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# TRANSFER RELEASES OF COHO SALMON AND TROUT INTO AN UPPER PART OF PLATTE RIVER, AND OBSERVATIONS ON SALMONID SPAWNING[1]

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## ABSTRACT

Adult coho salmon (600 males and 600 females) were introduced into a 1.4-mile stretch of Platte River (above the State hatchery) each fall in 1969, 1970, and 1971, to provide populations of young coho for a study of competition between salmon and trout. The total redd count in the respective years was 311, 357, and 262; and success of reproduction was rated moderate, poor, and poorer, respectively. Many eggs were retained by the salmon to the time they died; retention was estimated at approximately 44, 51, and 67% in the respective years. Possibly a relationship existed between the high rate of retention and the considerable mortality of eggs and fry that has occurred in the hatchery.

All of the rainbow trout and brown trout that entered the weir, along with coho salmon, were passed upstream also. Observations were made on spawning behavior of the three species. Spawning habits of rainbow trout and coho were similar in several respects, while the habits of brown trout were different from both. Number of redds per 300 lineal feet of stream, by species and stream section, during 1969-71, ranged as follows: rainbow trout, Exp. Sect. I, 4 to 6 redds; coho salmon, Exp. Sect. I, 13 to 15 redds; and brown trout, Control Sect., 1 to 2 redds.

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[1] A contribution from Dingell-Johnson Project F-31-R, Michigan.

## Introduction

In the autumns of 1969, 1970, and 1971, we released adult coho salmon (Oncorhynchus kisutch) above the weir at the Platte River Anadromous Fish Hatchery. Full-term (3-year-old) coho migrants from Lake Michigan previously had been barred from this part of the river. The salmon were introduced to obtain reproduction in an experimental section for assisting study of competition between coho salmon and trout. Brown trout (Salmo trutta) and rainbow trout (Salmo gairdneri) that entered the weir were passed upstream along with the salmon. In addition, spawning activities of the three species were observed. Besides serving as background information on the study of competition, the procedures and results of the transfers may be helpful guidance for making similar transfers in the future. The observations on spawning may be useful in salmonid management.

Following are distinctive segments of the stretch of river that received the transferred salmon: (1) from the dam of the weir upstream to the experimental water--2,100 feet; (2) Experimental Section I--5,280 feet; (3) from the upstream end of Section I to the location of a fish barrier--100 feet (Fig. 1). The dam, with grating at the top, quite effectively blocks downstream, as well as upstream, movement of fish, although some 2-year-old coho salmon of the upstream migration reach the top and pass through the steel-bar grating. The dam is designed to hold a 5 1/2-foot head of water, but the head is maintained at about 4 1/2 feet during the salmon spawning migration. Late in the fall, several stop logs (wooden planks) are removed from the gateways to reduce the head by 1 foot to 2 feet, to prevent damage from ice. In March, the head is reduced further, to a depth of around 2 feet, which allows rainbow trout from Lake Michigan to pass upstream, but prevents passage of sea lampreys.[2]

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[2] Walter C. Houghton and Lyle O. Newton, respectively Superintendent and Foreman of the Platte River Hatchery, provided the information on the operation of the dam.

