PROJECT REPORT

NECHAKO FISHERIES CONSERVATION PROGRAM

WINTER CONDITIONS ON THE NECHAKO RIVER, 1992-1993

NECHAKO FISHERIES CONSERVATION PROGRAM
Data Report No. M92-4

A Joint Program of the Government of Canada,
Alcan and the Province of British Columbia

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Prepared by:
G. Faulkner, Department of Fisheries and Oceans
B. Ennevor, Department of Fisheries and Oceans
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ABSTRACT

Nechako River hydrologic data for the winter of 1992-93 were collected using thermographs, dataloggers, local ice observers and overview flights of ice conditions.

Using air temperature as an index of severity of winter, 1992-93 was the 27th mildest winter in 55 years of record. This breaks the recent pattern of a series of milder winters over the last 10 years. Over this period 5 of the 9 mildest winters during the 55 years of record have occurred. Observations of water temperature and ice conditions are discussed in the long term context based on this index of winter severity.

Monthly average flows in Nechako River at Irvine's varied slightly between 33.5 and 35.2 m^3/s from November to March. Input from the Nautley River ranged on average from 7.7 to 11.4 m^3/s over the winter period. Winter discharge at Vanderhoof ranged from 43.6 to 49.6 m^3/s.

Water temperatures were recorded at three locations on the Upper Nechako River: Cheslatta Falls (km 9); Irvine's (km 19); and Greer Creek (km 44). At Irvine's, temperatures dropped from an average of 4.6°C in November to 1.4°C in December, reaching 0.0°C by early December to early February depending on the particular location. Freezing water temperatures were recorded until late February, followed by a gradual increase in temperatures in March. Mean monthly water temperatures at Irvine's for all winter months, except December, were higher than the long term average (1980-93) recorded at this station.

Ice observations, using both overview flights of the entire river and daily observations, indicated that the warmer than average air and water temperatures resulted in an ice regime similar to that observed in milder winters. The duration of ice cover at Vanderhoof was 7 days shorter than the long term mean average, based on 38 years of record. An ice cover persisted at Vanderhoof from November 23, 1992 to March 31, 1993. Duration of ice cover at Fort Fraser was from November 25, 1992 to March 29, 1993. At Irvine's, ice cover persisted from January 14 to 20, 1993. Ice conditions at Irvine's, near the upstream limit of ice cover formation, demonstrated the greatest response to annual variation in meteorological conditions.

INTRODUCTION

The purpose of this study was to continue to monitor and document the winter conditions of Nechako River. Data collected over the winter of 1992-93 are presented and discussed in the long term context. Historical summaries of various physical parameters have been extracted from previous publications (Blachut 1988; Blachut and Faulkner 1989, 1990; Faulkner 1993, 1998a, 1998b, 1998c; Faulkner and Wilkins 1998; and Wilkins and Faulkner 1998).

This project was approved by the Technical Committee of the Nechako Fisheries Conservation Program (NFCP), as part of the sixth year of implementation of the Settlement Agreement. Specifics of the work plan included:

i. routine monitoring of hydrologic data, including river stage and flow from three Water Survey of Canada (WSC) Stations: Nechako River below Cheslatta Falls at Irvine's; Nechako River at Vanderhoof; and Nautley River;

ii. routine retrieval of meteorological data from Vanderhoof, Fort Fraser (at Larson's) and Irvine's;

iii. collection of water temperature data at six stations - Cheslatta Falls, Irvine's, Greer Creek, Fort Fraser, Nautley River and Vanderhoof ; and

iv. ice observations, including aerial mapping and local observers at five stations - Irvine's (km 19), River Ranch (km 27), Greer Creek (km 44), Larson's (km 57), and Fort Fraser (km 95).

METHODS

Data collection and analyses included: (i) the use of Weksler mechanical recording thermographs and a Terra-8 datalogger to monitor water temperatures; (ii) accessing of the WSC (1989) air and water temperature data; (iii) reduction of WSC data on DFO VAX/VMS mainframe computer; (iv) aerial ice observations; and (v) use of local ice observers.

The Weksler recording thermographs were calibrated periodically, and the data reduced to the nearest 0.1°C based on the equipment accuracy (Stevens et al. 1975). Nechako River at Greer Creek water temperature data were compiled and graphed using Excel software. At Irvine's, thermograph data were used as backup to fill any data gaps in the WSC data record. The Terra-8 datalogger used at Cheslatta Falls was housed in an insulated shelter, with a catalytic propane heater. Water temperature data were downloaded to audio cassette tape and transferred to a computer.

Water Survey of Canada data were accessed by obtaining a magnetic tape from WSC, which was downloaded onto the DFO VAX/VMS computer. The data is then reduced and converted into water level, air temperature, and water temperature files using software developed by DFO. A new information management system was adopted in November 1990 that utilizes an Atmospheric Environment Service (AES)/WSC ground station link to access the raw data directly to the DFO/VMS mainframe computer. This link allows direct access of raw data from the AES VAX/VMS mainframe computer. The data is then copied to a computer for data reduction.

The ice observer program consisted of four observers conducting daily observations and taking photographs at four locations on the river: Irvine's (km 19); River Ranch (km 27); Larson's (km 57); and Fort Fraser (km 95). A fifth site, Greer Creek (km 44) was visited on an irregular basis. Observers were provided with data sheets and fully automatic date stamp cameras. In addition, they were trained on ice type recognition and instructed in the methods of data collection. Additional ice observations were collected during four overview flights of the entire river using fixed wing aircraft, and during on-site visits to recorder and observer locations.

The locations of all monitoring stations for air and water temperatures, discharge and ice observers are located on Figure 1.

RESULTS

Meteorology

Mean daily and mean monthly air temperature data recorded at the WSC station at Irvine's and the AES stations at Fort Fraser (Larson's) and Vanderhoof are presented in Tables 1, 2 and 3, respectively.

The winter of 1992-93 was slightly warmer than average for the period of record (1983-93), both in the Upper Nechako River basin and in the Vanderhoof area. Mean monthly air temperatures recorded at Irvine's were warmer than average temperatures in November and March (Table 4). Comparison of the temperatures at Irvine's with those at Vanderhoof indicate that the Upper Nechako River basin was an average of 1.8°C colder than the Vanderhoof area for the years of record (Table 5).

To put the 1992-93 winter in a long term context in the Vanderhoof area, it was compared to the 68 year record (Table 6). November, February and March were warmer than the long term average, with December and January colder. As a quantitative index of overall severity of winter conditions, seasonal total accumulated degree days below 0°C or freezing degree days have been tabulated (Table 7). The decline to freezing air temperatures commenced on October 13, 1992, 6 days earlier than the long term average of October 19, based on 55 years of complete record at Vanderhoof. The end of mean daily air temperatures below freezing occurred on March 18, 1993, 22 days earlier than the long term average. The seasonal total freezing degree days for 1992-93 was 1206.5, which ranks 29th of 55 years of record, or 27th warmest in 55 years. A recent trend of much warmer winters is evident (Table 7) in which 5 of the 9 mildest winters, in a 55 year record, have occurred in the last 10 years.

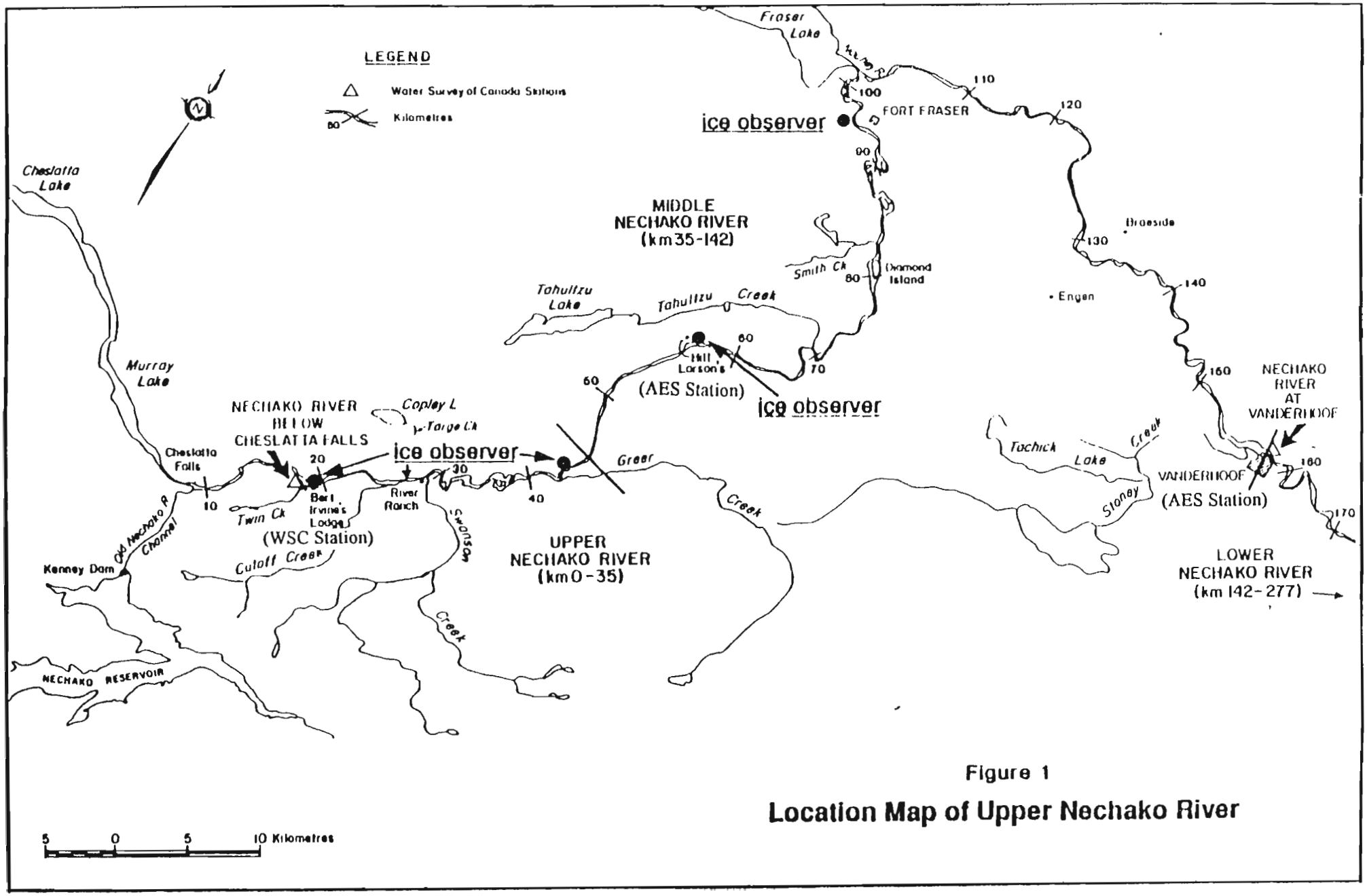

Figure 1

Location Map of Upper Nechako River

Table 1
Mean Daily Air Temperatures (°C) at Irvine's
(Unpublished DFO data); Winter 1992-93

