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MONTANA DEPARTMENT OF FISH AND GAME
ECOLOGICAL SERVICES DIVISION
FLATHEAD BASIN FISHERY PROPOSALS
OCTOBER 1977

INTRODUCTION

Flathead Lake and the Flathead Rivers in northwestern Montana and southeastern British Columbia, Canada are well known as pristine, oligotrophic waters. The sport fishery is famed for its spring runs of Dolly Varden (*Salvelinus malma*), cutthroat trout (*Salmo clarki*), and fall runs of kokanee salmon (*Onchorhynchus nerka*) which annually migrate from the lake into the rivers to spawn. Recently fisheries and limnological research in Flathead Lake and river areas upstream have increased due primarily to the need for suitable land, timber, and water resource management plans in the face of exploitation of coal and gas reserves in the drainage.

The system has never been holistically studied, and until recently a paucity of accurate biotic and chemical data has persisted even though investigations were initiated in the early 1900's (Potter 1976). Published research studies have recently encompassed the drainage to a limited degree physically, chemically and ecologically. It is now clear that the lake-river system functions as a single ecosystem; river discharges influence the limnology of Flathead Lake, and the spawning, larval, and juvenile fish ecology of migrating species is an important part of the structure and function of upstream communities.

Activities associated with timber harvest, flood control, hydroelectric generation and fossil fuel mining in the drainage have, in certain areas, altered natural ecosystem processes enough that specific effects may be quantified. Yet, the system presently retains pristine qualities. Extensive additional resource exploitation that may lack ecological foresight is presently in progress or imminent, particularly in oil and coal reserves. Certainly, progress toward development of sound resource use plans has been made as best evidenced by the sincere efforts of the Flathead 208 Planning Board, Canadian Department of Environment and other state, federal and international groups. These programs have been very limited. The proposal asks for necessary funds to scientifically delineate and quantify these ecosystem processes and develop management strategies to prevent degradation of their natural structure and function in the Flathead Lake-River ecosystem.

The Flathead Lake-River Fishery

Flathead Lake and its tributaries are interconnected biotically by spawning migrations of several species of adult fish from the lake into upstream areas and by subsequent movement of larval and juvenile fish back to the lake (Block 1955, Johnson 1963, Hanzel 1976). Only 10 of the 23 presently known resident fishes are native. Nine of these are adfluvial. Distances moved upstream for spawning vary by

or within species and range from the mouth area of the Flathead River to 100 miles or more upstream and into tributaries.

Dolly Varden, westslope cutthroat, kokanee, and some whitefish live in Flathead and other lakes in the drainage as sub-adults and adults, migrating into tributaries to spawn. These are termed adfluvial populations. Dolly Varden and cutthroat eggs hatch and young fish live in tributaries and rivers for two to three years. Whitefish and kokanee eggs hatch and young migrate soon after hatching into downstream areas. They become adults in two to four years. Variations in habits of Dolly Varden, westslope cutthroat, and mountain whitefish cause some racial strains to live as adults in larger streams but still migrate into small tributaries to spawn. Upon hatching, the young generally stay in small tributaries from one to three years before migration into larger streams. These are termed fluvial populations. Additional variation, either genetic or somatic, cause some westslope cutthroat and mountain whitefish to live their entire life span in smaller tributaries, although access to larger streams or lakes is possible; these are termed stream resident populations. Some species and/or populations complete their life histories without leaving Flathead Lake or other lakes in the drainage.

The migrational aspects of the fishery have received a fair amount of study (see Block 1955, Hanzel 1959, and Hanzel 1970-76), but trophic relationship and quality and quantity of available spawning and larval habits are poorly documented. Rahrer (1963) studied aspects of age and growth of Dolly Varden, yellow perch, peamouth, and squawfish in localized areas at the north end of Flathead Lake. Knowledge of the fishery to 1972 has been summarized by Gaufin, Prescott and Tibbs (1976).

Construction of Hungry Horse Dam blocked access to a major spawning area, the South Fork Flathead River and its tributaries. The Swan and Stillwater rivers have also been blocked by dams to some extent. The Stillwater River Dam was removed in 1962 and spawning runs of some game fish are starting to reestablish there.

It has been estimated that 60 percent of the original spawning runs of westslope cutthroat trout and Dolly Varden from Flathead Lake were blocked by construction of Hungry Horse Dam. In addition, some spawning and rearing areas for whitefish and kokanee were inundated by Hungry Horse Reservoir. The reservoir has developed viable cutthroat, whitefish, and Dolly Varden populations and has supported a fair fishery. But the quality and quantity of this fishery has declined in recent years. Reduced numbers and size of game fish in Hungry Horse Reservoir are thought to be a direct result of increased seasonal withdrawal and changes in water level manipulations.

As has been documented for aquatic insects, alteration of river flow and thermal regimes by hypolimnial releases from Hungry Horse Reservoir apparently have changed spawning migrations (i.e., prolonged or delayed rate of migration thus reducing egg survival) of most adfluvial species. Movements of juveniles downstream likely are also affected. Local anglers and Department of Fish and Game personnel have observed that water regulation has increased utilization of the mainstream Flathead River by spawning kokanee salmon and decreased shoreline spawning in Flathead Lake. Significant mortality in fall spawned eggs

probably occurs in Flathead Lake due to fall and winter drawdown thus favoring adfluvial populations.