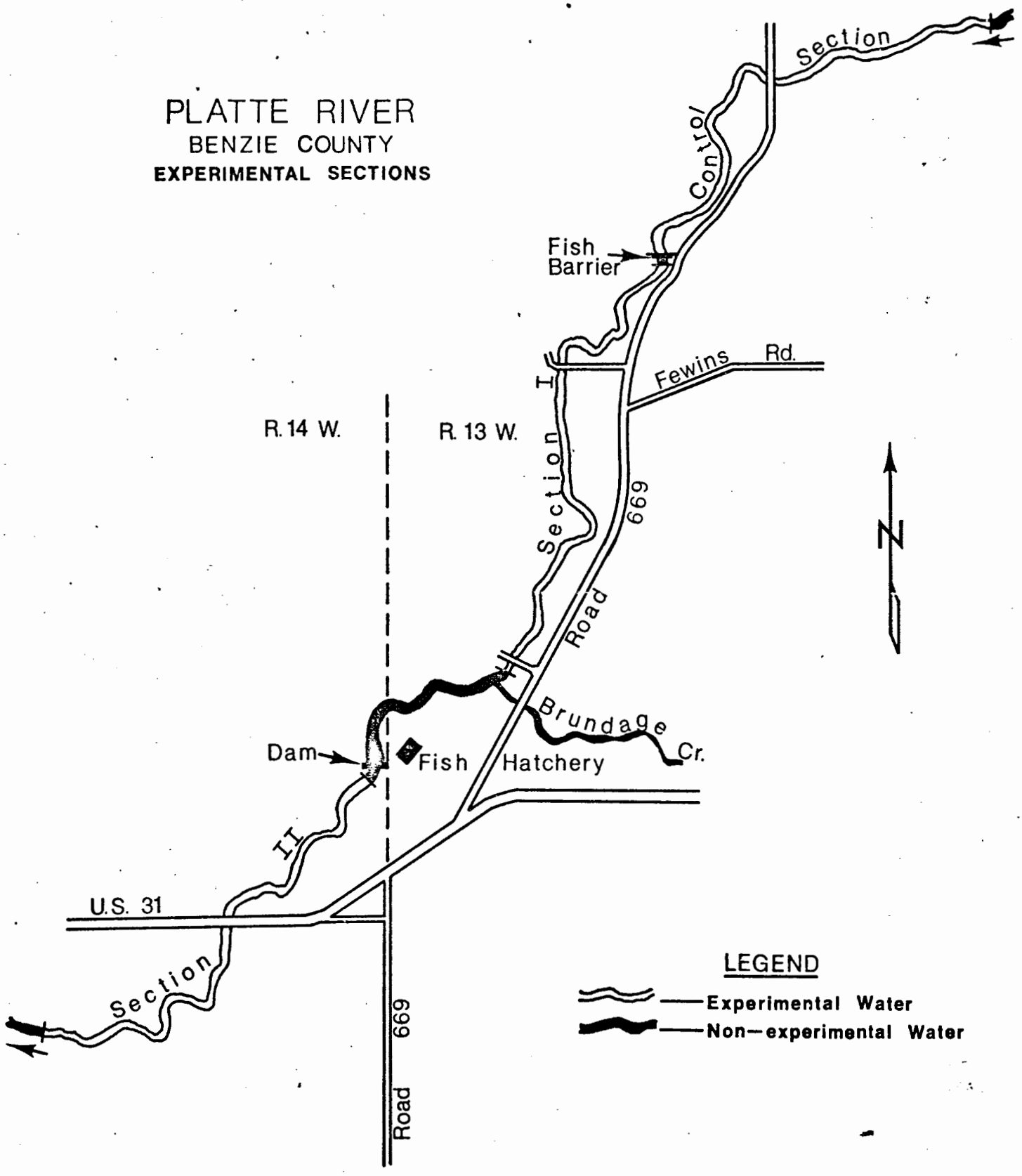


Figure 1.--Map of study area of Platte River.

A fish barrier (Figs. 2 and 3) was installed about 100 feet above Experimental Section I in October 1969, shortly before we released adult coho above the hatchery weir the first time. While the structure retained the salmon, it permitted passage of smaller fish. The basic design of this barrier was developed by T. R. Merrell, Jr.[3] A photograph of an early model appears on page 2 of Merrell's publication (1964). Wayne H. Tody, Chief of the Fisheries Division, saw and inspected this kind of structure in Alaska in 1968, and subsequently introduced its use on Michigan streams to control salmon migrations. As there evidently is no published description of these barriers, the one used in the experimental area of Platte River will be described here in some detail.

Robert C. Barber, construction foreman in the Fisheries Division, designed this model from one of the other barriers and assembled it. Its main difference lies in the structure that supports the pipes which are the barricading elements. The galvanized steel beams used in the supporting structure came from dismantled forest fire lookout towers. This structure consists of A-shaped frames made of (1) 2- by 2- by 3/16-inch sections of "L" beam stock (the sections joined one with another by welds), and (2) braces made of 3- by 3- by 1/4-inch "L" beam stock that are welded to the "A" frames. A functional barrier is formed by setting units of this structure end-to-end across a stream and fitting them with pipes (Fig. 3). Each unit contains three "A" frames, and is approximately 10 feet long, 6 feet wide at the base, and 4 1/2 feet high at the apex (Fig. 2).

In the case of the barrier used in the study of salmon-trout competition, the "A" frames were constructed in a shop, and the braces and pipes were cut to design size there also. All were transported to the stream by truck, where the framework units were assembled on the bank. The units were equipped with one brace on the downstream side, and two braces on the upstream side. One-inch holes were drilled through the latter two braces for insertion of the pipes, and were spaced to allow about 1 1/2 inches of clearance between adjacent pipes.

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[3] Personal communication from William M. Hartman, Investigation Chief, Biological Laboratory, U.S. Bureau of Sport Fisheries and Wildlife, Sandusky, Ohio.

Figure 2.--The fish barrier located above Experimental Section I, showing the downstream side.

Figure 3.--The fish barrier located above Experimental Section I, showing the upstream side.

After the framework units were assembled, they were carried into the stream and positioned. They were coupled on the upstream side with a 2- by 10- by 1/4-inch section of flat-stock steel through which four holes had been drilled to match the diameter and the spacing of the holes in the front-side braces of the frame units. One of these sections was positioned on top of each of the braces at the junction of adjoining units. Insertion of two pipes from the end of each of the units completed the union (observable by close inspection of the upper brace, Fig. 3). The coupling on the downstream side was a section of flat stock, which was bolted to the legs of adjoining units just above the brace (Fig. 2).