Date	Nov	Dec	Jan	Feb	Mar
1	1.4	-7.5	-29.0	1.0	3.0
2	-0.1	-11.5	-34.0	-3.5	4.0
3	1.2	-10.4	-31.5	-0.5	2.0
4	0.9	-8.9	-26.5	0.0	1.0
5	-0.2	-10.1	-30.0	-0.5	-3.0
6	0.5	-9.2	-35.0	-8.5	-5.0
7	0.4	-14.2	-36.5	-11.5	-7.0
8	-0.8	-9.9	-35.5	-10.5	-4.5
9	-4.8	-6.4	-35.5	-6.5	-1.0
10	-0.7	-14.5	-35.5	-1.5	1.5
11	-4.7	-15.1	-32.0	-17.0	-10.0
12	-3.6	-11.9	-29.5	-18.5	-17.5
13	0.1	-2.0	-29.0	-16.5	-10.5
14	-0.6	-2.3	-26.5	-9.0	-6.5
15	0.3	-9.0	-17.0	-12.5	-4.0
16	0.4	-5.5	-7.5	-11.0	2.5
17	0.3	-13.5	-16.0	-16.0	1.0
18	0.0	-28.5	-15.0	-22.0	6.0
19	-0.1	-22.5	-15.0	-21.5	3.5
20	-2.4	-1.5	-9.0	-17.5	0.0
21	-1.1	-15.0	-3.5	-15.5	-2.5
22	-7.9	-11.0	-3.5	-6.5	-3.0
23	-14.4	-13.5	-5.0	0.0	-5.0
24	-10.9	-2.5	-8.0	4.5	-2.0
25	-9.2	-5.5	-7.5	4.0	-1.0
26	-4.8	-10.5	3.5	8.5	1.0
27	-0.4	-14.0	3.0	1.0	1.5
28	-7.4	-30.5	-2.5	7.0	3.5
29	-2.8	-28.5	1.0		7.0
30	0.1	-30.0	-2.5		4.0
31		-33.0	-1.5		4.0
Mean	-2.4	-13.2	-17.8	-7.2	-1.2

Table 2
Mean Daily Air Temperatures (°C) at Fort Fraser
(Unpublished AES data); Winter 1992-93

Date	Nov	Dec	Jan	Feb	Mar
1	4.0	-4.8	-29.8	-0.3	4.5
2	-1.0	-9.0	-23.3	-3.3	-3.3
3	1.0	-11.3	-15.3	-2.5	-2.5
4	3.3	-7.0	-21.3	-0.5	-0.5
5	0.3	-9.8	-27.0	0.8	0.8
6	-0.8	-7.3	-27.3	-3.8	-3.8
7	0.8	-12.0	-20.0	1.3	1.8
8	0.8	-10.8	-17.8	0.8	0.8
9	-2.3	-7.5	-24.5	-5.3	-2.0
10	0.0	-13.0	-30.0	-9.3	-3.5
11	-1.0	-15.0	-26.5	-10.3	-5.8
12	-3.8	-11.0	-26.3	-10.5	-3.5
13	-0.3	-2.8	-28.8	-10.3	1.0
14	-0.3	-1.0	-29.3	-9.0	-2.5
15	0.5	-4.0	-24.5	-16.0	-10.8
16	0.3	-4.8	-24.8	-14.0	-13.0
17	-0.8	-22.5	-22.5	-14.0	-8.0
18	-0.5	-23.0	-14.5	-8.3	-4.0
19	0.3	-18.0	-10.8	-11.5	-2.8
20	0.3	-16.5	-7.5	-12.0	3.5
21	-2.0	-9.0	-13.0	-15.8	4.0
22	-7.5	-9.5	-14.5	-17.5	7.3
23	-13.5	-6.0	-16.8	-15.8	2.0
24	-14.0	-3.0	-4.0	-15.8	2.3
25	-7.0	-2.0	-1.5	-11.3	-1.0
26	-5.0	-9.3	-0.5	-4.5	-2.0
27	0.3	-25.5	-8.0	3.3	-1.5
28	-7.8	-24.8	-6.0	4.5	-1.5
29	-4.8	-26.3	0.3		2.0
30	-0.5	-28.5	4.0		0.0
31		-30.8	0.0		5.0
Mean	-2.0	-12.4	-16.5	-7.5	-1.2

Table 3
Mean Daily Air Temperatures (°C) at Vanderhoof
(Unpublished AES data); Winter 1992-93

DATE	NOV	DEC	JAN	FEB	MAR
1	6.3	-3.5	-31.5	1.5	5.8
2	-0.5	-8.8	-24.8	-3.5	1.5
3	-0.5	-9.3	-14.0	-0.3	3.8
4	3.3	-9.3	-19.5	3.0	6.0
5	0.3	-6.8	-30.5	4.3	6.0
6	1.5	-4.8	-30.0	-0.8	4.5
7	2.3	-7.0	-20.8	4.3	1.5
8	1.3	-6.8	-13.8	2.8	1.3
9	-1.8	-4.5	-28.5	-2.0	0.5
10	0.0	-11.0	-32.5	-6.0	-2.3
11	-0.3	-12.0	-31.5	-8.8	-2.5
12	-2.3	-6.3	-31.8	-9.5	0.0
13	1.8	0.0	-31.0	-8.3	0.8
14	0.8	-1.8	-32.3	-8.3	-2.0
15	0.0	-3.5	-27.0	-13.8	-9.5
16	0.3	-5.8	-26.5	-14.5	-9.3
17	-0.5	-21.5	-23.0	-13.5	-5.3
18	1.5	-22.8	-13.0	-7.0	-1.3
19	2.5	-14.8	-11.3	-10.0	0.8
20	0.5	-16.3	-8.0	-11.3	5.3
21	-0.8	-11.0	-13.3	-14.0	6.0
22	-4.5	-11.5	-18.3	-16.5	8.5
23	-10.5	-4.8	14.0	-16.0	1.8
24	-10.3	-4.8	-1.3	-14.5	2.0
25	-8.8	-4.8	-1.8	-13.0	0.3
26	-5.0	-10.0	-2.3	-6.0	0.0
27	1.3	-25.3	-8.5	5.3	2.5
28	-4.8	-24.5	-6.3	4.3	0.8
29	-2.5	-24.0	0.8		2.0
30	0.5	-30.0	6.5		3.3
31		-33.3	2.8		5.5
Mean	-1.0	11.6	-17.3	-6.1	1.2

Table 4
Mean Monthly Air Temperatures (°C) at Irvine's (Unpublished DFO data); 1982-93

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1982	-	-	-	-	-	-	-	-	-	-	-	-9.5
1983	-	-	-	-	-	-	-	-	-	4.0	-1.6	-
1984	-7.1	-0.8	-	-	-	-	-	-	-	0.3	-7.8	-18.2
1985	-10.5	-8.4	-2.0	2.3	8.4	10.6	15.0	13.2	8.0	2.1	-18.2	-12.8
1986	-7.3	-14.3	0.4	2.1	6.5	11.4	13.8	14.8	7.9	5.9	-6.4	-9.5
1987	-9.2	-3.5	-1.5	3.8	7.5	12.8	15.0	12.7	10.0	3.2	-1.3	-7.1
1988	-12.4	-6.2	-0.1	4.4	8.3	10.9	13.9	13.6	8.9	4.7	-1.8	-9.4
1989	-9.5	-14.6	-4.3	4.1	8.8	13.5	14.6	14.9	9.8	3.8	-1.7	-4.8
1990	-7.8	-9.0	-1.5	3.6	8.8	11.8	15.0	14.8	10.3	1.7	-5.8	-12.2
1991	-17.6	-1.3	-4.8	4.2	8.8	11.9	15.9	14.7	9.8	1.2	-2.5	-2.5
1992	-4.1	-5.1	1.0	4.1	7.0	15.1	15.3	13.8	8.1	2.6	-2.4	-13.2
1993	-17.8	-7.2	-1.2	10.3	12.1	11.4	13.2	13.4	9.2	4.3	-4.8	-5.6
Mean	-10.3	-7.1	-1.5	4.3	8.5	12.2	14.6	14.0	9.1	3.1	-4.9	-9.5
Long Term Mean			2.2									

Table 5
Difference Between Mean Monthly Air Temperatures (°C) at Irvine's (Unpublished DFO data)
and Vanderhoof (Unpublished AES data); 1982-93

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1982	-	-	-	-	-	-	-	-	-	-	-	-0.5
1983	-	-	-	-	-	-	-	-	-	-1.1	-0.7	-
1984	-1.9	-0.9	-	-	-	-	-	-	-	-1.8	-1.9	-2.9
1985	-3.4	2.4	-2.1	-2.2	-2.7	-2.3	-1.6	-1.9	-1.2	-1.6	-3.3	-3.5
1986	-3.3	-3.8	-1.8	-2.2	-2.7	-2.1	-1.6	-1.4	-1.4	-1.2	-1.8	-2.1
1987	-2.9	-2.0	-1.8	-2.5	-2.4	-1.8	-2.3	-2.0	-3.1	-2.9	-2.1	-1.7
1988	-1.3	-0.4	-1.7	-2.0	-2.2	-2.1	-0.9	-1.7	-2.0	-3.1	-1.6	-0.9
1989	-0.6	0.4	0.3	-2.4	-2.0	-1.2	-2.0	-2.2	-2.4	-2.3	-2.0	-1.0
1990	-0.6	-0.3	-1.3	-1.9	-2.3	-2.1	-2.2	-2.4	-2.4	-1.7	-0.7	-0.3
1991	-2.0	-1.4	-2.3	-2.0	-2.4	-1.8	0.5	-2.0	-2.0	-1.4	-1.4	-1.0
1992	-1.7	-1.4	-2.3	-2.2	-2.5	-1.4	-1.6	-1.9	-1.7	-2.1	-1.4	-1.5
1993	-0.5	-1.0	-2.4	4.1	-1.5	-2.1	-2.2	-1.9	-2.6	-1.8	-2.7	-1.7
Mean	-1.8	-1.3	-1.7	-1.5	-2.3	-1.9	-1.5	-1.9	-2.1	-1.9	-1.8	-1.6
Long Term Mean			-1.8									
Range			-3.8 to 4.1									

Table 6
Mean Monthly Air Temperatures (°C) at Vanderhoof (Unpublished AES data); 1916-93

