FISHERIES EVALUATION AND MONITORING PROGRAM FOR THE FLATHEAD LAKE/RIVER SYSTEM AND HUNGRY HORSE AND LIBBY RESERVOIRS

prepared by

John Fraley, Project Manager
Bruce May, Pat Clancey, Will Beattie; Project Biologists

Montana Department of Fish, Wildlife and Parks
Special Projects
P.O. Box 67
Kalispell, Montana 59903

Prepared, January 1986
Revised, August 1986

Montana Department
of
Fish, Wildlife & Parks

P.O. Box 67
Kalispell, MT 59903
September 30, 1986

Mr. James A. Posewitz
c/o Department of Fish, Wildlife and Parks
1420 E. Sixth Avenue
Helena, MT 59620

Dear Jim:

Please consider supporting the enclosed proposal entitled "Fisheries Evaluation and Monitoring Program for the Flathead Lake/River System and Hungry Horse and Libby Reservoirs". The project is needed to (1) evaluate and fine-tune mitigation steps taken in relation to Northwest Power Act fisheries studies, (2) continue building a data base necessary for wise fisheries management decisions in the Flathead and Kootenai drainages, and (3) evaluate any future changes in the fishery if the Cabin Creek Coal mine is developed in the North Fork of the Flathead drainage in Canada.

The proposal is designed for shared funding, and success is dependant on the active participation of each agency or group. I'll be contacting you soon to discuss the project.

Thank you for your consideration.

Best Regards,

John

John Fraley
Special Projects Manager

JF:dg

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CONTENTS

SUMMARY PROPOSAL

Introduction

We propose to continue the fisheries monitoring and research program established for the Flathead and Kootenai Systems during the federally funded Northwest Power and River Basin studies from 1978 through 1987. This program will aid in the management of kokanee, westslope cutthroat, bull trout, rainbow and other species in relation to hydropower operations, forest practices, other forms of resource development, and fishing pressure. We would also maintain the established computer system data base for the drainage, issue monthly narrative summaries, produce annual reports, and continue publishing the results of past and future studies.

The approach is based on the establishment of a long term fisheries data base, enabling the use of adaptive management principles. With the maintenance of long-term data base, we can assess responses of the fishery to changes in hydropower operations, habitat alterations, or changes in management. In addition, the continuation of the fishery monitoring program from 1988-1992 will allow us to validate biological models developed for Libby and Hungry Horse Reservoirs, thus linking fisheries recommendations and hydropower operations.

The project will provide information necessary for the management of the important fisheries resources in the Flathead Lake/River System, and in Libby Reservoir and its tributaries. These fisheries annually provide over 200,000 man-days of recreational fishing and produce a harvest of nearly one million gamefish to the angler. The project would address elements in the MDFWP Strategic Plan related to cold water lake and reservoir fisheries, river fisheries, and protection of fish species of special concern to Montana (westslope cutthroat and bull trout).

If this project is not conducted, management of these resources will be based on a more limited data base, and it will not be possible to monitor the fisheries to fully evaluate the results of mitigation or management actions. The project is timely and cost-effective because methods and procedures are in place, personnel are available, and there is a continuous record of information spanning five years or more.

We propose that the cost of the project be shared by the Montana Department of Fish, Wildlife and Parks (MDFWP), and federal agencies which have been involved in the Flathead River Basin/Northwest Power Act studies. If the project is fully funded by the Department and the agency consortium, it would maintain a special projects group consisting of one Program Manager/biologist, two biologists, four fisheries technicians, and an administrative secretary/word processor.

Description of the Evaluation/Monitoring Plan

Specific objectives and methods for the proposed program are presented in detail in the attached work plans for each segment: Hungry Horse/Libby Reservoirs (HHLRS), Flathead Lake/River Kokanee (FLRK), and Flathead River Basin Studies (FRBS). A generalized account is given below.

Segment	Major objectives or performance measures
ANNEX A Libby/Hungry Horse Reservoirs	Monitor the phytoplankton, zooplankton, benthic macroinvertebrates, insects on surface film, and fish species complex in the reservoirs; Validate and fine tune quantitative models of fisheries and operations; Input results into the Region 1 fisheries management program.
ANNEX B Flathead System Kokanee	Monitor kokanee escapement, spawning, incubation, and fry production in the river and lake system; Evaluate Mysis/ Zooplankton/Fry interactions in Flathead Lake; Fine-tune and evaluate mitigation measures; Input results into the Region 1 fisheries management program.
ANNEX C Flathead River Basin Studies Monitoring	Monitor bull trout spawning escapement in the river system; Monitor abundance of bull trout and westslope cutthroat juveniles in selected rearing areas; Monitor stream habitat conditions; Cooperate with regional staff in monitoring Flathead Lake fisheries; Input results into the fisheries management program.

PROPOSED FUNDING FOR ONE YEAR

(Proposed monitoring/evaluation period: 1988-1992)

Segment	Funding	Agency	Funded	Cost	Overhead +15.5%	Total Cost
Hungry Horse Libby Reservoir Study	147,066	MDFWP	15%	$ 22,060		$ 22,060
		BPA	40%	58,826	$9,118	67,945
		BOR	20%	29,413	4,558	33,971
		ACOE	25%	36,766	5,669	42,465
Total Hungry Horse Libby Reservoir Study						$166,441
Flathead Lake/ River Kokanee	115,624	MDFWP	15%	$ 17,344		$ 17,344
		BPA	50%	57,812	$8,961	66,773
		BOR	29%	25,125	3,584	26,709
		MPC	10%	11,562	1,792	13,354
		IJC	5%	5,781	896	6,677
Total Flathead Lake/ River Kokanee						$130,857
Flathead River Basin	25,681	MDFWP	23%	$ 6,221		$ 6,221
		USFS	62%	15,409	$2,388	17,797
		EPA	5%	1,284	199	1,483
		IJC	5%	2,568	398	2,966
Total Flathead River Basin						$ 28,467
TOTALS		MDFWP		$ 45,625		
		BPA		134,717		
		BOR		60,680		
		MPC		13,355		
		ACOE		42,465		
		USFS		17,797		
		EPA		1,483		
		IJC		9,643		
				$325,765		

SUMMARY
MONITORING BUDGET ESTIMATE

One year (proposed monitoring/evaluation period: 1988-1992)

A. SALARIES

Title	Grade/ Step	FTE	Salaries and Benefits	Total
Program Manager/Biologist	15/09	1.00	$ 33,108 00	
Project Biologist	14/12	1.00	32,438.00	
Project Biologist	14/06	1.00	28,766.00	
Fisheries Fieldworker II	10/07	1.00	21.833.50	
Fisheries Fieldworker II	10/07	1.00	21,833.50	
Fisheries Fieldworker II	10/07	1.00	21,833.00	
Fisheries Fieldworker I	08/05	1.13	20,780.00	
Secretary/Word Processor	10/05	1.00	20,961.00	
Work Study	01/01	.15	1,600.00	
TOTAL SALARIES				$203,153.00

B.	CONTRACTED SERVICES	$ 7,800.00
C.	SUPPLIES AND MATERIALS	$ 19,524.00
D.	COMMUNICATIONS	$ 4,300.00
E.	TRAVEL AND TRANSPORTATION	$ 35,593.00
F.	RENT	$ 6,000.00
G.	UTILITIES	$ 0.00
H.	MAINTENANCE/REPAIR	$ 12,000.00
I.	EQUIPMENT	$ 0.00

SUBTOTAL	$288,370.00
Less MDFWP Share	-47,108.00
Subtotal	241,262.00
Overhead 15.5%	37,395.00
Subtotal	278,657.00
Plus MDFWP Share	47,108.00
GRAND TOTAL	$325,765.00

ANNEX A

MONITORING EFFECTS OF RESERVOIR OPERATION ON GAMEFISH POPULATIONS IN HUNGRY HORSE AND LIBBY RESERVOIRS

Proposed Workplan FY1988

By:

Bruce May - Project Biologist
Fisheries Research and Special Projects
Montana Department of Fish, Wildlife and Parks
P.O. Box 67
Kalispell, Montana 59903

INTRODUCTION

The Hungry Horse and Libby Reservoir Studies (HHLRS) resulted from the Pacific Northwest Electric Power Planning and Conservation Act passed by Congress in 1980. The Act created the Northwest Power Planning Council (NPPC) which developed a comprehensive plan to protect and enhance fish and wildlife populations impacted by hydroelectric development in the Columbia River Basin. The maximum drawdown recommendation (Graham et al. 1982) of 90-110 ft. for Libby and 85 ft. for Hungry Horse Reservoirs were adopted by NPPC as part of the plan, except in years of extreme runoff,. Timing of the drawdown and refill was not addressed, but may play an important role in determining the effects of operation upon reservoir fisheries. The plan is being implemented by the Bonneville Power Administration (BPA).

