Proceedings of the Montana Academy of Sciences 25:20-40, 1965

INVESTIGATION OF TWO CLARK FORK RIVER HYDROELECTRICAL IMPOUNDMENTS*

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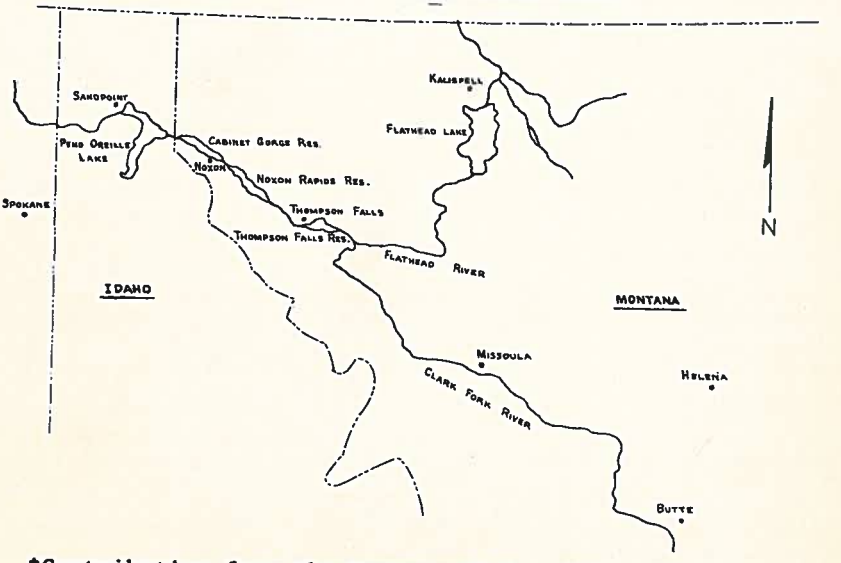
INTRODUCTION

This report covers ten years' work on a 15-year program to determine practical sport fishery management procedures for "run-of-the-river" hydroelectrical impoundments in Western Montana. These include two Washington Water Power Company reservoirs: Noxon Rapids and Cabinet Gorge. The Montana fish and Game Department and the Washington Water Power Company are cooperating in this investigation. The financial contribution of the Company by contract with the Department was $100,000 in 1954, $5,950 in 1956, and $81,100 in 1958. As the program has progressed since 1958 the Company has contributed additional money and technical assistance.

The two reservoirs under investigation lie heel-to-toe extending from Thompson Falls, Montana, downstream 56 miles (Figure 1). Noxon Rapids is 38 miles and Cabinet Gorge 18 miles in length. The lower 1/4 mile of Cabinet Gorge Reservoir and the dam are located in Idaho. Cabinet Gorge Dam was

Figure 1. Area map showing location of Thompson Falls, Noxon Rapids and Cabinet Gorge Reservoirs



*Contribution from the Montana Fish and Game Department, Project No. 29-E-1.

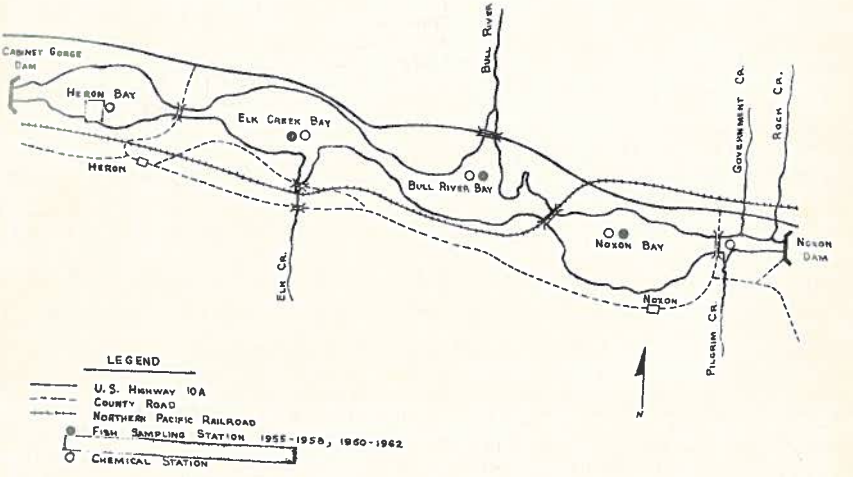
completed in 1952 and Noxon Rapids Dam in 1959.

DESCRIPTION OF PROJECT AREA

Cabinet Gorge Reservoir has a maximum surface acreage of 3,400 acres and a minimum pool of 2,450 acres. Prior to the completion of Noxon Rapids Reservoir in 1959, the daily and weekly fluctuation of the Cabinet forebay ranged from 3 to 14 feet. After Noxon was placed in operation, the pattern changed and the daily and weekly fluctuations ranged from 3 to 5 feet. The reservoir is generally narrow. At full pool, the sideslope is steep allowing only limited shoal area. The shoreline consists of moderately steep, rocky areas on the lower end. The upper part of the shoreline is more open, characterized by wooded areas on low, rather flat benches. Aquatic vegetation is present between the 5 and 20 foot depths, but is scarce elsewhere. The bottom of shallow bay areas is silt and organic debris. In the deep areas and "drop-off zones" the bottom is sand, gravel, and rubble.

There are several minor drainages entering this reservoir of which Elk Creek, Rock Creek and Bull River are the most important (Figure 2). Bull River enters from the north and is the largest and most important.