It is also significant that kokanee populations key spawning movements by river temperatures and select spawning sites in lotic areas thermally moderated by lake discharges. In the years immediately after kokanee were introduced into Flathead Lake, most spawning occurred along the lake shoreline during fall turnover (about 7 C). For reasons not fully elucidated, kokanee now spawn most abundantly in MacDonald Creek just above its confluence with the Middle Fork. Often more than 300 bald eagles and several grizzly bears congregate annually in the fall to feed on salmon concentrated on the spawning beds. Some successful spawning also apparently occurs in the mainstream Flathead River below the confluence of the South Fork; this trend appears to be increasing (Hanzel 1970-76). Both of the consumers are listed as rare and endangered by the U. S. Fish and Wildlife Service. This area of MacDonald Creek is naturally influenced by hydrodynamics of deep Lake MacDonald and kokanee spawn during fall overturn when temperatures in the creek are around 7° C. However, kokanee spawn with some success in the South Fork below Hungry Horse Dam and in Swan River below the small hydroelectric diversion dam near Bigfork. Again, thermal moderation by the lakes upstream increases temperatures in late fall to about 7 C in these areas slightly above ambient mainstream river temperature, providing a good thermal key for adfluvial populations. Furthermore, hypolimnial discharges from Hungry Horse Reservoir during late summer and fall moderate the mainstream Flathead River and may explain observed increases of river spawning. The quality of river spawning sites in the South Fork directly below Hungry Horse Dam is, however, questionable due to extreme variation in water volume and the compacted nature of the substrata.

One final aspect of the fishery deserves mention. Populations of northern pike (*Esox lucius*) are being discovered in new areas of the drainage every year. This carnivorous and highly competitive exotic occurs abundantly in the Flathead River below Flathead Lake and in lower Stillwater Lake. Their status in Flathead Lake is not known, but at least a few specimens have been taken there.

OBJECTIVES OF PROPOSED FISHERIES RESEARCH

Part A. Temporal and Spatial Fish Distribution (A-1 North Fork, A-2 Middle Fork)

Thorough inventory of fish spawning habitat and complete documentation of fish movements in the North and Middle Forks of the Flathead River are needed. This research is proposed in two temporally segregated segments, one for work on the North Fork and the other for the Middle Fork, each with the same objectives. This is necessary because of logistical problems in simultaneously deploying manpower and equipment over such a large area. The North Fork is of special interest for two reasons. The western tributaries of the North Fork drain areas already altered by timber harvest and designated for mining of fossil fuels. Coal strip mines and associated human concentrations are located just across the border in Canada. The eastern tributaries to the North Fork all drain Glacier and Waterton National Parks and remain in natural state. Thus,

the tributaries of the North Fork are ideally suited to quantify habitat degradation, as well as document natural life histories and environmental requirements of migrating species.

1. Locate the varied populations in the river or tributaries at frequent intervals, monthly or more frequently, to verify residency, or migration times and patterns. Findings will be correlated with weather, time and streamflows to interpret migration distribution.

2. Determination on indices of abundance for adults by time and area for major tributaries. Findings will enable ranking of streams for strength or spawning populations, and calculation of adfluvial migration and arrival times.

3. Determine downstream migration patterns of juveniles for time, age, size of individuals and index of recruitment numbers to downstream river and lake system. Findings will be used to separate resident from fluvial or adfluvial populations, to verify periods of movement or migration, and to evaluate carrying capacity. Growth and natural mortality rates of various juvenile age classes may be correlated with habitat classifications.

4. Identify wave movements (by tributary) of migrants to and from Flathead Lake, as they sort out in time.

5. Quantify and quality habitat types for spawning and rearing of presmolts on all significant tributaries on the United States side of the border. Analyses of results in comparable streams on the east and west sides of the North Fork should allow quantification of possible deleterious impacts on the fishery.

Part B-1 Alteration of the Fishery by Hypolimnial Discharges

The goal of this portion of research is to firmly quantify the influence of altered discharge and temperature regimes on adfluvial and fluvial fish populations in areas below Hungry Horse Reservoir.

This research will investigate and explain variations in fish life histories and behavior as a direct result of discharges from Hungry Horse Reservoir. This information will be used to make recommendations for discharge programming to ensure optimum fish production and survival in the altered areas. Consideration will also be given to planning discharge schedules relative to angler success, a matter of considerable interest to the local public. Major research emphasis will be given in study of sport fish populations (e.g., Dolly Varden, cutthroat and kokanee). However, other species will not be overlooked and as much information as possible will be gathered.

1. The influence of moderated temperature and discharge regimes on fish passing through the mainstream Flathead River on their way to spawning areas above the confluence of the South Fork will be quantified. Similar study of juveniles moving downstream will be made. We are especially interested in deciding: (a) how kokanee migrations might

be prolonged, delayed or enhanced by reservoir discharges; (b) how such mechanisms operate and what the quantitative effects are on kokanee spawning success upstream; and, (c) subsequent year class strengths in Flathead Lake.

