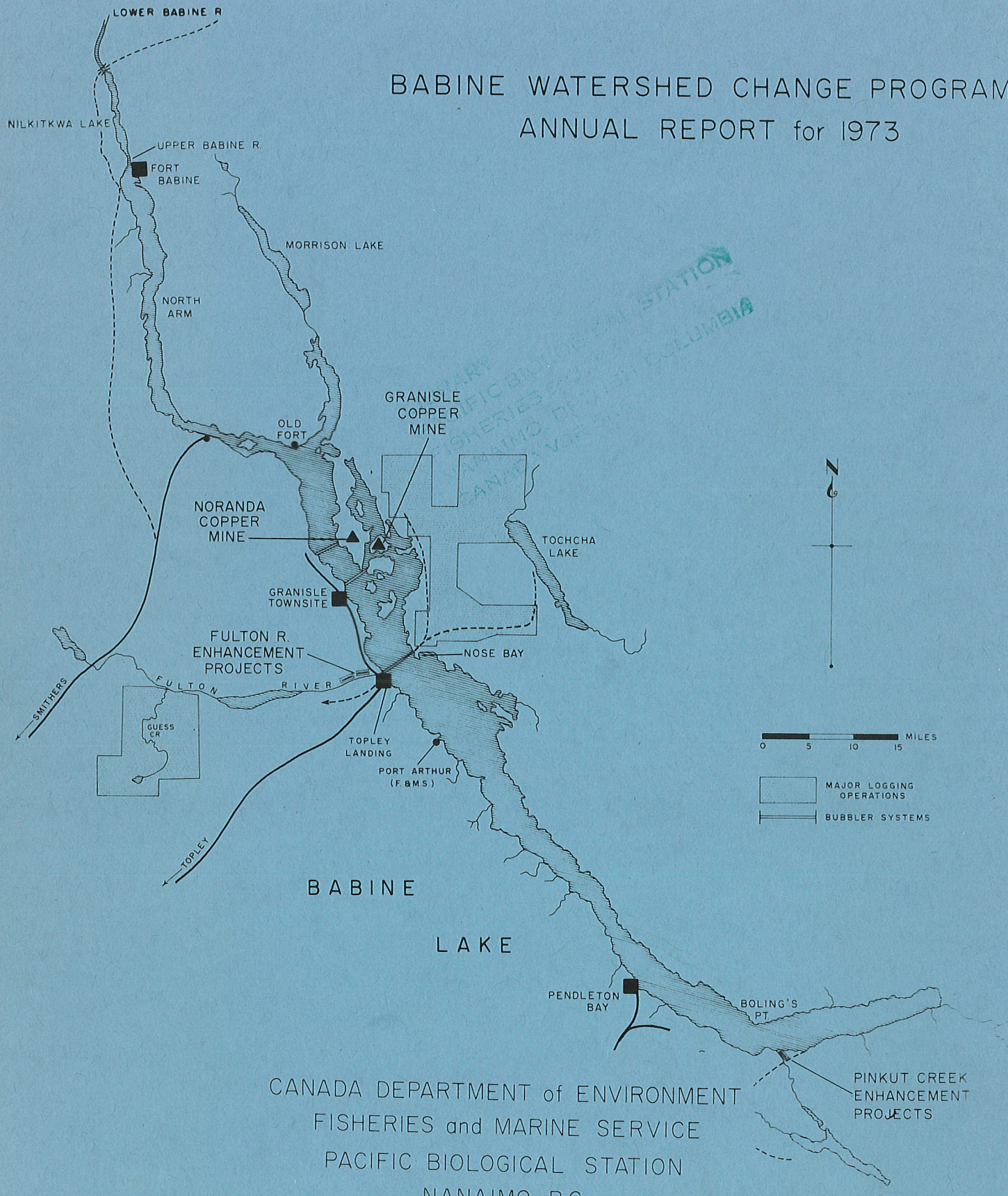
BABINE WATERSHED CHANGE PROGRAM
ANNUAL REPORT for 1973



CANADA DEPARTMENT of ENVIRONMENT
FISHERIES and MARINE SERVICE
PACIFIC BIOLOGICAL STATION
NANAIMO, B.C.

BABINE WATERSHED CHANGE PROGRAM

ANNUAL REPORT FOR 1973

Submitted to the Regional Board, Pacific Region,

by the Steering Committee

Edited by Howard D. Smith

Department of the Environment
Fisheries and Marine Service
Pacific Biological Station
Nanaimo, B.C.

NOVEMBER, 1975

BABINE WATERSHED CHANGE PROGRAM

Objectives

To assess the effects of environmental change on salmon and trout in the Babine watershed and propose action to protect the fisheries should they be threatened.

Steering Committee - Terms of Reference

To provide direction and continuity of effort to achieve objectives of the cross-mission Babine Watershed Change Program; to review progress, and recommend to the Regional Board, Pacific Region, and through the RBPR to appropriate agencies or companies with respect to program needs, funding, reporting and implementing results.

Introduction

Salient physical features of the Babine Watershed and a brief history of its salmon stocks and their enhancement, and of mining and timber resource extraction have been presented in the 1972 Annual Report of the Babine Watershed Change Steering Committee.