Figure 2. Cabinet Gorge Reservoir and Sampling Sites 1955-1958, 1960-1962

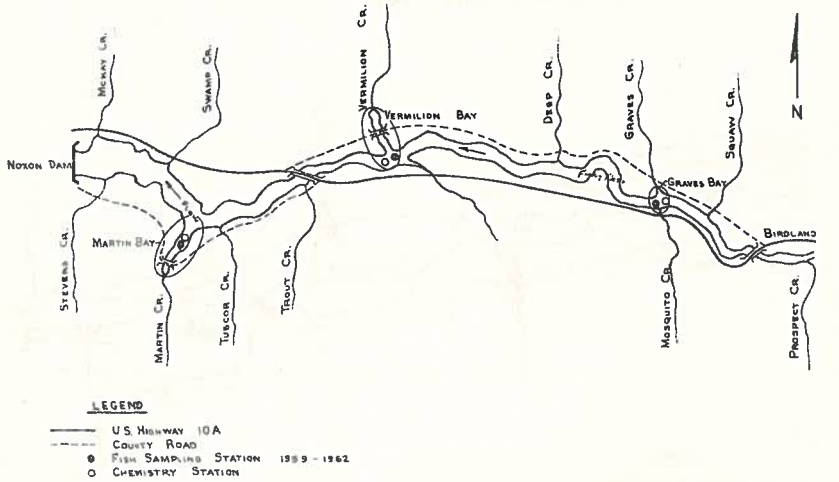


Cabinet Gorge Reservoir is presently operated in close coordination with Noxon Rapids and serves as a reregulating reservoir having very little fluctuation. Noxon on the other hand is a storage reservoir with something over 300,000 acre feet of usable storage. In order to meet regional power needs, The Washington Water Power Company has changed the reservoir operation patterns. During 1958 to 1960, reservoir fluctuations were around 5 feet during the week with a spring draft of 10 to 15 feet. Since 1961, operation schedules incorporate a drawdown of as much as 60 feet in the early spring. Currently, however, this ranges from 35 to 40 feet. The reservoir is also operated to assist in the U. S. Corps of Engineers flood control program. Filling usually begins in late May or June and levels are reasonably stable until spring drawdown.

This drawdown reduces Noxon Rapids Reservoir to about 5,500 acres compared to 8,600 acres when full. Inflows and outflows during spring runoff of 65,000 to 120,000 cfs., produce a current throughout the entire reservoir system.

Noxon Rapids Reservoir can be divided into two distinct habitat types: (1) a slow-moving river area which extends from Vermilion Bay upstream, and (2) the lake area which extends downstream from Vermilion Bay to the dam (Figure 3).

Figure 3. Noxon Rapids Reservoir and Sampling Sites



The upper area is 20 miles in length, and averages about 300 yards wide. It has a maximum depth of 75 feet, and has a visible current throughout the entire year. Shoreline slopes are steep and areas less than 30 feet deep are scarce. The lower area is 18 miles long and averages about 1,000 yards wide.

It has a maximum depth of 225 feet and a current is visible only during spring drawdown. Shoreline slopes are generally moderate to mild and areas less than 30 feet deep make up a significant portion of the area.

Aquatic vegetation is scarce in Noxon Rapids Reservoir at present. Prior to the 1961 33-foot drawdown, rooted and floating aquatics were abundant at depths less than 20 feet. In Cabinet Gorge aquatic vegetation was always present at depths of 5 to 20 feet, but since 1961 plants have become more dense, probably due to the stabilizing of the lake level.

A few temperature and oxygen determinations were made in Cabinet Gorge and Noxon Rapids reservoirs in the summers of 1960 and 1962 in order to determine whether either of these factors restricted trout production. Neither reservoir formed a thermocline during the summer. Surface temperatures during July and August never rose above 74°F and averaged about 72°F. Temperatures 100 feet deep averaged 65°F, while those at 175 feet were about 55°F. Oxygen levels at all depths to 200 feet were adequate for game fish. During July and August, oxygen concentrations were from 7.5 to 9.0 ppm at the surface and never below 5.5 ppm at the 175 to 200 feet levels. Temperature and oxygen levels were well within the range of game-fish tolerance during the critical months, but a large volume of water was above the desirable temperature range for trout.

No temperature or oxygen data were taken during the winter months. Observations during the short period of ice cover for both reservoirs show no critical conditions during the winter. Noxon Rapids has nearly complete ice cover only 2 - 3 months each year, while Cabinet Gorge has about a 30 percent cover 1 - 2 months each year.

Rapid water change in lakes and reservoirs has an adverse effect upon productivity.[1] Under normal operation a complete water exchange could occur in about 15 days for Cabinet Gorge and about 75 days for Noxon Rapids reservoirs.

METHODS AND MATERIALS

Nylon gill nets with equal sections of 3/4-, 1-, 1 1/4-, 1 1/2-, and 2-inch square mesh were used for all population sampling. These nets were 125 feet by 6 feet, and 250 feet by 6 feet. Sampling with respect to calendar time, areas of the lake sampled, and time of day sampled have been standard. A total of 18 species of fish were found in these waters (Table 1). Fish planting sites and methods of distribution were the same for each year of the study. Temperatures were determined with Taylor temperature recorders and a Foxboro resistance thermometer. Oxygen concentrations were determined using the Winkler method.