The HHLRS studies began in May 1983 with a goal of quantifying seasonal water levels needed to maintain or enhance principal gamefish species in the two reservoirs. The end product of the studies in March 1988 will be two models which estimate the effect of reservoir operation on primary production, secondary production, fish habitat and gamefish populations. The project will result in a plan outlining the most desirable reservoir operations scenarios for fisheries. The information will be used to make future adjustments in operations as needed and will be applicable to other reservoir systems in the northwest.

Annual drawdown of reservoirs for flood control and power production causes reductions in surface area, volume, shoreline length, area in littoral zone, volume in euphotic zone and volumes in preferred temperature strata for trout. In addition, large outflow volumes reduce hydraulic residence times and weaken thermal structure. These changes in reservoir morphometrics and thermal stability translate into a reduction of habitat for fish food organisms and gamefish populations. The loss of the productive littoral zones in the upstream part of a reservoir may be especially detrimental to fish populations.

The objectives of the monitoring proposal are: 1) to provide the long-term data which is needed to verify the models, 2) evaluate the effects of any modification in reservoir operation upon gamefish populations, and 3) evaluate impacts of kokanee population in Libby Reservoir on food resources and other fish species.

DESCRIPTION OF THE STUDY AREAS

LIBBY RESERVOIR

Physical Environment

Libby Reservoir located in northwest Montana (Figure 1) was created in 1972 when Libby Dam impounded the Kootenai River. Operation of Libby dam for flood control and generation of hydroelectric power results in an annual drawdown and refill of the

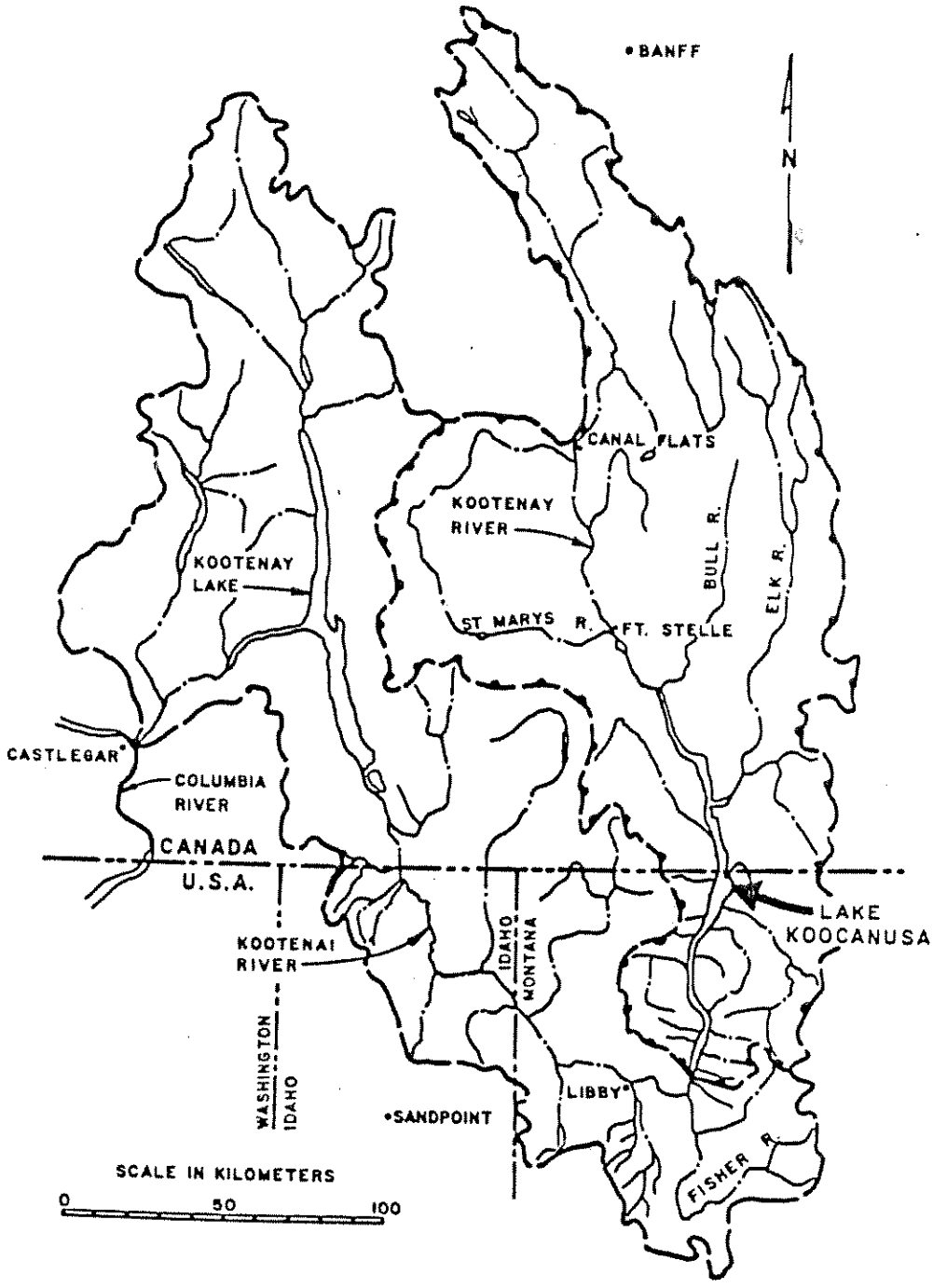

Figure 1. Map of the Kootenai River Basin showing the location of Libby Reservoir (Lake Koocanusa)(from Woods and Falter 1982).

reservoir. The morphometrics of the reservoir changes dramatically with changes in annual vertical water level fluctuations (Figure 2) of up to 172 ft (52.4 m).

Reservoir Biota

Primary productivity in Libby Reservoir was estimated by Woods and Falter (1982). Irving and Falter (1981) described the species composition, biomass, and spatial and temporal distribution of both the phytoplankton and zooplankton communities within Libby Reservoir during 1977. The phytoplankton community was dominated by Chrysophyta and Euglenophyta. The zooplankton community was dominated by Daphnia sp. in the upper part of the reservoir within the United States, and Cyclops and Diaptomus were most abundant in the lower reservoir. Phytoplankton and zooplankton densities peaked in early to mid-summer and were lowest in the winter. Shepard (1985) found a similar seasonal progression of zooplankton in 1983-84.

The fish community in Libby Reservoir has been monitored from impoundment through 1982 under a contract with the U.S. Army Corp of Engineers. A final report summarizing the work was completed in 1984 (Huston et al. 1984). The relative abundance of each species in the reservoir and trend of abundance from gill net and creel census sampling suggests the reservoir's fish community is still in a state of flux (Table 1).

Kokanee salmon abundance increased dramatically during recent years and a large spawning run was observed in 1982. The origin of this large year-class was probably an unauthorized release of kokanee fry from the Kootenay Trout Hatchery, upstream from the reservoir in British Columbia (Huston et al. 1984). Age information indicated the 1982 spawning run was dominated by the 1980 year class. The 1982 year class was also extremely strong, with an estimated 200,000 fish in the 1985 spawning run. Mountain whitefish and redside shiner abundance has declined in recent years, while peamouth abundance has steadily increased.

HUNGRY HORSE RESERVOIR

Physical Environment

Hungry Horse Dam was completed in 1952 and the reservoir reached full pool elevation of 3,560 feet msl in July 1953. The dam impounded the South Fork of the Flathead River eight km upstream from its confluence with the Flathead River (Figure 3). Hungry Horse is a large storage reservoir, operated by the Bureau of Reclamation, whose primary benefits are flood control and power production. At full pool the reservoir is 56 km in length with a surface area of 23,800 acres and a volume of 3,468,000 acre-feet. Fluctuations in pool elevtion have large impacts upon the morphometrics of the reservoir (Figure 4).