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1916	-	-11.2	-2.3	4.8	8.0	12.6	12.6	13.8	8.6	4.0	-4.9	-14.1
1917	-16.1	-12.8	-6.6	2.3	8.4	11.4	12.8	13.1	7.9	3.8	1.9	-17.9
1918	-11.1	-12.2	-6.7	2.6	6.9	10.5	14.2	12.5	10.9	3.8	-1.6	-8.5
1919	-8.5	-14.3	-7.7	4.4	6.5	9.5	13.6	13.3	11.3	-0.5	-8.5	-14.6
1920	-17.2	-8.5	-5.6	-1.2	6.5	10.4	15.6	12.0	10.3	6.0	-2.2	-7.1
1921	-11.3	-4.5	-4.1	2.9	7.8	11.5	11.6	12.3	10.6	8.2	-9.4	-13.4
1922	-14.9	-18.2	-6.0	2.4	7.4	12.3	13.9	14.4	11.0	4.8	-1.8	-11.0
1923	-14.3	-11.5	-4.8	3.5	9.2	13.6	14.4	15.1	9.4	9.3	0.3	-6.6
1924	-10.7	-5.5	-7.9	-0.1	8.8	13.0	14.6	13.3	10.7	2.8	-6.2	-17.4
1925	-12.1	-9.3	-4.4	2.5	10.1	12.6	15.1	12.8	9.4	-0.1	-2.3	-3.1
1926	-4.9	-0.5	-	-	-	-	14.4	13.5	0.1	-0.2	-4.1	-9.4
1927	-14.9	-6.9	-5.9	-	-	-	-	-	-	-	-	-19.7
1928	-12.0	-7.3	-2.4	2.4	10.2	14.6	15.1	13.3	9.9	3.2	-0.6	-9.0
1929	-14.0	-9.6	2.3	1.0	8.1	12.1	12.6	13.5	11.7	4.7	-1.1	-10.7
1930	-21.5	-5.8	-2.0	4.4	7.3	10.8	12.4	15.8	9.1	4.7	-	-0.5
1931	-5.2	-5.0	-3.3	5.0	5.0	11.0	12.9	13.2	9.8	3.1	-6.3	-
1932	-	-	-	-	-	-	-	-	-	-	-	-12.1
1933	-17.1	-4.2	-6.0	-0.9	9.4	12.2	15.6	13.1	10.0	2.9	-6.0	-3.8
1934	-12.2	-24.6	-3.0	3.7	11.3	13.9	13.7	-	8.8	6.0	-1.8	-9.5
1935	-21.1	-12.2	-0.3	4.3	9.5	13.8	14.2	11.6	10.5	5.9	-4.5	-10.3
1936	-9.2	-11.4	-1.9	4.6	8.4	12.3	14.8	13.3	12.7	6.3	-3.7	-9.9
1937	-7.3	-12.1	-4.5	3.8	9.3	12.0	14.6	13.5	9.5	4.6	2.6	-2.2
1938	-10.8	-7.4	2.5	5.9	10.1	12.0	14.8	13.6	11.6	5.1	-7.8	-6.3
1939	-6.3	-5.8	0.3	8.8	9.0	14.1	16.5	15.7	10.1	6.8	-	-10.8
1940	-7.8	-6.3	-1.1	5.4	11.1	-	-	-	-	-	-	-
1951	-	-	-	-	-	13.7	16.0	13.6	9.4	1.6	-3.1	-14.2
1952	-13.7	-8.2	-2.7	3.5	9.4	11.2	14.8	14.2	10.9	6.8	-1.8	-5.6
1953	-15.0	-3.0	-1.1	3.1	10.3	12.2	14.3	13.5	9.3	5.9	1.3	-5.1
1954	-17.6	-6.1	-5.6	-2.3	8.2	10.9	12.1	13.3	8.9	3.8	2.7	-6.6
1955	-8.3	-8.2	-8.4	1.9	6.6	11.8	14.2	11.2	9.0	3.1	-13.4	-16.8
1956	-17.5	-12.0	-3.6	3.6	10.0	11.0	14.8	14.3	9.5	2.2	-2.4	-9.9
1957	-22.2	-12.7	-1.9	4.1	10.6	12.0	12.2	11.0	11.0	1.3	0.1	-6.8
1958	-3.4	-7.6	-2.6	4.7	11.4	16.1	17.5	13.3	8.4	5.7	-4.8	-8.3
1959	-14.0	-10.4	0.4	3.8	8.1	11.7	13.8	10.5	8.6	3.3	-7.6	-3.9
1960	-11.1	-5.1	-3.0	5.0	7.2	11.2	15.1	12.3	8.5	5.0	-2.9	-9.8
1961	-8.2	-5.1	-0.4	4.2	9.1	13.8	15.8	15.0	7.6	3.9	-7.0	-12.1
1962	-11.3	-9.9	-4.8	-	7.3	10.3	14.5	13.2	9.1	5.4	0.3	-
1963	-11.3	-1.1	-0.6	3.9	8.5	11.7	-	15.3	11.8	5.7	-5.5	-8.5
1964	-7.5	-1.6	-3.7	-	-	12.7	13.4	-	8.2	5.1	-5.2	-17.3
1965	-12.0	-7.3	-4.2	3.8	8.7	11.8	15.8	15.5	8.9	5.7	-5.0	-9.5
1966	-16.0	-4.7	-	-	-	-	14.4	12.9	10.4	3.4	-6.0	-9.3
1967	-12.3	-4.3	-6.5	1.4	8.0	13.7	13.5	15.3	11.0	4.3	-1.6	-10.5
1968	-11.2	-9.7	0.3	3.2	8.5	10.2	14.6	12.2	8.6	3.4	-2.0	-15.8

Table 6 (continued)
Mean Monthly Air Temperatures (°C) at Vanderhoof (Unpublished AES data); 1916-93

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1969	-26.4	-10.5	-1.4	5.0	9.7	15.9	13.8	11.5	9.7	3.2	0.8	-3.5
1970	-	-	-	-	7.6	13.2	13.3	12.8	7.8	4.1	-7.2	-14.8
1971	-14.0	-7.9	-5.5	3.5	8.7	12.0	15.6	14.1	7.5	2.3	-3.4	-18.5
1972	-20.1	-12.5	-1.4	1.2	9.6	11.7	13.5	13.6	7.0	3.0	-1.4	-13.3
1973	-13.0	-9.7	-1.6	3.8	8.8	10.7	13.1	11.1	8.6	2.8	-11.1	-9.2
1974	-18.3	-6.3	-3.9	4.2	7.0	11.0	12.3	14.0	10.3	4.9	-5.4	-6.4
1975	-13.7	-13.7	-5.0	2.0	7.8	11.2	15.7	11.9	9.5	3.6	-5.6	-10.0
1976	-10.2	-9.6	-4.0	3.7	7.9	10.3	13.0	13.3	9.6	3.5	-1.6	-5.5
1977	-9.2	-2.4	-1.4	5.6	8.2	12.1	13.4	15.2	8.1	4.0	-5.1	-17.4
1978	-12.6	-6.4	-1.5	5.0	7.1	13.8	14.0	13.1	8.4	5.1	-7.0	-14.3
1979	-21.1	-15.4	-1.7	3.4	8.0	10.9	15.0	14.4	10.4	5.3	-5.1	-9.8
1980	-17.3	-7.7	-4.4	5.5	9.9	13.1	13.6	-	10.6	6.5	0.6	-8.8
1981	-3.2	-4.1	2.5	4.1	11.6	11.6	16.9	17.4	11.8	5.4	-0.5	-9.2
1982	-17.5	-11.5	-4.0	1.8	9.5	17.3	16.8	14.4	12.3	5.5	-5.9	-9.0
1983	-6.7	-2.2	-0.4	6.3	12.5	12.9	15.3	15.2	9.1	5.1	-0.9	-18.0
1984	-5.2	0.1	2.4	5.2	8.0	12.8	15.4	15.0	8.1	2.1	-5.9	-15.3
1985	-7.1	-6.0	0.1	4.5	11.1	12.9	16.6	15.1	9.2	3.7	-14.9	-9.3
1986	-4.0	-10.5	2.1	4.3	9.2	13.5	15.4	16.2	9.3	7.2	-4.6	-7.3
1987	-6.3	-1.5	0.3	6.2	9.9	14.6	17.3	14.7	13.1	6.1	0.8	-5.3
1988	-11.1	-5.9	1.6	6.4	10.5	13.0	14.8	15.3	10.9	7.8	-0.2	-8.5
1989	-8.9	-15.0	-4.6	6.5	10.8	14.7	16.6	16.7	12.2	6.1	0.3	-3.7
1990	-7.1	-8.8	-0.1	5.5	11.1	13.9	17.2	17.2	12.7	3.4	-5.0	-11.9
1991	-15.7	0.1	-2.5	6.2	11.2	13.7	15.3	16.7	11.8	2.5	-1.5	-1.5
1992	-2.4	-3.7	3.3	6.3	9.5	16.5	16.9	15.7	9.8	4.7	-1.0	-11.6
1993	-17.3	-6.1	1.2	6.1	13.6	13.5	15.4	15.4	11.9	6.1	-2.1	-3.9
Mean	-12.2	-8.0	-2.5	3.8	9.0	12.5	14.6	13.9	9.7	4.4	-3.6	-9.9
Long Term Mean		2.6										

Table 7

Accumulated Degree Days Below 0°C at Vanderhoof and Ranking (Unpublished AES data); 1916-93

Rank	Year	Start Date	End Date	Degree Days To Dec. 31	Degree Days After Jan. 1	Total Degree Days Below 0
1	1921-22	Nov-07	Apr-16	712.6	1172.5	1885.1
2	1978-79	Oct-26	Apr-13	682.9	1166.0	1848.9
3	1971-72	Oct-15	Apr-17	728.0	1117.5	1845.5
4	1919-20	Oct-13	Apr-14	792.9	1041.1	1834.0
5	1968-69	Oct-10	Apr-02	573.8	1195.2	1769.0
6	1916-17	Oct-01	May-02	598.1	1075.7	1673.8
7	1935-36	Oct-08	Apr-04	396.2	1262.6	1658.8
8	1956-57	Oct-18	Apr-12	467.1	1129.5	1596.6
9	1970-71	Oct-05	Apr-16	691.5	842.8	1534.3
10	1917-18	Oct-14	Apr-16	609.2	924.1	1533.3
11	1924-25	Oct-17	Apr-15	732.6	798.4	1531.0
12	1973-74	Oct-19	Apr-26	618.6	893.8	1512.4
13	1964-65	Oct-25	Apr-20	716.9	740.4	1457.3
14	1961-62	Oct-09	Mar-28	611.8	827.6	1439.4
15	1936-37	Oct-30	Mar-28	392.5	1039.4	1431.9
16	1955-56	Oct-18	Apr-06	937.7	488.8	1426.5
17	1979-80	Oct-17	Apr-08	474.7	914.2	1388.9
18	1977-78	Oct-19	Apr-14	711.3	671.1	1382.4
19	1981-82	Oct-21	Apr-15	325.7	1044.5	1370.2
20	1974-75	Oct-28	Apr-08	366.6	994.1	1360.7
21	1929-30	Oct-27	Apr-23	384.4	958.2	1342.6
22	1922-23	Oct-26	Apr-29	411.0	920.5	1331.5
23	1975-76	Oct-25	Apr-03	506.2	749.9	1256.1
24	1918-19	Nov-05	Apr-13	334.5	918.1	1252.6
25	1972-73	Sep-22	Mar-28	500.1	748.5	1248.6
26	1966-67	Oct-10	Apr-19	506.1	733.6	1239.7
27	1938-39	Nov-05	Apr-05	443.5	791.1	1234.6
28	1937-38	Oct-28	Apr-01	491.2	715.7	1206.9
29	**1992-93**	**Oct-13**	**Mar-18**	**426.4**	**780.1**	**1206.5**
30	1984-85	Oct-17	Mar-29	738.8	463.0	1201.8
31	1985-86	Oct-07	Apr-12	738.5	460.9	1199.4
32	1958-59	Oct-08	May-01	411.0	776.6	1187.6
33	1988-89	Oct-28	Mar-22	313.4	867.5	1180.9
34	1990-91	Oct-11	Mar-26	541.5	631.6	1173.1
35	1928-29	Oct-10	Apr-11	331.7	815.1	1146.8
36	1967-68	Oct-28	Apr-12	396.1	685.6	1081.7
37	1959-60	Oct-07	Mar-29	386.9	643.6	1030.5
38	1954-55	Nov-06	Apr-25	228.7	776.4	1005.1
39	1923-24	Nov-04	Apr-27	234.5	763.6	998.1
40	1920-21	Nov-08	May-06	303.9	678.1	982.0
41	1953-54	Oct-23	Apr-30	173.7	789.6	963.3

