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Partial Rehabilitation of a section of The Clark Fork River

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MONTANA FISH AND GAME DEPARTMENT
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PARTIAL REHABILITATION OF A SECTION OF THE CLARK FORK RIVER

by John J. Gaffney
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The Federal Power Commission approved an application by the Washington Water Power Company for permission to construct a dam and hydro electric plant on the Clark Fork River near Noxon, Montana. The reservoir created by this dam would inundate that section of the Clark Fork River between the headwaters of Cabinet Gorge Reservoir and the tailwaters of the Thompson Falls hydro-electric plant (Figure 1). A pre-impoundment survey was conducted in 1955 to obtain information regarding the existing fish population and to determine probable biological conditions to be expected in the Noxon Rapids Reservoir. The survey was conducted by the Montana Fish and Game Department and was financed by the Washington Water Power Company.

The survey indicated that the river supported a population of rough fish that would be a major limiting factor in any attempt to provide a trout fishery in the new reservoir. Natural reproduction by these species during initial years of impoundment would very likely saturate the reservoir with undesirable fish before a trout population could be established with hatchery fish. With this in mind, a cooperative agreement was drawn up between the Montana Fish and Game Department and the Washington Water Power company whereby these two agencies would share the cost of a long term study of the ecology of this and adjoining reservoirs. The first objective of this project was to introduce a fishicide in an attempt to reduce rough fish numbers below the level where they could bring off big year classes in the Noxon Rapids Reservoir, during the first years of impoundment. It would be desirable to completely eliminate the rough fish from the entire drainage. However, these fish are generally distributed throughout the Clark Fork and Flathead drainages and chemical rehabilitation on this scale cannot be considered at this time. Very little information was available regarding chemical treatment under the conditions to be encountered. Therefore, the phase of the study covered by this report was undertaken as an experiment to determine the value of partial rehabilitation in managing run-of-the-river reservoirs for recreational fishing.

Common names of fish used in this paper are those adopted by Weisel.

METHODS AND MATERIALS

Completion of the Noxon Rapids plant was scheduled for the winter of 1958-1959. Therefore, it was possible that rough fish could move upstream through the sluices during the interval between treatment of the river and closure of the dam. On February 5, 1958, velocities were determined in these sluices by representatives of the Washington Water Power Company. Velocities at the discharge end of the sluices ranged from 6.08 feet per second to 8.29 feet per second. The sluices were 119.6 feet long. These were assumed to be near minimum velocities that would