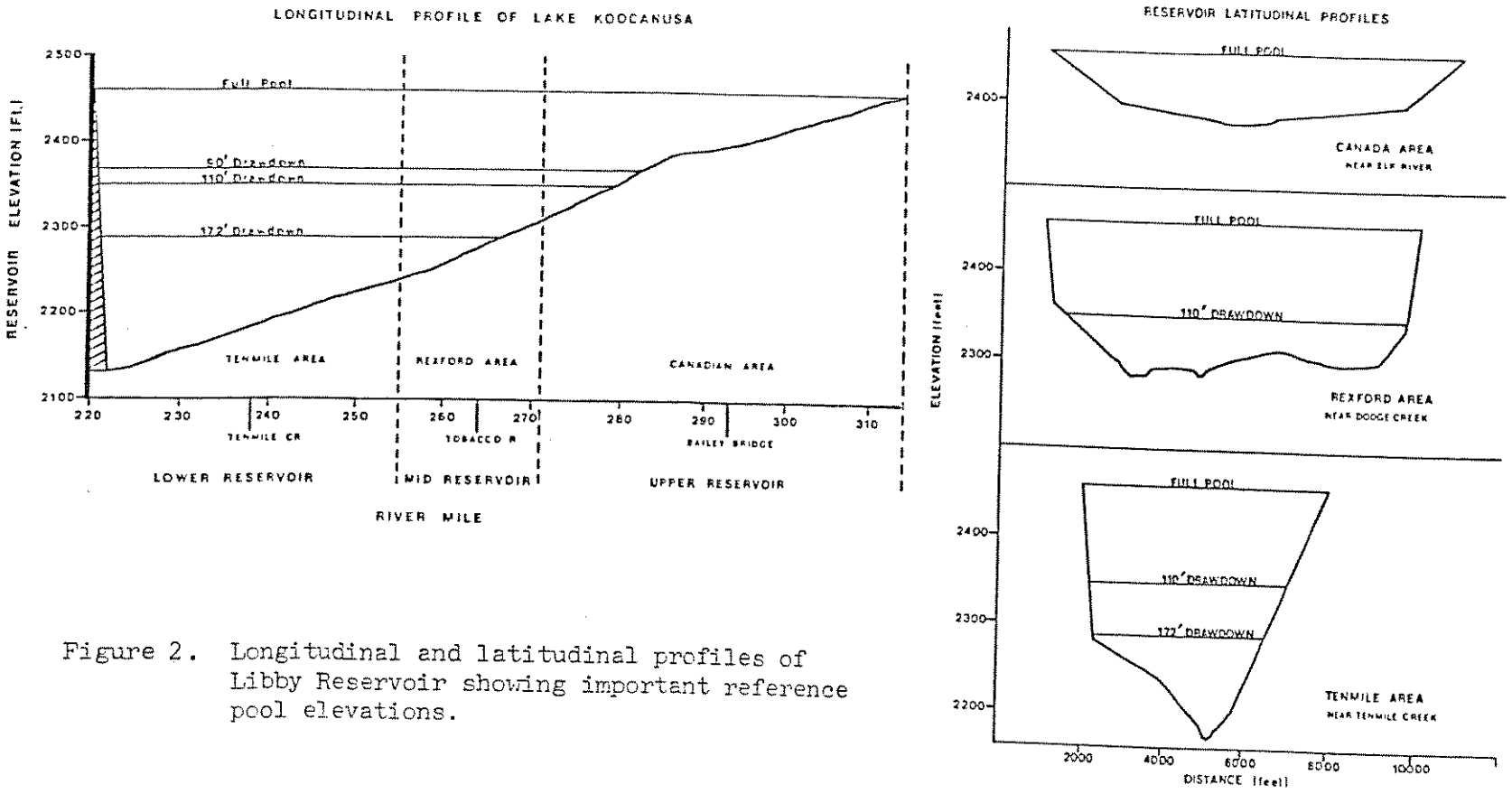

Figure 2. Longitudinal and latitudinal profiles of Libby Reservoir showing important reference pool elevations.

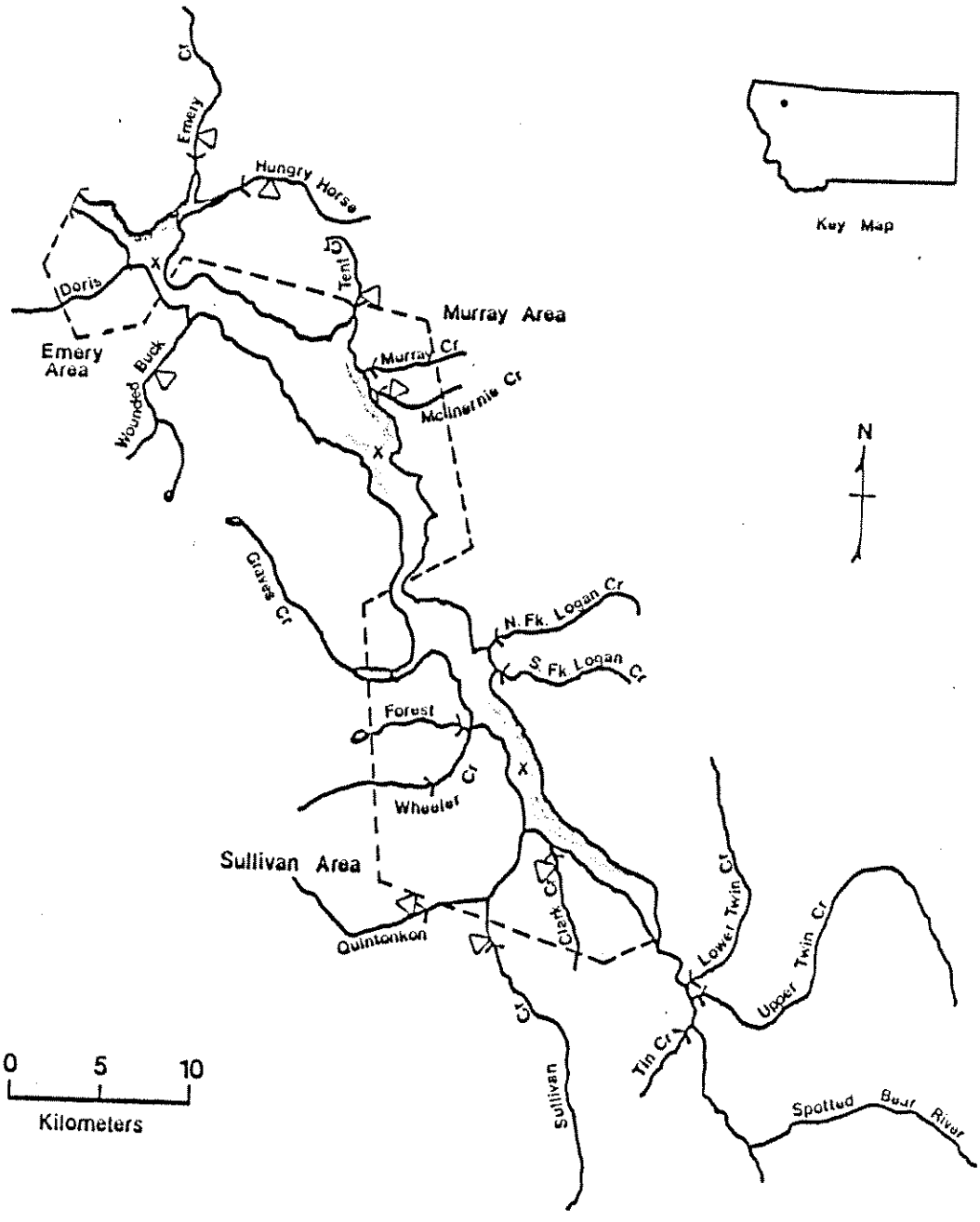

Figure 3. Map of Hungry Horse Reservoir showing study areas, netting areas (▒), water quality, vertical net and zooplankton stations (X), fish trap location (>), and electrofishing sections (Δ).

Table 1. The relative abundance of fish species in Hungry Horse Reservoir as determined by gill net catches and creel surveys from 1958 to 1983. Abbreviations are given in parentheses.

Species	Scientific name	Relative abundance[a]
	Native Species	
Westslope cutthroat trout (WCT)	Salmo clarki lewisi	A
Bull trout (DV)	Salvelinus confluentus	A
Mountain whitefish (MWF)	Prosopium williamsoni	A
Pygmy whitefish (PWF)	Prosopium coulteri	R[b]
Northern Squawfish (NSQ)	Ptychocheilus oregonensis	A
Largescale sucker (LnSU)	Catostomus catostomus	C
Sculpin species	Cottus sp.	R
	Exotic species	
Rainbow trout (RB)	Salmo gairdneri	R
Yellowstone cutthroat trout (YCT)	Salmo lewisi bouvieri	R
Arctic grayling (GR)	Thymallus arcticus	R

[a] Relative abundance: A=abundant, C=common, R=rare.

[b] Pygmy whitefish may be more abundant than net catches indicated because they inhabit deep offshore waters and are not vulnerable to shoreline nets sets.

