

RADIO TRACKING TO DETERMINE STEELHEAD TROUT SMOLT
MIGRATION PATTERNS AT THE CLEARWATER AND SNAKE
RIVER MIGRANT TRAPS NEAR
LEWISTON, IDAHO

by

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INTRODUCTION

The Idaho Department of Fish and Game (IDFG) traps juvenile chinook salmon and steelhead trout in the Snake and Clearwater rivers to provide timing and migration rate data for the Fish Passage Center's systemwide monitoring program. For this, a migrant dipper trap has been employed on the Snake River and a scoop trap on the Clearwater River (Fig. 1). Both are effective at catching chinook salmon but not steelhead trout. Steelhead trout smolts may be avoiding the traps or not following the same migrational paths as chinook salmon smolts. Knowledge of the behavior and horizontal distribution of steelhead trout smolts in the vicinity of the traps would provide an opportunity to determine why steelhead trout are not being captured and whether repositioning the traps would increase the rate of capture.

The trap in the Clearwater River operates in a free-flowing section with a strong current. The trap is positioned mid-stream and is suspended from an overhead cable anchored to towers on the north and south shores. Trap position can be adjusted horizontally across the width of the river to change fishing location. Some upstream-downstream adjustments can be made by lengthening or shortening the cables. The river at this point is approximately 140 m wide.

The trap in the Snake River is anchored to and suspended below the two western most piers of the Lewiston-Clarkston Interstate Highway Bridge. The site is in the upper portion of the Lower Granite Pool, and velocities are lower than experienced at the Clearwater River trap. River width at this site is approximately 305 m.

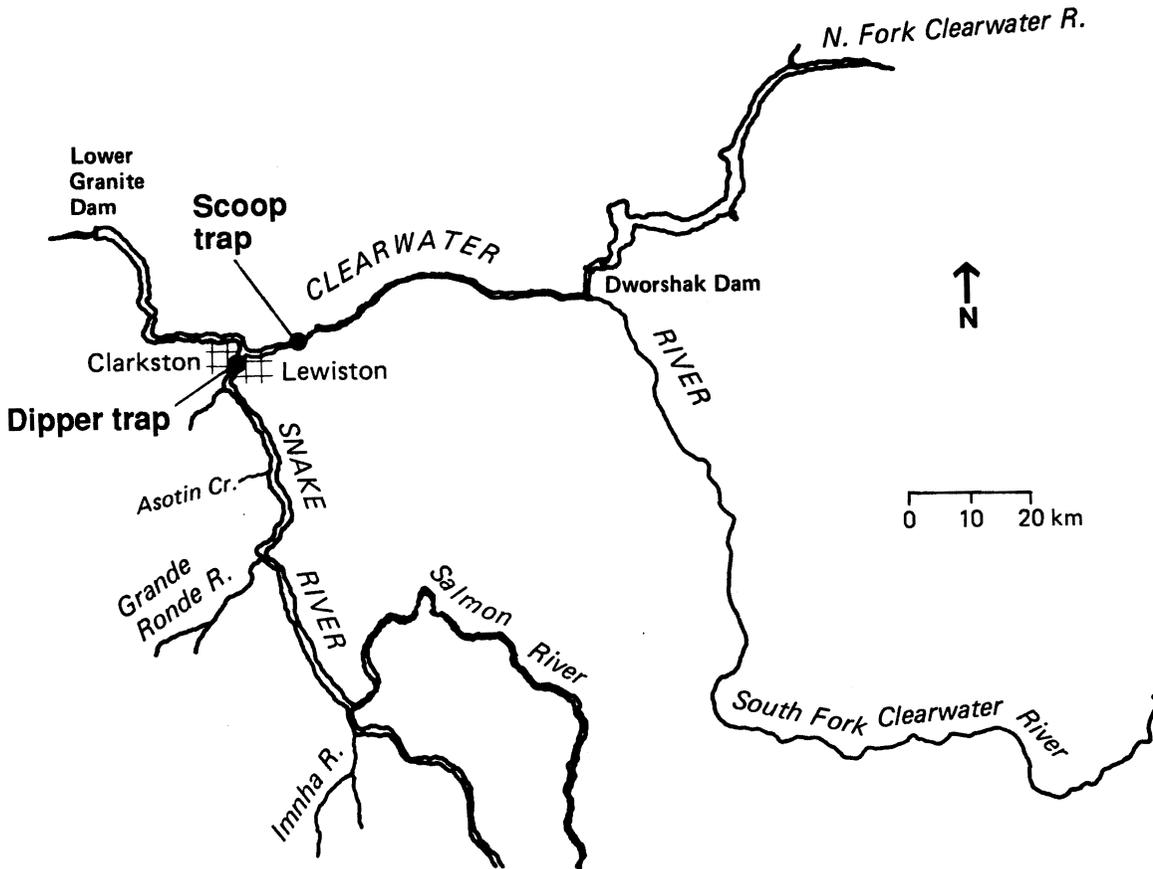


Figure 1.--Map showing the location of the two smolt
Lewiston.

A request was made by IDFG to the Coastal Zone and Estuarine Studies Division of the National Marine Fisheries Service (NMFS), Seattle, Washington, for the services of their Radio Tracking Subtask to determine horizontal distribution and migrational behavior of steelhead trout smolts at the two trap sites. Radio tracking is an effective way to determine behavior and travel routes of migrating salmonids. An agreement was reached by the two agencies, and a study was carried out from mid-April to mid-May 1987.

EQUIPMENT

Radio Tag

The radio tag used to monitor the steelhead trout smolts was developed by NMFS personnel to study individual fish movements. Power for the tags is supplied by batteries, and the tags operate on a carrier frequency of approximately 30 megahertz (MHz) with a minimum tag life of 3 days. The transmitter and batteries are coated with Humiseal^{1/} and a mixture of paraffin and beeswax to form a flattened cylinder measuring 26x9x6 mm and weighing approximately 2.9g in air. The tag is inserted into the stomach of the fish through the esophagus while the fish is anesthetized. A 127-mm flexible whip antenna attached to one end of the tag protrudes from the fish's mouth. Each tag transmits pulses set at a rate of 2 pulses per second on one of nine frequencies spaced 10kHz apart (30.17 to 30.25 MHz). The electronic character of each pulse provides individual identification (codes) for each tag. Tracking range is up to 1000 m depending on tag output and fish depth.

^{1/} Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Because we have not used steelhead trout smolts in previous radio tagging studies, their rate of tag retention was unknown. Therefore, prior to this study, we conducted regurgitation tests at the NMFS Laboratory in Seattle, WA. Results indicated that regurgitation was more frequent than acceptable. To solve this, a small piece of compressed sponge was attached to the tag body with a small rubber band. Regurgitation was minimized by expansion of the sponge from body fluids in the fishes stomach (Fig. 2). Subsequent examination of fish revealed that the softness of the sponge prevented over-extension of the stomach while providing adequate bulk to keep the tag from being ejected. The addition of the sponge did not prevent the fish from feeding, as food was found in their stomachs.

Tracking Devices

Tracking was accomplished with standard NMFS tracking equipment (Liscom et al. 1985): a receiver, loop antenna, and headset. Portable radio transceivers were used for communications. Automatic recording monitors warned trackers of approaching tags, gave the frequency of the tag(s), and recorded passing tags when trackers were not present (Stuehrenberg et al. 1985).

PROCEDURES

Originally, the plan called for three releases of 15-20 radio-tagged smolts at each trap site. After initial releases of six fish each showed rapid movement from the release site through the tracking areas, the remaining fish were divided into six groups of nine fish each (one tagged fish per frequency) for a total of seven releases for each trap site. Fewer fish per

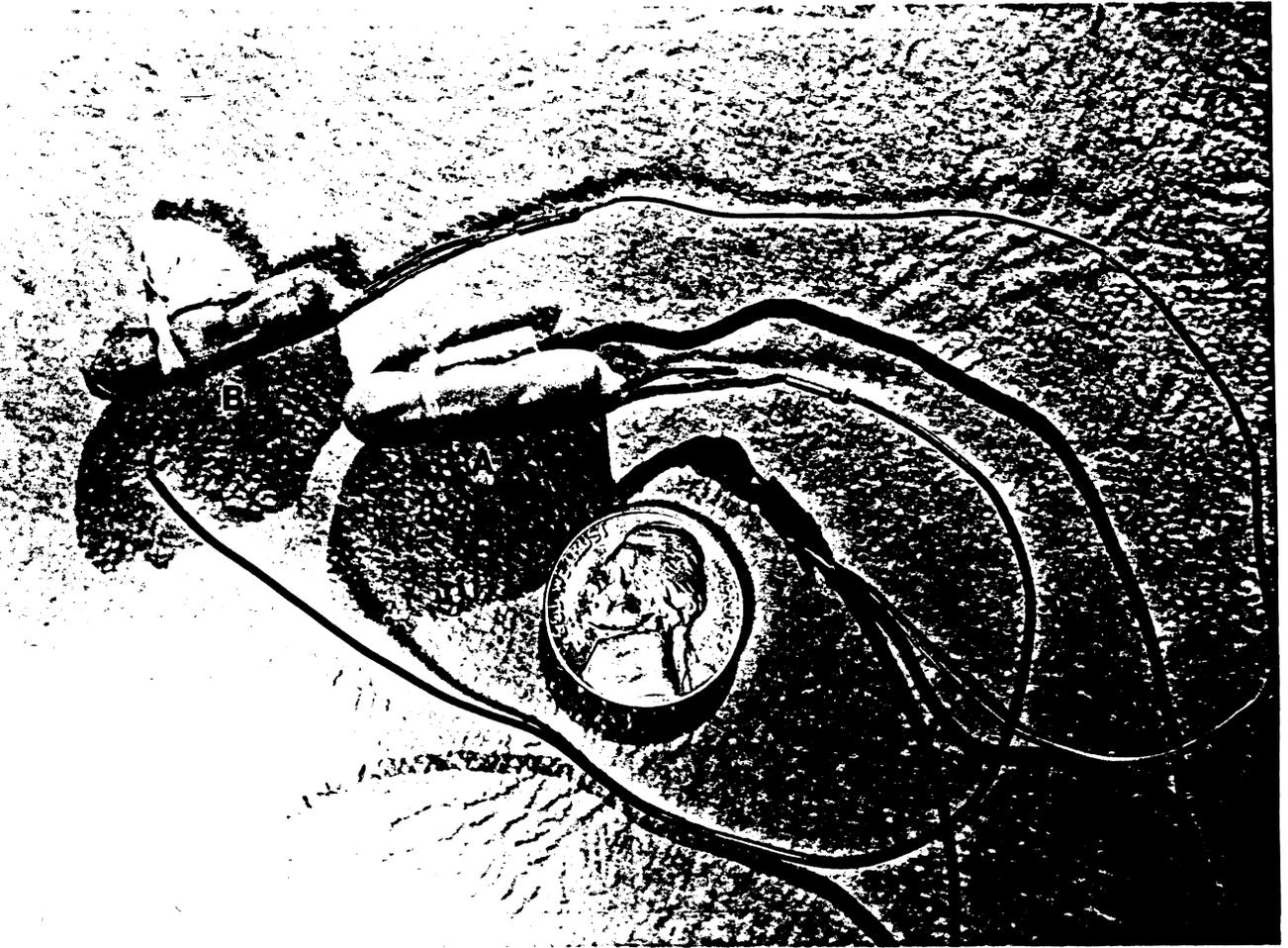


Figure 2.--Photograph of juvenile radio tag with attached sponge to prevent regurgitation. A compressed dry sponge, B-sponge after wetting.

release reduced the chance of having too many fish in the tracking area at one time. The additional releases also provided a greater number of completed tracks.

An outline map of each study site was traced from aerial photos and enlarged. Tracking stations were located as precisely as possible from the photos. Reference grid lines were then accurately drawn on the maps from the tracking stations to visual landmarks. (See Appendix B for grid lines used for tracking). On 22 April, the Clearwater trap was moved closer to the north shore due to high water, which made the reference lines slightly off but not far enough to bias the data. The bearings taken by the trackers were recorded in relation to the established grid lines.

Clearwater River

Steelhead trout smolts used for tagging were taken from the trap except for Groups 5 and 6. These fish were transported from Dworshak National Fish Hatchery (NFH) via truck to the trap for tagging. Tagging took place between 0900 and 1200 h. Tagged fish were transported upstream 5.6 km by boat to the release site and held in weighted 20-gallon garbage cans in a shallow riffle. The cans were perforated to ensure good water exchange until the fish were released. Holding times ranged from about 1.5 to 7 h.

One tracker was stationed near the shore monitor to take bearings on approaching fish and plot fish movement. Another tracker on the trap relayed bearings to the shore-side tracker for triangulation and subsequent plotting of the tagged fish's positions. A monitor placed on the trap was used to indicate whether a passing tagged fish came close to the trap or not.

Snake River

All steelhead trout used for tagging were taken from the trap. Fish were tagged between 0900 and 0930 h and held in two perforated, 20-gallon plastic containers which had river water circulated through them. Three fish were held in each container for the first release of six fish. Five tagged smolts were held in one container and four in the other for the remaining six releases of nine fish each. After waiting approximately 3 h, the fish were transported upriver 8.8 km by boat and released. All releases were made between 1200 and 1345 h. To determine whether tagged fish oriented to the shore and followed it from release, one container of tagged fish was released on the west shore and one on the east shore for Groups 1 through 4. Fish from both containers in Groups 5, 6, and 7 were released at mid-stream. The fish from each container were released at about the same time for Groups 1, 2, and 5, and 30 minutes apart for Groups 3, 4, 6, and 7. This latter group's release times were staggered in an attempt to reduce the possibility of too many tags in the tracking area at the same time.

Surveillance of the radio-tagged smolts was conducted from shore upstream from the interstate bridge. Tracking from the trap was not feasible because of interference from the metal and concrete of the bridge. The shore monitor and tracking station on the west shore (Clarkston side) were approximately 198 m upstream from the bridge. Bearings from the east shore (Lewiston side) were taken from a tracking station located approximately 305 m upstream from the bridge.

RESULTS AND DISCUSSION

Clearwater River

Tracking on the Clearwater River began 20 April with a release of six radio-tagged steelhead trout smolts. Releases were then made for the next 4 days until a total of 61^{2/} smolts out of 63 tagged fish had been released (see Appendix A for detailed tagging data). A summary of fish released, number of tracks, and fish disposition is shown in Table 1. A composite of all tracks showing the major routes taken by the tagged fish as they passed the trap and the individual tracks for each release are given in Appendix B.

Of the 61 smolts released, 35 (57%) were tracked to the trap. Of that number, 25 (71%) passed the trap on the south side and only two (6%) on the north side. The remaining eight fish (23%) swam directly toward the trap but avoided it.

Although two fish paused for a short time above the trap, none actually entered the trap. These data suggest that even if the trap were repositioned nearer the south shore, the increased numbers of fish available for trapping might be negated by the obvious avoidance problem.

Smolts trucked from Dworshak NFH did not show any noticeable behavioral differences from fish taken directly from the trap as they passed through the study area.

Time for tagged smolts to migrate from the release site to the study area ranged from 34 minutes to over 58 h and averaged 8 h 47 minutes. Time through

^{2/} A miscount on the last release caused 61 tagged fish to be released instead of the planned 60.

Table 1. Total steelhead trout smolts radio-tagged, released, and tracked in the Clearwater River study area.

Category	Totals
Steelhead trout smolts tagged	63
Mortalities	2
Tagged smolts released	61
Monitored at trap but not tracked	<u>2</u> ^{a/}
Tracks plotted	35
Smolts veering away from trap	<u>8</u> ^{b/}
Smolts passing north of trap	2
Smolts passing south of trap	25

a/ One fish went by at the time another fish was being tracked. The second fish went by after tracking terminated for the day.

b/ These fish came downstream directly above the trap then veered to the right or left avoiding the trap.

the tracking area ranged from 1 minute to 1 h and 16 minutes, averaging 7 minutes. Tracking continued for 2 days after the last release.

Checks from points along the highway between the trap and release site indicated that some of the 24 tagged smolts not heard at the trap were holding in side channels as well as in the main river. One fish swam upstream from the release site. When the river flow increased, some fish holding upstream began to move down. Because of the delay, signals from tags released on the first few days were probably too weak to be heard or no longer functioning and may have swam past the trap undetected.

Snake River

The first release of six radio-tagged steelhead trout smolts in the Snake River was made on 29 April. Six additional releases of nine fish each were made through 5 May, for a total of 60 fish (See Appendix A). Results are summarized in Table 2.

Of the steelhead trout smolts tagged and released, 48 (80%) were tracked through the study area. A total of 45 (93%) of those fish tracked passed under the bridge at the middle or east spans. Only three smolts were tracked under the west span in the vicinity of the trap. One of these fish (#7024 - Appendix B) was thought to be in the trap, but later the signal disappeared. Subsequent sampling of the trap's live box revealed no tagged fish. A composite of all the tracks showing the major route taken by the tagged fish and the individual tracks for each release are given in Appendix B.

These results indicate considerably more steelhead trout would be available for trapping if the trap fished below the middle or east span of the

Table 2. Total steelhead trout smolts radio-tagged, released, and tracked in Snake River study area.