By way of review, the watershed had likely been little affected by human activity other than logging until about 1965. Rapid expansion of both logging and mining thereafter may affect water quality and complicate assessment of an $8 million sockeye salmon development program on Fulton River and Pinkut Creek (see Fig. 1). For this reason the Regional Board of the Pacific Region (DOE) authorized formation of a formal Steering Committee to review activity in the watershed, to propose programs to assess effects on salmon and trout and to direct and co-ordinate approved work. Participation was invited from several provincial government agencies, from major industries active in the watershed and from the Regional District of Bulkley Nechako. Members for 1973 are listed in an appendix to this report.

Meetings of the full committee and of those responsible for major projects on the watershed were convened as needed during the year and members took a three-day familiarization trip to Babine Lake and environs June 4-6.

The 1973 Program

The committee believed that it should begin immediately to assess the physical, chemical and biological characteristics of Babine Lake, and on completion of this to initiate a comprehensive water monitoring program.

Early development of a "baseline" was considered necessary in order that any future changes in water quality could be demonstrated. Assessments of lake circulation patterns and how they are generated, the chemical composition of the water and biological productivity, encompassing both phytoplankton and zooplankton were initiated in 1972 and continued with some expansion of projects in 1973. The productivity of Babine Lake sockeye salmon is an important element in the overall study and is under careful surveillance through ongoing programs

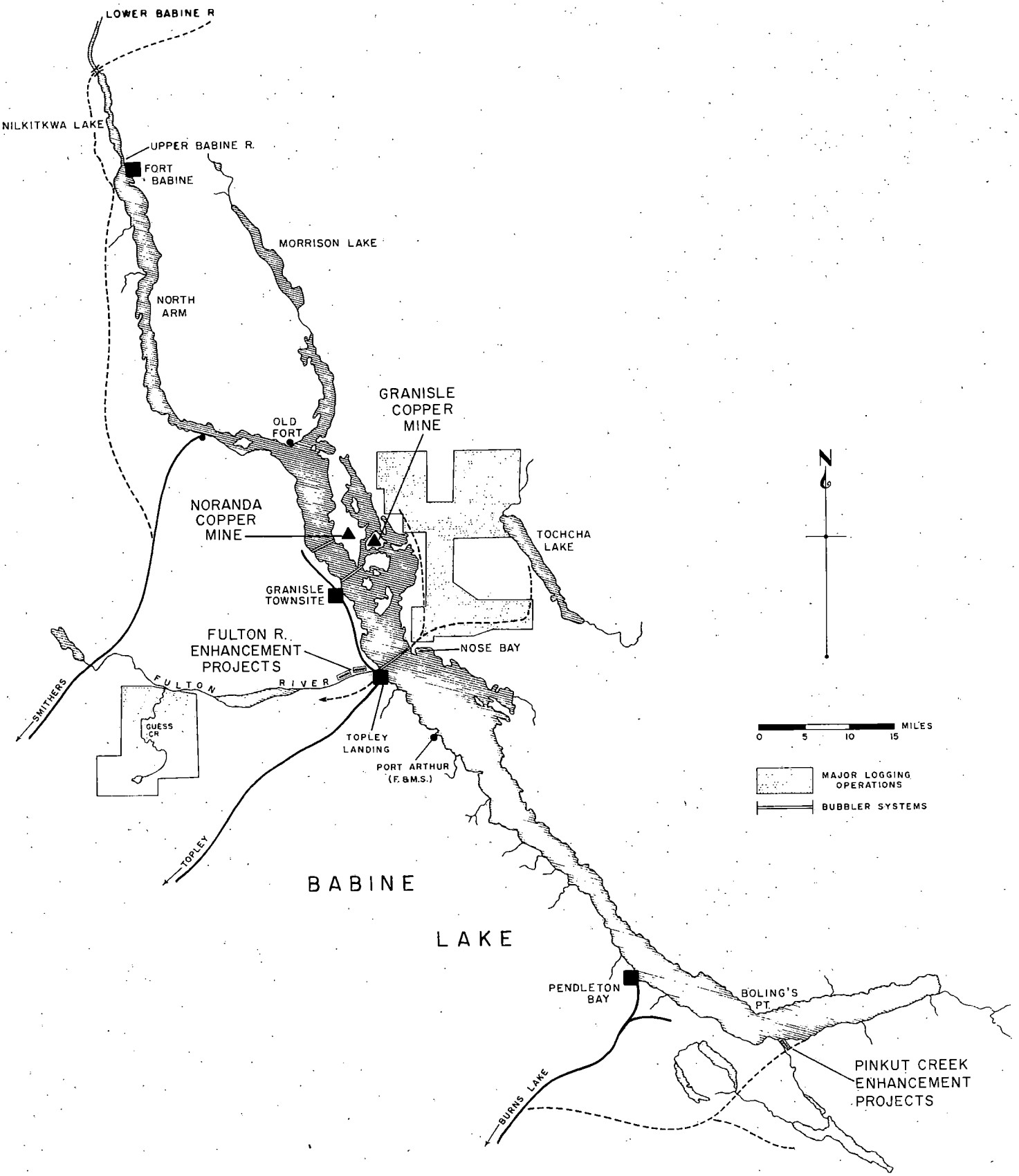


Fig. 1. Babine Lake and environs.

of the Fisheries Service Operations and Research and Development Branches.[1]

The bulk of field work is expected to be completed in 1973-74, and reporting on all phases will follow.