2. Evaluation of reproductive success and year class production of adfluvial and fluvial species which spawn in the South Fork and mainstream Flathead Rivers below Hungry Horse Dam will be made. Factors of interest here include: movements of adults and juvenile fish in response to flow and temperature patterns, selection of spawning sites, variation of egg and larval fish survival within altered gradient, and temperature and habitat selection by emergent fry and fingerling fish.

Part B-2 Benthic Ecology in Altered Riverine Habitats

Interrelationships in life history criteria and production of invertebrates and fish in altered areas must be carefully examined, for they may correlate independently of each other and of temperature and discharge effects. The responses of fish and invertebrates may be entirely different, especially in the lower South Fork. Each responds in its own way to the experimental gradient ranging from total alteration directly below the dam to a moderate alteration in 30 miles of the main Flathead River. The main river is influenced by fluctuating water volumes and temperatures flowing from natural areas above the confluence of the South Fork, as well as those released from Hungry Horse Reservoir.

The objectives of this research are to quantify the changes in abundance and species diversity of periphyton and benthic invertebrates in those areas above the South Fork's confluence, in the South Fork below the dam, and in the main river. Also investigated will be riverine environments immediately downstream of impoundments, including lower MacDonald Creek, lower Swan River and South Fork of Flathead River below Hungry Horse Dam. Autotrophic and heterotrophic adaptations must be characterized, quantified, and compared to pristine regions of the river system. Interpretation of basic floral and faunal responses to environmental alterations will be made.

1. Temporal dynamics in physical and chemical parameters (e.g., temperature, photoperiod, turbidity, discharge, dissolved solids, etc.) will be firmly documented in the specified areas. Assessment will be made of the nutritive impact of decaying salmon for MacDonald Creek.

2. Primary productivity, including species composition, standing crops, turn-over rates, in the specified areas will be compared and will involve quantification of autotrophic and heterotrophic microbial activity as it correlates with carbon fixation and detrital processing. The importance of drift and organic seston material from impoundments will be quantified and related to benthic trophic structure in the specified lotic habitats.

3. The structure and function of the macroinvertebrate community will be studied within the specified areas to illustrate quantitative differences in composition and biomass and life history compared to the ecology of the unaltered river system.

Part C. Trophic Relationships in Flathead Lake

The objectives of this research are to firmly document food chain interrelationships of the various year classes of fish in Flathead Lake with particular research emphasis on the ecological energetics of the sport fishes (e.g., lake trout, Dolly Varden trout, cutthroat trout, kokanee salmon, mountain whitefish and lake whitefish).

1. Feeding habits of the major fish species in the lake will be determined quantitatively on a time-series basis.

2. Estimates of temporal standing crops (biomass) of major fish species in the lake will be made. Distributional maps will be constructed to demonstrate temporal and spatial (including depth) preferences of the various populations occurring at any particular time in relation to lake hydrodynamics.

3. Annual production of principal lake fishes will be estimated using all available recent data on river migrations and lake recruitment of the various year classes. Historical data will be consulted for comparative purposes and to help facilitate formulation of a firm statement on the state-of-the-fishery. Major factors limiting production of the adfluvial fish populations in Flathead Lake will be identified in association with reservoir studies.

Part D. Status, Utilization and Habitat Inventory of Hungry Horse Reservoir Fishery

This research will document the present condition and utilization of the fishery in the Hungry Horse Reservoir system and investigate the influence of lake level fluctuations on production. Specific objectives are:

1. Determine age and rate of growth of major game fish species and major nongame species.

2. Determine total mortality rates on game fish and nongame fish.

3. Make estimates of temporal standing crops (biomass) of major fish species in the reservoir and determine angler harvest.

4. Inventory and quantify spawning and rearing habitat in important tributaries to the reservoir excluding the South Fork above Gorge Creek.

5. Make population estimates where numbers of fish are great enough and make population indices of abundance on lesser used tributaries.

6. Determine times of movement from reservoir to tributaries and tributaries to reservoir for cutthroat trout, Dolly Varden trout, and mountain whitefish. Both spawning populations and presmolt populations will be considered.

7. Determine food habits of game fish in the reservoir.

8. Determine food habits of nongame, forage and predation species.

FISHERIES RESEARCH METHODS

The methods and equipment to be used in all phases of fisheries work are standard fishery methods or more recent and sophisticated electronic assessments. Fish populations will be sampled using a variety of trawls, nets and traps and other appropriate fishing gear. Several tagging programs will be employed to obtain migration and production data. In order to obtain maximum information on adfluvial populations, it will be most appropriate to perform Parts A and C starting in 1978, to facilitate a drainage-wide tagging (i.e., mark and recovery) effort.

Parts B and D must be delayed due to funding shortages for other Flathead River related studies. Funding for Parts B and D could come from the Bureau of Reclamation, as they will need this information to do a feasibility study on adding extra generators to Hungry Horse Reservoir and building a power generating reregulating reservoir below Hungry Horse Dam but above the South Fork's confluence with the main Flathead River.

