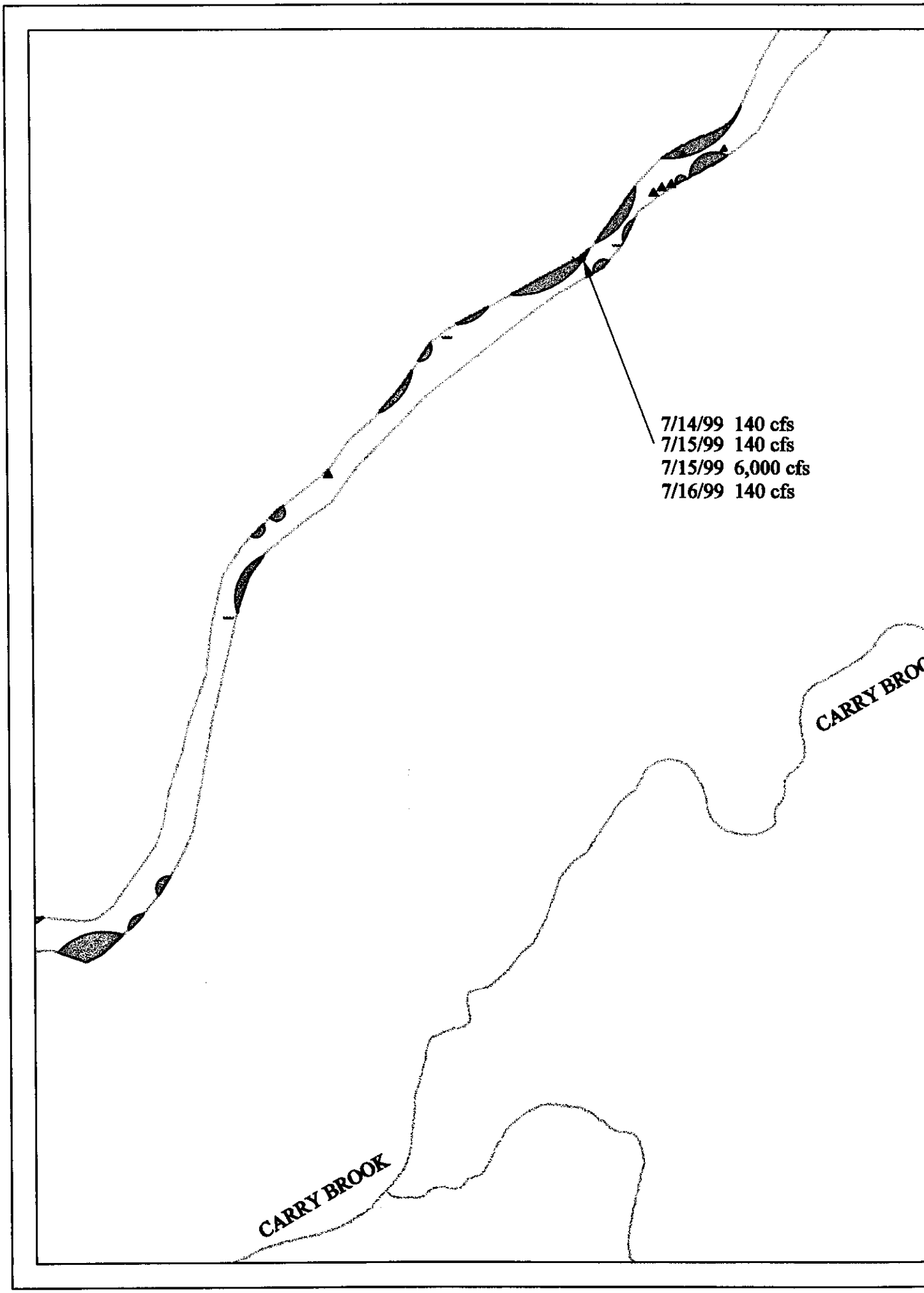
LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on July 8, 1999, at Viking Beach during a 6,000 cfs generating flow. The fish was transported upstream to Harris Station for tag implantation, and was released into the tailrace when the Station went back to the minimum flow of 140 cfs. On July 14, the fish was located downstream at Chase Stream Sluice. On July 15 and 16, the fish remained in the Chase Stream Sluice area during all flows. On July 29, the fish was located further downstream below the Moxie Lunch Site near Turtle Island at both the minimum flow of 140 cfs and generating flow of approximately 6,000 cfs. The fish was located in the same area on July 30, at 140 cfs. On August 5, the fish was located approximately ¼ mile up Moxie Stream. On August 6, the fish was located at the mouth of Moxie Stream. On August 11, the fish was located up Cold Stream approximately ¼ mile. On August 25, it was located approximately 2 miles up Cold Stream, beyond a beaver dam. It was not located again until September 23, when it was located at Gilroy Pool. On September 30, October 6, and during an aerial check on October 21, the fish was located in the upper limits of Wyman Lake where the tag was determined to be stationary.

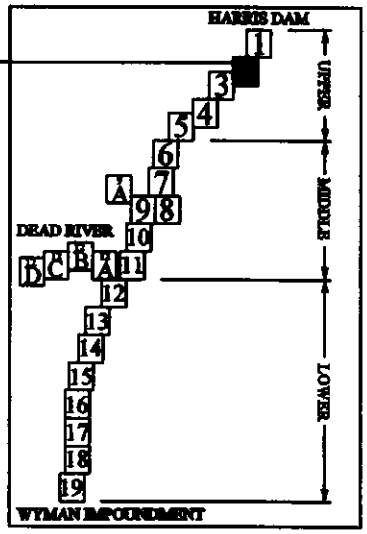
200 100 0 200 400 600 YARDS

E-PRO Engineering & Environmental Consulting, LLC
41 Anthony Ave, Augusta, Me. 04330


7/14/99 140 cfs
7/15/99 140 cfs
7/15/99 6,000 cfs
7/16/99 140 cfs
CARRY BROOK
CARRY BROOK

Fish Movement over the Course of the Radio Telemetry Study #50BKT, July 8 - October 21, 1999

SHEET 2



LOCATION DIAGRAM

N

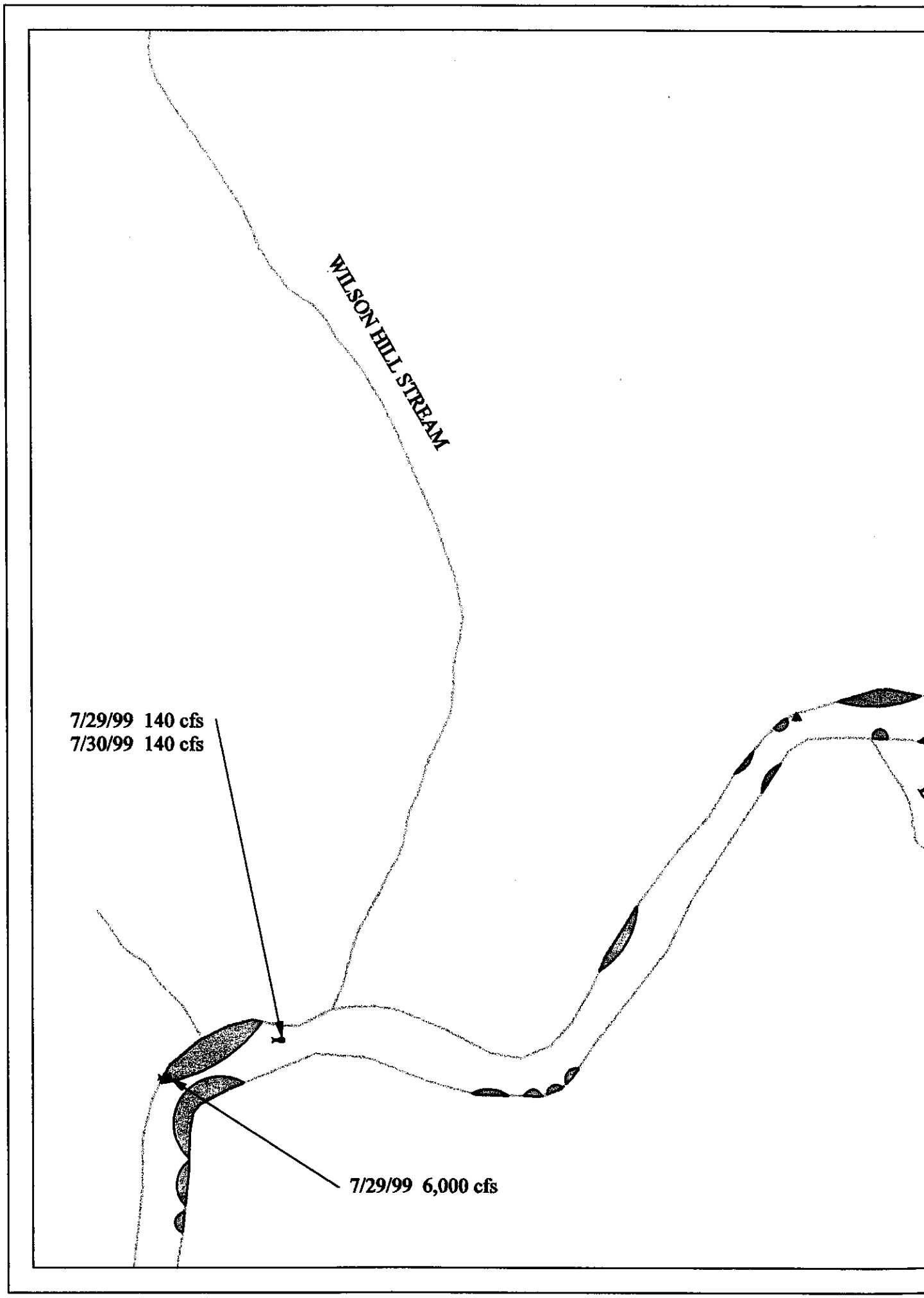
LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on July 8, 1999, at Viking Beach during a 6,000 cfs generating flow. The fish was transported upstream to Harris Station for tag implantation, and was released into the tailrace when the Station went back to the minimum flow of 140 cfs. On July 14, the fish was located downstream at Chase Stream Sluice. On July 15 and 16, the fish remained in the Chase Stream Sluice area during all flows. On July 29, the fish was located further downstream below the Moxie Lunch Site near Turtle Island at both the minimum flow of 140 cfs and generating flow of approximately 6,000 cfs. The fish was located in the same area on July 30, at 140 cfs. On August 5, the fish was located approximately ¼ mile up Moxie Stream. On August 6, the fish was located at the mouth of Moxie Stream. On August 11, the fish was located up Cold Stream approximately ¼ mile. On August 25, it was located approximately 2 miles up Cold Stream, beyond a beaver dam. It was not located again until September 23, when it was located at Gilroy Pool. On September 30, October 6, and during an aerial check on October 21, the fish was located in the upper limits of Wyman Lake where the tag was determined to be stationary.

