FINAL REPORT

SONIC TRACKING OF ADULT STEELHEAD IN ICE HARBOR RESERVOIR, 1969

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Bureau of Commercial Fisheries
Biological Laboratory
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INTRODUCTION

Production of hydroelectricity along the Columbia and Snake Rivers has created major changes in their hydraulic patterns. As the free-flowing, unimpounded portions of the rivers are inundated, so are the accustomed fishing sites of the steelhead trout angler.

The adult steelhead is much sought after by Northwest anglers as it makes its way up the rivers to the spawning grounds. Consequently, the species has supported a valuable fishery, which at one time extended throughout much of the drainage. However, now that much of the steelhead's migration route is being transformed into large lake-like impoundments, many of the favored fishing sites may be lost unless new fishing techniques are developed. The development of new techniques is complicated by the vastness of the impoundments and the obvious realization that the completely changed environment has probably resulted in new patterns of fish behavior that must be understood and documented before reestablishment of the fishery can be attempted.

Steelhead fishermen in the vicinity of Walla Walla, Washington, concerned about their loss of fishing areas, asked the Walla Walla District of the U.S. Army Corps of Engineers to assist them in developing a sports fishery for steelhead in Ice Harbor Reservoir. To aid in the development, the Corps let a contract to the Bureau of Commercial Fisheries to provide information on the pattern of travel for steelhead through the reservoir.

The objectives of the study were to determine and chart routes of travel, depths of travel, and natural congregating areas for adult steelhead passing through Ice Harbor Reservoir on the Snake River. These objectives were achieved by tagging adult steelhead with sonic tags at Ice Harbor Dam and by tracking them through the reservoir during three periods--September 27-October 4, November 3-8, and December 1-6, 1969.

ICE HARBOR RESERVOIR

Physical characteristics

Ice Harbor Reservoir is on the Snake River and extends from river mile 9.7 to 41.6. It is formed by Ice Harbor Dam, and is bordered at its upstream limit by Lower Monumental Dam. The reservoir has many bends; it contains wide bays and narrow channels. It has a surface area of 9,200 acres and varies in width from about 225 to 1,675 yards. Depth is variable, ranging from 25 feet near the upper extremities to over 100 feet in some areas between Ice Harbor Dam and mile 22. River miles are clearly indicated by appropriate markers throughout the reservoir. Average water temperatures during our three tracking periods were 66°F in October, 53°F in November, and 45°F in December.

Adult steelhead population

The population of steelhead in Ice Harbor Reservoir can be estimated by examining fish counts at Ice Harbor and Lower Monumental Dams. The total count of adult steelhead passing over Ice Harbor Dam each year has varied from 44,000 to 116,000 fish. The 1969 count of 64,000 fish was below the 71,000 fish average for the past 8 years. Counting at Lower Monumental Dam, recently completed, has been in effect for only 1 year. The 1969 counts at the two dams show very little accumulation or delay of steelhead in Ice Harbor Reservoir. Generally, the time interval between corresponding peaks is only 1 to 4 days. The majority of the steelhead pass through the reservoir in September and October. In 1969 during September, October, and November, corresponding counts over Ice Harbor were 27,219, 14,953, and 3,874 steelhead, whereas in the same periods 26,647, 15,175, and 4,187 were counted over Lower Monumental.

MATERIALS AND METHODS

Tags and tagging

Fish to be tracked were tagged with a sonic tag placed in the stomach. The sonic tag is a high frequency sound transmitter that operates on a carrier frequency of 70 kHz, which is well above the highest frequency reported audible by fish (Kleerekoper and Chagnon, 1954). The transmitter is battery powered and has a transmitting life of 12 weeks. Transmitter and batteries are sealed in a plastic capsule 2.87 inches long and 0.75 inches in diameter. Tags weigh only 0.66 ounce in water and can be coded by varying the pattern of the transmitted signal. During this experiment we used four codes. Previous experiments have shown that steelhead tagged with the completely internal sonic tag traveled at a speed comparable to and suffered no higher mortality than fish tagged with a simple spaghetti tag.

Twenty adult steelhead were tagged with sonic tags. The fish were taken from the trap-separator installed in the south shore fish ladder at Ice Harbor Dam. A comparable trap and separator is described by Durkin, Ebel, and Smith (1969).

