Mercury Levels in Labrador Fish, 1977-78

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MERCURY LEVELS IN LABRADOR FISH, 1977-78

by

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ABSTRACT

Bruce, W. J., and K. D. Spencer. 1979. Mercury levels in Labrador fish, 1977-78. Can. Ind. Rep. Fish. Aquat. Sci. 111: iv + 12 p.

Approximately 6000 tissue samples representing fourteen fish species from Labrador were analyzed for mercury content. Mean mercury values were highest in the two fish-eating species, lake trout and northern pike, where mean mercury values exceeded 0.5 ppm. Mean mercury values for whitefish and suckers were generally less than 0.5 ppm as was also the case for brook trout. Resident or landlocked populations of Arctic char and Atlantic salmon displayed higher mean mercury values than their oceanic counterparts. Anadromous rainbow smelt showed mean mercury values slightly greater than 0.2 ppm.

Key words: mercury, Labrador, fishery, flooding, bioaccumulate

RÉSUMÉ

Bruce, W. J., and K. D. Spencer. 1979. Mercury levels in Labrador fish, 1977-78. Can. Ind. Rep. Fish. Aquat. Sci. 111: iv + 12 p.

On a mesuré la teneur en mercure d'environ 6 000 échantillons de tissus représentant 14 espèces de poissons du Labrador. La teneur moyenne la plus élevée se trouvait chez les deux espèces piscivores, le touladi et le grand brochet, chez qui la teneur moyenne dépassait 0,5 ppm. La teneur moyenne en mercure était généralement inférieure à 0,5 ppm chez le corégone et les meuniers et catostomes ainsi que chez l'omble de fontaine. Les populations résidentes ou landlockées d'omble chevalier et de saumon de l'Atlantique présentaient des teneurs moyennes en mercure plus élevées que les spécimens océaniques des mêmes espèces. L'éperlan arc-en-ciel anadrome présentait une teneur moyenne en mercure légèrement supérieure à 0,2 ppm.

INTRODUCTION

During the past 20 years there has been documentation of mercury contamination of fish in Japan, Sweden, United States and Canada. Although most of these cases have been attributed to point-source emission of mercury, abnormally high mercury levels have been reported in remote areas from any type of industrial development.

A world-wide interest in mercury contamination has been maintained because of the toxicity of this element to humans, particularly the methlymercury form which accounts for 80-100% of the mercury found in fish. Methylmercury attacks the central nervous system and the symptoms of mercury poisoning in man may include loss of vision, hearing, coordination and intellectual ability. The damage is usually irreversible and there is no known treatment other than prevention.

Mercury levels in fish are generally measured in parts per million (ppm) wet weight. One-half (0.5) ppm is equivalent to 1/2 pound of mercury in 1 million pounds of fish flesh. The maximum mercury level allowable in fish intended for human consumption in Canada, established by National Health and Welfare, is 0.5 ppm. The United States has recently changed its tolerance level from 0.5 to 1.0 ppm, making it similar to Japan and Sweden. For fish containing 0.5 ppm, the "acceptable daily in take" (ADI) for methylmercury for a 70 kg man would be reached by eating 420 g of this fish per week.

This present study was undertaken to delineate mercury levels in Labrador's freshwater and anadromous fishes after a preliminary survey in 1976 showed 'above background' levels for several species in two areas of the Smallwood Reservoir. The primary objective was to examine mercury content in fish from those areas of Labrador currently being heavily fished for food. This would include the Labrador coast where the Inuit and other native people fish salmon and char, the North West River area and the Smallwood Reservoir. At present there is no fishery on Smallwood Reservoir but there are plans to establish a commercial whitefish fishery. For this reason a major emphasis was placed on fish of Smallwood Reservoir, particularly lake whitefish. The study also included popular recreational fishing areas for residents of major population centres such as Churchill Falls, Wabush-Labrador City and Happy Valley-Goose Bay. Selected river systems supporting commercial fly-in sport fishing camps were also sampled.

Other objectives of the study were to define those areas in Labrador which produce fish with high mercury content, to define their geographic boundaries, and to determine the cause of high mercury content in the fish.

This is also the first baseline study of mercury levels of Labrador fishes.

REVIEW

Mercury is ubiquitious in the environment and can exist in a variety of physical and chemical states. In its metallic form mercury is a liquid at room temperature. It is the only naturally occurring metal that can exist in the atmosphere in a gaseous form. Mercury occurs principally as the sulphide "cinnabar" which is mined and roasted to yield metallic mercury.