Category	Totals
Steelhead trout smolts tagged	60
Mortalities	0
Tagged smolts released	60
Monitored at trap but not tracked	<u>4</u> ^{a/}
Tracks plotted	48
Smolts passing under west span	3
Smolts passing under mid span	17
Smolts passing under east span	28

a/ Not tracked due to other tagged fish in the area.

bridge. Unfortunately too few fish passed near the trap to determine if there was trap avoidance.

Travel time from release site to the study area was faster and less variable than for fish released in the Clearwater River. The average time was 3 h and 27 minutes with a range of 2 h and 5 minutes to 7 h and 25 minutes. Fish movement through the study area was steady and downstream. Tracks lasted from 1 to 26 minutes and averaged 8 minutes.

There were eight tagged smolts released that were never monitored in the study area. Two smolts were released with tags that apparently quit after tagging. A third was released having a very weak signal. Five tag signals were lost before the fish swam past the bridge. Two of these were lost due to tracking of other tags in the area at the same time and the rapid rate at which the fish moved through the area. Apparently weak tag signals and the fish's position put some tagged fish out of the range of the receivers.

CONCLUSIONS

Clearwater Trap

1. The major migration route taken by steelhead trout was between the trap and the south shore.
2. There appeared to be trap avoidance.

Snake River Trap

1. The major migration route for steelhead trout was through the middle and eastern spans of the Lewiston-Clarkston Interstate Bridge (the trap was located below the west span).
2. Insufficient numbers of fish passed near the trap to determine if there was a trap avoidance problem.

ACKNOWLEDGMENTS

We wish to express our appreciation to Mr. Ed Buettner and Mr. Lance Nelson of the IDFG for their assistance and for the help afforded us by their staff. IDFG also provided the necessary support equipment to help make the study a success.

LITERATURE CITED

- Liscom, Kenneth, Lowell Stuehrenberg, and Frank Ossiander. 1985. Radio-tracking studies of adult chinook salmon and steelhead to determine the effect of "zero" river flow during water storage at Little Goose Dam on the Lower Snake River. Final Report to Bonneville Power Administration. Contract No. DE-A179-81BP27780. 64 p.
- Stuehrenberg, Lowell C., A. E. Giorgi, C. W. Sims, J. R. Powell, and J. Wilson. 1986. Juvenile Radio-Tag Study: Lower Granite Dam. Annual Report 1985 to Bonneville Power Administration. Contract No. DE-A179-85BP21237. 68 p.

APPENDIX A

Tagging Data

CLEARWATER RIVER

Release Group 1
 Date 4-20-87
 Tagging Time - 1510
 (Fish from trap)

<u>CODE #</u>	<u>Release Time</u>	<u>Time in Study Area</u>
2055	1510	1614-1618
4047	1510	- - ₁₇
5052	1510	- -
7052	1510	- -
8052	1510	1924-1928
9051	1510	- -

Release Group 2
 Date 4-21-87
 Tagging Time - 0915
 (Fish from trap)

<u>CODE #</u>	<u>Release Time</u>	<u>Time in Study Area</u>
1030	1230	1348-1351
2032	1230	1359-1414
3026	1230	1351-1355
4029	1230	- -
5030	1230	- -
6036	1230	- -
7031	1230	- -
8037	1230	2129-2132
9028	1230	- -

Release Group 3
 Date 4-22-87
 Tagging Time 1100
 (Fish from trap)

<u>CODE #</u>	<u>Release Time</u>	<u>Time in Study Area</u>
1042	1330	Mortality
2045	1330	- -
3040	1330	1510-1513
4035	1330	Mortality
5047	1330	2024-2027
6047	1330	2132-2136
7038	1330	2334-2339 (4-24-87) ^{2/}
8038	1330	- -
9037	1330	- -

Release Group 4
 Date 4-22-87
 Tagging Time - 1100
 (Fish from trap)

<u>CODE #</u>	<u>Release Time</u>	<u>Time in Study Area</u>
1030	1540	- -
2032	1540	- -
3023	1540	1806-1809
4027	1540	1623-1624
5028	1540	- -
6034	1540	1635-1641
7027	1540	- -
8024	1540	1731-1738
9024	1540	- -

Release Group 5
 Date 4-23-87
 Tagging Time 1200
 (Fish from Dworshak Hatchery)

<u>CODE #</u>	<u>Release Time</u>	<u>Time in Study Area</u>
1042	1330	1910-2026
2043	1330	2340-2345 (4-24-87) ^{2/}
3037	1330	1621-1624
4035	1330	1657-1703
5046	1330	- -
6045	1330	0404-0408 (4-25-87) ^{3/}
7038	1330	1621-1625
8032	1330	1724-1728
9037	1330	- -

Release Group 6
 Date 4-23-87
 Tagging Time 1200
 (Fish from Dworshak Hatchery)

<u>Code #</u>	<u>Release Time</u>	<u>Time in Study Area</u>
1025	1540	2207-2211
2027	1540	- -
3022	1540	2100-2103
4024	1540	- -
5026	1540	2322-2328
6031	1540	2326-2329 (4-24-87) ^{2/}
7028	1540	1812-1823 (4-24-87) ^{2/}
8022	1540	- -
9023	1540	1636-2137

Release Group 7
 Date 4-24-87
 Tagging Time 1130
 (Fish from trap)

<u>CODE #</u>	<u>Release Time</u>	<u>Time in Study Area</u>
1033	1615	1701-1704
1047	1615	2122-2124 (4-25-87) ^{2/}
2036	1615	1653-1655
2046	1615	1649-1651
2029	1615	- -
3040	1615	- -
4037	1615	Missed tag due to other tags in area
5046	1615	- -
6045	1615	1907-1919
7049	1615	1731-1733
8025	1615	- -
9037	1615	1641-still holding after midnight track terminated

1/ Not monitored at trap

2/ Delayed upstream before arrival in study area

3/ Crew left site at midnight - tag never monitored

SNAKE RIVER

Release Group 1
 Date 4-29-87
 Tagging Time 0930

<u>Code #</u>	<u>Release Time</u>	<u>Time in Study Area</u>
	<u>West Shore</u>	
1055	1300	1615-1620
3050	1300	1651-1655
4047	1300	1607-1612
	<u>East Shore</u>	
6050	1300	1913-1923
7054	1300	1649-1655
8041	1300	1540-1545

Release Group 2
 Date 4-30-87
 Tagging Time 0930

<u>Code #</u>	<u>Release Time</u>	<u>Time in Study Area</u>
	<u>West Shore</u>	
1017	1315	- - <u>1/</u>
2023	1315	1607-1619
3017	1315	1518-1524
4017	1315	1553-1556
5020	1315	1544-1547
	<u>East Shore</u>	
6023	1315	1526-1535
7023	1315	- -
8017	1315	1601-1608
9016	1315	- -

Release Group 3
Date 5-1-87
Tagging Time - 0930

<u>Code #</u>	<u>Release Time</u>	<u>Time in Study Area</u>
	<u>West Shore</u>	
1034 ^{2/}	1345	- -
2026	1345	1550-1556
3033	1345	1546-1554
4033	1345	1651-1701
5037	1345	1633-1641
	<u>East Shore</u>	
6040	1315	1606-1613
7036	1315	1528-1538
8028	1315	1538-1543
9031 ^{2/}	1315	- -

Release Group 4
Date 5-2-87
Tagging Time - 0900

<u>Code #</u>	<u>Release Time</u>	<u>Time in Study Area</u>
	<u>West Shore</u>	
1018	1252	1647-1658
2023	1252	1546-1552
3017	1252	1520-1537
4016	1252	- -
5020	1252	1640-1650
	<u>East Shore</u>	
6024	1322	1541-1548
7021	1322	1830-1837
8018	1322	1845-1850
8018	1322	1610-1623

Release Group 5
Date 5-3-87
Tagging Time - 0915

<u>Code #</u>	<u>Release Time</u>	<u>Time in Study Area</u>
	<u>Released in Center of River</u>	
1035	1200	1505-1508
2040	1200	1503-1504
3035 ^{2/}	1200	- -
4033	1200	1454-1456
5042	1200	- -
6043	1200	1524-1527
7037	1200	1611-1621
8027	1200	1458-1503
9036	1200	1724-1739

Release Group 6
 Date 5-4-87
 Tagging Time - 0900

<u>Code #</u>	<u>Released in Center of River</u>	
	<u>Release Time</u>	<u>Time in Study Area</u>
1021	1252	1526-1533
2033	1252	1542-1551
3021	1252	- -
4020	1252	1612-1619
5023	1252	1703-1710
6027	1322	1942-1952
7024	1322	1800-1807
8019	1322	- -
9023	1322	1533-1559

Release Group 7
 Date 5-5-87
 Tagging Time - 0915

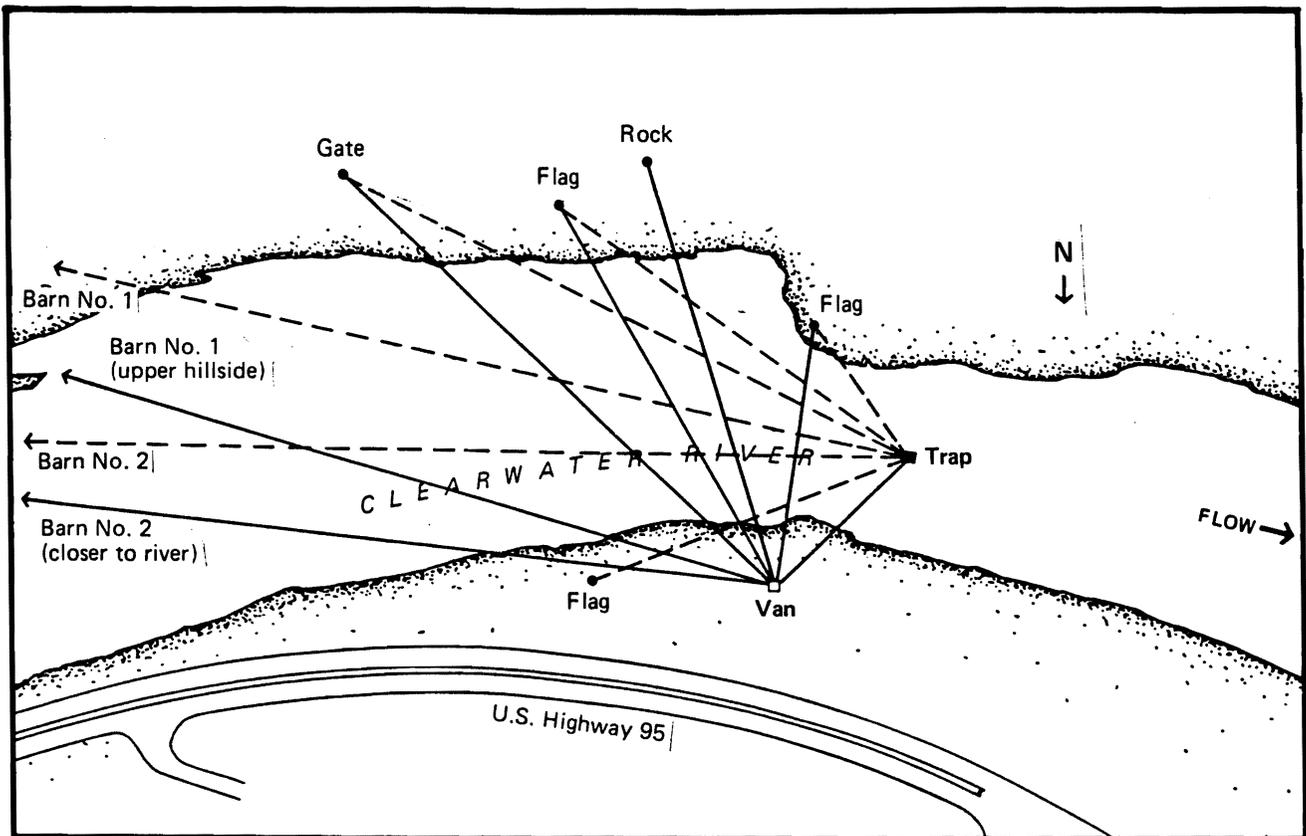
<u>Code #</u>	<u>Released in Center of River</u>	
	<u>Release Time</u>	<u>Time in Study Area</u>
1037	1153	- -
2046	1153	1917-1921
3036	1153	1729-1737
4034	1153	- -
5045	1153	1543-1552
6044	1225	1536-1546
7036	1225	- -
8032	1225	1628-1642
9035	1225	1644-1654

1/ Not monitored in study area

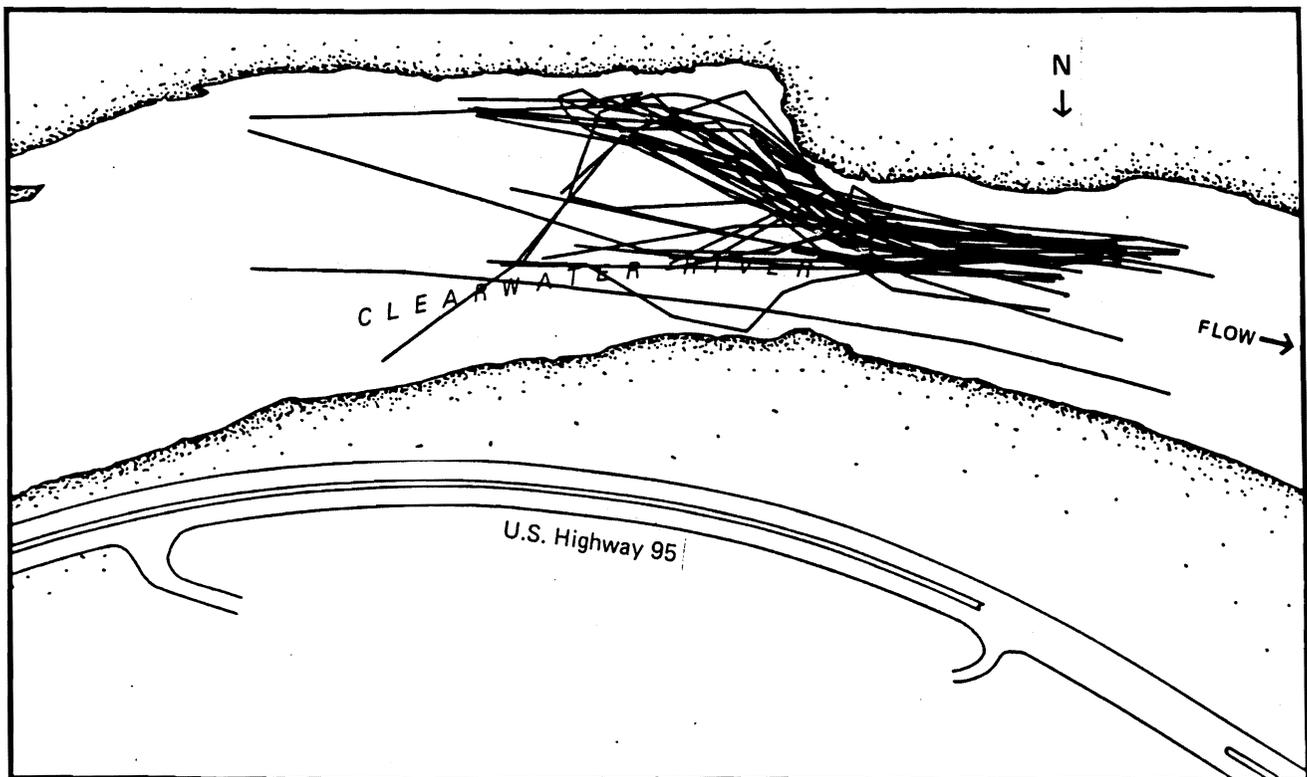
2/ Did not hear signal at time of release