The sections of galvanized steel piping (7/8-inch diameter, 1/8-inch wall) that formed the barricade were about 7 1/2 feet long. They were driven 1 foot into the bottom of the river. Immediately after the pipes were installed the first time, 3/16-inch holes were drilled through the wall of each pipe, about 1 inch below the upper brace. Then a 1/8-inch woven wire cable was threaded through the openings, from one end of the barrier to the other, drawn taut, and firmly clamped at the ends. This arrangement prevented the pipes from turning, and it also insured against easy removal.

The river was about 60 feet wide at the location of the barrier and from 1 foot to 2 feet deep. The barrier served its purpose well, and was easily maintained. Very few of the introduced salmon passed through it. What escapement did occur resulted from greater than normal spread between pipes. This was caused by a pipe slanting off course when it struck a stone or some other obstruction as it was being driven into the bottom. Plugging the enlarged opening easily corrected the flaw.

Usually someone visited the barrier once or twice a day to brush debris off the pipes. Except at times of high stream flow or heavy leaf fall, such frequent cleaning would have been unnecessary. Frequent visits were desirable, however, to check on possible vandalism that could have allowed salmon to escape upstream. Fortunately, the barrier was never molested.

After the salmon had finished spawning, the pipes were removed from the framework and were stored until they were needed again the next fall. The framework remained in the river the year round until the barrier was no longer needed. Then the units were uncoupled and removed from the river, the braces were cut off the "A" frames, and all were stored for possible use in the future.

## Coho transfers

### Procedures

Various references were consulted to determine how many coho spawners would be needed to adequately populate Experimental Section I with young. Apparently 500 males and 500 females per mile of stream would produce a sufficient number of progeny (Salo and Bayliff, 1958). It was anticipated that some salmon would spawn in the upper 1, 100 feet of the 2, 100-foot stretch between the dam and the lower end of Section I, so this segment was included in calculating the total allotment of 1, 208 spawners. It was decided that the transfer would be segmented temporally because salmon could be of much better quality for spawning at some stages of the run than at others. Salmon were obtained by dip-netting them out of the fishway that leads from the river to the weir. These fish were removed within a few feet of the river. They were narcotized, in a bath of MS-222, in either a sheep-dip tank (1969) or a wooden box (1970, 1971) that held enough water to barely cover the salmon when they were in a natural position. Each fish was examined to determine the sex, and for presence of identifying marks and lamprey wounds or scars, and then it was measured and fin-clipped. The coho used were selected at random, except that 21 inches was the minimum length (one 20-inch fish was transferred) and injured fish were discarded, Fin-clipping permitted recognition of coho that entered the experimental area accidentally. It also provided a way to identify the salmon of different segmented releases.

The first several hundred salmon that were handled in 1969 were kept in a holding pen for a day; then they were removed and carried to the river with dip nets for release. The rest of the transferred fish were

released immediately after handling, by chuting them through a section of aluminum pipe into the weir passage to the river. This release was on the upstream side of the dam, and adjacent to the passage from which the salmon had been removed. The few salmon that did not survive this handling were replaced with substitutes.

The 1969 transfer

The release of 1,208 adults was apportioned as follows: 21-23 October, 204 males and 204 females (left pectoral fin clipped); 28-29 October, 200 of each sex (left pectoral clip); 4-5 November, 200 of each sex (adipose clip). Although many of the salmon went directly into Section I, a considerable number remained below it. Some of the latter dug redds in the river, others entered the short outlet channel of a fish-rearing pond, and still others went into Brundage Creek. A low-head dam with a screen on top prevented invasion of the pond, but coho persistently tried to surmount the barrier and destroyed several screens. Several pairs spawned in Brundage Creek between the mouth and a dam that was situated about 200 feet above the mouth. When planning the transfer, we had been concerned about the possibility that many salmon would try to move beyond Section I, which could result in a heavy concentration immediately below the introduced barrier. Although some concentration occurred here each fall, it never reached extreme size.

An escapement of salmon before transfer commenced in 1969 pointed up the desirability of marking them. Heavy rainfall one night around 14 October caused the grating on the lip of the dam at the weir to clog with debris. This resulted in flooding of the fish-retaining screen in the passage between the weir and the river on the upstream side of the dam, and some coho escaped upstream. As marked and unmarked salmon were tabulated separately when the carcasses were examined later on, use of the simple proportion formula provided an estimate of the number (104) that escaped.

