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Yukon Branch

A SURVEY OF ENVIRONMENTAL MERCURY CONCENTRATIONS IN YUKON TERRITORY, 1977

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by

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ABSTRACT

The Yukon mercury survey was set up to establish a data base of mercury concentrations throughout the Territory. Samples of fish muscle tissue, sediment and water were obtained from 38 water bodies around Yukon. Several moose tissue and waterfowl tissue samples were also analyzed for mercury concentration. The project was jointly funded by the Environmental Protection Service and Department of National Health and Welfare.

Results of the sampling were compared with results found in the literature from other areas. The general finding was that the Yukon is problem free in terms of mercury contamination, although there are a few areas with naturally elevated concentrations. There is no evidence of anthropogenic mercury pollution in Yukon.

RÉSUMÉ

Des relevés de la teneur en mercure ont été réalisés au Yukon afin d'établir une banque de données sur la concentration de ce métal à la grandeur du territoire. Des échantillons de tissu musculaire de poisson, de sédiments et d'eau ont été prélevés dans 38 nappes d'eau. Plusieurs échantillons de tissu d'orignal et de sauvagine ont aussi été analysés. Le programme a été financé conjointement par le Service de la protection de l'environnement et le ministère de la Santé et du Bien-être social.

Les résultats de l'échantillonnage ont été comparés à ce que donnait la documentation pour d'autres régions. De façon générale, il ressort que le Yukon n'est pas contaminé par le mercure, même si, à quelques endroits, la concentration de ce métal est naturellement élevée. Rien ne laisse supposer qu'il existe une pollution anthropique par le mercure.

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CONCLUSIONS

The 1977 Yukon mercury sampling program was reasonably successful in fulfilling the objectives of gathering background data on mercury in the territory. The data, although limited, does give a good indication of areas which should be sampled again to clarify the limited information provided in this report.

Areas of concern were labelled as those where sediment concentrations were greater than or equal to 500 ppb Hg; and/or fish tissue mean concentrations (by wet weight) which were greater than or equal to 0.30 ppb. The areas identified by these criteria were Fox Lake, Francis Lake, Lake Laberge, Little Atlin Lake, Mayo Lake, Porcupine River, Quiet Lake, Simpson Lake, Teslin Lake, and possibly Aishihik Lake. Each of these lakes supports either sport fishing, commercial fishing or native fishing.

The lack of wildlife samples was a weakness of this study which should be corrected. Moose, caribou, muskrat and game birds are widely hunted and used for food year round by both native and non-native Yukon residents.

1 INTRODUCTION

1.1 Rationale

The mercury survey undertaken by the Environmental Protection Service (EPS), Yukon, was initiated for a number of reasons. In their 1975 study, Desai-Greenaway and Price (1975) indicated a potential mercury (Hg) problem in various areas in Canada and a need for more data was emphasized. A thorough inventory of background data was recommended by Allan _et al_, in their 1974 geological study; with this information it might be possible to avoid unnecessary development in areas where the synergistic effects of other minerals and ligands could compound the mercury problem. The avoidance of human exposure to dangerous mercury levels, and further degradation of the environment would also be facilitated.

The Medical Services Branch of National Health and Welfare requested that EPS undertake the collection of mercury data in waterways of the Yukon in conjunction with a nationwide effort to pinpoint problem areas. Mercury was declared a top priority for the Environment Protection Service for 1977. It is also an important political, social, and environmental issue. With very little data available from Yukon, this study was undertaken to provide up-to-date and widely distributed data from areas of potential concern. The areas under scrutiny were areas which could have natural mercury, or where human contact with mercury could adversely affect health.

The objectives of this survey were to broaden the data base and to assist National Health and Welfare, Indian and Northern Affairs, and Environment Canada fulfill their respective mandates regarding mercury in Canada.

1.2 Background

Mercury has long been known as a hazardous material throughout the world. It has been recognized as a major problem in industrialized nations such as Japan, United States, Canada, and Sweden (Peakall and Lovett, 1972).

Approximately 80 industries, past or present, use mercury in over 3000 different ways. The major present-day uses of mercury are in production of electrical apparatus (13.1 to 19.9% of world use) and the electrolytic preparation of chlorine and caustic soda (10.2 to 20.6% of world use) (Peakall and Lovett, 1972). As many North American chlorine and caustic soda producers have converted or are in the process of converting to use of the diaphragm cell instead of the mercury cell, this use of mercury will decline considerably (George, 1976). Mercury is used to a considerable extent in pharmaceuticals, dental analgams, dry-cell batteries, as a mildew-proofer in paint manufacturing, as an agricultural fungicide; and, a major historical use was as a slimicide in pulp and paper manufacture (Aaronson, 1971; Peakall and Lovett, 1972; MacGregor, 1975; George, 1976) (Table 1). Mercury is used as a catalyst in chemical reactions, as a mold for precision or investment castings, and because of its ability to absorb neutrons, it is useful as shielding against atomic radiation (George, 1976).

Mercury is a naturally occurring substance and man's uses increase the cycling, redistributing it to new and often potentially dangerous locations (Wood, 1972; Peakall and Lovett, 1972). Different mercury compounds pose a varying hazard to the natural environment, and the alkyl mercury compounds are the most hazardous to man and other living organisms (Aaronson, 1971; Peakall and Lovett, 1972). Mercury in the aquatic environment is eventually converted to methyl mercury by microorganisms (MacGregor, 1975) and methyl mercury is the most toxic of all mercury forms (Aaronson, 1971).

Mercury is of concern because of its extreme toxicity. Once in the body, inorganic mercury is carried in the bloodstream to concentrate in the kidneys where it may cause fatal damage. The more hazardous organic mercury compounds tend to attack the central nervous system (Aaronson, 1971) and may result in permanent mental or physical retardation or death (Durham, 1976). Pre-natal infants are most susceptible to mercury poisoning as the fetal brain may concentrate two or three times more mercury than the maternal brain, and the blood of the fetus may have a 30% higher concentration than the mother (Aaronson, 1971; Anon., 1973). In Minimata,

TABLE 1 UNITED STATES MERCURY CONSUMPTION BY USES; PRIMARY AND SECONDARY IN ORIGIN (George, 1976)

	1972	1975	1976P
Agriculture*	1 836	600	707
Amalgamation	-	7	-
Catalysts	800	838	473
Dental preparations	2 983	2 340	1 686
Electrical apparatus	15 553	16 971	26 423
Electrolytic preparation of chlorine and caustic soda	11 519	15 222	15 433
General laboratory use	594	335	529
Industrial and control instruments	6 541	4 598	4 572
Paint:			
Antifouling	32	-	-
Mildew-proofing	8 190	6 928	7 846
Pulp and paper manufacture	1	-	-
Pharmaceuticals	578	445	361
Other**	4 258	1 750	3 026
Total known uses	52 885	50 034	64 546***
Unknown uses	22	804	. .
Grand Total	52 907	50 838	64 546

Sources: Preprint from the 1975 U.S. Bureau of Mines <u>Minerals Yearbook</u>, for 1972 and 1975 statistics. U.S. Bureau of Mines, <u>Mineral Industry Surveys</u>, "Mercury in the Fourth Quarter 1976", for 1976 statistics.

* Includes fungicides and bactericides for industrial purposes.
** Includes mercury used for installation and expansion of chlorine and caustic soda plants.
*** The individual items do not add to the total which has been increased to cover approximate total consumption.

p preliminary
\- nil
. . not available

Japan, in the 1950's, many people and especially children were discovered to be suffering from mercury poisoning (Durham, 1976). This tragedy set up a world-wide concern and subsequent investigation into the sources, pathways, and sinks for mercury in our environment.

Figure 1 shows a schematic diagram of the global mercury balance as portrayed by MacGregor (1975). As may be seen from the diagram, much of the circulating mercury is brought into contact with people either by airborne contamination or from the water supply. Man is responsible for increasing the availability of much of this mercury for environmental cycling by his industrial uses. The airborne burden of mercury from industrial sources as well as domestic burning of fossil fuels has led to an increase in mercury content of the Greenland ice sheet (Bull et al, 1977). The burning of fossil fuels contributes twice as much mercury to the environment as to other industrial sources (MacGregor, 1975), as coal and oil may contain traces of mercury up to 0.5 ppm (Aaronson, 1971). This evidence gives credence to the possibility that high "background" mercury levels in remote areas may be partially due to atmospheric transport from distant sources.

Municipal sewage treatment facilities have proven to be a source of mercury contamination. Bacterial action apparently leads to the conversion of inorganic mercury into more volatile organic forms which are subsequently released to the atmosphere (Soldano et al, 1975; Bisogni and Lawrence, 1975). Resource extraction (particularly mining of sulfide ores), and refining are also important sources of mercury (MacGregor, 1975).

Analysis of museum specimens of fish from the St. Clair River system done by Dr. Frank D'Itri showed a three-fold increase in mercury content in certain species from 1965 to 1970, and a five-fold increase in other species over the same time period (Wood, 1972). This increase shows as an exponential rise in mercury content since the opening of a nearby chloralkali plant.

Similar work was done by Borg et al (1966) with feathers of the Goshawk (Accipiter genetilis). It was found that from 1863 to 1946 the mean mercury concentration in feathers was 2.2 ppm, whereas from 1947 to 1965 the mean was 29 ppm. This shows more than a ten-fold increase in recent years with increased industrial use of mercury (Peakall and Lovett, 1972).

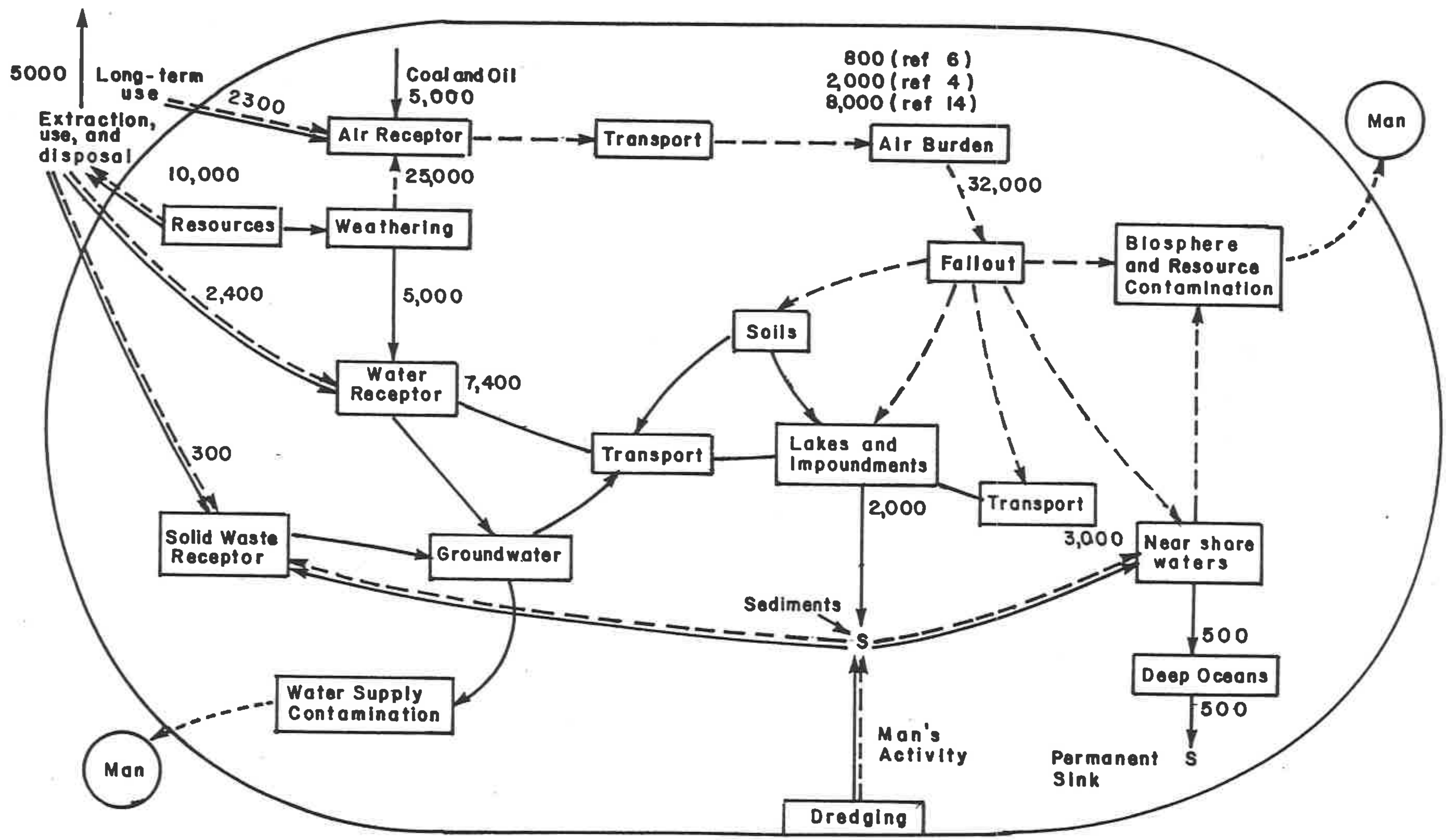

FIGURE I ENVIRONMENTAL METAL FLOW, GLOBAL MERCURY BALANCE: (— — →) AIR PATHWAYS; (———→) WATER PATHS; (═══⇒). MAN-INDUCED TRANSPORT (- - - →) HUMAN EXPOSURES; (S) SEDIMENT SINK. ALL DATA IN TONS / YR. (Adapted from MacGregor, 1975)

According to A. Hanson of the National Swedish Environmental Protection Board (Aaronson, 1971), industrial uses of mercury account for only about 50 to 60% of all mercury, and pharmaceutical use of mercury accounts for much of the remainder. N.E. Cooke of Canadian Industries Ltd. says an estimated 4500 lbs of Hg per year are flushed from homes from broken thermometers and pharmaceutical wastes in Canada alone. Cooke also states 14 000 lbs of mercury are expelled annually as waste from homes and hospitals and homes as over 30 000 thermometers are broken in Canada (Aaronson, 1971).

The Whitehorse General Hospital uses about 8000 thermometers per year, and the total waste contribution of mercury is about 1700 g mostly to the solid waste disposal system and a slight amount to the aquatic system (personal communication, Dr. D. Dimitroff, NHW).