The fish were anesthetized in a solution of M.S. 222, and tagging, by a two-man team, was quick and simple. The assistant held the anesthetized steelhead with its belly up and raised the lower jaw so the mouth of the fish was wide open. The tagger then took the sonic tag out of the antiseptic solution of zephiran chloride, dipped the posterior end (that portion entering the fish initially) in glycerin, and inserted the tag into the stomach of the fish through the esophagus. The tag was held during insertion by a special tool that could be inserted in a small depression at one end. After being held for about 10 minutes while it recovered from the anesthetic, the tagged fish was released into the exit pool of the fish ladder.

Tracking equipment

Tagged steelhead were tracked from two outboard-powered boats. Each boat had a crew of two and was equipped with a hydrophone and a sonic receiver. Normally, one crewman operated the boat and recorded data while the other monitored the movements of the fish and gave instructions to the boat operator. The hydrophone is a unidirectional pickup for the tag signal. The sonic receiver (Smith-Root Type TA)[1/] is a self-contained unit that receives the signal from the hydrophone, amplifies it, and converts it to an audible tone. Effective range of the system is variable, depending upon water conditions, but under good conditions ranges over 2 miles are possible. By rotating the directional hydrophone in the water and listening for the loudest tone, the operator can determine the direction of the tagged fish. By moving the boat and taking multiple sightings on the fish, it is possible to determine its location quite accurately.

Tracking usually began at dawn and terminated at dark. Most of the tracking was done by traveling along behind the fish and recording its course. Earlier studies by Johnson (1960) showed that careful tracking of salmon did not alter their travel pattern.

None of the presently available sonic tag systems provide precise information on the depth the fish is traveling.

1/ Trade names referred to in this publication do not imply endorsement of commercial products by the Bureau of Commercial Fisheries.

Recording sonar system

We used a precision recording echo sounder (Ross 200-A Fineline) to determine the depth of travel. The system operated at a frequency of 200 kHz with pulse lengths of 0.1 or 0.6 msec. The sonar is capable of recording the depth of single fish even if it is close to the bottom.

During a track, we frequently positioned the boat with shipboard sonar equipment in front of, and in line with, a tagged fish swimming toward the boat. When our tracking equipment indicated the fish was in range of the sonar, we watched the recorder for an approaching fish and recorded its depth. We also used the sonar to monitor the depth of the water over the routes traveled by the tagged fish.

MIGRATION PATTERNS

Twenty adult steelhead were tagged during three tracking periods—eight in September-October, eight in November, and four in December. Complete or partial tracks were obtained from 17 of these fish. The three fish not tracked were tagged during our first period; one went down the fish ladder, and the other two were detected only briefly in front of the dam. Initial efforts were plagued by bad weather. Strong winds and rough water made fish tracking extremely difficult. Extensive wave action considerably reduces the effective range of our sonic tag due to attenuation of the signal by entrained air in the water between the tag and the hydrophone.

Because all the fish tracked came from the south-shore fish ladder, we know nothing about the pattern of movement for steelhead leaving the north-shore ladder. However, about 85 percent of the steelhead use the south-shore ladder at Ice Harbor Dam.

Routes traveled

Fish moving upstream through the reservoir generally followed a similar route during all three tracking periods. The major migration routes are shown by a solid line in figure 1. The dotted lines indicate alternate routes fish occasionally traveled. Tagged fish showed a definite preference for the left bank (looking downstream) throughout most of the reservoir. This was particularly true in the lower reservoir between miles 11 and 21.5. It was only between miles 31 and 33 that an equally strong preference was shown for the right bank. When traveling along the sides of the reservoir, fish were usually within 100 feet of the bank. Occasionally fish would swing out farther and often they would move in within 10 feet of the bank. They favored riprapped banks and generally avoided large shallow areas. The general migration route was similar to the route reported by Strickland (1967).[2/] Figure 2 shows the area of preference within each river mile for steelhead tracked through that mile, based on both upstream and extended downstream movement.

Rate of travel

The speed that fish traveled varied from no movement during periods of apparent rest to movement in excess of 4 mph. The overall rate for six fish tracked the length of the reservoir ranged from 0.58 to 1.1 mph and averaged 0.78 mph. This rate was based on the total time spent traveling and resting.