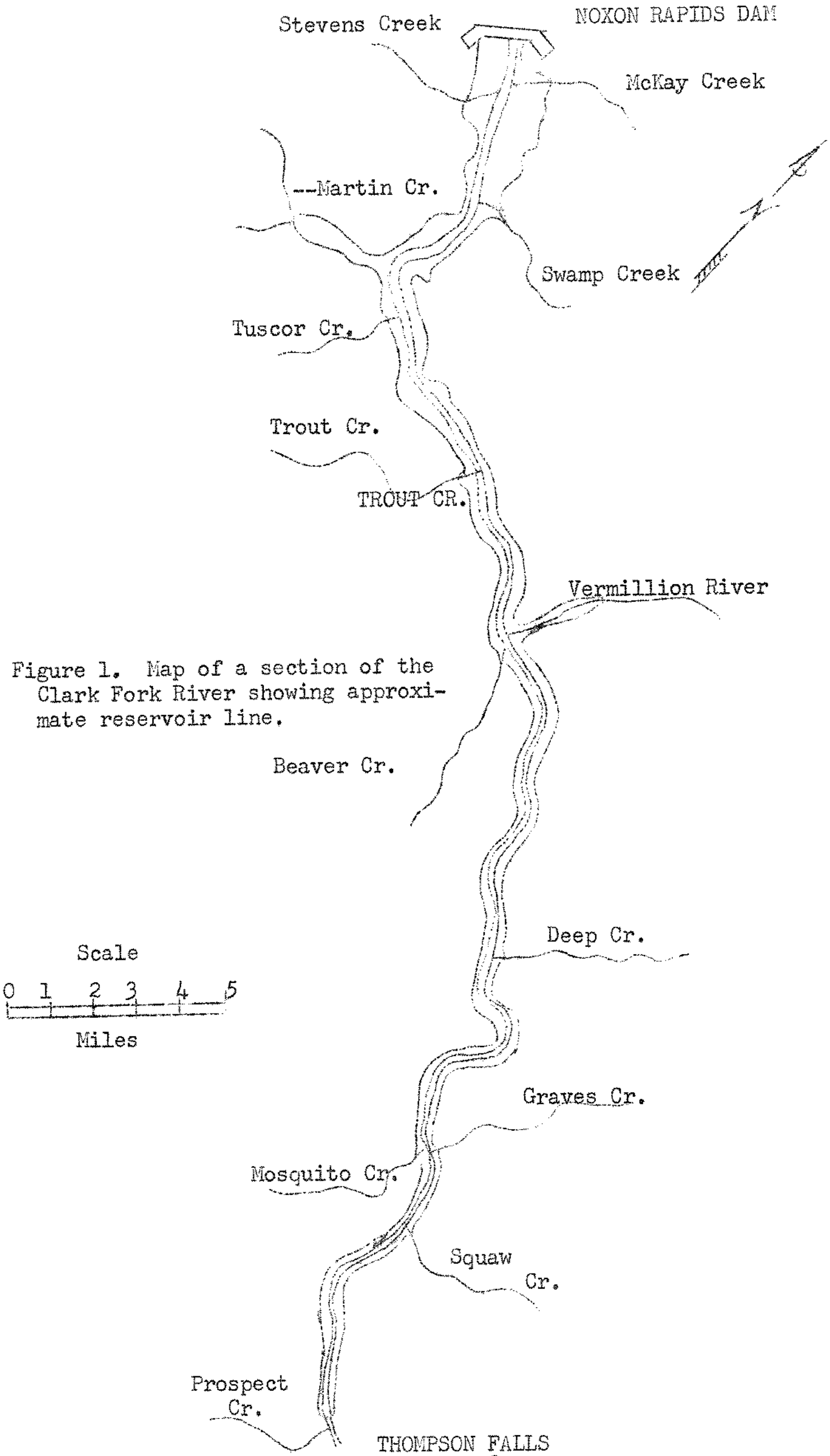

Figure 1. Map of a section of the Clark Fork River showing approximate reservoir line.

occur during the fall and winter seasons.

Arrangements were made by the Washington Water Power Company to test the swimming ability of the major rough species concerned at the University of Washington Fisheries Laboratory in Seattle. Mature northern squawfish were collected on hook and line from Hubbart Reservoir. Peamouth chubs and longnose suckers on spawning runs from Little Bitterroot Lake were collected in a weir-type trap. It would have been desirable to collect the test fish from Cabinet Gorge Reservoir but the available gear did not capture enough fish for the experiments.

The fish were collected between May 20 and May 23, 1958. They were held at the Somers hatchery until May 27, when they were transported to the laboratory in Seattle. The fish were in excellent condition upon arrival in Seattle and were assumed to be representative of fish below the Noxon Rapids plant.

Methods and results of the tests are described by Clancy (1958). None of the individuals tested could swim 120 feet against a velocity of 6 feet per second. Only two chubs and two squawfish were able to swim that distance at a flow of 4 feet per second. Therefore, it seemed unlikely that rough fish would move upstream through the Noxon Rapids plant during the fall of 1958. Several factors such as water temperature, degree of maturity and the effect of transportation may have affected the swimming ability of the experimental fish. However, these variables could not be eliminated under the conditions of the experiment.

It was known that the section of the river to be chemically treated contained some deep holes, but detailed information regarding bottom contours was not available. After high water in 1958, a series of soundings were made in the river between Thompson Falls and the Noxon plant. These soundings indicated that pool areas were more extensive than previously estimated. Consequently, seasonal flow volumes were of little value in calculating the amount of chemical needed. A longitudinal profile based on these soundings showed that the 38 miles of river were roughly equivalent to 18 pools ranging up to 75 feet in depth with depths of 30 - 50 feet being common. These pools were connected by riffles varying from 0.1 to over 2 miles in length. These areas were also irregular in depth. The total calculated volume of these pools was about 5500 acre feet. This is a maximum figure since some widths were estimated and these estimates were large enough to allow some safety factor.

The amount of fishicide provided for in the original agreement was not adequate to give assurance of a good kill in this volume of water. A cooperative plan was then drawn up between the Montana Power Company, the Washington Water Power Company and the Montana Fish and Game Department, whereby the Montana Power Company would regulate their plants at Kerr Dam and Thompson Falls in such a way that flow would be at a minimum during the treatment. Thompson Reservoir would be pulled to its lowest level by 1:00 P.M. on August 31, at which time treatment would begin. At the same time, the Thompson Falls plant would be shut down to prevent flushing away of the toxicant. This plant would remain shut down until about 7:00 P.M. on September 1 to allow treatment of the river at minimum flow on Labor Day. It was estimated that leakage through the dam and power plant would be about 200 c.f.s.