According to Dr. C.R. Pugh, of the Whitehorse Dental Clinic (personal communication) approximately 1500 g to 6800 g of mercury (10 to 14 lbs) are used in dental work each year, but only a very insignificant amount of that; less than about 28 g (one ounce) is lost to the sewage system.

Mercury content of water is usually quite low. MacGregor (1975) found an average concentration of 0.01 ppb in the water of Lake Powell. Mercury in the water column has an affinity for particulate and especially organic matter and is therefore most often found in association with the suspended solids and the sediments of a water system. Sediments may concentrate mercury to a factor of 3000 times the concentration found in the water column (Potter _et al_, 1975). Inorganic mercury is relatively harmless but once in the sediments, microbial activity will convert it to methyl mercury (Wood, 1972; Bisogni and Lawrence, 1975) as any bacteria capable of vitamin B_{12} synthesis can methylate mercury (Wood, 1972). Microbial methylation of mercury may occur either aerobically or anaerobically. The rate depends on the growth and metabolic rate of the methylating organisms, as well as the availability of mercuric ions (Bisogni and Lawrence, 1975) an other essential nutrients (Wood, 1972).

From the sediments, methyl mercury is released to the overlying water where it can enter the food chain in fish and other aquatic organisms. Fish may accumulate mercury from contaminated food sources as well as by diffusion of mono-and-dimethyl mercury across their gills (Wood, 1972; Aaronson, 1971). The half-life of methyl mercury in fish is so long (Table 2) that it tends to accumulate and may eventually contain levels of mercury which may be harmful to consumers, although the fish themselves may show no symptoms of mercury poisoning (Aaronson, 1971). It is also evident that certain species of fish concentrate naturally higher tissue mercury concentrations than other species (Wood, 1972).

Fish-eating waterfowl also build up mercury concentrations in their bodily tissues (Peakall and Lovett, 1972). According to J.A. Keith (Aaronson, 1971) of the Canadian Wildlife Service, Ottawa, the reproductive success of fowl may be adversely affected by Hg, although apparently there have been no confirmed mercury-induced bird deaths in Canada. In Alberta, in 1969 a ban was placed on the hunting of Hungarian partridge because of elevated mercury concentrations, evidently due to their consumption of mercury-treated grain seed.

Other organisms in the food chain also accumulate mercury. Bull et al (1977) have shown accumulations of mercury in soil, vegetation and small mammals in the vicinity of chloralkali works, although the half-life of mercury in small mammals is low and the accumulations are not pronounced.

The U.S. Food and Drug Administration and the Canadian Food and Drug Directorate have set safe muscle tissue concentration levels for fish at 0.5 ppm Hg (by wet weight) (Aaronson, 1971). This level is considered safe for the average healthy adult. According to Peakall and Lovett (1972), an additional safety factor should be applied for pregnant women to avoid danger to the unborn fetus. The World Health Organization recommends a concentration of not greater than 0.05 ppm Hg in edible fish tissue. This level is based on the estimated average North American consumption of fish and the known human blood concentrations associated with mercury poisoning; a factor of 0.01 is applied as a safety margin (MacGregor, 1975).

TABLE 2 METHYL MERCURY HALF-LIFE* IN FISH (Wood, 1972)

Variety of Fish	Days
Flounder	400 to 700
Perch	500
Pike	500 to 700
Eels	900 to 1000

* The time required to eliminate half of the methyl mercury.

Health and Welfare Canada recommends a safe concentration of mercury in fish as being 0.2 ppm Hg for people who eat a lot of fish (i.e., at least three or more fish meals per week) (personal communication, Dr. D. Dimitroff, Health and Welfare Canada) (Table 3). The 0.5 ppm limit as mentioned above, was used for fish in Yukon. The native people themselves claimed that they do not consume more than three fish meals per week throughout the year. They supplement their diet with moose, caribou, wild fowl, and muskrat.

Many suggestions have been made as to how to prevent the continued buildup and distribution of mercury in the food chain. One effort was the dredging of the bay at Minimata, Japan, but this merely compounded the problem by making the mercury more readily available to the methylating organisms. Covering the sediments with 2 cm of flourspar tailings has been shown to reduce the methylation of mercury by 82% (Langley, 1973; Wood, 1972). Another solution to improve water quality would appear to be reduction of nutrients which support the life of the methylating bacteria (Wood, 1972). To this end, internal recycling, product substitution, and metal recovery could be implemented (MacGregor, 1975).

Fortunately the concentration of mercury in the Yukon environment is not seriously elevated and is not attributable to any industrial source.

TABLE 3 RECOGNIZED MERCURY CONCENTRATION LIMITS

Mercury	Authority	Concentration	Reference
in Fish muscle tissue	Canadian Food and Drug Directorate	0.5 ppm**	Aaronson, 1971
	Canadian Department of Health and Welfare	0.2 ppm**	Dimitroff, 1978*
	United States Food and Drug Administration	0.5 ppm**	Aaronson, 1971
	World Health Organization	0.05 ppm**	MacGregor, 1975
in Water	United States Environmental Protection Agency		
	- for drinking water	2.0 ppb	EPA, 1972
	- for protection of aquatic life	0.2 ppb	EPA, 1972
in Sediment	Canadian Environmental Protection Service		
	- uncontaminated	0-100 ppb	Sherbin, 1978
	- slightly contaminated	100-1000 ppb	Sherbin, 1978
	- associated with elevated concentrations in fish tissue	1000 ppb	Sherbin, 1978

* This limit applies for consumers of at least three fish meals per week.
** Wet weight.

2 METHODS

2.1 Sample Locations

All locations as described in Figure 2 and Table 4 were sampled for sediments, water, and fish where possible. The moose samples were obtained by the Environmental Protection Service (Wolf Lake) and by the Yukon Territorial Game Branch (Two Horse Creek); the ducks were obtained by the Canadian Wildlife Service.

2.2 Sediments

Sediment samples were obtained using an Eckman grab sampler or a gravity-type sediment core sampler. The top 5 cm were scooped into sterile whirl-packbags, sealed, and frozen as soon as possible. They were then shipped frozen to the Environmental Protection Service/Fisheries and Marine Service Laboratory in West Vancouver for analysis. The samples were freeze-dried, passed through a 100-mesh seive (150 m) and weighed into 100 ml beakers. A mixture of 8 ml of (1:2) nitric acid/sulfuric acid and 1 ml of concentrated hydrochloric acid was added to each beaker. These solutions were then heated on a hotplate, cooled and filtered into reaction vessels. The mercury in the reaction mixture was reduced by a solution of 1% hydrazine sulfate and 3% stannous chloride for freshwater and sediment samples. For tissue samples, a solution of 2% hydroxylamine sulfate, 1% hydrazine sulfate, and 3% stannous chloride was used. The mercury was atomized into the absorption cell using inert argon gas as a carrier. The mercury vapor content was then determined by atomic absorption spectrophotometry using the cold vapor technique.

2.3 Water

Water samples were collected by EPS in acid-washed Nalgene (linear polyethylene) bottles, and acidified for preservation with 12.5 - 13 ml of nitric-dichromate per 250 ml of sample. They were then shipped cool (4°C) to the EPS/FMS Laboratory in West Vancouver. Decomposition was carried out in the following manner: a sample portion was oxidized with 6 ml of (1:2)

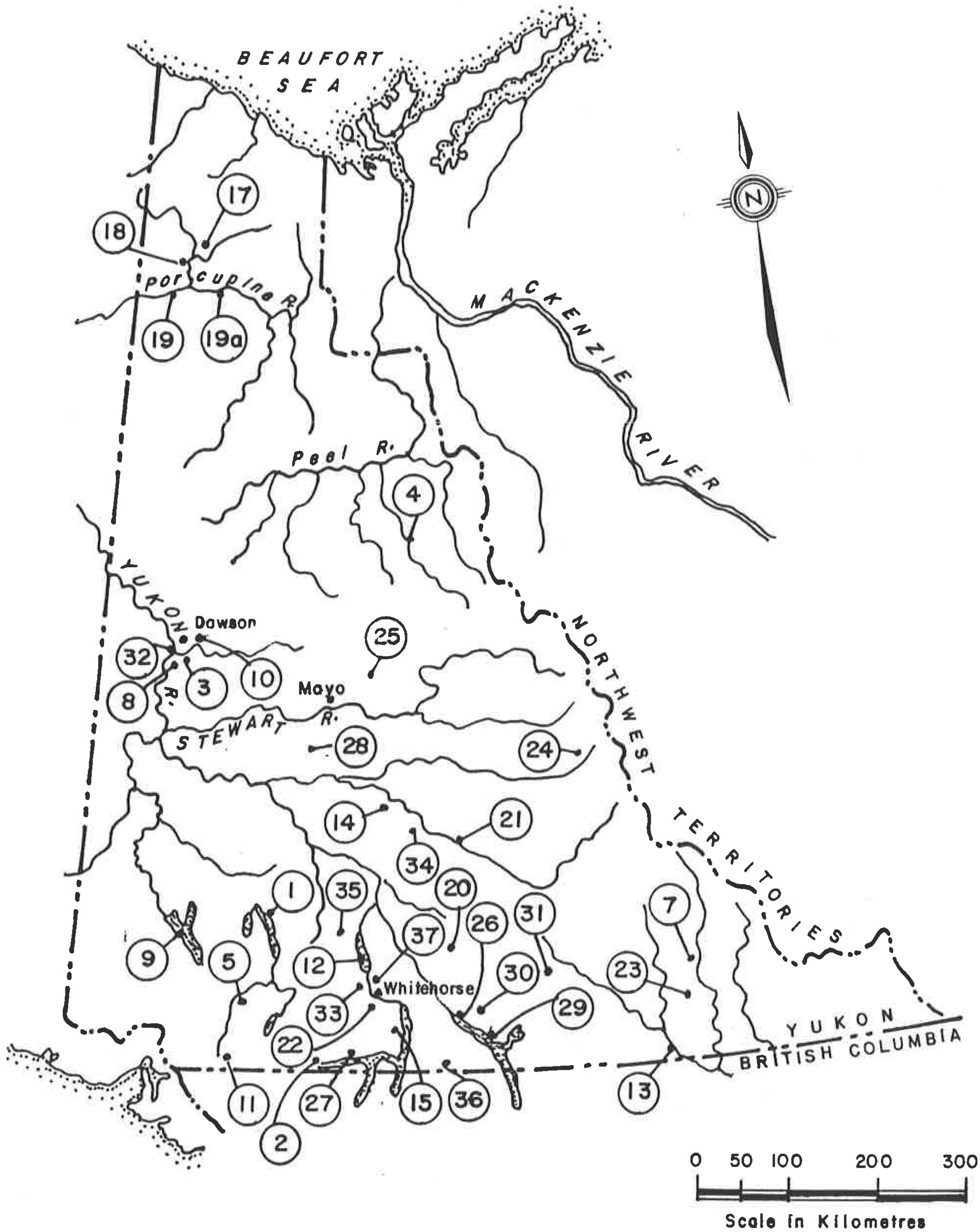

FIGURE 2 LOCATIONS OF MERCURY SAMPLING IN YUKON

TABLE 4 LOCATIONS OF MERCURY SAMPLING

Number/Location	Longitude/Latitude	Remarks
1. Aishihik Lake	61°25'N 137°15'W	Samples taken offshore in small bay at about km 80 on the Aishihik Road.
2. Bennett Lake	60°01'N 134°56'W	Water samples were taken at all 8 stations, sediments at Station 1 and fish were obtained by FMS field crew via variously located gill nets.
3. Bonanza Creek	64°03'N 139°25'W	Samples taken about 4 miles upstream from confluence with Yukon River, downstream of several placer operations.
4. Bonnet Plume River	64°58'N 133°43'W	Water samples and sediments were taken from the Bonnet Plume River at Fairchild Lake.
(Margaret Lake)	65°21'N 134°30'W	Fish taken from Margaret Lake as angling was totally unsuccessful along the length of river between two lakes.
5. Dezadeash River	60°45'N 137°30'W	Samples were taken just downstream from the bridge on the Haines Road at the south end of town of Haines Junction.
6. Firth River	69°32'N 139°22'W	Sediment, water and Arctic char samples were taken at the mouth, grayling were angled further upstream.
7. Francis Lake	63°26'N 135°41'W	Samples were taken in the west arm, offshore from the camp site area.
8. Hunker Creek	64°06'N 139°14'W	Samples were taken just downstream of the crossing of the Klondike Highway.
9. Kluane Lake	61°15'N 138°40'W	Water samples were obtained at 8 stations, sediments were sampled only at Station 5; fish were collected by FMS field crew with gill nets.

TABLE 4 LOCATIONS OF MERCURY SAMPLING (Continued)

Number/Location	Longitude/Latitude	Remarks
10. Klondike River	64°03'N 139°26'W	Sediment and water samples were obtained about 0.40 km upstream of the crossing of the Klondike Highway.
11. Klukshu River	60°07'N 137°02'W	All samples were taken at Dalton Post 100 m upstream of the confluence with the Tatshenshini River.
12. Lake Laberge	61°11'N 135°12'W	Water samples were collected at 8 stations, sediments were only from Station 8; fish were gill-netted by FMS staff.
13. Liard River	61°51'N 121°18'W	Samples were taken just upstream of the Alaska Highway bridge, at Upper Liard.
14. Little Salmon Lake	62°11'N 134°40'W	Water and sediments were sampled near the mouth of Drury Creek at the east end of the lake; fish were gill-netted by FMS field staff.
15. Marsh Lake	60°31'N 134°20'W	Water and sediment samples were collected at two locations: one was 100 m from shore, across the lake from the old Marsh Lake Lodge site; the other was in the bay where cottages and a campground are located, 1/2 km west of campground.
16. Mayo Lake	63°43'N 135°04'W	Water and sediments were sampled at the western end of the lake, off the north shore; fish were gill-netted by FMS field crew.
17. Old Crow Flats	68°10'N 140°10'W	Two lakes were sampled in the Old Crow Flats area for water, sediment, and fish.
18. Old Crow River	67°35'N 139°50'W	Sediment and water samples were collected from the Old Crow River, 1.5 km upstream from the confluence with Porcupine River; fish samples were collected in nets set by the native people of Old Crow.