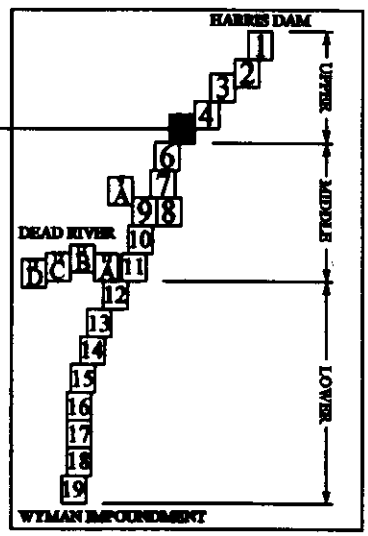
200 100 0 200 400 600 YARDS

E-PRO Engineering & Environmental Consulting, LLC
41 Anthony Ave, Augusta, Me. 04330


WILSON HILL STREAM
7/29/99 140 cfs
7/30/99 140 cfs
7/29/99 6,000 cfs

Fish Movement over the Course of the Radio Telemetry Study #50BKT, July 8 - October 21, 1999

SHEET 5



LOCATION DIAGRAM

N

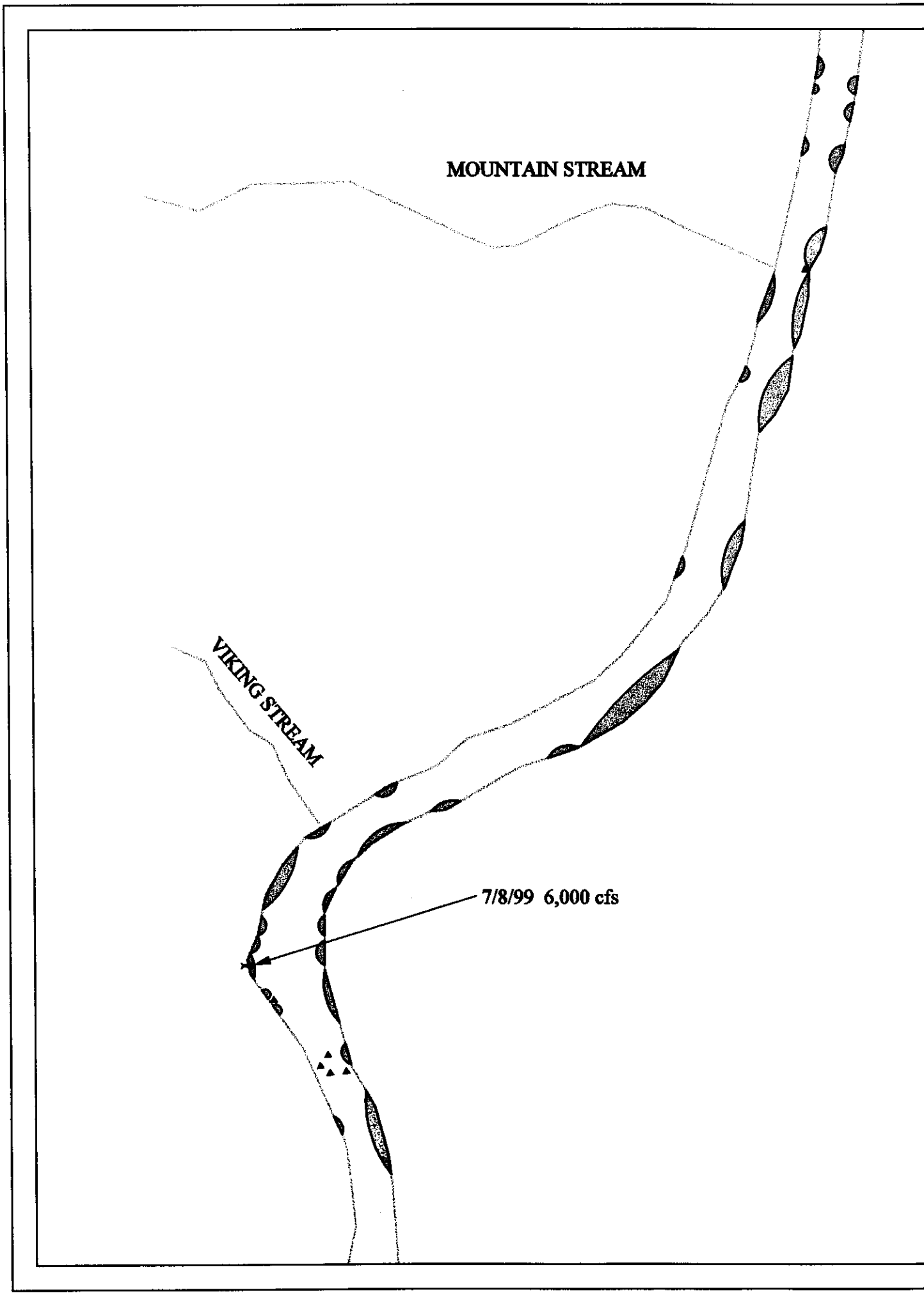
LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on July 8, 1999, at Viking Beach during a 6,000 cfs generating flow. The fish was transported upstream to Harris Station for tag implantation, and was released into the tailrace when the Station went back to the minimum flow of 140 cfs. On July 14, the fish was located downstream at Chase Stream Sluice. On July 15 and 16, the fish remained in the Chase Stream Sluice area during all flows. On July 29, the fish was located further downstream below the Moxie Lunch Site near Turtle Island at both the minimum flow of 140 cfs and generating flow of approximately 6,000 cfs. The fish was located in the same area on July 30, at 140 cfs. On August 5, the fish was located approximately ¼ mile up Moxie Stream. On August 6, the fish was located at the mouth of Moxie Stream. On August 11, the fish was located up Cold Stream approximately ¼ mile. On August 25, it was located approximately 2 miles up Cold Stream, beyond a beaver dam. It was not located again until September 23, when it was located at Gilroy Pool. On September 30, October 6, and during an aerial check on October 21, the fish was located in the upper limits of Wyman Lake where the tag was determined to be stationary.

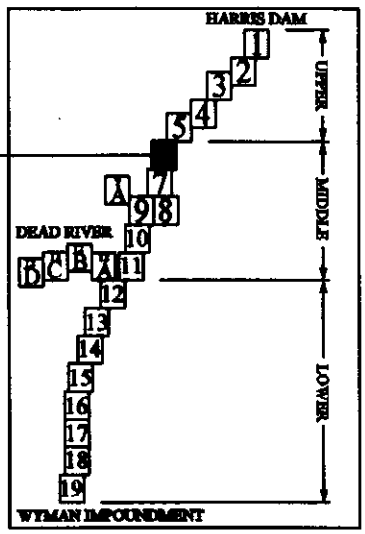
200 100 0 200 400 600 YARDS

E-PRO


MOUNTAIN STREAM
VIKING STREAM
7/8/99 6,000 cfs

Fish Movement over the Course of the Radio Telemetry Study #50BKT, July 8 - October 21, 1999

SHEET 6



LOCATION DIAGRAM

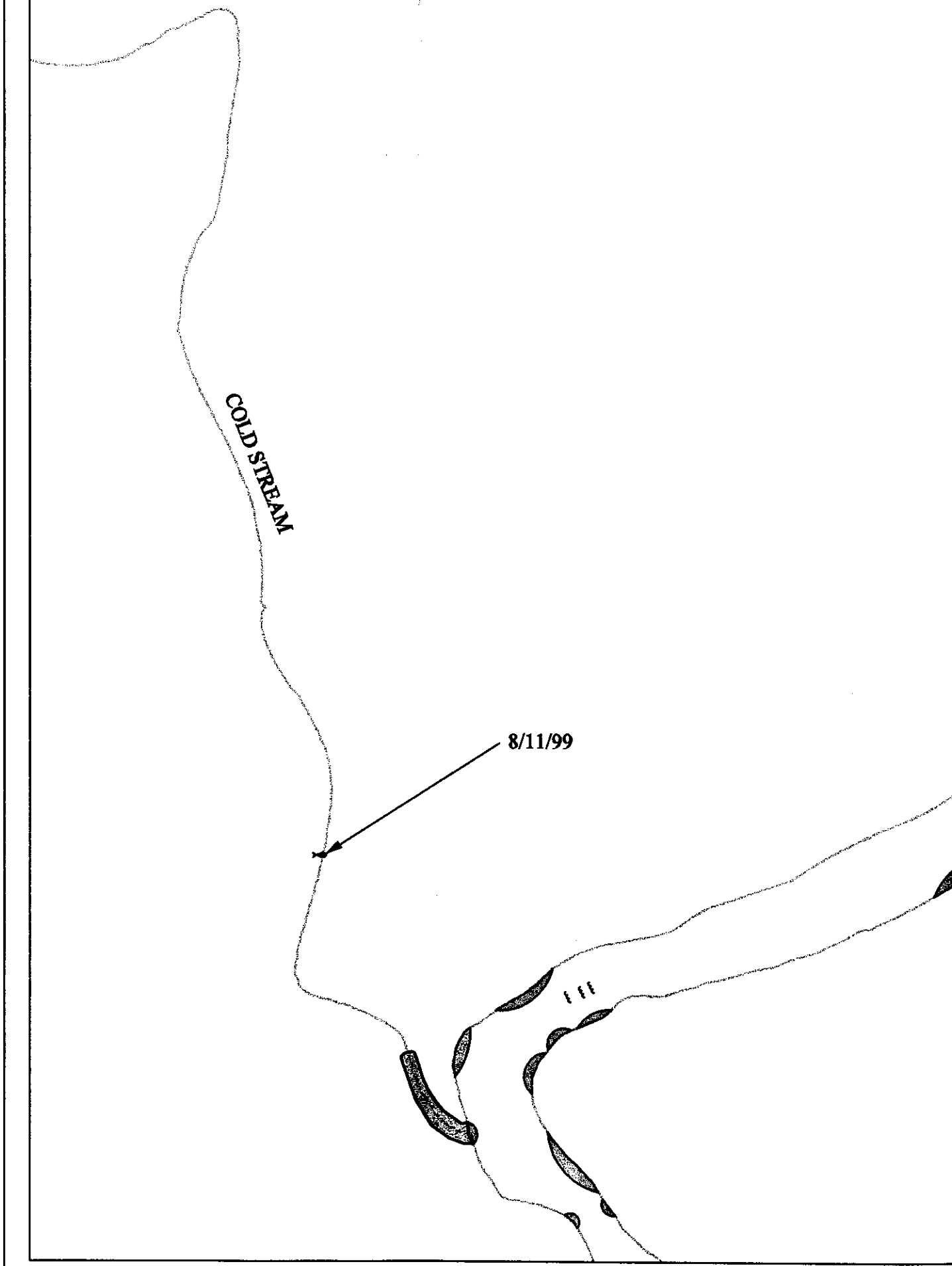
N

LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

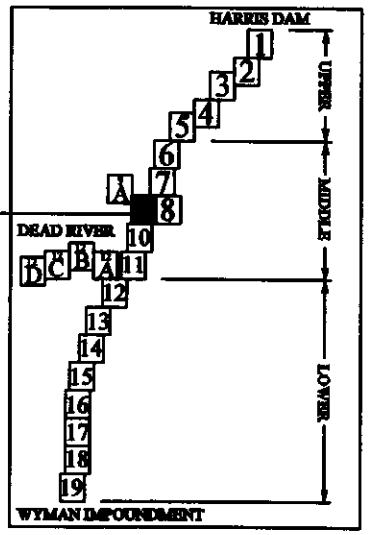
The fish was captured on July 8, 1999, at Viking Beach during a 6,000 cfs generating flow. The fish was transported upstream to Harris Station for tag implantation, and was released into the tailrace when the Station went back to the minimum flow of 140 cfs. On July 14, the fish was located downstream at Chase Stream Sluice. On July 15 and 16, the fish remained in the Chase Stream Sluice area during all flows. On July 29, the fish was located further downstream below the Moxie Lunch Site near Turtle Island at both the minimum flow of 140 cfs and generating flow of approximately 6,000 cfs. The fish was located in the same area on July 30, at 140 cfs. On August 5, the fish was located approximately ¼ mile up Moxie Stream. On August 6, the fish was located at the mouth of Moxie Stream. On August 11, the fish was located up Cold Stream approximately ¼ mile. On August 25, it was located approximately 2 miles up Cold Stream, beyond a beaver dam. It was not located again until September 23, when it was located at Gilroy Pool. On September 30, October 6, and during an aerial check on October 21, the fish was located in the upper limits of Wyman Lake where the tag was determined to be stationary.