Table 7 (continued)
Accumulated Degree Days Below 0°C at Vanderhoof and Ranking (Unpublished AES data); 1916-93

Rank	Year	Start Date	End Date	Degree Days To Dec. 31	Degree Days After Jan. 1	Total Degree Days Below 0
42	1940-41	Oct-26	Mar-25	447.5	468.5	916.0
43	1960-61	Oct-17	Apr-14	417.7	495.8	913.5
44	1952-53	Oct-25	Apr-14	258.9	630.1	889.0
45	1963-64	Oct-26	Mar-26	452.8	426.0	878.8
46	1983-84	Nov-05	Mar-20	621.5	237.1	858.6
47	1982-83	Oct-19	Mar-25	468.9	355.2	824.1
48	1987-88	Nov-02	Apr-02	203.6	443.2	746.8
49	1989-90	Oct-28	Apr-09	186.7	547.0	733.7
50	1957-58	Oct-02	Mar-25	282.5	448.7	731.2
51	1986-87	Oct-30	Mar-28	404.7	306.8	711.5
52	1939-40	Oct-05	Mar-23	140.1	560.6	700.7
53	1976-77	Oct-14	Mar-30	246.7	424.0	670.7
54	1980-81	Oct-26	Apr-12	340.5	282.3	622.8
55	1991-92	Oct-17	Apr-10	203.8	228.0	431.8
Earliest		Sep-22	Mar-18			
Mean		Oct-19	Apr-09			1210.5
Latest		Nov-08	May-06			

Hydrology

Discharges in Nechako River from November 1992 to March 1993 were 32.5 to 35.0 m^3/s at the WSC station at Irvine's (Table 8).

Discharges in the Nechako River at Vanderhoof (1992-93) are presented in Table 9. The November to March discharge data were compared from 1980 to 1993 (Table 10). Flows from December 1992 to March 1993 were below the 1980-93 average (Table 10). The mean winter discharge for the past 13 years at Vanderhoof has ranged from 39.5 to 52.7 m^3/s, while the average winter flow was 44.1 m^3/s (Table 10). The average winter flow for 1992-93 was 46.2 m^3/s. Based on Nechako Reservoir releases of 32.5 to 33.4 m^3/s at Skins Lake Spillway from November 1992 to March 1993 (Table 11), all tributaries between Skins Lake and Vanderhoof, including the Nautley River, were contributing an approximate winter discharge of 10 to 20 m^3/s. The Nautley River contributed 7.7 to 11.4 m^3/s in the winter of 1992-93 and had an overall average winter discharge of 9.0 m^3/s (range 5.1 to 13.4 m^3/s) over the past 13 years (Table 12).

Water Temperature

Winter water temperatures were recorded on Nechako River at three locations: Cheslatta Falls; Irvine's; and below Greer Creek. These sites are located at 9 km, 19 km and 44 km, respectively, downstream of Kenney Dam. The data are presented in Tables 13, 14 and 15, respectively.

All three stations indicated relatively mild water temperatures in November and December, with lake outlet temperatures at the base of Cheslatta Falls cooling to below 0°C by mid-December. The water temperatures at Irvine's, 10 km further downstream, showed further cooling to 1.0 - 2.0°C by mid-December (Table 14), in response to the negative air temperatures in the upper basin (Table 3). Greer Creek, a further 25 km downstream of Irvine's, showed additional cooling in response to negative air temperatures, with water temperatures at approximately -0.1°C by the end of December. The relationship between the three temperature records is indicated in Figure 2. The relationship between air and water temperatures and ice cover formation at Irvine's is indicated in Figure 3.

Ice began forming at Irvine's in late December and at Greer Creek in early December. Freezing water temperatures were present on the Upper Nechako River until late January, followed by a slow rise in temperatures in February. Table 16 gives the mean monthly water temperatures at Irvine's for 1980 to 1993. Mean monthly water temperatures for November and January through March were all higher than the 13 year average. This response of water temperatures is predictable given the warmer than average air temperatures during these months at both Irvine's (Table 4) and Vanderhoof (Table 6).

Ice Regime

Information on the ice regime of the Nechako River was obtained from several sources: local observer notes (Appendix 1); three aerial overview flights (Appendix 2); and stage and water temperature records from WSC and DFO stations. The data are presented in two formats: ice conditions over time at a single observation point, and ice conditions along the entire river on a single day.

Ice observations at a single observation point are available for four stations, with a partial record at a fifth station. The sites were Irvine's (km 19), River Ranch (km 27), Greer Creek (km 44), Larson's (km 57), and Fort Fraser (km 95), where km are measured downstream from Kenney Dam.

The observation of ice cover at fixed locations was conducted again in the winter of 1992-93. A local ice observer, L. LaRocque, made observations on the Nechako River at the railroad bridge crossing at Fort Fraser (km 95). The total duration of ice cover at this location was 125 days, with a full ice cover persisting from November 25, 1992 to March 29, 1993. This is 44 days longer than the duration of ice recorded at this location the previous winter. The observer's notes are included in Appendix 1, location #4. The ice cover at Fort Fraser appears to be typical of the broader, low velocity reaches of the Nechako River, with a rapid freeze-up due to formation of an accumulation cover, a stable, mid-winter cover and a long gradual process of ice cover deterioration. Although this long period of cover deterioration at this location was not documented in photographs and observer notes for this winter, the previous four winters exhibited this type of ice decay and is partly

Table 8
Nechako River Daily Discharge (m^3/s) at Irvine's
(Unpublished WSC data); Winter 1992-93

Date	Nov	Dec	Jan	Feb	Mar	Apr
1	33.3	34.8	35.3	33.5	34.6	34.8
2	33.8	34.5	35.2	33.7	34.7	35.2
3	33.7	34.6	35.1	33.6	34.8	35.2
4	34.1	34.2	34.6	33.5	35.4	35.8
5	34.4	34.1	33.6	33.0	34.8	36.3
6	34.8	34.2	32.4	33.3	35.1	36.2
7	35.5	34.2	32.0	33.7	35.6	35.8
8	35.1	34.1	32.8	34.0	35.6	36.3
9	34.8	33.9	33.0	33.6	35.6	37.8
10	35.5	34.3	32.5	34.1	35.6	37.5
11	35.5	34.2	31.5	34.5	35.5	37.6
12	34.3	33.9	31.0	35.1	35.2	37.5
13	34.1	34.2	30.8	35.1	34.6	37.7
14	34.3	34.6	30.5	34.8	35.2	37.6
15	34.5	34.7	30.7	34.0	34.5	37.7
16	34.5	34.4	31.0	33.7	35.0	38.1
17	34.3	34.2	31.6	33.9	34.4	38.4
18	34.3	34.4	32.2	34.0	34.4	38.3
19	34.6	35.1	32.2	33.6	34.3	38.5
20	34.7	35.2	31.7	33.0	34.1	39.2
21	34.6	35.3	31.5	33.3	34.1	40.5
22	34.6	36.1	31.6	32.9	34.4	41.0
23	34.8	35.7	31.7	32.7	34.4	41.5
24	34.7	35.9	32.0	33.1	34.9	42.3
25	34.6	36.0	32.5	33.5	34.7	43.9
26	34.4	36.1	33.0	33.9	34.6	46.6
27	34.9	36.2	32.8	34.2	34.6	48.2
28	35.4	36.4	33.0	34.7	34.7	49.8
29	34.8	36.6	33.1		34.3	51.9
30	34.7	36.0	32.9		34.6	52.8
31		35.8	33.1		34.7	
Mean	34.6	35.0	32.5	33.8	34.8	40.0

Table 9
Nechako River Daily Discharge (m^3/s) at Vanderhoof
(Unpublished WSC data); Winter 1992-93

Date	Nov	Dec	Jan	Feb	Mar	Apr
1	48.0	44.0	45.4	44.2	45.3	55.5
2	48.2	41.8	45.3	45.0	45.2	57.0
3	48.4	40.8	45.3	46.3	45.1	58.2
4	49.5	41.2	45.3	46.0	45.3	59.0
5	49.9	42.0	44.0	45.2	46.0	60.0
6	50.8	43.0	43.0	44.7	46.3	60.3
7	52.7	44.2	43.3	44.7	46.6	59.5
8	53.3	45.5	44.0	45.0	46.7	60.2
9	52.9	45.2	43.5	45.4	46.6	65.8
10	52.8	44.5	42.5	45.8	46.5	68.2
11	52.2	44.0	42.0	46.0	46.0	68.2
12	51.6	44.6	42.0	46.3	45.9	66.8
13	51.2	45.5	42.0	46.1	45.8	67.6
14	50.7	45.4	41.7	45.8	45.2	67.9
15	50.8	45.3	42.0	45.2	44.9	68.2
16	51.1	47.0	42.3	44.9	45.1	68.6
17	50.9	47.2	43.0	44.6	45.5	69.5
18	50.4	44.0	43.6	44.6	45.8	70.5
19	49.8	37.2	43.4	44.8	46.8	72.2
20	50.0	38.5	43.5	44.6	48.0	74.1
21	50.1	40.5	43.2	44.1	48.5	76.1
22	49.7	42.9	43.0	43.9	49.0	79.0
23	47.3	46.0	43.5	43.7	49.4	83.0
24	47.0	48.5	44.0	43.8	49.8	85.6
25	48.0	50.2	44.9	44.0	50.0	89.6
26	47.9	51.2	45.0	44.5	50.4	94.0
27	46.5	52.0	44.9	44.8	50.9	97.9
28	46.0	51.0	44.5	45.2	51.6	100.0
29	46.2	50.0	44.2		52.7	103.0
30	45.5	48.0	44.0		53.5	105.0
31		45.5	44.0		54.4	
Mean	49.6	45.1	43.6	45.0	47.7	73.7

Table 10
Nechako River Mean Monthly Discharge (m^3/s)
at Vanderhoof (Unpublished WSC data);
Winter 1980-93

Year	Nov	Dec	Jan	Feb	Mar	Mean
1980-81	50.6	53.9	54.2	50.3	54.5	52.7
1981-82	45.8	40.5	40.2	41.2	43.9	42.3
1982-83	48.5	42.4	41.3	41.6	35.4	41.8
1983-84	47.3	34.3	39.2	42.7	45.3	41.8
1984-85	42.3	39.3	43.4	44.9	47.6	43.5
1985-86	48.0	35.7	36.9	37.9	39.2	39.5
1986-87	42.4	41.9	41.9	44.8	43.4	42.9
1987-88	45.5	43.1	41.2	40.6	40.5	42.2
1988-89	48.5	47.6	46.3	38.7	39.5	44.1
1989-90	43.8	47.2	51.6	51.1	51.6	49.1
1990-91	40.9	36.8	33.4	33.2	55.1	39.9
1991-92	47.2	43.4	40.3	37.7	68.0	47.3
1992-93	49.6	45.1	43.6	45.0	47.7	46.2
Mean	46.2	42.4	42.6	42.3	47.1	44.1

Table 11
Nechako River Daily Discharge (m^3/s)
at Skins Lake Spillway (Unpublished WSC data);
Winter 1992-93