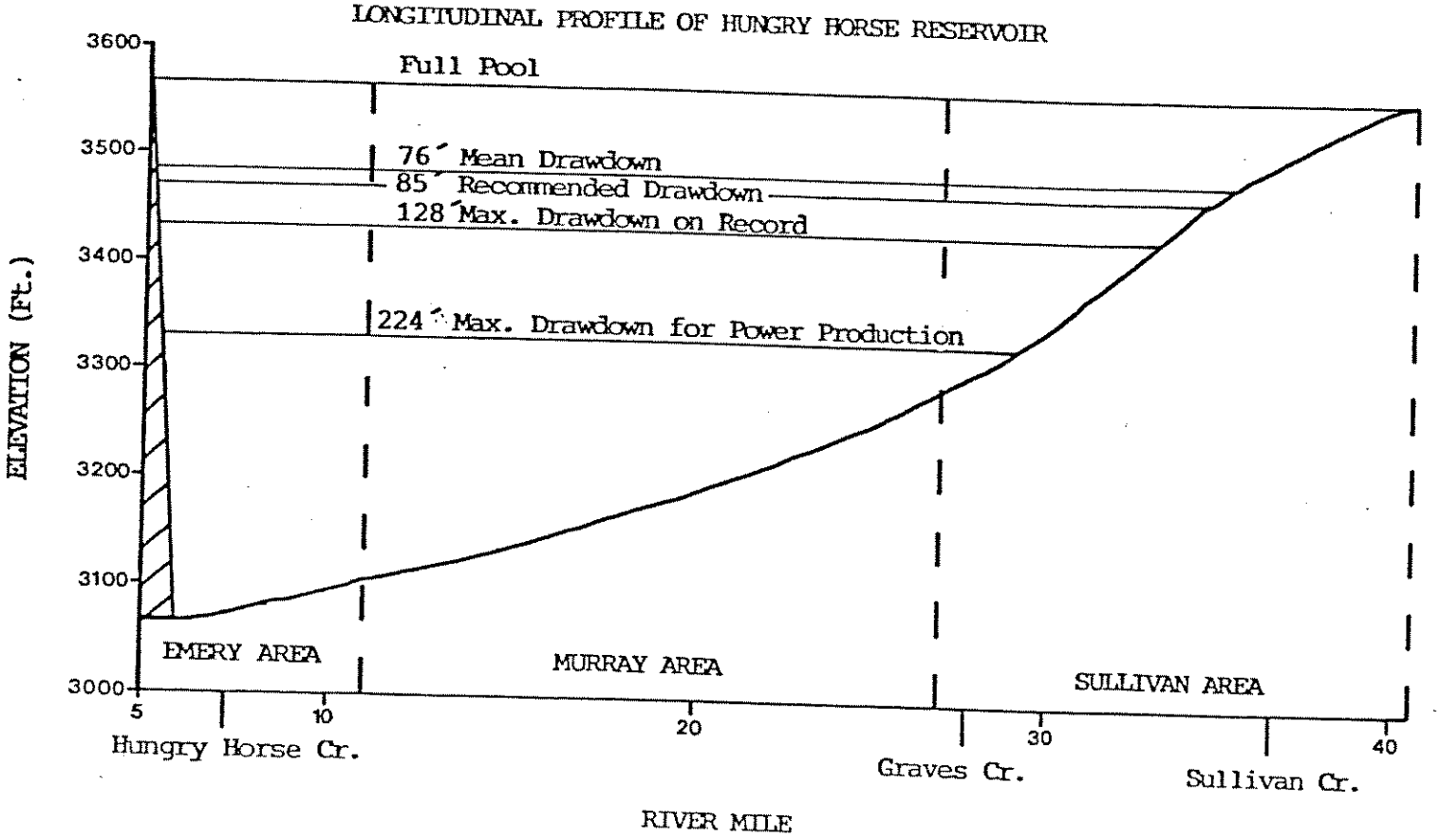

Figure 4. Longitudinal cross-sectional profile of Hungry Horse Reservoir at water surface elevations of 3,560 (full pool), 3,484; 3,475; 3,432 and 3,336.

Reservoir Biota

Phytoplankton and zooplankton communities were not studied prior to the present reservoir study. Zooplankton data collected in 1984 indicated that Daphnia comprised about 49% of the biomass followed by Cyclops with 24% and Diaptomus approximately 20%. The remainder was comprised of Bosmina, Epischura and Leptodora. Zooplankton peaks of abundance occurred in August and November. A primary productivity study will be conducted in 1986.

Prior to construction of Hungry Horse Dam in 1952, the South Fork of the Flathead River drainage was considered the major spawning area for adfluvial fish stocks from Flathead Lake. Substantial numbers of bull trout and westslope cutthroat trout spawned in the South Fork drainage along with smaller numbers of mountain whitefish and kokanee salmon. Native fish species in the South Fork drainage prior to dam construction included westslope cutthroat, bull trout, mountain whitefish, northern squawfish, largescale sucker, longnose sucker, pygmy whitefish and sculpins.

Today, the native species comprise almost the entire fish population in the reservoir. They are considered abundant except for pygmy whitefish and longnose suckers which are rated as rare and common, respectively (Table 1). Populations in the reservoir appeared to have stabilized and changes in relative abundance since 1970 appear to be comparatively small.

MONITORING WORK PLAN

The sampling program for the two reservoirs includes: 1) water quality profiles; 2) quantifying benthos, macroinvertebrates, zooplankton, and surface macroinvertebrates, and; 3) assessing the abundance of fish populations by the use of horizontal and vertical gill nets, and fish traps, acoustical gear and trawling (Tables 2 & 3). The Murray area in Hungry Horse and the Rexford area in Libby will be the primary locations sampled. An outline of sampling frequency and methodology is given below. Methodology is detailed in previous reports (May and Zubik 1985) and (Shepard 1985).

WATER QUALITY

Temperature and pH will be measured with a Martek V meter, and euphotic zone depth with a Protomatic photometer. Both light penetration and water quality profiles will be measured at the permanent station biweekly from April through November in Libby and May through November in Hungry Horse. This data will be entered into the U.S. Geological Survey WATSTORE system and the data summarized in isopleth diagrams.

Table 2. Project year 1987-88 Activities Matrix for Hungry Horse Reservoir.

	Man Days												
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Total
Data Collection:													
Water quality	1	--	--	--	--	--	1	1	1	1	1	1	7
Surface insects	1	--	--	--	--	--	1	1	1	1	1	1	7
Zooplankton tows	1	--	--	--	--	--	1	1	1	1	1	1	7
Benthos	--	--	--	--	--	--	2	--	--	2	--	2	6
Gill netting	20	--	--	--	--	--	20	--	--	--	--	--	40
Fish trapping	--	--	--	--	--	--	5	30	25	10	--	--	70
Equipment maintenance	5	5	--	--	--	6	6	5	5	5	5	5	47
													184
Laboratory:													
Surface insects	*----------											----------*	21
Zooplankton	*----------											----------*	22
Benthos	*----------											----------*	10
Mount scales	*----------											----------*	10
Read scales	*----------											----------*	15
													78
Data Analysis:													
Data entry	*----------											----------*	40
Statistical analysis	*----------											----------*	20
Data summary	*----------											----------*	20
(graphs & figures)	. . . . .											. . . . .	80
Report Preparation:													
Literature review	*----------											----------*	10
Report preparation	*----------											----------*	30
Word processing	*----------											----------*	15
													55
Administrative and Clerical:	*----------											----------*	30
Word processing	*----------											----------*	30
Clerical	*----------											----------*	30
Project manager	*----------											----------*	90
													487
TOTAL													

Table 3. Project year 1987-88 Activities Matrix for Libby Reservoir.

	Man Days												
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Total
Data Collection:													
Water quality	1	--	--	--	--	1	1	1	1	1	1	1	8
Surface insects	1	--	--	--	--	1	1	1	1	1	1	1	8
Zooplankton tows	1	--	--	--	--	1	1	1	1	1	1	1	8
Benthos	--	--	--	--	--	--	2	--	--	2	--	2	6
Vertical netting	--	--	--	--	--	--	8	--	--	8	--	8	24
Gill netting	--	--	--	--	--	--	20	--	--	--	--	20	40
Sonar kokanee estimates	--	--	--	--	--	--	--	--	--	30	--	--	30
Kokanee juvenile sampling	--	--	--	--	--	--	--	--	--	40	20	--	60
Kokanee spawning run monitoring	--	--	--	--	--	--	--	--	--	--	--	10	10
Fish trapping	--	--	--	--	--	--	20	30	20	10	--	--	80
Equipment maintenance	6	6	6	--	--	6	6	6	6	6	6	6	60
											334		
Laboratory:													
Surface insects	*----------*												25
Zooplankton	*----------*												25
Benthos	*----------*												10
Mount scales	*----------*												15
Read scales	*----------*												20
													95
Data Analysis:													
Data entry	*----------*												60
Statistical analysis	*----------*												30
Data summary (graphs & figures)	. . . . .												20
													110
Report Preparation:													
Literature review	*----------*												10
Report preparation	*----------*												40
Word processing	*----------*												15
													65
Administrative and Clerical:													
Word processing	*----------*												30
Clerical	*----------*												30
Project manager	*----------*												35
													95
TOTAL													699

FISH FOOD ORGANISMS

Zooplankton

Three 30 m vertical tows will be made biweekly with a Wisconsin plankton net in one area from April through November. One tow will be from the permanent station and two will be randomly selected. Cladocerans and copepods will be identified to genus.