The 1970 transfer

Before transfer commenced this fall, barriers were installed in the two inlets that salmon entered in 1969. This was done to improve reproduction in Section I, and to insure against loss of many coho if the other barriers in the inlets should fail. The new structures resembled the one between Section I and the Control Section, but were much smaller. The transfer was made in two stages, as follows: 20-21 October, 300 males and 300 females, left pectoral fin clipped; 27-28 October, 300 and 300, right pectoral fin clipped. Some of the salmon tried to invade the barricaded inlets. The barrier in Brundage Creek was completely effective, but the one in the pond outlet was not satisfactory. At the latter location, a stone substrate beneath a shallow layer of soil kept the pipes from penetrating the bottom to sufficient depth, which allowed salmon to pass between them. Also, the low banks of the channel occasionally permitted passage around the ends of the structure. Although coho continually tried to jump over the dam at the foot of the pond as in 1969, the only appreciable escapement into the pond happened during a rainy night when debris plugged the screen at the top of the dam and water flowed over the bank into the river. Salmon from the river swam through the overflow into the pond. These fish (about 60) were recovered by seining, and were discarded and replaced with substitutes.

The 1971 transfer

The release this fall was planned to be completed within one continuous period, rather than in a segmented plan. The revision was made with the hope that using fish only from the early part of the spawning run would improve reproduction. Since the old rearing ponds had been abandoned and filled with earth earlier in 1971, one potential route of escapement was now closed. The barrier employed in Brundage Creek in 1970 again blocked entry into this inlet. Transfer began on 13 October and proceeded daily to completion on the 16th. The coho were marked by fin-clipping.

The salmon in the 1971 spawning run behaved differently from those in the two preceding runs. These coho did not challenge the dam so

persistently as the others, and were more reluctant to enter the weir. The hatchery staff experienced difficulty in obtaining the desired quota of eggs. Incidence of early death (before spawning) among the transferred salmon was higher than it had been in 1969 and 1970. Other comments on the peculiar situation follow on page 17, below.

Length data from the salmon released in 1969, 1970, and 1971 appear in Table 1. Incidence of sea lamprey wounds and scars in the respective years amounted to 3.1, 1.4, and 2.2% of the releases. A representative number of the coho transferred in 1971 were weighed (Table 2).

## Observations on spawning by coho salmon

My observations were concerned with abundance and distribution of redds, with egg retention, and with other aspects of spawning. Two reports by a co-worker (Stauffer, 1970 and 1973) describe fecundity of Platte River coho, and also deal with egg retention.

### Redd counts

In each of the transfer years, salmon began to dig redds soon after release. Redds were counted periodically after the transfers had been completed. Also at these times, dead salmon that were found were examined. Quite surely a few redds escaped detection through concealment by cover. Some early redds were abandoned, and no doubt some others were unproductive.

Frequently several redds were grouped close together, but distribution in Experimental Section I was in general remarkably uniform. Table 3 shows the density and distribution here and in the two other contiguous segments of river available to the transferred salmon. Salmon dug more redds below Section I than had been anticipated. Possibly the rearing of these fish to smolt size in water from Brundage Creek significantly influenced many to remain in this area. Occurrence of the heaviest concentration of redds, in the upper 180 feet of Section I

Table 1.--Size distribution and mean length of coho salmon released above the upper Platte River weir in 1969-71

| Inch group | Number of males | | | Number of females | | |
|---|---|---|---|---|---|---|
| | 1969 | 1970 | 1971 | 1969 | 1970 | 1971 |
| 20 | 1 | ... | ... | ... | ... | ... |
| 21 | 2 | 4 | 4 | ... | 2 | 1 |
| 22 | 2 | 14 | 6 | ... | 4 | ... |
| 23 | 9 | 28 | 19 | 5 | 17 | 4 |
| 24 | 27 | 39 | 25 | 12 | 22 | 15 |
| 25 | 37 | 58 | 48 | 30 | 74 | 31 |
| 26 | 41 | 78 | 75 | 65 | 124 | 78 |
| 27 | 51 | 96 | 90 | 137 | 171 | 125 |
| 28 | 88 | 78 | 92 | 177 | 138 | 168 |
| 29 | 124 | 96 | 101 | 134 | 43 | 136 |
| 30 | 123 | 81 | 82 | 35 | 5 | 38 |
| 31 | 69 | 25 | 43 | 9 | ... | 4 |
| 32 | 22 | 3 | 14 | ... | ... | ... |
| 33 | 8 | ... | 1 | ... | ... | ... |
| Total number | 604 | 600 | 600 | 604 | 600 | 600 |
| Mean length | 28.4 | 27.2 | 27.7 | 27.7 | 26.7 | 27.6 |

Table 2. --Weight of coho salmon in a sample from among salmon released above the upper Platte River weir in October 1971

| Inch group | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | Number weighed | Mean weight (pounds-ounces) | | Number weighed | Mean weight (pounds-ounces) | |
| 22 | 2 | 3 | 13 | - | -- | -- |
| 23 | 4 | 4 | 4 | 1 | 4 | 3 |
| 24 | 8 | 5 | 3 | 2 | 5 | 6 |
| 25 | 2 | 5 | 14 | 5 | 6 | 4 |
| 26 | 8 | 6 | 6 | 9 | 6 | 15 |
| 27 | 4 | 7 | 3 | 5 | 8 | 5 |
| 28 | 8 | 8 | 4 | 8 | 8 | 12 |
| 29 | 6 | 8 | 13 | 12 | 9 | 10 |
| 30 | 5 | 10 | 4 | 5 | 10 | 12 |
| 31 | 3 | 11 | 15 | - | -- | -- |
| 32 | 2 | 12 | 7 | - | -- | -- |
| 33 | 1 | 12 | 7 | - | -- | -- |
| Total number and mean weight | 53 | 7 | 5 | 47 | 8 | 4 |