Principal studies and those primarily responsible for them in 1973 are as follows:

Physical limnology studies - Dr. David Farmer, Ocean and Aquatic Affairs, Victoria

The field operations of the physical limnology program concluded with the removal of instrumentation left in the lake through the winter of 1973-74. These winter measurements included thermistor chain observations near Fulton River and also near Bolings Point (Fig. 2).

Previous observations during the 1972-73 season had demonstrated a remarkable convection pattern beneath the ice in the spring, caused by absorption of solar radiation in the water. The 1973-74 measurements were to provide information on the process of autumnal cooling prior to the formation of ice. Initial examination of the data shows that all thermister chains worked satisfactorily during the cooling phase up to ice formation.

A short field operation was also run during the early spring in support of Dr. Stockner's biological measurements. The convective circulation occurred later this year owing to a thick snow cover on the ice.

With the conclusion of field operations our effort has turned to analysis of data. The detailed temperature sections are now being compiled for publication as a Technical Report. A scientific paper on convection beneath lake ice entitled, "Penetrative Convection in the absence of Wind Effects" has now been written. Dr. Hamblyn of the Canada Centre for Inland Waters has written a paper "Upwelling in a model of an intermontane lake," motivated by the special features of the topographically induced wind effects in Babine Lake.

A contract has been let to Dr. Mysak and Mr. Clinton Lee at the Institute of Oceanography, to study certain aspects of the current measurements in Babine Lake. Mr. Lee has already discussed some upwelling effects at Babine Lake in his Ph.D. thesis. It is expected that analysis of Babine Lake physical data will continue for at least a further two years.

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[1] Management of Babine Lake sockeye salmon is directed by the Skeena Salmon Management Committee, comprised of the Area Director, Department of Fisheries, and the Director of the Pacific Biological Station.

Fig. 2. Crew preparing instruments for use through Babine Lake ice.

Phytoplankton studies - Dr. J. G. Stockner, Pacific Environment Institute

Phytoplankton studies were carried out in 1973 to determine the primary production of Babine Lake (Stockner and Shortreed, 1974). Ten stations, located in six zones (sub-basins) were sampled biweekly from May to October to assess regional differences in this large, dystrophic (humic-stained) lake. The spring bloom was caused mainly by diatoms, notably Rhizosolenia longiseta and Cyclotella stelligera. The fall bloom was restricted to south basin stations only, and was caused chiefly by the diatoms Tabellaria fenestrata and fragileria spp.

Carbon assimilation (production) showed two peaks at south basin stations but only one at stations north of Topley Landing. Mean daily production at northern stations was 100 mg.C. m^{-2}, but at south basin stations it was higher at 145 mg.C. m^{-2}. Annual primary production was 25 g.C. m^{-2} in the north basin and 40 in the south. Main causes of this regional disparity are mean depth, mixed layer stability, and surface inflow (loading) differences. The development of the autumnal bloom of Tabellaria fenestrata was considered to be the principal factor responsible for increased annual production in the south basin. The sustainment of the autumnal bloom was the result of the previously mentioned physical factors.

A preliminary total phosphorus load was computed and an estimated 24,134 kg TP entered the lake in 1973. This is equivalent to 0.05 g TP m^{-2} yr^{-1}. This loading rate can vary depending on the return of adult sockeye salmon, whose carcasses contributed 20% of the annual load in 1973. An estimated 30% of the annual load was lost via the outflow - Babine River - and it was estimated that of the remaining 70%, most if not all, is lost to the sediments. Phosphate limitation is implied as a chief factor limiting primary production in the north, but not south basins. On the basis of total phosphorus load, Babine is classified as oligotrophic, but in terms of annual production and its humic-stained waters it is more correctly considered mixotrophic.

Monitoring program

In 1973 the Babine Lake steering committee recommended that the waters of Babine be monitored yearly to ascertain whether watershed activities will bring about a change in water quality and whether these changes will or will not be detrimental to the fisheries. A program was set up using the OECD format, results of which will be comparable with similar studies on lakes throughout the world. Physical, chemical, and biological parameters are included in the monitor which will be carried out four times each year.

Paleolimnology

Results are now available from the analyses of eleven phleger cores obtained in 1973 (Stockner and Smith, 1973; Stockner, 1975, in press). The cores reflected the same regional disparity in algal biomass and production as did the primary production studies with greatest diatom numbers occurring in cores in the south basin. On the basis of diatom "influx" (diatoms/cm^2/yr), over the past decade increased influx has occurred signifying enhanced diatom production during this period perhaps in response to subtle watershed changes or regional climactic changes.

Zooplankton studies - P. Rankin, Institute of Animal Resource Ecology, University of British Columbia

The first substantial studies of Babine Lake zooplankton were started in 1956 by W. E. Johnson. These lead to the hypotheses that on the basis of available planktonic food, the main basins of Babine Lake were capable of supporting substantially more young salmon than were usually found there at peak population periods (Johnson, MS 1961). Additional information on Babine Lake zooplankton was provided by Narver (1970), and the most recent study began in 1972. It continued through May-September 1973 and annual field work terminated with three winter field trips during the period of ice cover in 1973/74.

In recent years Babine sockeye fry production has greatly increased as a result of the major enhancement facilities at Fulton River and Pinkut Creek and there has been substantial environmental change associated with increased mining, logging and other human activity in the drainage.

