EFFECT OF LAKE LEVEL FLUCTUATIONS ON KOKANEE REPRODUCTION AND FISHERY IN FLATHEAD LAKE

Project Study Proposal

Submitted to Montana Power Company

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By

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Long-time residents of the Flathead Lake area can relate that lakeshore spawning populations of kokanee salmon provided significant opportunity for shoreline spawning in the years prior to construction of Kerr and Hungry Horse Dams. More recent observations indicate that the major kokanee spawning population utilize the main Flathead River. Shoreline spawning is limited and the recreational snagging fishery reduced.

Hypothesis

The hypothesis is that Flathead Lake offers an undetermined potential for successful lakeshore spawning of kokanee salmon resulting in increased numbers of salmon available for trolling and snagging fisheries in the lake which may be presently limited by the timing of lake level staging.

Natural lake level fluctuations in Flathead Lake showed a relatively constant level was attained in September and maintained through mid-April on the average. Lake levels increased during April, peaking generally in May and June. Lake levels at time of emergence were within one foot of lake levels at the time of spawning. Presently operations of Kerr Dam significantly influence the level of Flathead Lake. Lake levels are at their lowest in late winter and spring and full pool is attained in late May and maintained into the fall. Since Kerr Dam was built, lake levels at the time of kokanee fry emergency have been 6.5 feet lower than at the time of spawning on the average.

Successful lakeshore spawning by kokanee most notably occurs in areas influenced by ground water, which elevates minimum temperatures. Successful incubation of kokanee eggs depends on the minimum water temperatures they are subject to during spawning. Historical changes in the natural lake level patterns have two probable influences on success of kokanee spawning. Kokanee spawning at the present high lake levels may deposit their eggs in areas where ground water sources would decline when lake levels were reduced thereby subjecting the eggs to extreme winter temperature conditions, resulting in freezing or desiccation. A second influence would be on those eggs successfully incubating in ground water areas above the low pool level. When the fry are ready to emerge, they might be left stranded unless lake levels were raised or ground water flows could carry them to the lake.

Kokanee salmon home or return to the areas they were spawned four years later. This provides an opportunity for anglers to snag fish from these concentrated schools. With the increased awareness and restrictions on gasoline consumption, it is quite likely that this type of recreation will be enhanced and others decline. First, low energy consumptive recreation will become more popular (i.e. shoreline fishing as opposed to boating). Second, more people will be seeking recreational activities closer to their own area which would favor utilization of a site specific

fishery such as kokanee snagging. Finally, recreationists from other areas are more likely to come to specific areas to recreate rather than wandering across country. Fewer non-resident day users may be evident, but total use should not decline because those that come will likely stay longer. This is already being observed in Glacier National Park.

Enhancement of lakeshore spawning appears to be a logical and progressive attempt to meet the needs of people in a time where energy restraints are becoming overwhelming.

FUNDING

Proposed Project Funding

We suggest this study should be funded by Montana Power Company of Butte, Montana. Because of the possible impacts of the operation of Kerr Dam on Flathead Lake fishery, we believe Montana Power Company has a responsibility to support an investigation into the affects of the project as a service to its customers and the citizens of Montana. The timing of this study would coordinate closely with the relicensing of Kerr Dam as well as other important studies on the kokanee salmon in the Flathead River Basin.

Associated Funding

Three additional studies will contribute information pertinent to the objectives presented in this study. These additional projects are being funded by the Water and Power Resource Service, Environmental Protection Agency, and State of Montana (Dingell-Johnson Project). Objectives of the other studies are contained in Appendix A. Pertinent objectives are marked with an asterisk. Coordination with these projects provide data and resources that would not otherwise be available to this study without significantly larger cost.

Funding contributions by other agencies as part of the Flathead River Basin Study include $60,000 by the Environmental Protection Agency to study the food habits and growth rates of kokanee salmon and cutthroat trout in Flathead Lake. The Montana Department of Fish, Wildlife and Parks is contributing $48,000 to monitor the abundance of kokanee in Flathead Lake using acoustical sounding equipment. Related studies include assessment of the spawning population of kokanee in the river and the impacts of Hungry Horse Dam. This study was funded at a level of $113,000 for FY 1980 and continued funding is expected.