These study parts should be programmed to run in the same time-frame as the North and Middle Fork studies in order to reduce the number of years that complete water quality stations need be operated on the three main forks.

Age and growth data will be generated from scale readings and length-weight frequency data. These methods are nicely summarized in Lagler (1956) and Ricker (1968). In addition, the Montana Department of Fish and Game has also required state-of-the-art acoustical gear for monitoring fish movement and biomass in the lake environment (see Thorne, Nunnallee and Green 1972).

Part A. Temporal and Spatial Fish Distributions in the North and Middle Forks

North Fork Study Segment (A-1)

Spawning and rearing habitat in each significant tributary will be inventoried as to quality and quantity of spawning gravels. Ground surveys combined with low altitude aerial photos studied steroptically will be used in combination to cover the 270 miles of North Fork tributaries outside Glacier National Park. Ground surveys will classify gravels as to size, potential permeability, water depth, velocities and

I. Proposed yearly budget for segment 1 (North Fork) of Fisheries Research, Part A. Temporal and spatial fish distributions in the North and Middle Forks. Total time required: 3.0 years (A-1)

A. Salaries and Benefits

Project leader	3 mos @ $1,400	$ 4,200	
Assistant leader	9 mos @ 1,200	10,800	
Technical asst.	36 mos @ 1,178	42,400	
G-10 Fish Field Man	12 " 830	9,960	$ 57,400
	Benefits @ 10%		5,740

B. Permanent equipment rented from Montana Fish and Game - see attached rental list sheet (II) 6,127

C. Expendable Equipment

Wire trap leads	600	
Steel fence posts	130	
Plastic vials	200	
Preservative	50	
Miscellaneous	100	
Fish tags	700	1,780

D. Travel

Auto 1,500 miles @ 15c/mile	2,250	
Boat - gas, oil	1,200	
Airplane reconnaissance photos (1 yr only) 135 miles @ $200/mile	27,000	
Per diem	3,962	34,412

E. Publication Costs 1,000

F. Other Costs

Laboratory analysis of caloric value and organism identification	2,900	
Secretarial and graphic arts	800	3,700

Total - FY 78	$110,159
Total - FY 79	89,473
Total - FY 80	98,420
Total Cost of North Fork Study Segment	$298,052

II. Annual rental costs for equipment to be used by Montana Department of Fish and Game in segment 1 (North Fork) of Fisheries Research, Part A. Temporal and spatial fish distributions in the North and Middle Forks.

Item	Cost/Mo.	Months Used	Totals	
Scientific				
Foxoboro thermograph	15.00	12	$ 180	
Scale reading equipment	10.50	2	21	
Length-weight equipment	5.00	11	55	
Current meter	18.00	6	108	
Microscopes	13.50	2	27	
Hydraulic scale press	12.00	2	24	$ 415
Electrical				
2 My-T-Lite generators	30.00	9	270	
2 Variable voltage regs	50.00	9	450	
2 Boom shockers	40.00	9	360	
1 Backpack shocker	18.00	3	54	
1 Small boat shocker	10.00	3	30	
2 Electrodes & dip nets	20.00	12	240	1,404
Boats and Motors				
2-18 ft. john boats	30.00	18	540	
1-16 ft. john boat	12.00	4	48	
1-14 ft. john boat	10.00	3	30	
115 hp jet engine	110.00	18	1,980	
55 hp jet engine	80.00	4	320	
2 boat trailers	20.00	18	360	3,278
Fish Traps and Nets				
15 box traps	90.00	3	270	
4 fry traps	80.00	3	240	
1 wolf trap	30.00	4	120	
20 emergent traps	200.00	2	400	1,030
	Total			$6,127

available cover. The 134 miles of tributaries in Glacier National Park will be inventoried in cooperation with park and U. S. Fish and Wildlife personnel. Rearing habitat will be inventoried as to pools, water velocity, depth and cover just as on the west side tributaries. Spawning habitat surveys for mountain whitefish will also be made in the 52 miles of the North Fork itself.

Migration patterns of mature trout in spawning runs will be followed up on the North Fork to determine their time and duration. Recovery methods using electrofishing gear on booms and large flat-bottom jet boats will facilitate capture for identification and enumeration of spawning run segments. Smolt and adult game fish will be marked or tagged as necessary for immediate documentation of migration patterns and identification in future recoveries, both in Flathead Lake and in the rivers. Adult sampling in the mainstream Flathead and North Fork rivers will vary from once or more a week to monthly, depending on the stage of the migration run and river flood stages.

Electroshocking with small boats or hand electrodes and hook and line fishing will be used to identify tributary use by adults of the major game fish species. Sections of individual streams will be routinely electrofished to determine trout age-class structure, trout numbers per unit area of rearing space, and condition factors. Growth and trophic data will also be collected in as many tributaries as possible. Population estimates, growth rates, condition factors and mortality rates will be determined (Ricker 1971) for each species of game fish collected in the North Fork drainage. Similar data for non-game species will be collected when possible and as time permits. Correlations will be made to limnological data in detail, using appropriate statistical designs. Standing crop estimates of presmolts will be made in major tributary streams by electrofishing. These data will be obtained seasonally and extend through the hatching and emergency period. Quantification of smolt movement toward Flathead Lake will be made several days a week by fishing downstream traps at the mouths of several tributaries. Winter ice cover and high water will prohibit sampling at times; also some important stream sections are inaccessible. Therefore, data will be extrapolated for some streams during periods of the year when traps cannot be operated.