Surface Insects

Surface insects will be sampled at three randomly selected transects weekly from April through November in one area using a net attached to a one meter by 0.3 meter frame. Two tows will be made at each transect, one within 100 meters of the shoreline and the other farther than 100 meters from the shore. The tows will be made in a zig-zag pattern at a speed of about one meter per second until a distance of 600 meters has been sampled. The insects will be identified to order and the weight of each order determined.

Benthos

Collect benthos seasonally with a Peterson dredge in the reservoir study area. A total of nine samples will be taken at a permanent transect and taken from each of the following depths: 1) full pool elevation to recommended drawdown, 2) recommended to maximum drawdown on record, and 3) below maximum on record. The macroinvertebrates will be identified to order and the wet weights of each insect order determined.

FISH POPULATIONS

Abundance

Seasonal and annual changes in fish abundance in near-shore zones will be assessed using floating and sinking gill nets. These nets are 38.1 m long and 1.8 m deep and consist of five equal panels of 19, 25, 32, 38 and 51 mm mesh. A floating gill net set consists of two nets tied end-to-end creating a 76.2 m long net. Sinking net sets will be individual. All nets will be set perpendicular from shore and catches reported as the number of fish per single net.

Both reservoirs will be sampled in the spring and fall. Libby will be netted when water temperatures are appxoimately 10°C in the spring and 15°C in the fall, while the gill net sampling in Hungry Horse will take place in the spring and fall when temperatures are in the 8° - 10°C range. Approximately 40 sinking and 10 floating sets will be made in Libby in the spring as compared to 20 sinking and 20 floating sets in Hungry Horse. The fall net series in Libby will consist of 20 floating sets, whereas in Hungry Horse the net numbers will be the same as in the spring.

Fish traps in Big Creek and Young Creek will be used to capture spawning runs of westslope cutthroat trout from Libby Reservoir; an upstream box trap in the bypass channel collects spawning adults and a Wolfe type downstream trap captures spent adults and smolting juveniles. All fish collected in the traps will be anesthesized, measured, weighed, scale sampled, marked and released.

Additional sampling to determine abundance and growth of kokanee will be done in Libby Reservoir. Vertical gill nets will be set seasonally to evaluate kokanee year class strength and determine emperical seasonal growth increments. Four vertical nets will be set in the evening and retrieved the next morning. The nets are 3.7 m wide, 45.6 m deep and depths are marked in 1.0 m increments. Each set includes 4 nets of square mesh size 19, 25, 32, and 38 mm. The number of adult kokanee will be estimated using hydroacoustical sampling during moonless nights in August and September. Vertical gill net data will be used to assign a proportion of the targets as kokanee. Approximately 40 transects covering 78 km will be surveyed throughout the reservoir. A Tucker Trawl will be used to estimate abundance of Age 0 and Age I kokanee. This is a new technique and the details of the sampling design are in the process of being developed. Aerial flights will be used to count spawning densities of kokanee in tributary streams during September and October.

DATA PROCESSING AND REPORTING

Data collected during the monitoring study will be integrated into the data base management system currently being used for the HHLR studies. Summaries and analysis of data will be accomplished by methods developed during the present studies. The processed data will be used to validate the models relating reservoir operation to the production of fish and fish food organisms and to evaluate the impacts of changes in reservoir operation upon the reservoir fishery.

A brief narrative summary describing the months activities and next month's workplan will be prepared. An annual report which covers the years activies will be prepared. This report will include results and discussions, summary, conclusions, and appendices that contain detailed summaries of all data collected. We will continue to evalute additional information as it applies to reservoir operations and management of the fisheries.

LITERATURE CITED

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HUNGRY HORSE AND LIBBY RESERVOIRS
MONITORING BUDGET ESTIMATE

November 15, 1987 - November 14, 1988

A. SALARIES

Title	Grade/ Step	FTE	Salaries and Benefits	Total
Program Manager/Biologist	15/09	.25	$ 8,276.88	
Fisheries Biologist II	14/12	1.00	32,438.43	
Fisheries Fieldworker II	10/07	1.00	21,833.18	
Fisheries Fieldworker II	10/07	1.00	21,833.18	
Fisheries Fieldworker I	08/05	.58	10,664.37	
Work Study Student	01/01	.15	1,599.94	
Secretary/Word Processor	10/05	.58	12,159.49	
TOTAL SALARIES				$108,804.00

B. CONTRACTED SERVICES

Airplane rental for kokanee spawning counts	$ 1,000.00	
U.S.G.S. water quality data base isopleth generation	1,000.00	
Otolith aging for monthly and seasonal growth	3,000.00	
Statistical model consulting	1,000.00	
TOTAL CONTRACTED SERVICES		$ 6,000.00

C. SUPPLIES AND MATERIALS

Propane for Anna Creek	$ 300.00	
Gasoline for boats (3,000 gal. @ 1.20/gal)	3,000.00	
10 gill nets (replacement of damaged nets)	1,500.00	
Laboratory reagents and supplies	500.00	
Field supplies (minor tools and instruments, field monitoring supplies, photographic supplies, fish trap materials, etc.)	3,000.00	
Office supplies and materials	2,000.00	
TOTAL SUPPLIES AND MATERIALS		$ 10,300.00

D. COMMUNICATIONS $ 800.00

E.	TRAVEL (Includes per diem)		
	Two 3/4 ton 4x4 pickups (1 with propane conversion) 1,200 mi/mo x 8 mo. = 19,200 mi. @ .28	$ 5,376.00	
	One compact pickup 1,000 mi/mo x 8 mo. = 8,000 mi. @ .22	1,760.00	
	One subcompact sedan 300 mi/mo x 10 mo. = 3,000 mi. @ .19	570.00	
	Per diem 4 people in field @ 16.00 per day x 10 days/mo. x 8 mos.	5,120.00	
	One trip to Portland airfare-$300.00, lodging-$35.00, meals-$50.00, car rental-$50.00	435.00	
	BPA Coordination meeting - Sandpoint, Idaho (3 people mileage-$200.00, meals-$200.00, lodging-$100.00)	500.00	
	Kootenai/Flathead Coordination Meeting mileage-$150.00, meals-$150.00, lodging-$100.00	400.00	
	TOTAL TRAVEL		$ 14,161.00
F.	RENT		$ 2,000.00
G.	UTILITIES		$ 0.00
H.	MAINTENANCE/REPAIR Boats, trailers, field equipment		$ 5,000.00
I.	EQUIPMENT		$ 0.00
	SUBTOTAL		$147,065.00
	Less MDFWP Share		-22,060.00
	Subtotal		125,005.00
	Overhead 15.5%		19,376.00
	Subtotal		144,381.00
	Plus MDFWP Share		22,060.00
	TOTAL CONTRACT		$166,441.00

ANNEX B

MONITORING OF FLATHEAD SYSTEM KOKANEE FISHERIES AND EVALUATION OF METHODS TO MITIGATE THE EFFECTS OF HYDROELECTRIC DAM OPERATION ON KOKANEE REPRODUCTIVE SUCCESS

PROPOSED WORK PLAN - FY1988

Prepared by:
Pat Clancey, Project Biologist
Will Beattie, Project Biologist

FISHERIES RESEARCH - SPECIAL PROJECTS
MONTANA DEPARTMENT FISH WILDLIFE AND PARKS

PREFACE

Study of the effects of hydroelectric dam operation on the kokanee salmon fisheries of the Flathead system began in 1981 and will conclude in 1987 under funding from the Bonneville Power Administration. The results of these studies will include recommendation of methods to mitigate the effects of hydropower operations. This proposal outlines a plan to monitor the effectiveness of the controlled flows in the Flathead River and mitigation strategies with continued study of the population dynamics of kokanee salmon in Flathead Lake and in the Flathead River system.

PROJECT STATUS

Studies of kokanee salmon in the Flathead River system were conducted by the Montana Department of Fish, Wildlife and Parks (MDFWP) from 1979-1982 with funding provided by the Bureau of Reclamation (Graham et al. 1980, McMullin and Graham 1981, Fraley and Graham 1982). These studies recommended flow of 3,500 to 4,500 cfs, measured at Columbia Falls, during the kokanee spawning period (15 October-15 December). A minimum flow of 3,500 cfs was recommended during the incubation period (15 December-30 April). These flows were intended to reduce redd dewatering, and the resulting high egg mortality, caused by the fluctuating discharge from Hungry Horse Dam. Flows were recommended by the Northwest Power Planning Council (NPPC 1982) and were provided by the Bureau of Reclamation during 1982-83 and 1983-84. Preliminary study flows were provided by the Bureau of Reclamation during 1980-81 and 1981-82. Research has focused on enumerating escapement and measuring egg-to-fry survival in spawning areas influenced by these flows and in tributaries that are not affected by releases from Hungry Horse Dam.