Problem Definition and Selection

A. Scope and Approach

Phase I -- operation of Kerr Dam has had an as yet unquantified impact on the lakeshore spawning kokanee population. The

amount of suitable spawning habitat available to lakeshore spawners has been reduced due to drawdowns in lake level following the spawning period and maintenance of these low flows until after the time of fry emergence.

Trends in abundance of kokanee spawning on the lakeshore indicate a decline has occurred in most areas in Flathead Lake over the period of record. A lakeshore snagging fishery was observed and censused by Stefanich (1954) and Robbins (1966). In recent years little effort has been expended on snagging kokanee or lakeshore spawning.

Prior to impoundment of the South Fork by Hungry Horse Dam, nearly all of the known kokanee spawning took place within Flathead Lake. During the 1950's, some spawning was observed in McDonald Creek, just below McDonald Lake, and in the Whitefish River. A trend of increased utilization of the river by spawning kokanee has been observed since the early 1960's (Hanzel 1964). It is believed that the warmer winter discharges from Hungry Horse Dam favored successful incubation of eggs.

This study should result in an estimate of the potential lakeshore spawning habitat for kokanee salmon in Flathead Lake. Despite the lack of quantifiable historical data, we should also be able to assess the relative importance of the lakeshore spawning population to the total lake population. This would require close coordination with ongoing studies on the river spawning population (funded by the WPRS) and kokanee population estimates (funded by the state).

Investigations in this study would include:

a. Identify and quantify at selected sites the amount and success of lakeshore spawning of kokanee salmon.

b. Identify influences of lake level and ground water on incubation success and recruitment of fry.

c. Through coordination with on-going river studies, the relative importance of each component of the basin for producing kokanee salmon would be determined.

Phase II -- this phase of study will provide specific information needed to assess factors critical to incubation success, stranding or other factors important in optimizing recruitment of kokanee fry into the population. This information will be necessary to assess the feasibility of options available for enhancement of the lakeshore spawning population as well as implementing an alternative and monitoring its long-term success. This phase will be implemented simultaneously with Phase I.

Phase III -- this phase of study is presented here because the need for this information is vital in assessing the importance of the lakeshore fishery. In this phase we would determine the fisherman use, success and effort for the various fisheries including lakeshore, snagging, boat, winter, summer and others. This one year census would not determine the value of the fisherman day. We would rely on values determined for lake fisheries which would likely approximate those on Flathead Lake. This phase is not presented for funding at this time.

Kokanee salmon are a significant economic resource to the Flathead Valley. Based on a range of values for an angler day of $14 (U.S. Fish and Wildlife and U.S. Forest Service) and $40 per day (WPRS), the value of the river fishery alone ranges from $630,000 to $1.8 million. Pressure estimates were taken in a 1975 creel census (Hanzel 1977).

The last census of the lake fishery was in 1962 (Robbins 1965). At that time, estimated fisherman use was over 100,000 man-days during the summer period. The value of that fishery today would be $1.4 to 4 million. It is probably that angler use on the lake has nearly doubled since 1962 boosting the value to approximately $3 to 8 million. According to the Montana Statewide Comprehensive Outdoor Recreation Plan done in 1978, there is a projected increase of 30 percent by 1985.

Data from all three phases will be necessary to develop recommendations accounting for both biological and economic concerns. Realizing the complexity of demands on the operation of Kerr Dam, an evaluation of the success of a selected alternative would assist in making long-term management recommendation for lake levels.

Data from Phase I, II and III would be necessary to develop a simple and relatively inexpensive system to monitor the success of an alternative for enhancement of lakeshore spawning populations. The specifics of the monitoring scheme cannot be determined until results from the study are known and an alternative is selected. It may be that a no-action alternative is adopted if significant enhancement benefits are not evident from any feasible alternative. In that case, no monitoring system would be necessary unless additional baseline data was desired.

OBJECTIVES

Phase I

1. Delineate extent of successful shoreline spawning, both on-shore (to an approximate depth of 20 feet below full pool) and off-shore (approximately 20 to 70 feet in depth).