2/ Strickland, Roy. 1967. Sonic tracking of steelhead in the Ice Harbor Reservoir. Washington Game Department, Olympia, Wash. 17 p. [Processed.]

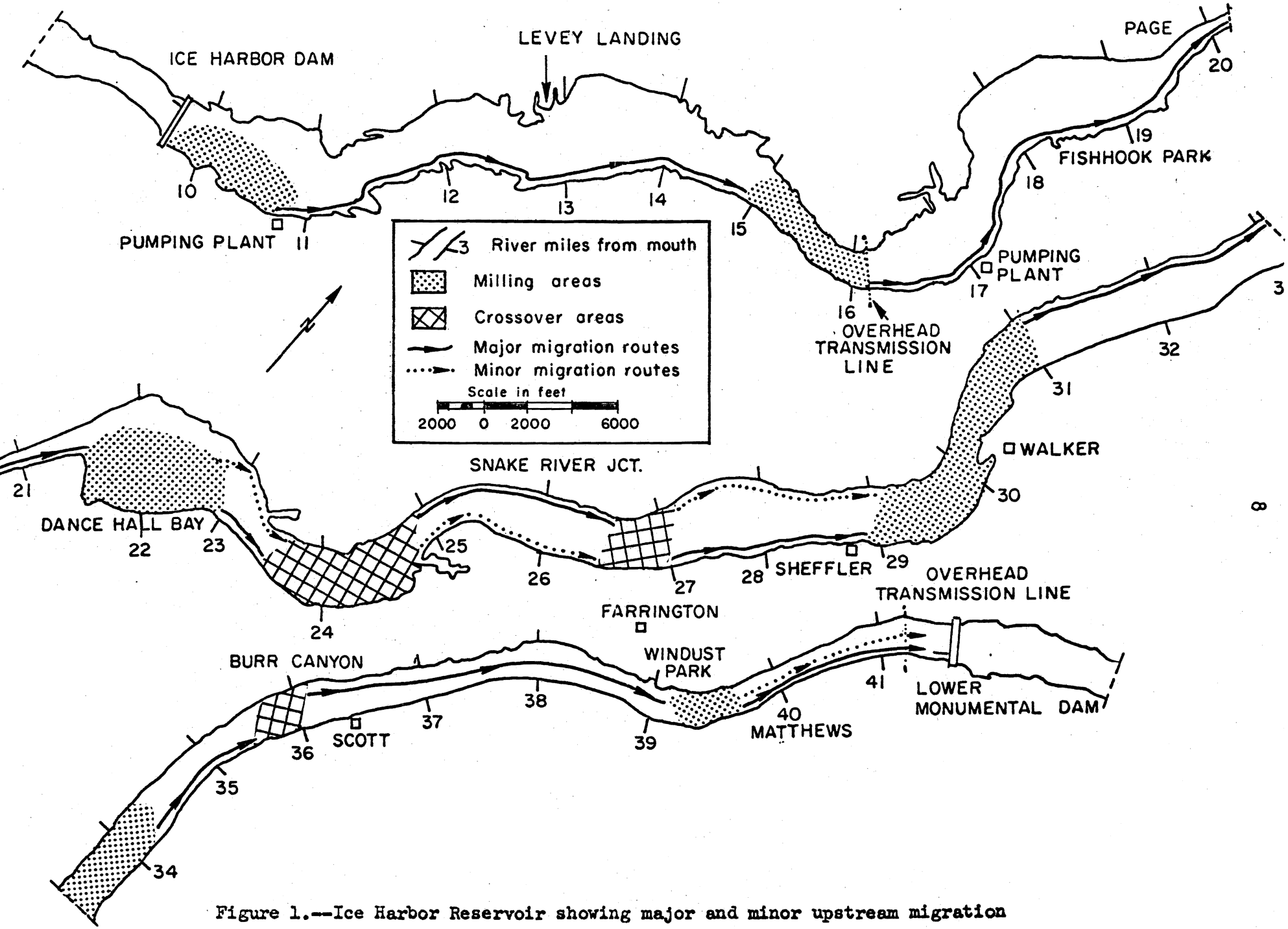

Figure 1.--Ice Harbor Reservoir showing major and minor upstream migration routes, milling areas, and crossover areas of adult steelhead trout.