Middle Fork Study Segment (A-2)

Middle Fork studies will be less extensive, but require more manpower, due to the number of large streams in the roadless and wilderness areas. Methods will be as above on the North Fork segment.

Part B. Alteration of Fishery by Hypolimnial Discharges

Part B will not be initiated in FY 1978 as planned, but will be delayed at least until 1979. This part may be further delayed if the Bureau of Reclamation fund assistance is not forthcoming.

III. Proposed yearly budget for segment 2 (Middle Fork) of Fisheries Research, Part A. Temporal and spatial fish distributions in the North and Middle Forks. Total time required: 3.0 years. (A-2)

A. Salaries and Benefits			
Project leader	2 mos/year	$ 2,800	
Assistant leader	12 mos/year	14,400	
Technical asst.	36 man mos/yr	25,200	$42,400
Benefits @ 10%			4,240
B. Permanent equipment rented from Montana Fish and Game - see attached rental list (IV)			4,651
C. Expendable Equipment			
Fish tags		1,500	
Vials		200	
Wire net leads - 600 ft		700	
Steel posts		130	2,530
D. Travel			
Auto 30,000 mi. @ 15¢/mile		4,500	
Boat - gas, oil		1,000	
Airplane reconnaissance photos (1 yr only)		20,000	
Per diem		3,880	29,380
E. Publication Costs			1,000
F. Other Costs			
Contract with USGS for water quality monitoring station		13,600	
Laboratory analysis and identification of forage organisms		2,900	
Secretarial and graphic arts		800	17,300
		Total FY 79	$101,501
		Total FY 80	86,165
		Total FY 81	91,295
Total Cost of Middle Fork Study Segment			$278,961

IV. Annual rental costs for equipment to be used by Montana Department of Fish and Game in segment 2 (Middle Fork) of Fisheries Research, Part A. Temporal and spatial fish distributions in the North and Middle Forks.

Item	Cost/Mo.	Months Used	Totals	
Scientific				
Foxoboro thermograph	15.00	12	$180	
Scale reading equipment	10.50	2	21	
Length-weight equipment	5.00	7	35	
Current meter	18.00	7	126	
Microscopes	13.50	2	27	
Hydraulic scale press	12.00	2	24	$ 413
Electrical				
2 My-T-Lite generators	30.00	5	150	
2 Variable voltage regs	50.00	5	250	
2 Boom shockers	40.00	5	200	
Backpack fish shocker	18.00	3	54	
2 Electrodes and dip nets	20.00	5	100	754
Boats and Motors				
18-ft. john boat	15.00	7	105	
16-ft. john boat	12.00	3	36	
14-ft. john boat	10.00	3	30	
115 hp jet engine	110.00	7	770	
55 hp jet engine	80.00	3	240	
18 hp outboard	35.00	3	105	1,286
Fish Traps and Nets				
12 Box traps	72.00	4	288	
2 Fry traps	40.00	4	160	
10 Emergent traps	100.00	4	400	848
Backcountry Travel				
Horse and saddle	75.00	18		1,350
		Total		$4,651

V. Proposed yearly budget for Fisheries Research, Part B-1. Alteration of fishery by hypolimnial discharges. Total time required: 3.0 years. Part B to be funded by Bureau of Reclamation.

A. Salaries and Benefits			
Project leader	3 mos/year	$ 4,320	
Assistant leader	12 mos/year	14,400	
Technical assistants	40 man mos/yr	28,000	$46,720
	Benefits @ 10%		4,672
B. Permanent equipment rented from Montana Fish and Game - see attached rental list sheet (VI)			7,190
C. Expendable Equipment			
Fish tags		1,500	
Wire trap leads		700	
Steel fence posts		130	2,330
D. Travel			
Auto	15,000 miles @ 15¢/mile	2,250	
Boat - gas, oil		1,000	
Per diem		4,280	7,530
E. Publication Costs			800
F. Other Costs			
Laboratory Costs			
Fish food analysis and identification		2,900	
USGS water quality station - full station (less sediment)		6,060	8,960
	Total FY 78		$78,202
	Total FY 79		86,022
	Total FY 80		94,624
Total Project Cost (Bureau of Reclamation)			$258,848

The Bureau of Reclamation has asked that this project be funded over the 5-year period 1978-1981. Manpower and budget will be realigned to fit their funding schedule.

VI. Annual rental costs for equipment to be used by Montana Department of Fish and Game in Fisheries Research, Part B-1 Alteration of fishery by hypolimnial discharges.