2. Quantify influence of ground water on incubation success of on-shore spawners.

3. Assess the relative importance of lakeshore spawning to recruitment of kokanee into Flathead Lake.

Phase II

1. Assess timing of and factors controlling emergence of fry in areas under influence of lakeshore fluctuation.

2. Assess degree of stranding of fry in ground water areas.

Phase III

Assess fisherman effort, use and success in Flathead Lake over a one-year period to include the various seasonal fisheries.

Study Resources

The Fish, Wildlife and Parks Department will provide major equipment items such as boats, motors, trailer, generators, thermographs, nets, etc. The Department will assess a monthly rental charge for these items. This same procedure is used on contracts with the Water and Power Resources Service, EPA and Army Corps of Engineers.

The Department will provide at no charge office quipment, typewriter, computer terminal, microfiche reader, desks, sample storage, copy machine, maps and files and minor chemicals.

Computer terminal service is provided at the Regional headquarters in Kalispell and linked to the MSU computer and Bozeman and the computer in Helena. Limited access is available to the federal computer in Fort Collins, Colorado.

Assumptions

1. Egg embryos appearing white at the time of redd excavation would be assumed dead prior to excavation. Translucent, normal appearing embryos would be assumed living.

2. We assume salmon egg mortality in areas exposed to the air is due to desiccation, freezing, or to water temperatures below 2.6^{o}C during critical stages of incubation.

3. We assume that egg mortality estimates from random stratified sampling of selected lakeshore spawning sites will be representative of similar spawning areas in the lake. These samples will also be representative of the specific area being sampled.

4. We assume that potentially successful lakeshore spawning areas that will be exposed at low pool can be identified visually as wetted areas between low and high pool.

5. We assume that potential fry recruitment from the river system can be represented by enumeration of successful spawning areas in the river system and mortality rates from egg to alevin.

6. We assume that a random stratified creel census will reflect the harvest, catch rates and other parameters measured in the census.

Methodology and Analysis

1. Potential kokanee spawning areas between the low (2883 msl) and high (2893 msl) pool elevation will be identified by presence of ground water and delineated by ground surveys or planimetering scale aerial photographs. These must be taken in the spring after snow melt and before the lake is filled.

2. Existing spawning areas will be identified by presence of redds. Identification of spawning areas in the lake and below the low pool area will be assessed using SCUBA gear. Survey areas where spawners are known to congregate and other randomly selected sites will be used to assess extent of spawning.

3. Egg mortality will be determined in ground water areas on shallow water areas by use of a hydraulic square-foot sampler. Excavation of eggs will be necessary at depths in excess of two feet or in ground water areas.

4. Egg mortality will be correlated with lake level, timing of drawdown, presence of groundwater and other related physical parameters. Stand pipes will be used to measure flow and water quality in ground water areas.

5. Eggs will be sampled in areas where spawning is concentrated enough to allow random sampling. Redds will be identified under a range of lake level - ground water conditions and screen will be placed over redds of known age to prevent multiple spawning. This way development can be monitored.

6. To assure that a range of conditions are surveyed, experimental containers will be used to incubate eggs under the same range of natural conditions to aid in documenting the influence of lake level and ground water on length of incubation, time of emergence, egg mortality, fry size, etc.

7. Density of redds in selected sites and the survival rate of the eggs to fry will be expanded to determine existing and potential recruitment to the lake by lakeshore spawners.

8. Similar techniques will be applied to the river-spawning portion of the population under a contract with the Water and Power Resources Service. From these combined efforts an estimate of the relative importance of the two types of spawners can be made.

9. Netting of lakeshore spawning populations in the fall will be continued in an effort to develop an index of relative abundance.

10. Tows with a meter or larger net will be made in the spring to collect fry near spawning areas in an effort to develop an index of relative abundance.

11. Preliminary surveys will be run several times during the summer to determine the most efficient way to collect fishing pressure and catch rate data on Flathead Lake. Methods will include boat, aerial and ground census.

Reports

1. Monthly reports will be made to include a brief description of work performed during that month, some pertinent data and plans for the succeeding month's work.

2. The first annual report will be prepared detailing results and analysis of Phase I studies and making recommendations as whether to continue with Phase I only, initiate Phase II, Phase III or all. The second annual report would detail results and analysis of the agreed work for that year and integrate with the previous year's report.