Date	Nov	Dec	Jan	Feb	Mar	Apr
1	33.4	33.4	32.8	32.2	32.6	33.1
2	33.4	33.3	32.8	32.5	32.6	33.1
3	33.4	33.2	32.8	33.3	32.6	33.1
4	33.4	33.2	32.7	33.3	32.6	33.1
5	33.4	33.1	32.7	33.3	32.6	33.0
6	33.4	33.1	32.7	33.2	32.6	33.0
7	33.4	33.1	32.6	33.2	32.6	33.0
8	33.4	33.1	32.6	33.2	32.5	33.0
9	33.4	33.1	32.6	33.2	32.5	33.0
10	33.4	33.1	32.6	33.2	32.5	33.0
11	33.4	33.1	32.6	33.1	32.5	32.9
12	33.4	33.1	32.6	33.1	32.5	32.9
13	33.4	33.1	32.5	33.1	32.5	32.9
14	33.4	33.1	32.5	33.0	32.5	32.9
15	33.4	33.1	32.5	33.0	32.5	32.8
16	33.4	33.1	32.5	33.0	32.5	32.8
17	33.4	33.1	32.5	33.0	32.4	32.8
18	33.4	33.0	32.5	32.9	32.4	32.8
19	33.4	33.0	32.5	32.9	32.4	32.8
20	33.4	33.0	32.5	32.9	32.4	32.8
21	33.4	33.0	32.5	32.9	32.3	32.8
22	33.4	33.0	32.4	32.8	32.3	32.8
23	33.4	33.0	32.4	32.8	32.8	37.4
24	33.4	33.0	32.4	32.8	33.3	49.2
25	33.4	33.0	32.3	32.7	33.3	49.2
26	33.4	33.0	32.3	32.7	33.2	49.2
27	33.4	33.0	32.3	32.7	33.2	49.3
28	33.4	32.9	32.3	32.6	33.2	49.3
29	33.4	32.9	32.3		33.2	49.3
30	33.4	32.8	32.2		33.1	49.3
31		32.8	32.2		33.1	
Mean	33.4	33.1	32.5	33.0	32.7	36.9

Table 12
Nautley River Mean Monthly Discharge (m^3/s)
(Unpublished WSC data); Winter 1980-93

Year	Nov	Dec	Jan	Feb	Mar	Mean
1980-81	12.1	13.6	15.7	13.7	11.8	13.4
1981-82	9.6	7.3	8.8	8.6	9.0	8.6
1982-83	10.9	9.3	7.2	6.6	6.1	8.0
1983-84	9.2	7.8	6.9	8.2	8.2	8.0
1984-85	9.2	8.3	8.5	7.5	8.6	8.4
1985-86	7.0	3.8	4.3	4.7	5.9	5.1
1986-87	9.3	7.5	7.6	7.4	7.5	7.9
1987-88	8.0	8.3	10.0	10.0	9.8	9.2
1988-89	12.6	11.3	10.0	8.5	9.1	10.3
1989-90	9.0	10.8	13.0	12.2	11.5	11.3
1990-91	8.0	6.3	7.2	8.7	8.3	7.7
1991-92	9.1	10.2	9.7	9.8	14.0	10.5
1992-93	11.4	8.7	8.4	8.2	7.7	8.9
Mean	9.6	8.7	9.0	8.8	9.0	9.0

Table 13
Nechako River Mean Daily Water Temperatures
(°C) at Cheslatta Falls (Unpublished DFO data);
Winter 1992-93

Date	Nov	Dec	Jan	Feb	Mar
1	7.6	1.3	0.0	0.0	0.0
2	7.3	0.9	0.0	0.0	0.0
3	7.2	0.5	0.0	0.0	0.0
4	7.0	0.5	0.0	0.0	0.0
5	6.9	0.6	0.0	0.0	0.0
6	6.8	0.9	0.0	0.0	0.0
7	6.8	0.6	0.0	0.0	0.0
8	6.6	0.1	0.0	0.0	0.0
9	6.3	0.2	0.0	0.0	0.0
10	6.2	0.1	0.0	0.0	0.0
11	4.7	0.1	0.0	0.0	0.0
12	4.5	0.2	0.0	0.0	0.0
13	4.4	0.5	0.0	0.0	0.2
14	4.2	0.5	0.0	0.0	0.1
15	4.2	0.5	0.0	0.0	0.0
16	4.2	0.4	0.0	0.0	0.0
17	3.8	0.0	0.0	0.0	0.1
18	3.8	0.0	0.0	0.0	0.2
19	3.4	0.0	0.0	0.0	0.3
20	3.3	0.1	0.0	0.0	0.3
21	3.0	0.1	0.0	0.0	0.3
22	2.7	0.0	0.0	0.0	0.3
23	2.2	0.0	0.0	0.0	0.3
24	2.2	0.0	0.0	0.0	0.3
25	2.0	0.0	0.0	0.0	0.4
26	1.8	0.0	0.0	0.0	0.4
27	2.1	0.0	0.0	0.0	0.5
28	1.7	0.0	0.0	0.0	0.6
29	1.7	0.0	0.0		0.8
30	1.6	0.0	0.0		0.7
31		0.0	0.0		0.9
Mean	4.3	0.3	0.0	0.0	0.2

Table 14
Nechako River Mean Daily Water Temperatures (°C) at Irvine's (Unpublished DFO data); Winter 1992-93

Date	Nov	Dec	Jan	Feb	Mar
1	6.8	2.2	1.5	1.4	2.0
2	6.5	1.7	1.8	1.6	2.2
3	6.3	1.5	1.5	1.8	2.5
4	6.1	1.6	1.8	1.7	2.4
5	6.2	1.4	1.6	1.9	2.6
6	5.9	1.8	1.6	1.9	2.4
7	5.9	1.4	1.2	1.2	2.3
8	5.7	1.2	1.1	1.6	2.3
9	5.0	1.3	1.0	1.4	2.3
10	5.3	0.8	0.5	1.4	2.5
11	4.6	0.8	0.9	1.6	2.8
12	4.7	1.0	1.4	1.3	2.3
13	5.2	1.8	1.1	1.1	2.1
14	5.0	1.8	0.0	1.1	2.1
15	5.2	1.4	0.4	1.1	2.2
16	5.0	1.3	0.1	1.2	2.6
17	4.9	1.3	0.5	1.1	2.8
18	4.7	1.2	0.5	1.1	2.2
19	4.5	1.2	1.1	1.1	2.6
20	4.1	1.1	1.4	1.4	3.3
21	4.0	1.2	1.3	1.5	3.1
22	3.4	1.3	0.8	1.6	3.1
23	2.5	1.3	1.0	1.3	3.4
24	2.5	1.4	1.1	1.3	3.3
25	2.7	1.4	0.5	1.6	3.4
26	2.9	1.5	1.1	1.8	3.7
27	3.4	1.5	0.8	2.0	3.8
28	2.7	1.5	0.2	1.9	3.7
29	3.0	1.6	0.0		4.3
30	2.8	1.6	0.0		4.4
31		1.7	1.1		4.3
Mean	4.6	1.4	0.9	1.5	2.9

Table 15
Nechako River Mean Daily Water Temperatures (°C) Below Greer Creek (Unpublished DFO data); Winter 1992-93

Date	Nov	Dec	Jan	Feb	Mar
1	7.0	1.1	0.0	0.0	0.0
2	7.1	0.2	0.0	0.0	0.0
3	6.5	0.2	0.0	0.0	0.0
4	6.4	0.2	0.0	0.0	0.2
5	6.1	0.2	0.0	0.0	0.3
6	6.1	0.2	0.0	0.0	0.4
7	6.0	0.0	0.0	0.0	1.4
8	5.7	0.0	0.0	0.0	1.9
9	5.6	0.0	0.0	0.0	1.5
10	4.9	0.0	0.0	0.0	1.5
11	5.0	0.0	0.0	0.0	1.4
12	4.9	0.0	0.0	0.0	1.8
13	5.0	0.0	0.0	0.0	2.3
14	5.3	0.0	0.0	0.0	2.1
15	5.3	0.1	0.0	0.0	0.3
16	5.4	0.6	0.0	0.0	0.5
17	4.0	0.0	0.0	0.0	1.0
18	4.0	0.0	0.0	0.0	2.0
19	3.9	0.0	0.0	0.0	2.1
20	3.7	0.0	0.0	0.2	2.8
21	2.9	0.0	0.0	0.3	3.0
22	2.0	0.0	0.0	0.3	3.5
23	0.8	0.0	0.0	0.2	2.7
24	0.7	0.0	0.0	0.2	2.6
25	1.1	0.0	0.0	0.2	2.7
26	1.2	0.0	0.0	0.0	2.8
27	2.5	0.0	0.0	0.0	2.9
28	1.5	0.0	0.0	0.0	3.2
29	1.5	0.0	0.0		3.5
30	1.9	0.0	0.0		3.6
31		0.0	0.0		4.2
Mean	4.1	0.1	0.0	0.0	1.9

Figure 2
Comparison of Three Water Temperature Stations, Nechako River; Winter 1992-93

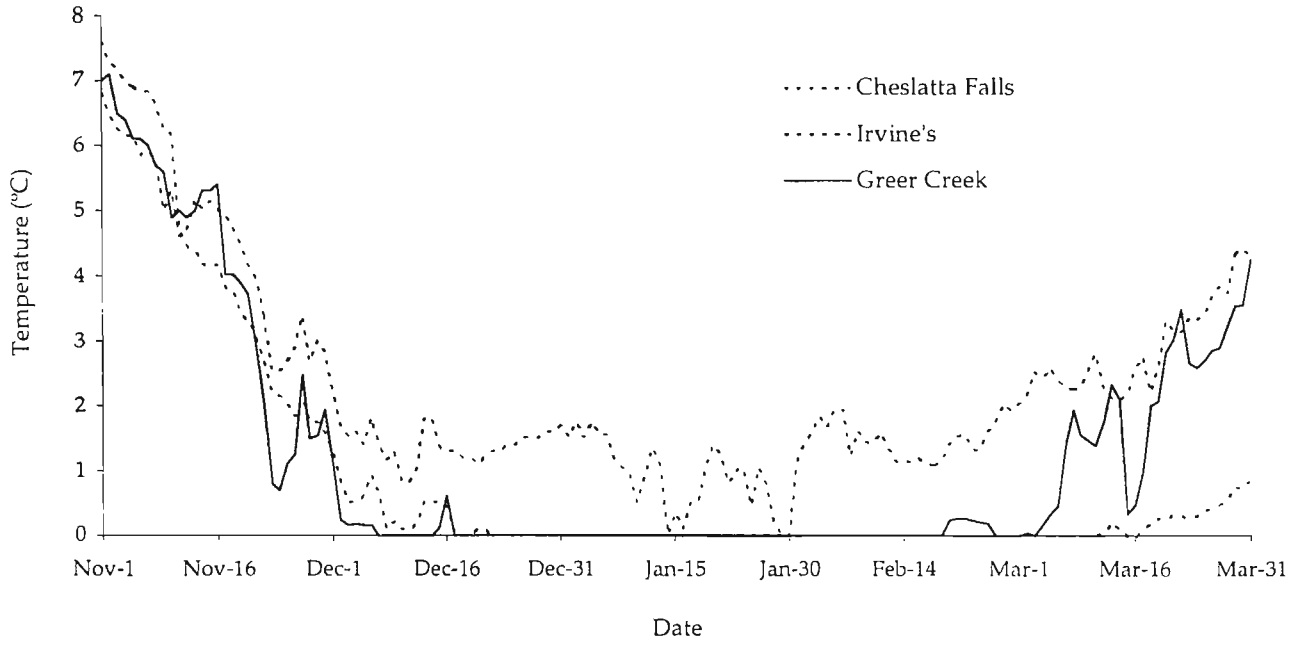

Figure 3
Comparison of Water and Air Temperatures, Nechako River at Irvine's; Winter 1992-93