200 100 0 200 400 600 YARDS


COLD STREAM
8/11/99

Fish Movement over the Course of the Radio Telemetry Study #50BKT, July 8 - October 21, 1999

SHEET 9



LOCATION DIAGRAM

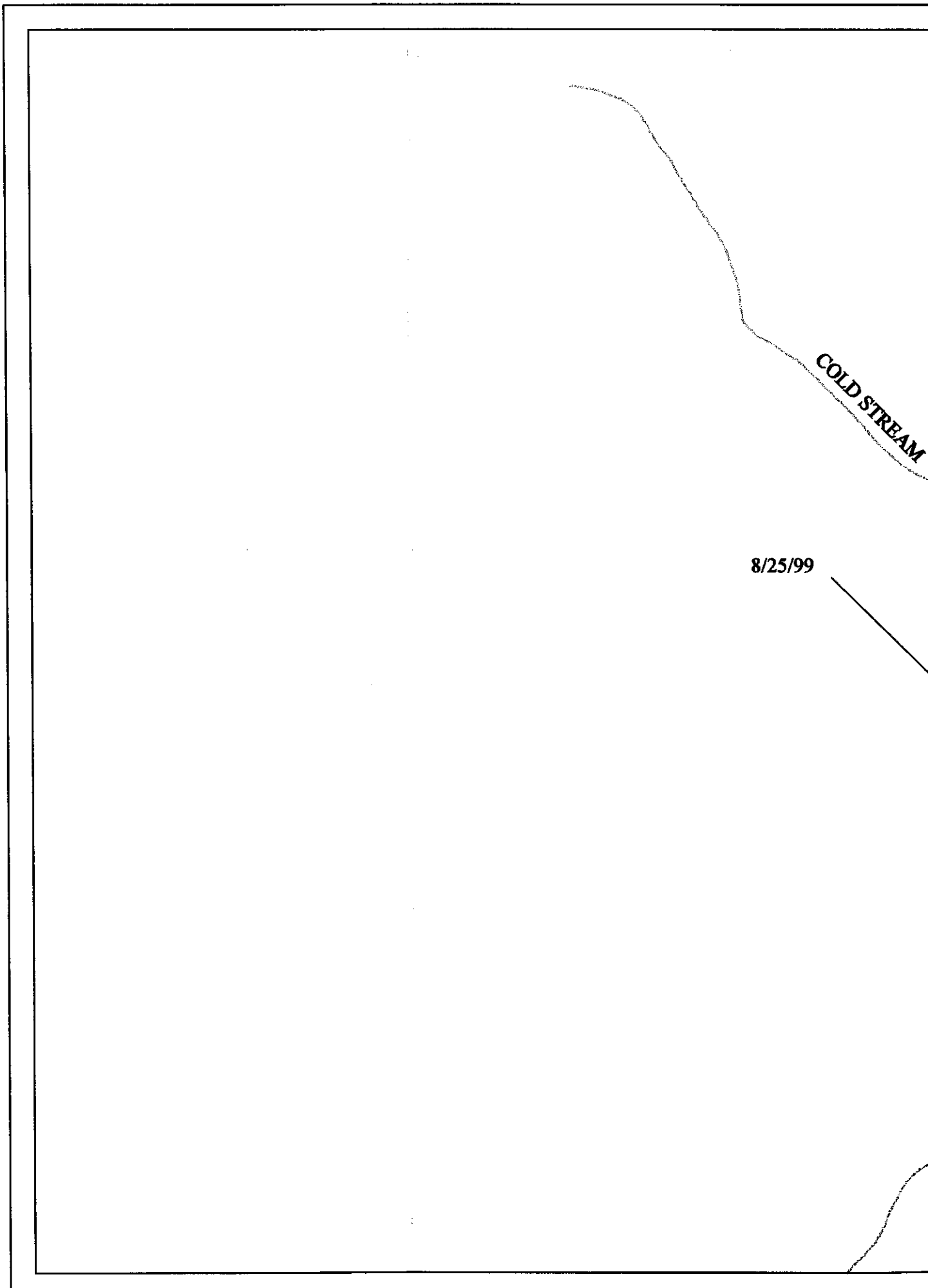
N

LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

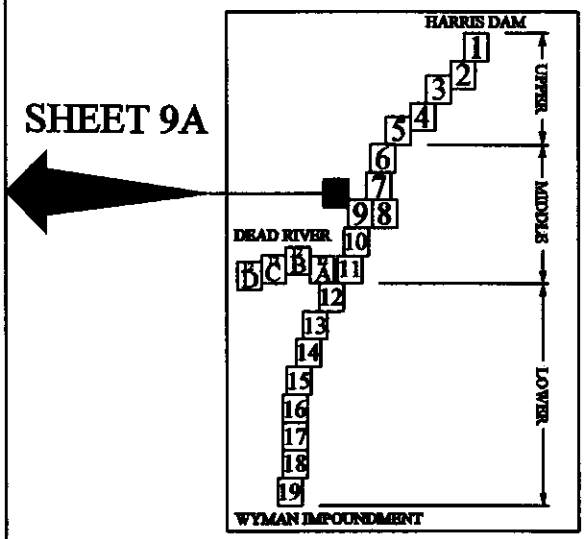
The fish was captured on July 8, 1999, at Viking Beach during a 6,000 cfs generating flow. The fish was transported upstream to Harris Station for tag implantation, and was released into the tailrace when the Station went back to the minimum flow of 140 cfs. On July 14, the fish was located downstream at Chase Stream Sluice. On July 15 and 16, the fish remained in the Chase Stream Sluice area during all flows. On July 29, the fish was located further downstream below the Moxie Launch Site near Turtle Island at both the minimum flow of 140 cfs and generating flow of approximately 6,000 cfs. The fish was located in the same area on July 30, at 140 cfs. On August 5, the fish was located approximately ¼ mile up Moxie Stream. On August 6, the fish was located at the mouth of Moxie Stream. On August 11, the fish was located up Cold Stream approximately ¼ mile. On August 25, it was located approximately 2 miles up Cold Stream, beyond a beaver dam. It was not located again until September 23, when it was located at Gilroy Pool. On September 30, October 6, and during an aerial check on October 21, the fish was located in the upper limits of Wyman Lake where the tag was determined to be stationary.

200 100 0 200 400 600 YARDS


COLD STREAM
8/25/99

Fish Movement over the Course of the Radio Telemetry Study #50BKT, July 8 - October 21, 1999

SHEET 9A



LOCATION DIAGRAM

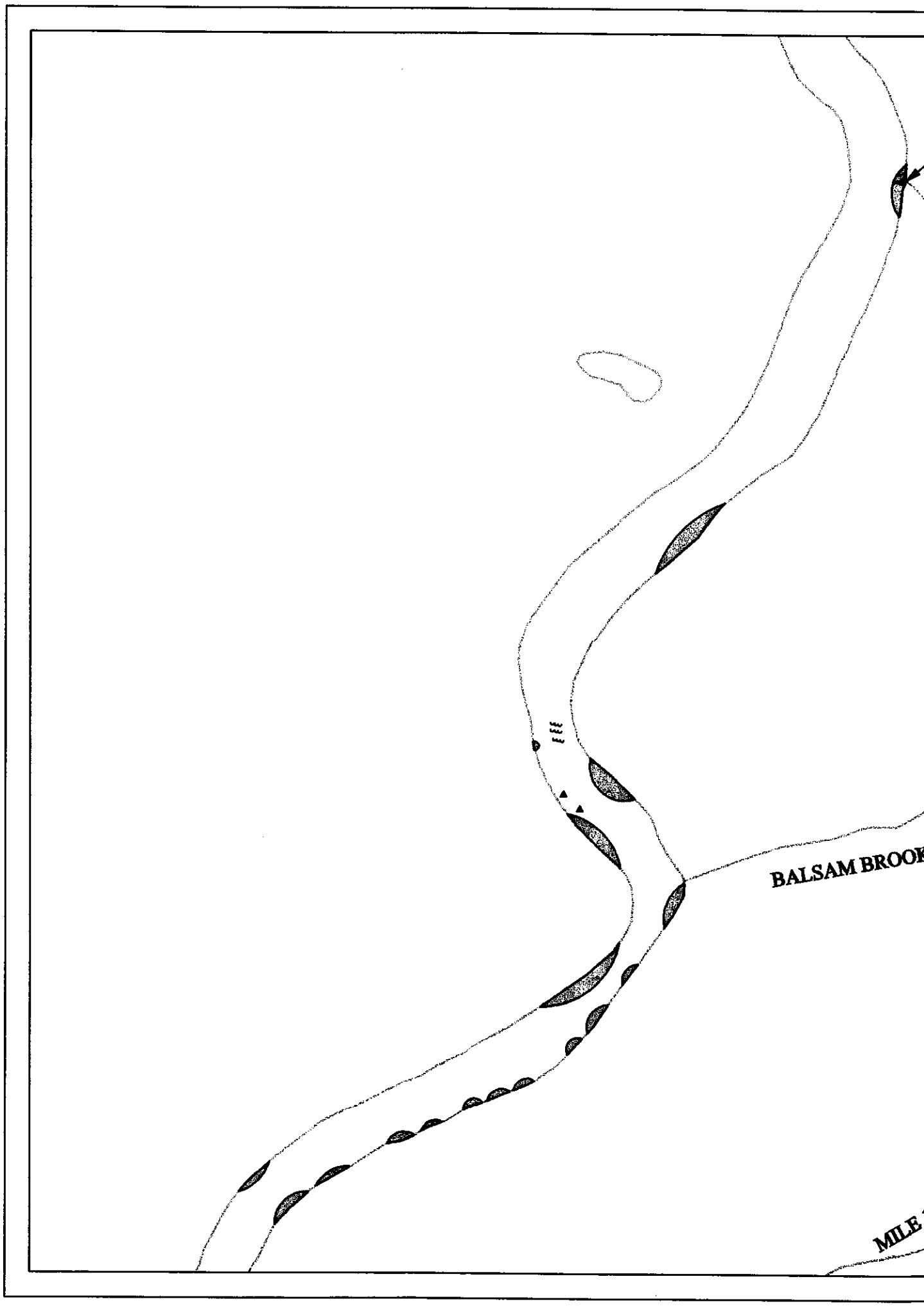
N

LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on July 8, 1999, at Viking Beach during a 6,000 cfs generating flow. The fish was transported upstream to Harris Station for tag implantation, and was released into the tailrace when the Station went back to the minimum flow of 140 cfs. On July 14, the fish was located downstream at Chase Stream Sluice. On July 15 and 16, the fish remained in the Chase Stream Sluice area during all flows. On July 29, the fish was located further downstream below the Moxie Lunch Site near Turtle Island at both the minimum flow of 140 cfs and generating flow of approximately 6,000 cfs. The fish was located in the same area on July 30, at 140 cfs. On August 5, the fish was located approximately ¼ mile up Moxie Stream. On August 6, the fish was located at the mouth of Moxie Stream. On August 11, the fish was located up Cold Stream approximately ¼ mile. On August 25, it was located approximately 2 miles up Cold Stream, beyond a beaver dam. It was not located again until September 23, when it was located at Gilroy Pool. On September 30, October 6, and during an aerial check on October 21, the fish was located in the upper limits of Wyman Lake where the tag was determined to be stationary.

200 100 0 200 400 600 YARDS


BALSAM BROOK

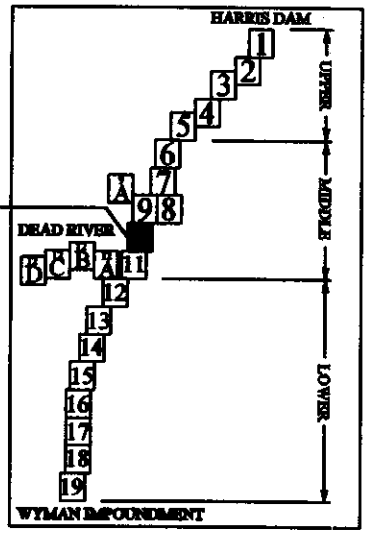
Fish Movement over the Course of the Radio Telemetry Study #50BKT, July 8 - October 21, 1999