Table 1. List of fish in the project area

Species	Scientific Name	Abbrevi-ations*	Native to area
Mountain whitefish	*Prosopium williamsoni*	MWf	yes
Lake whitefish	*Coregonus clupeaformis*	LWf	no
Dolly Varden	*Salvelinus malma*	DV	yes
Brook trout	*Salvelinus fontinalis*	EB	no
Cutthroat trout	*Salmo clarki*	Ct	yes
Rainbow trout	*Salmo gairdneri*	Rb	no
Brown trout	*Salmo trutta*	LL	no
Kokanee	*Oncorhynchus nerka kennerlyi*	KOK	no
Coho salmon	*Oncorhynchus kisutch*	SS	no
Largemouth bass	*Micropterus salmoides*	LMB	no
Northern squawfish	*Ptychocheilus oregonensis*	Sq	yes
Longnose sucker	*Catostomus catostomus*	FSu	yes
Largescale sucker	*Catostomus macrocheilus*	CSu	yes
Peamouth	*Mylocheilus caurinus*	CRC	yes
Yellow perch	*Perca flavescens*	YP	no
Black bullhead	*Ictalurus melas*	BULH	no
Pumpkinseed	*Lepomis gibbosus*	Ps	no
Redside shiner	*Richardsonius balteatus*	RSh	yes

*These abbreviations are those used by the Montana Fish and Game Department.

CABINET GORGE INVESTIGATIONS - YEARS 1952 TO 1958

Before the completion of Cabinet Gorge Dam, the Clark Fork River and its tributaries between Lake Pend Oreille, Idaho, and the Thompson Falls Dam provided spawning areas for fish from Lake Pend Oreille. Species of fish spawning in this area included mountain whitefish, kokanee, Dolly Varden, Cutthroat trout, and a few Kamloops rainbow trout. These spawning runs, along with whitefish taken in the winter in the Clark Fork, furnished an important part of the angler harvest in this part of Montana. Cabinet Gorge Dam blocked migration and eliminated angler harvest from this source. In 1960 the Washington Water Power Company constructed an artificial spawning area about 1/2 mile below Cabinet Gorge Dam for Dolly Varden. The area has been used by both Dolly Varden and Kokanee.

The fish management objectives for Cabinet Gorge Reservoir from 1952 through 1958 were to establish fishing in the reservoir and re-establish spawning runs of cutthroat and kokanee. From 1953 through 1956, 1,707,000 kokanee fry, 1,184,000 cutthroat fry, and 100,000 coho salmon fry were planted in Cabinet Gorge Reservoir. The kokanee fry were obtained from Flathead Lake and were presumably progeny of

the kokanee stock that originally populated Lake Pend Oreille. The cutthroat were of the Yellowstone variety, and not native to Western Montana and Lake Pend Oreille.

Gill netting in 1955 and 1958 and creel census from 1954 through 1956 were used to determine the success of hatchery fish in the reservoir. There were 32 overnight gill net sets in 1955, but only 12 in 1958 (Table 2). The sampling stations are shown in Figure 2.

The principal part of the Cabinet Gorge fish population was non-game fish. Suckers, squawfish, and peamouth were the most numerous in the catch both years. The total catch per net-night was much greater in 1955 than 1958. Several of the 1955 sets were on sucker and squawfish spawning beds when these fish were spawning. The 1958 nets were placed in the same vicinity during the same month, but were not over spawning areas. This probably accounted for some difference between the two years.

Very few cutthroat trout and no kokanee were taken in the 1955 and 1958 sampling. To date only one kokanee has been taken from Cabinet Gorge by netting and this was in 1961. Cutthroat trout examined since 1960 showed little coloration indicative of the Yellowstone stock, but closely resembled cutthroat native to Western Montana. The numbers of Dolly Varden, mountain whitefish, and lake whitefish were fairly consistent although their contribution to the total catch rose in 1958.

Creel census data collected by Gaffney[2] and by Montana game wardens for the years of 1954-1956 are presented in Table 3. No catch information is available for 1957 and 1958.

Table 3. Creel census, Cabinet Gorge Reservoir, 1954-1956.

Year	No. of Anglers	DV	CT	Rb	MWf	Others*	CPMH**
1954	4	3	3	1	-	-	0.58
1955	57	29	14	4	2	4	0.33
1956	23	14	5	2	1	2	0.38

* Includes brown trout, brook trout, largemouth bass
** Catch-per-man-hour of angling effort

Anglers from Noxon, Montana, reported that cutthroat trout angling was good from 1954 through 1957, but ended abruptly thereafter. Small Dolly Varden were numerous in the catch during the same years. No anglers reported kokanee in the catch.

Table 2. Average catch per-net-night and percent of total catch by species, Cabinet Gorge Reservoir, 1955 and 1958

Year		Wf[1]	DV	Ct	Rb	Other[2]	Sq	Su[3]	CRC	YP	Other[4]	Total
1955	Number	2.0	1.2	0.2	0.1	0.1	21.6	21.8	3.7	0.9	0.9	72.5
	Percent	3.8	2.4	0.4	0.1	0.1	41.4	41.2	7.2	1.8	1.9	
1958	Number	1.6	0.6	0.2	0.1	0.2	3.4	3.6	2.6	1.3	0.2	13.2
	Percent	11.6	4.3	1.2	0.6	1.2	25.2	26.4	19.0	9.3	1.2	

[1] Includes mountain and lake whitefish.