Table 3.--Number of coho salmon redds per 300 lineal feet of stream in three stretches of the 7480-foot portion of Platte River that received introduced adults

For the backwater, the stretch from backwater to lower end of Section I, and the uppermost segment from 5100 feet to the barrier, the numbers of redds are by computation; for the 300-foot segments of Section I, the numbers of redds are actual counts.

| Stretch (length in feet)* | Redds per 300 feet | | | Mean number |
|---|---|---|---|---|
| | 1969 | 1970 | 1971 | |
| Backwater of dam (900) | 2 | 7 | 1 | 3 |
| Between backwater and Section I (1200) | 10 | 16 | 9 | 12 |
| Section I + 100 feet (5380) | | | | |
| 0-300 | 12 | 10 | 9 | 10 |
| 300-600 | 11 | 10 | 6 | 9 |
| 600-900 | 15 | 11 | 7 | 11 |
| 900-1200 | 21 | 17 | 16 | 18 |
| 1200-1500 | 21 | 16 | 9 | 15 |
| 1500-1800 | 14 | 10 | 8 | 11 |
| 1800-2100 | 13 | 7 | 7 | 9 |
| 2100-2400 | 19 | 18 | 16 | 20 |
| 2400-2700 | 21 | 22 | 16 | 20 |
| 2700-3000 | 16 | 18 | 20 | 18 |
| 3000-3300 | 11 | 20 | 14 | 15 |
| 3300-3600 | 12 | 16 | 13 | 14 |
| 3600-3900 | 6 | 2 | 2 | 3 |
| 3900-4200 | 7 | 10 | 11 | 9 |
| 4200-4500 | 11 | 15 | 14 | 13 |
| 4500-4800 | 17 | 11 | 16 | 15 |
| 4800-5100 | 18 | 17 | 20 | 15 |
| 5100-barrier | 22 | 21 | 30 | 24 |

* Stream width averaged approximately 100 feet in the backwater, and 44 feet in the other two stretches.

plus the 100 feet between the upstream end of Section I and the barrier, probably was influenced by the presence of the barrier.

In 1969, redd excavation had ceased in the upper river by 18 November, when salmon still frequented only a few redds; this was 28 days after the first release of spawners, and 12 days after the last. On 25 November I counted 56 live salmon in Section I.

Similarly in 1970, redd excavation ended early, apparently by 19 November. In the course of the last redd count, during 30 November to 2 December, I saw 18 live salmon.

Spawning in 1971 had virtually ceased by 2 November. I tallied 58 surviving salmon in Section I on 6 November, and 2 days later saw 11 salmon in the 2,100-foot stretch below this section. No live salmon were seen during the last redd count, on 2-4 November, nor when carcasses in both areas were examined on 14 December.

Coho salmon were so numerous below the upper weir (at the hatchery) the first four spawning seasons (1967-70) following the initial introduction that redds could not be counted in Experimental Section II. Activity by thousands of these large fish cleared sand off vast areas of underlying gravel. The activity also either exposed what may have been old current-formed depressions, or it formed new depressions, some of which resembled redds. An estimate which I made here on 24 October 1968 should aid comprehension of salmon abundance in the autumns of 1967-70. I started at the upstream end of Section II and roughly counted fish from bank by groups. I conservatively estimated 6,100 three-year-old coho in the mile distance, of which 1,200 were in the first 300 feet, where the stream averaged 48 feet wide.

## Egg retention

I looked for dead salmon whenever redds were counted, and also after redd counting had been concluded. This was done between the weir dam and the fish barrier above Section I. The carcasses were examined to determine the origin of the fish (whether from introduction or from escapement, and from which segment of transfer) and to determine the

sex; females were inspected further to assess egg retention. Stauffer (1970, 1973) evaluated egg retention in his study of fecundity in coho of the 1969 and 1970 runs. Most of the Platte River salmon he examined were transferred fish. While my procedures were less refined than Stauffer's, the two sets of data on egg retention allow at least a gross comparison.

I used the following categories of egg expenditure when evaluating retention in dead coho I examined on the stream: spent (< 50 eggs retained); nearly spent (50-200 eggs retained); partly spent (> 200 eggs but < full complement); and unspawned (apparently full complement). To estimate percentage of retention, I used the mid-point egg number for each assessment category of less than full complement, and an average of 3,000 for full complement (Stauffer, 1973). A possible source of error was the classification of nearly spent fish in 1969 as partly spent fish. To calculate retention that occurred in 1969, I had to estimate the number of nearly spent salmon from the 1970 data.