Mercury is released naturally into the atmosphere through the degassing of the earth's crust and soil, through volcanic activity, directly from the land surface by weathering of rocks, and by evaporation from water. It is re-deposited in soil and water through precipitation and fallout of dust particles. Widespread distribution of mercury over the surface of the earth is due more to natural processes than to human activity.

However, local high concentrations of mercury are generally the result of human activity and arise from a number of sources: agricultural uses, use of metallic mercury in laboratories and homes, mercury mining, fossil fuel burning, pulp and paper mills, chlor-alkali plants, manufacture of paints, solid waste incineration and sewage disposal.

Mercury concentrations less than 0.2 ppm in freshwater fish have been widely accepted as representative of natural mercury levels in fish of unpolluted environments (Holden, 1972). However, fish mercury levels greater than 0.5 ppm under natural conditions have been reported (Holden 1972; Kleinert and Degurse 1972). Mercury accumulation in the absence of polluted conditions is considered to reflect the presence of low levels of mercury in the environment due to natural and man-caused weathering processes.

The forms of mercury vary in their relative toxicity to man. The alkyl (methyl and ethyl) compounds are believed to be the most toxic, followed by metal mercury vapor, (which is more toxic then inorganic salts), and organic forms other than alkyl compounds.

Many forms of mercury are introduced into the aquatic environment. As mercury has a strong affinity with organic compounds, a large portion of the incoming mercury will eventually be adsorbed by organic particles and settle to the bottom. It would appear, that regardless of the form in which mercury is introduced into the aquatic environment, it eventually can be converted to methylmercury by the interaction of microbial action and chemical reaction in the sediment.

Fish can then take up methylmercury indirectly from its food and directly from the water via the gills and the skin. The rate of uptake varies between fish species and can be influenced by such factors as temperature and metabolic rate. Methylmercury accumulates in aquatic organisms according to trophic level, the highest concentrations being found in large and older carnivorous fish such as lake trout and northern pike. Studies have shown that generally mercury levels are positively correlated with the length, weight and age of fish.

STUDY AREA

Labrador forms the northeastern corner of Continential North America and is that eastern portion of the Labrador-Ungava Peninsula, which drains towards the Atlantic Ocean. The land area of Labrador is approximately 293,000 km^2.

The Labrador plateau is the eastern extremity of the Canadian Shield and is comprised primarily, of granite bedrock dating back to the early pre-Cambrian era. However, in several locations, and particularly within the Labrador trough, folded sediments occur which contain considerable quantities of iron as well as some limestone. These younger sedimentaries are also found in northeastern Labrador where they comprise the slates and quartzites of the Torngat Mountains.

Forest growth occurs mainly in the southern and central portion of Labrador. The softwoods, black spruce and balsam fir are dominant, with some white spruce scattered throughout the forest region. Hardwood stands of white birch and trembling aspen occur in areas of good forest growth (Wilton 1965). Submarginal forest of scattered stunted trees and shrub is found throughout western Labrador and coastal tundra parallels the entire coastline. Arctic tundra appears on the Mealy Mountain Range; is found inland from Hopedale to Nain; and covers the entire area north of Okak.

Labrador has a vast number of rivers and lakes where waters are generally quite soft (total alkalinity and total hardness less than 10 ppm) and slightly acidic (mean pH of 6.4) (Jamieson, 1979).

In this study fish were sampled from 88 sites throughout Labrador (Table 1, Fig. 1). These sites were generally sampled using gangs of gillnets of varying mesh sizes, together with fyke nets and angling gear. The fish samples were frozen in the field and later sent back to the Inspection Lab at St. John's for mercury analysis and results of these analyses are presented below.

ARCTIC CHAR

Mean mercury content of 377 anadromous Arctic char from 19 sites along the Labrador coast was 0.04 ppm with mean values for stations ranging between 0.01 ppm (Nachvak Lake) and 0.13 ppm (St. Paul's River). The maximum value of 1.75 ppm was recorded from Shapio Lake.

Mean mercury level of 107 landlocked char from 7 inland lakes was 0.35 ppm with mean station values ranging from 0.11 ppm (Komaktorvik Lake) to 0.50 ppm (Mistinippi Lake) where 46.2% exceeded 0.5 ppm.

ATLANTIC SALMON

Fifty-eight Atlantic salmon sampled from three areas along the Labrador coast had a mean mercury value of 0.08 ppm with the maximum value of 0.14 ppm being reported from Pack's Harbour. The two other areas sampled were Makkovik Bay and Hopedale (Ugjoktok Bay).