APPENDIX B

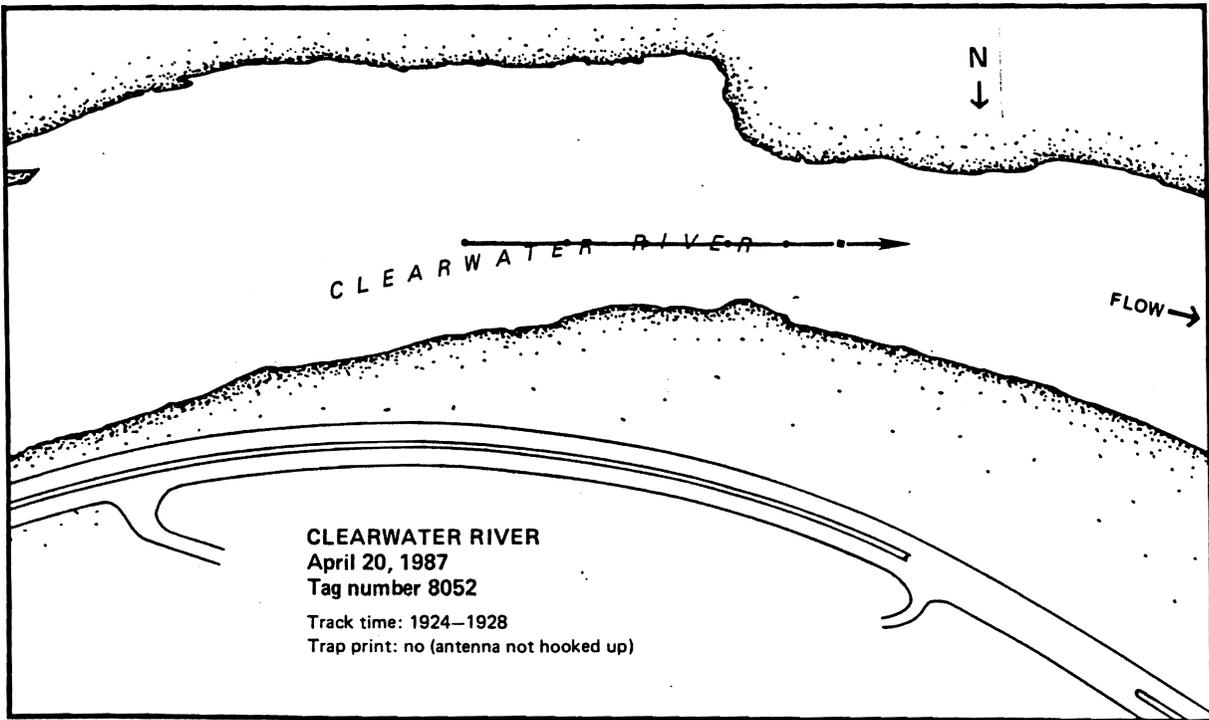
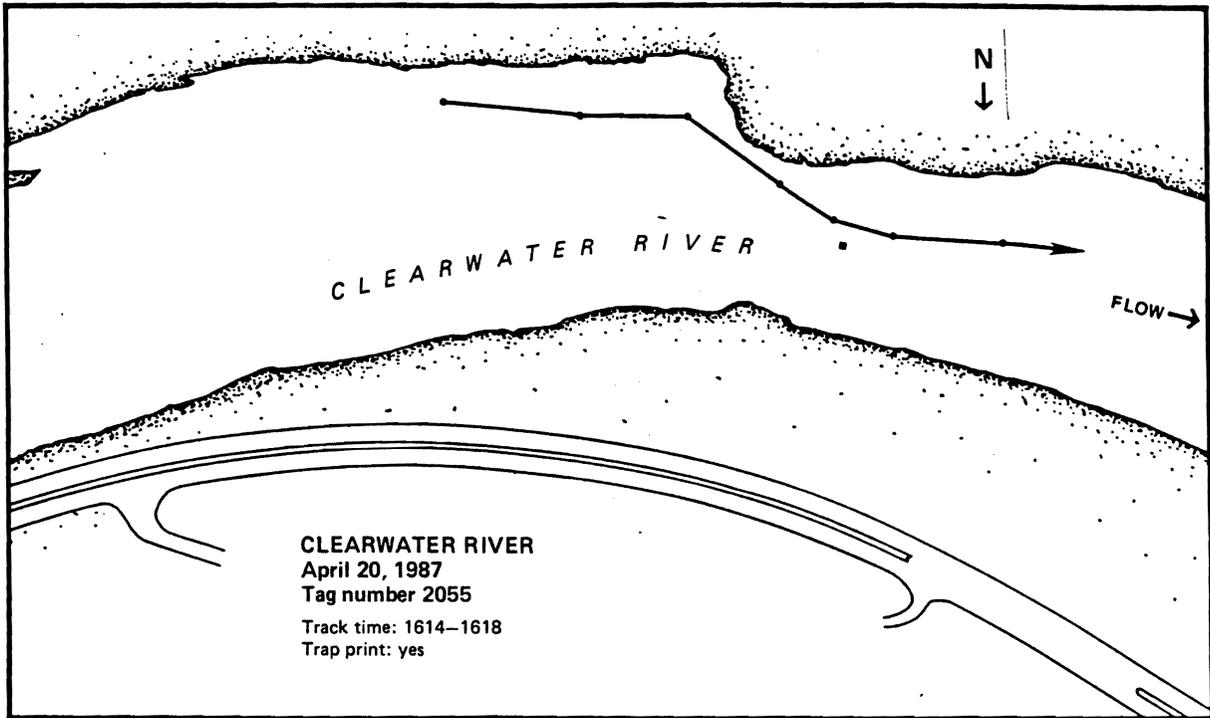
Individual Tracks

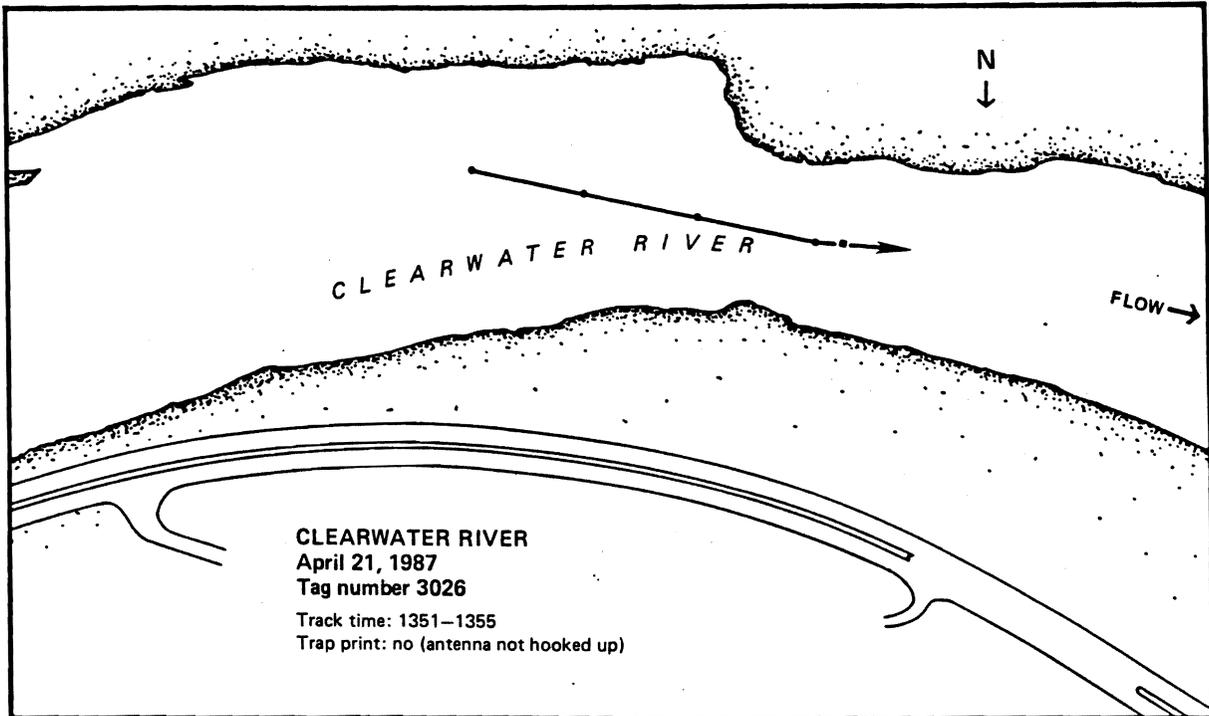
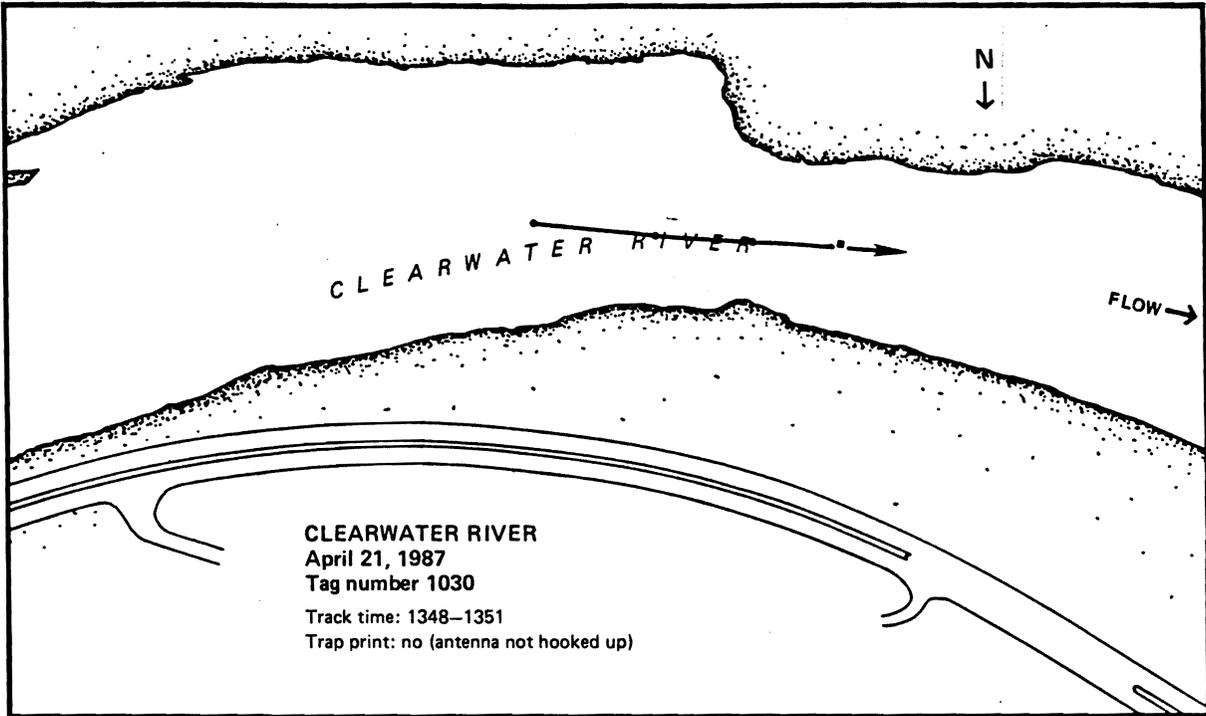


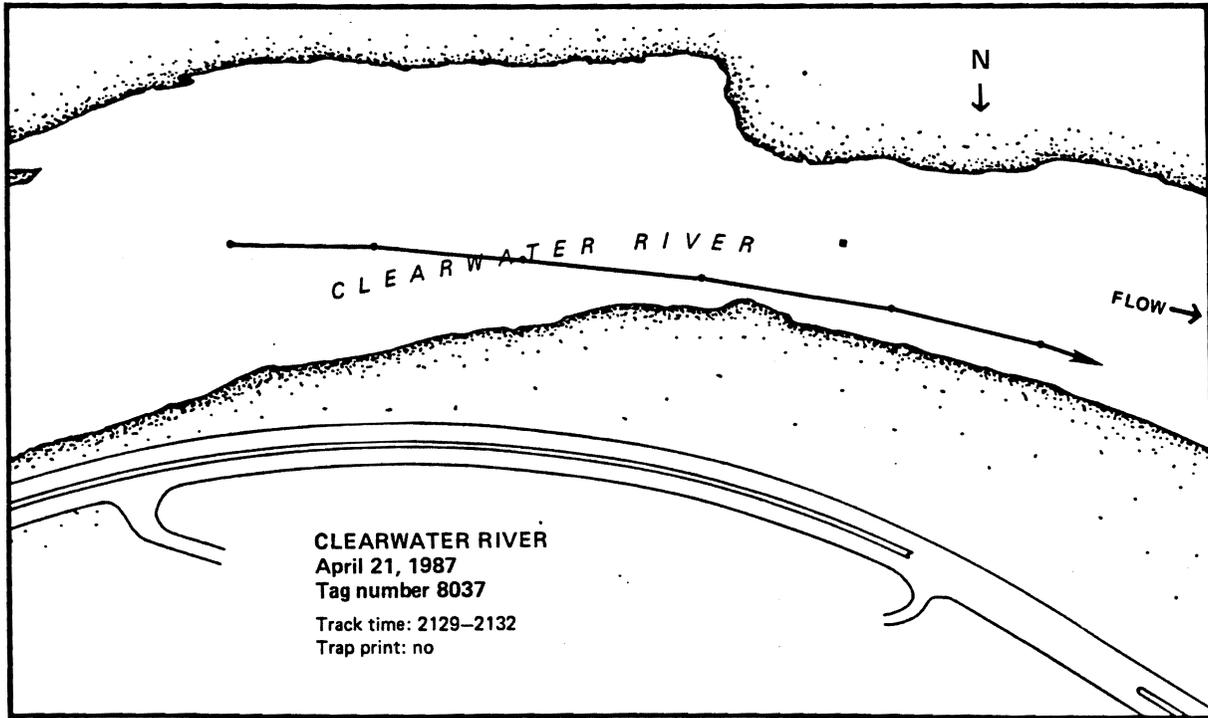
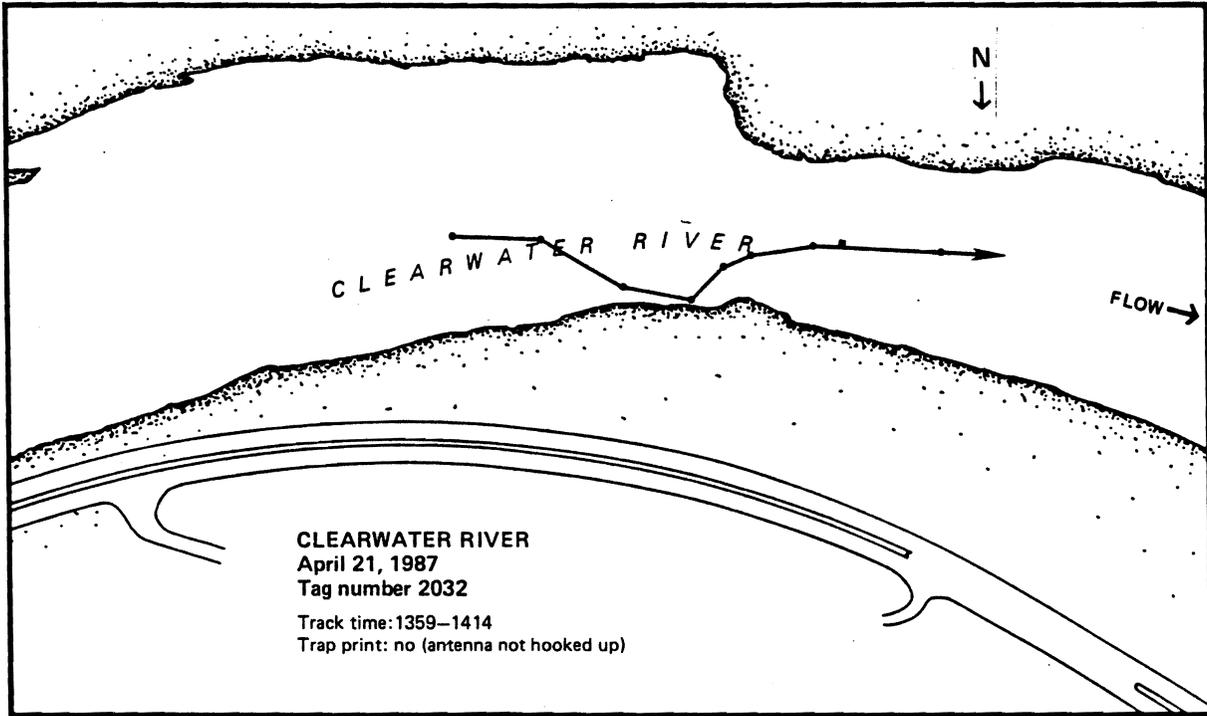
Diagrammatic view of Clearwater River study area showing grid lines used for tracking.