Timing

A. Initial reconnaissance level survey of some lakeshore spawning areas has been done during a previous spring to identify possible study sites. It is necessary to do this while the lake level is low to locate areas influenced by ground water.

Information on average length of spawners is available from six sites around the lake from annual lakeshore netting.

B. This project would commence in July, 1981; Phase I and II would be conducted during the following two-year period.

Contractor's Experience and Qualifications

Fisheries personnel of the Montana Department of Fish, Wildlife and Parks in Region One (northwest Montana) have and are conducting several large, multi-year contracts for the U.S. Army Corps of Engineers, Water and Power Resources Service and Environmental Protection Agency. Additional contract work has been performed in cooperation with Montana Department of Health, U.S. Forest Service, U.S. Soil Conservation Service and others.

It is timely to undertake this study because of the equipment, resources and data that will be available from three other ongoing studies in the Flathead River Basin, all dealing in part with related investigations on kokanee salmon as outlined in Appendix A.

A list of present key personnel that will be affiliated with this study are listed in Appendix B.

Budget

A.	Salaries and benefits	
	Project Leader (3 mo./yr.)	4,826
	Asst. Leader (12 mo./yr.)	15,537
	Fisheries Aide (12 mo./yr.)	10,269
	Secretarial (2 mo./yr.)	1,500
	Benefits (17%)	5,462
B.	Travel	
	Vehicle	2,040
	Boat	600
	Per diem	1,440
C.	Expendable equipment	500
	Equipment rental	1,000
	Contracted services: computer analysis	500
	aerial photographs	1,000
	Communications, reports, etc.	600
		45,274

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Stefanich, Frank A. 1954. Natural reproduction of kokanee in Flathead Lake and tributaries. Comp. Report, Mont. Fish and Game Dept., F-7-R-3, Job IIIA, 10 pp. Multilith.

APPENDIX A

FLATHEAD BASIN

PROJECT OBJECTIVES

I. Water and Power Resources Service Study

A. Fishery Study

1. To provide the Water and Power Resources Service with the Department of Fish, Wildlife and Park's best estimate of minimum flows which will result in the most desirable level of reproduction and survival of kokanee salmon, mountain whitefish and fish food organisms.

2. To determine the effects of reservoir discharge fluctuations on survival of incubating whitefish and kokanee salmon eggs in the Flathead River below the South Fork junction.

3. To quantify the suitable kokanee habitat at staged flows in Flathead River Basin on additions of flow increments with one to four turbine generators; that is, natural flows from above the South Fork plus increments of approximately 2,500 cfs per generator.

4. To monitor delays in upstream migration of adult cutthroat trout as a result of unnatural seasonal flow and temperature regimes caused by discharges from Hungry Horse Dam.

B. Aquatic Invertebrate Study

1. To estimate biomass and species diversity and to compare life history characteristics of major macroinvertebrates in the Flathead River above and below the confluence of the South Fork and in the South Fork of the Flathead River below Hungry Horse Dam.

2. To make estimates of macroinvertebrate habitat loss as related to extended periods of minimum discharges from Hungry Horse Dam. To compare the biomass, composition and life histories of the macroinvertebrate communites altered by reservoir discharges. Cooperation and coordination with the Flathead Basin Study under the Environmental Protection Agency's (EPA) guidance will be necessary to interpret altered and nonaltered riverine relationships.

C. Temperature Study

1. To estimate desirable seasonal water temperatures to release if it is determined that a multiple outlet discharge structure is significantly beneficial to game fish and macroinvertebrate production.

II. Flathead River Basin Study (EPA)

A. North Fork of the Flathead River Funded Projects

1. Assess relative importance of tributary streams for producing migratory and resident populations of westslope cutthroat and bull trout.

2. Develop a long-term monitoring index for juvenile trout in major tributaries and the main river for correlation with habitat inventories and to monitor changes in environmental quality.

3. Identify the timing and distribution of spawning and feeding, and "smolt" migrations for major fish species.

4. Assess existing aquatic habitat in major tributary streams and the main river. Habitat components will be assessed to determine their importance in maintaining the existing cutthroat trout, bull trout and sculpin community. Stream reaches will be ranked in relation to relative importance for providing spawning and rearing areas.