BROOK TROUT

Mean mercury content of 504 brook trout from 41 sites in Labrador was 0.23 ppm with mean mercury values at stations ranging from 0.02 ppm (Dominion Lake) to 0.76 ppm (Whitefish Lake, Churchill River). Whitefish Lake also recorded the maximum value (1.54 ppm). The mean mercury value of 69 brook trout from seven areas of Smallwood Reservoir was 0.41 ppm with 17.4% exceeding 0.5 ppm.

Areas where mercury in brook trout exceeded 0.5 ppm on average were Birch Lake, Lobstick Structure, Jacopie Lake, Whitefish Lake and the Tailrace area. Birch Lake is in the Smallwood Reservior and the other areas drain the Smallwood Reservoir.

BURBOT

Sixty-five burbot from 20 stations had a mean mercury value of 0.67 ppm with mean values for stations ranging from 0.15 ppm (Mile 24, Orma Road) to 1.36

(Winokapau Lake, Churchill River). The maximum value, 1.93 ppm, was recorded at Lobstick Structure. Thirty fish from seven areas of Smallwood Reservoir showed a mean mercury value of 0.60 ppm with 60% exceeding 0.5 ppm.

Two stations outside Smallwood Reservoir, Mud Lake and Grand Lake, had mean mercury values exceeding 0.5 ppm.

LAKE TROUT

Mean mercury content of 682 lake trout from 41 areas of Labrador was 1.01 ppm, with mean station values ranging from 0.21 ppm (Anaktalik Lake) to 2.40 ppm (Churchill Falls, Tailrace). The maximum value recorded was 3.93 ppm at Gabbro Control Structure, Smallwood Reservoir. The mean mercury value of 318 lake trout from 12 areas of Smallwood Reservoir was 1.10 ppm with 84.6% exceeding 0.5 ppm.

A number of natural lakes throughout Labrador had mean mercury values exceeding 0.5 ppm, but in most cases the mean values were less than mean values for areas of the Smallwood Reservoir.

LAKE WHITEFISH

A total of 2052 lake whitefish from 49 stations had a mean mercury value of 0.33 ppm with mean station values ranging from 0.02 ppm (Lac Gaffaret) to 1.10 ppm (Winokapau Lake, Churchill River). The highest mercury value recorded was 2.40 ppm from Winokapau Lake. The mean mercury content for 766 fish from 13 stations on Smallwood Reservoir was 0.34 ppm with 6.0% exceeding the 0.5 ppm tolerance level. The mean values for lake whitefish from waters outside any influence of the Smallwood Reservoir were generally less than 0.20 ppm. The only areas where the mean mercury content exceeded 0.5 ppm were Lobstick Control Structure (0.53 ppm), Churchill Falls, Tailrace (0.96 ppm) and Winokapau Lake (1.10 ppm).

LANDLOCKED SALMON (OUANANICHE)

Mean mercury content of 71 ouananiche from 16 stations was 0.35 ppm with mean station values ranging from 0.05 ppm (Mistinippi Lake) to 1.78 ppm (Winokapau Lake, Churchill River). The maximum value of 2.30 ppm was recorded from Winokapau Lake. Seven ouananiche from three stations on Smallwood Reservoir had a mean value of 0.79 ppm. None of the lakes outside the Smallwood Reservoir showed a mean mercury value exceeding 0.5 ppm.

LONGNOSE SUCKER

Mean mercury content value for 826 longnose suckers from 45 stations was 0.35 ppm with mean station values ranging from 0.03 ppm (Wilson Lake) to 1.06 ppm (Churchill Falls, Tailrace). The maximum value of 2.93 ppm was recorded from the Tailrace area. Mean mercury content of 153 suckers from nine areas of the Smallwood Reservoir was 0.38 ppm with 14.4% exceeding 0.5 ppm. Like lake whitefish, (which have similar food habits) mean mercury levels of suckers in waters outside the Smallwood Reservoir influence were generally less than 0.20 ppm. Whitefish Lake was the only other station showing a mean mercury value greater than 0.5 ppm.

NORTHERN PIKE

Mean mercury value of 735 northern pike was 0.87 ppm with mean station values ranging from 0.11 ppm (No Name Lake) to 1.61 ppm (Churchill Falls, Tailrace). The maximum value (3.08 ppm) was reported from a 90.7 cm fish taken in Gull Lake, Churchill River. The mean mercury level of 207 pike from 10 stations on Smallwood Reservoir was 0.91 ppm with 91.5% of these fish exceeding 0.5 ppm. A number of lakes outside the Smallwood Reservoir showed mean mercury values greater than 0.5 ppm but mean values were less than that of either fish from the reservoir itself or lakes which drain the Smallwood Reservoir.