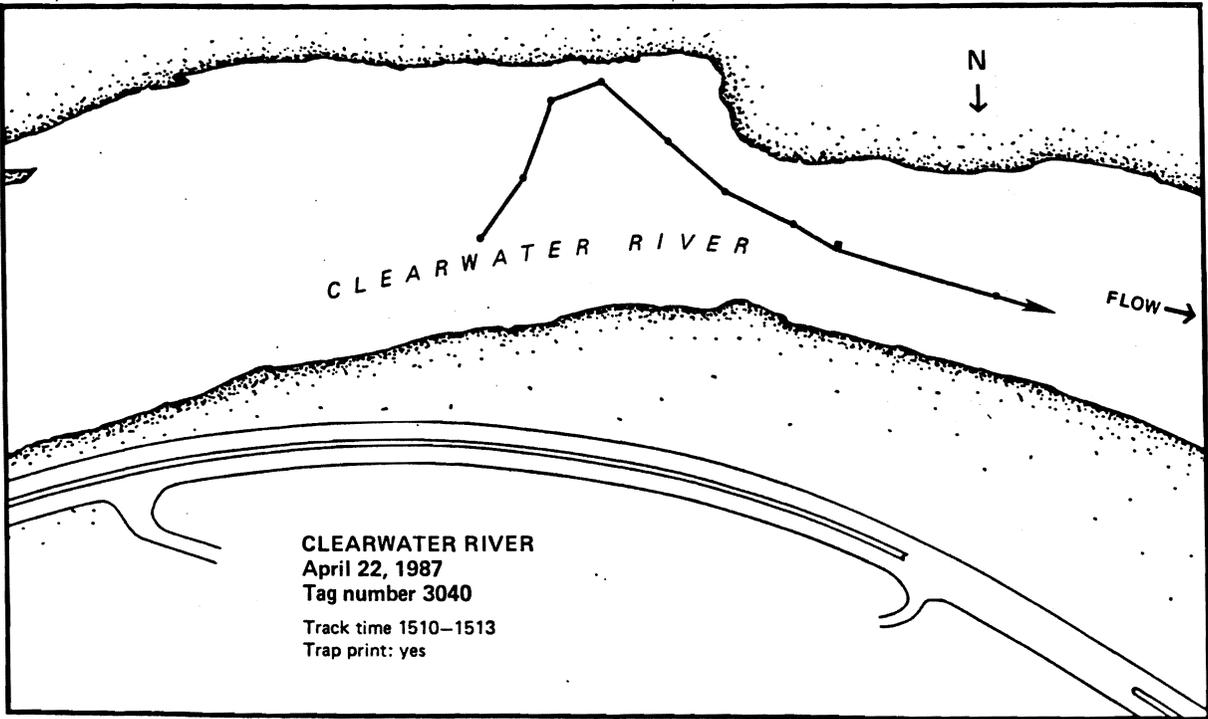
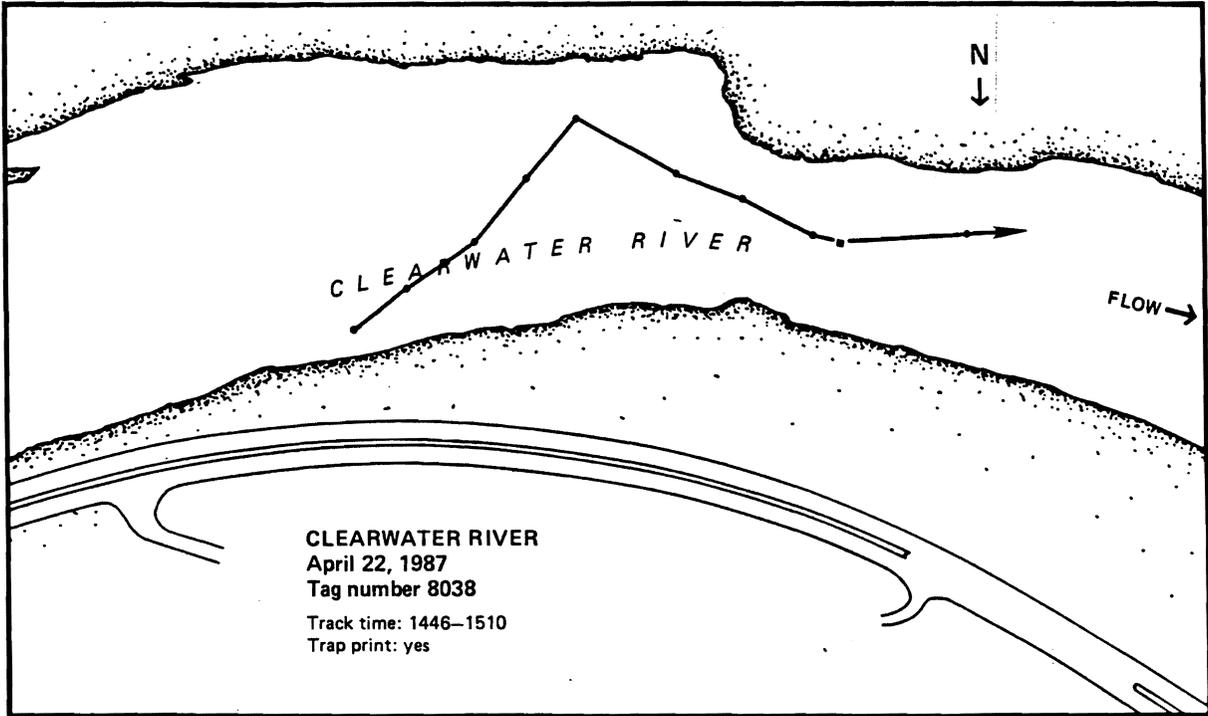


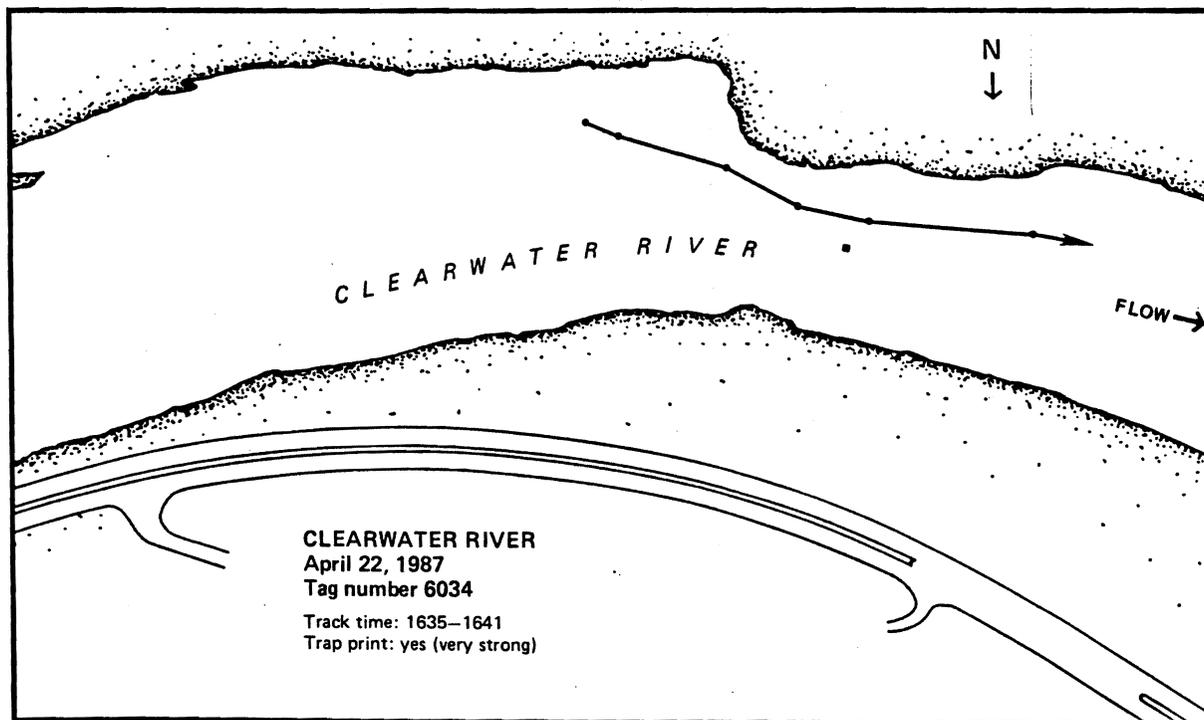
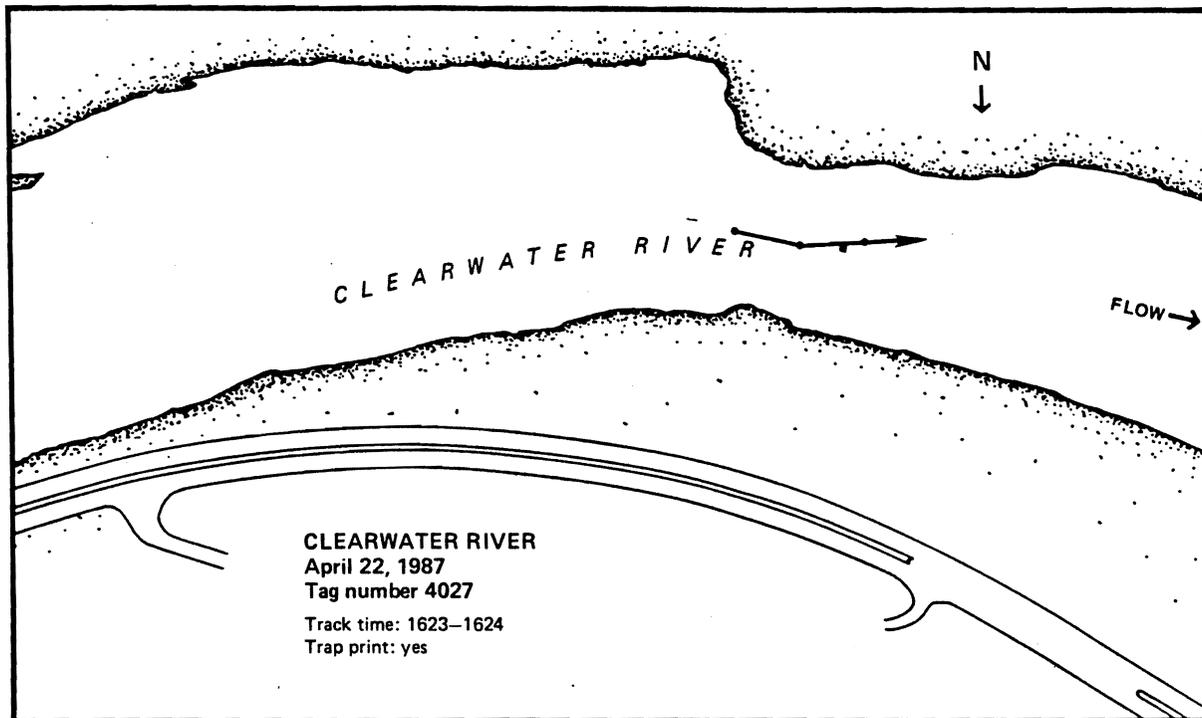
Composite of 35 tracks completed on juvenile steelhead at the Clearwater River trap site, 1987.

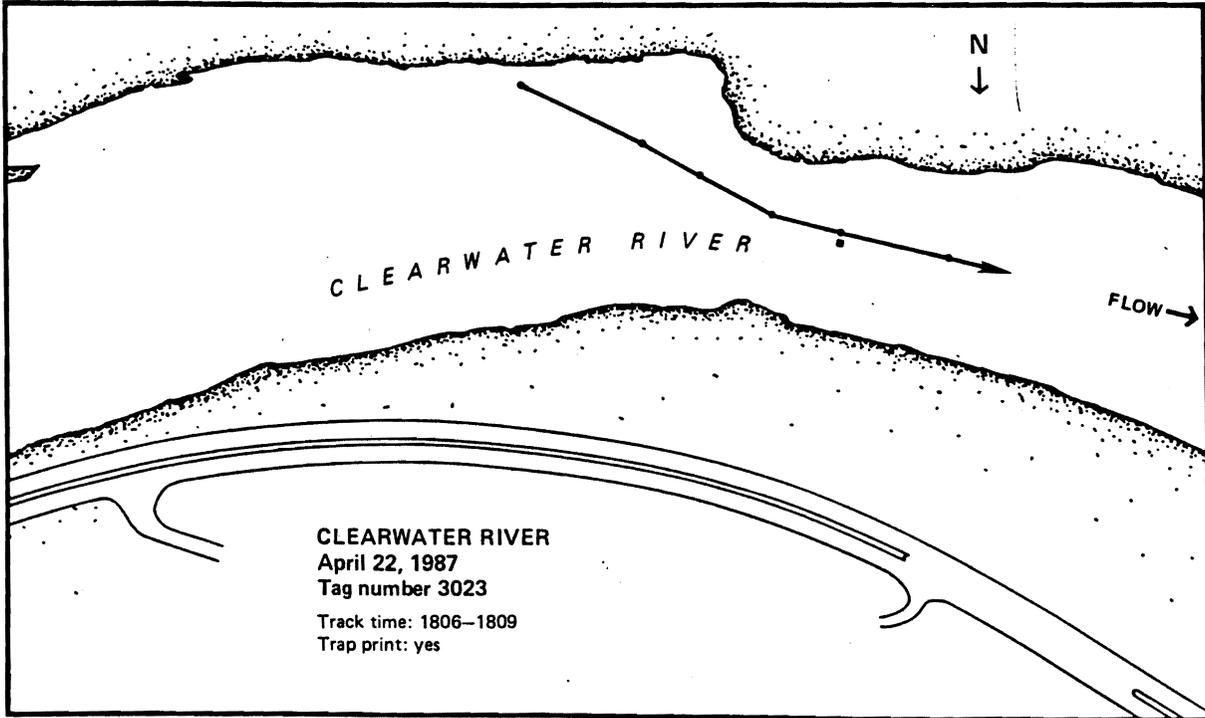
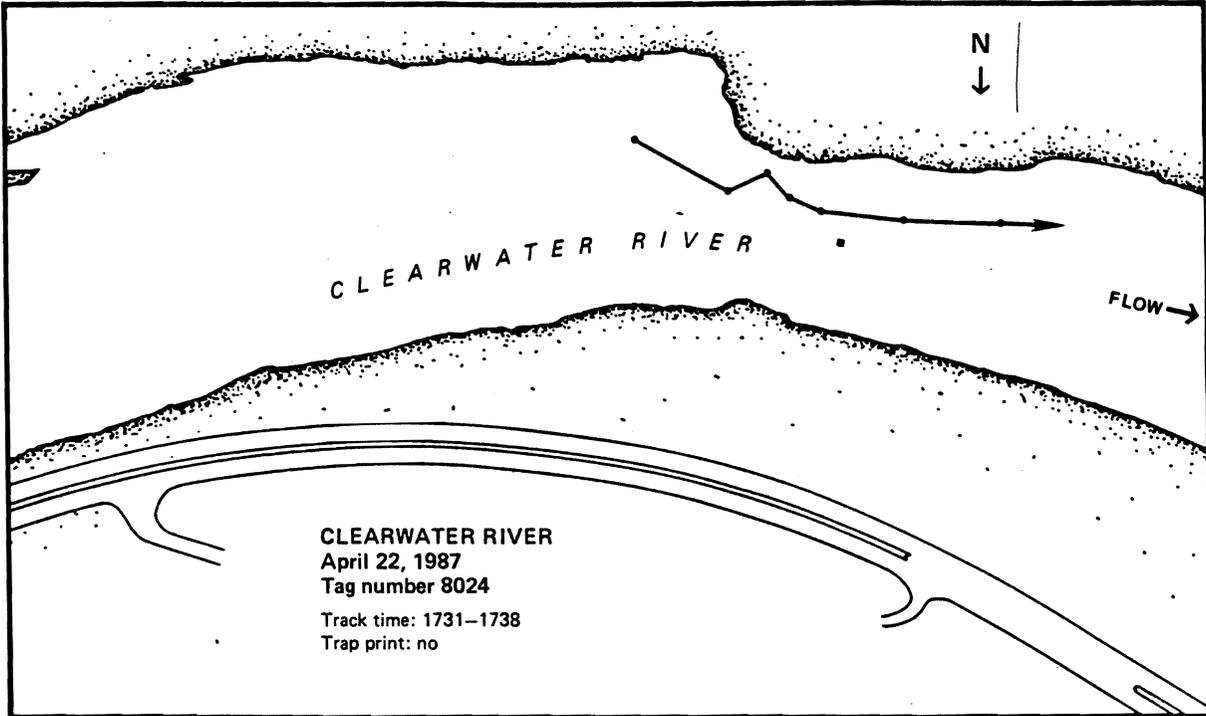