TABLE 4 LOCATIONS OF MERCURY SAMPLING (Continued)

Number/Location	Longitude/Latitude	Remarks
19. Porcupine River	67°35'N 139°50'W	Water and sediment samples were collected at Old Crow. Fish were obtained in nets by the native people of Old Crow, as well as by angling at David Lord Creek (19a on map).
20. Quiet Lake	61°05'N 133°05'W	Sediment and water samples were collected offshore about midlake; fish were gill-netted by FMS field crew.
21. Rose Creek	60°18'N 135°49'W	Water samples were taken at several stations both up and downstream from the Cyprus Anvil Mine.
22. Schwatka Lake	60°41'N 135°02'W	Water and sediment samples were obtained about 100 m east of the float-planedocks near the north end of the lake.
23. Simpson Lake	60°43'N 129°14'W	Water and sediment samples were obtained offshore (about midlake) near the campground; fish were gill-netted by FMS field crew.
24. South Macmillan River	63°03'N 133°18'W	Water and sediment samples were taken just upstream of the Canel Road bridge (near Itsi Mountain); fish were angled from about 6 km downstream of the bridge.
25. South McQuesten River	63°50'N 136°19'W	Water and sediment samples were obtained about 8 km downstream from Elsa at the bridge of the Old Shanghai Mine road.
26. Squanga Lake	60°29'N 133°38'W	Water and sediment samples were obtained 100 m offshore, across the lake from the campsite.
27. Tagish Lake	60°10'N 134°20'W	Water and sediment samples were obtained from Windy Arm of Tagish Lake.
28. Tatlmain Lake	62°37'N 135°59'W	All samples were obtained midlake just off a gravel spit; fish samples were gill-netted by EPS field-crews.

TABLE 4 LOCATIONS OF MERCURY SAMPLING (Continued)

Number/Location	Longitude/Latitude	Remarks
29. Teslin Lake	60°14'N 132°55'W	Water samples were collected at 8 stations; sediments were sampled at Station 4.
30. Teslin River	60°14'N 132°55'W	Water and sediment samples were taken about 2/3 km downstream from the Alaska Highway bridge at Johnson's Crossing.
31. Wolf Lake	60°39'N 131°40'W	Water, sediment, and moose samples were all obtained from the southeast end of the lake; ducks were transitory.
32. Yukon River (at Dawson)	64°04'N 139°25'W	Water and sediment samples were obtained at the downstream end of town just above the ferry dock; fish were obtained both from commercial fishing nets and by FMS field crew.
33. Yukon River (at confluence of Takhini River)	60°27'N 136°08'W	Water and sediments were sampled offshore just downstream of the confluence; fish were netted in the same locale by FMS field crew.
34. Pelly River (at Anvil Creek)	62°27'N 134°08'W	Fish samples only, netted by FMS crew.
35. Fox Lake	61°14'N 135°28'W	Fish samples were obtained from Fox Lake by FMS field crew.
36. Atlin and Little Atlin	60°14'N 133°58'W	FMS sample fish from Little Atlin Lake.
37. Yukon River	60°43'N 135°03'W	Water was sampled at 12 stations between Whitehorse and Lake Laberge, as part of routine work. The mercury results were added to this mercury survey.
38. Nansen Creek	62°06'N 137d17'W	At Mount Nansen Mine road.

nitric acid/sulfuric acid mixture, followed by 2 ml of 3% potassium persulfate. The reduction, atomization, and determination were executed as described above (Section 2.2). Water samples were also collected by Department of Indian Affairs and Northern Development (DIAND) as part of their routine water-quality, sampling program.

The water samples obtained by DIAND were collected in sterile teflon bottles. The water was acidified with nitric dichromate in the field, and samples were shipped to the Inland Waters Directorate (Water Quality Branch) laboratory in Vancouver. The sample water was filtered through a 0.45 m membrane filter and then 1 ml of concentrated sulphuric acid was added per 100 ml of sample. The samples were further prepared by a technicon autoanalyser and analysis was done by automated atomic absorption spectrophotometry.

2.4 Tissue Analysis

Fish were caught either by angling or in nets by Fisheries and Marine Service field crews or by Environmental Protection Service field crews (Appendix I). The samples of fish tissue, wildlife, and waterfowl were taken using an uncontaminated stainless-steel blade and were placed into sterile whirlpack bags, sealed and frozen as soon as possible. They were then shipped frozen to the Pacific Environment Institute laboratory in West Vancouver for analysis. Samples were freeze-dried and a portion was placed into a reaction vessel. Samples were completely digested by agitating them in a sulfuric acid solution. They were cooled and hydrogen peroxide was added to the reaction mixture. The reaction vessel was placed on a hot block for approximately one hour, then cooled and 46 ml of 0.1% potassium permanganate was added. The reduction, atomization, and determination of samples was carried out by the same procedure as described in section 2.2 for sediment samples.

All the data were put into tables (Appendix I); means and standard deviations were calculated for fish (Table 5) and sediment and water results (Table 6). There was not enough data for wildlife or waterfowl to warrant these calculations. Coefficients of determination (r^2) and correlation coefficients (r) were calculated where at least 5 fish were sampled to see if mercury concentrations in fish tissue were linearly dependent upon fish length (Table 7).

TABLE 5 FISH TISSUE DATA (Wet Concentrations) - MEAN AND STANDARD DEVIATION

Location	Species	No.	Mean Species Concen-tration	Standard Deviation	Maxi-mum Value	Mini-mum Value
Aishihik	arctic grayling	3	0.15	0.1790	0.36	0.05
	lake trout	3	0.26	0.3119	0.62	0.07
	lake whitefish	5	0.07	0.0336	0.11	0.02
Atlin Lake	lake trout	6	0.16	0.0914	0.34	0.10
Little Atlin Lake	northern pike	1	0.77	-	-	-
	lake whitefish	10	0.15	0.9900	0.31	0.03
Bennett Lake 1977	arctic grayling	1	0.02	-	-	-
	lake trout	5	0.18	0.0367	0.22	0.15
	lake whitefish	5	0.10	0.1242	0.32	0.04
	longnose sucker	5	0.06	0.0130	0.07	0.04
Bonanza Creek	arctic grayling	1	0.14	-	-	-
Bonnet Plume	northern pike	3	0.20	0.0500	0.25	0.16
Firth River	arctic grayling	5	0.05	0.0230	0.09	0.03
	round whitefish	3	0.03	0.0100	0.04	0.02
	arctic char	2	0.03	0.071	0.03	0.02
Fox Lake	lake whitefish	7	0.19	0.0923	0.37	0.12
	round whitefish	1	0.09	-	-	-
	burbot	1	0.48	-	-	-
Francis Lake	lake trout	3	0.13	0.0351	0.16	0.09
	lake whitefish	5	0.22	0.0422	0.29	0.19
	longnose sucker	2	0.11	0.0071	0.11	0.10
Kluane Lake	lake trout	2	0.08	0.0141	0.09	0.07
	lake whitefish	1	0.21	-	-	-
Klondike River	arctic grayling	2	0.08	0.0212	-	-
Klukshu River	coho salmon	5	0.05	0.0130	0.07	0.04
	sockeye salmon	5	0.04	0.0084	0.05	0.03
Lake Laberge	lake whitefish	12	0.26	0.1558	0.57	0.10
	burbot	2	0.45	0.0424	0.48	0.42
Liard River	arctic grayling	5	0.09	0.0300	0.11	0.04

TABLE 5 FISH TISSUE DATA (Wet Concentrations) - MEAN AND STANDARD DEVIATION (Continued)

Location	Species	No.	Mean Species Concentration	Standard Deviation	Maximum Value	Minimum Value
Mayo Lake	lake trout	1	0.46	-	-	-
	northern pike	3	0.30	0.2468	0.57	0.09
	lake whitefish	5	0.05	0.0164	0.07	0.03
	round whitefish	4	0.06	0.0100	0.06	0.04
Old Crow Flats	northern pike	6	0.06	0.0223	0.07	0.04
Old Crow River	round whitefish	2	0.06	0.000	0.06	0.06
	dog salmon	2	0.05	0.000	0.05	0.05
	inconnu	1	0.33	-	-	-
Pelly River	arctic grayling	5	0.09	0.0356	0.15	0.06
Porcupine River	arctic grayling	5	0.09	0.0122	0.11	0.08
	northern pike	6	0.39	0.2600	0.86	0.13
	lake whitefish	2	0.14	0.0424	0.17	0.11
	chinook salmon	1	0.09	-	-	-
	inconnu	1	0.97	-	-	-
Quiet Lake	arctic grayling	2	0.14	0.2120	0.15	0.12
	lake trout	5	0.30	0.0832	0.42	0.22
	lake whitefish	5	0.12	0.0381	0.18	0.08
	round whitefish	5	0.18	0.0409	0.24	0.13
	burbot	2	0.38	0.3748	0.65	0.12
	lake cisco	5	0.20	0.5540	0.30	0.17
Schwatka Lake	northern pike	5	0.13	0.0606	0.22	0.08
	longnose sucker	5	0.07	0.0311	0.11	0.04
Simpson Lake	lake trout	5	0.52	0.1582	0.72	0.32
	lake whitefish	5	0.13	0.0265	0.16	0.09
S. MacMillan River	arctic grayling	4	0.08	0.0096	0.09	0.07
S. McQuesten River	arctic grayling	3	0.03	0.0000	0.04	< 0.02
Squanga Lake	northern pike	2	0.08	0.0424	0.21	0.15
	round whitefish	5	0.03	0.0114	0.05	0.02
Tagish Lake	lake whitefish	3	0.07	0.0306	0.10	0.04
	burbot	3	0.10	0.0361	0.13	0.06
Tatlmain Lake	lake whitefish	3	0.09	0.0153	0.10	0.07

TABLE 5 FISH TISSUE DATA (Wet Concentrations) - MEAN AND STANDARD DEVIATION (Continued)

Location	Species	No.	Mean Species Concentration	Standard Deviation	Maximum Value	Minimum Value
Teslin Lake	lake trout	1	0.09	-	-	-
	northern pike	1	0.23	-	-	-
	lake whitefish	4	0.12	0.0762	0.23	0.06
	burbot	7	0.34	0.1771	0.65	0.17
	longnose sucker	1	0.07	-	-	-
Yukon River (Dawson)	arctic grayling	6	0.07	0.0853	0.24	< 0.02
	lake whitefish	2	0.19	0.1536	0.30	0.08
	round whitefish	2	0.08	0.0141	0.09	0.07
	burbot	1	0.41	-	-	-
	longnose sucker	1	0.26	-	-	-
	dog salmon	6	0.03	0.0147	0.05	< 0.02
	chinook salmon	5	0.04	0.0164	0.07	0.03
Yukon River (Takhini)	arctic grayling	1	0.22	-	-	-
	lake whitefish	6	0.11	0.0451	0.15	0.04
	round whitefish	5	0.09	0.0370	0.14	0.05
	burbot	4	0.24	0.0427	0.27	0.18
	longnose sucker	5	0.16	0.0652	0.27	0.10

TABLE 6 WATER AND SEDIMENT DATA: MEANS AND STANDARD DEVIATIONS

Location	Sediments		Water	
	Mean Hg Concentration ppb	Standard Deviation	Mean Hg Concentration ppb	Standard Deviation
Aishihik	10	-	0.02	-
Bennett Lake	596.7	0.2804	0.203	0.0010
Bonanza Creek	23.3	0.0058	0.02	-
Bonnet Plume	46.7	0.0115	0.02	-
Dezdeash River	326.7	0.4110	-	-
Firth River	-	-	0.02	-
Francis Lake	513.3	0.1079	0.02	-
Hunker Creek	20	0.02	0.02	-
Kluane Lake	46.7	0.0115	0.22	0.1144
Klondike River	26.7	0.0058	0.02	-
Klukshu River	70.0	0.0265	0.02	-
Lake Laberge	-	lost	0.02	-
Liard River	-	lost in analysis	-	-
Little Salmon Lake	23.3	0.0058	0.02	-
Marsh Lake	345.0	0.5229	0.02	-
Mayo Lake	20	0.000	0.02	-
Mount Nansen Creek	-	-	0.02	-
Old Crow Flats	23.3	0.0058	0.02	-
Old Crow River	26.7	0.0058	0.02	-
Porcupine River	33.3	0.0058	0.02	-
Quiet Lake	20.0	-	0.02	-
Rose Creek	286.7	0.4040	-	-
Schwatka Lake	343.3	0.1443	-	-
Simpson Lake	310.0	0.1758	0.02	-
South MacMillan River	53.3	0.0058	0.02	-
South McQuesten River	93.3	0.0058	0.02	-

TABLE 6 WATER AND SEDIMENT DATA: MEANS AND STANDARD DEVIATIONS

Location	Sediments		Water	
	Mean Hg Concentration ppb	Standard Deviation	Mean Hg Concentration ppb	Standard Deviation
Squanga Lake	20.0	-	0.02	-
Tagish Lake	20.0	-	0.02	-
Tatlmain Lake	26.7	0.0058	0.02	-
Teslin Lake	800.0	0.3500	0.0416	0.0941
Teslin River	176.7	0.0115	-	-
Wolf Lake	60.0	0.0436	0.02	-
Yukon River (Dawson)	43.3	0.0058	0.02	-
Yukon River (Whitehorse to Lake Laberge)	-	-	0.02	-

"-" = No samples taken.

TABLE 7 CORRELATION OF FISH CONCENTRATION AND FISH LENGTH*

Location	Species	Coefficient of Determination r^2	r
Aishihik Lake	lake whitefish	0.90	0.95
Atlin Lake	lake trout	0.61	0.78
Little Atlin Lake	lake whitefish	0.34	0.58
Bennet Lake	lake trout	0.49	0.70
	lake whitefish	0.23	0.48
	longnose sucker	0.47	0.69
Firth River	arctic grayling	0.88	0.94
Fox Lake	lake whitefish	0.22	0.47
Lake Laberge	lake whitefish	0.04	0.20
Liard River	arctic grayling	0.20	0.45
Marsh Lake	lake trout	1.00	1.00
Mayo Lake	lake whitefish	0.44	0.66
Old Crow Flats	northern pike	0.23	0.48
Porcupine River	arctic grayling	0.0014	0.04
	northern pike	0.32	0.57
Schwatka Lake	northern pike	0.74	0.86
	longnose sucker	0.60	0.77
Simpson Lake	lake trout	0.22	0.47
	lake whitefish	0.12	0.35
South MacMillan River	arctic grayling	0.38	0.62
Yukon River at Takhini River	lake whitefish	0.02	0.14
	round whitefish	0.44	0.66
	burbot	0.85	0.92
	longnose sucker	0.00015	0.01

* Only those species with four or more individuals per water body were used in this calculation.