RAINBOW SMELT

Thirty-three American smelt taken from Melburn Bay and Otter Creek (Lake Melville), had mean mercury values of 0.25 and 0.24 ppm, respectively. The maximum value, 0.41 ppm, was recorded at Melburn Bay.

ROCK COD

Twenty-two rock cod from Makkovik Bay and Hopedale had mean mercury values of 0.08 and 0.13 ppm, respectively. The maximum value, 0.20 ppm, was recorded from Hopedale.

ROUND WHITEFISH

Seventy-seven round whitefish from 11 different sites had a mean mercury value of 0.14 ppm with mean values for stations ranging between 0.03 ppm (Mile 33, Esker Road) and 1.00 ppm (Churchill Falls, Tailrace). The Tailrace also recorded the maximum value (1.68 ppm). This station, together with Gull Lake on the Churchill River, were the only areas where mean mercury values exceeded 0.5 ppm.

TOM COD

Eight tom cod from North West River had a mean mercury level of 0.31 ppm and a maximum value of 0.86 ppm. One fish (or 12.5%) exceeded 0.5 ppm.

WHITE SUCKER

Mean mercury value for 420 white suckers from 36 sampling sites was 0.16 ppm with mean values for stations ranging between 0.01 ppm (Dominion Lake) and 0.48 ppm (Gull Lake, Churchill River). The maximum value of 0.90 ppm was recorded from Winokapau Lake, Churchill River. Fifty-four fish from six areas of Smallwood Reservoir had a mean mercury value of 0.35 ppm with 5.5% exceeding 0.5 ppm.

DISCUSSION

Results from this study indicate mercury levels in some fish species in certain parts of Labrador exceed normal background levels. The area showing highest mean mercury levels in nearly all fish species is the Smallwood Reservoir and associated waters. This hydroelectric reservoir has an area of 6650 km^2

(including Ossokmanuan Reservoir) and was initially flooded in 1971. It is drained by the Churchill River which flows eastward to the Atlantic Ocean.

There is no known point source for mercury in Labrador. Mining activities (iron ore) occur in the Labrador City-Wabush area but mercury levels in fish in nearby waters receiving tailings are not abnormally high. These iron ore bodies lie in the rich mineral belt known as the Labrador Trough. This trough which is composed of sedimentary and volcanic rocks underlies the western portion of the Smallwood Reservoir and the remainder of the reservoir is in the Churchill Province which consists of high grade metamorphic rock. Evidence from other areas of the Canadian Shield indicate these rock types contain natural mercury. Coupled with this is the oligotropic condition of most Labrador Lakes (total alkalinity as $CaCO_3$ less than 30 ppm and pH less than 7) which make conditions very favourable for inorganic mercury to become soluble in water.

Another possible source of mercury in the environment is through long range atmospheric transport and fallout, but this doesn't appear to be occurring to any great extent in Labrador although it still maybe making a minor contribution.

It appears mercury occurs naturally in the rocks and soils of Labrador and the recent flooding of the Smallwood Reservoir has leached mercury from the ground at a faster rate then natural historical weathering processes. This seems further substiantiated in that lakes downstream contain fish with mercury levels similar to Reservoir fish and higher than natural (unflooded) lakes nearby. There are few exceptions where fish in natural lakes have elevated mercury levels but this may be explained by isolated occurrences of geological formations containing mercury.

One place where mercury seems to settle as it moves downstream through the system is Winokapau Lake on the lower Churchill River. This large, deep lake (over 130 m) acts as a sink for particulate matter which has mercury bound to it. Once the mercury reaches the sediments here it becomes methylated by bacterial and chemical action and re-enters the water column as methylmercury which is transported across the fish's gills and ingested with its food (Fig. 2). Two other areas where mercury values are highest are Lobstick Structure area and the Tailrace area. Both places are sites of tremendous water flow (volume and velocity). It would appear biological activity at these sites could be very high and this possibly would account for mercury entering the aquatic environment at a faster than normal rate.

The species most contaminated by mercury are lake trout, northern pike, burbot and ouananiche. These species are predominantly fish eaters and mercury bioaccumulates through the food chain. Mean mercury values for these species from both the Reservoir and surrounding waters were greater than 0.5 pmm, the regulated level established by Health and Welfare Canada. The lake trout is the longest lived species (up to 40 years) and as a consequence contain the highest mercury levels.