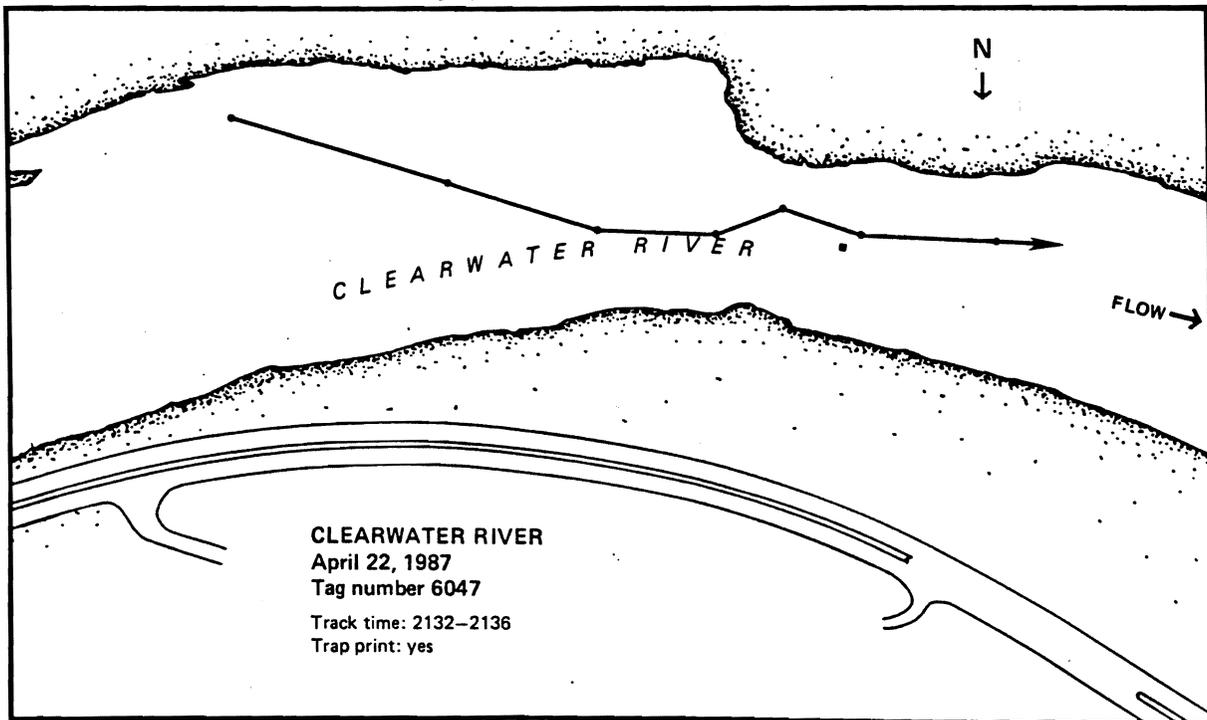
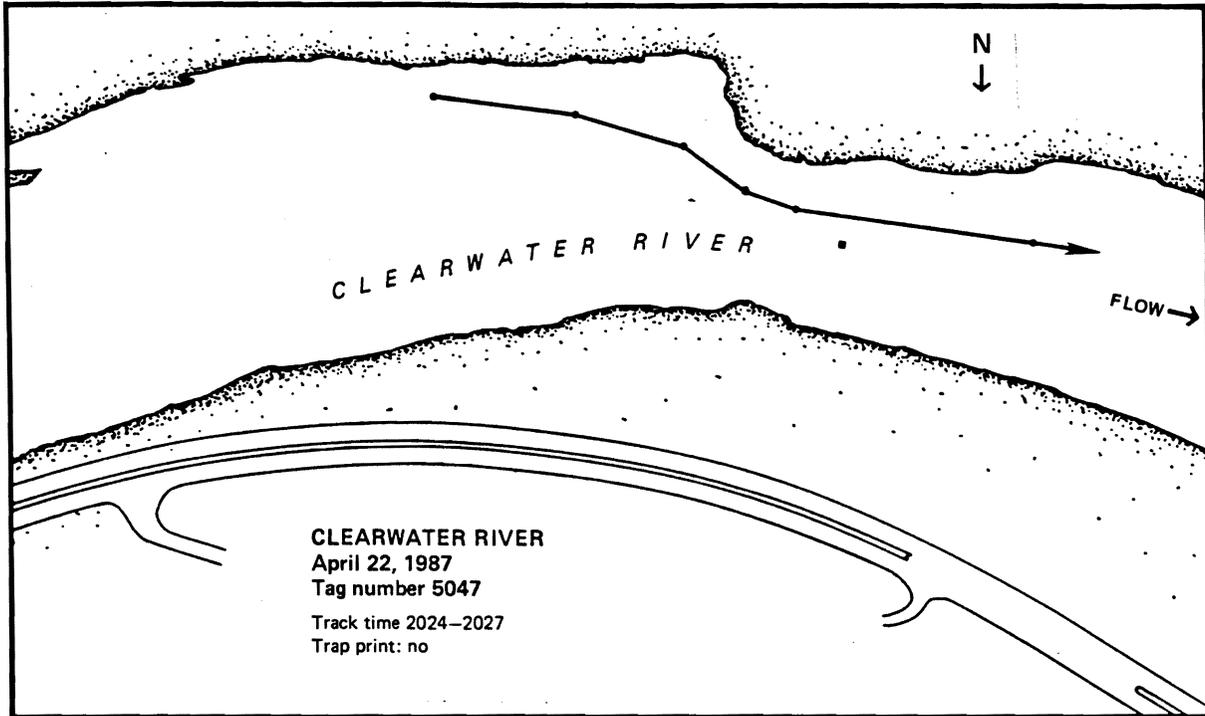


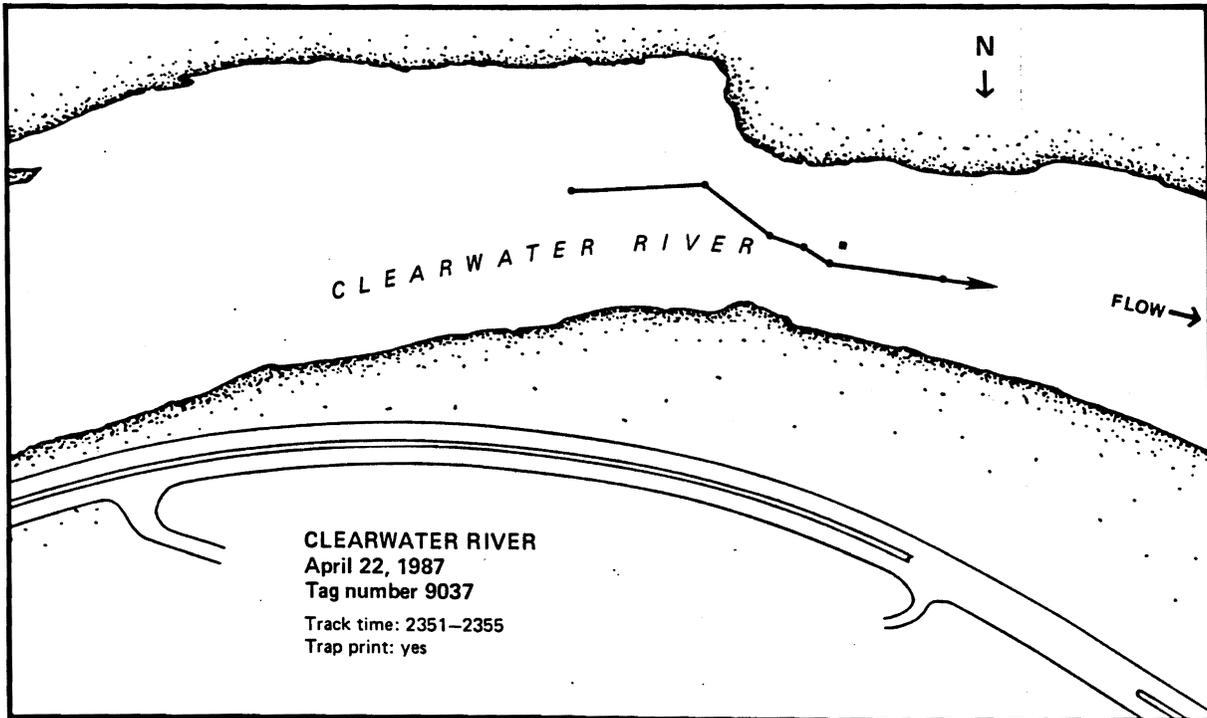
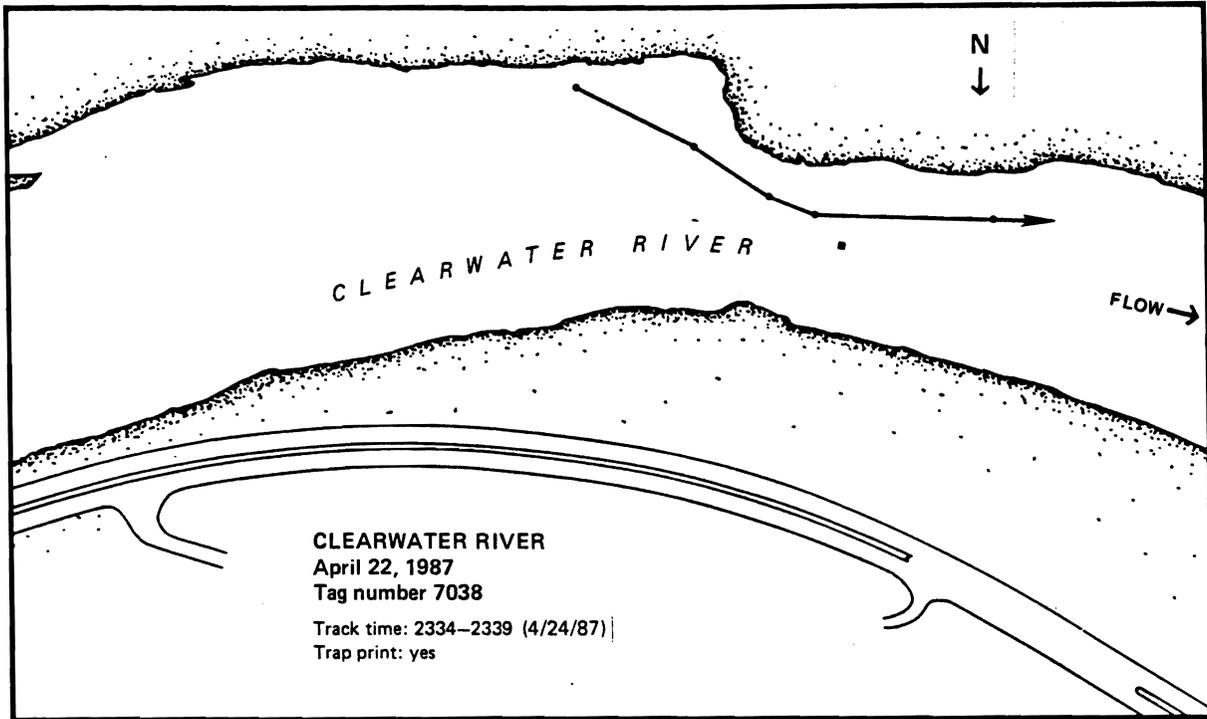


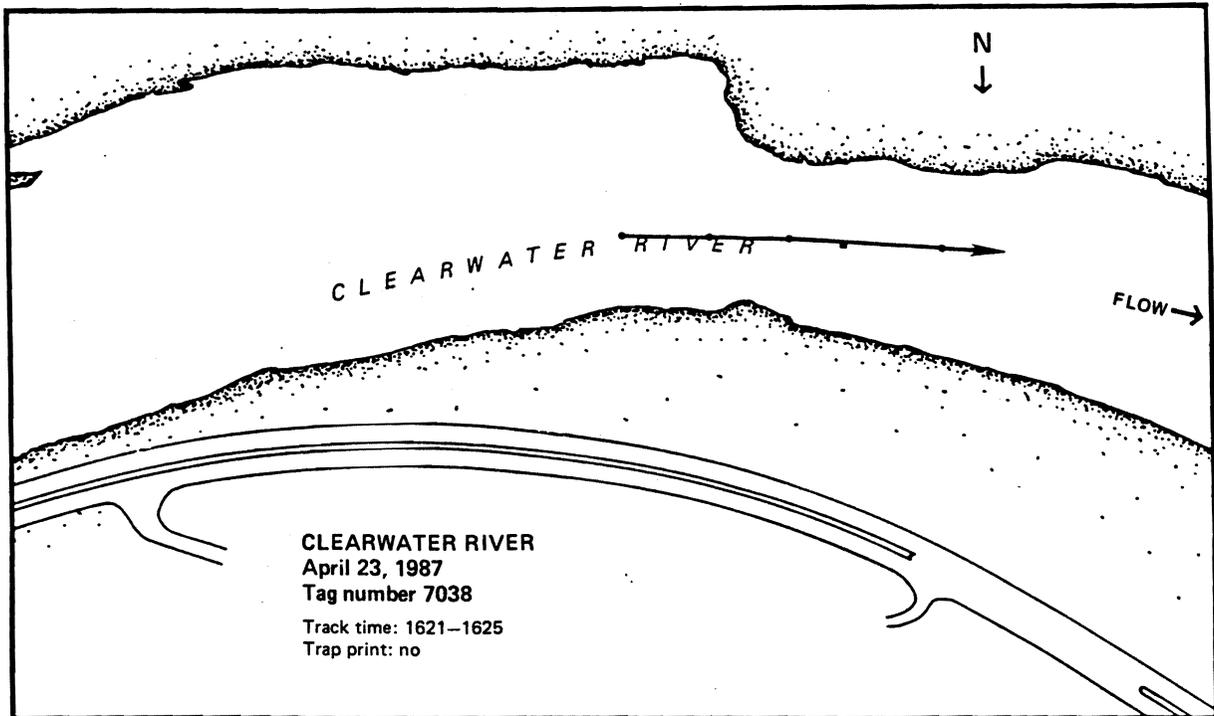
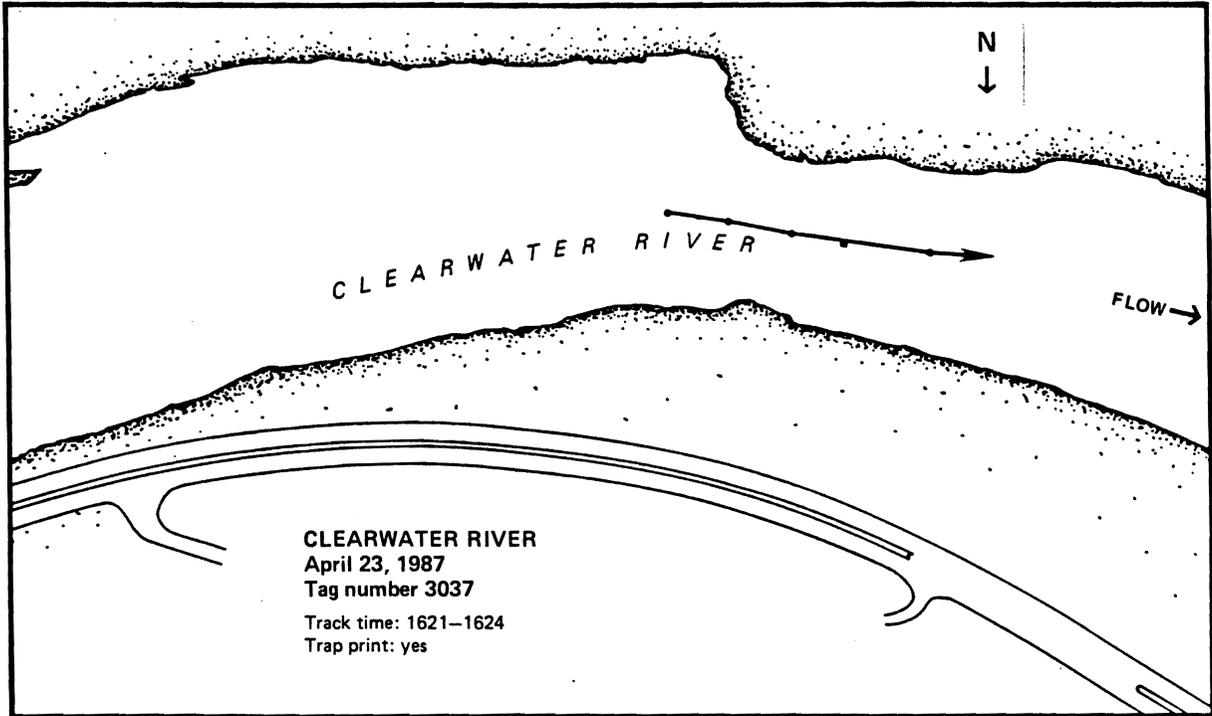