The current plankton studies are expected to show any appreciable change in standing stock since the 1956-62 study.

In 1973 the zooplankton was sampled at ten different depths and by a vertical haul at each of nine stations along the lake (Fig. 3). Miller samplers (Miller, 1961) were operated from a pontoon barge outfitted in the manner described by Andersen (1968) and as illustrated in Fig. 4. Samples were preserved in 3% formalin until settled volumes, dry weights and species counts could be determined in the laboratory.

Further sampling is planned for 1974 and special care will be taken to cover major stations used in the 1956-62 studies. A series of experiments are also planned to investigate some aspects of predator-prey interactions of Babine sockeye fry and important zooplankton species.

Atmospheric effects - D. G. Schaefer, Atmospheric Environment Service

Routine climatological data were collected from shoreline stations by Fisheries Service personnel with technical advice and instruction from A.E.S. as in 1972.

Summer student D. Guenther extended previous work on air-lake interactions to include fluxes of sensible heat and moisture for the 1973 season as a further step toward calculating an energy budget for Babine Lake. The paper on evaporation estimates has been completed for publication as a Canadian Meteorological Research Report (Spring and Schaefer, 1974). Their estimate of total evaporation from Babine Lake during the open water period in 1972 was 38 cm, somewhat higher than the preliminary estimate of 30 cm which appeared in the 1972 report of the committee.

Assessment program of the Habitat Protection Unit, Fisheries Operations, and the Pollution Abatement Branch, Environment Protection Service - R. H. Kussat, Environmental Protection Service

An assessment of major activities with potential for environmental damage was conducted jointly by Fisheries Operations and Environmental Protection Service units. Results were as follows:

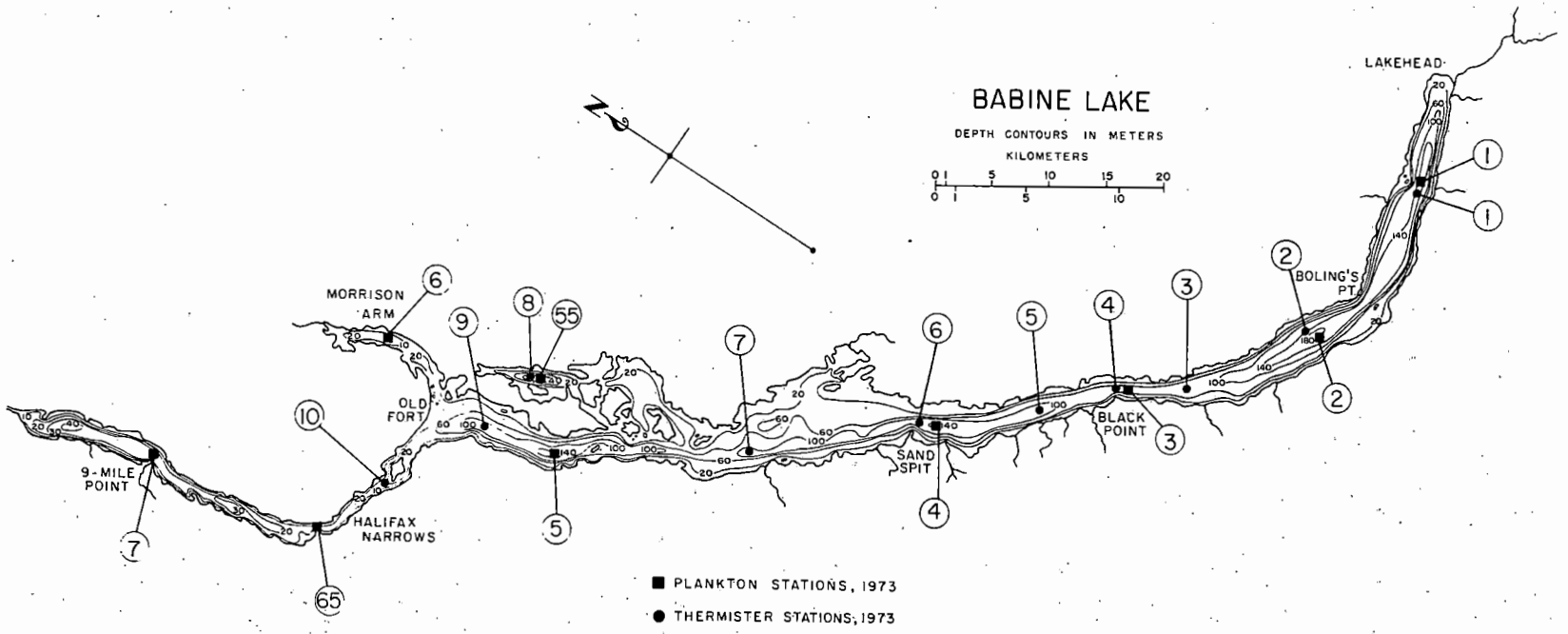

Fig. 3. Locations of plankton sampling and thermister stations.