The mean mercury value for lake whitefish (0.34 ppm) from the Smallwood Reservoir was less than the regulated level for Canadian commercially caught fish and therefore shouldn't pose a health threat to any proposed whitefish fishery on the Reservoir. Mercury values for lake whitefish were considerably less than that of the other four species mentioned above because of its position in the food chain. Whitefish are invertebrate feeders and at the lower end of the aquatic food chain and therefore accumulate less mercury.

The two species of suckers found in the reservoir have similar feeding habits and their mean mercury values were very similar to lake whitefish. Brook trout, principally an invertebrate feeder but sometimes feeding on forage fish (minnows and small whitefish), had a mean mercury value higher than either whitefish or suckers but still below the 0.5 ppm regulated level.

Two important commercial species along the Labrador coast, Atlantic salmon and Arctic char, had mean mercury values which are considered normal background levels (i.e. <0.2 ppm). As pointed out earlier this is due to the marine feeding habits of these two species. Most of their feeding is done in the marine environment where mercury is less concentrated.

Two of the other three marine species sampled, American smelt and tom cod, had higher mean mercury values than salmon or char, but they were still well below the 0.5 ppm safety level.

SUMMARY

1. The source of mercury in Labrador appears to be natural, i.e. the underlying geological deposits but there is no one local source.

2. Highest mercury values were found in fish from the Smallwood Reservoir and waters of the Churchill River downstream of the Lobstick Control Structure.

3. It appears flooding of the Smallwood Reservoir has accelerated the normal leaching rate of mercury into the aquatic environment.

4. Areas of very high water flow, and turbulence (i.e. Lobstick Structure and the Tailrace area), have fish with some of the highest mercury values.

5. Species with highest mercury concentrations are invariably the fish eaters (i.e. lake trout, northern pike, burbot and ouananiche). These species have mean mercury values exceeding 0.5 ppm.

6. Invertebrate feeding fish (i.e. lake whitefish, suckers and brook trout), have mean mercury values less than 0.5 ppm.

7. Anadromous salmonid fish, Atlantic salmon and Arctic char, have mean mercury values <0.2 ppm.

8. Sea-run smelt have mercury values slightly greater than 0.2 ppm.

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Table 1. Number, name and location of 88 fish sampling stations, Labrador, 1977-78.