Fish-Tox (sold by Standard Supply Distributors, Wenatchee, Washington) was selected for this project because, being in powder form, it was more easily carried to areas of limited access in the canyon. Barry and Larkin (1954) tested this product on several small streams of less than 100 c.f.s. They suggested that in small, fast flowing streams, applications of 5 p.p.m. be made at 1 mile intervals. These authors also felt that even this application rate may not effect a complete kill on the more resistant species. Economics placed a limit on the amount of chemical to be used since reinfestation will occur, in time, from upstream. It was decided that optimum use of available funds would be made if a concentration of about 1.25 p.p.m. were applied at 1/4 mile intervals. This was based on the assumption that a shorter distance between application points would minimize dilution and that each application would, to some extent, be bolstered by toxicant being carried down from upstream stations.

The physical characteristics of the riffle areas at low flow was not known, but it was conceivable that large boulders would impede boat travel through these areas. Therefore, a helicopter was employed to spray Chem-Fish Special (sold by Chemical Insecticide Corporation, Metuchen, N. J.) on these areas. Provisions were made for six crews, equipped with boats and outboard motors, to apply the Fish Tox. A schedule was prepared whereby each crew would treat a given area, load their gear and proceed to a second assigned area downstream. The assigned areas varied in length and volumes depending upon available access points. Flow patterns in the pools were not known so a crew was assigned to dynamite weighted sacks of Fish-Tox in the deeper holes to assure proper distribution of the chemical. Arrangements were also made for a four-man biological crew and two skin divers to be on hand to make collections and observations.

Thompson Falls reservoir, which was treated to form a buffer zone, was scheduled for about 1 ppm to be applied at intervals of about 1.5 miles.

The Fish Tox for the river was distributed at one-quarter mile intervals along the pool areas prior to the day of treatment. The chemical for Thompson Falls Reservoir was also placed at strategic points prior to August 31. The total amount of material used in the project is shown in Table 1.

Table 1. Fishicide used in Noxon Rapids Rehabilitation Project.

Thompson Falls Reservoir:	
Fish Tox	11,920 pounds
Pro-Nox Fish	220 gallons
Clark Fork River:	
Fish-Tox	17,720 pounds
Chem-Fish Spec.	220 gallons

APPLICATION OF FISHICIDE

The treatment began on August 31. The full effect of the shut-down at Kerr Dam was not apparent in Thompson Falls Reservoir by early afternoon so treatment was delayed until 3:00 P.M. Application in the river began below the Thompson Falls plant at 5:30 A.M. on September 1. The crews started at 20 minute intervals in the first six sections which covered 21 miles of the river. The remaining sections were not treated in sequence because of unequal work loads in the various sections. Progressive treatment through the entire 38 miles would have been desirable but was not possible because of limited access and limited time available for completing the project. Six crews, working simultaneously, required about 13 hours to complete the application.

The Chem Fish Special was applied from the helicopter on each riffle area at about the time that the boat crew approached the upstream end of the riffle. A truck followed the helicopter downstream to provide chemical when needed. Benchlands above the river channel provided numerous landing areas for the helicopter.

Flow data: The river flow was measured below the Thompson Falls plant by representatives of the U. S. Geological Survey and the Washington Water Power Company between 7:30 A.M. and 9:05 A.M. At that time, the river was carrying 765 c.f.s. Additional turbine gates were then closed at the Thompson Falls plant and by 2:00 P.M. the flow was down to 498 c.f.s. A discharge measurement made at a temporary gaging station near Noxon at 6:00 P.M. on September 1 showed 1600 c.f.s. Data from this station indicated that the average inflow from streams and underground springs in the treated area was about 350 c.f.s. over the Labor Day weekend. Therefore, the 1600 cubic foot discharge at Noxon could be allocated as follows: 498 c.f.s. through the Thompson Falls plant, 350 c.f.s. inflow from tributaries and ground water, and the remaining 752 c.f.s. from bank drainage. The water level dropped .03 of a foot during the 50 minutes of observation and it is evident that the flow continued to decrease at this station until late afternoon of September 2. At that time a rising stage occurred due to water released at Thompson Falls plant. No estimate of bank drainage was available prior to the treatment but it was not expected to be this high.