3 RESULTS

The data obtained during this survey are presented in Appendix I. In Tables 5 and 6, the concentration means and standard deviations are presented.

In looking at the results, the concentration of 0.5 ppm Hg in muscle tissue of fish and wildlife is used as the maximum acceptable level (as recommended by the Canadian Food and Drug Directorate).

Mercury in water is generally undetectable at concentrations less than 0.20 ppb, using the standard lab procedures employed by the EPS/FMS laboratory in West Vancouver. For protection of aquatic life, this concentration (0.2 ppb) is recommended as maximum desirable level for mercury. The recommended concentration for drinking water is 2.0 ppb Hg (EPA, 1972).

The background concentration for mercury in apparently uncontaminated sediments is 50 to 100 ppb. Any concentration in the range of 100 ppb - 1000 ppb is considered slightly contaminated, and elevated concentrations in fish are usually associated with any concentration greater than 1000 ppb Hg in the sediments (personal communication, Griff Sherbin, EPS, Ottawa). The only regulation pertaining to mercury in sediments is set by the Ontario Ministry of Environment, stating that if any dredging by normal practices is to be carried out, the maximum sediment concentration cannot exceed 300 ppb Hg (personal communication, Griff Sherbin, EPS, Ottawa). The Ocean Dumping Control Act has similar regulations governing ocean dredging, but the maximum concentration stipulated under this act is 750 ppb Hg in the sediments (Ocean Dumping Control Act, Ocean Dumping Control Regulations).

Observations on the results of Yukon mercury sampling are based on limited data. In some cases the sample size was too small to be statistically significant. The data does identify areas of apparently elevated mercury concentrations, which could potentially pose a threat to humans if consumption increased substantially.

Unless discussed in the following section (Table 8), all water, sediment, and fish mercury concentrations were below the levels of concern as mentioned (Table 3).

TABLE 8 MERCURY CONCENTRATION IN EXCESS OF "CONCERN LEVELS"

Location of Sample	Species	Fish (ppm)			Sediments (ppb)		Water (ppb)
		Sampled	Elevated Samples	Location Mean	Elevated Samples	Location Mean	Elevated Samples
Aishihik Lake	lake trout	3	0.62	(0.26)			
Bennet Lake					290	596.7	0.23
					660		0.23
					840		
Desdeash River					800	326.7	
Fox Lake	burbot	1	(0.48)	(0.48)			
Francis Lake					560	513.3	
					590		
					390		
Lake Lebarge	lake whitefish	12	0.57	(0.26)			
	lake whitefish		(0.44)				
	lake whitefish		(0.45)				
	burbot		(0.42)	(0.45)			
			(0.48)				
Little Atlin Lake	northern pike	1	0.77	0.77			
Marsh Lake					750	345	
					1500		
Mayo Lake	northern pike	3	0.57	(0.30)			

TABLE 8 MERCURY CONCENTRATION IN EXCESS OF "CONCERN LEVELS" (Continued)

Location of Sample	Species	Fish (ppm)			Sediments (ppb)		Water (ppb)
		Sampled	Elevated Samples	Location Mean	Elevated Samples	Location Mean	Elevated Samples
Porcupine River	northern pike	6	0.86	0.39			
			(0.45)				
			(0.40)				
	inconnu	1	0.97	0.97			
Quiet Lake	burbot	2	0.65	0.39			
	lake trout	5	(0.42)	0.30			
Rose Creek					280	286.7	
					250		
					330		
Schwatka Lake					510	343.3	
					260		
					260		
Simpson Lake	lake trout	5	0.72	0.52	510	310	
			0.55		240		
			0.59				
			(0.40)				
Teslin Lake	burbot	7	0.65	0.34	1200	800	0.43
			(0.43)		550		
			(0.40)		650		
Teslin River						170	176.7
						170	
						190	
Yukon River at Dawson	burbot	1	(0.41)	0.41			

() = signifies that the concentration is just less than the limits.

3.1 Fish

In Aishihik Lake, one lake trout was found to contain 0.62 ppm Hg, although the mean concentration was only 0.26 ppm Hg.

In Lake Laberge, 12 lake whitefish samples were taken and only one was found to have a concentration of 0.57 ppm Hg. The mean concentration was only 0.26 ppm Hg. (Two other lake whitefish from Lake Laberge were just below the 0.5 ppm maximum, at 0.44 ppm and 0.45 ppm. Two burbot were also just below this limit at 0.42 ppm and 0.48 ppm Hg in the muscle.)

A similar situation existed in Mayo Lake where one of three northern pike sampled had a muscle concentration of 0.57 ppm Hg although the mean concentration was only 0.30 ppm.

One northern pike (of six sampled) from the Porcupine River near Old Crow had a mercury concentration of 0.86 ppm Hg although the mean value was 0.39 ppm. (Two others were slightly lower than the 0.5 ppm limit at 0.45 and 0.40 ppm). Only one inconnu was sampled from the Porcupine River and was found to have a muscle concentration of 0.97 ppm Hg.

From Quiet Lake two burbot were sampled and one had a concentration of 0.65 ppm Hg although the species mean concentration was 0.38 ppm Hg. Of five lake trout from this lake, one contained 0.42 ppm mercury, again just less than the 0.5 ppm maximum acceptable limit.

Simpson Lake was sampled and of the five lake trout analyzed, three contained elevated mercury concentrations at 0.72 ppm, 0.55 ppm and 0.59 ppm Hg in muscle tissue. (One lake trout had 0.40 ppm Hg in muscle tissue and one had only 0.32 ppm.) The mean concentration of mercury in muscle tissue of lake trout from Simpson Lake was 0.52 ppm Hg.

From Teslin Lake seven burbot were sampled and one contained 0.65 ppm of mercury, two were just below the 0.5 ppm limit at 0.40 and 0.43 ppm Hg. The mean mercury concentration for this species in Teslin Lake was 0.34 ppm.

Only one northern pike was caught in Little Atlin Lake and was found to contain 0.77 ppm Hg. All other fish from this lake contained mercury concentrations well below the 0.5 ppm maximum.

One burbot from Fox Lake contained 0.48 ppm Hg in muscle tissue. Other fish from this lake had lower concentrations of mercury. One burbot from the Yukon River at Dawson had a muscle concentration of 0.41 ppm Hg, and all other fish from that location had lower values. It should be mentioned that considerable variability in results may be due to the various ages of fish, their sex, weight and length, unfortunately this information was unavailable in most cases.

3.2 Sediments

Simpson Lake had a mean sediment mercury content of 310 ppb. All three of the sedient samples from this lake were in the range of slight contamination (100-1000 ppb) at 180 ppb, 510 ppb and 240 ppb Hg. Teslin Lake had sediment concentrations of 1200 ppb, 550 ppb and 650 ppb with a mean concentration of 800 ppb Hg. Some fish samples from Teslin Lake were elevated as may be expected with elevated sediment concentrations. Teslin Lake also had one water sample concentration (0.43 ppb) which was above the acceptable value of 0.2 ppb Hg.

Other waterways with mean sediment concentrations in the "slightly contaminated" range were Bennett Lake with a mean concentration of 596.7 ppb, Dezadeash River at 326.7 ppb, Francis Lake with 513.3 ppb, Marsh Lake at 345 ppb, Rose Creek at 286.7 ppb, Schwatka Lake at 343.3 ppb, and the Teslin River at 176.7 ppb Hg. Further work in many of these areas would be useful in order to add significance to these results.

3.3 Water

The level of concern for mercury in water was 0.02 ppb (Table 3). (Due to a variation in analytical procedures, the detection limit for DINA's results was 0.05 ppb). The results of DIAND's water testing were occasionally inconsistent, and the extraordinary elevated values could be due to sudden pulses of high concentrations of mercury, or to contamination related to sample collection and/or analysis.

At the Venus Mine (Gold and Silver mining) a value of 0.38 ppb Hg was obtained on August 22, 1975, from the effluent streams in the tailings pond, and on June 22 the seepage had 0.23 ppb Hg. In the Whitehorse area, a sample from the Yukon River at the Whitehorse Copper Mine pumphouse had 0.49 ppb Hg, on September 1, 1977. In Tagish Lake at the center of Windy Arm a value of 1.2 ppb Hg was found on September 4, 1975.

The tailings and effluent from the Cyprus Anvil Mine (Lead, Zinc and Silver mining) were excessive (8.5 and 0.40 ppb Hg) on March 3 and September 22, 1976. The seepage and effluent had been elevated in 1975 to 0.32 ppb Hg and 0.70 ppb Hg on August 6 and August 26 respectively. In Rose Creek adjacent to the tailings pond, a value of 0.60 ppb Hg was obtained August 6, 1975. In the area of the Kerr-Addison (Lead, Zinc and Silver mining) property, the effluent from the "Grum deposit" settling pond was 1.6 ppb Hg on March 10, 1976, and 0.31 ppb Hg on December 1, 1976 and on September 22, 1976 a value of 3.8 ppb Hg was recorded for the effluent from a portal to the settling pond. Vangorda Creek (eastfork) had 0.30 ppb Hg on August 6, 1976, and 1.3 ppb Hg on August 27, 1976. On March 10, 1976 an extraordinarily high value of 14 ppb was recorded at Vangorda Creek above the road and campsite.

In the Mt. Nansen (Gold and Silver mining) area two slightly elevated values were found: 0.40 ppb Hg from the tailings pond effluent on June 23, 1975; and 0.31 ppm Hg in the effluent adit on April 21, 1975.

The United Keno Hill (Silver, Lead and Zinc mining) area had 0.40 ppm Hg in the effluent at Keno 700 on November 24, 1976. On July 15, 1975, at the times noted for Flat Creek (Appendix III), the concentrations in the settling pond effluent were 2.5 ppb, 0.12 ppb, 0.38 ppb, 1.3 ppb and 0.20 ppb Hg. On August 12, 1975, the concentration was 0.40 ppb Hg. A creek below No Cash adit 500 had a mercury concentration of 12.0 ppb which was exceptionally high. Lower Faro Gulch had 1.2 ppb Hg on July 17, 1975; Lower Gambler Gulch was 1.1 ppb Hg on July 16, 1975; Crystal Creek at the Keno City road was 0.63 ppb Hg on July 16, 1975; and at the McQuesten Road crossing that creek was 0.78 ppb Hg on the same day. The South McQuesten River above Hanson Lake was 0.28 ppb Hg on July 17, 1975; the Ladue River above Faith Creek was 2.2 ppb Hg also on July 17, 1975.

4 DISCUSSION

In interpretation of the results of mercury in fish and sediments, it is helpful to relate these results to the literature. Westoo and Rydalv (1969) (in Peakall and Lovett, 1972) found that nearly all the mercury contained in fish tissue was in the form methylmercury. This methylmercury is distributed throughout the fish and concentrated in different tissues, each species having a distinct ratio of mercury in muscle and non-muscle tissue (Potter et al, 1975) regardless of the source or mode of uptake (McKim et al, 1976). Hannerz (1968) found that upon initial exposure of a fish to mercury, the highest metal concentrations will be in gill, kidney and liver tissue. After removal from mercury exposure a redistribution of mercury occurs with decreases in muscle and liver concentrations (Peakall and Lovett, 1972). The tissues to which mercury is relocated appear to be skin, muscle and bone (Wobeser, 1975). In most fish species, mercury seems to accummulate in muscle tissue, but in trout it accummulates in heavily vascularized tissues with muscle having the lowest concentration (Potter et al, 1975).

The varying distribution of mercury in tissues of the fish may have implications for interpretation of the results of the Yukon study. Only dorsal muscle tissue was analyzed for mercury content as this is the part most commonly used for food. If further work is done, it would be interesting to sample not only muscle tissue but also liver, kidney and whole body concentrations. This would help to clarify any misleading conclusions based only on muscle tissue concentrations. Data should also include length, age, weight and sex as these factors have documented affects on tissue concentrations.

Physiological effects of mercury are somewhat similar to those associated with other heavy metals. Gill damage is prevalent with all mercury compounds; the exact type of damage depends upon the compound (Wobeser, 1975). The epithelial damage commonly found with other metals is not especially evident in fish exposed to mercury contamination (MacLeod and Pessah, 1973).

Mercury impairs the olfactory response so that the greater the exposure to mercury, the less the response. A concentration of 0.10 ppm $HgCl_2$ was found, in experimental work, to be the minimum ambient concentration to cause a depression in response. The olfactory response is important in feeding, migration, predator-prey relationships, sexual and social behavior and depression of olfactory sensitivity could have severe implications for the relationship of fish with their environment (Hara et al, 1976). There are several anadromous fish species travelling Yukon waterways and any of these could be adversely affected by aquatic mercury concentrations.

All Yukon fish species could be affected by changes in social and mating behavior, and especially by any reduction in reproductive success. A concentration of 1.0 ppm Hg will drastically impair trout sperm viability (McIntyre, 1973). Brook trout were used by McKim et al (1976) in tests with three generations of fish. It was found that the adult fish (first generation) could reproduce, but with slightly limited success. Second generation embryos showed severe deformities and many did not hatch, and third generation (viable only in lower concentrations) were deformed and none survived longer than three weeks at 0.93 ppb Hg in the water. Although no concentrations of mercury in Yukon waterways were consistently elevated to this extent, some areas had concentrations which may be high enough (Table 6 and Appendix III) to cause some disruption in reproductive success and viability of the fry. If elevated mercury concentrations were consistent near a mine or other potentially contaminated area during spawning, the population may be reduced.

A direct relationship between the age and size (body weight) of fish and their susceptability to mercury poisoning has been documented (Wobeser, 1975). In early stages of development, fish have a lower resistance to the toxic effects of mercury (McKim et al, 1976). As the period of exposure increases, the accumulation rate of mercury in body tissues increases (McKim et al, 1976), but with increasing age and size, fish have increased resistance to the toxic effects of mercury (Wobeser et al, 1975). Water temperature is also important as warmer water encourages faster accumulation of mercury (MacLeod and Pessah, 1973). With cold water in the Yukon the accumulation rate would be minimized.