Station number	Station name	Position	Station number	Station name	Position
1	Lobstick Structure	53°52'N, 65°01'W	45	Ann Marie Lake	52°43'N, 60°44'W
2	Sandgirt Lake	53°55'N, 65°03'W	46	Eagle River	52°50'N, 58°44'W
3	Lobstick Lake	53°56'N, 64°59'W	47	No Name Lake	52°36'N, 60°50'W
4	Michikamau Lake (Hook Bay)	53°56'N, 64°07'W	48	Gull Lake (Churchill River)	52°58'N, 61°21'W
5	Michikamau Lake	54°04'N, 63°47'W	49	Muskrat Falls	53°15'N, 60°46'W
6	Michikamau Lake	54°07'N, 64°01'W	50	Churchill River	53°17'N, 60°18'W
7	Michikamats Lake	54°24'N, 64°26'W	51	Churchill River (Sandy Point)	53°26'N, 60°02'W
8	Orma Lake	54°07'N, 63°07'W	52	Mud Lake	53°18'N, 60°08'W
9	Sail Lake	54°23'N, 63°18'W	53	St. Paul's River	52°18'N, 58°19'W
10	Birch Lake	54°14'N, 65°54'W	54	Sand Hill River	53°36'N, 56°29'W
11	Gabbro Structure	53°45'N, 65°22'W	55	Packs Harbour	53°51'N, 57°00'W
12	Gabbro Lake	53°46'N, 65°25'W	56	Goose River	53°22'N, 60°21'W
13	Ossokmanuan Lake	53°27'N, 64°50'W	57	Melburn Bay	53°25'N, 60°15'W
14	Ossokmanuan Structure	53°27'N, 64°46'W	58	Gosling Lake	53°25'N, 60°23'W
15	Jacopie Lake	53°40'N, 64°24'W	59	Northwest River	53°31'N, 60°08'W
16	Whitefish Lake	53°38'N, 64°13'W	60	Grand Lake	53°37'N, 60°25'W
17	Mile 9 (Esker Road)	53°49'N, 66°21'W	61	Seal Lake	54°19'N, 61°46'W
18	Tamarack River	53°48'N, 66°18'W	62	Nipishish Lake	54°10'N, 60°46'W
19	Mile 40 (Esker Road)	53°47'N, 65°46'W	63	Double Mer Lake	54°02'N, 59°35'W
20	Mile 33 (Esker Road)	53°47'N, 65°57'W	64	White Bear Lake	54°32'N, 59°31'W
21	Sims River	53°48'N, 65°34'W	65	Makkovik Bay	55°10'N, 59°00'W
22	10 Mile Lake	53°44'N, 65°07'W	66	Snegamook Lake	54°32'N, 61°27'W
23	Mile 81 Lake	53°40'N, 64°41'W	67	Mistinippi Lake	54°47'N, 61°19'W
24	Valley River	53°35'N, 64°30'W	68	Shapio Lake	54°58'N, 61°17'W
25	Blueberry Lake Stream	53°32'N, 64°01'W	69	Hopedale (Ugjoktok Bay)	55°28'N, 60°12'W
26	Mile 24 (Orma Road)	53°44'N, 63°31'W	70	Mistastin Lake	55°54'N, 63°16'W
27	Mile 45 (Orma Road)	53°48'N, 63°22'W	71	Cabot Lake	56°09'N, 62°38'W
28	Atikonak Lake	52°52'N, 64°39'W	72	Voisey Bay	56°15'N, 61°54'W
29	Menihek Lake	54°26'N, 66°42'W	73	Anaktalik Lake	56°30'N, 62°50'W
30	Menihek Lake	54°06'N, 66°31'W	74	Fraser River	56°43'N, 63°35'W
31	Menihek Lake	53°54'N, 66°30'W	75	Tasialuk Lake	56°45'N, 62°45'W
32	Menihek Lake (Marie Rapids)	53°39'N, 66°26'W	76	Tikkoatokak Bay	56°42'N, 62°13'W
33	Shabogamo Lake	53°15'N, 67°30'W	77	Esker Lake	57°09'N, 62°55'W
34	Julienne Lake	53°13'N, 66°45'W	78	Umiakovik Lake	57°24'N, 62°50'W
35	Wabush Lake	53°00'N, 66°52'W	79	Okak Bay	57°29'N, 62°03'W
36	Long Lake	52°52'N, 66°58'W	80	Shallow Lake	57°39'N, 63°16'W
37	Wahnahnish Lake	52°49'N, 66°51'W	81	Napaktok Bay	57°58'N, 62°35'W
38	Tailrace (Churchill River)	53°31'N, 64°01'W	82	Hebron Fiord	58°08'N, 63°00'W
39	Winokapau Lake (Churchill River)	53°09'N, 62°28'W	83	Ikarut Lake	58°08'N, 63°38'W
40	Wilson Lake	53°21'N, 62°50'W	84	Saglek Lake	58°49'N, 63°21'W
41	Dominion Lake	52°38'N, 61°41'W	85	Ramah Bay	58°52'N, 63°12'W
42	Lac Gaffaret	52°13'N, 61°54'W	86	Nachvak Lake	59°00'N, 64°08'W
43	Lac Fourmont	52°01'N, 60°16'W	87	Komaktorvik Lake	59°09'N, 64°14'W
44	Minipi Lake	52°29'N, 60°51'W	88	Ikkudliayuk Fiord	60°12'N, 64°31'W