ANALYSIS OF KILL

The skin divers encountered very poor visibility under water and therefore could make no quantitative evaluation of the kill. However, they did observe large numbers of unidentified fish on the bottom of the reservoir and also on boulders and rock ledges in the river. The river-stations used by the divers were 60-65 feet deep. Therefore, the fish that sank would soon reach a depth where they could not be seen by the divers. No live fish were observed by either diver except for distressed fish swimming on the surface. The divers found very little current in the deeper holes. Neither air bubbles from the diving apparatus, nor stirred bottom materials, showed any appreciable drift. There was no noticeable change in temperature between the surface and the 50-60 foot level, indicating little or no thermal stratification.

Although no counts were made, the largescale sucker, mountain whitefish and redside shiner were the most abundant fish observed along shorelines in the reservoir and also in the river proper. Very few trout were seen and those that did come to the surface were soon picked up by observers along shore or in boats. Northern squawfish were less abundant than suckers among those fish that drifted into the river banks but they outnumbered suckers in the 1955 gill-net sets by about 2 to 1. Barry and Larkin (1954), dealing with the same species as were present in the Clark Fork River, found that squawfish were less resistant to rotenone than were the suckers. Pintler and Johnson (1958) also reported that suckers were more difficult to kill than was the Sacramento squawfish. Therefore, it is probable that a good kill of squawfish was accomplished even though they were not abundant along shoreline.

General observations indicated that whitefish and shiners were affected sooner than the suckers were, although it could not always be determined when the fish in a given area were exposed to the chemical. Some of the distressed or dead fish were carried by the current and drifted into shore some distance from where they were actually affected by the rotenone. Dead and dying fish were observed from the helicopter as much as 3/4 mile ahead of the crews, but this does not necessarily indicate killing distance.

Dead fish were observed for a distance of 5 miles below the Thompson Falls dam at daylight on September 1. These fish were probably killed by treated water passing through the plant, although some may have drifted through the plant after being killed in the reservoir.

A long riffle area located about 1 1/2 miles above the Noxon Rapids Dam was sprayed about 4:00 P.M. Fish began showing distress in about one half hour and they were noticeably more numerous in this area than in other sections of the river. It is possible that fish had more tendency to sink in the pool areas but this would not explain the greater abundance of dead fish here as compared to other riffle areas. Fish may have been moving downstream ahead of the rotenone although there is no supporting evidence.

Toxicity in Cabinet Gorge Reservoir:

Test cages were placed in Cabinet Gorge reservoir on September 2 to determine the toxicity of water spilling through the Noxon Rapids plant. These cages were placed at 4 stations located 1 to 6 miles below the dam. Each station consisted of one cage on the bottom and one on the surface. Depths ranged from 4 to 24 feet. Fingerling and catchable-sized hatchery rainbow trout were used as test fish. On September 6, live fish were still present at 3 of the stations and the test fish had escaped from the fourth set of cages. Some trout died at each station but it appeared that handling or other mechanical injuries had caused their death. Surface temperatures ranged from 60 to 63 degrees F. during this period of observation. Three stations were removed on September 6 but the 4th was left in place until September 25. The test fish were still alive at that time. One live-car was placed in the Clark Fork River below Cabinet Gorge dam on September 4. Fingerling rainbow trout were used as test fish and they were still alive and active 5 days later when the cage was removed.

Some dead fish were observed in the upstream portion of Cabinet Gorge during the period of Sept. 2 - 6. Observations were limited to the surface and the shallow areas because of turbid water. These fish were not counted but their abundance did not indicate a heavy kill in the reservoir. It is possible that some of these fish were killed upstream and drifted through the Noxon Rapids plant. A few large suckers were observed showing distress during this period. They may have represented delayed mortality or they could have been individuals recovering from sub-lethal amounts of rotenone.

Water released through the Thompson Falls plant totaled 86,600 acre-feet by noon on September 7. This represents a turnover of about 84% of total storage in Cabinet Gorge.

Population sampling:

A limited amount of sampling with dynamite and gill nets was carried out during September and October. Six sites in the river were sampled by the percussion method but no fish were observed. This sampling method has definite limitation in a large river but most of the sites were in areas where dynamiting had killed fish previously. Three nets fished below the Thompson Falls plant took 2 largescale suckers and 1 small Dolly Varden. These fish were taken near the mouth of Prospect Creek. A series of nets set about 1 mile upstream from Martin Creek did not take any fish. The average catch at this site during the summer and fall of 1955 was 8 fish per overnight set.