[2] Includes brook trout, borwn trout, and largemouth bass.

[3] Includes longnose and largescale suckers.

[4] Includes black bullheads, pumpkinseeds, and redside shiners.

Data show that planted cutthroat and kokanee did not establish themselves in the reservoir. These fish were planted in the face of large populations of competitor and predator species. Jeppson and Platts,[3] investigating Northern Idaho lakes, found that squawfish occupied the same habitat as trout resulting in acute competition for some areas. Squawfish, peamouth, yellow perch, and Dolly Varden are predaceous fish present in Cabinet Gorge Reservoir. Crossman and Larkin[4] have reported that redside shiners compete with small trout both for food and space and are sometimes predators upon small trout.

The fluctuation of the reservoir level limited the production of micro-food organisms thereby disrupting the food chain essential to the survival of kokanee. The same is probably true with the lake-variety of cutthroat stocked at the same time. The unstable water level, particularly the severe drawdowns, may have triggered a movement of these species out of the reservoir. Klaveno and Jeppson[5] reported that fish stocked in Cabinet Gorge undoubtedly contributed to the catch of kokanee from Lake Pend Oreille but that the amount would be difficult to determine. It would seem that the newly created reservoir did not provide suitable habitat for the production of kokanee and Yellowstone cutthroat trout. The lack of proper food, the presence of many predator fish, and the stimulous of changing water levels probably account for the failure of kokanee and cutthroat trout.

CABINET GORGE AND NOXON RAPIDS INVESTIGATIONS - 1958 TO 1962

In 1955 the Federal Power Commission issued a license to the Washington Water Power Company to build Noxon Rapids Dam. Soon thereafter a pre-impoundment survey of the fishery was undertaken by the Montana Fish and Game Department and the Company. This survey[2] covered Thompson Falls Reservoir (Figure 1), Cabinet Gorge Reservoir, and the proposed reservoir area of the Noxon Rapids project. Non-game fish were predominant in all three areas, and mountain whitefish was the principal game species. Angler success was poor throughout and the most numerous game species were mountain whitefish, cutthroat trout, and Dolly Varden. It was recommended that the Noxon Rapids project area be chemically treated to eliminate, in so far as possible, the existing fish population. It was also recommended that the 8-mile long Thompson Falls Reservoir be treated to form a buffer zone between the Noxon Rapids area and the Clark Fork River upstream from Thompson Falls.

In 1958 the Montana Fish and Game Department, in cooperation with the Washington Water Power Company, undertook to poison the prescribed areas. The methods used and the success of this project are described by Gaffney.[6] A good, but incomplete, kill was obtained.

The planting of cutthroat trout and kokanee in Cabinet Gorge Reservoir prior to 1958 was ineffective. With the completion of the Noxon Rapids Reservoir and the chemical treatment of the river to be inundated, a new management plan was undertaken for both reservoirs. Noxon Rapids was planted for three years beginning in 1958 with about 850,000 fingerling rainbow trout annually; Cabinet Gorge, starting in 1959, was planted for three years with 150,000 or more 4-5 inch rainbow trout annually. The planting record for each reservoir is given in Table 4.

Table 4. Rainbow trout planted in Noxon Rapids and Cabinet Gorge Reservoirs, 1958-1962

Reservoir	Year	Number	Size	Remarks
Noxon Rapids	1958	850,000	2-4"	A few 7-9" fish also
Noxon Rapids	1959	800,000	2-4"	
Noxon Rapids	1960	900,000	2-4"	
Noxon Rapids	1960	10,000	4-5"	All with adipose clip
Noxon Rapids	1960	14,240	6-8"	All with right pelvic clip
Noxon Rapids	1961	20,000	4-5"	All with left pectoral clip
Noxon Rapids	1962	500,000	4-5"	
Cabinet Gorge	1959	165,000	4-5"	
Cabinet Gorge	1960	150,000	4-5"	1/2 with left pelvic clip
Cabinet Gorge	1961	150,000	4-5"	

The success of planting large numbers of small rainbow trout in Noxon Rapids with its reduced rough fish population was compared to the success of planting smaller numbers of larger fish of the same species in Cabinet Gorge with its large rough fish population. Analyses of other factors which might limit the success of plantings were made and corrective measures explored.

Population Trends. Fish population trend information was collected by sampling with experimental gill nets at three stations in each reservoir. Sampling was done at approximately the same time each spring, summer, and fall of 1960, 1961, and 1962. Population trends were considered for only predominant species taken in the nets. The combination of cutthroat trout, brook trout, largemouth bass, redside shiner, black bullhead, and pumpkinseed contributed less than one percent of the total catch for any one year.

The number of net sets by station and by year for each reservoir is given in Table 5. Station locations are shown in Figures 2 and 3. The number of net sets at any one station during a sampling period was governed by lake conditions, manpower available, and boat launching facilities as regulated by drawdown. It is believed that sufficient sets

were made to obtain a valid sample. The average catch-per-net-

Table 5. Number of net sets in Noxon Rapids and Cabinet Gorge Reservoirs, 1960, 1961, 1962.

Reservoir	Year	Station 1 Graves Bay	Station 2 Vermilion Bay	Station 3 Martin Bay	Total
Noxon Rapids	1960	5	9	14	28
	1961	8	18	20	46
	1962	4	10	12	26
		Noxon Bay	Bull River Bay	Heron Bay	
Cabinet Gorge	1960	16	11	7	34
	1961	6	11	3	20
	1962	15	11	16	42

night by species by year for Noxon Rapids is given in Table 6; for Cabinet Gorge in Table 7.