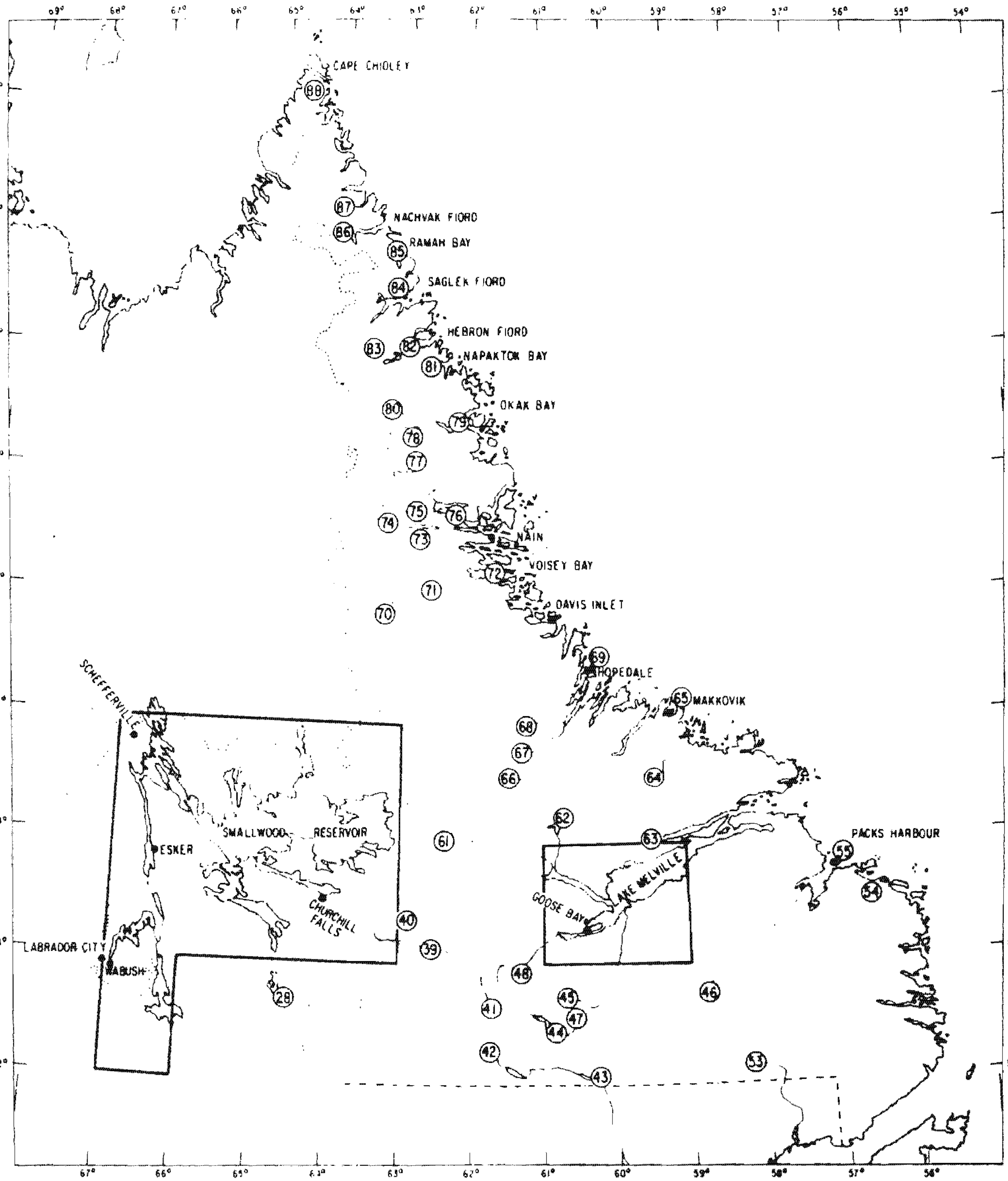

Fig. 1. Mercury sampling stations in Labrador, 1977-78.