The results for fish lengths and mercury concentration obtained in this study showed little, consistent, positive, linear correlation for lake whitefish or northern pike (Table 7). Arctic grayling, lake trout and longnose sucker show a tendency for positive correlation, as do burbot and round whitefish. Any conclusions based on such limited data are not statistically valid. This data does support the results in literature to some extent, and any future sampling should include weight, age, and length of fish, if any such correlation is to be substantiated.

Fish mercury concentrations are variable throughout the world. In Sweden, Johnels et al, (1967) found a one kilo (standard fish) pike to have 300 ng/g (0.3 ppm) tissue concentration of mercury. McKim et al (1976) quote several sources denoting normal background levels for fish tissue as being in the range 0.018 to 0.20 ppm. Westoo and Rydalv (1969) sampled approximately 3000 fish from 44 locations in Sweden and found average tissue concentrations of 0.2 - 5 ppm Hg, with most values in the range of 0.5 - 1.5 ppm. They also found about a 25-45% decrease in mercury content between 1966 and 1969 when use of mercury for slimicides in paper manufacturing substantially declined (Peakall and Lovett, 1972). In Lake Powell (a man made impoundment of the Colorado River, Arizona), Potter et al (1975) found wet weight muscle concentrations of 0.084 ppm in trout as the lowest, and 0.427 ppm in walleye as the highest value. Comparing values from the literature with the Yukon results, the latter seem relatively low. Areas in the territory which had elevated concentrations should be sampled again to obtain more statistically valid species means, and to ensure a representative sample.

The potential for biomagnification exists in Yukon waterways as in any others. Stock and Cucuel (1934) showed magnification from 0.03 ppb in seawater to 30-37 ppb in algae and 105-110 ppb in fish (in Peakall and Lovett, 1975). Konrad (1971) claims that biomagnification of mercury from sediments of relatively low concentrations to fish, will occur much more easily if the pH of the water is less than seven (Matsumura et al, 1972) and if the alkalinity is less than fifty (Hannan and Thompson, 1977). The concentration of mercury in brook trout was found to be directly dependent on the concentration of methyl-mercury chloride in the water, and also on exposure time and on temperature. A concentration factor of 1.2×10^4 was exhibited after the brook trout had been exposed to 0.29 ppb Hg in the water for 36-108 weeks. This concentration is within the range of waterways in Yukon, although it is not known whether Yukon mercury levels are consistently elevated at all times and locations, as only grab samples were taken.

Mercury in sediments may come from a manmade pollution source such as any of the industries previously mentioned. In most areas of Yukon, mercury in sediments is a natural occurrence. Placer mining could be an historic source, although samples from the Dawson area where placer mining was and is, most active, show no mercury accumulations. In forested areas, organic debris may accumulate mercury as mercury has a known affinity for organic matter. In areas of low organic content in the soil (as is most of Yukon), the mercury would probably be carried with runoff, into lakes and streams.

Once in the sediments, mercury may be methylated by micro-organisms under aerobic or partially anaerobic conditions, as previously discussed. Mercury may also be carried in suspension with organic material in suspended solids, and in this way methylation may occur in the water column.

Allan et al (1974) conducted a survey of mercury in the Canadian Shield and found that the age and nature of the rock, and especially the presence of sulphide ores, were important factors in relation to the mercury content. Mercury concentration was high in areas of relatively young volcanic rocks. In the Bear-Slave structural province, Allan et al (1974) found the range from an average of 129 ppb in Archean age rock to 513 ppb average in the more recent Proterozoic aged rock. Mercury is associated with areas of heavy mineralization, especially iron rich areas containing pyrite, pyrrhotite or cinnabar and also with lead, zinc and copper mineralization and gold-pyrite occurrences. In areas of copper deposits, a mercury "halo" is sometimes found vaguely dispersed around the perimeter of the ore body.

Many areas of the Yukon contain similar zones of mineralization. The sample locations with any elevated mercury concentrations were investigated through geological survey maps, and most were found to be areas of Pb-Zn, Cu, Fe or Au mineralization (Table 9). Mining activities around the Yukon increase the cycling of mercury and consequently hasten its release to the waterways. The only non-natural source of mercury may be the Whitehorse General Hospital and local medical clinics, as previously mentioned. This contributes only an insignificant quantity of mercury.

In areas where mercury has been used in agriculture as a fungicidal seed dressing, seed eating birds, small mammals and their predators have been found to contain elevated tissue and skeletal concentrations (Fimreite and Karstad, 1971; Peakall and Lovett, 1972). Larger birds such as chickens and pheasants are much more resistant to mercury related disorders than are smaller seed eaters.

Symptoms of elevated mercury concentrations in birds include weight loss despite regular feeding (Fimreite, 1971; Parkhurst and Thaxton, 1973), a decrease in egg production, and smaller and or lighter eggs, (Fimreite, 1971; Heinz, 1971), discoloration or shell-less eggs and decreased rate of hatching (Fimreite, 1971). Different species of birds, because of their differing resistance to mercury poisoning may have considerably different "toxic concentrations". Red-tailed hawks died when liver concentrations reaches 7-10 ppm Hg (Fimreite and Karstad, 1971). Chicken with tissue concentrations of 250 ppm Hg managed to survive, albeit with reduced growth rates.

Fish-eating birds such as the great blue heron (Ardea herodias) were found to contain up to 23.0 ppm Hg in the muscle and 175 ppm in the liver, while the fish found in their guts had only 1.8 to 3.6 ppm Hg respectively (Peakall and Lovett, 1972). Common tern (Sterno hirundo) which consumed fish containing 3.8 ppm Hg had a carcass concentration of 7.5 ppm and a liver concentration of 39.0 ppm (Dustman et al, 1970; Peakall and Lovett, 1972).

Mercury may be physiologically excreted into the feathers of birds, thereby lowering the concentration in more important, physiologically

TABLE 9 MINERAL OCCURRENCES IN THE VICINITY OF WATERWAYS WITH ANY ELEVATED MERCURY LEVELS

Location	Minerals Present	Notes
Aishihik Lake	Cu, Pb, Zn, Mo, W	marble, chalcopyrite
Bennet Lake	Cu, Au, Ag, Zn, Mo	sphalerite, volcanic rock, chalcopyrite
Desdeash River	Fe, Cr, Mg, Pt, asbestos	
Fox Lake	Cu	
Francis Lake	Pb, Zn, Ag, As, Fe, Cu, W	minor chalcopyrite, pyrite, sphalerite
Lake Laberge	Cu	
Little Atlin Lake	N.I.*	
Marsh Lake	Cu	chalcopyrite, greenstone
Mayo Lake	Au, Pb, Zn, Ag, W, Cu, Cd	
Porcupine River	Pb, Zn, Cu, W	sphalerite, galena, pyrite
Quiet Lake	Au, asbestos	much placer gold
Rose Creek	Pb, Zn, Ag, Cu	sphalerite, galena, chalcopyrite, pyrite
Schwatka Lake	Cu, W, Mo, Au, Ag, asbestos	coal, volcanic rock, basalt
Simpson Lake	N.I.	
Teslin Lake	N.I.	
Teslin River	N.I.	
Yukon R. (at Dawson)	Au, Cu, Pb, Zn, Fe, Ni, Sb, asbestos	cinnabar occurrence at Miller Creek tributary of 60 mile R. - also placer Au.

Based on Geological Survey of Canada Maps.
*N.I. - no information

active organs. The few birds sampled in the Yukon all had low concentrations of mercury in muscle tissues. They were sampled after a summer season of feeding in the territory where they would not have been exposed to agricultural mercury sources.

The Yukon food chain is presently uncontaminated by industrial mercury with the exception of some increased levels around the hard rock mining areas. If Yukon is to maintain this condition at the present or better level, development must be done in such a way as to minimize impacts and protect the aquatic resources which we now have at our disposal.

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APPENDICES

APPENDIX I

(a) Mercury in Water, Sediments and Fish

(b) Mercury in Moose and Waterfowl

APPENDIX I (a) MERCURY IN WATER, SEDIMENTS AND FISH

Sample Location	Mercury Concentration in Water mg/l (ppm)	Mercury Concentration in Sediments mg/kg (ppm)	Fish Concentrations mg/kg Wet	Fish Concentrations mg/kg Dry	Species	Date	Sex	Length cm	Others
1	$<0.20 \times 10^{-3}$	<0.01	0.05	0.20	arctic grayling	17/09/77	-	-	When reagents
		<0.01	0.11	0.49	lake whitefish	04/10/77	-	44.5	were added a
Aishihik Lake	19/07/77	<0.01	0.08	0.39	lake whitefish	04/10/77	-	42.6	precipitate
		19/07/77	0.07	0.33	lake whitefish	04/10/77	-	39.7	formed. The Hg
			0.02	0.11	lake whitefish	04/10/77	-	37.8	may have been
			0.05	0.26	lake whitefish	04/10/77	-	39.2	complexed by
			0.05	0.23	arctic grayling	04/10/77	-	41.4	that precipitate
			0.36	1.7	arctic grayling	04/10/77	-	89.1	or there may
			0.62	2.2	lake trout	04/10/77	-	76.8	have been only
			0.09	0.43	lake trout	04/10/77	-	32.2	an undetectable
			0.07	0.38	lake trout	0.410/77	-	45.1	amount of Hg. (LY-lab tech.)
2 Bennett Lake	18 samples	0.29	0.22	0.66	lake trout	30/09/77	-	90.7	fish samples
	16 were 0.20×10^{-3}	0.66	0.22	1.1	lake trout	30/09/77	-	56.1	collected by
	10	0.84	0.15	0.65	lake trout	30/09/77	-	51.6	FMS.
		14/07/77	0.15	0.62	lake trout	30/09/77	-	51.2	
	2 were 0.23×10^{-3}		0.16	0.72	lake trout	30/09/77	-	49.9	FMS caught
			0.06	0.29	longnose sucker	30/09/77	-	42.1	
			0.04	0.20	longnose sucker	30/09/77	-	38.1	
			0.05	0.22	longnose sucker	30/09/77	-	39.4	
			0.07	0.37	longnose sucker	30/09/77	-	-	

APPENDIX I (a) MERCURY IN WATER, SEDIMENTS AND FISH (Continued)

Sample Location	Mercury Concentration in Water mg/l (ppm)	Mercury Concentration in Sediments mg/kg (ppm)	Fish Concentrations mg/kg Wet	Fish Concentrations mg/kg Dry	Species	Date	Sex	Length cm	Other
2 Bennett Lake			0.07	0.35	21 longnose sucker	30/09/77	-	40.1	
			0.04	0.16	22 lake whitefish	30/09/77	-	47.8	
		Probably reversed? →	0.32	0.15	23 lake whitefish	30/09/77	-	50.5	
			0.04	0.20	24 lake whitefish	30/09/77	-	49.4	
			0.04	0.19	25 lake whitefish	30/09/77	-	42.4	
			0.05	0.24	26 lake whitefish	30/09/77	-	40.9	
			0.02	0.09	27 arctic grayling	30/09/77	-	25.4	
3 Bonanza Creek	$<0.20 \times 10^{-3}$ 02/08/77	<0.02	0.14	0.69	arctic grayling	02/08/77	-	23.1	
		0.03							EPS caught.
		0.03							
4 Bonnet Plume R.	$<0.20 \times 10^{-3}$ 27/07/77	0.04	0.25	1.2	northern pike	27/07/77	-	37.2	
		0.04	0.16	0.81	northern pike	27/07/77	-	41.1	EPS
		0.06	0.19	0.91	northern pike	27/07/77	-	36.5	
5 Desdeash R.		0.12							
		0.06							
		0.80							
		19/07/77							
6 Firth R.	3 samples were analyzed from - Firth R. - Malcolm R. - Herschel Is.	lost in analysis	<0.02	<0.06	round whitefish	15/09/77	-	-	these samples were collected by Arnie Williamson (Dawson Foresty) Fish were caught in the Firth River.
			0.03	0.12	round whitefish	15/09/77	-	-	
			0.04	0.15	round whitefish	15/09/77	-	-	
			0.02	0.07	arctic char	15/09/77	-	-	
			0.03	0.14	arctic char	15/09/77	-	-	

APPENDIX I (a) MERCURY IN WATER, SEDIMENTS AND FISH (Continued)

Sample Location	Mercury Concentration in Water mg/l (ppm)	Mercury Concentration in Sediments mg/kg (ppm)	Fish Concentrations mg/kg Wet	Fish Concentrations mg/kg Dry	Species	Date	Sex	Length cm	Other
6	all were found		0.05	0.20	arctic grayling	18/08/77	M	34.6	
	to contain		0.04	0.15	arctic grayling	18/08/77	F	31.9	
	$<0.02 \times 10^{-3}$		0.06	0.23	arctic grayling	18/08/77	M	34.1	caught by FMS
	15/09/77		0.03	0.16	arctic grayling	18/08/77	M	28.4	
			0.09	0.37	arctic grayling	18/08/77	-	38.1	
7	$<0.20 \times 10^{-3}$	0.56	0.29	1.5	lake whitefish				
Francis		0.39	0.19	0.94	lake whitefish				
Lake		0.59	0.19	0.97	lake whitefish				
		22/07/77	0.20	0.93	lake whitefish				
			0.21	1.1	lake whitefish				FMS
			0.09	0.40	lake trout	20/10/77	-	55.5	
			0.16	0.70	lake trout	20/10/77	-	52.2	
			0.13	0.58	lake trout	20/10/77	-	40.8	
			0.10	0.51	longnose sucker	20/10/77	-	40.0	
			0.11	0.50	longnose sucker	20/10/77	-	42.1	
8	$<0.20 \times 10^{-3}$	<0.02			No fish in this				
	02/08/77	<0.02			creek				
Hunker		0.02							
Creek		02/08/77							
9		0.04	0.21	0.96	lake whitefish	17/02/77	-	29.4	
Kluane L.		0.06	0.09	0.40	lake trout	17/02/77	-	43.5	FMS
		0.04	0.07	0.30	lake trout	18/02/77	-	38.4	
		08/07/77							

APPENDIX I (a) MERCURY IN WATER, SEDIMENTS AND FISH (Continued)