Item	Cost/Mo.	Months Used	Totals	
Scientific				
Foxoboro thermograph	15.00	24	$ 360	
Scale reading equipment	10.50	4	42	
Length-weight equipment	5.00	12	60	
Current meter	18.00	4	72	
Microscopes	13.50	4	54	
Hydraulic scale press	12.00	2	24	$ 612
Electrical				
2 My-T-Lite generators	15.00	10	150	
2 Variable voltage regs	25.00	10	250	
2 Boom shockers	20.00	10	200	
Backpack shocker	18.00	4	72	
2 Electrodes and dip nets	10.00	10	100	772
Boats and Motors				
2-18ft. john boats	30.00	14	420	
1-16 ft. john boat	12.00	7	84	
1-14 ft. john boat	10.00	3	30	
115 hp jet engine	110.00	14	1,540	
55 hp jet engine	80.00	7	560	
18 hp outboard	35.00	4	140	2,774
Fish Traps and Nets				
4 Fry traps	80.00	16	1,280	
20 Emergent traps	200.00	3	600	
8 Box traps	48.00	24	1,152	3,032
		Total		$7,190

Movements of Dolly Varden, cutthroat and other migrants through the main Flathead River will be monitored by capture with electrofishing gear. Resident fish will be similarly sampled. Adult spawners will be tagged in conjunction with the North Fork study. Downstream movement of smolts will be sampled with electrofishing gear, hook and line fishing, nets and traps and marked by tagging or cold branding. Study of age, cohort growth, and food habits of smolts and adults will be made in the main river at a site near Kalispell. This will be the principal river recovery area for smolts and adults tagged in upstream tributaries. Therefore, it is important that Parts A and B of the Fisheries Research be accomplished in the same time frame if at all possible. Age and growth will be calculated from scale readings and population information from tagging studies.

An inventory of kokanee salmon spawning areas in the mainstream Flathead River will be quantified into suitable areas available at various water discharge elevations. Habitat availability and quality will be correlated with discharge from Hungry Horse Reservoir, normal river flows and other limnological data. Ground surveys will be made on known, heavily-used spawning areas. These data will be supported by aerial photos taken and analyzed for the whole area from Bad Rock Canyon to Kalispell.

Measurements of salmon egg mortality will be made by excavating spawning redds and capturing eggs and larvae in benthic nets. The ratio of dead to live eggs will be visually quantified by laboratory counts of samples. Mortality related to dewatering of redds and critical temperatures will be determined during low stream flows of short (i.e., 12 to 24 hours) and long (i.e., several days) duration. Vertical temperature profiles will be monitored in the redds to measure the effect of ambient air temperatures on gravel bars which become exposed and rise above the stream surface for various periods of time.

Emerging kokanee fry will be trapped to determine the effects of various discharge rates on downstream movement of young salmon. Salmon egg and fry survival rates will yield information on year class recruitment and may be correlated with year class strengths of adults in Flathead Lake. Whitefish ecology will also be studied. Salmon redds and whitefish spawning areas dried by reduced discharges will be evaluated on the basis of spawning habitat (and hence production) lost by artificial fluctuations in river volume. Fish population estimates or indices of abundance will be made through evaluation of all mark and recapture, and spawning data. The fisheries habitat in severely altered sections of the South Fork below Hungry Horse Dam will be inventoried for existing resident and migratory species. Projection of habitat quantity and quality will be estimated for populations expected to exist in a rereg reservoir. Much depends on the design and discharge pattern developed by the engineering feasibility study and relationships to the needs of the fishery in the mainstream Flathead River.

An important aspect of this research is to determine exactly how discharges from Hungry Horse Reservoir affect diel behavioral patterns,

VII. Proposed yearly budget for Limnological Research, Part B-2. Benthic ecology of altered areas. Total time required: 2.5 years. Part B-2 to be funded by Bureau of Reclamation.

A.	Salaries and Benefits			
	Project leader Assistant leader	6 man mos/yr	$7,200	
	Technical assistants	4 man mos/yr	2,520	
		Benefits @ 10%	972	$10,692
B.	Permanent equipment rented from Montana Department of Fish and Game			-
C.	Expendable Supplies			3,500
D.	Travel			960
E.	Publication Costs (FY 80)			(1,200)*
F.	Other Costs			
	Chemical analyses		9,900	
	Laboratory fees		700	10,600
G.	Administrative Costs			4,290
		Total FY 78		$30,042
		Total FY 79		32,142
		Total FY 80		13,636
	Total Project Cost (Bureau of Reclamation)			$75,820

*Publication costs the last year of project only.

especially during emergence of insect populations. In cooperation with the Bureau of Reclamation, discharge volumes from the dam will be experimentally raised and lowered at precise time intervals so that variances in drift and benthic activity may be quantified. Stanford (1975) indicated that such an approach would yield very valuable ecological information.

This study will also require 2.5 years to complete. The first year will be devoted entirely to field work, including experimental rearing and discharge studies. Field collections will be made during the second year, along with thermal laboratory experiments. The final 6 months will be used to analyze data and prepare manuscripts.