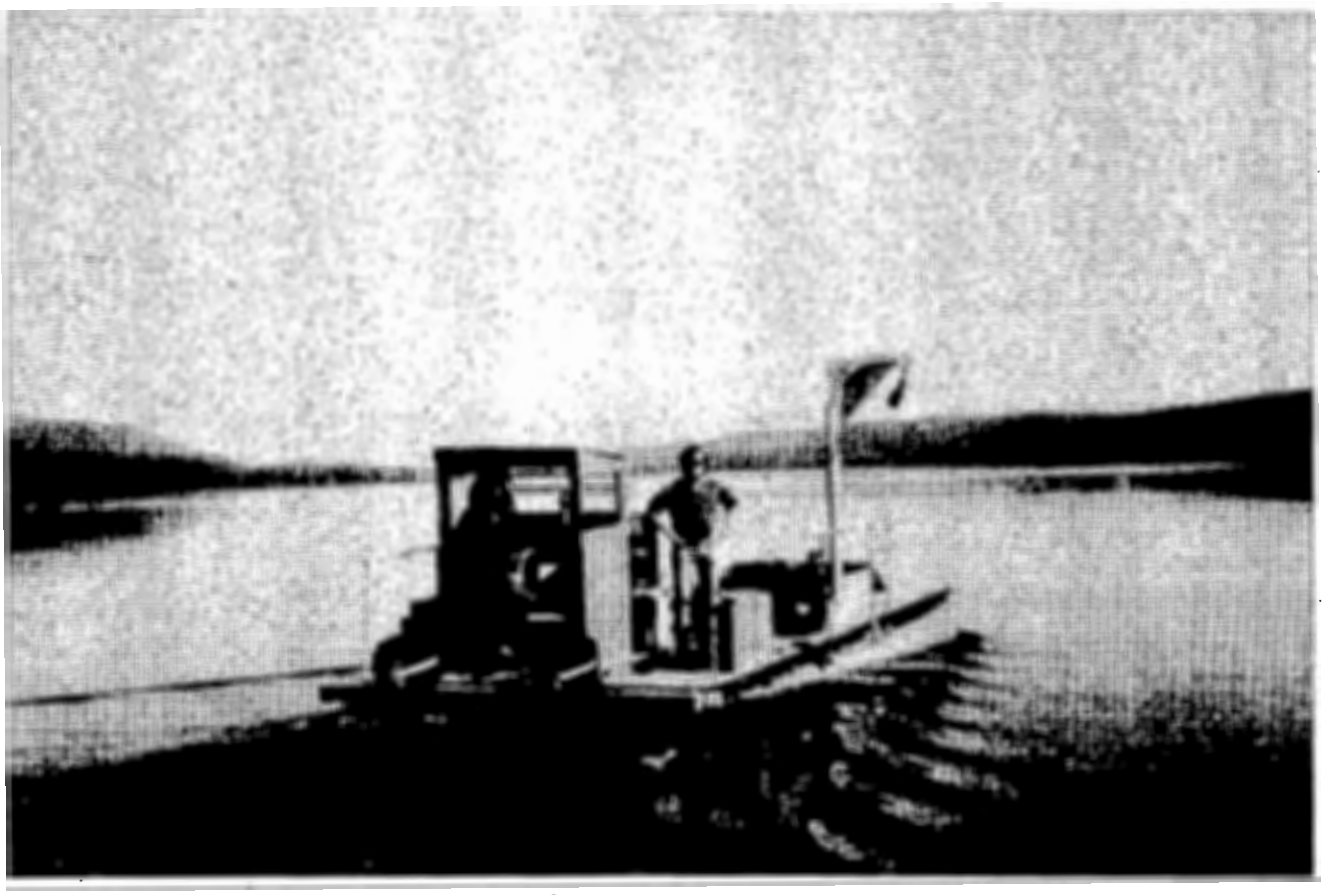

Fig. 4. Outboard driven raft used for plankton sampling.

1. Logging operations

Studies initiated in 1972 to assess the impact of logging operations on stream water in the Nose Bay area were continued. During the year logging activity expanded from that area in a northeasterly direction to Hagan Arm.

Soil erosion from logging road construction abated noticeably in comparison with that observed in 1972. Proper culverting and regeneration of stream bank vegetation were probably the major reasons.

Dramatic temperature increases were recorded in some small feeder streams flowing through clear cut areas. One stream clear cut on the southern exposure ceased flowing during the summer period leaving only small pools of heated water. Temperatures in these pools reached 80°F and dissolved oxygen levels dropped to 2 ppm.

Rainbow trout fingerlings and aquatic invertebrates in the clear cut section of the stream expired while no visual stress on the biota in the forested reaches of the same stream were observed.

The watering periods and quantities of boomed log bundles in sheltered bays of Babine Lake increased significantly during 1973. Possible detrimental effects on water quality were not assessed.

2. Mining

Noranda Mines, Bell Copper Division, impounds its tailings inland whereas Granisle Copper is building tailings impoundments into the lake. The potential hazard to living creatures in the lake through accidental mishaps and seepage appears greater from Granisle Copper than Noranda Bell Copper. The major studies of the 1973 mine monitoring program were therefore directed toward the Granisle operation. (Fig. 5).

Water samples adjacent to the major tailings impoundments were analyzed in June 1973 for pH, total residue, sulfate and turbidity. In July additional water samples were collected and analyzed for dissolved metals. Results obtained from samples near the mines were similar to those from control sites.