Sample Location	Mercury Concentration in Water mg/l (ppm)	Mercury Concentration in Sediments mg/kg (ppm)	Fish Concentrations mg/kg		Species	Date	Sex	Length cm	Other
			Wet	Dry					
10	$<0.20 \times 10^{-3}$	0.04	0.09	0.36	arctic grayling	08/09/77	-	37.8	
Klondike	05/08/77	0.04	0.06	0.29	arctic grayling	29/09/77			
River		0.03							FMS
		05/08/77							
11	$<0.20 \times 10^{-3}$	0.08	0.04	0.17	coho salmon	08/10/77			
Klukshu	18/07/77	0.09	0.05	0.22	coho salmon	08/10/77			
River		0.04	0.07	0.31	coho salmon	08/10/77			
		18/07/77	0.04	0.19	coho salmon	08/10/77			
			0.04	0.18	coho salmon	08/10/77			FMS
			0.05	0.33	sockeye salmon	08/10/77			
			0.05	0.27	sockeye salmon	08/10/77			
			0.03	0.21	sockeye salmon	08/10/77			
			0.04	0.27	sockeye salmon	08/10/77			
			0.04	0.37	sockeye salmon	08/10/77			
12	17 water samples		0.44	1.8	lake whitefish	24/01/77	-	32.1	
	all $<0.20 \times 10^{-3}$		0.12	0.59	lake whitefish	24/01/77	-	38.7	
Lake	01/09/77		0.57	2.8	lake whitefish	24/01/77	-	22.2	
Laberge			0.33	1.6	lake whitefish	24/01/77	-	28.5	
			0.10	0.42	lake whitefish	24/01/77	-	22.9	
			0.15	0.69	lake whitefish	24/01/77	-	26.4	FMS
			0.17	0.76	lake whitefish	24/01/77	-	23.4	
			0.12	0.54	lake whitefish	24/01/77	-	20.0	
			0.15	0.69	lake whitefish	26/01/77	-	21.9	
			0.45	2.0	lake whitefish	26/01/77	-	34.3	
			0.27	1.1	lake whitefish	26/01/77	-	34.9	
			0.24	1.0	lake whitefish	26/01/77	-	27.2	

APPENDIX I (a) MERCURY IN WATER, SEDIMENTS AND FISH (Continued)

Sample Location	Mercury Concentration in Water mg/l (ppm)	Mercury Concentration in Sediments mg/kg (ppm)	Fish Concentrations mg/kg Wet	Fish Concentrations mg/kg Dry	Species	Date	Sex	Length cm	Other
12 Lake Laberge			0.42	1.9	burbot	10/02/77	-	63.0	
			0.48	2.2	burbot	10/02/77	-	57.6	
13 Liard River			0.11	0.60	arctic grayling	21/10/77	-	26.3	
			0.07	0.33	arctic grayling	21/10/77	-	33.7	FMS
			0.06	0.25	arctic grayling	21/10/77	-	31.2	
			0.04	0.18	arctic grayling	21/10/77	-	28.8	
			0.09	0.41	arctic grayling	21/10/77	-	-	
14 Little Salmon Lake	$<0.20 \times 10^{-3}$ 17/08/77	<0.02	0.16	0.78	northern pike	14/10/77*	-	54.7	*fish actually from Little Salmon River just d/s from the lake.
		0.03	0.22	1.0	lake trout	14/10/77	-	50.4	
		0.02	0.08	0.40	lake whitefish	14/10/77	-	50.5	
		17/08/77	0.10	0.50	lake whitefish	14/10/77	-	46.8	
			0.06	0.30	lake whitefish	14/10/77	-	45.1	
			0.09	0.51	lake whitefish	14/10/77	-	46.0	FMS
			0.09	0.41	lake whitefish	14/10/77	-	43.7	
15 Marsh L.	15 water samples all $<0.20 \times 10^{-3}$ 12/08/77	0.75	0.14	0.71	burbot	10/02/77	-	35.4	
		1.5	0.17	0.79	burbot	10/02/77	-	30.0	
		0.13	0.18	0.79	burbot	10/02/77	-	32.4	
		0.12	0.13	0.46	lake trout	10/02/77	-	40.2	FMS
		0.13	0.02	0.10	lake whitefish	17/02/77	-	35.7	
		06/07/77	0.19	1.0	burbot	17/02/77	-	37.8	
		0.04	0.15	0.65	burbot	17/02/77	-	38.3	
		0.04	0.11	0.43	lake trout	17/02/77	-	37.9	
		0.05	0.10	0.44	lake trout	17/02/77	-	36.6	
		08/08/77	0.23	0.92	lake trout	17/02/77	-	49.4	
			0.20	0.71	lake trout	17/02/77	-	47.1	

APPENDIX I (a) MERCURY IN WATER, SEDIMENTS AND FISH (Continued)

Sample Location	Mercury Concentration in Water mg/l (ppm)	Mercury Concentration in Sediments mg/kg (ppm)	Fish Concentrations mg/kg Wet	Fish Concentrations mg/kg Dry	Species	Date	Sex	Length cm	Other
16	$<0.20 \times 10^{-3}$	0.02	0.23	1.0	northern pike	09/10/77	-	79.3	
Mayo Lake	26/07/77	<0.02	0.57	2.6	northern pike	09/10/77	-	73.8	
		<0.02	0.09	0.43	northern pike	09/10/77	-	43.7	FMS
		26/07/77	0.46	1.8	lake trout	09/10/77	-	80.2	
			0.07	0.33	lake whitefish	09/10/77	-	37.1	
			0.06	0.29	lake whitefish	09/10/77	-	38.0	
			0.04	0.20	lake whitefish	09/10/77	-	34.6	
			0.06	0.29	lake whitefish	09/10/77	-	38.2	
			0.03	0.15	lake whitefish	09/10/77	-	36.3	
			0.06	0.31	round whitefish	09/10/77	-	39.4	
			0.04	0.18	round whitefish	09/10/77	-	38.9	
			0.06	0.29	round whitefish	09/10/77	-	39.4	
			0.06	0.25	round whitefish	09/10/77	-	41.9	
17	$<0.20 \times 10^{-3}$	<0.02	0.10	0.46	northern pike	04/08/77	-	34.3	
Old Crow	04/08/77	0.03	0.06	0.29	northern pike	04/08/77	-	41.8	
Flats		<0.02	0.06	0.28	northern pike	04/08/77	-	32.1	EPS
		04/08/77	0.04	0.17	northern pike	04/08/77	-	42.3	
			0.04	0.18	northern pike	04/08/77	-	36.5	
			0.07	0.35	northern pike	04/08/77	-	31.8	
18	$<0.20 \times 10^{-3}$	0.03	0.33	1.4	inconnu	05/09/77	-	-	these samples
Old Crow	04/08/77	<0.02	0.05	0.21	chum salmon	05/09/77	M	-	were collected
River		0.03	0.05	0.19	chum salmon	05/09/77	-	-	by Mr. Steven
		04/08/77	0.06	0.25	lake whitefish	05/09/77	-	-	Frost, a native
			0.06	0.24	lake whitefish	05/09/77	F	-	of Old Crow

APPENDIX I (a) MERCURY IN WATER, SEDIMENTS AND FISH (Continued)

Sample Location	Mercury Concentration in Water mg/l (ppm)	Mercury Concentration in Sediments mg/kg (ppm)	Fish Concentrations mg/kg Wet	Fish Concentrations mg/kg Dry	Species	Date	Sex	Length cm	Other
19	<0.20 x 10^{-3}	0.03	0.09	0.34	arctic grayling	03/08/77	-	31.0	
Porcupine	04/08/77	0.04	0.11	0.46	arctic grayling	03/08/77	-	34.3	caught on the
R. at Old		0.03	0.08	0.33	arctic grayling	03/08/77	-	37.4	Porcupine R. at
Crow		04/08/77	0.08	0.33	arctic grayling	03/08/77	-	30.6	at Lord Creek
			0.09	0.34	arctic grayling	03/08/77	-	37.1	(upstream from Old Crow)
			0.86	5.5	northern pike	03/08/77	-	49.3	EPS
			0.13	0.63	northern pike	03/08/77	-	52.4	
			0.45	2.3	northern pike	03/08/77	-	55.3	
			0.40	1.8	northern pike	03/08/77	-	52.1	
			0.22	1.1	northern pike	03/09/77	-	48.2	
			0.26	1.2	northern pike	03/09/77	-	57.4	
			0.11	0.39	lake whitefish	03/09/77	-	40.1	these fish were
			0.17	0.64	lake whitefish	03/09/77	-	36.7	caught down-
			0.09	0.49	chinook salmon	03/09/77	-	78.6	stream of town
			0.97	3.9	inconnu	03/09/77	-	68.4	
20	<0.20 x 10^{-3}	0.02	0.22	0.88	lake trout	26/10/77			
Quiet Lake	08/08/77	<0.02	0.32	1.30	lake trout	26/10/77			
		<0.02	0.42	2.0	lake trout	26/10/77			
		08/08/77	0.22	0.91	lake trout	26/10/77			FMS
			0.31	1.3	lake trout	26/10/77			
			0.17	0.71	lake cisco	26/10/77			
			0.17	0.61	lake cisco	26/10/77			
			0.19	0.71	lake cisco	26/10/77			
			0.30	1.3	lake cisco	26/10/77			
			0.18	0.85	lake cisco	26/10/77			
			0.12	0.63	burbot	26/10/77			
			0.65	3.4	burbot	26/10/77			

APPENDIX I (a) MERCURY IN WATER, SEDIMENTS AND FISH (Continued)

Sample Location	Mercury Concentration in Water mg/l (ppm)	Mercury Concentration in Sediments mg/kg (ppm)	Fish Concentrations mg/kg		Species	Date	Sex	Length cm	Other
			Wet	Dry					
20 Quiet Lake			0.12	0.54	arctic grayling	26/10/77			
			0.15	0.62	arctic grayling	26/10/77			
			0.18	0.76	lake whitefish	26/10/77			
			0.13	.53	lake whitefish	26/10/77			
			0.11	.44	lake whitefish	26/10/77			
			0.10	.42	lake whitefish	26/10/77			
			0.08	.34	lake whitefish	26/10/77			
			0.13	.64	round whitefish	26/10/77			
			0.20	1.0	round whitefish	26/10/77			
			0.17	0.78	round whitefish	26/10/77			
			0.24	1.2	round whitefish	26/10/77			FMS
			0.17	0.83	round whitefish	26/10/77			
21 Rose Creek		0.28							
		0.25							
		0.33							
22 Schwatka Lake		0.51	0.04	0.25	longnose sucker	29/09/77	-	36.5	
		0.26	0.09	0.44	longnose sucker	29/09/77	-	39.3	
		0.26	0.04	0.23	longnose sucker	29/09/77	-	38.7	
		06/07/77	0.11	0.57	longnose sucker	29/09/77	-	42.0	
			0.06	0.35	longnose sucker	29/09/77	-	40.5	
			0.12	0.63	northern pike	29/09/77	-	56.9	
			0.15	0.73	northern pike	29/09/77	-	66.6	
			0.22	1.0	northern pike	29/09/77	-	64.0	
			0.08	0.37	northern pike	29/09/77	-	49.1	
			0.07	0.35	northern pike	29/09/77	-	48.5	

APPENDIX I (a) MERCURY IN WATER, SEDIMENTS AND FISH (Continued)

Sample Location	Mercury Concentration in Water mg/l (ppm)	Mercury Concentration in Sediments mg/kg (ppm)	Fish Concentrations mg/kg Wet	Fish Concentrations mg/kg Dry	Species	Date	Sex	Length cm	Other
23	0.20×10^{-3}	0.18	0.14	0.61	lake whitefish	20/10/77	-	47.8	
Simpson	21/07/77	0.51	0.09	0.40	lake whitefish	20/10/77	-	49.5	
Lake		0.24	0.16	0.76	lake whitefish	20/10/77	-	47.0	
		21/07/77	0.12	0.53	lake whitefish	20/10/77	-	46.8	
			0.14	0.63	lake whitefish	20/10/77	-	50.3	
			0.72	3.50	lake trout	20/10/77	-	47.8	
			0.40	1.60	lake trout	20/10/77	-	44.7	
			0.32	1.30	lake trout	20/10/77	-	46.5	FMS
			0.55	2.60	lake trout	20/10/77	-	53.0	
			0.59	3.20	lake trout	20/10/77	-	55.5	
24	$<0.20 \times 10^{-3}$	0.06	0.08	0.40	arctic grayling	09/08/77	-	18.2	
South	09/08/77	0.05	0.07	0.34	arctic grayling	09/08/77	-	21.6	
MacMillan		0.06	0.09	0.43	arctic grayling	09/08/77	-	28.1	EPS
River		09/08/77	0.09	0.39	arctic grayling	09/08/77	-	23.7	
25	$<0.20 \times 10^{-3}$	0.09	0.03	0.14	arctic grayling	07/10/77			
South	27/07/77	0.09	0.04	0.15	arctic grayling	07/10/77			FMS
McQuesten		0.10	0.02	0.07	arctic grayling	07/10/77			
River		27/07/77							
26	$<0.20 \times 10^{-3}$	<0.02	0.04	0.18	lake whitefish	19/10/77			
Squanga	08/08/77	<0.02	0.05	0.22	lake whitefish	19/10/77			
Lake		0.02	0.02	0.11	lake whitefish	19/10/77			FMS
		08/08/77	0.03	0.12	lake whitefish	19/10/77			
			0.03	0.16	lake whitefish	19/10/77			
			0.15	0.77	northern pike	19/10/77			
			0.21	1.1	northern pike	19/10/77			

APPENDIX I (a) MERCURY IN WATER, SEDIMENTS AND FISH (Continued)