Part C.-1 Trophic Relationships in Flathead Lake

Estimates of fish biomass (i.e., population size) will be made using the latest developments in acoustical methods and in combination with purse seine and midwater trawl catches. Echo traces will be quantified to identify particular species at specific depths; simultaneous open water seine and trawl catches at the same depths will allow verification of sonar-determined species composition and abundance. The acoustical gear will also permit thorough study of diel migrations or activity patterns. Depth, seasonal and geographical distributions of various populations will be determined from temporally collected sonar data. Acoustical data will also be supported by pelagic and littoral gill netting programs.

Major lake factors which could likely limit fish populations will be assessed for lake trout, mountain whitefish and lake whitefish, and limiting factors for kokanee. Dolly Varden and cutthroat are most likely tributary or mainstream oriented, and will be assessed mostly in upper drainage studies. However, the standing crop and trophic dynamics of these species will be thoroughly studied in the lake.

Lake trout spawning areas are believed to be limited. Sonar reconnaissance and quantification of spawning areas will be made. Existing Montana Fish and Game netting data will be reanalyzed and combined with new findings on lake trout status.

An attempt will be made to assess recruitment of kokanee, cutthroat and Dolly Varden to the lake in conjunction with upstream studies. Methods and reliable gear to sample waters as large and debris-laden as the Flathead River in the area immediately upstream of the Flathead Lake confluence have not been developed, but we will make an extreme effort to get an index of recruitment levels during the study. Fry nets, trap nets and possibly sonar gear will be used.

C-2 Flathead lake creel census.

An extensive creel census was planned for the ~~second~~ 1981 year of study to provide harvest and age class data for game fish. Angler use will be monitored drainage-wide with concentration on Flathead Lake and the lower Flathead River. The census would be especially valuable in gathering data leading to production estimates and involve the public

VIII. Proposed yearly budget for Fisheries Research, Part C. Trophic relationships in Flathead Lake. Total time required: 3.0 years. (C-1)

A.	Salaries and Benefits		
	Project leader — 2 mos/year	$2,800	
	Assistant leader — 6 mos/year	7,200	
	Technical assistants — 6 man mos/year	4,200	$14,200
	Benefits @ 10%		1,420
B.	Permanent equipment rented from Montana Fish and Game - see attached rental list sheet (IX)		11,161
C.	Expendable Equipment		
	Plastic vials (stomach)	800	
	Preservative		
	Floats and Markers	200	1,000
D.	Travel		
	Auto — 5,000 miles @ 15¢/mile	750	
	Boat - gas and filters	750	
	Airplane reconnaissance and photos	1,000	
	Per diem	3,880	6,380
E.	Publication Costs		1,000
F.	Other Costs		
	Laboratory analyses — Fish food caloric analysis & identification	2,900	
	Secretarial and graphic arts	800	
	Telephone and postage	200	3,900
	Total FY 78		$39,061
	Total FY 79		40,623
	Total FY 80		42,341
	Total Project Costs		$122,025

IX. Annual rental costs for equipment owned and to be used by Montana Department of Fish and Game in Fisheries Research, Part C. Trophic relationships in Flathead Lake.

Item	Cost/Mo.	Months Used	Totals	
Scientific				
Scale reading equipment	10.50	2	$ 21	
Length-weight equipment	5.00	12	60	
Current meter	18.00	3	54	
Microscopes	13.50	2	27	
Fineline acoustical sounder	60.00	3	180	
Hydraulic scale press	12.00	2	24	
Bathy thermometer	30.00	3	90	
Net depth recorder	30.00	3	90	$ 546
Boats and Motors				
Dolly Varden (35' seiner)	2,250.00	4	9,000	
Seine barge and motor	100.00	1.5	150	
16-ft. boat and motor	65.00	4	260	9,410
Fish Traps and Nets				
Purse (600'x50')	160.00	1.5	240	
Midwater trawl	50.00	2.5	125	
7 Gill nets	280.00	3	840	1,205
		Total		$11,161

X. Annual budget for creel census to be completed in FY79 as a part of Fisheries Research, Part C. Trophic relationships in Flathead Lake. Total time required: 1.0 year (not funded*) (C-2)

A. Salaries and Benefits			
Project leader	1 mos/year	$ 1,400	
Assistant leader	12 mos/year	14,400	
Technical assistants	36 man mos/year	25,200	$41,000
	Benefits @ 10%		4,100
B. Permanent equipment rented from Montana Fish and Game - see attached rental list sheet (XI)			3,000
C. Expendable Equipment			
Forms, envelopes and stationery		700	
Computer rental		4,768	5,468
D. Travel			
Auto 30,000 miles @ 15¢/mile		4,500	
Boat - gas, oil		1,200	
Airplane reconnaissance photos		1,000	
Per diem		3,880	10,580
E. Publication Costs			1,800
F. Other Costs			
Office rental		1,500	
Secretarial and graphic arts		1,000	
Postage - 30,000 stamps and cards		3,900	6,400
Total Project Costs (1979 only)			$72,348

*This part of the project has been withdrawn from the proposal due to reduced federal funding. It will be reinstated in the project if alternate funding can be found.

XI. Annual rental costs for equipment to be used by Montana Department of Fish and Game during creel census portion of Fisheries Research, Part C. Trophic relationships in Flathead Lake.