Eight overnight sets in Thompson Falls Reservoir took 1 largescale sucker, 4 peamouth chubs, 2 northern squawfish, 2 rainbow trout and 1 mountain whitefish for an average catch of 1 1/2 fish per net. The average catch in October, 1955, was about 14 fish per set.

Bioassays:

The skin divers collected vertical series of water samples from 2 stations where dynamite had been used to disperse the fishicide. These samples were taken to Missoula and bio-assays were conducted with small gold fish. The results of these tests were somewhat inconsistent and therefore no conclusion was reached regarding the need for dynamiting in these deep water areas. Individual test fish died at intervals ranging from 23 to 80 hours after being placed in the samples.

Samples were collected at the first station about 30 minutes after the explosive was detonated and less than 1 hour after the surface application was completed. At the second station, at least 4 1/2 hours had elapsed between the time that dispersal charges were fired and the time that water samples were taken. In general, the test fish died sooner in jars from station 1 than did those in samples from the second station, although there was some overlap. The average killing time was 43.5 hours (range 23 - 60) in samples from the first station as compared to 56.4 hours (range 43 - 80) for the second series. This may reflect dilution that occurred during the 4 hour period.

FISH PLANTING

Water samples were collected from the 0, 35, and 65 foot levels in the river on September 19. Fingerling rainbow trout placed in these jars were still alive and active on September 22 so the water was considered safe for planting. Approximately 486,000 rainbow trout were planted in the project area on September 29 and 30. About 90,000 of the smallest fish were planted in Thompson Falls Reservoir and the remainder went into the river. These trout ranged from about 1 1/2 to 4 inches in length. The entire plant averaged about 200 fish per pound.

Aerial planting was employed because of limited access in the canyon. The airplane and procedures used were those described by Cooper (1957) except that a 4-compartmented tank with separate release valves was substituted for the single large tank. The 4 tanks enabled the pilot to make 4 drops with each load and thereby get better distribution of the fish.

AGE AND GROWTH

Fish were collected from the Thompson Falls Reservoir and from 2 stations in the Clark Fork River, for age and growth data. These fish were selected to include all size classes and therefore the numbers collected do not indicate species composition of the kill. Scales were mounted and analysed at the Fish and Game laboratory at Bozeman. The relationship of body length to scale radius was assumed to remain constant throughout the life span of all species collected.

Trout: Six cutthroat and rainbow trout collected from the reservoir were classed as one group. The sample of either species, or of the two combined, is too small to be significant but the data is included for general interest.

Table 2. Growth rate of trout from Thompson Falls Reservoir.

Age Class	I		II		III		IV		V		VI
cal. length	2.3		4.6		7.5		9.8		12.8		15.0
no. fish	6		6		6		6		5		4
increment		2.3		2.9		2.3		3.0		2.2	

Mountain whitefish: The mountain whitefish was the only game species taken from the river in numbers large enough for growth determinations. Only a limited number were collected from the reservoir so their scales were not read. Analysis of 67 scale samples from the river is shown in table 3. Thirteen young-of-the-year whitefish averaged 3.9 inches in length (range 3.2 to 5.0 inches).

Table 3. Growth rate of mountain whitefish from the Clark Fork River.

Age Class	I		II		III		IV
cal. length	4.4		8.3		10.9		12.3
no. of fish	54		26		18		12
increment		3.9		2.6		1.4	

Largescale sucker: This species represented the largest collections from both waters. The data is summarized in table 4. The average length of 20 young-of-the-year suckers from the river was 1.9 inches (range - 1.3 to 2.8 inches). No data is available on the 0 age class in the reservoir.

Table 4. Growth rate of largescale suckers from Thompson Falls Reservoir and from the Clark Fork River.

Age Class	I	II	III	IV	V	VI	VII	VIII
(reservoir)								
cal. length	1.7	3.3.	5.1	7.3	10.1	13.3	15.9	17.0
no. of fish	82	63	39	30	29	18	16	3
increment		1.6	1.8	2.2	2.8	3.2	2.6	1.1
(river)								
cal. length	1.8	3.3	5.6	7.4	10.4	12.7	15.5	16.8
no. of fish	123	82	54	43	39	26	21	9
increment		1.5	2.3	1.8	3.0	2.3	2.8	1.3

Northern squawfish: The scales of 28 squawfish from the reservoir and 78 from the river stations were analysed (table 5). Three young-of-the-year fish were collected from the reservoir and 8 were taken in the river sample. These fish averaged 1.7 inches long in the reservoir and 2.3 inches in the river.