The netting data show a marked decrease in the catch of rainbow trout from 1960 through 1962 in Noxon Rapids Reservoir. This species was always most numerous at the upper sampling station and least at the lower station. Dolly Varden and brown trout sustained themselves from year to year. They were more numerous at the upper station and least at the lower station. Mountain whitefish showed a marked decrease in numbers caught, while lake whitefish had a slight increase. Mountain whitefish were caught in about equal numbers at all netting stations, while the lake whitefish were most common at the Martin Bay station.

The number of longnose suckers taken each year remained constant, while largescale suckers generally increased. Suckers were the first non-game species to become numerous after the chemical treatment in 1958. In Cabinet Gorge Reservoir, largescale suckers are much more abundant than longnose suckers. Small numbers of squawfish were taken each year but showed an increase in the catch. Almost all of the squawfish taken were of one size and from two year classes. Peamouth first appeared in the catch during the summer of 1961. All were similar in size and were probably from one or two year classes. The squawfish and peamouth were not large or old enough to spawn.

Yellow perch were scarce in the pre-impoundment survey and in fish killed during the chemical treatment. This species increased greatly in the 1962 catch and may limit the survival of young trout.

Table 6. Average catch-pet-net-night by year, Noxon Rapids Reservoir, 1960, 1961 and 1962

Year		Rb	LL	DV	MWf	LWf	Sq	CRC	FSu	CSu	YP	Total
1960	Number	6.6	0.6	1.0	5.8	0.9	1.0	0.0	7.4	3.2	3.5	30.0
	Percent	22.0	2.0	3.3	19.3	3.0	3.3	0.0	24.7	10.7	11.7	
1961	Number	2.1	0.9	1.0	1.6	1.7	1.3	1.9	8.5	5.4	3.0	27.4
	Percent	7.7	3.3	3.6	5.8	6.2	4.8	6.9	31.0	19.7	11.0	
1962	Number	0.2	1.4	1.2	1.0	2.0	2.9	4.3	6.9	11.0	16.0	46.9
	Percent	0.4	3.0	2.5	2.1	4.3	6.2	9.2	14.7	23.5	34.1	

Table 7. Average catch-per-net-night by year, Cabinet Gorge Reservoir, 1960, 1961 and 1962

Year		RB	LL	DV	Wf*	Sq	CRC	FSu	CSu	YP	Total
1960	Number	4.6	0.1	0.7	1.6	3.7	3.1	1.1	5.8	2.9	23.6
	Percent	19.5	0.4	3.0	6.8	15.7	13.1	4.6	24.6	12.3	
1961	Number	2.0	0.3	0.4	2.4	3.6	3.7	0.8	3.7	2.2	19.1
	Percent	10.5	1.6	2.1	12.6	18.7	19.4	4.2	19.4	11.5	
1962	Number	0.1	1.0	0.5	0.6	1.6	1.8	0.9	4.5	1.8	12.8
	Percent	0.8	7.8	3.9	4.7	12.5	14.0	7.0	25.3	14.0	

*Includes mostly mountain whitefish and a very few lake whitefish.

The few cutthroat and brook trout taken from Noxon Rapids are probably migrants from tributary streams. A few largemouth bass and black bullhead were taken in the nets. These two species were limited by unfavorable spawning conditions and poor growth. Pumpkinseed and redside shiner are also present in the reservoir. Since they were inadequately sampled by gill netting, no reliable data on numbers are available. Observations at night indicate that redside shiners are very abundant.

The catch of rainbow trout from Cabinet Gorge Reservoir has decreased steadily since 1960. This change is similar in magnitude to that found in Noxon Rapids Reservoir. The Noxon Rapids planting program was largely completed in 1960, but the Cabinet Gorge planting continued through 1961. The decrease of rainbow trout in Cabinet Gorge took place while the reservoir was being planted heavily. They were most frequently caught at the Bull River Bay station and least frequently at Heron Bay. The number of brown trout caught increased each year, while Dolly Varden remained about the same. Both were taken most frequently at the Noxon Bay station and least frequently at Heron Bay. The number of whitefish taken varied from year to year with no apparent trend. The mountain whitefish was more abundant than lake whitefish. This is in contrast to Noxon Rapids where the mountain whitefish decreased and the lake whitefish increased.

The number of non-game fish was fairly stable. The Cabinet Gorge non-game fish were mature while the peamouth and squawfish of Noxon Rapids were immature.

Cutthroat trout, brook trout, largemouth bass, bullhead, and pumpkinseed were taken infrequently in Cabinet Gorge Reservoir. Redside shiners were abundant and may be a serious predator on or competitive with the young game fish.

A comparison of the total net catch for all years sampled in Cabinet Gorge (Tables 2 and 7) shows that maximum fish production was reached in 1955, three years after impoundment. Canyon Ferry Reservoir near Helena, Montana also reached its maximum carrying capacity within three years of initial impoundment.[7] Rainbow trout catches were similar in 1958 and 1962, but other game fish show changes, notably an increase in brown trout.