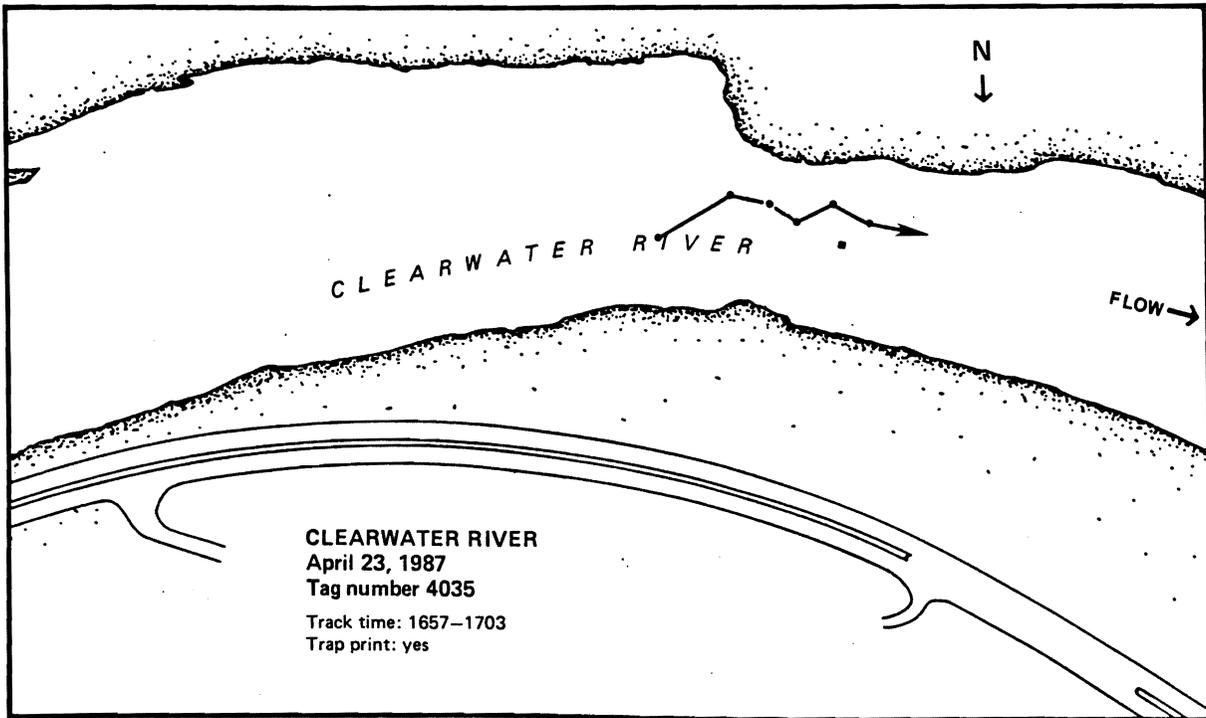
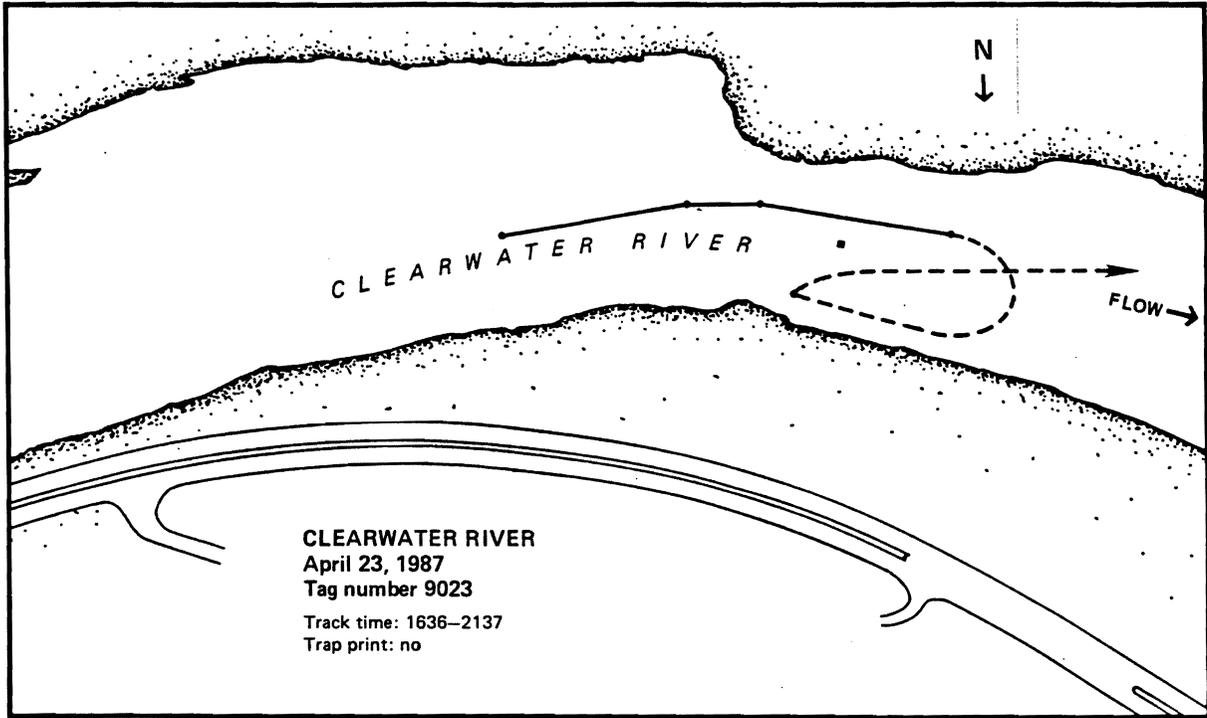


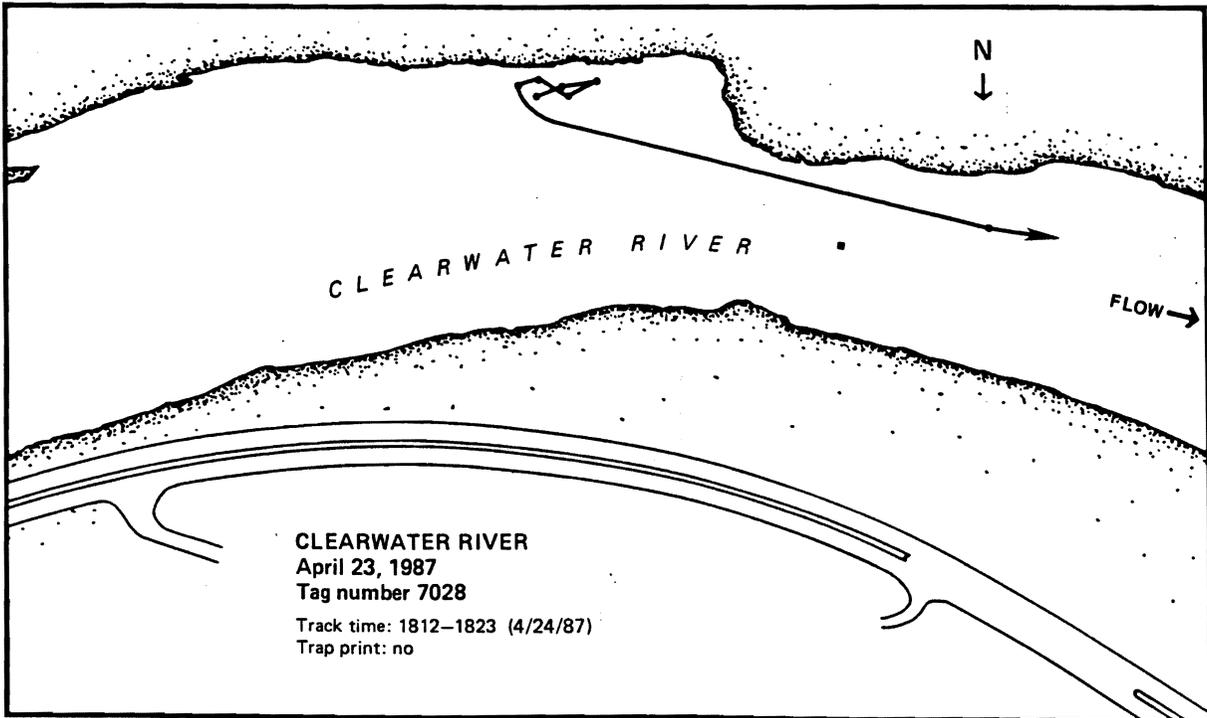
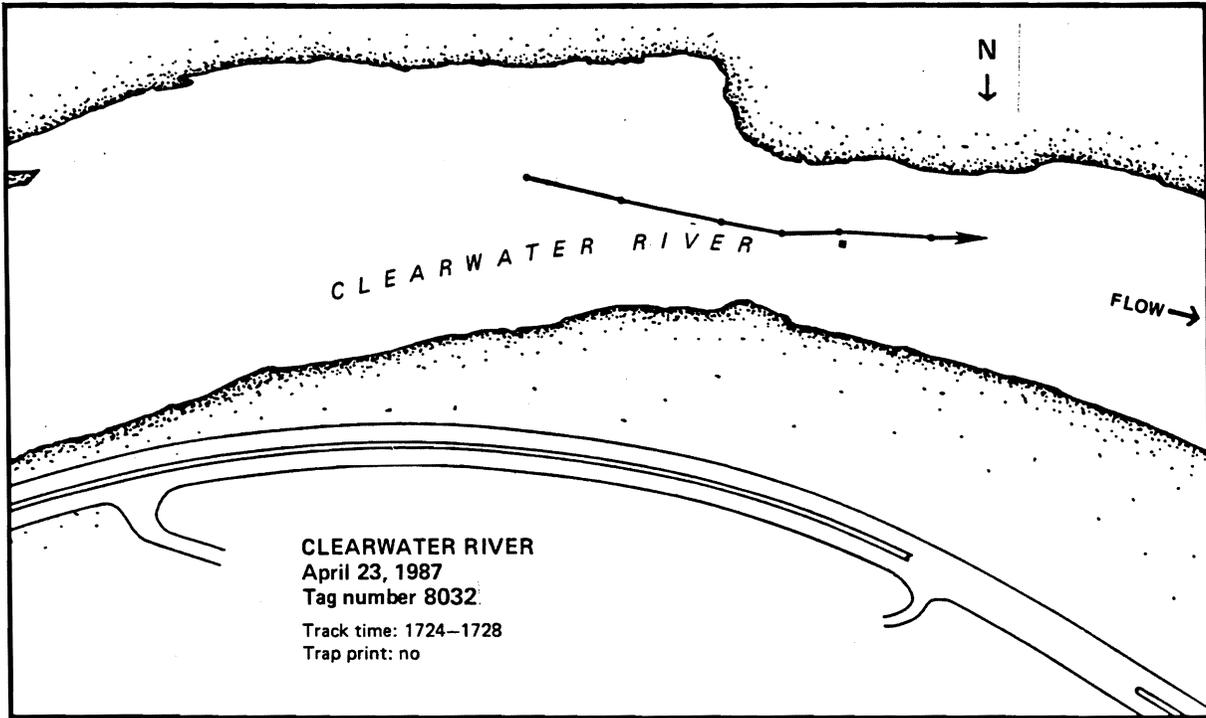


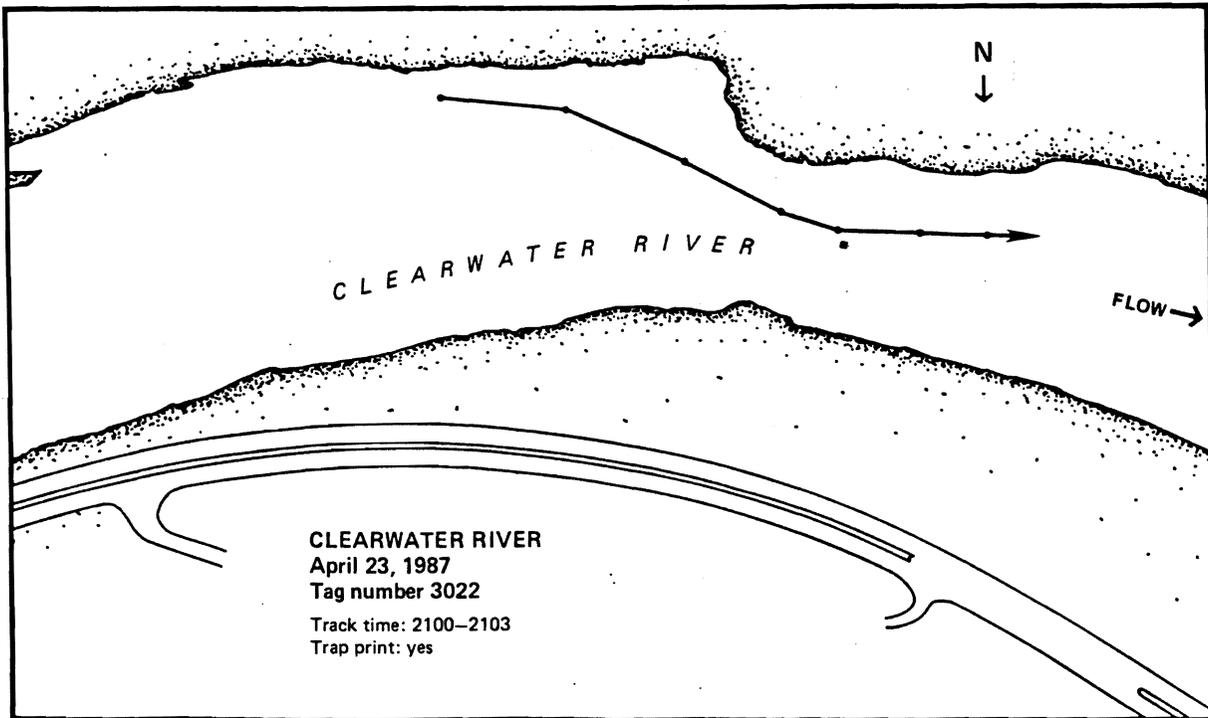
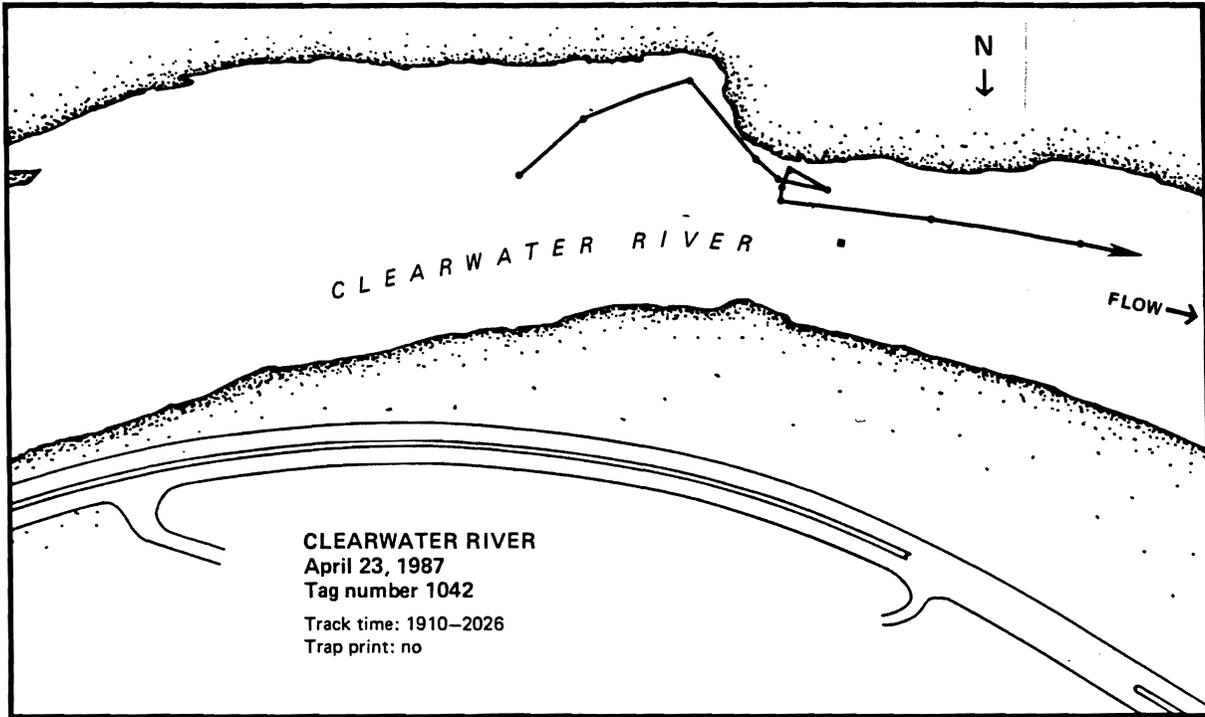


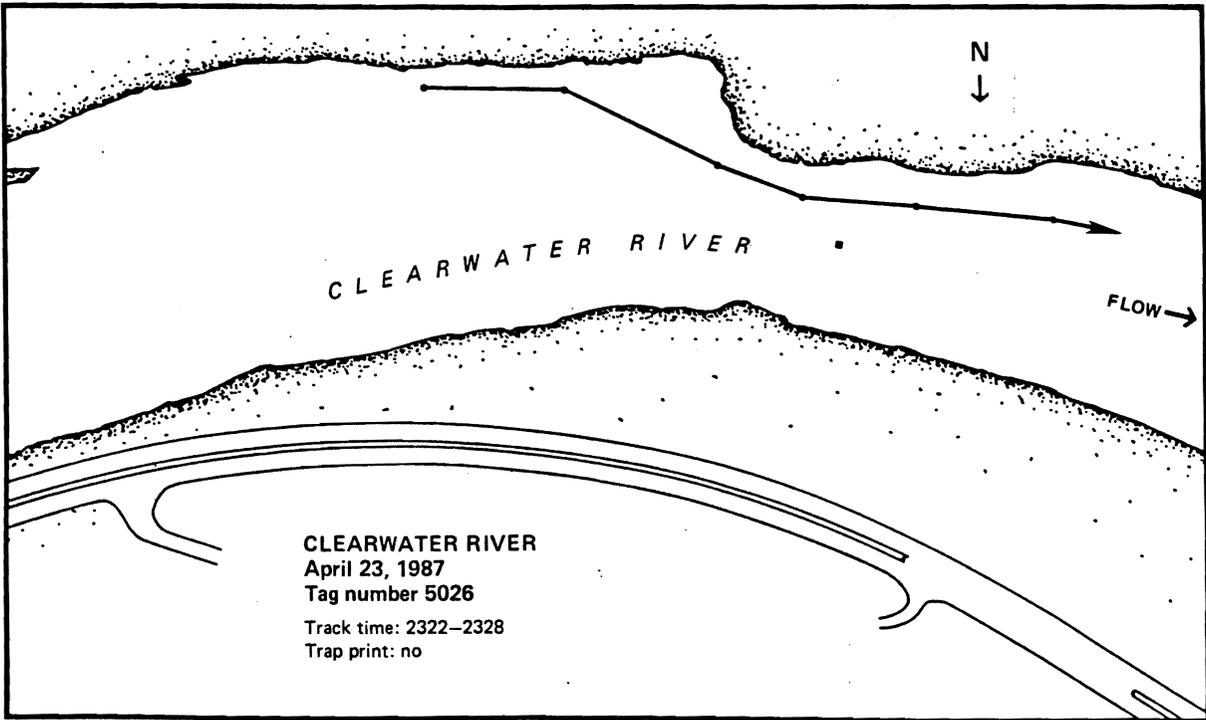
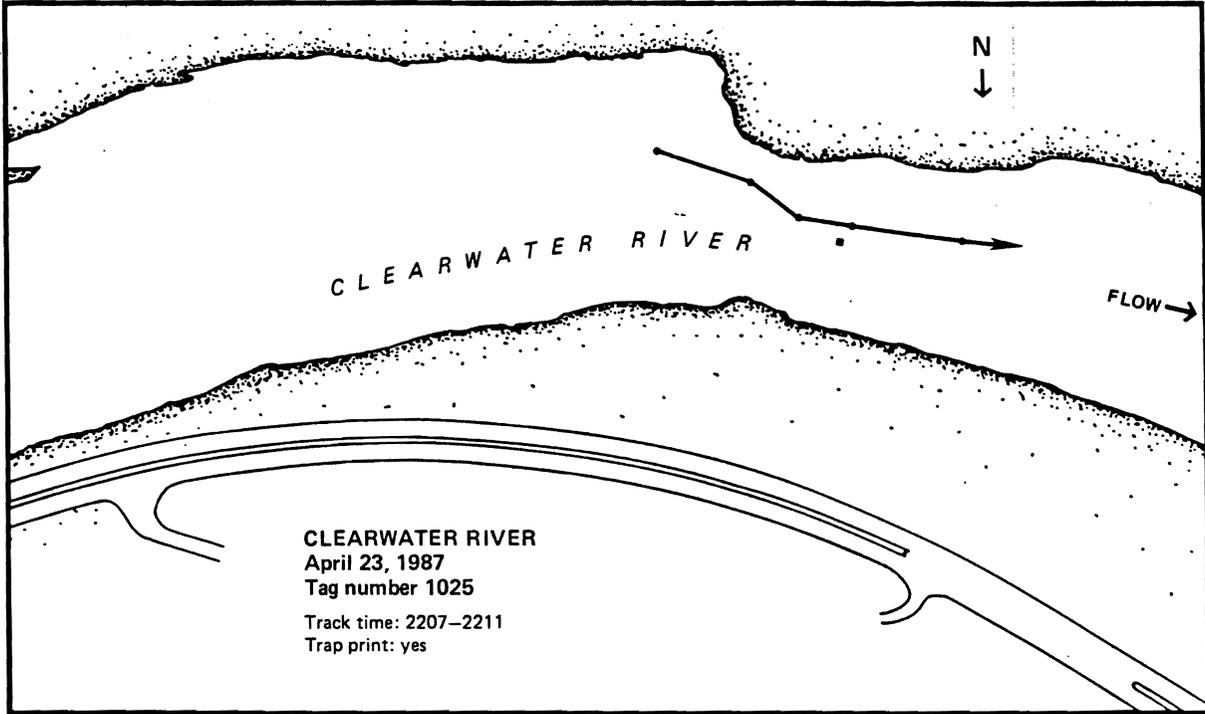