My estimates of percentage of egg retention were 44 (1969), 51 (1970), and 67 (1971). In comparison, Stauffer's (1973) results were 34 ± 19% (1969, 18 salmon) and 39 ± 8% (1970, 70 salmon). Although my estimate for 1969 was higher, it fell within the 95% confidence limit of his estimate; but in the 1970 estimates, my figure exceeded the upper level of the 95% confidence limit of his figure. While my estimates are fairly close, there is a suggestion that they err toward over-estimation. Table 4 shows how total retention was distributed among the various degrees of egg expenditure.

Egg retention apparently seldom occurs among the Pacific species of salmon in their native West Coast streams. Shapovalov and Taft (1954) found very little of it in California coho they studied, and they cite investigators who reported similar findings from chinook (Oncorhynchus tshawytscha) and sockeye (O. nerka) salmon in other regions. Merrell (1964) examined 367 dead female Alaskan sockeye on spawning grounds and found only 20 that were either unspawned (90% or more of eggs remaining) or partly spawned (between 25 eggs and 90% of full complement). McNeil (1962)

Table 4.--Number and percentage of female coho salmon in different categories of egg expenditure, based on carcasses from Section I of Platte River, 1969-1971

| Category of egg expenditure | 1969 | | 1970 | | 1971 | |
|---|---|---|---|---|---|---|
| | Number | Percent | Number | Percent | Number | Percent |
| Spent | 93 | 34 | 42 | 22 | 17 | 7 |
| Nearly spent | -- | -- | 24 | 13 | 16 | 7 |
| Partly spent | 92 | 34 | 51 | 27 | 65 | 28 |
| Unspawned | 89 | 32 | 71 | 38 | 137 | 58 |
| Total number | 274 | -- | 188 | -- | 235 | -- |

recorded less than 1% retention among pink salmon (O. gorbuscha) in three streams in each of 3 years. Reported instances of extensive retention apparently have mostly been isolated occurrences (Anon., 1951; McNeil, 1962).

Because egg retention, in coho that have come into Platte River to spawn, has been persistent and abnormally high, the subject has special interest. It seems likely that handling influenced some retention, and especially in transferred fish that died soon after release. That this is not the sole cause of the abnormality in coho of the Great Lakes region is illustrated by these items of evidence: (1) Egg retention in 15 carcasses of unhandled coho examined in Experimental Section II on 12 December 1967 was grossly estimated at 41%.[4] (2) When checking the carcasses of other unhandled coho in this area and downstream in succeeding years, I invariably saw unspawned and partly spent females. (3) Stauffer (1973) found no statistically significant difference in retention between unhandled females picked up several miles below the upper weir, and in handled females from the river above the weir. (4) Egg retention in unhandled coho examined in 1970 on the Anna River (a tributary of Lake Superior) amounted to 12% (Stauffer, 1973).

High density of spawners has been cited as a possible cause of egg retention in salmon (McNeil, 1962). There are no data for determining whether this situation bore some responsibility in Platte River, but high abundance of coho for several miles below the upper weir can be suspected of contributing to high egg retention in that area. There may be other possible causes besides handling and high density.

Whatever the principal cause of the abnormality may be, one may wonder if it has also influenced mortality of those eggs which are deposited, and of fry. Developments that especially suggest such relationship are those that occurred during and soon after the 1971 spawning period on Platte River. The peculiar behavior of the salmon in that year's run was mentioned previously (page 10) which was followed by the greatest

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[4] Letter from G. P. Cooper to C. M. Taube, 13 December 1967.

amount of egg retention (an estimated 67%) recorded in the 3 years of observation on transferred coho. Extensive mortality of eggs in the Platte River Hatchery (56% to eye-up), and later among fry (40%), were other poor results (Westers, 1972). While egg retention and loss of eggs and fry in hatcheries could stem from independent causes, it is also possible that this is not the situation. Although results at the Platte River Hatchery, from spawn obtained in 1972, improved over those from the 1971 collection (eye-up averaged 53% in 1972; Westers, 1973), they still were short of expectations.

Redd examinations

Redds both in and out of the experimental sections were sampled for eggs. This was done with either a shovel or a jet stream of water propelled by a motor-driven pump. Examinations were made in November 1967, February 1968, November and December 1969, and December 1970.

We found sizable numbers of eggs in only a few redds. Dead ova usually outnumbered viable ova. In a number of redds we found no eggs whatever. This was, of course, not certain proof of absence; but high incidence of egg retention in the salmon, and the scarcity of young afterwards in various areas, also lead to the belief that some redds were completely unproductive.

Coho redds usually were large. Field notes were made of measurements on two unusual redds. One was 8 feet long, 1 1/2 feet wide at the upstream end, and 2 feet wide at the lower end. Although larger than average, it was not exceptionally so. The size of the second measured redd was extraordinary: length from the head end to the end of the gravel tailings was 44 feet, and the maximum width was 12 feet.