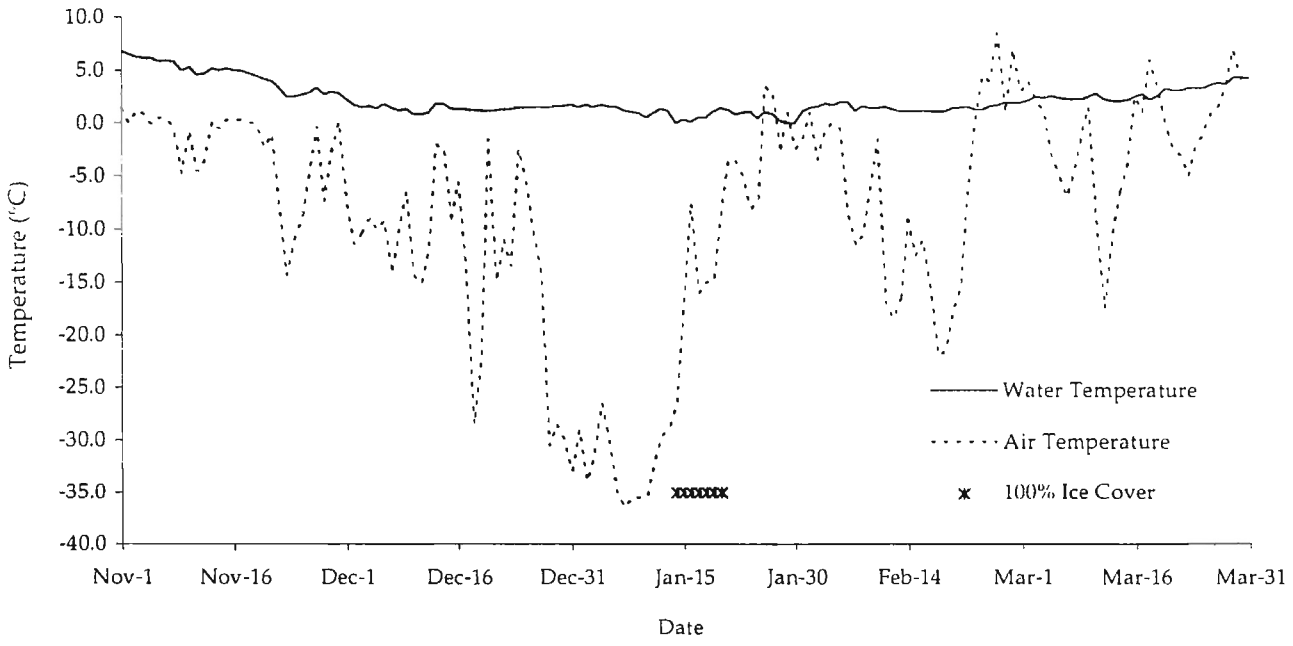

Table 16
Nechako River Mean Monthly Water Temperatures (°C) at Irvine's (Unpublished DFO data); 1980-93

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1980	-	-	-	-	10.6	15.8	16.6	16.0	13.5	10.0	5.7	1.7
1981	1.5	1.8	2.6	4.0	8.3	12.6	16.3	17.4	14.8	9.2	6.6	0.0
1982	0.3	0.7	1.1	1.7	5.4	14.0	17.9	15.5	14.5	10.3	4.2	1.5
1983	1.0	0.8	1.6	-	9.0	12.7	14.9	16.3	13.5	8.9	5.1	1.8
1984	0.6	0.9	2.0	3.8	7.1	10.0	14.0	15.1	12.2	9.0	3.0	1.5
1985	0.9	0.9	1.9	4.0	8.6	13.2	16.2	15.9	13.1	8.8	3.0	1.3
1986	1.1	0.0	1.3	3.9	6.8	13.1	15.7	16.8	14.0	10.2	4.0	1.4
1987	1.4	1.3	1.7	3.9	7.8	13.0	16.8	15.8	14.3	10.2	5.9	1.9
1988	0.7	0.8	2.2	4.1	8.4	12.0	15.3	16.0	14.3	10.3	5.1	1.5
1989	0.8	0.2	1.1	3.1	7.6	14.1	16.5	17.2	15.1	10.7	5.2	2.2
1990	0.9	0.4	1.6	3.6	7.5	12.8	16.9	17.7	15.6	8.8	3.2	0.9
1991	0.6	1.2	1.1	3.7	8.7	13.3	16.7	17.0	14.5	9.4	4.0	2.0
1992	1.2	1.1	2.4	4.7	9.0	15.2	17.0	17.7	13.1	8.6	4.6	1.4
1993	0.9	1.5	2.9	4.9	10.1	14.4	15.7	17.0	14.9	10.4	4.2	2.0
Mean	0.9	0.9	1.8	3.8	8.2	13.3	16.2	16.5	14.1	9.6	4.6	1.5

dependent on weather conditions. A long slow "thermal" type break-up is typical of regulated rivers where no rapid spring snowmelt peak is experienced. The eroding ice cover loses much of its mechanical strength and a rising stage in an unregulated system would probably break up the weakened cover and flush it from the river several weeks earlier than break-up would occur under regulated flows. Under the current flow regime, break-up is apparently governed by meteorological conditions rather than changes in discharge. The winter of 1992-93 was colder than the previous winter, which would account for the increase in the duration of ice cover.

Moving further upstream, the next observer station is located at Larson's (km 57) on a relatively narrow reach of the river, with rapids located both upstream and downstream of the observation site. The first onset of 100% cover occurred on January 12, 1993. This cover persisted until March 13, 1993, giving a duration of full ice cover of 61 days. This is much longer than the full ice cover duration recorded during the 1991-92 winter of only 6 days. The differences in length of ice cover can be attributed to the air temperatures experienced at this location. There was a persistent open lead before the onset of 100% cover that generated frazil and anchor ice during cold periods. A good record of the variable backwater effect with changing ice conditions was documented at this site (Appendix 1, location #3). Repeated overflow due to increased backwater caused the shore ice zones to increase in ice thickness. The ice regime at this location is controlled primarily by meteorological conditions and the production of ice in the rapids section upstream of Larson's, rather than the growth of a continuous ice cover progressing upstream.

Periodic observations of ice cover were made at Greer Creek (km 44) by B. Irvine (Appendix 1, location #2). A full width cover, with a persistent mid-channel open lead appears to have progressed upstream of Greer Creek on December 20, 1992. The length of ice cover at this location is not known exactly, as only partial records were kept at this location. The ice cover, with a central lead of varying width was in place until at least February 16, 1993, which was the date of the last observer flight that documented 100% cover at this location.

The next ice observer station was located further upstream at River Ranch (km 27). The observer record is by photograph only. Shore ice was present on December 6, 1992, as displayed by the first photograph taken. This shore ice was evident until December 26, 1992. On December 28, 1992 the river

was completely covered with ice. This 100% cover persisted until January 29, 1993, resulting in 33 days of 100% cover. Compared to the previous ice cover regimes at this station, the 1992-93 ice cover was 33 days longer than that of the 1991-92 winter and a minimum of 11 days shorter than the 1990-91 winter.

The ice observer station furthest upstream is located at Irvine's (km 19), in the zone of discontinuous ice cover. Interpretation of the WSC records for the Nechako River below Cheslatta Falls (at Irvine's) station can be used to supplement the observational record (Appendix 1, location #1). Ice events at Irvine's during the winter of 1992-93 are based on observer's notes, photographs and the WSC records (Table 18). According to observational records, the total duration of a full width cover at Irvine's was 6 days, between January 14 and 20, 1993. The total duration of ice conditions measured by the WSC gauge at Irvine's for the winter of 1992-93 was 5 days, which is 19 days shorter than the average for this location based on 13 years of record. There is a high degree of interannual variability with a range of 0 to 52 days of ice effects at this location (Table 17). This pattern can be attributed to the severity of freezing air temperatures. The winters with a low cumulative total of freezing degree days had a correspondingly low incidence of ice cover. The strong relationship between air and water temperatures and ice cover formation is well demonstrated for this location in Figure 3.

The furthest downstream station for ice observations is located at Vanderhoof, where a streamflow gauging site is maintained by the WSC. The station is located on the left bank immediately downstream of the highway bridge at Vanderhoof. There was some minor influence of the bridge piers on the ice regime. A small open water lead was often present in mid-channel under the bridge or immediately downstream, due to higher velocity and flow constriction. Duration of ice cover at Vanderhoof was qualitatively determined by WSC personnel by interpretation of stage recorder charts (Blachut 1988). Start and end dates for duration of ice cover at Vanderhoof were extracted from the unpublished database and were put in the long term context, based on the 38 years of record available from WSC (Table 18). The duration of ice cover at Vanderhoof for 1992-93 was 128 days, with ice present from November 23, 1992 to April 3, 1993. A period of approximately one week of initial

Table 17
Ice effects on the Water Survey of Canada Gauge;
Nechako River at Vanderhoof 1955-93

Year	Dates	Postulated Ice Effect	# Days	Yearly Total
1980-81	Feb 10-11	Unknown	2	6
	Feb 23-26	Unknown	4	
1981-82	Dec 28-Jan 29	Anchor/shore	33	50
	Feb 12-16	Full width	5	
	Feb 23-Mar 6	Full width	12	
1982-83	Jan 22-29	Anchor/shore	8	8
1983-84	Dec 17-31	Anchor/shore	15	27
	Jan 1-4	Anchor/shore	4	
	Jan 15-22	Anchor/shore	8	
1984-85	Nov 28-Dec 2	Anchor/shore	5	44
	Dec 11-31	Anchor/shore	20	
	Jan 1-6	Shore	6	
	Feb 6-18	Full width	13	
1985-86	Nov 21-Dec 4	Anchor/shore	14	27
	Feb 15-27	Full width	13	
1986-87	Jan 8	Anchor/shore	1	3
	Jan 14-15	Anchor/shore	2	
1987-88	Dec 30-31	Anchor/shore	2	36
	Jan 1-19	Full width	19	
	Jan 30-Feb 13	Full width	15	
1988-89	Dec 31-Jan 1	Shore	2	52
	Jan 6-16	Anchor/shore	11	
	Jan 23	Anchor/shore	1	
	Jan 30-Mar 4	Full width	34	
	Mar 10-11	Anchor/shore	2	
	Mar 16-17	Anchor/shore	2	
1989-90	Jan 29-Feb 5	Full Width	8	19
	Feb 11-21	Full Width	11	
1990-91	Dec 18-21	Anchor/shore	3	31
	Dec 28-Jan 24	Anchor/shore	28	
1991-92	no ice conditions	None	0	0
1992-93	Dec 27-31	Anchor/shore	5	5
Average # Days Per Year				24

Table 18
Ice effects on the Water Survey of Canada Gauge; Nechako River at Irvine's 1980-93