8/6/99 140 cfs

MOXIE STREAM

SHEET 10

8/5/99



LOCATION DIAGRAM

N

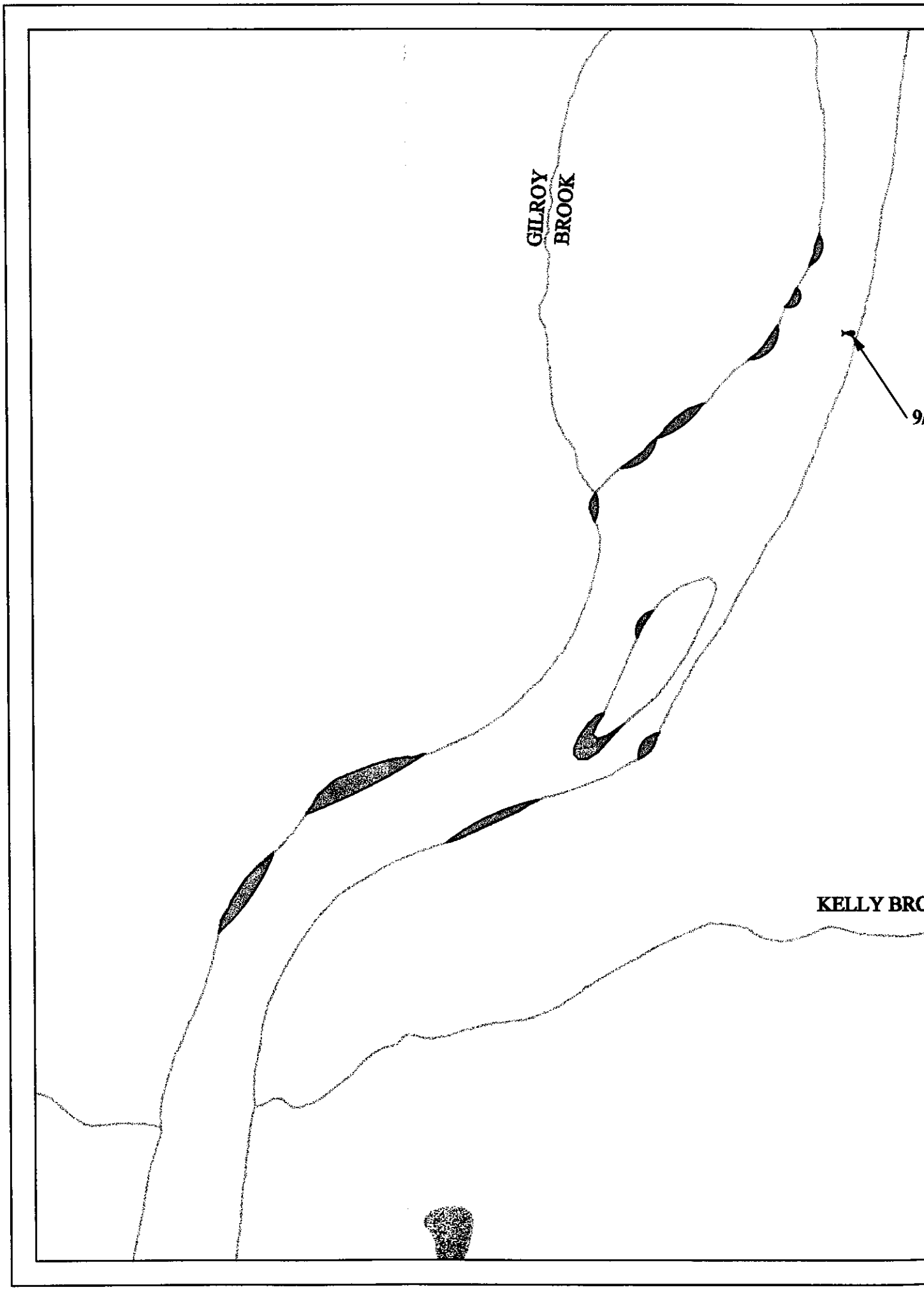
LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on July 8, 1999, at Viking Beach during a 6,000 cfs generating flow. The fish was transported upstream to Harris Station for tag implantation, and was released into the tailrace when the Station went back to the minimum flow of 140 cfs. On July 14, the fish was located downstream at Chase Stream Sluice. On July 15 and 16, the fish remained in the Chase Stream Sluice area during all flows. On July 29, the fish was located further downstream below the Moxie Lunch Site near Turtle Island at both the minimum flow of 140 cfs and generating flow of approximately 6,000 cfs. The fish was located in the same area on July 30, at 140 cfs. On August 5, the fish was located approximately ¼ mile up Moxie Stream. On August 6, the fish was located at the mouth of Moxie Stream. On August 11, the fish was located up Cold Stream approximately ¼ mile. On August 25, it was located approximately 2 miles up Cold Stream, beyond a beaver dam. It was not located again until September 23, when it was located at Gilroy Pool. On September 30, October 6, and during an aerial check on October 21, the fish was located in the upper limits of Wyman Lake where the tag was determined to be stationary.

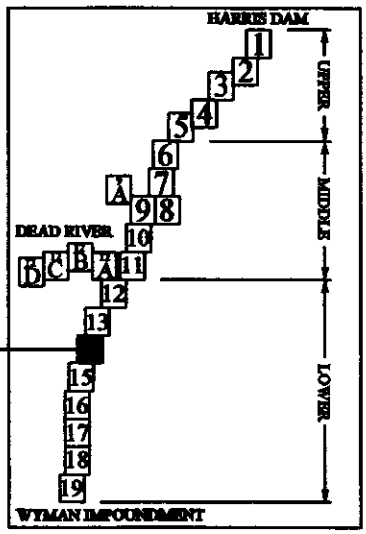
BROOK

200 100 0 200 400 600 YARDS


GILROY
BROOK
KELLY BRO

Fish Movement over the Course of the Radio Telemetry Study #50BKT, July 8 - October 21, 1999

SHEET 14



LOCATION DIAGRAM

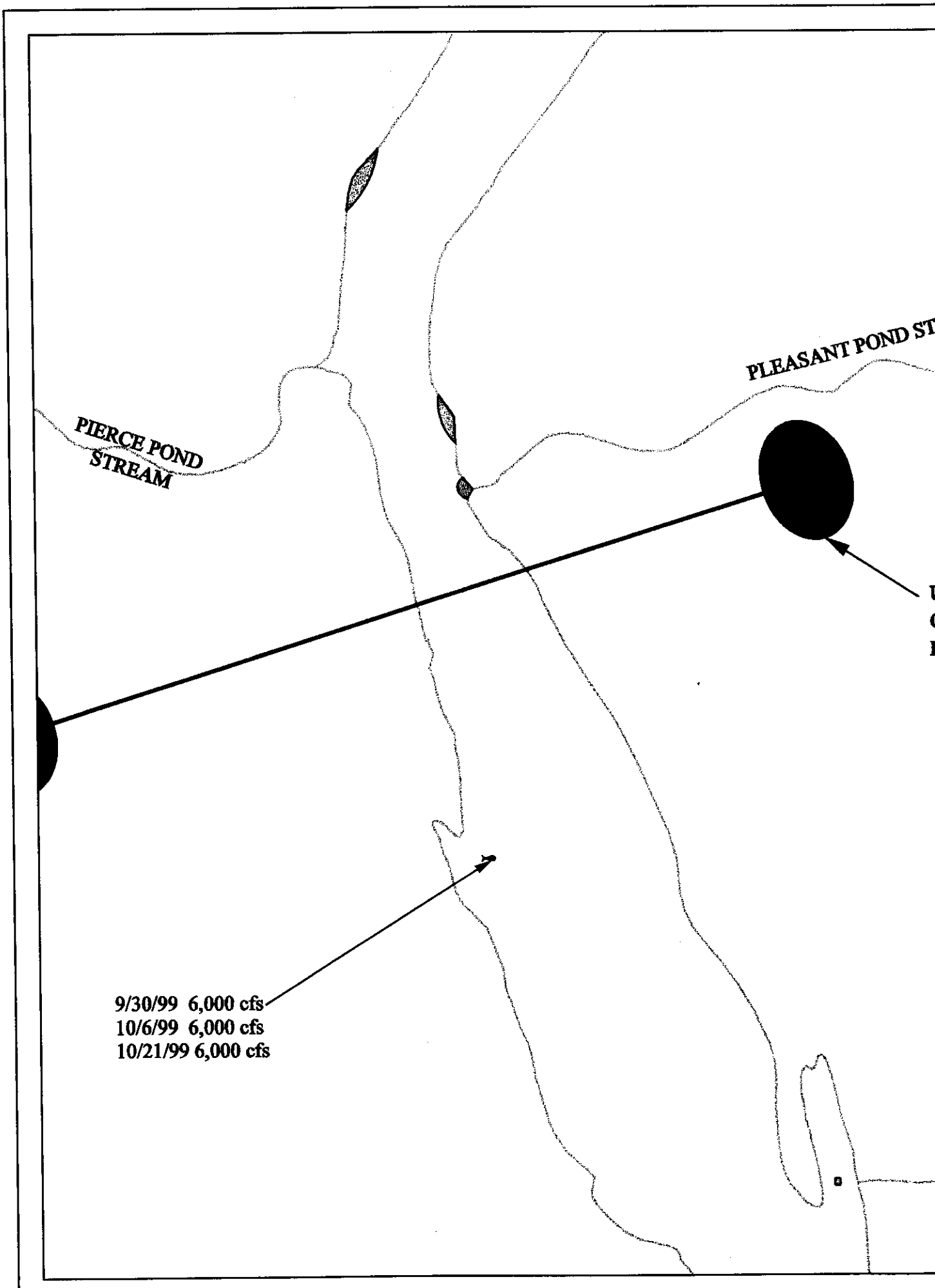
N

LEGEND

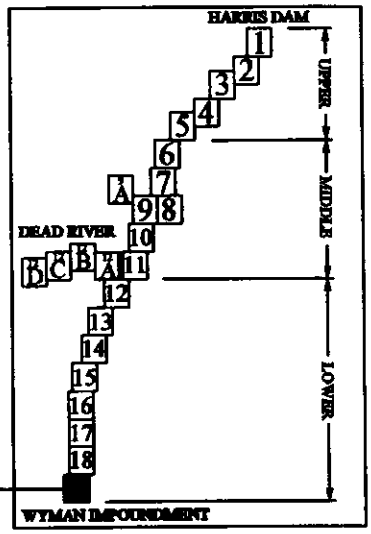
- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on July 8, 1999, at Viking Beach during a 6,000 cfs generating flow. The fish was transported upstream to Harris Station for tag implantation, and was released into the tailrace when the Station went back to the minimum flow of 140 cfs. On July 14, the fish was located downstream at Chase Stream Sluice. On July 15 and 16, the fish remained in the Chase Stream Sluice area during all flows. On July 29, the fish was located further downstream below the Moxie Lunch Site near Turtle Island at both the minimum flow of 140 cfs and generating flow of approximately 6,000 cfs. The fish was located in the same area on July 30, at 140 cfs. On August 5, the fish was located approximately ¼ mile up Moxie Stream. On August 6, the fish was located at the mouth of Moxie Stream. On August 11, the fish was located up Cold Stream approximately ¼ mile. On August 25, it was located approximately 2 miles up Cold Stream, beyond a beaver dam. It was not located again until September 23, when it was located at Gilroy Pool. On September 30, October 6, and during an aerial check on October 21, the fish was located in the upper limits of Wyman Lake where the tag was determined to be stationary.