## Trout transfers

Trout, upstream bound, were transferred above the Platte River weir by management biologists in 1967 and 1968, and by research biologists in 1969 to 1971. Trout encountered while salmon were being transferred

for the competition study were released immediately after various information had been obtained. When hatchery workers collected salmon spawn or handled coho for other purposes, they put the trout they found into a holding pen. We periodically examined and released these fish.

In the fall of 1966 and into February 1967, a temporary weir that was provided to capture precocious ("jack") coho salmon from the planting made in Platte River in March 1966, also captured trout. The components of this weir system were: (1) a fish barrier, constructed of wood, that spanned the river opposite the lowermost pond of the fish rearing station; (2) a portable fish trap, made of lumber and screen, that set in an outlet channel of the pond; (3) a low-gradient fish ladder that extended from the river (a few feet below the barrier) to the trap.[5]

The present weir system, which is situated within 1,000 feet below the location of the temporary weir, began operating in October 1967.

Transfers made in 1966-1971

All but a few of the weir-caught rainbow trout were adults from Lake Michigan; most were wild fish, some were of hatchery origin. Catches were similar during 1967-1971; the catch taken in 1966 was smaller than the catches in 1967-1971 (Tables 5 and 6). Average length, which ranged from 22 to 23 inches, was remarkably consistent, as was weight (Table 6).

Brown trout which were caught in the weir were mostly spawning migrants from the lower river, but included a few fish from Lake Michigan. About half as many were taken in 1969 and 1970 as were taken in 1967, 1968, and 1971 (Table 5). Average length in 1969-71 ranged from 15 to 17 inches, and average weight was 1 1/2 to 2 pounds (Table 7).

The appearance in the Platte River weir of rainbow trout that had been planted in Wisconsin waters was an interesting event because of the long distance these fish had traveled. The numbers of them handled here in 1969-71 were as follows:

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[5] A photograph of the barrier and ladder, and of the trap location, appears on page 11 of a report assembled by Borgeson and Tody, 1967.

Table 5.--Rainbow and brown trout caught in weirs in the upper part of Platte River, 1966-1971

| Weir operation* | | Source of data | Trout catch | |
|---|---|---|---|---|
| Year | Inclusive months | | Rainbow | Brown |
| 1966 | September-December | Reynolds, 1966 | 149 | 75 |
| 1967 | "early weeks" | Coopes, 1968 | 211** | --- |
| 1967-1968 | October - 8 February | Coopes, 1968 | 327 | 109 |
| 1968 | October-December | Bullen, 1969 | 247 | 109 |
| 1969 | October-December | This study | 298 | 51 |
| 1970 | October-December | This study | 324 | 49 |
| 1971 | October-November | This study | 220 | 105 |

* The temporary weir, described in the text, was operated in the fall of 1966 and "early weeks" of 1967; the permanent weir, presently used in the upper part of the river, began functioning in October 1967.

** This total includes the number caught through December 1966.

Table 6.--Number, length, and weight of rainbow trout handled at the upper Platte River weir during the fall, 1969-1971

| Year | Total number | | | |
|---|---|---|---|---|
| | Handled | Put above dam | Measured and weighed | Lamprey-scarred |
| 1969 | 298 | 290 | 285 | 11 |
| 1970 | 324 | 311 | 308 | 8 |
| 1971 | 220 | 211 | 162 | 5 |

| Year | Total length (inches) | | | Weight (pounds-ounces) | | |
|---|---|---|---|---|---|---|
| | Range | Mean | Median | Minimum | Maximum | Mean |
| 1969 | 9.1-32.6 | 22.1 | 23.2 | 0.6 | 14-9 | 4-14 |
| 1970 | 11.5-32.3 | 22.9 | 23.9 | 0.9 | 12-12 | 5-3 |
| 1971 | 10.5-33.2 | 23.0 | 23.7 | 0.7 | 14-2 | 5-6 |

Table 7.--Number, length, and weight of brown trout handled at the upper Platte River weir during the fall, 1969-1971

| Year | Total number | | | |
|---|---|---|---|---|
| | Handled | Put above dam | Measured and weighed | Lamprey-scarred |
| 1969 | 51 | 50 | 36 | 0 |
| 1970 | 49 | 40 | 42 | 2 |
| 1971 | 105 | 98 | 61 | 0 |

| Year | Total length (inches) | | | Weight (pounds-ounces) | | |
|---|---|---|---|---|---|---|
| | Range | Mean | Median | Minimum | Maximum | Mean |
| 1969 | 9.5-24.2 | 16.6 | 15.1 | 0.6 | 6-15 | 2-5 |
| 1970 | 11.0-24.5 | 15.0 | 13.6 | 0.8 | 6-4 | 1-8 |
| 1971 | 10.0-24.0 | 14.7 | 13.6 | 0.7 | 5-14 | 1-7 |

| Year | Left-maxillary clip | Right-maxillary clip |
|---|---|---|
| 1969 | 27 | 9 |
| 1970 | 17 | 12 |
| 1971 | 5 | 5 |