Substrate samples from stations approximately 100 feet off the tailings dams were obtained with a ponar dredge and analyzed for total copper, zinc and iron. High copper values (760 ppm, 780 ppm, 1000 ppm) were recorded at three stations. The mean copper concentrations at ten other stations was 117 ppm. Since some tailings fines were picked up during dredging it is conceivable that the high copper values reflect a past spill of tailings at those three sites. Mean zinc and iron concentrations in the substrate were 161 ppm and 58,760 ppm and were similar to control samples from other parts of the lake. An examination of the supernatant from the Granisle tailings ponds indicated that heavy metal concentrations were low but sulfate levels remained relatively high within the impoundments.

In summary, the two mines on the lake did not appear to have any demonstrable major deleterious effects on Babine Lake water quality.

Fig. 5. Granisle mine with Granisle village in the distance.

3. Granisle townsite

Granisle, with a population of approximately 2,000, is the main population centre of the lake and houses employees of both mining companies. Facilities include an elementary school, a hotel and a small shopping centre. Sewer trunk lines and domestic sewage treatment facilities were incorporated into the town plans. After biological treatment in two sewage lagoons, the effluent (120,000 gpd at 25 mg/l BOD under permit by P.C.B.) is discharged below the lake surface north of the marina.

Although the precise location of the sewage discharge pipe was not known, sampling stations straddled the estimated outfall. Samples from several stations and depths were examined. Temperature levels appeared normal. Dissolved oxygen averaged greater than 80% saturation. Nutrient levels were low and ranged from less than 0.01 to 0.14 ppm for total phosphates and 0.02 to 0.06 ppm for nitrate-nitrites. No adverse effects on the lake from this domestic discharge were demonstrated.

Notes on logging operations - J. A. McIntosh, Forest Management Institute

During the summer Northwood Pulp and Timber Company Ltd., which has the timber cutting rights in the watershed, provided both aerial and ground transportation to committee members in order to familiarize them with the logging area and some of the problems of local road construction and harvesting.

Important features were noted as follows:

1. Stream sedimentation resulting from road construction, as described by Kussat in the 1972 Annual Report, will be difficult to eliminate, as the soils in the area are a deep loam type, and on the east and north slopes particularly, have a high moisture content. There was considerable evidence of extensive soil movement along the main haul road and a very wide right-of-way had been cleared to hasten the drying and stabilizing of the soil along the road.

2. Culvert construction could be improved to permit passage of fish. A drop of several feet from one culvert was noted (Fig. 6). Fish could not pass this culvert. As considerable added cost is incurred in constructing culverts to allow fish passage there is a definite need to have "fish streams" identified prior to the start of road construction.

3. The logs were dumped in strapped, truck-load bundles into Nose Bay where they were boomed for towing across the lake to Topley Landing. The bundles were reloaded on trucks for transport to the sawmill at Houston. Dust and mud from the dumped logs was causing some discoloration of the water in the bay. This would be a normal situation in summer logging. There was little evidence of silt outside the bay, or of loose logs escaping from the dumping and booming operation.

Logging Operations - L. Johnson, Manager, Forestry and Engineering Division, Northwood Pulp and Timber Ltd.

During 1973 there was heavy logging activity on the east side of Babine Lake. This followed a period of relatively little activity in 1972.