200 100 0 200 400 600 YARDS


PIERCE POND
STREAM
PLEASANT POND ST
9/30/99 6,000 cfs
10/6/99 6,000 cfs
10/21/99 6,000 cfs

Fish Movement over the Course of the Radio Telemetry Study #50BKT, July 8 - October 21, 1999



LOCATION DIAGRAM

SHEET 19

N

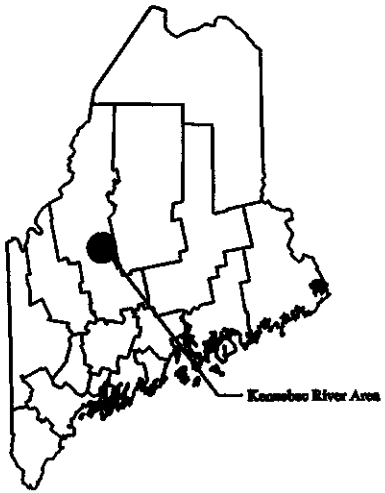
LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

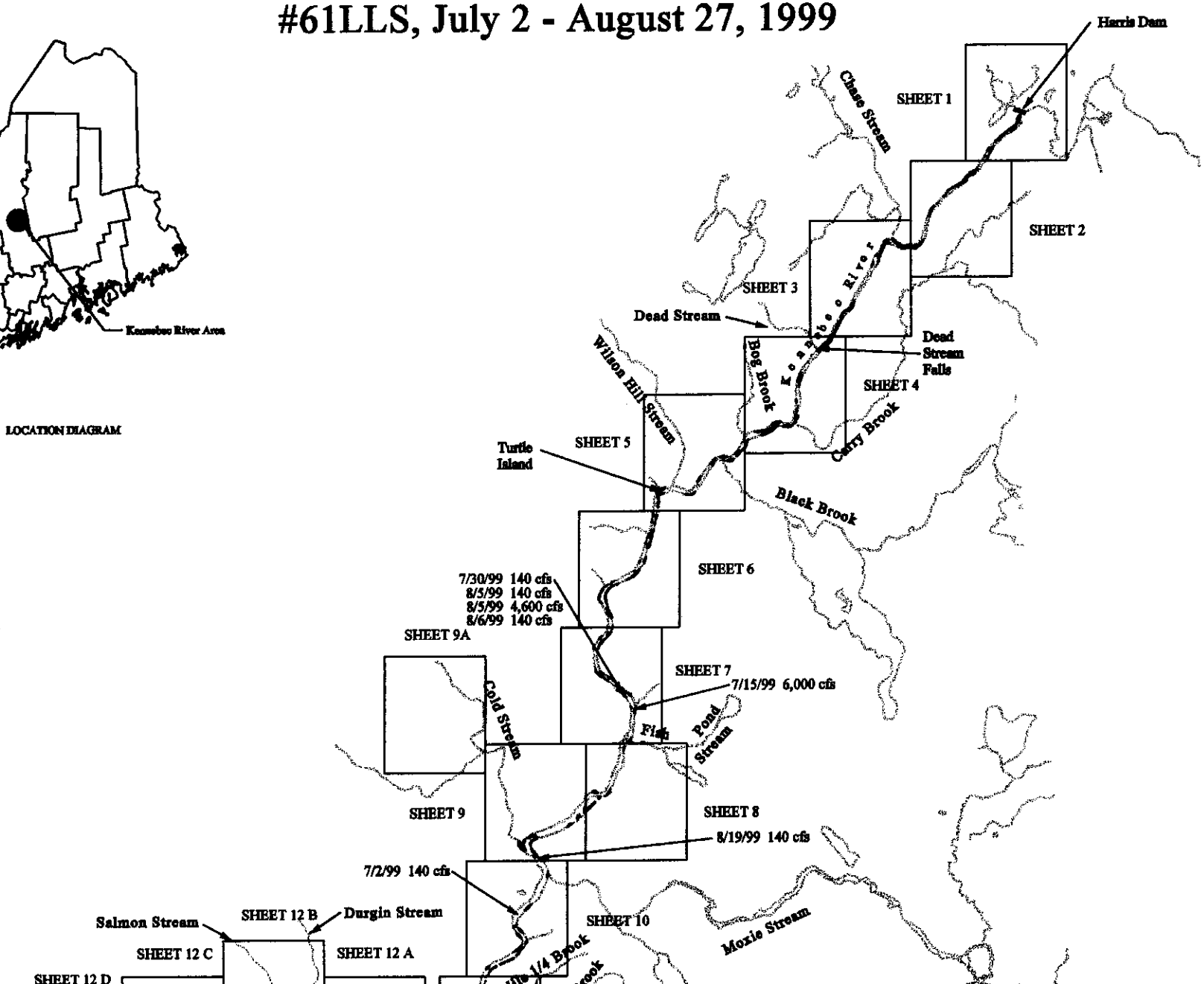
The fish was captured on July 8, 1999, at Viking Beach during a 6,000 cfs generating flow. The fish was transported upstream to Harris Station for tag implantation, and was released into the tailrace when the Station went back to the minimum flow of 140 cfs. On July 14, the fish was located downstream at Chase Stream Sluice. On July 15 and 16, the fish remained in the Chase Stream Sluice area during all flows. On July 29, the fish was located further downstream below the Moxie Lunch Site near Turtle Island at both the minimum flow of 140 cfs and generating flow of approximately 6,000 cfs. The fish was located in the same area on July 30, at 140 cfs. On August 5, the fish was located approximately ¼ mile up Moxie Stream. On August 6, the fish was located at the mouth of Moxie Stream. On August 11, the fish was located up Cold Stream approximately ½ mile. On August 25, it was located approximately 2 miles up Cold Stream, beyond a beaver dam. It was not located again until September 23, when it was located at Gilroy Pool. On September 30, October 6, and during an aerial check on October 21, the fish was located in the upper limits of Wyman Lake where the tag was determined to be stationary.

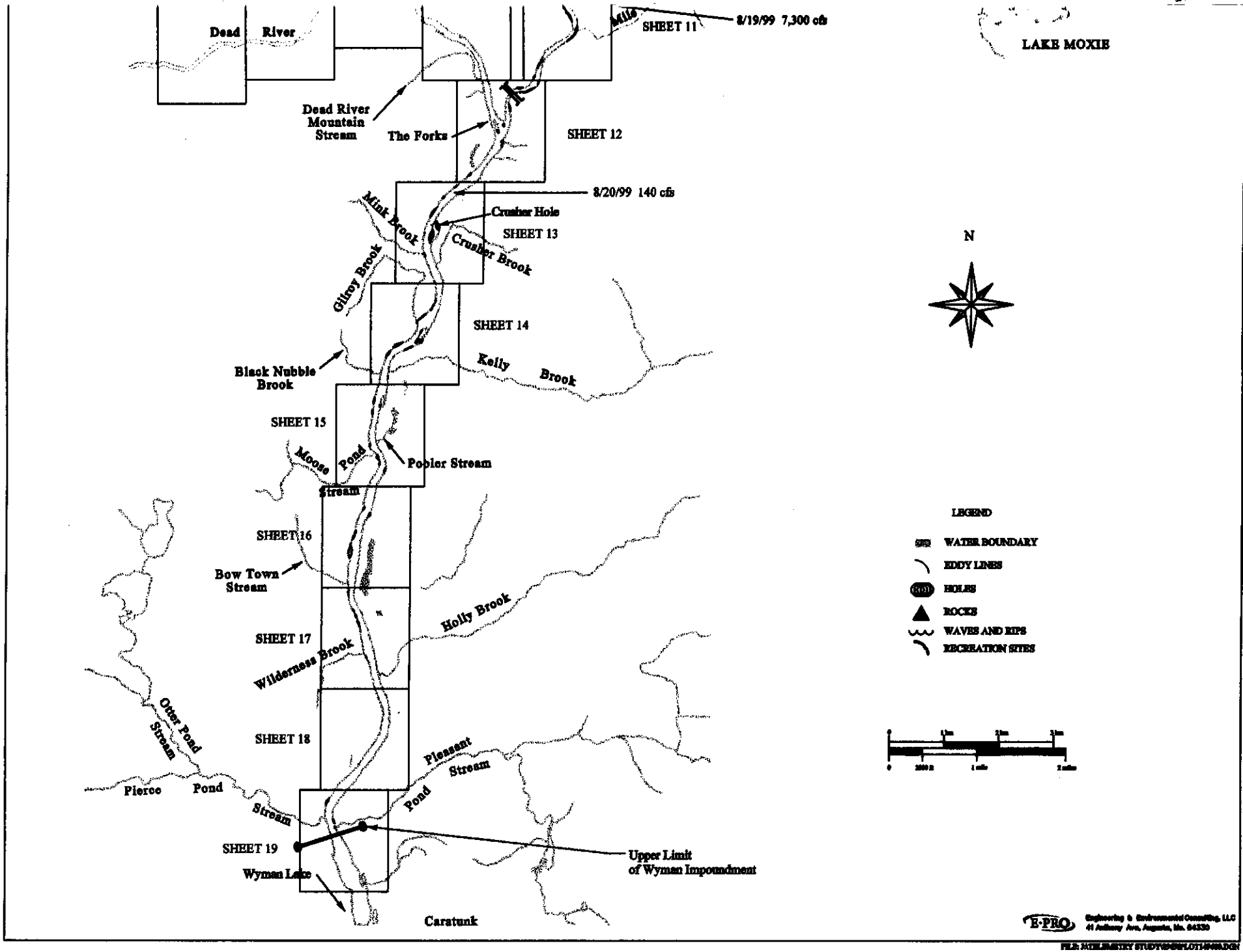
200 100 0 200 400 600 YARDS

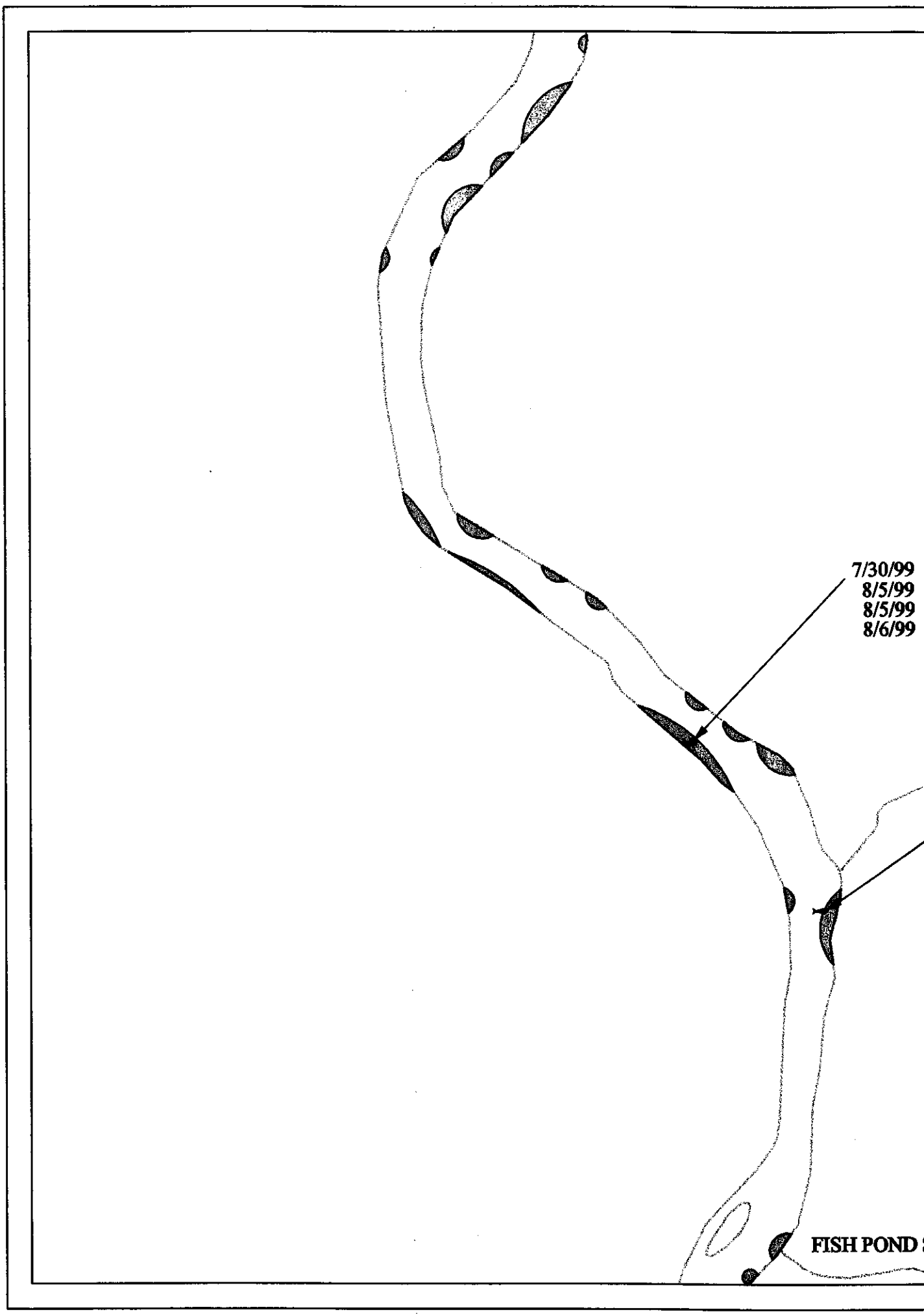
Fish Movement over the Course of the Radio Telemetry Study
#61LLS, July 2 - August 27, 1999