Year	WSC Ice Conditions		Total Days
	Start	End	
1955-56	Oct-28	Apr-20	176
1956-57	Oct-29	Apr-02	156
1957-58	Dec-21	Jan-08	54
	Feb-05	Mar-11	
1958-59	Dec-06	Apr-12	128
1959-60	Nov-16	Nov-20	105
	Dec-17	Dec-19	
	Jan-01	Apr-06	
1960-61	Dec-15	Apr-08	115
1961-62	Nov-16	Apr-17	153
1962-63	Dec-24	Apr-07	105
1963-64	Nov-17	Apr-20	156
1964-65	Nov-27	Apr-10	135
1965-66	Nov-24	Apr-01	129
1966-67	Nov-27	Apr-16	141
1967-68	Nov-25	Apr-09	137
1968-69	Dec-04	Apr-08	126
1969-70	Dec-14	Apr-03	111
1970-71	Nov-20	Apr-22	154
1971-72	Nov-29	Apr-11	135
1972-73	Nov-28	Apr-06	130
1973-74	Nov-03	Apr-12	161
1974-75	Nov-22	Apr-18	148
1975-76	Nov-27	Apr-14	140
1976-77	Jan-01	Feb-20	51
1977-78	Nov-17	Apr-07	142
1978-79	Nov-11	Apr-11	152
1979-80	Nov-08	Apr-10	155
1980-81	Nov-22	Mar-25	124
1981-82	Nov-28	Apr-24	148
1982-83	Nov-16	Apr-12	148
1983-84	Nov-16	Mar-29	135
1984-85	Oct-27	Apr-09	165
1985-86	Nov-06	Apr-12	158
1986-87	Nov-08	Apr-05	149
1987-88	Nov-16	Apr-04	141
1988-89	Nov-24	Apr-18	146
1989-90	Nov-14	Apr-10	148
1990-91	Nov-05	Apr-10	157
1991-92	Oct-27	Nov-10	135
	Nov-21	Mar-19	
1992-93	Nov-23	Apr-03	132
Earliest	Oct-27	Feb-20	
Mean	Nov-22	Apr-07	136.2

shore, anchor and frazil ice formation occurred prior to completion of a full surface ice cover. The start of ice conditions was 1 day later than the long term average date of November 22nd, and the end of ice conditions was 4 days earlier than the long term average date of April 7th. The total duration of ice cover was 4 days shorter than the long term average of 136 days. This seasonal duration appears to bear little relationship to the cumulative freezing degree days data (Table 7), which indicated that 1992-93 was a slightly warmer than average winter. The start of sub-zero mean daily air temperatures and the freezeup date were not very close, with sub-zero temperatures occurring 42 days before freezeup. There was also a difference between breakup and the end of sub-zero air temperatures, with the latter occurring on March 18, 1993 and the former not being recorded until April 3, 1993. Based on the last six winters, the duration of ice cover at Vanderhoof appears to be better correlated with the extent of freezing degree days of air temperature rather than the intensity of cumulative total degrees of freezing.

Based on observed conditions from these flights and those of previous years, several persistent open lead areas can be noted. The causes of open water in these locations vary from high velocity, thermal influences from lakes, tributaries or groundwater, to channel hydraulic conditions at constrictions, rapids, et cetera. Persistent open water areas and their postulated mode of origin are given in Table 19. The significance of the location of these open water areas is that they are prone to anchor ice formation by their nature of not being protected by a surface ice cover.

CONCLUSIONS

Based on the available physical data, the winter of 1992-93 was only slightly warmer winter than average for the 55 year period of record. It varies from the general occurence of significantly warmer winters observed in the last 10 years. Water temperature and ice conditions observed each winter must be viewed in the longer term context, and any individual year can not be considered representative of an average regime.

The ice observer program using local residents to record ice conditions on a daily basis was successful

Table 19
Winter Open Water Areas and Mode of Origin

Location	Mode of Origin
km 0-30	Thermal influence of Murray-Cheslatta
Canyons at Larson's (km 51 and 62)	High velocity, channel constriction
Perched Lake (km 52)	Groundwater flow out of lake
Diamond Island (km 75)	Shallow riffle, higher velocity
Groundwater feed near powerline (km 85)	Groundwater
Further downstream groundwater (km 89)	Groundwater
km 101-110	Thermal influence of Fraser Lake
Bird sanctuary area, Vanderhoof (km 156)	Shallow riffle, higher velocity
Vanderhoof road bridge (km 158)	Channel constriction, higher velocity
Hulatt Rapids (km 190)	Channel constriction, higher velocity

to varying degrees, depending on the reliability of the individual observer. In general however, the observer program provides valuable information at very low cost. The ice observers require some refinement of their observation techniques, in particular the documentation of a full time series should be stressed.

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APPENDIX 1
Ice Observer Notes

Appendix 1
Ice Observer Notes

The original forms and photographs are on file with the Department of Fisheries and Oceans.

In transcribing these notes, some editing was carried out to make photograph numbers compatible. Some additional comments based on the photographs have also been added. Finally, the percentage of ice types has been adjusted in some cases based on the photographs, to make the totals not greater than 100%, or to adjust overestimated ice cover.

Observer forms for the four locations, with three observers are included:

Location	Observer
1. Irvine's (km 19)	B. Irvine
2. Greer Creek (km 44)	B. Irvine
3. Larson's (km 57)	H. Larson
4. Fort Fraser (km 95)	L. LaRocque
5. River Ranch (km 27)	L. Stewart

NOTE:

OBSERVER: B. Irvine

LOCATION: #1 - Irvine's (km 19)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
2-Dec-92				open from sandbar d/s, shore breaking		1, 2	
3-Dec-92						3, 4	
4-Dec-92						5, 6	
5-Dec-92						7	
6-Dec-92						9, 10	
8-Dec-92						11, 12	
10-Dec-92						13, 14	
11-Dec-92						15, 16	
14-Dec-92						17, 18	
17-Dec-92						19, 20	
18-Dec-92	1045	1	650	3.5-7.0 m from shore	small amount frazil	21, 22	min air T -35, present -24
19-Dec-92	945	1	650	same, 18 cm snow	snow ice	23, 24	min air T -20, far channel frozen
20-Dec-92	1530	1	655	less	none	25, 26	air T -20
21-Dec-92						27, 28	

NOTE:

OBSERVER: B. Irvine

LOCATION: #1 - Irvine's (km 19)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
22-Dec-92						29, 30	
23-Dec-92						31, 32	
24-Dec-92				less	none	33, 34	air T -8
27-Dec-92	900	0.5	669	shore 30%, pan 50%, shallow anchor	shore, pan and anchor		air T -28, winds strong NW
28-Dec-92	900	0.5	828	shore 9.1 m, 50% anchor	frazil, pan	35, 36	air T -30, blowing snow
29-Dec-92	910	0.5	957			37, 38	air T -30, calm
30-Dec-92	1200	0.5	819	more shore , anchor gone, less floe	shore, floe	39, 40	air T -33, no wind
31-Dec-92	1230	0.5	778	more shore , anchor gone, less floe	shore, floe	41, 42	air T -38
1-Jan-93	1200	0.5	966	15.2 m shore , pan 75%	shore, pan	43, 44	max air T -33, min -41, river frozen 0.4 km d/s
2-Jan-93	800	0.5	1091 1111(1200h)		pan and slush	45, 46	max air T -30, min -38
4-Jan-93	1530	0.5	722	river clear, opening moved d/s		47, 48	max air T -16, min -20
5-Jan-93	840	0.5	815	pan 75%	pan and slush	49, 50	air T -40+
6-Jan-93	900	0.5	851	shore is 15.2 m or less	pan, frazil, anchor near top	51, 52	air T -40

NOTE:

OBSERVER: B. Irvine

LOCATION: #1 - Irvine's (km 19)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
7-Jan-93	1200	0.5	905	1.8 m more shore , 7.6 m anchor	shore, anchor and snow ice	53, 54	air T -35
8-Jan-93	800	0.5	746	same	frazil 10%	55, 56	air T -30
9-Jan-93	830	0.5	757	shore moving out, 75% pan and frazil	shore, pan and frazil	57, 58	air T -40
10-Jan-93	930	0.5	981 1052(1500h)	shore letting loose	pan	59, 60	air T -40
11-Jan-93	800	0.5	1301	pans piling up in front of dock	pan	61, 62	air T -40
12-Jan-93	845	0.5	1432	frozen over, open channel nest to island	ruff		air T -40
13-Jan-93	830	0.5	1410	10 cm at dock		63, 64	air T -42
14-Jan-93	800	0.5	1404	river frozen .8 km u/s		65, 66	air T -42
15-Jan-93	945	0.5	1402			67, 68	air T -35
16-Jan-93	830	0.5	1383				air T -36
20-Jan-93	900	0.5	1134	10 cm water overflow over 30 cm		69, 70	air T -13
21-Jan-93	845	0.5	1005	river opening up			air T -25
22-Jan-93	830	0.5	900				air T -25

NOTE:

OBSERVER: B. Irvine

LOCATION: #1 - Irvine's (km 19)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
23-Jan-93	830	1	767				air T -20
24-Jan-93	900		702	opening more		71, 72	air T -13
25-Jan-93	1630		649	breaking loose from shore			air T 2
26-Jan-93	830		649			73, 74	air T -8
30-Jan-93	900	1.5	629			75, 76	air T at 900 hrs 2, at 1530 12
11-Feb-93	900	1	633	1.8 m new shore , 25% frazil	shore and frazil	77, 78	air T -20
15-Feb-93	800		705	3.6 m shore , 75% frazil, 25% anchor	shore, frazil and anchor	79, 80	air T -29
20-Feb-93			794	50% anchor	anchor, conglomerate and	81, 82	air T -15, anchor ice rising to top
21-Feb-93		-1		lots of anchor	anchor	83, 84	air T -20
22-Feb-93					pan	85,86	air T -31
23-Feb-93			713		shore	87,88	air T -33
24-Feb-93			713		pan	89	air T -30
27-Feb-93						90,91	
28-Feb-93						92	

NOTE:

OBSERVER: B. Irvine

LOCATION: #2 - Greer Creek (km 44)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
2-Dec-92	830	1	1100	2.4 to 3 m shore , 25% pan	shore and frazil	93,94	air T -14
4-Dec-92				fairly thin shore			air T -13
5-Dec-92					small fragile ice floes		air T -13
7-Dec-92				thin from sandbar point to ramp	med. fragile ice floes		air T -8
8-Dec-92					med. and lrg. fragile ice floes		skim of ice across channel, air T -8
9-Dec-92							air T -2
10-Dec-92					huge fragile ice floes		air T -12
11-Dec-92				90% of sandbar covered, 3 to 6 m shore			air T -12
12-Dec-92						95,96	
13-Dec-92							air T from 0 to 8 at 1200 hrs
16-Dec-92				open from sandbar d/s, shore breaking		97,98	
20-Dec-92							river frozen from cabin d/s, air T -20
31-Dec-92						99,100	

NOTE:

OBSERVER: H. Larson

LOCATION: #3 - Larson's (km 57)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
1-Nov-92	1230	5	0				
2-Nov-92		4	0				
3-Nov-92		4	0				
4-Nov-92		4	0				
5-Nov-92		4	0				
6-Nov-92		4	0				
7-Nov-92		4	0				
8-Nov-92		4	0				
9-Nov-92		3	0				
10-Nov-92		3	0				
11-Nov-92		3	0			1, 2	air T 3 to 5
13-Nov-92	1600	3	0				no change
14-Nov-92	1600	3	0				
15-Nov-92	1600	3	0				