Study of the effects of lake level fluctuation on kokanee spawning success in Flathead Lake began in 1981. Releases of water through Kerr Dam to meet winter power demands lower the elevation of Flathead Lake ten feet. The lake has been drafted to minimum pool between February 15 and March 15 for the last five years. Kokanee eggs, deposited in shallow water in October and November, are exposed to freezing and desiccation. For the past five years, 50-90% of lakeshore spawning has occurred in sites above minimum pool (2,883 ft.). In most of these areas egg mortality is complete after two months exposure. Kokanee spawning persists at some shallow sites because groundwater seeps improve egg survival and facilitate fry emergence. The lakeshore "run" now comprises 2-4% of spawning in the entire drainage. Returns to the west shore, which were abundant in the 1950's and 1960's, have been eliminated except at one site in Rollins Bay. The persistence of strong lakeshore spawning returns into the early 1960's, twenty-five years after Kerr Dam was built, was in part due to artificial enhancement at several eastshore areas.

Proposed monitoring activities on the Flathead River are essential to develop a clear understanding of kokanee escapement and population trends, and to evaluate the effectiveness of the recommended flows in the Flathead River. Continued monitoring of escapement will allow generation of a stock-recruitment curve. Studies of the alevin survival and fry production are also necessary to evaluate the effectiveness of the controlled flows in the Flathead River.

To mitigate the effects of dam operations on Flathead Lake kokanee, several strategies could be used. Enhancement of lakeshore and tributary spawning runs would add diversity to the reproductive potential of the population, and long-term stability to the fishery. Methods to enhance the lakeshore run should be tested. Enhancement could be implemented by minimizing the time that the lake is held at minimum pool, or by artificial means such as hatcheries or spawning channels. These methods could include artificial enhancement of spawning at sites below minimum pool and re-establishing runs into a tributary stream. The reproductive potential of the Swan River could be improved by constructing a spawning channel. Whatever mitigation strategy is adopted under the direction of the Federal Energy Regulatory Commission (FERC), considerable effort is warranted to monitor its effectiveness in enhancing and stabilizing the Flathead kokanee population.

Monitoring through 1990 would allow us to assess egg-to-adult survival in five successive year classes of kokanee. It would allow us to continue essential measurement of the growth and survival of juvenile kokanee in Flathead Lake which began in the spring of 1986. Understanding the survival of young of the year (YOY) fish is becoming more critical as the abundance of Mysis relicta, the oppossum shrimp, has increased exponentially in Flathead Lake over the past four years. Mysid shrimp compete with kokanee for cladoceran zooplankton. Changes in zooplankton community structure and YOY kokanee survival have been observed following the establishment of mysid shrimp populations in other lakes (Rieman and Falter, 1981). Identification of this kind of change in the carrying capacity of Flathead Lake with respect to kokanee salmon is essential to developing methods to mitigate the effects of hydropower operations on Flathead fisheries. Mitigation that proposes to stabilize reproduction and recruitment of kokanee must be consistent with concurrent changes in the trophic ecology, such as that attributed to mysid shrimp.

MONITORING WORK PLAN

A. Escapement counts

The number of kokanee redds are an indicator of the numbers of successful spawners in a particular area. Escapement can be estimated from redd counts by applying a ratio of the number of spawners associated with a completed redd. The number of spawners per completed redd averages 2.4 in the Flathead River system.

Redd counts to monitor kokanee population trends are proposed for major spawning sites in the main stem Flathead River, South Fork of the Flathead River, two tributaries of the Middle Fork of the Flathead River, the Whitefish River, and at ten areas on the shore of Flathead Lake. All redd counts are high priority, i.e. are considered essential to monitor kokanee population trends. We will collect kokanee at major spawning areas for age, sex and length analysis.

Snorkel counts of kokanee spawners in lower McDonald Creek should be conducted biweekly from early September through mid-November to determine timing of the spawning run. The counts are conducted on the 4 km of stream from McDonald Lake to the Middle Fork of the Flathead River.

Spawner surveys on Flathead Lake, using boat and SCUBA, would cover the principle east shore areas. Four surveys will be done - in November and early December. Two aerial surveys of the west shore would supplement boat surveys. The Swan River run will be monitored with biweekly snorkel counts at Bigfork Dam, from mid-October to early December.

Fishing success has been a good indicator of the strength of the kokanee spawning run in the main stem Flathead River during past years. Catch rates during the odd numbered years when main stem runs were relatively strong were 1.99, 1.94, 2.02 and 1.38 kokanee per hour during 1975, 1979, 1981 and 1983, respectively. Catch rates were only 0.40 and 0.48 during 1980 and 1982 when the main stem kokanee run was weak (Hanzel 1977, Fredenberg and Graham 1982, Fraley and Graham 1982, Fraley and McMullin 1983).

B. Preemergent Survival

Sampling kokanee eggs and alevins in spawning gravels provides data on survival and development that can be compared between years at a particular site. It is recommended that egg and alevin sampling be conducted during late January in McDonald Creek and the mainstem of the Flathead River to monitor development and survival.

C. Fry Survival

Estimating the abundance and timing of fry emigrating from the river system will be coordinated with studies of YOY kokanee on Flathead Lake. The number of emigrating fry will be estimated by drift-netting the lower Flathead River throughout the cross-sectional area of the water column. Several lower river sloughs and backwater areas will be netted or electrofished to determine if fry are rearing in them.

Fry will be sampled in Flathead Lake by trawling, during late spring/early summer. Early summer zooplankton abundance may be reduced by the rapidly increasing grazing pressure of oppossum shrimp (Mysis relicta). Growth rate and survival of YOY kokanee may be affected. Growth rate will be determined by reading daily growth increments on otoliths (Campana and Nielsen, 1985). The incidence of stress checks, associated with periods of starvation, should increase, and growth rates should decline if food availability becomes critical. Food habits of fry will be analyzed by examining stomach contents. If the abundance of preferred prey (cladocerans e.g. Daphnia thorata) is reduced, we should detect a shift in food habits. Sampling will continue on a monthly basis, from May through October, to follow food habits, growth and survival.

D. Adult and Sub-adult Year Class Strength

Age II+ and III+ kokanee will be sampled in Flathead Lake by trawling or with gill nets. Hydroacoustic gear will assist in locating aggregations of fish. We will develop estimates of abundance for each year class, and measure growth rates by reading otoliths. Baseline growth rate data has been collected by MDFWP for the past ten years, which will allow comparison of growth parameters before and after the impact of mysid shrimp. The assumptions of density dependent growth in the lake will be tested. Transects representative of all limnetic habitats in Flathead Lake will be sampled before mature fish begin the spawning run upriver, and after these mature fish have left the main lake. Species composition and age of acoustic targets will be verified in Tucker trawl and gill net samples. This yearly sampling of the kokanee population will provide accurate estimates of year class strength for all ages of fish, and will allow us to monitor the effectiveness of mitigation efforts that improve reproductive success. Hatchery produced fish will be marked to follow their survival and recruitment to the fishery. Abundance estimates will provide a sound basis for management of the kokanee fishery.

Food habits and yearly growth increments will be examined for the effects of changes in the zooplankton food base caused by the increased grazing pressure of Mysis relicta. Methods to investigate the effects of Mysis will be developed in the 1986 and 1987. Population dynamics studies will all be conducted in cooperation with FWP R-1 staff, and personnel at the Yellow Bay Biological Station.

E. Zooplankton abundance will be sampled at three index stations through the year. Spring/early summer community composition and species density will be sampled at six stations biweekly from break-up to the end of June. We will take zooplankton hauls at stations where we sample fish with the trawl. This sampling regime is designed to detect changes in the zooplankton community,

as mysid grazing pressure increases, especially during the growing season of kokanee. Mysid abundance will be monitored at all stations using vertical net hauls at night.

F. Evaluation of Artificial Enhancement

Experimental Fry Plants: As alternate strategies to mitigate the effect of dam operation are developed, some testing of artificial enhancement will be necessary. We will evaluate the effectiveness of shoreline egg/fry plants by marking subsamples of fry, either with tetracycline or fin clips. If a more sophisticated mark were employed, e.g. the coded wire bag, various release schedules could be tested to select the optimum timing. If competition with mysid shrimp decreases natural YOY fry survival, we will attempt large-scale fry plants in the lake. These plants will be timed to coincide with the maximum availability of cladoceran zooplankton. Mark/recapture techniques will be used to assess survival of these fry.