Angler success. The success of sport fish management is measured by the returns to the angler. The management program for Noxon Rapids and Cabinet Gorge Reservoirs was designed to provide the best possible sports fishery in spite of an anticipated build-up of rough fish in Noxon Rapids Reservoir. Angling for salmonoid species in lakes and reservoirs is generally considered best in spring and late fall, next in winter and the poorest in summer. Where possible, the Noxon Rapids and Cabinet Gorge creel census data has been divided into two time periods: Period I -

January 1 through June 30; Period II - from July 1 through December 31. Creel information was collected by project personnel, Montana game wardens, and from fisherman logs. Data secured from each angler included species, number caught, and hours fished (Table 8). Most anglers were interviewed on weekends.

Table 8. Angler success, Noxon Rapids and Cabinet Gorge Reservoirs, 1959-1962

Reservoir	Year	Period	Anglers	CPMH*	Rb	DV	LL	Ct	MWf
Noxon Rapids	1959	II	31	2.3	136	-	-	17	13
	1960	I	166	1.0	471	9	2	16	14
		II	197	0.7	316	14	1	4	-
	1961	I	68	1.2	157	3	1	-	-
		II	11	0.7	8	1	3	-	-
	1962	I	22	0.7	23	-	5	1	-
		II	39	0.4	4	-	5	1	1
Cabinet Gorge	1959	I&II	15	1.4	45	-	-	-	-
	1960	I	180	1.3	760	3	1	3	1
		II	19	1.4	60	22	-	2	-
	1961	I	292	1.5	1219	14	9	8	8
		II	- pressure almost nil after June 17						
	1962	I	42	0.3	15	5	3	2	2
		II	20	0.5	2	3	6	-	7

*Catch-per-man-hour

Good angler success was attained at Noxon Rapids in 1959 through Period I of 1962. Rainbow trout comprised almost all of the catch in 1959, 1960, and Period I of 1961. The catch fell considerably as did the angler effort in Period II, 1961 and in 1962. Although the catch-per-man-hour was still acceptable during this latter time, the number of rainbow trout caught decreased greatly over previous years.

Angler success in Cabinet Gorge was excellent in 1959, 1960, and Period I of 1961. There was no great difference in catch rates between periods and rainbow trout predominated. In Period II of 1961 and in 1962, the catch rate took a decided drop, especially for rainbow trout.

Planted fingerling rainbow trout should enter both the angler and gill net catches two years after stocking, according to growth studies. Rainbow trout taken by nets in 1960, 1961, and by nets and angling in 1962 were grouped into planted year-classes as determined from age-growth data.

Table 9. Contribution of rainbow trout planted year-classes to yearly catch

Year Caught	Year Planted - Percent of Catch			
	1958	1959	1960	1961
1960	51.3%	47.7%	1.0%	-
1961	26.6%	51.4%	22.0%	0.0%
1962	13.8%	79.3%	6.9%	0.0%

The catch for 1960 and 1961 largely depended upon the plant of the two prior years (Table 9), while the catch in 1962 depended almost solely upon plants made three and four years before. The 1961 plant did not contribute anything to the catch in 1961 or 1962 but plants prior to 1961 contributed small numbers to the catch the following year.

Catch distribution was not determined for Cabinet Gorge rainbow trout because their ages could not be determined with confidence. However, an indication of the contribution to the catch from one year's plant was available. About 75,000 fish of the 1960 plant were marked by fin-clipping. These should have entered the creel and gill nets in 1961 and 1962, but only five returns were recorded and all were caught by anglers in the spring of 1961. The Cabinet Gorge rainbow fishery was dependent upon plants made prior to 1961 or on fish from other sources.

Movement of Rainbow Trout. Along with the 75,000 marked fish planted in Cabinet Gorge, several small plants of marked fish were made in Noxon Rapids in 1960 and 1961 (Table 4). Of the 14,240 6-8 inch fish planted in 1960, nine were taken one month later by netting from the area where planted. Three were caught by anglers near the planting site six months later, and five were caught by anglers from Cabinet Gorge Reservoir six months after stocking. One was taken by angling from Lake Pend Oreille eight months after planting. Two of the 10,000 4-5 inch fish planted in 1960 were taken by gill netting one year after planting. One was taken from the planting site while the other was taken 30 miles upstream. No returns from the 1961 plant of 20,000 4-5 inch marked fish were recorded.

Fish did move downstream from Noxon Rapids as shown by returns of marked fish. Irving and Culpin[8] found that 197 of 405 returns from tagged rainbow trout were from below the hydroelectric impoundment in which they were planted. Jeppson[9] reported that 25 percent of the rainbow trout taken in the Clark Fork River below Cabinet Gorge Reservoir had turbine-caused injuries and he assumed that these fish came from Montana waters. Graben[10] suggested that a drawdown in Brownlee Reservoir of 25 feet, along with high power house discharge, increased velocities in the reservoir and thus

caused steelhead and salmon to leave the reservoir.

Fish population sampling in some Noxon Rapids tributaries shows that rainbow trout moved into these streams. Several streams with no history of rainbow trout prior to 1958 now contain good populations. Sampling in Prospect Creek shows that the rainbow trout are most numerous during the summer and fewest at other times of the year. This suggests a seasonal movement in and out of Prospect Creek.

The recovery of marked fish from Noxon Rapids Reservoir downstream is evidence that some rainbow trout moved out of the reservoir. This downstream movement started in the spring of 1961. A statistical comparison of the average catch-per-net-night for certain species was made for both reservoirs. The objective was to determine whether significant changes occurred in the numbers of fish caught before and after the 1961 spring drawdown.