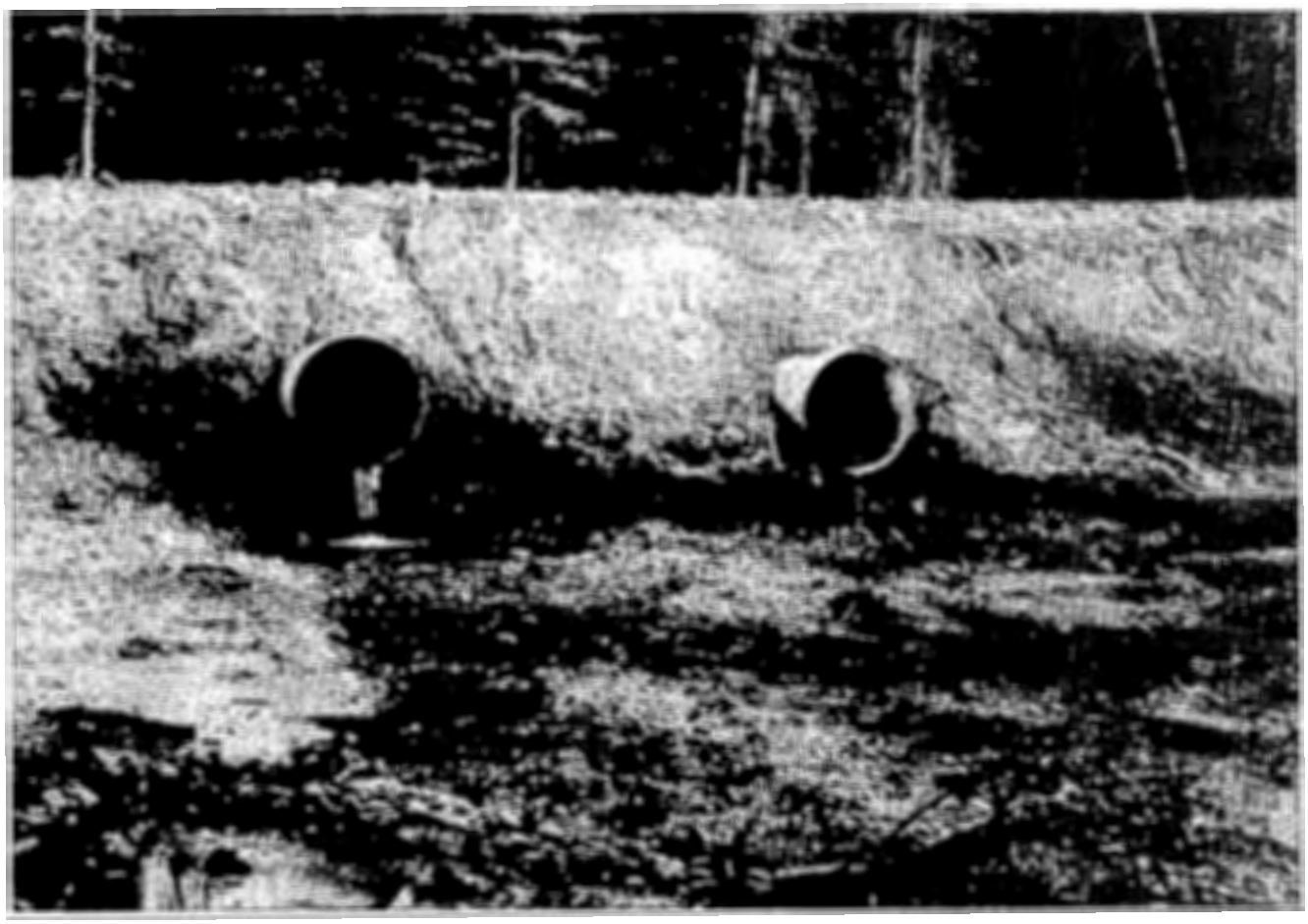

Fig. 6. Example of poor culvert location.

Roads in that logging area have been stabilized and a number of culverts have been earmarked for replacement or relocation, priority having been given those on streams carrying fish.

Operations also began on Guess Creek, an upstream tributary of Fulton River. Because of extremely fine soils and the possibility of siltation of the spawning channels below, special attention has been paid to road construction. Small bridges and box culverts have been used instead of metal culverts and rip-rap has been placed around culvert openings. Right-of-ways have been seeded and fish streams were identified as a guide in planning road construction and logging layout.

In 1973 the company constructed a bubbler system across Babine Lake between Michelle Bay and Nose Bay, to allow logs to be towed across in any season. The system operated during the winter of 1973-74.

Progress at Granisle Copper 1973 - K. Fahrni, Chief Geologist

During 1973 Granisle Mine operated at an increased rate, made possible by plant additions completed late in 1972. Daily thru'-put of the concentrator was raised from 6,000 tons to 13,000 tons. Mining equipment and the tailing disposal systems were expanded proportionally.

For the fiscal year to September 30th, 1973 the mine produced 4,188,000 tons of ore at an average grade of 0.46% copper. About 5,573,000 tons of waste rock were removed. Concentrating and refining gave 33,408,509 lbs of copper, 16,546 ounces of gold and 166,154 ounces of silver. The expansion of the mill required an increase in the capital investment in the plant of $15,069,000.

At the end of 1973, declared ore reserves indicate a life of at least 16 years for the mine. The present tailing disposal area will only last until about 1980, when additional tailing disposal areas will be required. A site entirely on land on Sterrett Island immediately south of the mine is being considered as the next stage and will provide more positive pollution control.

During 1973 the waste rock retaining dams for the current No. 2 tailing disposal area between Copper Island and Sterrett Islands were sealed. Displacement water was pumped into a clarification pond before entering the lake. Additional coarse rock was added at the toe of No. 2 Dam on the east side to provide a berm for increased stability. The dam is being constructed of cycloned tailing sands. Systematic water sampling is being carried out as required by the Pollution Control Branch. Work on dams is being done under the direction of Klohn Leonoff Consultants Ltd.

Reclamation was limited to some additional grass planting and fertilization on No. 1 Dam surface. Programs of landscaping at the townsite and plant site were continued. Fig. 7 is an aerial view of Granisle mine, looking south across the lake toward Granisle village.

Noranda Mines Ltd., Bell Copper Division - W. Allen, Manager

During 1973 some 4,114,000 tons of ore grading at 0.58% copper were treated in the concentrator. A conventional flotation process uses lime as a pH modifier for pyrite depression. Approximately 78,400 tons of concen-

Fig. 7. Aerial view of Granisle mine in winter.

trate was produced and transported in covered trucks to the railway at Topley. Gross value of the metal was $27.7 million. Ore reserves are estimated at 41 million tons and should contribute more than $20 million worth annually over the remaining ten year life.

Tailings are placed in an impoundment at Workburn Lake. All process water is reclaimed and recycled to the concentrator for reuse. Water which seeps through the rock fill perimeter dams is directed via ditches to seepage ponds from whence it is pumped back to the tailings ponds. Some 2.4 million tons of waste were extracted from the open pit and 1.7 million tons of this were used for tailing dam and road construction.

Management of the sockeye salmon enhancement facilities - R. M. J. Ginetz, Fisheries Service, Operations Branch

The 1973 adult sockeye escapement to the Babine Lake system exceeded 780,000 with approximately 335,000 spawning in the Fulton and Pinkut rivers and channel systems. In addition, jack sockeye escapements to these systems totalled 115,000. The pink salmon escapement to Babine River was approximately 121,000, and there were escapements of coho and chinook salmon.