5. Determine habitat requirements and species interaction for juvenile bull trout and westslope cutthroat trout.

6. Quantify instream flows for maintenance of native fish species in the North Fork of the Flathead River.

B. Middle Fork of the Flathead River Fisheries Study

1. Assess relative importance of tributary streams for producing migratory and resident populations of westslope cutthroat and bull trout. To compare the potential contribution of juvenile fish from the North and Middle Forks to Flathead Lake.

2. Develop a long-term monitoring index for juvenile trout in major tributaries and the main river for correlation with habitat inventories and to monitor changes in environmental quality in a natural system in the event development continues in the North Fork drainage.

3. Identify the timing and distribution of spawning and feeding, and "smolt" migrations for major fish species.

C. Flathead Lake -- Fish Food Habits Study

1. Assess food habits of westslope cutthroat trout, bull trout and kokanee salmon seasonally in representative areas of the lake to predict and, if need be, document negative impacts of development in the upper basin on the food chain.

2. Begin to develop a method for long-term monitoring of relative abundance of westslope cutthroat and bull trout in the lake.

3. Determine growth rates and the condition of bull and cutthroat trout in the lake.

III. Flathead Lake Project (State)

Fish population, composition and relative abundance from netting was gathered from 1976 through 1980. Acoustical population assessment started in 1974 and is currently being refined to give reliable population densities of salmon and perhaps lake trout and the three species of whitefish (lake, pygmy and mountain).

APPENDIX B

VITAE

Graham, Patrick J.

Address: Home: 1837 Stag Lane, Kalispell, MT 59901.
Phone: 257-2454.
Office: Montana Department of Fish, Wildlife and Parks, 490 N. Meridian, Kalispell, MT 59901
Phone: 755-5505.

Born: Bozeman, MT on August 21, 1952.

Education: Stillwater, Oklahoma and Bozeman public schools.
Montana State University - B.S. Fish and Wildlife Management 1970-1975.
University of Idaho - Graduate Fellowship.
M.S. Fisheries Management 1975-1977.

Employed: Fisheries Assistant: Montana Fish and Game for 12 months between March 1972 and September 1974. Worked on Big Horn Reservoir, Mountain Lake Surveys on Beartooth Plateau, Yellowstone River paddlefish study, and Elk Lake cutthroat trout study.

Fisheries Biologist: Montana Fish and Game from March 1977 to present.

Conducted research and compiled data on the fisheries and habitat components of the Lower Yellowstone River. Worked with instream flow methodologies.

Conducted a study on the aquatic impacts of a proposed low head hydroelectric dam on Kootenai Falls, Kootenai River. Work involved many different fish species, habitat analysis, aquatic insect and creel census.

Directed fisheries investigations on the North and Middle Forks of the Flathead River and Flathead Lake as part of the Flathead River Basin E.I.S. team. Directed aquatic studies on the impacts of Hungry Horse Dam and the feasibility of a reregulating dam.

Membership: Member of Montana Chapter of American Fisheries Society.
Member of National Chapter of American Fisheries Society.

PUBLICATIONS COMPLETED

Graham, P. J. 1977. Juvenile steelhead trout densities in the Lochsa and Selway River drainages. Unpub. Masters Thesis. University of Idaho.

Graham, P. J. and R. F. Penkal. 1978. Aquatic Environmental Analysis in the Lower Yellowstone River. Ecological Services Division Report. Montana Fish and Game. To be published as a technical report by the Bureau of Reclamation.

Graham, P. J. 1979. Kootenai Falls Fisheries Study. First Interim Report. Department of Natural Resources and Conservation.

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Graham, P. J., S. L. McMullin, S. Appert, K. J. Frazer, and P. Leonard. 1980. Impacts of Hungry Horse Dam on aquatic life in the Flathead River. First Annual Report. Mont. Dept. Fish, Wildlife and Parks, Kalispell, MT. 91 pp + App.

Hanzel, Delano A.

Address: Home: 215 Fifth Ave. E., Kalispell, MT 59901
Phone: 257-1676.
Office: Montana Department of Fish, Wildlife and Parks, 490 N. Meridian, Kalispell, MT 59901
Phone: 755-5505

Born: Belt, Montana on March 20, 1935.