The "before drawdown" data include the average net-catch per station for the sampling done in 1959, 1960, and May 1961. The "after drawdown" data include the average net-catch per station for the sampling done in the summer and fall of 1961 and in 1962. The statistical procedure followed Moyle and Lound[11] and involved setting confidence limits around the median net catch of each series (Table 10).

Table 10. Comparison of the number of fish per net-night before and after 1961 Noxon Rapids drawdown, Cabinet Gorge and Noxon Rapids Reservoirs

Lake	Species	Median Catch Before Drawdown	Median Catch After Drawdown	Significant Change*
Noxon Rapids	Rainbow trout	6.6	0.3	yes
Cabinet Gorge	Rainbow trout	3.2	0.0	yes
Noxon Rapids	Brown trout	0.1	0.4	no
Cabinet Gorge	Brown trout	0.0	0.4	yes
Noxon Rapids	Game fish	12.7	3.5	no
Cabinet Gorge	Game fish	5.9	2.2	no
Noxon Rapids	Non-game fish	9.5	29.6	no
Cabinet Gorge	Non-game fish	13.8	11.4	no

*at 95 percent confidence level

There was a significant drop in the numbers of rainbow trout taken in the gill nets after the drawdown from each reservoir. An increase in the number of brown trout was significant for Cabinet Gorge Reservoir, while no significant changes occurred in the over-all number of game and non-game fish from either reservoir. Fish other than rainbow trout were not greatly affected by the reservoir drawdown.

Age and Growth. Scales for age and growth determinations were taken from almost all species of fish found in Noxon Rapids Reservoir. In computing growth rates, a straight line relationship between body and scale length was assumed. These data are given in Table 11. Rainbow trout scale samples were collected in 1960 and 1961 and all other species in 1960. The rainbow trout samples were divided into two groups: (1) fish taken from the 1961 spawning run, and (2) fish taken at other times of the year in both 1960 and 1961. Few rainbows were found to be older than the first hatchery rainbow trout planted in 1958. The planting mark of the hatchery rainbow trout and the first annulus of the "native" rainbow coincided so that the planting mark and the first annulus are considered the same.

The growth rate of Noxon Rapids rainbow trout was slow except for the few samples taken from the 1961 spawning run. Age-class II and III fish would be expected to show fast growth because they were planted during the first two years after rehabilitation. The spawners taken in 1961 showed good growth. Rainbow trout, other than 1961 spawners, did not reach a size large enough to enter the catch (both angler and gill net) until their third year of life. The growth of brown trout was similar to that of the rainbow trout; they did not reach catchable size until the third year of life.

The growth of Dolly Varden was also slow, but this is quite characteristic for this species. Lake whitefish showed excellent growth and the population was comprised largely of the 1958 year-class. Mountain whitefish growth was fair with the 1959 and 1960 year-classes dominating the catch. The growth of largemouth bass was slow compared to that of fish from Nine-Pipe Reservoir which is probably the best bass lake in Montana. The growth of yellow perch in Noxon Rapids is above the Montana-wide average.[12]

The growth of squawfish from Noxon Rapids Reservoir was slow, but similar to that reported by Jeppson and Platts.[3] The growth of the longnose sucker was somewhat faster than that of the largescale sucker. The number of non-game species from year-classes prior to 1958 indicates that chemical treatment failed to destroy a large number of small, young fish.

Game Fish Reproduction. Observations were made on both reservoirs to measure the development of spawning runs in tributary streams. Unfortunately Noxon Rapids and Cabinet Gorge have few tributary streams suitable for salmonid spawning.

Bull River is the only tributary to Cabinet Gorge Reservoir that has good spawning for salmonids. Pilgrim Creek and the tailwater of Noxon Rapids Reservoir provide small areas of suitable gravel. Bull River, before construction of Cabinet Gorge Dam, was one of the principal spawning streams for Lake Pend Oreille fish. At present this

Table 11. Age and growth of fish from Noxon Rapids Reservoir

Species	Length in inches at annulus						
	I (p)	II	III	IV	V	VI	VII
Rainbow trout	2.5(79)*	5.0(79)	9.4(51)	13.5(15)	16.3(8)	22.4(1)	
Rainbow spawners	3.2(15)	8.7(15)	13.6(15)	15.3(10)			
Brown trout	3.1(39)	6.0(31)	10.2(28)	12.8(16)	15.3(2)		
Dolly Varden	2.6(25)	5.1(25)	8.4(23)	11.1(15)	13.6(8)	16.0(3)	19.2(1)
Mt. Whitefish	3.6(46)	6.1(28)	10.6(4)	12.8(2)			
Lake Whitefish	7.2(70)	11.2(69)	14.0(53)				
Largemouth bass	1.9(6)	5.1(6)	6.6(2)				
Yellow perch	3.0(43)	5.6(29)	6.9(18)	8.5(5)	10.1(3)		
Squawfish	1.8(13)	3.3(13)	4.7(12)	6.2(8)	7.3(2)	9.4(1)	10.7(1)
Largescale sucker	2.0(30)	3.6(24)	5.5(15)	7.6(6)	8.7(1)		
Longnose sucker	2.1(34)	4.8(32)	6.8(11)	8.8(1)			

*Number in parenthesis is number of fish in sample.

stream has only limited spawning use by brown trout and Dolly Varden and no rainbow have been observed spawning there. Pilgrim Creek is not used by rainbow trout, but a few Dolly Varden and brown trout were observed spawning there in 1961 and 1962. The tailwater below Noxon Rapids Dam is used by a considerable number of Dolly Varden and brown trout for spawning. No rainbow trout were observed in this area.