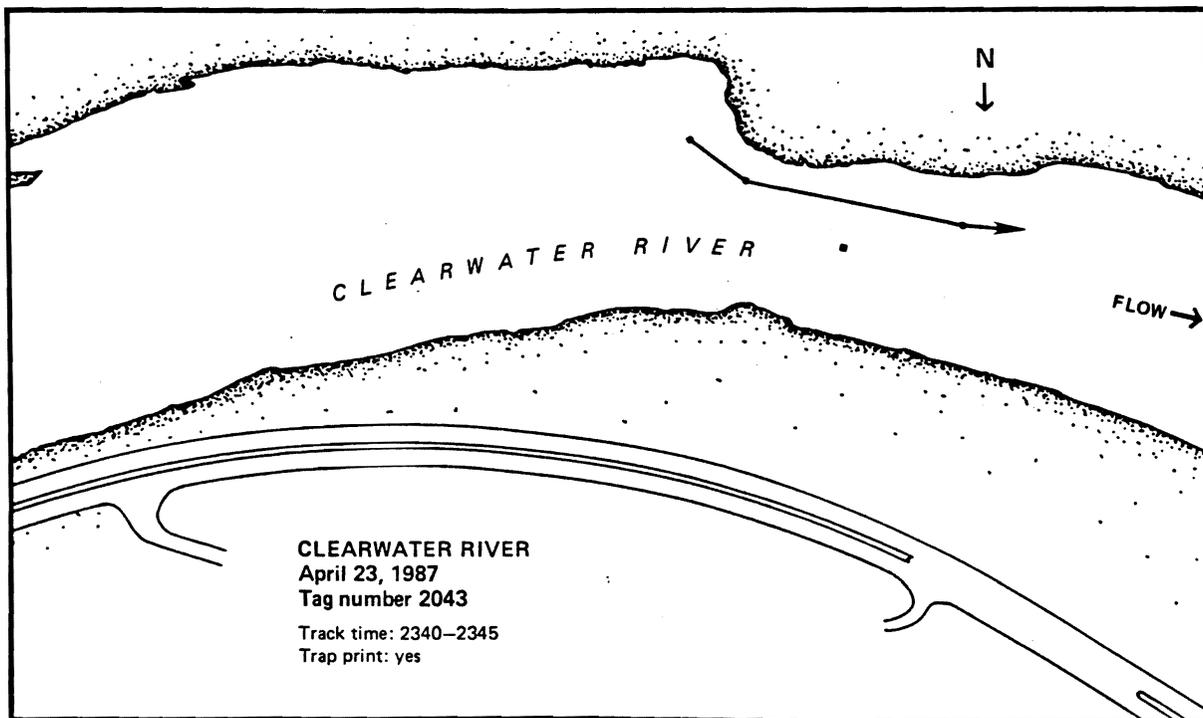
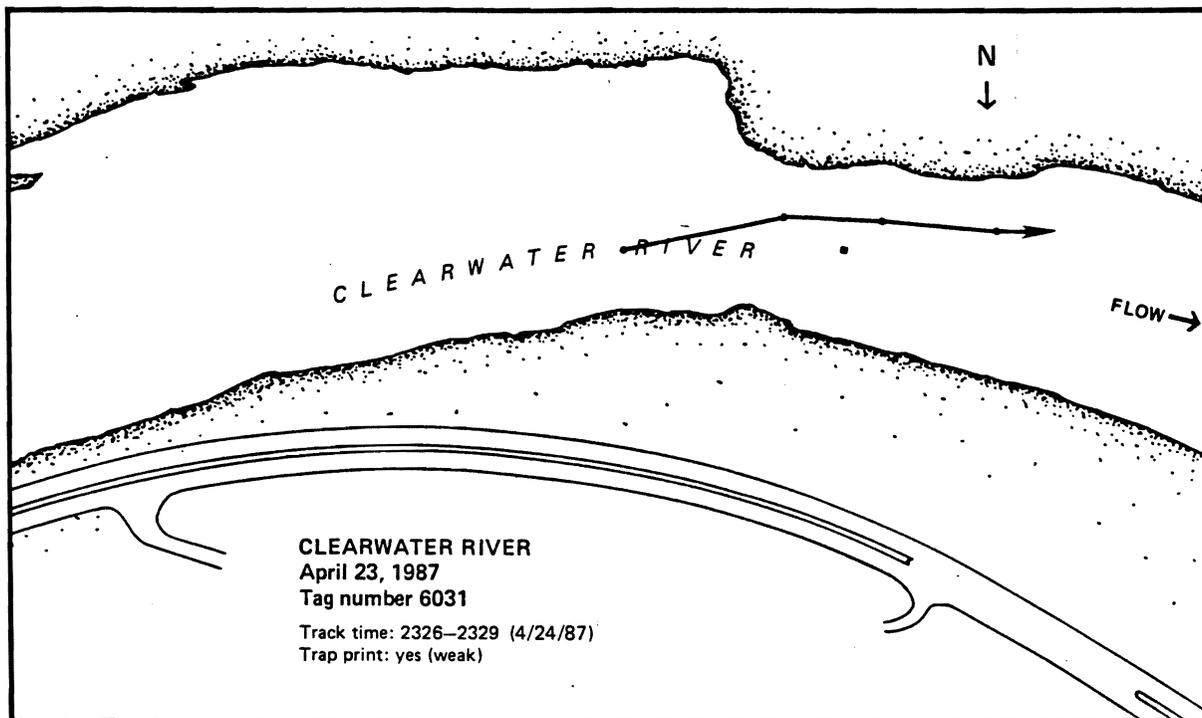


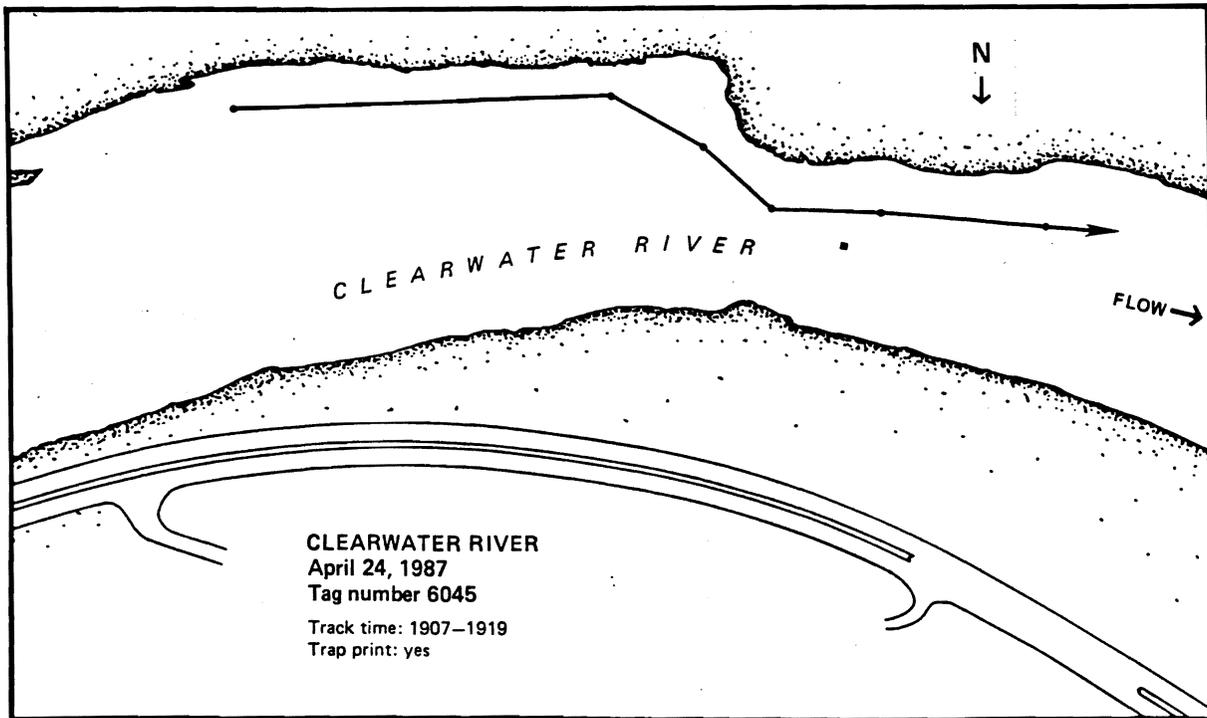
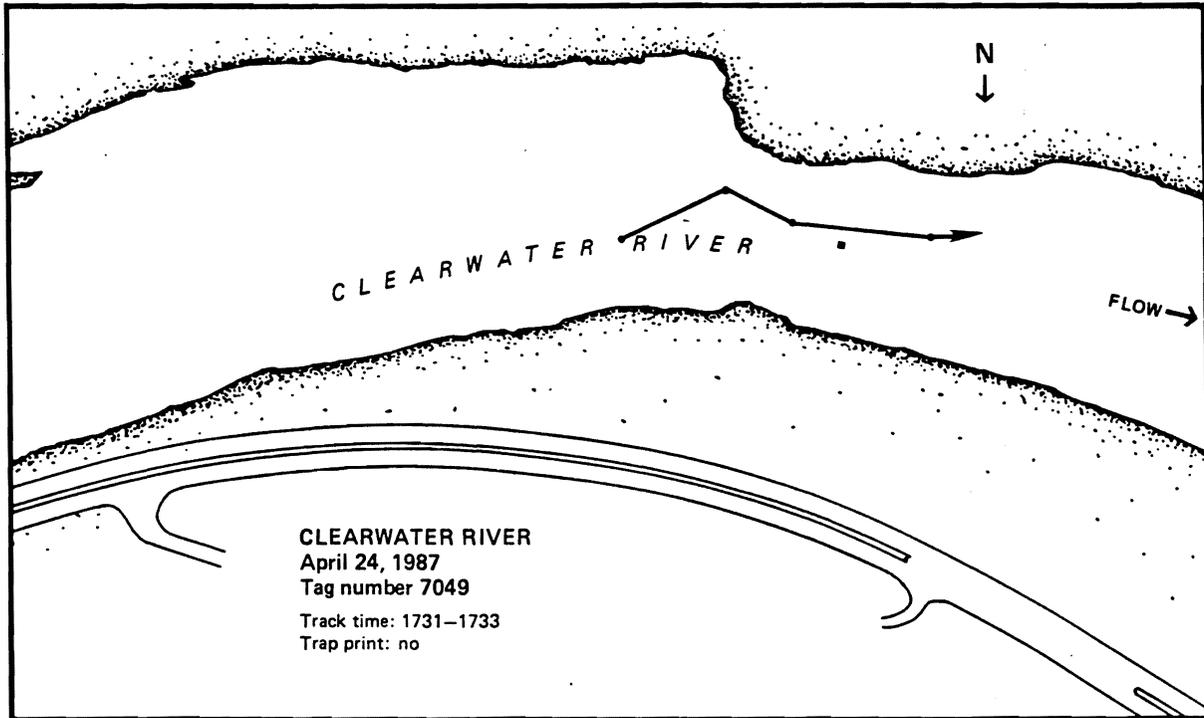


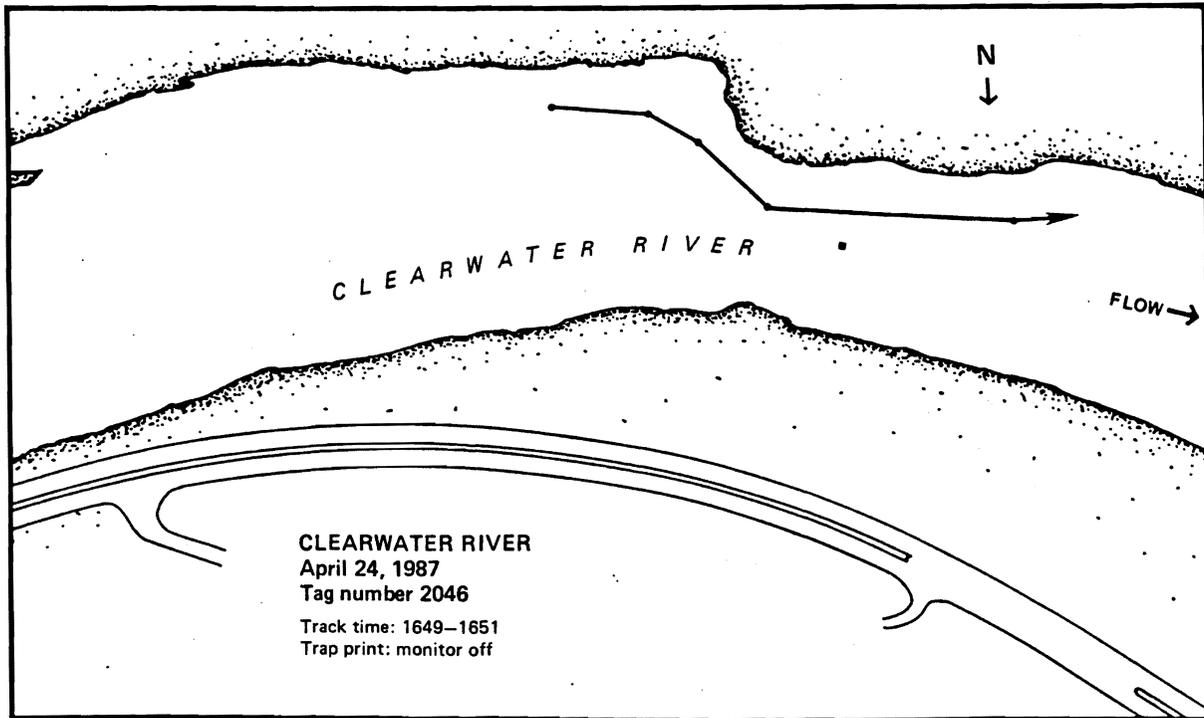
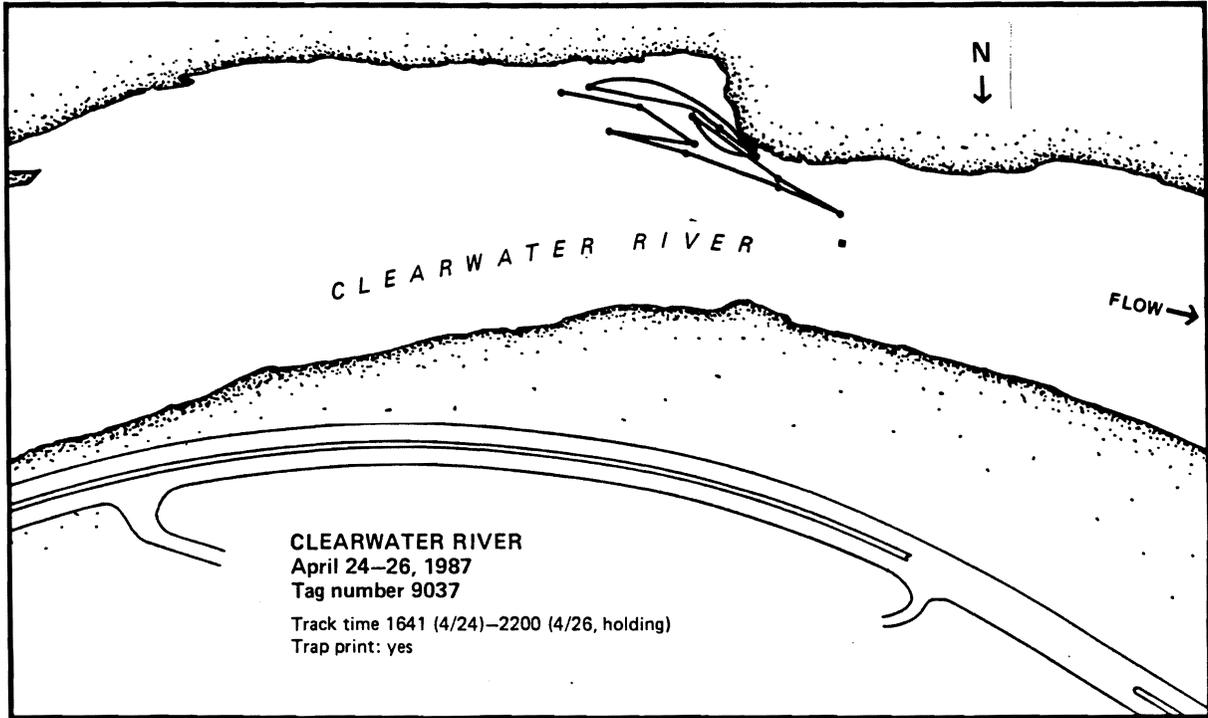