Education: Montana State University, September 1954 - June 1957, B.S. in Fish and Wildlife Management.
Montana State University, September 1957 - May 1959.
Hydroacoustic Stock Estimation, Short Course, University of Washington. March 1975.
Advanced Hydroacoustic Stock Assessment, Short Course, University of Washington, October 1976.

Employed: Montana Fish and Game, Kalispell, Montana, as Project Biologist. May 1959 - May 1964.
Montana Fish and Game, Kalispell, Montana, as Fisheries Manager. May 1964 - June 1966.
Montana Fish and Game, Kalispell, Montana, as Special Project Biologist, June 1966 to present.

Membership: Membership in American Fisheries Society since 1960.
American Fisheries Society Certified Scientist.
Member of Montana Chapter of American Fisheries Society.
Member of American Institute of Fisheries Research Biologists.

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Hanzel, Delano A. 1960. The distribution of the cutthroat trout (Salmo clarki) in Montana. Proc. Mont. Acad. Sci. 19:32-71.

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Hanzel, Delano A. 1971. The seasonal and depth distribution of the fish population in Flathead Lake. Comp. Report, Montana Fish and Game Dept. F-33-R-4, Job Ia, 27 pp. Multilith.

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Schumacher, Robert E.

Address: Home: 1227 Fifth St. W., Kalispell, MT 59901.
Phone: 257-1757.
Office: Montana Department of Fish, Wildlife and Parks, 490 N. Meridian, Kalispell, MT 59901.
Phone: 755-5505.

Born: Heron Lake, Minnesota on October 14, 1918.

Education: Attended Heron Lake Public Schools.
Five years in U.S. Army Air Corps, October 1940 - October 1945.
University of Minnesota, B.S. in Fish and Wildlife Management 1945 - 1949.
University of Minnesota Graduate School 1950 - 1951, 34 quarter credits in Fisheries Biology and Management (thesis incomplete).

Employed: Aquatic Biologist I, Minnesota Department of Conservation, March 1950 - October 1951. Trout Nutrition and Disease Research.
Aquatic Biologist II, November 1951 - November 1955. Biological Trout Hatchery Management. Lake and stream survey supervising.
Research Biologist, November 1955 - November 1956. Performed research work in trout population dynamics in lakes and streams of Minnesota. Supervised all trout research programs statewide. In House report 1964, Reorganization plan, Game and Fish Division as team member.
State of Montana - District Fisheries Manager, November 1965 to present time. Responsibility entails detailing study areas for management needs as habitat preservation, preparation of budgets, preparing long-range and short-term research plans and management plans. Coordinate our, and other, research findings into appropriate management action. Assign duties and responsibilities to fishery project leaders (all with M.S. in Fisheries Science) and supervise those plus three fisheries fieldmen and up to eight temporary summer student assistants. Reports are prepared for both management and research reports. Regulations for seasons and limits and appropriate limitations on fishing activities or developments for the region are recommended.
Make field reviews of an average of 150 construction projects per year proposed by state and federal highway departments, state agencies and U.S. Forest Service and private individuals.

Membership: American Fisheries Society.
President North Central Division of American Fisheries Society 1960.
Certified Fisheries Biologist 1964.
Certified Fisheries Scientist 1970.

REPORTS AND SCIENTIFIC PAPERS

Schumacher, R. E. Blood sedimentation rates of brook trout as affected by furunculosis. Progressive Fish Culturist. Vol. 18, No. 4, October 1956.

Schumacher, R. E. Some effects of increased angling pressure on lake trout populations in four northeastern Minnesota Lakes. Minn. Fish and Game Investigations. Fish Services No. 3. 1961.

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Schumacher, R. E. Additional articles on humpback salmon in Lake Superior. Probably 1957-58. A.F.S.

Special Publication No. 3. A review of comparative trout feed costs at state trout rearing stations for five consecutive years spanning a change in trout diets and feeding methods. February 1955.

A manual for operations related to trout hatchery disease control and sanitation program. September 1950.

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Investigational Report No. 142. Results of fortifying standard Minnesota hatchery diet with Aureomycin and Thiamin Hydrochloride on the growth of brown trout. November 9, 1953.

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Investigational Report No. 171. Aerial car counts on trout streams of southeastern Minnesota. April 30 - May 1, 1955. January 26, 1956.