Sample Location	Mercury Concentration in Water mg/l (ppm)	Mercury Concentration in Sediments mg/kg (ppm)	Fish Concentrations mg/kg Wet	Fish Concentrations mg/kg Dry	Species	Date	Sex	Length cm	Other
27 Tagish Lake	10 water samples all <0.20 x 10^{-3} 15/08/77	<0.02	0.04	0.18	lake whitefish	04/03/77	-	34.1	
		0.02	0.10	0.49	lake whitefish	04/03/77	-	31.5	
		0.02	0.06	0.32	burbot	16/02/77	-	36.5	
			0.11	0.60	burbot	14/02/77	-	39.6	
			0.13	0.62	burbot	16/02/77	-	38.6	
			0.06	0.32	lake whitefish	16/02/77	-	48.5	
28 Tatlmain Lake	0.20 x 10^{-3} 18/08/77	0.03	0.09	0.43	lake whitefish	18/08/77	-	31.0	
		0.02	0.07	0.40	lake whitefish	18/08/77	-	28.7	EPS
		0.03	0.10	0.52	lake whitefish	18/08/77	-	29.4	
29 Teslin Lake	18 water samples all <0.20 x 10^{-3} except sample #92 = 0.43 18/07/77	1.2	0.43	2.5	burbot	24/02/77	-	43.9	
		0.55	0.06	0.28	lake whitefish	24/02/77	-	29.5	FMS
		0.65 12/07/77	0.11	0.52	lake whitefish	24/02/77	-	28.9	
			0.23	1.3	lakewhitefish	24/02/77	-	32.6	
			0.19	1.0	burbot	24/02/77	-	40.1	
			0.35	1.9	burbot	23/02/77	-	41.0	
			0.17	0.81	burbot	23/02/77	-	36.9	
			0.17	0.72	burbot	19/10/77			
			0.40	2.3	burbot	19/10/77			
			0.65	3.7	burbot	19/10/77			
			0.23	1.1	northern pike	19/10/77			FMS
			0.07	0.33	longnose sucker	19/10/77			
			0.09	0.35	lake trout	19/10/77			
			0.08	0.39	lake whitefish	19/10/77			

APPENDIX I (a) MERCURY IN WATER, SEDIMENTS AND FISH (Continued)

Sample Location	Mercury Concentration in Water mg/l (ppm)	Mercury Concentration in Sediments mg/kg (ppm)	Fish Concentrations mg/kg Wet	Fish Concentrations mg/kg Dry	Species	Date	Sex	Length cm	Other
30	lost in analysis	0.17							
Teslin		0.17							
River		0.19							
		06/07/77							
31	<0.20 x 10^{-3}	0.11							
Wolf Lake	19/09/77	<0.04							
		<0.03							
		19/09/77							
32	<0.20 x 10^{-3}	0.04	<0.02	<0.07	chum salmon	08/10/77			
Yukon River	02/08/77	0.05	0.03	0.11	chum salmon	08/10/77			
at Dawson		0.04	<0.02	<0.07	chum salmon	08/10/77			FMS
Ferry		02/08/77	0.02	0.07	chum salmon	08/10/77			
			0.03	0.09	chinook salmon	08/10/77			
			0.04	0.13	chinook salmon	08/10/77			
			0.07	0.21	chinook salmon	08/10/77			
			0.04	0.13	chinook salmon	08/10/77			
			<0.03	<0.07	chinook salmon	08/10/77			
			0.26	1.0	longnose sucker	08/10/77			FMS
			<0.02	<0.07	arctic grayling	08/10/77			
			0.41	2.3	burbot	08/10/77			
			0.07	0.27	round whitefish	08/10/77			
			0.30	1.5	lake whitefish	08/10/77			
			0.05	0.20	chum salmon	08/10/77			
			0.08	0.39	lake whitefish	29/09/77			
			0.09	0.35	round whitefish	29/09/77			
			0.03	0.11	arctic grayling	29/09/77			

APPENDIX I (a) MERCURY IN WATER, SEDIMENTS AND FISH (Continued)

Sample Location	Mercury Concentration in Water mg/l (ppm)	Mercury Concentration in Sediments mg/kg (ppm)	Fish Concentrations mg/kg		Species	Date	Sex	Length cm	Other
			Wet	Dry					
32			0.07	0.30	arctic grayling	29/09/77			
Yukon R.			0.04	0.17	arctic grayling	29/09/77			
at Dawson			0.02	0.10	arctic grayling	29/09/77			
Ferry			0.24	0.96	arctic grayling	29/09/77			
			0.05	0.21	chum salmon	28/09/77			
33			0.04	0.13	lake whitefish	14/09/77			
Yukon R.			0.18	0.93	burbot	21/10/77	F	69.3	
at confluence			0.25	1.4	burbot	21/10/77	F	74.0	
of Takhini			0.27	1.5	burbot	21/10/77	M	74.0	
			0.27	1.5	burbot	21/10/77	M	77.0	
			0.15	0.74	lake whitefish	21/10/77	F	41.0	
			0.14	0.72	lake whitefish	21/10/77	F	32.9	
			0.07	0.28	lake whitefish	21/10/77	F	39.4	
			0.09	0.45	lake whitefish	21/10/77	F	31.2	
			0.14	0.66	lake whitefish	21/10/77	F	36.6	
			0.10	0.49	longnose sucker	21/10/77	M	40.2	
			0.13	0.66	longnose sucker	21/10/77	F	44.0	FMS/EPS
			0.14	0.68	longnose sucker	21/10/77	M	43.0	
			0.27	1.3	longnose sucker	21/10/77	M	41.8	
			0.16	0.83	longnose sucker	21/10/77	M	39.5	
			0.22	0.49	arctic grayling	21/10/77	M	30.9	
			0.14	0.67	round whitefish	21/10/77	F	34.5	
			0.11	0.56	round whitefish	21/10/77	F	35.0	
			0.05	0.25	round whitefish	21/10/77	M	30.8	
			0.10	0.50	round whitefish	21/10/77	F	38.5	
			0.06	0.30	round whitefish	21/10/77	F	30.3	

APPENDIX I (a) MERCURY IN WATER, SEDIMENTS AND FISH (Continued)

Sample Location	Mercury Concentration in Water mg/l (ppm)	Mercury Concentration in Sediments mg/kg (ppm)	Fish Concentrations mg/kg Wet	Fish Concentrations mg/kg Dry	Species	Date	Sex	Length cm	Other
34 Pelly River at Anvil Creek			0.10	0.60	arctic grayling	18/08/77			
			0.06	0.31	arctic grayling	18/08/77			
			0.07	0.34	arctic grayling	18/08/77			EPS
			0.08	0.42	arctic grayling	18/08/77			
			0.15	0.90	arctic grayling	18/08/77			
35 Fox Lake			0.48	2.4	burbot	17/02/77	-	60.4	
			0.09	0.41	round whitefish	11/02/77	-	35.9	
			0.15	0.62	lake whitefish	11/02/77	-	36.1	
			0.12	0.54	lake whtefish	11/02/77	-	31.7	
			0.24	1.1	lake whitefish	11/02/77	-	44.9	
			0.19	0.87	lake whitefish	11/02/77	-	49.5	
			0.37	1.7	lake whitefish	11/02/77	-	43.7	FMS
			0.12	0.51	lake whitefish	11/02/77	-	30.1	
			0.12	0.51	lake whitefish	11/02/77	-	44.8	
36 Little Atlin			0.77	4.1	northern pike	07/03/77	-	52.5	
			0.26	1.2	lake whitefish	07/03/77	-	42.5	
			0.18	0.87	lake whitefish	07/03/77	-	43.3	
			0.16	0.82	lake whitefish	07/03/77	-	41.3	
			0.31	1.5	lake whitefish	07/03/77	-	39.6	
			0.21	0.99	lake whitefish	07/03/77	-	42.8	
			0.03	0.13	lake whitefish	04/03/77	-	45.5	FMS
			0.04	0.17	lake whitefish	04/03/77	-	46.5	
			0.20	0.05	lake whitefish	04/03/77	-	42.7	
			0.08	0.31	lake whitefish	11/03/77	-	42.9	
			0.04	0.17	lake whitefish	11/03/77	-	47.2	

APPENDIX I (a) MERCURY IN WATER, SEDIMENTS AND FISH (Continued)

Sample Location	Mercury Concentration in Water mg/l (ppm)	Mercury Concentration in Sediments mg/kg (ppm)	Fish Concentrations mg/kg		Species	Date	Sex	Length cm	Other
			Wet	Dry					
37 Atlin			0.10	0.53	lake trout	07/03/77	-	28.5	
			0.15	0.62	lake trout	07/03/77	-	50.6	
			0.12	0.51	lake trout	07/03/77	-	47.0	
			0.12	0.46	lake trout	07/03/77	-	50.0	
			0.34	0.08	lake trout	04/03/77	-	36.2	
			0.11	0.52	lake trout	04/03/77	-	37.4	
38 Yukon R.	12 water samples taken between Whse. and Lake Laberge $<0.20 \times 10^{-3}$								
39 Mt. Nansen	$<0.20 \times 10^{-3}$ 5 samples		0.06	0.19	arctic grayling				
			0.04	0.17	arctic grayling				

APPENDIX I (b) MERCURY IN MOOSE AND WATERFOWL

Location	Species	Date	Mercury Concentration ppm	
			Dry Wt.	Wet Wt.
Aishihik Lake	adult male Lesser Scaup	28/09/77	<0.02	<0.07
Marsh Lake	juvenile male bufflehead	21/09/77	0.71	0.22
Wolf Lake	moose flesh	16/09/77	<0.02	<0.07
	moose liver	16/09/77	<0.02	<0.07
	common gull	19/09/77	0.05	0.17
	Lesser Scaup (breast)	17/09/77	0.06	0.20
Fox Creek (Mayo Road)	adult male bufflehead	20/09/77	0.39	0.11
Two Horse Creek	moose hindquarter	Sept/77	0.04	0.16
	moose hindquarter		0.04	0.15

APPENDIX II

FISH SPECIES LIST

APPENDIX II FISH SPECIES LIST

1. arctic grayling (Thymallus arcticus)
2. lake trout (Salvelinus namaycush)
3. northern pike (Esox lucius)
4. lake whitefish (Coregonus clupeaformus)
5. round whitefish (Prosopium cylindraceum)
6. burbot (Lota lota)
7. longnose sucker (Catastomus catastomus)
8. coho salmon (Oncorhynchus kisutch)
9. sockeye salmon (Oncorhynchus nerka)
10. chum salmon (Oncorhynchus keta)
11. chinook salmon (Oncorhynchus tshawytscha)
12. lake cisco (Coregonus artedii)

APPENDIX III

MERCURY IN WATER SAMPLES COLLECTED BY DINA AT VARIOUS LOCATIONS THROUGHOUT YUKON

APPENDIX III

MERCURY IN WATER SAMPLES COLLECTED BY DINA AT VARIOUS LOCATIONS THROUGHOUT YUKON

Area	Location	1975	1976	1977	Results µg Hg/ml
Bennet Lake	north side by gray ridge			June 20	< 0.05
	near Watson River			June 20	< 0.05
	by Tank Creek			June 20	< 0.05
	near Carcross			June 20	< 0.05
Arctic Gold and Silver Mines	drainage effluent	June 13			0.11
		Sept 5			< 0.05
Tank Creek	above Bennet Lake	June 9			< 0.05
		Sept 4			< 0.05
	at Bennet Lake	June 9			< 0.05
		Sept 4			< 0.05
Nares Lake	below bridge	June 20-21			< 0.05
	by Carcross school	June 20-21			< 0.05
	near outlet	June 20-21			< 0.05
Venus Mine	effluent streams in pond	Aug 22			0.38
			Aug 19		< 0.05
			Nov 18		< 0.05
				May 11	< 0.05
	seepages	June 22			0.23
		June 22			0.14
		June 22			< 0.05
		June 22			< 0.05
Tagish Lake	Windy Arm near Venus Mine	June 11			< 0.05
	Windy Arm east side	Sept 4			< 0.05
	Windy Arm center	June 11			< 0.05
		Sept 4			1.2

APPENDIX III MERCURY IN WATER SAMPLES COLLECTED BY DINA AT VARIOUS LOCATIONS THROUGHOUT YUKON (Continued)

Area	Location	1975	1976	1977	Results µg Hg/ml
Tagish Lake	at Dall Peak	June 11			< 0.05
		Sept 4			< 0.05
	at B.C. border	June 11			< 0.05
				June 21	< 0.05
	near Venus Mine	Sept 4			< 0.05
	Windy Arm at Bove Island			June 21	< 0.05
	Windy Arm near Thing Creek			June 21	< 0.05
		June 11			< 0.05
		Sept 4			< 0.05
	Windy Arm at Taku Arm			June 21	< 0.05
	by Jubilee Mountain			June 22	< 0.05
	near Tagish village			June 22	< 0.05
	at Six Mile River			June 22	< 0.05
	inflow from Six Mile River			June 22	< 0.05
	east side near lodge			June 22	< 0.05
	west side near lodge			June 23	< 0.05
	near Army beach			June 23	< 0.05
	near McClintock Bay			June 23	< 0.05
	at Yukon River			June 23	< 0.05
				June 23	< 0.05
Cyprus Anvil Area	tailings pond effluent		Mar 3		8.5
			July 20		0.11
			Sept 22		0.40
				Feb 22	< 0.05
				Apr 13	< 0.05
				Apr 14	< 0.05
				Apr 14	< 0.05
				Apr 14	< 0.05
				Apr 15	< 0.05

APPENDIX III MERCURY IN WATER SAMPLES COLLECTED BY DINA AT VARIOUS LOCATIONS THROUGHOUT YUKON (Continued)

Area	Location	1975	1976	1977	Results µg Hg/ml
Cyprus Anvil Area	tailings pond effluent			May 25	< 0.05
	effluent seepage from tailings pond	Aug 6			0.32
		Aug 26			0.70
			Mar 17		< 0.05
			July 20		< 0.05
			Sept 22		< 0.05
			Nov 30		< 0.05
				Feb 22	0.05
				Apr 14	< 0.05
				May 25	< 0.05
	Northfork Rose Creek		Sept 22		< 0.05
			Nov 30		< 0.05
				Feb 22	< 0.05
				May 25	< 0.05
	Rose Creek above reservoir		Sept 22		< 0.05
			Nov 30		< 0.05
				Feb 23	< 0.05
				May 26	< 0.05
	Rose Creek near pumphouse		Sept 22		< 0.05
			Nov 30		< 0.05
				Feb 22	< 0.05
				Apr 14	< 0.05
	Rose Creek below mine (S4)		Sept 22		< 0.05
				Feb 22	< 0.05
				Apr 14	< 0.05
				May 25	< 0.05
			Sept 22		< 0.05
			Nov 30		< 0.05
				Feb 22	0.05
				Apr 14	< 0.05

APPENDIX III MERCURY IN WATER SAMPLES COLLECTED BY DINA AT VARIOUS LOCATIONS THROUGHOUT YUKON (Continued)