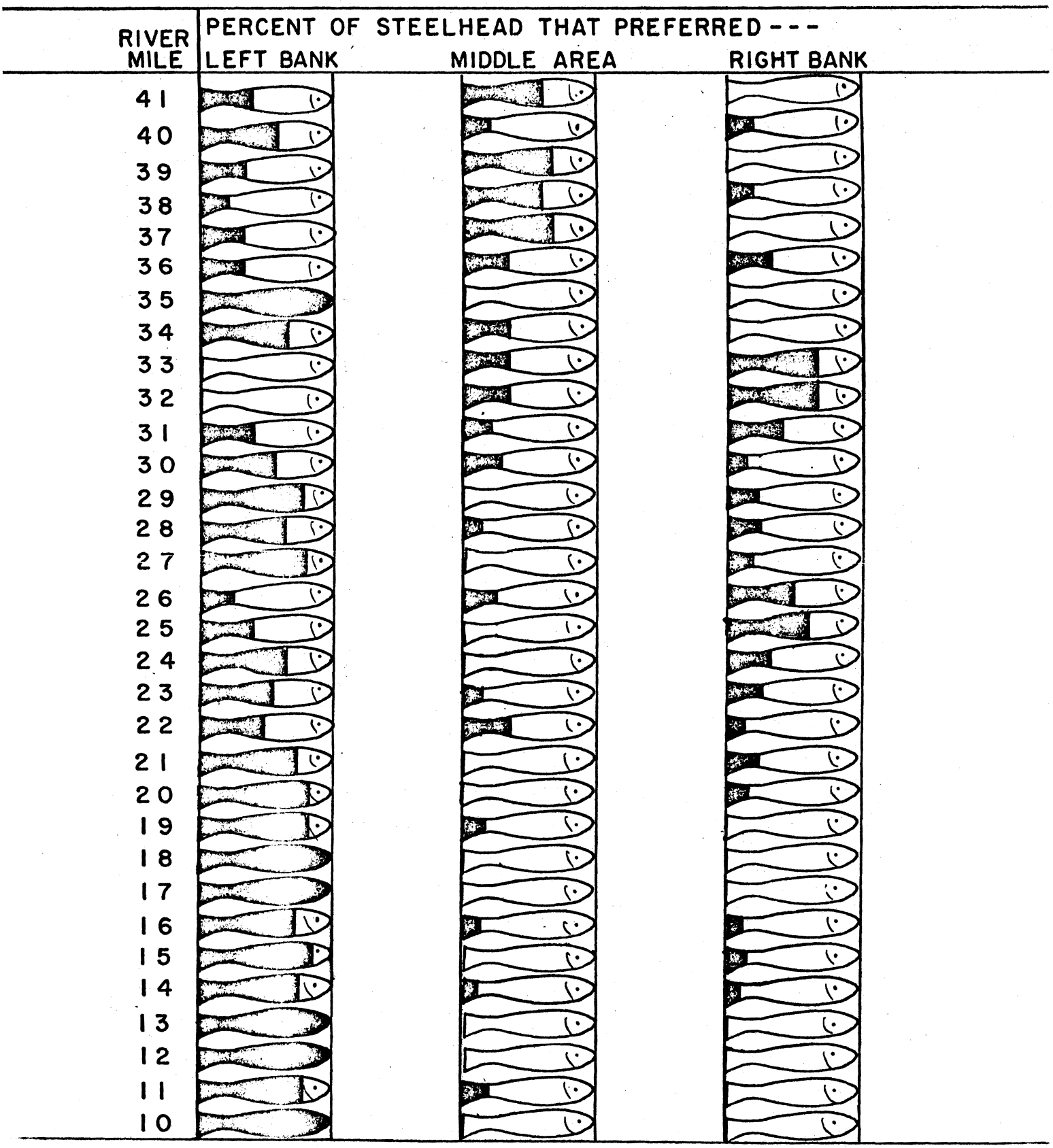

Figure 2.--Area preferred by adult steelhead within each river mile in Ice Harbor Reservoir, based on sonic-tracks of steelhead during upstream and downstream movements. (Degree of shading indicates percentage)