The Wisconsin Department of Natural Resources had planted maxillary-clipped rainbow trout at various locations in Lake Michigan.[6] Plantings made in 1967 and 1968 were:

1967

35,160 fingerlings, 9-inch avg., left-maxillary clip
1,200 yearlings, 10-inch avg., left-maxillary clip
15,000 fingerlings, 7-9 inches, right-maxillary clip
38,760 yearlings, 7-9 inches, right-maxillary clip

1968

10,010 fingerlings, 9-inch avg., left-maxillary clip
75,315 yearlings, 9-10 inch, right-maxillary clip

Rainbow trout have traveled westward across Lake Michigan as well as eastward. Of tagged rainbows that were planted in five Michigan streams in 1929, four were reported caught off the Wisconsin shore (Metzelaar, 1929).

## Observations on spawning of rainbow trout

We counted rainbow trout redds in the experimental sections from 1968 to 1972 (Table 8). The final counts in 1969 and 1970 probably were close to the actual totals in these areas. The single count in 1968 was minimal, because the spawning season was in its early stage at this time, and 40 females had been removed from the river for stripping on April 10. The 1971 tally also was minimal, for unspawned fish were encountered in the river 1 week following the count. In 1972, when April was unusually

[6] Information reported to me in a letter from R. J. Poff of Wisconsin DNR.

Table 8.--Rainbow trout redds counted in three 1-mile experimental sections of Platte River in 1968-1972

| Year, and dates | Number of redds, by section | | |
|---|---|---|---|
| | Control | I | II* |
| 1968 | | | |
| 10, 11 April | 42 | 56 | 38 |
| 1969 | | | |
| 7 April | 14 | 18 | 4 |
| 19 April | 70 | 65 | 30 |
| 1970 | | | |
| 13 April | 37 | 23 | 19 |
| 28 April | 85 | 103 | 91 |
| 1971 | | | |
| 21 April | 53 | 65 | 59 |
| 1972 | | | |
| 17, 18, 19 April | 69 | 83 | 47 |

* The counts in Section II covered only the upper 2,100 feet of the section.

cold, probably most of the counted redds had been dug by fall-run rainbows, as apparently few spring-run fish had entered the stream by that time.

Both redds and spawning habits of rainbow trout and coho salmon are quite similar in several respects. Shapovalov and Taft (1954) commented on the similarity, from their observations on a California stream. In Platte River, one of these species commonly chose areas for spawning that the other had used in its spawning season. Redds dug by the larger rainbow trout were as large as the average coho redd. Small males of both species frequently tried to spawn with a female that was also attended by a male about her size.

During 1968-71, several rainbow trout redds were seen in the river in late fall. A few of the rainbows handled at the upper weir in the fall season were sexually "ripe." Special records were kept of such fish in the 1971 transfer. The results, by date and for rainbows at least 12 inches long, were as follows:

16 October: no ripe fish seen among 26 handled;
9 November: 9 ripe males and no ripe females among 101 fish;
23 November: 6 ripe males and 2 ripe females among 55 fish.

We attempted to determine the sex of the 156 rainbows handled on 9 and 23 November. A determination could not be made on about 10% of them, but the sex ratio of the remainder was approximately 1:1.

## Observations on spawning of brown trout

Brown trout redds were counted in the Platte River experimental sections each fall from 1967 to 1971, as conditions permitted. Reliable counts could not be made where salmon were abundant. Therefore no tallies were made in Section II, nor in Section I after adult coho were introduced there. Whereas these redd counts are of little use in the present study, they are included for possible future reference. It was difficult to differentiate true redds from other depressions, a fact

demonstrated by excavating various "redds" on 20 October 1968. During this examination it was found that two features distinguished active redds from other depressions, namely, the strong predominance of gravel over sand in the pocket of the redd, and the polished appearance of this gravel.

The density of brown trout redds was low. On 20-21 November 1968, incidence of redds was 1 per 300 feet of stream in Section I, and 2 per 300 feet in the Control Section. Incidence of redds in the Control Section during the spawning seasons of 1969, 1970, and 1971 ranged from 1 to 1 1/2 per 300 feet of stream.

Brown trout generally used spawning sites other than those chosen by rainbow trout and coho salmon. Brown trout redds were commonly located near cover or a bank of the stream, whereas rainbow and coho redds usually were in more exposed locations. Areas at the edge of log cover were especially favored by brown trout; possibly some redds were hidden under log jams. Colonial nesting rarely occurred among brown trout, but did occur commonly among rainbows and coho.

Most brown trout redds were much smaller than the redds of rainbow trout and coho. Perhaps this characteristic was determined almost solely by the smaller size of the brown trout. Brown trout were seldom seen on or near redds, unlike salmon and rainbow trout.

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