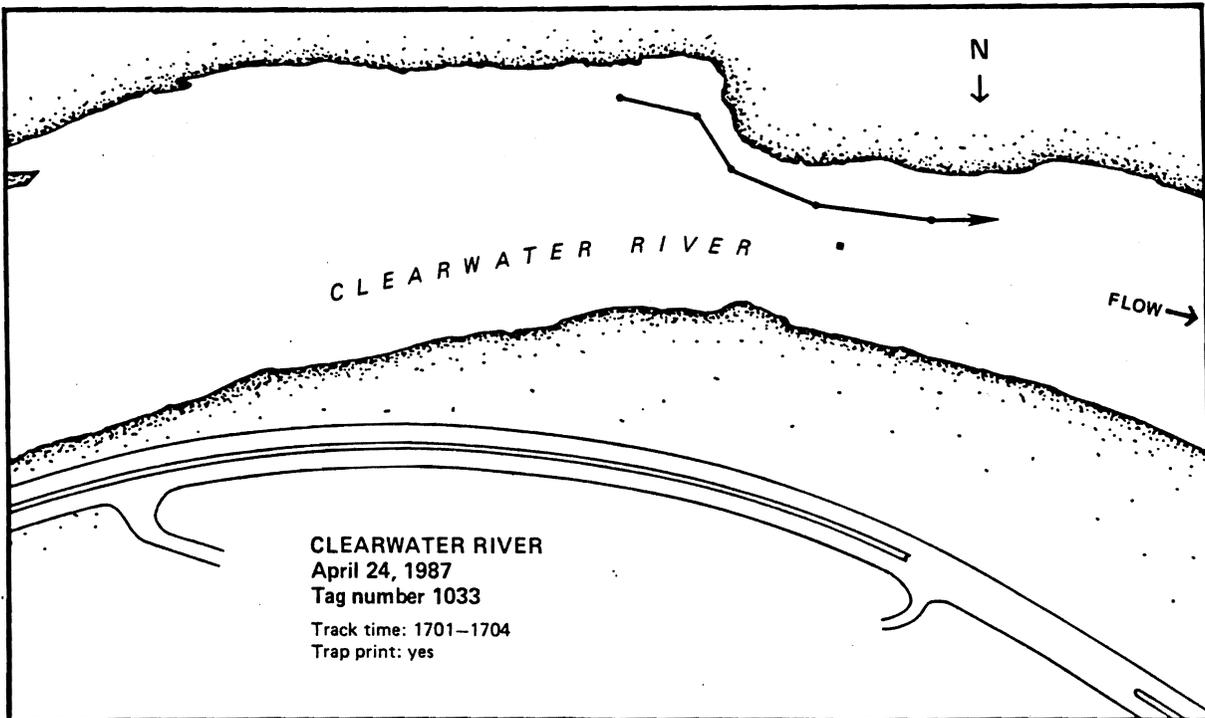
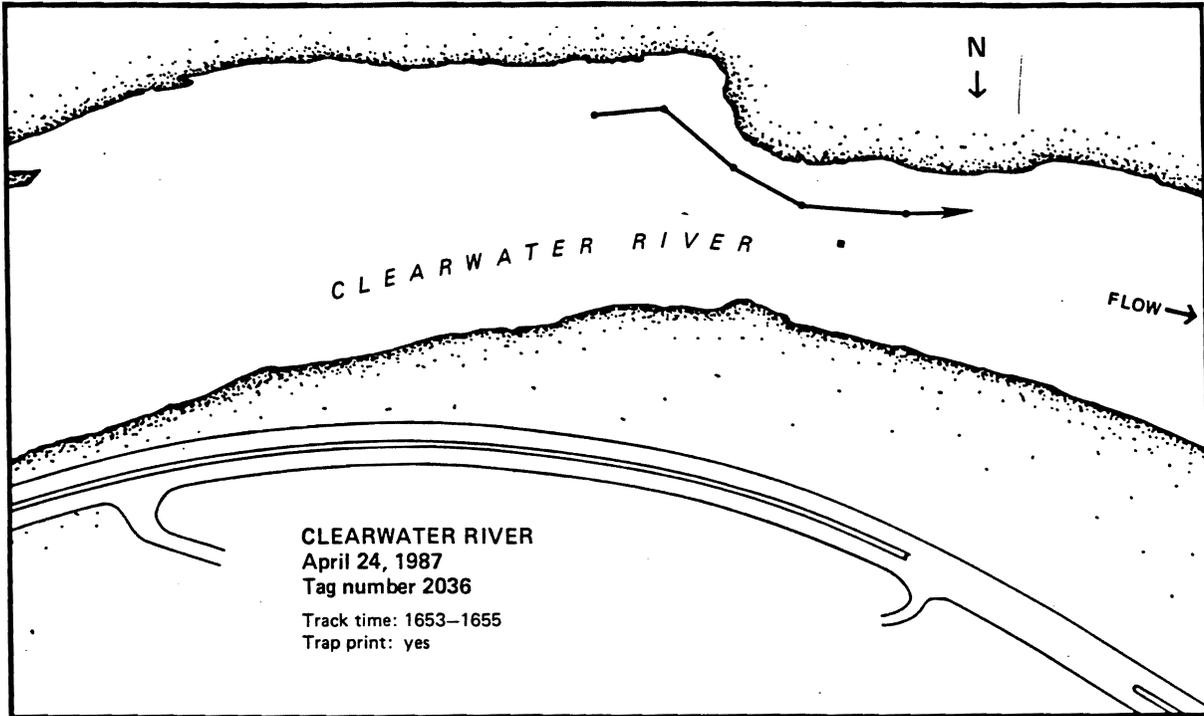


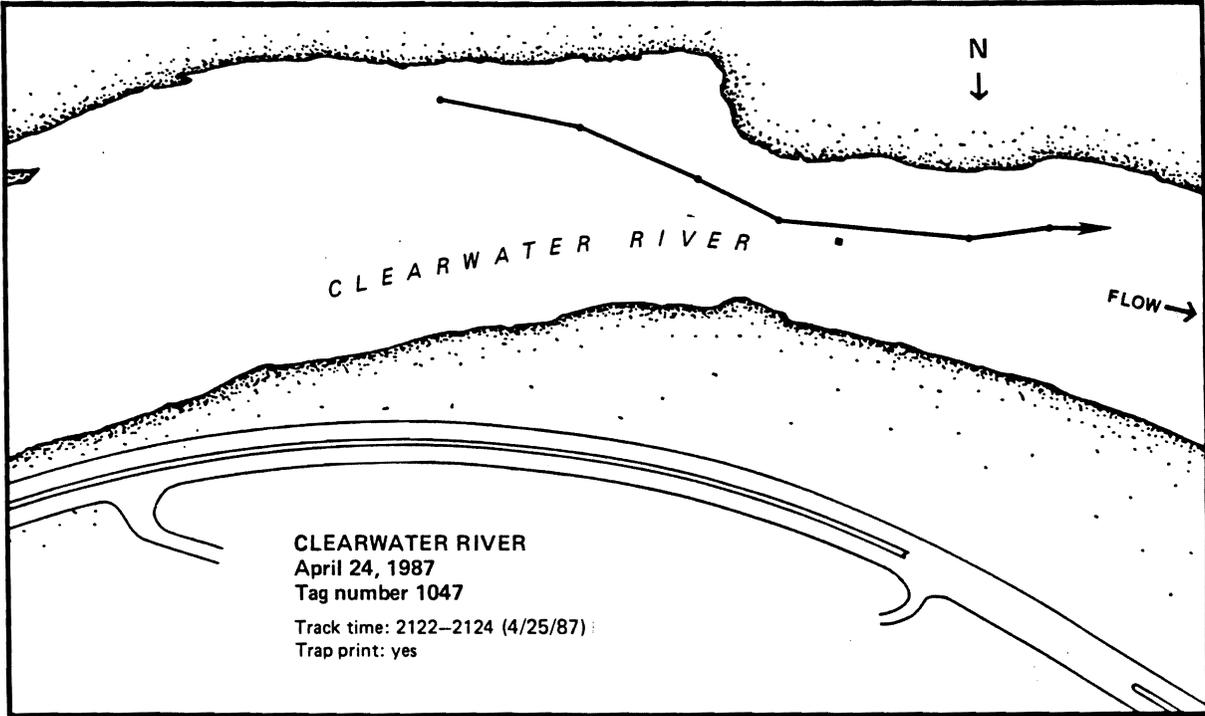


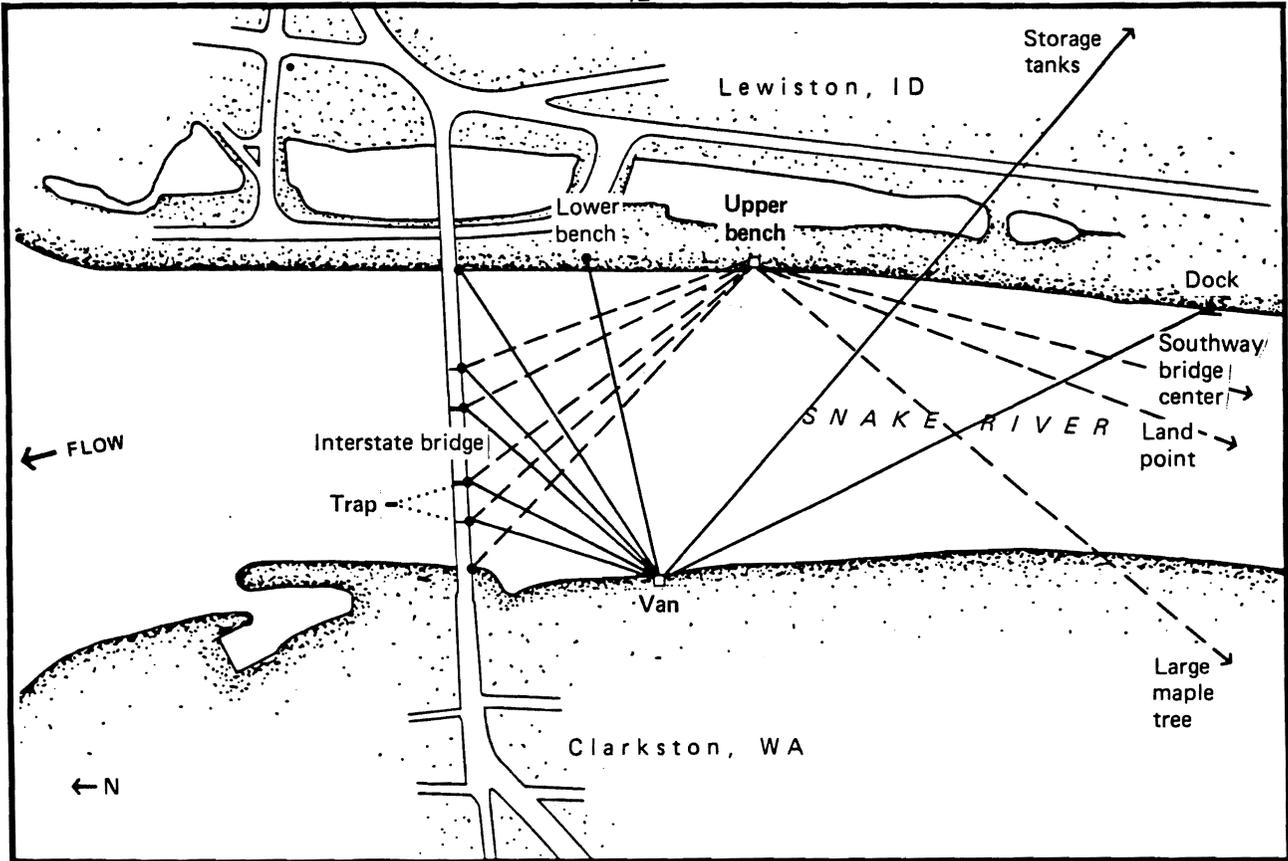




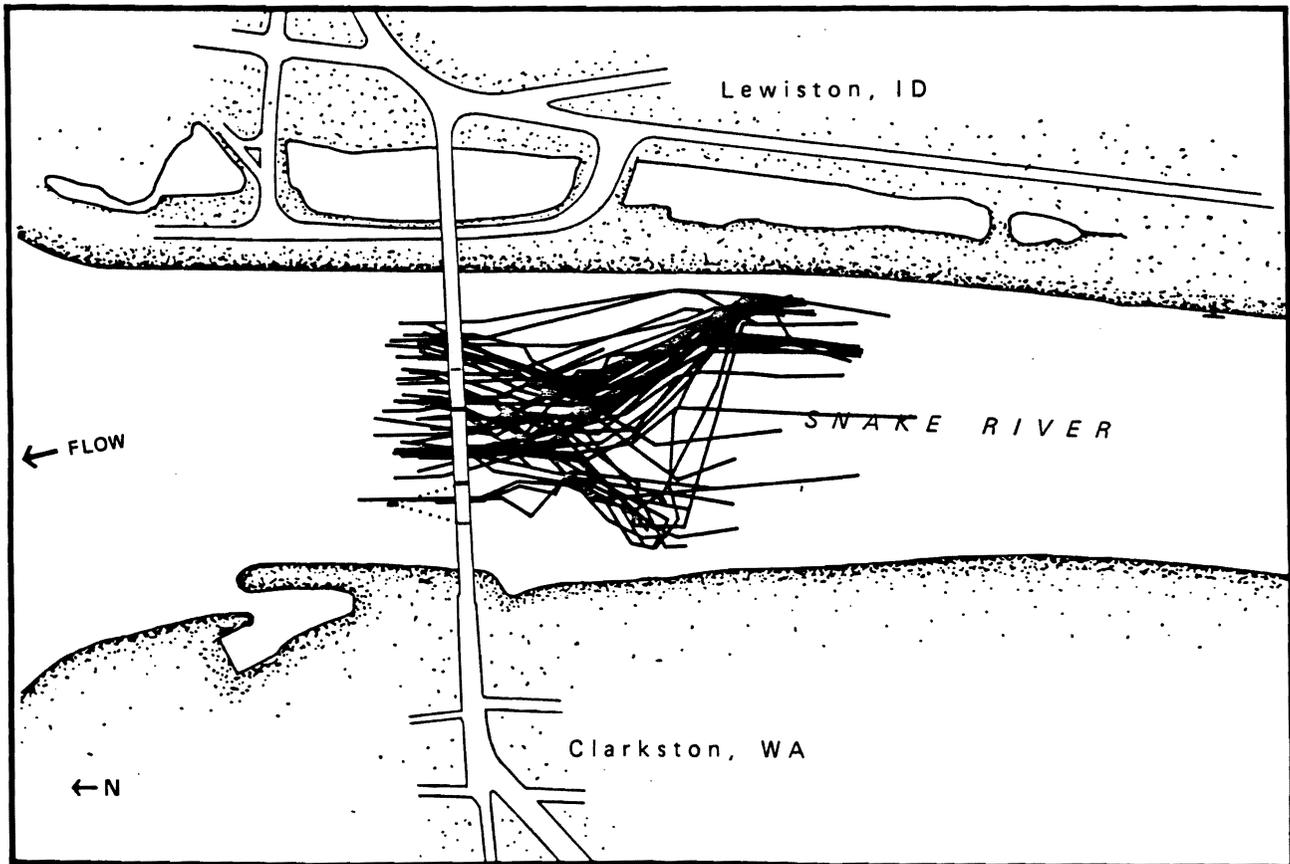








Diagrammatic view of Snake River study area showing grid lines used for tracking.



Composite of 48 tracks completed on juvenile steelhead at the Snake River trap site, 1987.