We will study the feasibility of building a spawning channel at Bigfork Dam to enhance the productivity of the Swan River kokanee run. Reproduction in Swan River is now limited by lack of spawning habitat. The present spawning escapement of 1000 to 1500 fish could be increased to 5000 fish by improving reproductive success. The spawning run into Dayton Creek, on the west shore of the lake, could also be re- established. Experimental plants of sac-fry will test the feasibility of this plan, once the availability of spawning habitat has been determined. Planted fry will be marked to allow their recognition as adults four years later.

FLATHEAD RIVER KOKANEE MONITORING
ACTIVITY SCHEDULE

Activity	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Man-days
Redd counts		4	12										16
Snorkel counts	7	9	3										19
Fish samples		2	3	1									6
Fry sampling							2	8	13	13			36
Creel survey	5	5											10
Egg & alevin sampling					4	2							6
Clerical	11	11	11	11	11	11	11	11	11	11	10	10	130
TOTAL MAN DAYS	23	31	29	12	15	13	13	19	24	24	10	10	223

Summary of activities and man-day requirements outlined in the Flathead River system kokanee monitoring report.

FLATHEAD LAKE KOKANEE MONITORING
ACTIVITY SCHEDULE

Activity	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Man-days
Spawner surveys		8	13	8	25								54
YOY survival & abundance	16	16	30	30					16	16	16	16	156
Population dynamics	20				25	25	30					20	120
Zooplankton monitoring	9	9	9	9	9	25	25	15	15	15	9	9	158
Expt'l fry plants								20		20	20		60
Clerical	11	11	11	11	11	11	11	11	11	11	10	10	130
TOTAL MAN DAYS	56	44	63	58	70	61	66	46	42	62	55	55	678

FLATHEAD SYSTEM
MONITORING BUDGET ESTIMATE

November 15, 1987 - November 14, 1988

A. SALARIES

Title	Grade/ Step	FTE	Salaries and Benefits	Total
Project Manager	15/09	.35	$ 11,588.00	
Fisheries Biologist II	14/06	1.00	28,766.00	
Fisheries Fieldworker II	10/07	.80	17,467.00	
Fisheries Fieldworker I	08/05	.47	8,648.00	
Secretary/Word Processor	10/05	.38	7,965.00	
TOTAL SALARIES				$ 74,434.00

B. CONTRACTED SERVICES

Aircraft rental (kokanee migration, angler counts redds surveys) 30 hr @ $60/hr	$ 1,800.00	
TOTAL CONTRACTED SERVICES		$ 1,800.00

C. SUPPLIES AND MATERIALS

Gasoline for boats (900 gal @ 1.36/gal)	$ 1,224.00	
Field supplies (minor tools and instruments, photographic supplies, field monitoring supplies, etc.)	1,000.00	
Office supplies (photocopying, photography, etc.)	3,500.00	
Computer materials/supplies	3,000.00	
TOTAL SUPPLIES AND MATERIALS		$ 8,724.00

D. COMMUNICATIONS

Telephone	$ 2,500.00	
Postage	1,000.00	
TOTAL COMMUNICATIONS		$ 3,500.00

E. TRAVEL AND TRANSPORTATION

One 1/2 ton 4x4 pickup 1,000 mi/mo x 12 mos = 12,000 mi @ .24	$ 2,880.00	
One 1 ton 4x4 pickup 800 mi/mo x 12 mos = 9,600 mi @ .50	4,800.00	
One 1/2 ton pickup 400 mi/mo x 12 mos = 4,800 mi @ .21	1,008.00	
Per diem 4 people in field @ 14.50 per day x 161 days	9,338.00	
Three trips to Portland airfare-$300.00, per diem/bus-$150.00 = $450/trip total	1,350.00	
Annual 1987 Montana, Idaho, British Columbia, Alberta annual fisheries meeting - mileage-$150, per diem-$90(2), lodging-$50(2) =	$ 290.00	
TOTAL TRAVEL AND TRANSPORTATION		$ 19,666.00
F. RENT		$ 2,000.00
G. UTILITIES		$ 0.00
H. MAINTENANCE/REPAIR Boats, trailers, diving gear, thermograph pumps, freight, etc...	$ 3,000.00	
Computer/office equipment	2,500.00	
TOTAL MAINTENANCE/REPAIR		$ 5,500.00
I. EQUIPMENT		$ 0.00
SUBTOTAL		$115,624.00
Less MDFWP Share		17,344.00
Subtotal		98,280
Overhead 15.5%		15,233.00
Subtotal		113,513.00
Plust MDFWP Share		17,344.00
TOTAL CONTRACT		$130,857.00

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ANNEX C

A PROGRAM FOR MONITORING WESTSLOPE CUTTHROAT AND BULL TROUT POPULATIONS AND STREAM HABITAT IN THE FLATHEAD RIVER SYSTEM

Workplan

Prepared by:
John Fraley, Project Manager

Fisheries Research and Special Projects
Montana Department of Fish, Wildlife and Parks
P.O. Box 67
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December, 1985

INTRODUCTION

Monitoring of fishery resources in the Flathead Basin is essential for the responsive management of fish populations in the drainage. In addition, a comprehensive monitoring program is required to detect changes in fish populations and habitat caused either naturally or by various forms of resource development. The monitoring program outlined in this report is a revision and update of a previous fishery resource monitoring strategy (Shepard and Graham 1983). The program involves fish abundance monitoring, bull trout spawning site inventories, and streambed composition in the Flathead River basin. The areas proposed for monitoring include selected tributaries of the North and Middle Forks of the Flathead River, the North Fork of the Flathead River and selected tributaries of the Swan River.

The Flathead River Basin Studies (FRBS), which were conducted from 1978-1983, provided an extensive fishery resource data base for comparisons of fish population and habitat trends (Montana Department of Fish, Wildlife and Parks 1979, Graham et al. 1980, Fraley et al. 1981, Shepard et al 1982, Graham et al. 1982, Fraley and Graham 1982, Shepard and Graham 1983, 1983a, Shepard et al. 1984). These studies also evaluated methods for evaluating fish abundance and habitat. The monitoring program recommended in this report is based on results and recommendations from the FRBS, as well as on information generated from other studies conducted since the FRBS were completed.

AREA DESCRIPTION AND MONITORING SITES

The Flathead Lake-River system is the northeastern-most drainage in the Columbia River Basin (Figure 1). Flathead Lake is a large oligomesotrophic lake with a surface area of 476 km^2 and a mean depth of 32.5 m. The upper 3 m of Flathead Lake is regulated by Kerr Dam, constructed on the outlet in 1938. The Flathead River enters the north end of the lake. The lower 35 km of the river is regulated by Kerr Dam, and is slough-like with a silt bottom. The remainder of the river has a moderate gradient and gravel-rubble bottom for 55 km to its forks.

The South, Middle and North Forks drain areas of approximately equal size in portions of the Great Bear and Bob Marshall Wildernesses, Glacier National Park and the Flathead National Forest (Figure 1). The upper North Fork drains southern British Columbia. The South Fork is regulated and the main stem below the South Fork is partly regulated by Hungry Horse Dam, located on the South Fork 8 km above its mouth. The Swan river enters Flathead Lake near the mouth of the Flathead river.

Many fish species are migratory within the lake-river system. Adfluvial bull trout and cutthroat grow to maturity in Flathead Lake, ascend the river system and its tributaries to spawn, then return to the lake. Bull trout spawn in river tributary system in