LOCATION DIAGRAM

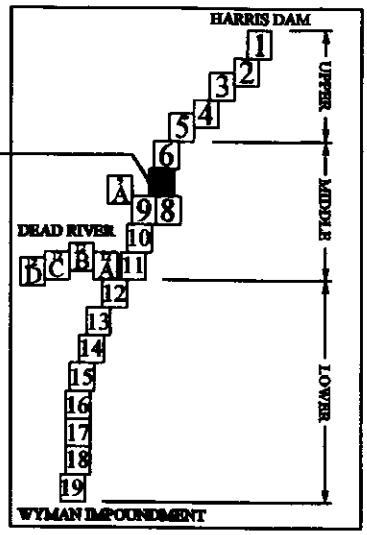



Dead River
SHEET 11
8/19/99 7,300 cfs
LAKE MOXIE
Dead River Mountain Stream
The Forks
SHEET 12
8/20/99 140 cfs
Mink Brook
Crusher Hole
SHEET 13
Crusher Brook
Gilroy Brook
SHEET 14
Kelly Brook
Black Nubble Brook
SHEET 15
Moose Pond
Pooler Stream
Stream
SHEET 16
Bow Town Stream
Holly Brook
SHEET 17
Wilderness Brook
Otter Pond Stream
SHEET 18
Pleasant Stream
Pierce Pond
Stream
Pond
SHEET 19
Upper Limit of Wyman Impoundment
Wyman Lake
Caratunk
N
LEGEND
WATER BOUNDARY
EDDY LINES
HOLES
ROCKS
WAVES AND RIPS
RECREATION SITES
E-PRO


7/30/99
8/5/99
8/5/99
8/6/99
FISH POND

Fish Movement over the Course of the Radio Telemetry Study #61LLS, July 2 - August 27, 1999

SHEET 7



LOCATION DIAGRAM

N

LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on July 2, 1999, at Standup Rips. On July 15, it was located downstream of Sandbar Eddy during a 6,000 cfs generating flow. During the subsequent tracking events that occurred on July 30, August 5, and August 6, the fish was located in a pool/run on the eddy lines during all flows. On August 19, the fish was located downstream near Cold Stream during the minimum flow of 140 cfs. During the subsequent generating flow of approximately 7,300 cfs later that day, the fish was located further downstream near the area of Mile and 1/4 Brook and Mudhole. On August 20, the fish was located below The Forks near the "Joe Bruce Camp". On August 27, the tag was retrieved (absent the fish) from the bank on river-left, just upstream of the "Joe Bruce Camp".

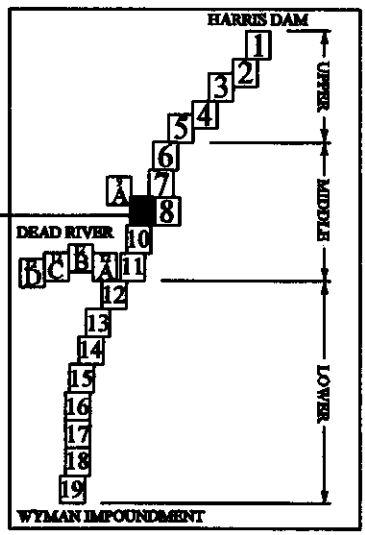
200 100 0 200 400 600YARDS

E-PRO Engineering & Environmental Consulting, LLC 41 Anthony Ave, Augusta, Me. 04330

COLD STREAM
8/19/99

Fish Movement over the Course of the Radio Telemetry Study #61LLS, July2 - August 27, 1999

SHEET 9



LOCATION DIAGRAM

N

LEGEND

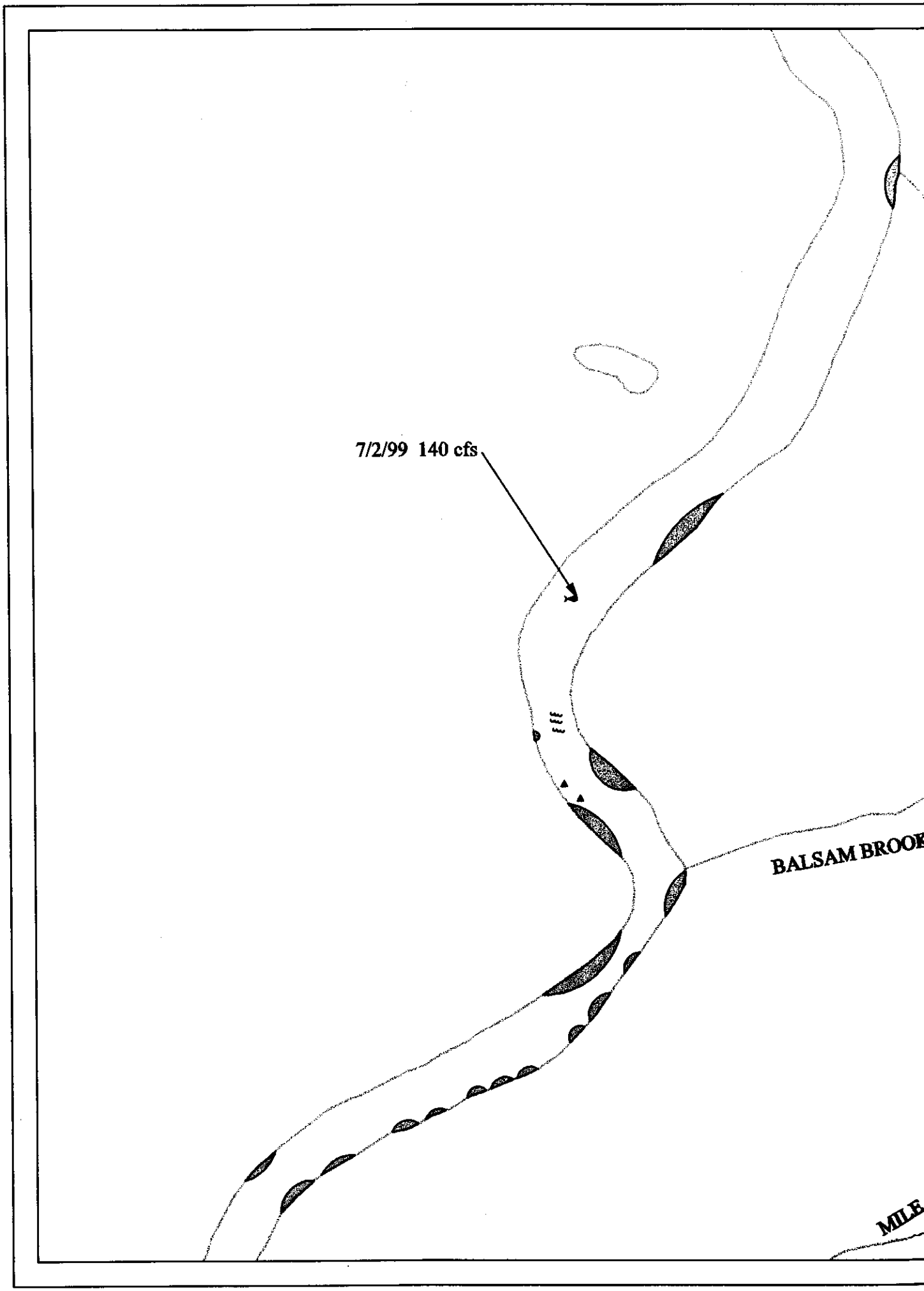
- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on July 2, 1999, at Standup Rips. On July 15, it was located downstream of Sandbar Eddy during a 6,000 cfs generating flow. During the subsequent tracking events that occurred on July 30, August 5, and August 6, the fish was located in a pool/run on the eddy lines during all flows. On August 19, the fish was located downstream near Cold Stream during the minimum flow of 140 cfs. During the subsequent generating flow of approximately 7,300 cfs later that day, the fish was located further downstream near the area of Mile and 1/4 Brook and Mudhole. On August 20, the fish was located below The Forks near the "Joe Bruce Camp". On August 27, the tag was retrieved (absent the fish) from the bank on river-left, just upstream of the "Joe Bruce Camp".

0 cfs

200 100 0 200 400 600 YARDS

E-PRO Engineering & Environmental Consulting, LLC 41 Anthony Ave, Augusta, Me. 04330

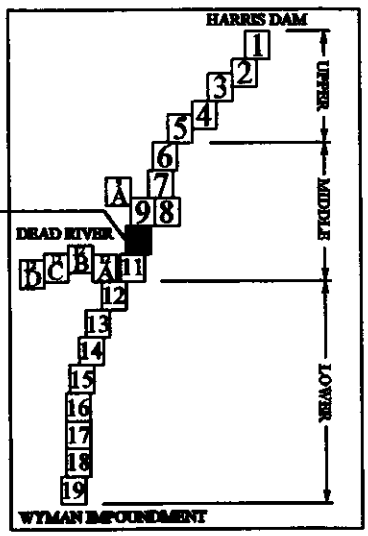

7/2/99 140 cfs
BALSAM BROOK
MILE

Fish Movement over the Course of the Radio Telemetry Study #61LLS, July 2 - August 27, 1999

MOXIE

STREAM

SHEET 10



LOCATION DIAGRAM

N

LEGEND

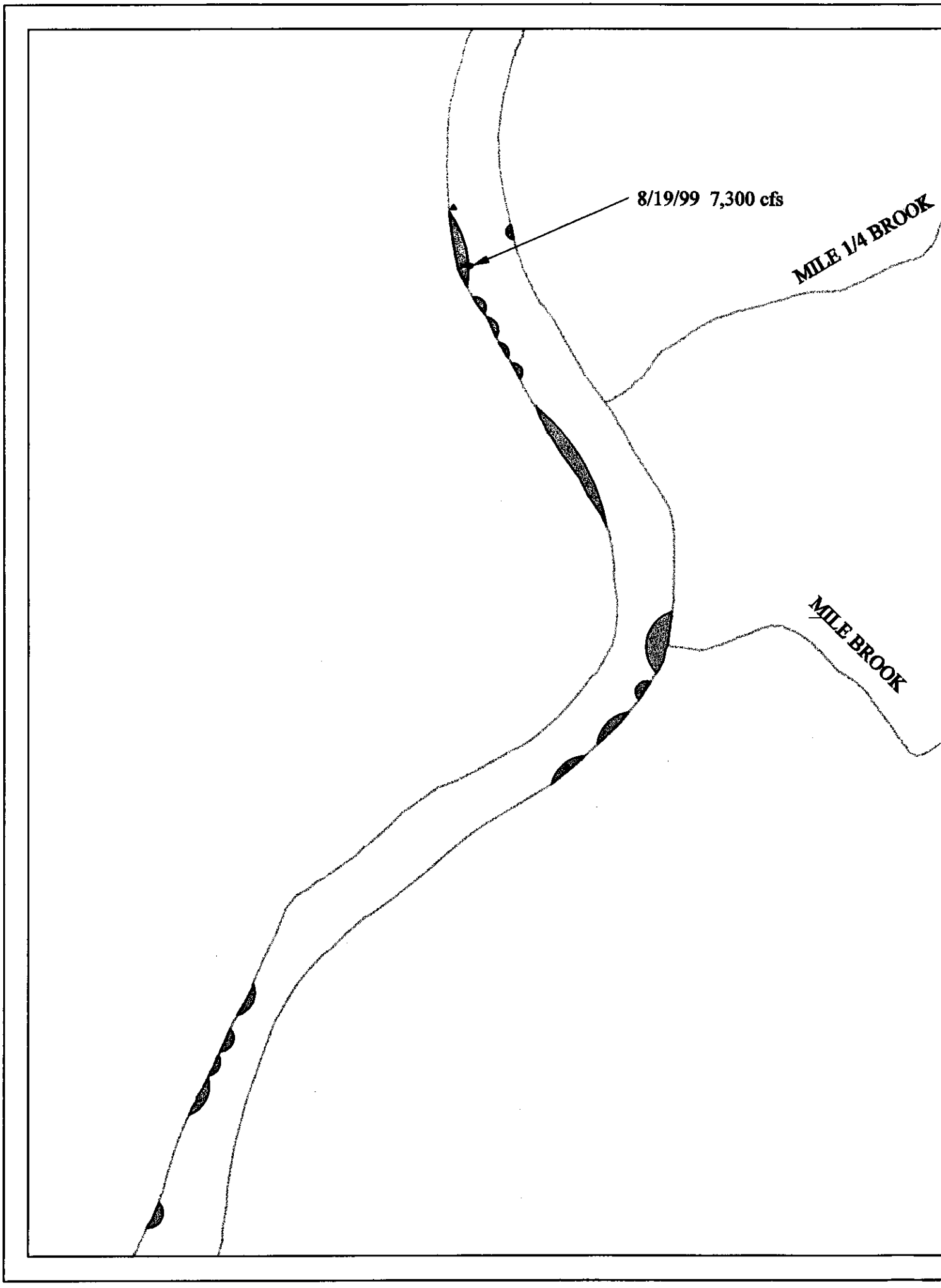
- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on July 2, 1999, at Standup Rips. On July 15, it was located downstream of Sandbar Eddy during a 6,000 cfs generating flow. During the subsequent tracking events that occurred on July 30, August 5, and August 6, the fish was located in a pool/run on the eddy lines during all flows. On August 19, the fish was located downstream near Cold Stream during the minimum flow of 140 cfs. During the subsequent generating flow of approximately 7,300 cfs later that day, the fish was located further downstream near the area of Mile and 1/4 Brook and Mudhole. On August 20, the fish was located below The Forks near the "Joe Bruce Camp". On August 27, the tag was retrieved (absent the fish) from the bank on river-left, just upstream of the "Joe Bruce Camp".