Area	Location	1975	1976	1977	Results µg Hg/ml
Cyprus Anvil Area	tributary to Rose Creek below mine	Aug 6			< 0.05
		Aug 26			0.06
	Faro Creek	Aug 6			< 0.05
		Aug 26			< 0.05
			Sept 22		< 0.05
	Rose Creek beside tailings pond	Aug 6			0.60
			Sept 22		< 0.05
Whitehorse Area	Yukon River at Whitehorse Copper pumphouse			Apr 7	< 0.05
				May 19	< 0.05
				May 13	< 0.05
				June 6	< 0.05
				June 29	< 0.05
				Aug 5	< 0.05
				Sept 1	0.49
	Schwatka Lake at city intake			Apr 4	< 0.05
				May 6	< 0.05
				June 6	< 0.05
				June 29	< 0.05
				Aug 5	< 0.05
				Sept 1	0.11
	Schwatka Lake hydro canal			Apr 4	< 0.05
				May 5	< 0.05
				June 6	< 0.05
				June 29	< 0.05
				Aug 5	< 0.05
				Sept 1	< 0.05

APPENDIX III MERCURY IN WATER SAMPLES COLLECTED BY DINA AT VARIOUS LOCATIONS THROUGHOUT YUKON (Continued)

Area	Location	1975	1976	1977	Results µg Hg/ml
Whitehorse Area	City of Whitehorse well			Apr 4	< 0.05
	Whitehorse Copper effluents:				
	ground water	Oct 8			0.05
	decant		May 19		< 0.05
	stream		May 19		< 0.05
	crater lake outfall		May 19		< 0.05
Kerr-Addison	Blind Creek at bridge	Aug 6			< 0.05
		Aug 27			< 0.05
			Sept 22		< 0.05
				Feb 22	< 0.05
				May 26	< 0.05
	Town of Faro pumphouse #1		Sept 22		< 0.05
			Dec 1		< 0.05
				Feb 22	< 0.05
				Apr 15	< 0.05
				May 26	< 0.05
	Vangorda Creek at mouth	Aug 6			< 0.05
		Aug 27			< 0.05
			Sept 22		< 0.05
			Dec 1		< 0.05
				May 26	< 0.05
	Effluent from settling pond - Grum deposit		Mar 10		1.6
			Sept 22		<0.05
			Dec 1		0.31
				Feb 22	<0.05
				Apr 14	<0.05
				May 26	<0.05

APPENDIX III MERCURY IN WATER SAMPLES COLLECTED BY DINA AT VARIOUS LOCATIONS THROUGHOUT YUKON (Continued)

Area	Location	1975	1976	1977	Results µg Hg/ml
Kerr-Addison	Effluent from portal to settling pond		Sept 22		3.8
	Vangorda Cr. Eastfork and tributaries	Aug 6			0.05
		Aug 6			0.15
		Aug 6			0.30
		Aug 27			1.3
		Aug 27			< 0.05
			Mar 9		0.07
			Sept 22		< 0.05
			Sept 23		< 0.05
			Sept 23		< 0.05
			Dec 1		< 0.05
			Dec 1		< 0.05
				May 26	< 0.05
				May 26	< 0.05
				May 26	< 0.05
	Vangorda Cr. above road and campsite	Aug 6			< 0.05
		Aug 27			< 0.05
			Mar 10		14.0
			Sept 22		< 0.05
				Feb 22	< 0.05
				May 26	< 0.05
	Rose Creek at Anvil Road	Aug 6			< 0.05
		Aug 27			0.06
			Mar 7		< 0.05
			Sept 23		< 0.05
			Dec 1		< 0.05
				Feb 22	< 0.05
				May 26	< 0.05

APPENDIX III   MERCURY IN WATER SAMPLES COLLECTED BY DINA AT VARIOUS LOCATIONS THROUGHOUT YUKON (Continued)

Area	Location	1975	1976	1977	Results µg Hg/ml
Howard Pass Area	Don Creek		July 19		< 0.05
				Mar 22	< 0.05
				July 13	< 0.05
	Zinc Creek		July 19		< 0.05
				Mar 22	< 0.05
				July 13	< 0.05
	Cannex Creek		July 19		< 0.05
				Mar 22	< 0.05
				July 13	< 0.05
	Placer Creek		July 19		< 0.05
				Mar 22	< 0.05
				July 13	< 0.05
	Wise Creek		July 19		< 0.05
				Mar 22	< 0.05
				July 13	< 0.05
	Lead Creek		July 19		< 0.05
				Mar 22	< 0.05
				July 13	< 0.05
	Kowalchuck Creek			Mar 22	< 0.05
				July 13	< 0.05
	Pelly River above Don Creek		July 19		< 0.05
				Mar 22	< 0.05
				July 13	< 0.05
	South Nahanni River			Mar 22	< 0.05
				July 13	< 0.05
Faro Town Area	Pelly River 32 km below town			July 6	< 0.05
	Pelly River 11 km below town			July 6	< 0.05
	Pelly River 1.6 km below town			July 6	< 0.05
	Pelly River 0.8 km below town			July 6	< 0.05

APPENDIX III

MERCURY IN WATER SAMPLES COLLECTED BY DINA AT VARIOUS LOCATIONS THROUGHOUT YUKON (Continued)

Area	Location	1975	1976	1977	Results µg Hg/ml
Dempster Highway	creek at DINA camp Eagle River			June 22	< 0.05
	Eagle River at bridge			June 22	< 0.05
	Benson Creek			June 20	< 0.05
	Wolf Creek			June 20	< 0.05
	North Klondike River			June 20	< 0.05
	Blackstone River (6 stations)			June 21	< 0.05
	Engineer Creek			June 21	< 0.05
	Ogilvie River at bridge			June 21	< 0.05
	Fly Camp Creek (km 351.8)			June 22	< 0.05
	borrow pit drainage (km 353.9)			June 22	0.06
	stream (km 357.9)			June 22	< 0.05
	borrow pit drainage (km 374.08)			June 22	< 0.05
	stream 1.6 km north Eagle River bridge			June 22	< 0.05
	stream 3.2 km north Eagle River bridge			June 22	< 0.05
MacMillan Pass	Dale Creek at bridge	Aug 7			< 0.05
			July 12		< 0.05
			July 12		< 0.05
	Cirque Creek	Aug 7			< 0.05
			July 12		< 0.05
			July 12		< 0.05
	Tishu River at bridge	Aug 7			< 0.05
			June 9		< 0.05
			June 9		< 0.05
			July 12		< 0.05
	Hess River	Aug 7			< 0.05
	Sekie River left fork above mine	Aug 14			< 0.05
	Sekie River at road	Aug 14			< 0.05
	Sekie River right fork above mine	Aug 14			< 0.05
Mt. Nansen	tailings pond effluent	Oct 20			0.10

APPENDIX III MERCURY IN WATER SAMPLES COLLECTED BY DINA AT VARIOUS LOCATIONS THROUGHOUT YUKON (Continued)

Area	Location	1975	1976	1977	Results µg Hg/ml
Mt. Nansen	tailings pond effluent	Aug 11			< 0.05
		Aug 11			< 0.05
		June 23			0.40
		June 23			0.05
			June 9		< 0.05
			June 9		< 0.05
	effluent - Adit	Apr 21			0.31
	Nansen Creek road crossing #2	Sept 3			< 0.05
	Nansen Creek road crossing #1	Sept 3			< 0.05
	Nansen Creek above tailings pond	Sept 3			< 0.05
	Nansen above Victoria Creek	Aug 11			< 0.05
	Nansen Creek fresh water pond	Aug 11			< 0.05
	Nansen Creek above mill	June 23			< 0.05
	Nansen Creek below tailings pond	June 23			< 0.05
	Nansen Creek above Victoria Creek		June 9		< 0.05
United Keno Hill	Galkeno Creek		Sept 29		< 0.05
	effluent Galkeno 900	July 11			< 0.05
		July 16			< 0.05
			Sept 28		< 0.05
			Nov 24		< 0.05
				Jan 11	< 0.05
				June 7	< 0.05
	effluent UN Adit	July 12			< 0.05
		July 15			0.07
	effluent Sadie Ladue Adit		Sept 28		< 0.05
			Nov 24		< 0.05
				June 7	< 0.05
				Jan 11	< 0.05
	effluent Keno 700	July 11			< 0.05

APPENDIX III MERCURY IN WATER SAMPLES COLLECTED BY DINA AT VARIOUS LOCATIONS THROUGHOUT YUKON (Continued)

Area	Location	1975	1976	1977	Results µg Hg/ml
United Keno Hill	effluent Keno 700	July 15			< 0.05
			Nov 24		0.40
				Jan 25	0.07
	south McQuesten R. below Flat Creek			Apr 19	< 0.05
				June 8	< 0.05
	south McQuesten R. above Flat Creek			June 8	< 0.05
	south McQuesten R. freshwater pumphouse			June 7	< 0.05
				Mar 17	< 0.05
	Flat Creek above south McQuesten R.			June 8	< 0.05
	effluent from settling pond	July 15			2.5 (9:30 hrs)
		July 15			0.12 (10:30 hrs)
		July 15			0.38 (12:45 hrs)
		July 15			1.3 (15:00 hrs)
		July 15			0.20 (17:00 hrs)
		Aug 12			0.40
			Sept 29		< 0.05
			Nov 24		< 0.05
				Apr 20	0.11
				June 7	< 0.05
				Mar 17	< 0.05
	effluent settling pond seepage	July 12			0.13
	Sandy Creek below calumet			June 7	< 0.05
	Star Creek at road crossing	July 16			< 0.05
			Sept 29		< 0.05
	Star Creek	July 11			< 0.05

APPENDIX III MERCURY IN WATER SAMPLES COLLECTED BY DINA AT VARIOUS LOCATIONS THROUGHOUT YUKON (Continued)

Area	Location	1975	1976	1977	Results µg Hg/ml
United Keno Hill	creek below No Cash Adit 500	July 11			< 0.05
		July 16			12.0
			Sept 29		< 0.05
				June 7	< 0.05
	effluent No Cash Adit 100	July 12			< 0.05
		July 15			0.70
			Sept 29		< 0.05
	No cash 100 cooling water	July 12			< 0.05
		July 16			0.06
	Flat Creek at Elsa Road		Sept 29		< 0.05
	Lightning Creek above Charity gulch	July 16			0.05
	Lightning Creek at Keno City	July 16			< 0.05
	Faro gulch lower	July 17			1.2
	Faro gulch at road crossing	July 16			< 0.05
	lower Gambler gulch	July 17			1.1
	Gambler gulch at road crossing	July 16			< 0.05
	Chrystal Creek at Keno City road	July 16			0.63
	Chrystal Creek at McQuesten road crossing	July 16			0.78
	outfall Hanson Lake	July 17			< 0.05
	south McQuesten above Hanson Lake	July 17			0.28
	Ladue River above Faith Creek	July 17			2.2
	Faith Creek above Keno Ladue River	July 17			< 0.05
	Duncan Creek above Parent Creek	July 17			< 0.05
Clinton Creek	Easter Creek at dam			May 26	< 0.05
	Clinton Creek at Hudgeion Lake			May 26	< 0.05
	Wolverine Creek above tailings pond			May 26	< 0.05
	Wolverine Creek below tailings pond			May 26	< 0.05
	Forty Mile River at power plant			May 26	< 0.05
	Forty Mile River at bridge			May 26	< 0.05

APPENDIX III MERCURY IN WATER SAMPLES COLLECTED BY DINA AT VARIOUS LOCATIONS THROUGHOUT YUKON (Continued)

Area	Location	1975	1976	1977	Results µg Hg/ml
Miscellaneous	Pine Creek at farm (Haines Jct)			Aug 3	< 0.05
	Stewart River below Mayo 8 km			July 26	< 0.05
	Stewart River below Mayo 3.2 km			July 26	< 0.05
	Stewart River above Mayo 40 km			July 26	< 0.05
	Stewart River above Stewart crossing 4.8 km			July 26	< 0.05
	Stewart River below Stewart Cr. 4.8 km			July 26	< 0.05
	Pelly River below Pelly Creek			July 26	< 0.05
	Kluane Lake at Slims River			Aug 2	< 0.05
	Kluane Lake near Kluane River			Aug 2	< 0.05
	Kluane Lake east bank Burwash Landing			Aug 2	< 0.05
	Kluane Lake west bank Burwash Landing			Aug 2	< 0.05
	Kluane Lake east bank Destruction Bay			Aug 2	< 0.05
	Kluane Lake west bank Destruction Bay			Aug 2	< 0.05
	Livingston Creek		July 8		< 0.05
	Parks Canada Well-Haines Jct			Apr 19	< 0.05
	Tom Creek near Watson Lake			May 18	< 0.05
	tributary Becker Creek Wheaton R. Valley			July 7	< 0.05
	Porter Creek drinking water			Apr 12	< 0.05
	Mayo town water			Jan 15	< 0.05
	Mayo town water			Mar 17	< 0.05
	Mayo town water			Apr 20	< 0.05
	War Eagle dump			Feb 5	< 0.05
	Sekie River on south MacMillan River		Oct 7		< 0.05
			Oct 7		< 0.05
			Oct 7		< 0.05
			Oct 7		0.09
				July 14	< 0.05
	Quill Creek-Hudson Bay Mine Adit		Sept 1		< 0.05

APPENDIX III MERCURY IN WATER SAMPLES COLLECTED BY DINA AT VARIOUS LOCATIONS THROUGHOUT YUKON (Continued)

Area	Location	1975	1976	1977	Results µg Hg/ml
Miscellaneous (contd.)	Sixty Mile River above Millar Creek			Aug	< 0.05
	Millar Creek			Aug	< 0.05
	Big Gold and Glacier Creek			Aug	< 0.05
	Little Gold Creek			Aug	< 0.05
	influent to Crestview sewage lagoon			Aug 16	0.14
Minto Area	stations on small streams			June 1	< 0.05
				June 1	< 0.05
				June 1	< 0.05
				June 1	< 0.05
				June 1	< 0.05
	Yukon River above Copper Creek			June 1	< 0.05
	Watson Lake sewage lagoon 1st cell			Aug 17	< 0.05
	Watson Lake sewage lagoon 2nd cell			Aug 17	< 0.05