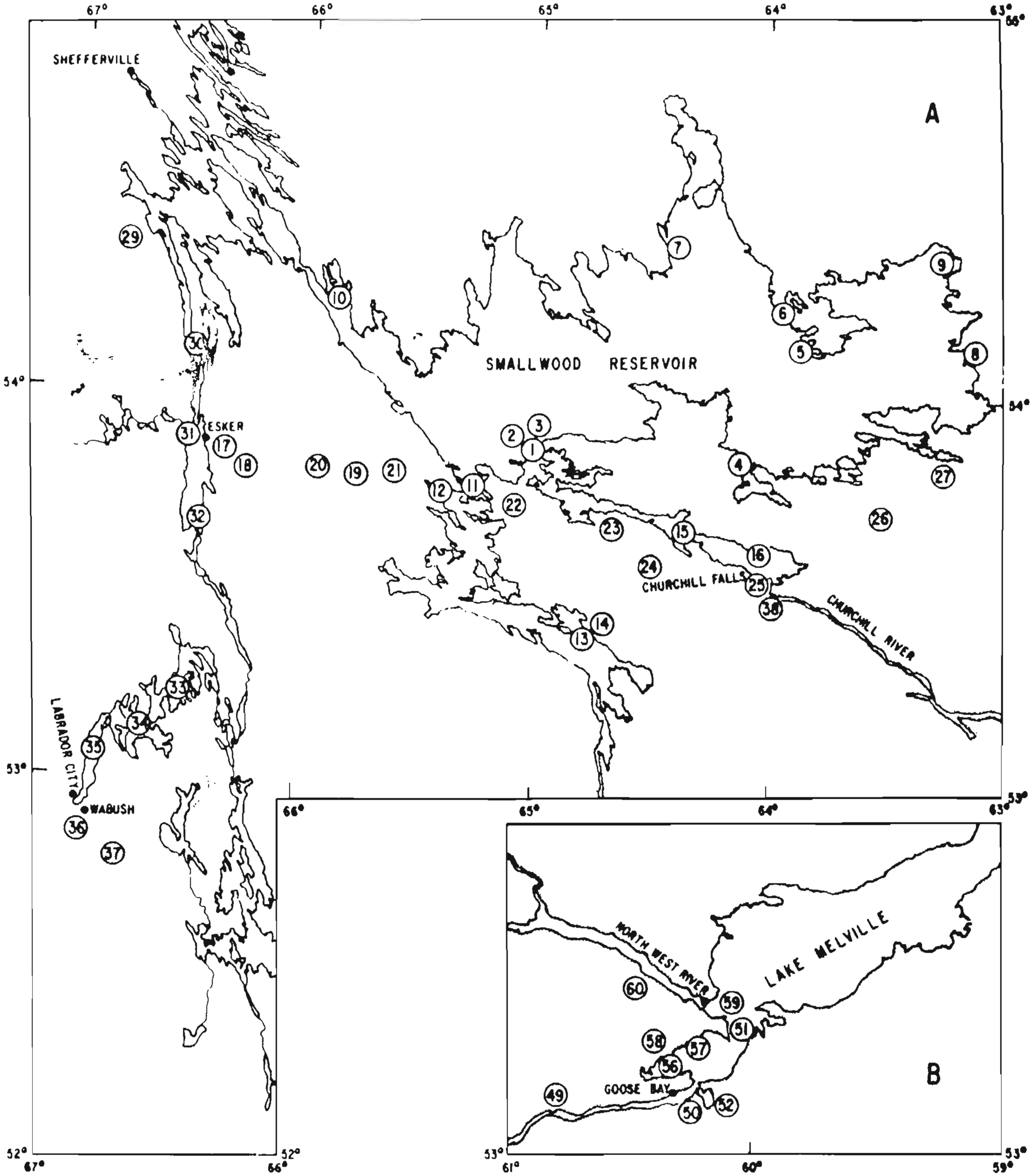

Fig. 1. Mercury sampling stations in Smallwood Reservoir and Happy Valley-Goose Bay areas, Labrador, 1977-78.

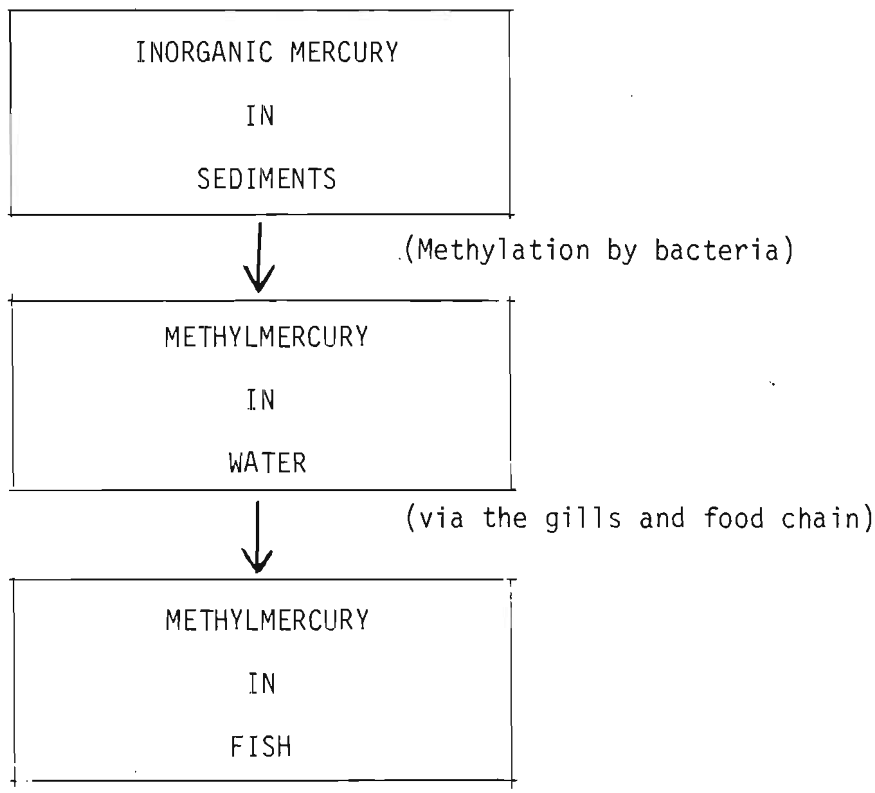

Fig. 2. Interconversion of mercury in nature.