BROOK

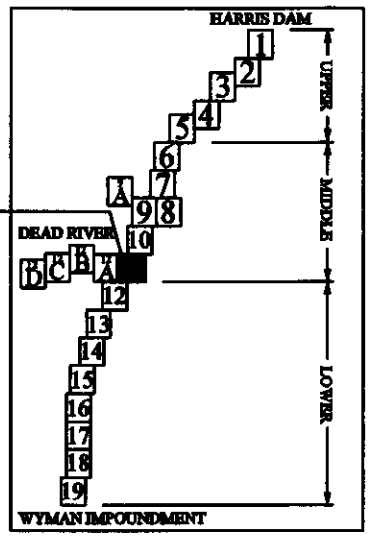
200 100 0 200 400 600 YARDS

E-PRO


8/19/99 7,300 cfs
MILE 1/4 BROOK
MILE BROOK

Fish Movement over the Course of the Radio Telemetry Study #61LLS, July 2 - August 27, 1999

SHEET 11



LOCATION DIAGRAM

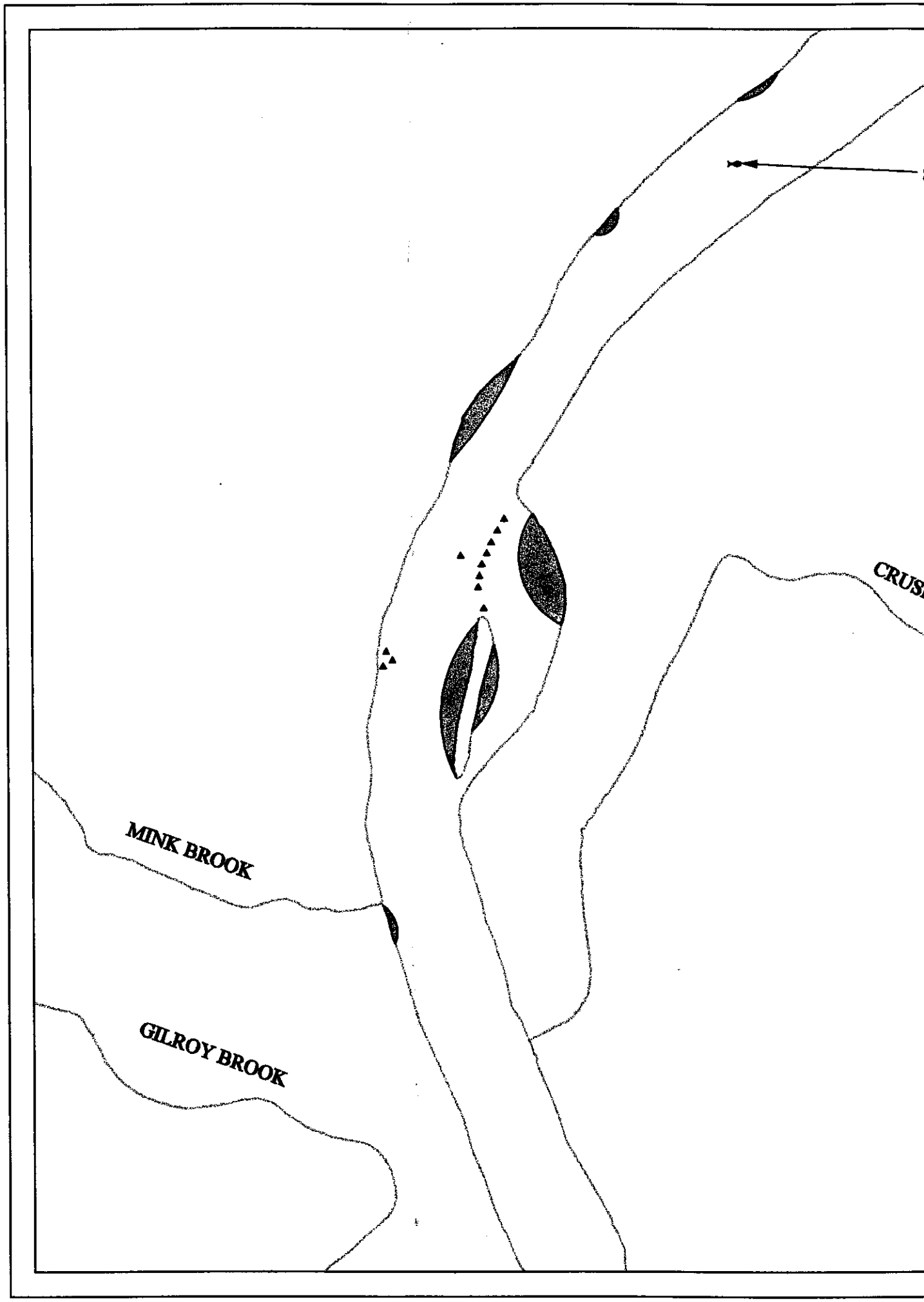
N

LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

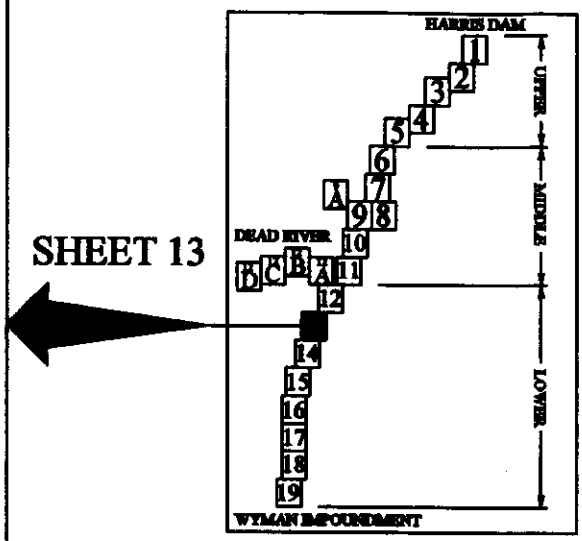
The fish was captured on July 2, 1999, at Standup Rips. On July 15, it was located downstream of Sandbar Eddy during a 6,000 cfs generating flow. During the subsequent tracking events that occurred on July 30, August 5, and August 6, the fish was located in a pool/run on the eddy lines during all flows. On August 19, the fish was located downstream near Cold Stream during the minimum flow of 140 cfs. During the subsequent generating flow of approximately 7,300 cfs later that day, the fish was located further downstream near the area of Mile and 1/4 Brook and Mudhole. On August 20, the fish was located below The Forks near the "Joe Bruce Camp". On August 27, the tag was retrieved (absent the fish) from the bank on river-left, just upstream of the "Joe Bruce Camp".

200 100 0 200 400 600 YARDS


MINK BROOK
GILROY BROOK

Fish Movement over the Course of the Radio Telemetry Study #61LLS, July 2 - August 27, 1999

'20/99 140 cfs



SHEET 13

LOCATION DIAGRAM

N

LEGEND

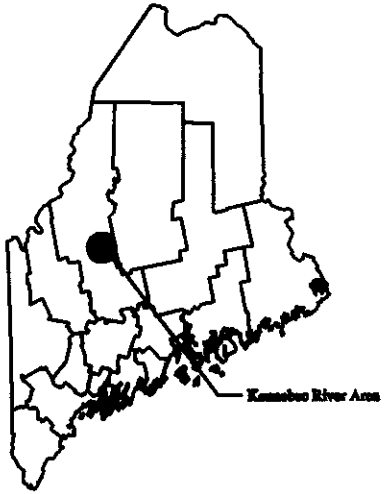
- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on July 2, 1999, at Standup Rips. On July 15, it was located downstream of Sandbar Eddy during a 6,000 cfs generating flow. During the subsequent tracking events that occurred on July 30, August 5, and August 6, the fish was located in a pool/run on the eddy lines during all flows. On August 19, the fish was located downstream near Cold Stream during the minimum flow of 140 cfs. During the subsequent generating flow of approximately 7,300 cfs later that day, the fish was located further downstream near the area of Mile and 1/4 Brook and Mudhole. On August 20, the fish was located below The Forks near the "Joe Bruce Camp". On August 27, the tag was retrieved (absent the fish) from the bank on river-left, just upstream of the "Joe Bruce Camp".