Peamouth chub: The calculated growth rate of 36 chubs from the Clark Fork River is shown in table 6. Two young-of-the-year chubs measured 2.7 and 2.9 inches in length. No data is available for this species in the reservoir.

Table 5. Growth rate of northern squawfish in Thompson Falls Reservoir and the Clark Fork River

Age Class	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
(reservoir)												
cal. length	1.6	3.2	4.6	6.5	8.3	9.9	11.8	13.0	14.6	16.0	17.4	18.4
no. of fish	28	22	15	3	2	2	1	1	1	1	1	1
increment		1.6	1.4	1.9	1.8	1.6	1.9	1.2	1.6	1.4	1.4	1.0
(river)												
cal. length	1.8	3.4	5.0	6.7	8.4	9.9	11.5	12.8	14.8	16.2		
no. of fish	78	58	38	19	14	11	8	4	2	2		
increment		1.6	1.6	1.7	1.7	1.5	1.6	1.3	2.0	1.4		

Table 6. Growth rate of peamouth chubs from the Clark Fork River

Age Class	I	II	III	IV
cal. length	2.4	4.6	6.1	8.4
no. of fish	36	22	6	3
increment		2.2	1.5	2.3

SUMMARY AND CONCLUSIONS

Preliminary analysis of this project indicates that the rough fish population in the river has been reduced to a very low level. A large number of fish were also killed in Thompson Falls reservoir, although some live fish were found 15 days after treatment. These could have been fish that survived the treatment or they could have been fish that moved downstream from the untreated portion of the river. A detailed post-impoundment study will be carried out to determine population changes that occur following partial rehabilitation. The extent of natural reproduction by rough species, survival of the young fish, and their effect on planted trout will indicate the value of partial rehabilitation in managing the fishery of a run-of-the-river reservoir. Data will also be obtained from Cabinet Gorge Reservoir where the fish population developed naturally following impoundment.

Perhaps the most important factor in planning a rehabilitation project is an accurate calculation of the amount of water to be treated. Volumetric measurement of a lake is a routine procedure and can be accomplished with a high degree of accuracy. Review of the literature regarding chemical treatment in moving water indicates that the amount of chemical needed is usually based on the volume of water flowing past a given point in a certain period of time. This method can be used in streams where pool depths are not great but it would not apply in the Clark Fork River where depths ranged up to 75 feet. Calculations showed that the treated section of this river could store about 5,000 acre feet of water regardless of the flow. The contour of the river channel is very irregular and, therefore, accurate measurements were difficult to obtain. Where any doubt existed regarding contours or depths, the largest measurement was used.

Detailed information regarding the hydrology of the river at low flow was lacking prior to the treatment. It was assumed that most of the bank storage would drain between the afternoon of August 31 and daylight the next morning. However, this did not happen. At 6:00 P.M. on September 1, when the treatment was completed, bank drainage was still contributing nearly as much water as the combined flow of all tributaries plus the water being released through the Thompson Falls plant. This bank drainage remained high for a minimum of 15-18 hours after the flow through the Thompson Falls plant was reduced. Storage capacity limited the shutdown at Thompson Falls to about the same length of time. Therefore, it would have been impossible to delay treatment until bank drainage had subsided. This illustrates the need for detailed hydrological data in planning a rehabilitation project on a large river.

Poor visibility limited the effectiveness of skin divers in evaluating the kill obtained in this project. Other data and samples collected by the divers could have been obtained from the surface. Therefore, diving is not recommended for future projects unless underwater visibility is good, or they are needed for a specific aspect of the project that can be accomplished with limited visibility. Neither of the divers employed on this project encountered conditions which they considered to be especially hazardous.

The additional flow in the river made boat travel possible through the entire treated section. However, the riffle areas were treated by helicopter as planned. This proved to be a very satisfactory method of applying the chemical in areas where boat travel is questionable. The air current created by the horizontally revolving blades forces the chemical downward with very little loss from wind or vaporization. The helicopter was also an excellent observation vehicle because of its low air speed.

Average growth rates were calculated for four species of fish collected during the chemical treatment. Scales collected in 1955 are still on file and will be read to supplement this pre-impoundment data. Age and growth studies will be continued to determine changes in growth rate following impoundment and to analyse changes in growth pattern associated with future population changes.

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