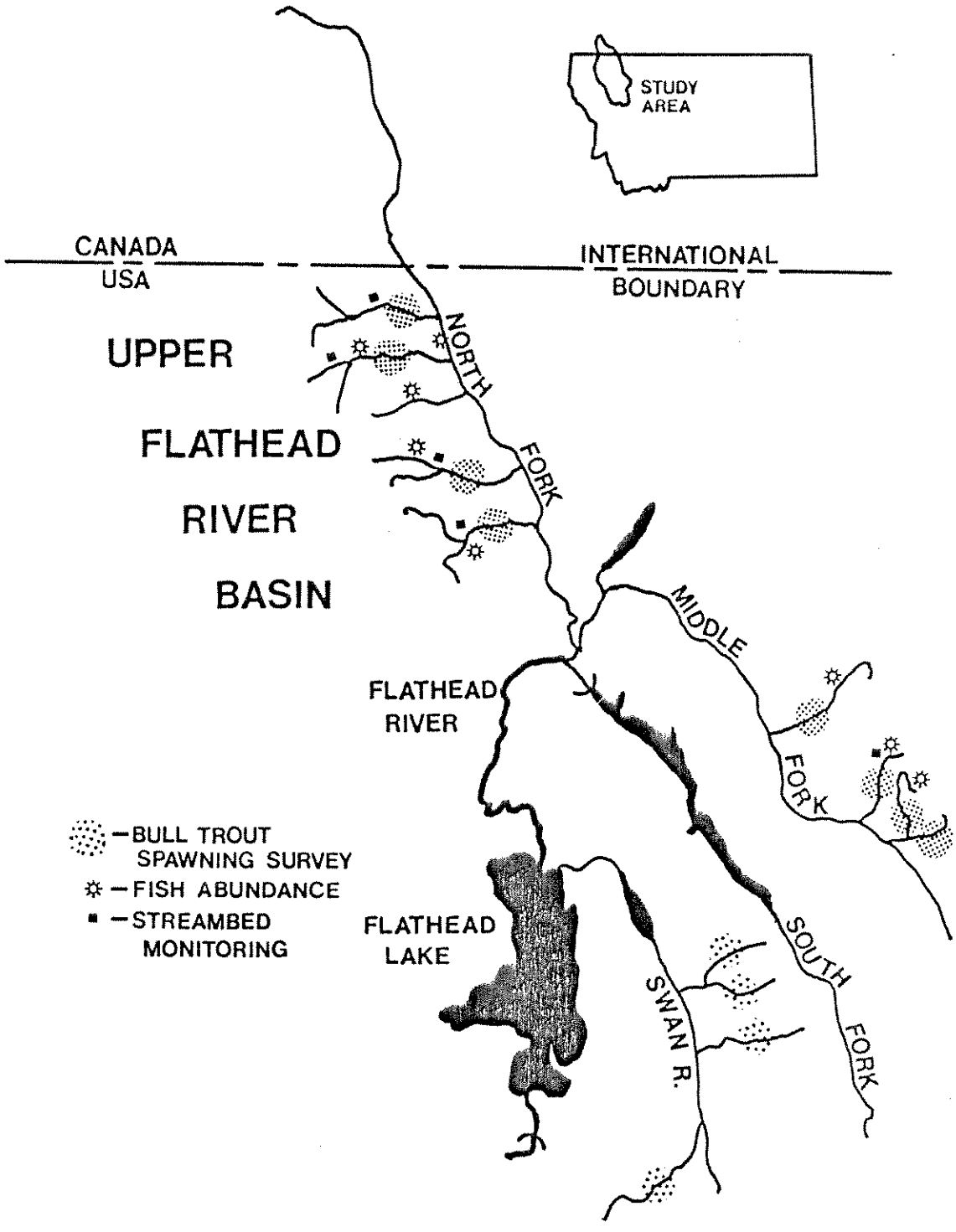

Figure 1. Fisheries monitoring sites in the Flathead Basin.

the fall; cutthroat spawn in the spring. Juveniles of these species rear in the tributary and river systems from 1-4 years before returning to the lake. There are also fluvial and resident populations of westslope cutthroat, and a few resident populations of bull trout.

Fisheries monitoring sites are located on 16 tributaries in the Flathead Basin (Figure 1). Five tributaries were selected in the North Fork Drainage, seven in the Middle Fork Drainage, and four in the Swan drainage. In addition, a river site is located on the North Fork between Ford and Whale Creek.

MONITORING PROGRAM

The proposed program is designed to monitor; 1) bull trout spawning population in the river system, 2) the abundance of westslope cutthroat and bull trout juveniles in selected rearing tributaries and, 3) streambed conditions in important bull trout spawning streams. The program will result in a continuous, time series data base for westslope cutthroat and bull trout in the Flathed River basin. This information will provide an important basis for adaptive management of the fish populations and habitat in the basin. All of the work proposed in this plan will be coordinated with the fisheries management staff of Region 1 MDFWP. We will assist the management staff in monitoring the fishery in Flathead Lake.

Fish abundance estimates are proposed for four tributaries and one site on the river near Whale Creek in the North Fork drainage (Table 1). In the Middle Fork drainage, three tributaries were selected for fish abundance monitoring. Electrofishing methods (two-pass, mark-recapture) will be used to estimate westslope cutthroat and bull trout abundance in tributaries (Shepard and Graham 1983). Westslope cutthroat density in one section of the North Fork Flathead River will be estimated by four snorkelers making two complete passes through 3 km section (Slaney and Martin 1986).

Bull trout redd surveys will be conducted on four tributaries in each of the North Fork and Swan drainages (Table 2). Six tributaries will be monitored in the Middle Fork Drainage. Survey methods and exact locations of the monitoring sites on each tributary are presented in Shepard and Graham (1983) and Leathe and Enk (1985).

Substrate size composition will be measured in five tributaries (Table 3). All sites are important bull trout spawning areas. Methods and locations for streambed monitoring are presented in Shepard and Graham (1983) and Weaver and Fraley (1985).

A total of 189 man days are required for the Flathead Basin Plan (Table 4). The budget for the proposed monitoring plan is presented in Attachment A.

Table 1. Summary of fish abundance estimates for the Flathead Basin monitoring plan.

Drainage	Stream	Species	Man Days Field	Man Days Data Analysis
Tributaries	Big	WCT,DV	8	1
North Fork	Coal Drainage	DV, WCT	24	2
	Red Meadow	WCT	8	2
	Whale	DV	8	2
	river near Whale Creek	WCT	8	1
Middle Fork	Ole	DV, WCT	3	1
	Morrison	DV	3	1
	Challenge	WCT	3	1
River				
North Fork near Whale Creek		WCT	8	1
		Subtotals	65	11
		Total	76	

1/ Includes the Deadhorse Bridge site, South Fork Bridge site and the South Fork of Coal Creek

Table 2. Monitoring sites and man day requirements for bull trout spawning surveys.

Drainage	Stream	Man days: Field	Man days: Data Analysis
North Fork			
	Coal	4	1
	Whale	4	
	Trail	2	1
	Big	2	
Middle Fork			
	Ole	2	
	Morrison	6	1
	Lodgepole	2	
	Granite	2	1
	Dolly Varden	4	
	Schafer	2	1
Swan			
	Goat	2	1
	Squeezer	2	
	Lion	2	
	Elk	2	1
	Subtotals	42	7
	TOTAL	49	

Table 3. Streambed monitoring sites and man day requirements for the Flathead Basin monitoring plan.

Drainage	Stream	Site	Man-days Field	Man-days Laboratory and data analysis
North Fork				
	Big	Skookoleel Creek Road Bridge	2	2
	Whale	Whale Buttes Road Bridge	2	2
	Trail	Junk car site	2	2
	Coal	Dead Horse Bridge Above South Fork Bridge, South Fork Coal Creek	6	6
Middle Fork				
	Granite	Creek below trailhead	2	2
		Subtotals	14	14
		TOTAL	28	

Table 4. Summary of activities outlined in the Flathead Basin Fisheries monitoring plan

Activity	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
Fish Abundance Estimates	10	40	15						65
Bull trout spawning site survey		2	40						42
Streambed monitoring		4	10						14
Laboratory and data analysis				6	14	6	6		32
Report preparation						4	4	8	16
Coordination/ administration		3	3	3	3	3	2	1	18
TOTALS	10	43	24	59	17	11	10	5	189

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ATTACHMENT A

Flathead River Basin Fisheries Monitoring Program
Budget Estimate

FLATHEAD RIVER SYSTEM
MONITORING BUDGET ESTIMATE

November 15, 1987 - November 14, 1988

A. SALARIES

Title	Grade/ Step	FTE	Salaries and Benefits	Total
Project Biologist/Manager	15/09	.40	$ 13,243.00	
Fisheries Fieldworker II	10/07	.20	4,366.64	
Fisheries Fieldworker I	08/05	.08	1,468.11	
Secretary/Word Processor	10/05	.04	836.96	
TOTAL SALARIES				$ 19,915.00

B. CONTRACTED SERVICES $ 0.00

C. SUPPLIES AND MATERIALS

Office supplies and materials	$ 500.00	
TOTAL SUPPLIES AND MATERIALS		$ 500.00

D. COMMUNICATIONS $ 0.00

E. TRAVEL AND TRANSPORTATION

Transportation (4,800 mi. @ .25/mi.)	1,200.00	
Per diem (121 days in field x 14.5/day)	1,754.00	
TOTAL TRAVEL		$ 1,766.00

F. RENT $ 2,000.00

G. UTILITIES $ 0.00

H. MAINTENANCE/REPAIR
Minor field equipment maintenance $ 1,500.00

I. EQUIPMENT $ 0.00

SUBTOTAL	$ 25,681.00
Less MDFWP Share	- 7,704.00
Subtotal	17,977.00
Overhead 15.5%	2,786.00
Subtotal	20,763.00
Plus MDFWP Share	7,704.00
GRAND TOTAL	$ 28,467.00