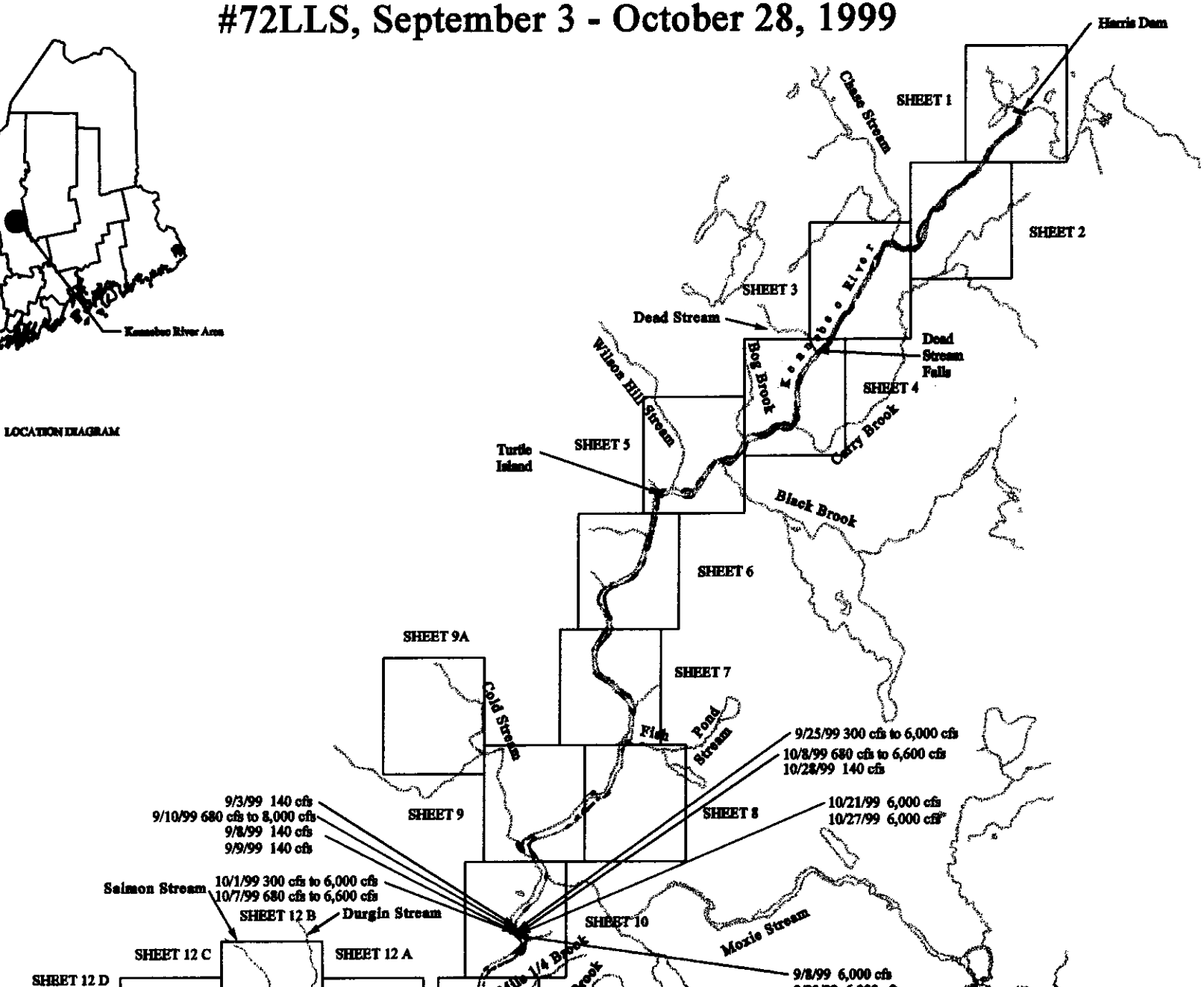
200 100 0 200 400 600 YARDS

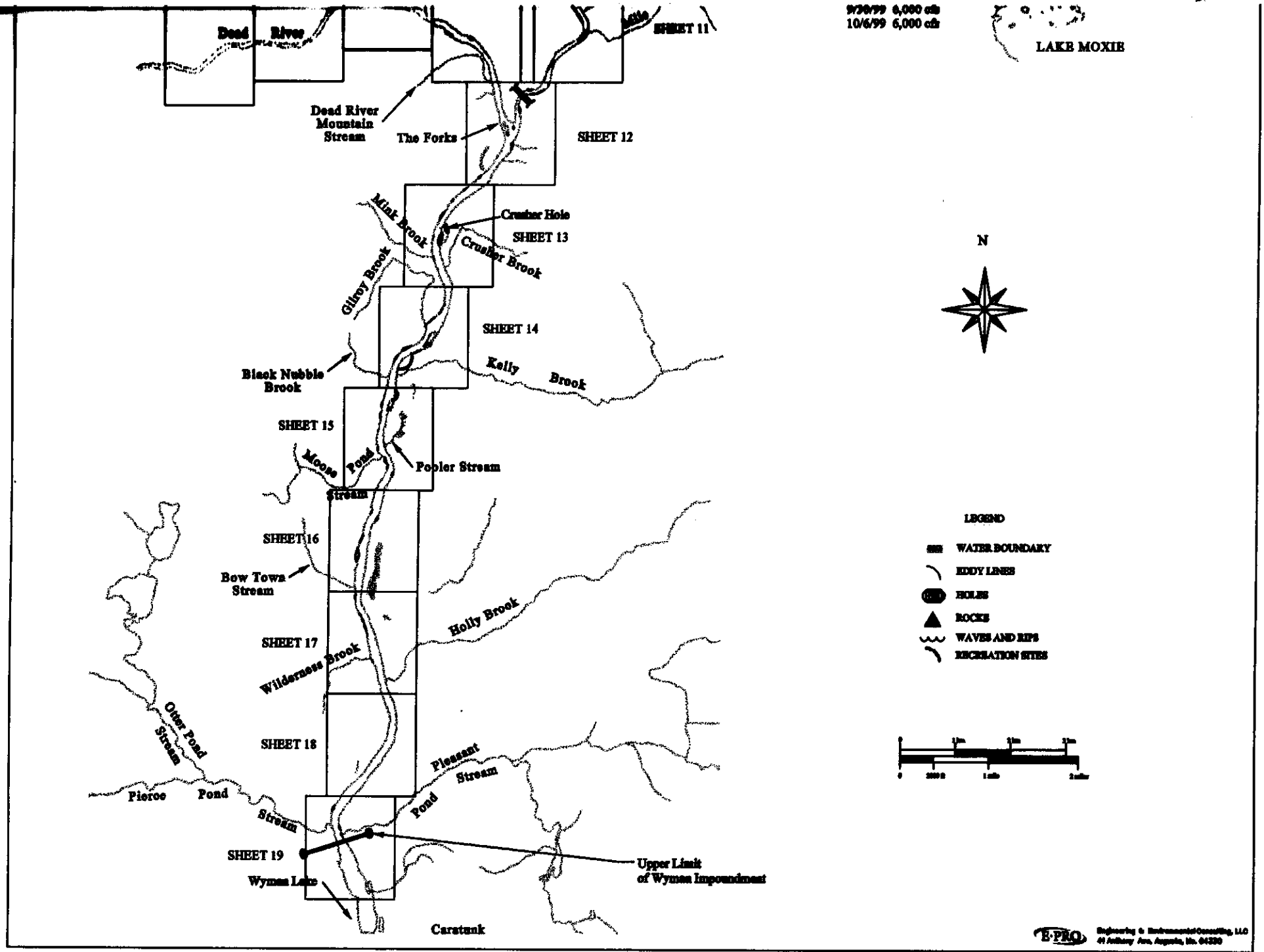
E-PRO

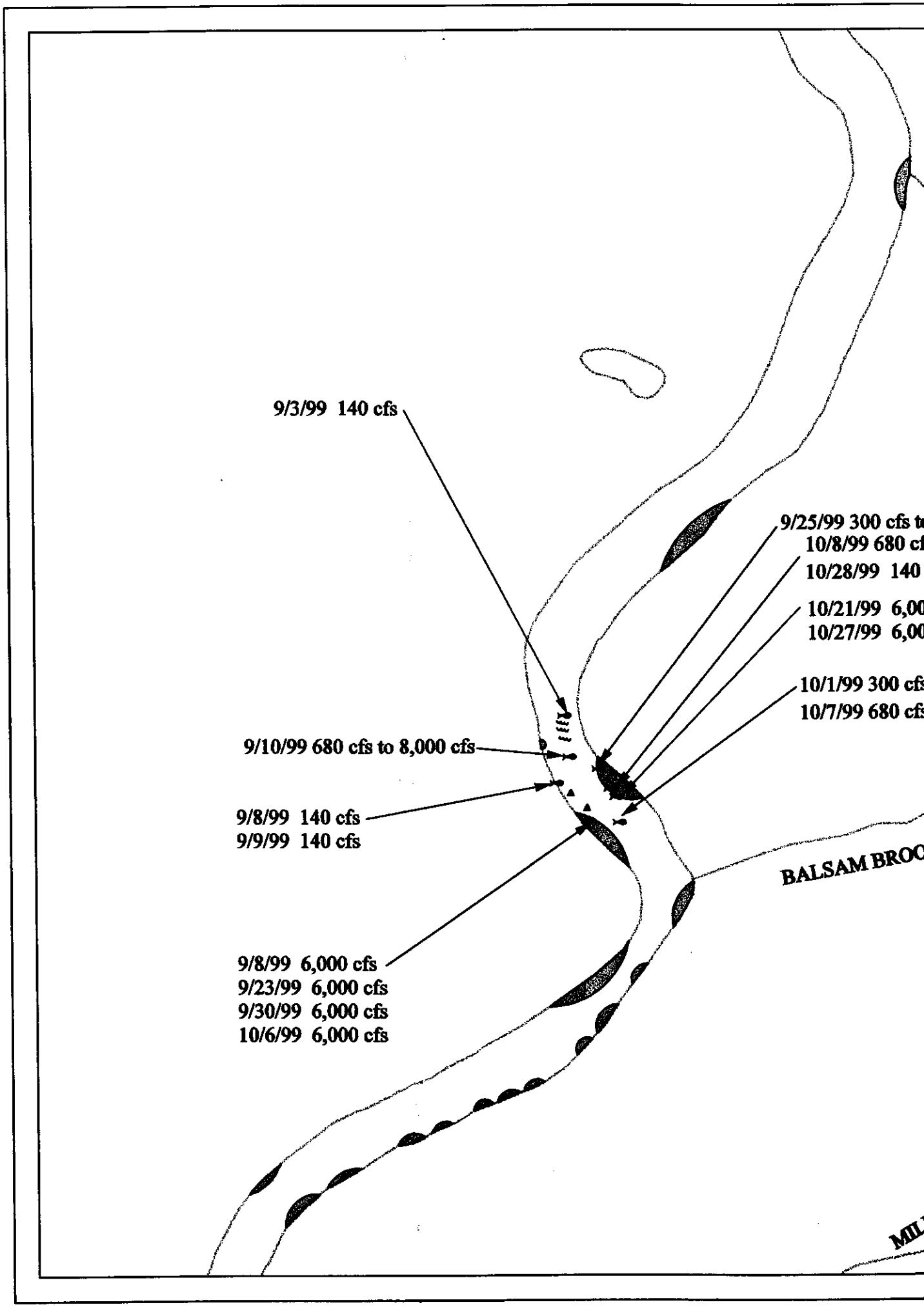
Fish Movement over the Course of the Radio Telemetry Study
#72LLS, September 3 - October 28, 1999



LOCATION DIAGRAM



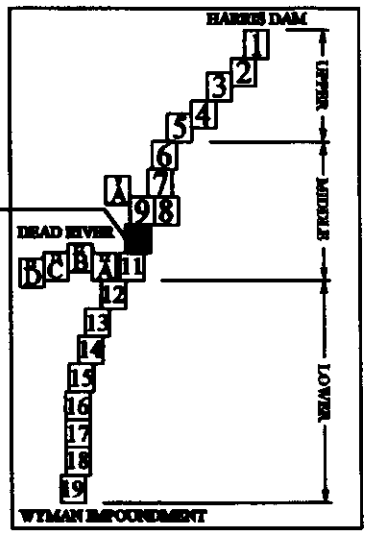

9/30/99 6,000 cfs
10/6/99 6,000 cfs
LAKE MOXIE
Dead River
SHEET 11
Dead River Mountain Stream
The Forks
SHEET 12
Mink Brook
Crusher Hole
SHEET 13
Crusher Brook
Gilroy Brook
SHEET 14
Black Nubble Brook
Kelly Brook
SHEET 15
Moose Pond
Pooler Stream
Stream
SHEET 16
Bow Town Stream
Holly Brook
SHEET 17
Wilderness Brook
Otter Pond Stream
SHEET 18
Pleasant Stream
Pond
Pierce Pond
Stream
SHEET 19
Upper Limit of Wyman Impoundment
Wyman Lake
Caratunk
N
LEGEND
WATER BOUNDARY
EDDY LINES
HOLES
ROCKS
WAVES AND RIPS
RECREATION SITES
E-PRO


9/3/99 140 cfs
9/25/99 300 cfs t
10/8/99 680 cf
10/28/99 140
10/21/99 6,00
10/27/99 6,00
10/1/99 300 cfs
10/7/99 680 cfs
9/10/99 680 cfs to 8,000 cfs
9/8/99 140 cfs
9/9/99 140 cfs
BALSAM BROO
9/8/99 6,000 cfs
9/23/99 6,000 cfs
9/30/99 6,000 cfs
10/6/99 6,000 cfs
MIL

Fish Movement over the Course of the Radio Telemetry Study #72LLS, September 3 - October 28, 1999

MOXIE STREAM

SHEET 10



LOCATION DIAGRAM

N

LEGEND

- WATER BOUNDARY
- FISH LOCATION
- EDDY AT GENERATION FLOWS
- BOULDERS
- WAVES AND RIPS

The fish was captured on September 3, 1999, at Standup Rips. During spot checks and Peaking Cycle Location Checks conducted on September 8, September 9, September 23, September 28 and September 30, the fish was located in the pool below Standup Rips. During spot checks on October 6 and October 28, the fish was located at Standup Rips

In addition to the Peaking Cycle Location Checks and spot checks, the fish was also the subject of five Intensive Monitoring Events. On September 10, the fish was monitored during a 680 cfs minimum flow to 8,000 cfs generating flow. On September 25, the fish was monitored during a 300 cfs minimum flow to 6,000 cfs generating flow. On October 1, the fish was monitored during a 300 cfs minimum flow to 6,000 cfs generating flow. On both October 7 and October 8, the fish was monitored during a 680 cfs minimum flow to 6,600 cfs generating flow.

Five aerial checks were conducted during the fall of 1999. This fish was located on two of these events. On both October 21 and 27, at 6,000 cfs the fish was located in the Standup Rips area. On October 28, E/PRO biologists confirmed that the tag had become stationary, but were unable to retrieve the tag.

200 100 0 200 400 600 YARDS

E-PRO