Differences in behavior were seen between the groups of fish tagged during the three study periods. The fish tagged in November did not move through the reservoir as rapidly as those tagged in September-October. Only one of the eight fish tagged traveled the length of the reservoir during the second tracking period. All five fish we were able to track in the first group reached the vicinity of Lower Monumental Dam by the end of the first tracking period. The second group spent more time traveling downstream. These long steady runs downstream often equaled their day's upstream journey. While traveling downstream, the fish usually followed a completely different course than they followed upstream. Most of the downstream movement was between mile 24 and Ice Harbor Dam, although some took place throughout the reservoir. Fish tagged in December moved at an even slower rate and none left the vicinity of Ice Harbor Dam during the week of tracking.

Most of the fish slowed down considerably or stopped at dark. Fish tracked in November were somewhat more inclined to travel at night than those tagged earlier.

Depth of travel

Tagged fish traveled in varying depths while migrating along the shore--usually 20 to 40 feet deep. The depths of water in areas where fish crossed the reservoir varied from 30 to 90 feet. Sustained movements in the middle of the reservoir were in waters 20 to 50 feet deep. As a general rule, the fish seemed to avoid large shallow areas, although they occasionally moved in close to shore.

Fish swam at varied depths between the first and second tracking periods. During the September-October period, tagged fish picked up by sonar were traveling 2 to 6 feet off the bottom in waters 20 to 40 feet deep. During the November tracking period, we were unable to pick up any tagged fish on the sonar. Whenever we positioned ourselves in their path, the fish changed course and skirted around the boat even though we maintained complete silence. This would seem to indicate the fish were traveling fairly close to the surface. We also visually observed steelhead close to the surface.

We obtained limited information concerning depth of travel for the fish tagged in December. Only one fish traveled away from the dam and it spent most of its time alternating between shallow waters near shore and resting near the bottom in water 12 to 20 feet deep. Other steelhead were also observed in shallow water near shore.

Milling, resting, and crossing areas

Tagged fish tended to move more slowly in rather specific areas in the reservoir. They either milled about or assumed a virtual resting position. Milling areas are shown in figure 1 (dotted sections). All fish spent some time--from a few hours to several days--near Ice Harbor Dam before proceeding upstream. After leaving this area, they traveled at a fairly uniform rate until they reached the next milling area between miles 15 and 16. A subsequent major milling area, between miles 21 and 23, was a favored overnight resting area. Other milling areas were between miles 29 and 31, 33 and 34, and between 39 and 40. In the milling areas, fish often appeared confused and wandered extensively. When fish appeared to be slowing down for the night they often moved away from the shore.

In addition to milling areas, where they often crossed and recrossed repeatedly, fish also apparently preferred certain nonmilling areas when crossing the reservoir. These specific crossover areas are shown by crosshatching in figure 1.

CONCLUSIONS

The following conclusions are drawn from tracking adult steelhead upstream through Ice Harbor Reservoir during the fall of 1969.

1. Adult steelhead from the south shore fish ladder at Ice Harbor Dam follow a fairly uniform route through the reservoir and have rather specific traveling, milling, and resting areas.

2. Steelhead usually travel through the reservoir relatively close to shore in waters 40 feet deep or less.

3. Steelhead travel at various depths during all periods. However, during the September-October tracking period they favor the area near the bottom, whereas during the November and December periods they are more surface oriented.

4. The comparatively uniform route taken by steelhead through the reservoir considerably reduces the area to be fished in developing a sports fishery.

ACKNOWLEDGMENTS

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LITERATURE CITED

Durkin, Joseph T., Wesley J. Ebel, and Jim Ross Smith.

1969. A device to detect magnetized wire tags in migrating adult coho salmon. J. Fish. Res. Bd. Canada 26: 3083-3088.

Kleerekoper, H., and E. C. Chagnon.

1954. Hearing in fish with special reference to Semotilus atromaculatus atromaculatus (Mitchill). J. Fish. Res. Bd. Canada 11: 130-152.

Johnson, James H.

1960. Sonic tracking of adult salmon at Bonneville Dam, 1957. U.S. Fish Wildl. Serv., Fish. Bull. 60: 471-485.