Item	Cost/Mo.	Months Used	Totals	
Scientific				
4 Length - weight equipment	20.00	36	$720	$ 720
Boats and Motors				
16-ft. "V" hull boat	30.00	12	360	
15-ft. Larson boat	25.00	12	300	
55 hp outboard	80.00	12	960	
18 hp outboard	35.00	12	420	
2 boat trailers	20.00	12	240	2,280
		Total		$3,000

in the research effort. Direct fisherman contacts would be made by Montana Department of Fish and Game personnel and mailable data forms will be made available throughout the drainage. Extensive media coverage will be devoted to the program to enhance public involvement and cooperation. The creel census portion of the study will not be done if reduced funding limits the total fishery study.

Specific trophic habits and interrelations in the Flathead Lake fishery will be determined from stomach analyses of specimens obtained by seining, trawling and gill netting. Stomachs will be collected and preserved from individual fish for later analysis. Species composition of food items will be identified and recorded. Total volume of stomach contents will be obtained and volumetric measurements will be made for selected taxonomic groups. Temporal series of trophic data will be related to ecology and population dynamics of forage items in the lake. Vertical net-plankton tows will be made at time and place of fish collection. Aliquots of major plankton and/or benthic forms will be analyzed for protein, carbohydrates, fats and ash.

Part D. Status, Utilization and Habitat Inventory of Hungry Horse Reservoir Fishery

Methods to be used in the reservoir will be the same as for Part C. Trophic relationships in Flathead Lake, except the acoustical population work, will be limited to total fish biomass estimates. This is due to our inability to transport the large vessel used on Flathead Lake to Hungry Horse Reservoir; we will use smaller, trailered craft. Age and growth rates will be determined, but food habit studies will not be done on the reservoir populations.

Tributary streams to the reservoir will be subjected to the same type of study using the same methods and equipment and analysis for tributaries as the North Fork tributaries. Initial studies will be made on (1) Spotted Bear River, (2) South Fork of the Flathead River below Meadow Creek Gorge, (3) Sullivan Creek, (4) Hungry Horse Creek, (5) Emery Creek, (6) Wheeler Creek, (7) Dorris Creek, and (8) Wounded Buck Creek. Other tributaries and secondary streams will be studied as needed.

Principal Investigator

This proposal is to be under the direction and supervision of Robert E. Schumacher, Regional Fisheries Manager, Montana Department of Fish and Game, Kalispell.

XII. Proposed yearly budget for Fisheries Research, Part D. Status, utilization and habitat inventory of Hungry Horse Reservoir fishery. Total time required: 3.0 years. Unfunded.*

A. Salaries and Benefits			
Project leader	2 mos/year	$ 2,800	
Assistant leader	12 mos/year	14,400	
Technical assistants	36 man mos/year	25,000	$42,200
	Benefits @ 10%		4,220
B. Permanent equipment rented from Montana Fish and Game - see attached rental list sheet (XIII)			13,558
C. Expendable Equipment			
Fish tags		1,000	
Plastic vials		200	
Wire trap leads - 600 ft		700	
Steel fence posts		130	2,030
D. Travel			
Auto	30,000 miles @ 15¢/mile	4,500	
Boat - gas and oil		1,400	
Per diem		3,920	9,820
E. Publication Costs			1,000
F. Other Costs			
Laboratory analyses Food caloric analysis & identification		2,900	
USGS water quality (7 mos) (Assumes Bureau of Reclamation continues current waterflow records at Twin Creek during this study)		7,933	10,833
	Total FY 80		$83,661
	Total FY 81		88,303
	Total FY 82		93,410
Total Project Cost			$265,374

This project is currently unfunded, but there is a good possibility that the Bureau of Reclamation will fund it near the end of the study period.

XIII. Annual rental costs for equipment to be used by Montana Department of Fish and Game in Fisheries Research, Part D. Status, utilization and habitat inventory of Hungry Horse Reservoir fishery.

Item	Cost/Mo.	Months Used	Totals	
Scientific				
25 Maximum-minimum thermometers	25.00	9	$ 225	
Scale reading equipment	10.50	3	32	
Length-weight equipment	5.00	9	45	
Current meter	18.00	9	162	
Fineline acoustical sounder	60.00	4	240	
Hydraulic scale press	12.00	3	36	
Plankton net	7.50	6	45	
Net depth recorder	30.00	3	90	
Clark Bumpas plankton	30.00	3	90	$ 965
Electrical				
2 My-T-Lite generators	15.00	12	180	
2 Variable voltage regs	25.00	12	300	
Boom shocker	20.00	3	60	
2 Electrodes and dip nets	10.00	3	30	
Backpack shocker	18.00	6	108	678
Boats and Motors				
2-18 ft. john boats	30.00	18	540	
55 hp jet engine	80.00	6	480	
14-ft. john boat	10.00	6	60	
115 hp jet engine	110.00	12	1,320	
28 hp outboard	35.00	9	315	2,715
Fish Traps and Nets				
10 Fry traps	200.00	10	2,000	
10 Box traps	60.00	10	600	
20 Gill nets	800.00	8	6,400	
Midwater trawl	50.00	4	200	9,200
		Total		$13,558

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