Eight tributaries with spawning potential enter Noxon Rapids Reservoir. Of these, only Prospect Creek, Graves Creek, and Tuscor Creek are accessible to spring spawning fish. Barriers exposed by the 30-foot spring drawdown block access to the other streams. A small number of spawning rainbow trout were observed in Prospect Creek in April and May, 1961 and 1962. The other creeks were devoid of this species.

Dolly Varden and brown trout, which are fall spawning species, were observed spawning in Prospect Creek, Graves Creek, Vermilion River, Tuscor Creek, and Martin Creek. Small runs of both species were first observed in 1961 and appeared to increase each year. Graves Creek and Prospect Creek are the tributaries most heavily used by brown trout. Spawning fish enter these creeks in November and December. Redd and adult counts in Graves Creek indicated that the 1961 run contained about 100 pairs of spawning fish. Counts in 1962 showed about 250 pairs. Unfortunately Graves Creek has intermittent winter flows near its mouth. No estimates of total use were made for Prospect Creek, but the 1962 run was considerably greater than the 1961 run. Spawning success has not been evaluated.

Prospect Creek and Vermilion River are the principal Dolly Varden spawning streams. They were important Dolly Varden spawning areas for Lake Pend Oreille prior to construction of Cabinet Gorge Dam. The number of Dolly Varden using these streams has not been determined, but use appears to be increasing. They enter Prospect Creek in late June and July and Vermilion River in late August and September. The Clark Fork River between Thompson Falls Dam and the high-water mark of Noxon Rapids Reservoir should provide some spawning area, but only for large fish because of the large size of bottom materials.

A few mountain whitefish spawn in Graves Creek and Vermilion River. The extent other tributaries are used by this species is not known. Lake whitefish spawn almost entirely in the reservoir proper. Ripe lake whitefish were largely taken from three areas: Martin Bay, Vermilion Bay and Finley Flats. Largemouth bass were observed spawning only in the Vermilion Bay area. Mountain whitefish spawn in September and October, lake whitefish in late December and January, and largemouth bass in late July.

In the winter of 1961 and spring of 1962 large numbers of eyed rainbow and brown trout eggs were planted in four Noxon Rapids tributary streams (Table 12). Vibert boxes were used for 100,000 eggs in Prospect Creek. All the remaining eggs were planted in man-made redds. Survival to the swim-up fry stage of all eggs planted was over 90 percent.

Table 12. Trout eyed-egg plants in tributaries to Noxon Rapids Reservoir

Stream	Date	Species	Number
Prospect Creek	January 1961	Rainbow	400,000
Graves Creek	May 1962	Rainbow	200,000
Martin Creek	May 1962	Rainbow	100,000
Tuscor Creek	May 1962	Rainbow	100,000
Tuscor Creek	May 1962	Brown	25,000

Fish from these plants are not expected to spawn until the spring of 1964 or 1965 at the earliest, at which time evaluations will be made.

SUMMARY

Fishery investigations were carried out on Noxon Rapids and Cabinet Gorge Reservoirs in Western Montana from 1952 through 1962. Cabinet Gorge Reservoir, completed in 1952, was heavily planted with kokanee and cutthroat fry from 1953 through 1956. These plantings apparently failed.

The Noxon Rapids Reservoir project area was chemically treated in 1958 to remove the existing fish population. A good kill was obtained in the area treated. Following the rehabilitation, Noxon Rapids Reservoir was planted with 2.5 million fingerling rainbow trout over a three-year period. During the same period Cabinet Gorge Reservoir was stocked with 465,000 4-5 inch rainbow trout.

Trend information showed that rainbow trout comprised a significant part of the Noxon Rapids fishery from 1958 through the spring of 1961, and the angler success was good. Rough fish populations were rapidly building up two years following rehabilitation. Operation of the Noxon Rapids Power plant from 1958 to 1961 were suitable for good trout production with no drawdown in excess of 10 feet. In the spring of 1961 plant operation changed and an annual spring drawdown of 30-40 feet was incorporated. Since 1961 rainbow trout populations in both Noxon Rapids and Cabinet Gorge steadily decreased in both gill net and anglers' catches. There was little change in the catch of other species. The rainbow trout may be

moving out of the reservoirs downstream into Lake Pend Oreille, Idaho.

Growth of all salmonids except lake whitefish from Noxon Rapids Reservoir is slow. Growth of yellow perch and largemouth bass is also poor. Spawning runs of Dolly Varden and brown trout have developed in several Noxon Rapids and Cabinet Gorge tributaries. These runs were first noticeable in 1961 and appear to be increasing each year. Increasing numbers of Dolly Varden and brown trout, and good lake whitefish growth indicate fall spawning species are adapting to the environment.

Few rainbow trout have spawned in either reservoir. Planting of eyed rainbow trout eggs in several Noxon Rapids Reservoir tributaries has been made to promote spawning runs. Evaluations of these plants have not been made.

ACKNOWLEDGMENTS

The author wishes to express his gratitude to Tim M. Vaughan, Washington Water Power Company, Dr. J. A. R. Hamilton, Pacific Power and Light Company, Dr. C. J. D. Brown, Montana State College, and George D. Holton, Montana Fish and Game Department for their manuscript editing and helpful suggestions.

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