At Fulton River, 25,000 adults spawned in Channel No. 1, 112,062 in Channel No. 2 and 100,000 in the natural stream. At Pinkut Creek 63,260 adults spawned in the channel and 37,000 spawned in the natural stream. An over-escapement of 16,500 spawners to the lower sections of Pinkut Creek necessitated an airlift of the surplus to good spawning gravels above the falls.

Fry production (in 1974) from the 1973 brood at Fulton and Pinkut exceeded 151 million and is the largest ever recorded from these sytems. Fulton River produced 27.5 million (18.3% survival), Fulton Channel No. 1 produced 15.0 million (43.7% survival), Channel No. 2 produced 75.0 million (44.5% survival). Pinkut Creek produced 9.1 million (16.9% survival), and the Pinkut channel produced 24.1 million (24.8% survival). Survival at Pinkut was higher for the airlifted stock (25.1%) than for those spawning in the lower river (11.4%).

Smolt production in 1973 was 89.3 million and an increase of 35.6 million over the previous high production recorded in 1972.

C. C. I. W. Program - Dr. C. Pharo

The Canada Centre for Inland Waters (C.C.I.W.) established a regional office to meet national responsibilities in lake studies late in 1972, and began its participation in the Babine Watershed Change Program at that time. It was felt that C.C.I.W. with its different area of expertise would broaden the scope of the study and increase the understanding of processes operating in the lake.

The C.C.I.W. project is geological and geochemical, and includes the analysis of bottom-sediment for trace and major element concentrations, organic carbon and phosphate contents, palynological changes, and mineral composition. Distribution of sediment types within the lake was traced by dual-channel, dual-frequency echo-sounder and verified by collecting bottom samples using grabs and corers. The relatively recent history of

conditions in the lake, as recorded in the sediments, is determined by close subdivision and analysis of 1 metre long gravity cores.

During the summer and fall of 1973 over 500 line-miles of echo-sounding were completed and over 100 grab samples collected. A subsidiary result of the echo-sounding has been the production of a provisional chart of the bathymetry of Babine Lake. While not considered of sufficient quality for navigational purposes, it has considerably improved previous knowledge of the depth and basin morphology of Babine Lake.

Winter studies in 1973-74 - H. D. Smith and C. Turner, Pacific Biological Station

Johnson (1958) and McDonald (1969) have shown the southern third of Babine Lake to be a major nursery area for underyearling sockeye, and primary and zooplankton production may usually be higher there than elsewhere in the system. (See current studies by Stockner and those of Johnson (1964), respectively).

Observations by Farmer and colleagues during the present studies indicated that convection currents caused by solar radiation through the ice in the southern part of the lake caused considerable mixing of near surface with lower water layers and that these conditions did not occur farther north.

In view of these observations and the general paucity of information bearing on fish and the food chain in Babine Lake in winter the Steering Committee recommended a series of physical and biological observations at three stations in the North Arm, mid-lake and South Arm regions during the period of ice cover (see Fig. 5).

Technicians from Marine Sciences, Fisheries Service (Operations, Pacific Biological Station and Pacific Environment Institute) and Institute of Animal Resource Ecology, U.B.C., collaborated in surveys from January 19-24 and again March 20-24.

Water samples were obtained for chemical analysis and phytoplankton and zooplankton samples were netted through holes cut in 8-16" of ice. A Furuno FUV 11, 200 Khz echo-sounder was mounted in a heated box and operated in both day and night studies from under a suitable shelter to assess the diel vertical movements of juvenile salmon. Gillnets of several mesh sizes were fished immediately beneath the ice on several occasions.

Juvenile sockeye were found by echo-sounding to occur in layers, at 16-26 m and at 40-51 m during daylight hours. The layers merged and moved toward the surface at dusk and descended and separated at dawn. The fish appeared to concentrate at about 10 m below the surface at their highest level of ascent though problems of interpretation of sounder charts prevent a clear measure of the upper limit of vertical migration. A total of six underyearling sockeye salmon were captured at depths ranging from 3-12 m.

Babine Lake, bubbling experiment - K. Stephens, Pacific Biological Station

Several air bubbler systems have been installed across Babine Lake by private industry to maintain ice-free traffic lanes in winter. Preliminary calculations suggest that these cause some heat loss and generate local circulation anomalies. It is not known if they affect the movement of young salmon and other fishes.

An experiment was undertaken to attempt to measure the amount of mixing of the water column, induced by the bubbling system installed between Granisle Copper Mine and the township of Granisle, Babine Lake. The bubble line was operated through the courtesy of Granisle Copper Ltd. continuously except for two 12-hour interruptions for servicing, during the period 27-31 July, 1973.

Observations of the temperature and nutrient profiles, at distances greater than 500 metres north and south of the bubble line, during the bubbling period, showed no measurable effect.

Surface temperatures directly above the bubble line and within 400 metres of its downwind side were significantly lower than those observed "upwind" of the line, and of those observed at distances greater than 400 metres "downwind" of the line.

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STEERING COMMITTEE
BABINE WATERSHED CHANGE PROGRAM[1]

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[1]Members in 1973. Several changes thereafter.

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