NOTE:

OBSERVER: H. Larson

LOCATION: #3 - Larson's (km 57)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
16-Nov-92	1600	3	0				persistant low cloud
17-Nov-92	1600	2	0				
18-Nov-92	1600	2	0				
19-Nov-92	1600	2	0				
20-Nov-92	1600	2	0				
21-Nov-92	1500	1	0				air T -1, heavy snowstorm
22-Nov-92	830	0	0	1%	shore	3, 4	air T -12
23-Nov-92	830	0	0	5%	shore	5, 6	air T -19
24-Nov-92	1530	0	0	10%	shore	7, 8	air T -11
25-Nov-92	1530	0	0	5%	shore		
26-Nov-92		0	0	5%	shore		
27-Nov-92	1600	0	0	5%	shore		no change
28-Nov-92	1600	0	0	5%	shore		
29-Nov-92	1600	0	0	5%	shore		

NOTE:

OBSERVER: H. Larson

LOCATION: #3 - Larson's (km 57)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
30-Nov-92	1530	0	0	5%	shore	9, 10	
1-Dec-92	1530	0	0	10%	shore		
2-Dec-92	1600	0	0	10%	shore		
3-Dec-92	1600	0	0	15%	shore		trace of frazil pans
4-Dec-92	1530	0	0	15% shore, 1% frazil pans	shore	11, 12	anchor and shore ice restricting flow 500 m d/s, flooding
5-Dec-92	800	0	0	15%	shore	13, 14	
6-Dec-92	800	0	0	20% shore, 5% frazil pans	shore and frazil pans		
7-Dec-92	800	0	0	20% shore, 5% frazil pans	shore and frazil pans		
8-Dec-92	1500	0	0	25% shore, 5% frazil pan	shore and frazil pans	15, 16	anchor and shore ice restricting flow 500 m d/s, flooding
9-Dec-92	1530	0	0	25% shore, 5% frazil pan			
10-Dec-92	1530	0	0	30% shore, 5% frazil, 5% anchor	shore, frazil and anchor	17, 18	signs of freeze-up
11-Dec-92	1530	0	0	30% shore, 5% frazil, 5% anchor	shore, frazil and anchor		
12-Dec-92	1530	0	0	30% shore, 5% frazil, 5% anchor	shore, frazil and anchor		

NOTE:

OBSERVER: H. Larson

LOCATION: #3 - Larson's (km 57)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
13-Dec-92	1530	0	0	30% shore, 5% frazil, 5% anchor	shore, frazil and anchor		
14-Dec-92	800		0	30%	shore		no anchor or frazil ice, unable to measure water T
15-Dec-92	800	0	0	30%	shore		
16-Dec-92	1400	0	0	30%	shore	19, 20	slight flooding
17-Dec-92	1230	0	0	30% shore, 15% pans		21	advancing ice cover 500 m d/s, air T -2
19-Dec-92							no report, blizzard conditions
20-Dec-92	1300	0	1	40% shore, 10% pans	shore and ice pans	22, 23	deep flooding, 23 cm new snow, 42 cm total
21-Dec-92	1300	0	1	40% shore, 10% pans	shore and ice pans		shore flooding
22-Dec-92	1600	0	1	40% shore, 5% pans	shore and ice pans		shore flooding
23-Dec-92	1500	0	1	40% shore, 5% pans	shore and ice pans	24, 25	slush down channel road, shore flooding
24-Dec-92	1400	0	1	50% shore, 5% pans	shore and ice pans	26	shore flooding
26-Dec-92	1400	0	1	55% shore, 5% pans	shore and ice pans	27, 28	arctic front, strong N wind

NOTE:

OBSERVER: H. Larson

LOCATION: #3 - Larson's (km 57)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
27-Dec-92							no report, zero vis., air T -26
28-Dec-92	1000	0	1	60% shore, 5% pans	shore and ice pans	29, 30	
29-Dec-92	1200	0	1	70% shore, 5% pans	shore and ice pans		
30-Dec-92	1000	0	1	75% shore, 5% pans	shore and ice pans	31, 32	air T at night -33
31-Dec-92	1100	0	1	95% shore, 5% pans	shore and ice pans	33, 34	air T -37
1-Jan-93	1600	0	1	85% shore, 5% pans	shore and ice pans		air T -36
2-Jan-93	1600	0	1	85% shore, 5% pans	shore and ice pans		heavy snow
3-Jan-93	1600	0	1	85% shore, 5% pans	shore and ice pans		15 cm new snow
4-Jan-93	1600	0	1	85% shore, 2% pans	shore and ice pans		total cover soon
5-Jan-93	1500	0	1	90% shore, trace pans	shore and ice pans	35, 36	air T -21
6-Jan-93	1300	0	1	95% shore, trace pans	shore and ice pans	37, 38	narrow open ice for 1 km
7-Jan-93	1500	0	1	95% shore, trace pans	shore and ice pans	39, 40	
8-Jan-93	1400	0	1	95% shore, trace pans	shore and ice pans	41, 42	narrow strip of open water
9-Jan-93	1600	0	1	95% shore, trace pans	shore and ice pans		

NOTE:

OBSERVER: H. Larson

LOCATION: #3 - Larson's (km 57)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
10-Jan-93	1100	0	1	95%	shore		ice fog, max air T -20, min -36
11-Jan-93	1600	0	1	98%	shore	43, 44	
12-Jan-93	1100	0	1	100%			ice fog
13-Jan-93	1100	0	1	100%		45, 46	mid-stream ice 43 cm
14-Jan-93							no change
15-Jan-93							no change
16-Jan-93							no change
17-Jan-93	1500	0	1	100%		47, 48	mid-stream ice 45 cm
18-Jan-93							no change
19-Jan-93							no change
20-Jan-93							no change
21-Jan-93							no change
22-Jan-93							no change
23-Jan-93							no change

NOTE:

OBSERVER: H. Larson

LOCATION: #3 - Larson's (km 57)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
24-Jan-93							no change
25-Jan-93							no change
26-Jan-93							no change
27-Jan-93	1600	0		100%		49, 50	ice 47 cm
28-Jan-93							no change
29-Jan-93							no change
30-Jan-93							no change
31-Jan-93							no change
1-Feb-93							no change
2-Feb-93	1600	0	1	100%		51, 52	ice holding solid
3-Feb-93							no change
4-Feb-93							no change
5-Feb-93							no change
6-Feb-93							no change

NOTE:

OBSERVER: H. Larson

LOCATION: #3 - Larson's (km 57)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
7-Feb-93							no change
8-Feb-93							no change
9-Feb-93	1600	0	1	100%		53, 54	ice 47 cm mid-stream
10-Feb-93							no change
11-Feb-93							no change
12-Feb-93							no change
13-Feb-93							no change
14-Feb-93							no change
15-Feb-93							no change
16-Feb-93							no change
17-Feb-93							no change
18-Feb-93							no change
19-Feb-93	1600	0	1	100%		55, 56	ice 49 cm mid-stream
20-Feb-93							no change

NOTE:

OBSERVER: H. Larson

LOCATION: #3 - Larson's (km 57)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
21-Feb-93							no change
22-Feb-93							no change
23-Feb-93							no change
24-Feb-93							no change
25-Feb-93							no change
26-Feb-93	1530	0	1	100%		57, 58	ice 49 cm, ice "creaking"
27-Feb-93	1600	0	1	100%			3 hinge cracks, ice settling
28-Feb-93	1100	0	1	water flowing on top of ice		59, 60	night air T -1, day air T 9, upturned pans u/s
1-Mar-93	830	0	1	100%			
2-Mar-93	1600	0	1	100%			
3-Mar-93	1600	0	1	100%			
4-Mar-93	1100	0	1	100%		61, 62	ice fragile, not open yet
5-Mar-93	1600	0	1	100%			

NOTE:

OBSERVER: H. Larson

LOCATION: #3 - Larson's (km 57)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
6-Mar-93	1600	0	1	100%		63, 64	air T max 9, min -2
7-Mar-93							no change
8-Mar-93							no change
9-Mar-93							no change
10-Mar-93	1600	0	1	100%		65, 66	
11-Mar-93	1600	0	1	100%			
12-Mar-93	1600	0	1	100%			
13-Mar-93	800	0	0			67, 68	ice break-up began in late evening
14-Mar-93	1600	0	0	15%	shore		
15-Mar-93	1600	0	0	15%	shore		snowstorm
16-Mar-93	1500	0	0	15%	shore	69, 70	night air T -23
17-Mar-93	1600	0	0	12%	shore		
18-Mar-93	1600	0	0	12%	shore		
19-Mar-93	1600	0	0	10%	shore	71, 72	

NOTE:

OBSERVER: H. Larson

LOCATION: #3 - Larson's (km 57)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
20-Mar-93	1600	0	0	10%	shore		
21-Mar-93	1130	0	0	5%	shore	73, 74	strong wind creating turbulance
22-Mar-93	1600	0	0	3%	shore		
23-Mar-93	1600	0	0	2%	shore		
24-Mar-93	1600	0	0	none			
25-Mar-93	800	0	0				
26-Mar-93	1700	0	0				
27-Mar-93	1600	0	0			75, 76	
28-Mar-93	1500	0	0				
29-Mar-93	1230	0	0				
30-Mar-93	1600	0	0				
31-Mar-93	1530	0	0			77, 78	
1-Apr-93	1600	2	5cm				
2-Apr-93	1230	2					

NOTE:

OBSERVER: H. Larson

LOCATION: #3 - Larson's (km 57)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
3-Apr-93	1600	3					
4-Apr-93	1100	2				79--82	
5-Apr-93	1500	3					air T 9
6-Apr-93	1230	2	5cm				snowing
7-Apr-93	1600	2	5cm				raining
8-Apr-93	1100	2	5cm			83,84	
9-Apr-93	1230	2	5cm				large hail storm
10-Apr-93	900	1	8cm			85,86	63.5 cm precip. in two days
11-Apr-93	900	1	10cm			87,88	
12-Apr-93	1500	3	10cm			89,90	air T ranges -5 to 11
13-Apr-93	1600	3	10cm				
14-Apr-93	1600	3	10cm				
15-Apr-93	1230	3	10cm				
16-Apr-93	1500	3	10cm			91,92	

NOTE:

OBSERVER: H. Larson

LOCATION: #3 - Larson's (km 57)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
17-Apr-93	1230	4	10cm				
18-Apr-93	1500	5	12cm				large rain storm
19-Apr-93	900	5	12cm			93,94	
20-Apr-93	1600	5	14cm				
21-Apr-93	800	6	14cm			95,96	
22-Apr-93	830	5	14cm				fog and cool wind
23-Apr-93	1000	5	16cm			97,98	
27-Apr-93	1600	6	20cm			99 - 100	water turbid
28-Apr-93	1600	7	30cm				water turbid
29-Apr-93	1300	8	35cm			101 - 102	water turbid
30-Apr-93	1630	8	40cm			103 - 104	water visability ~1m

NOTE:

OBSERVER: L. LaRocque

LOCATION: #4 - Fort Fraser (km 95)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
7-Nov-92	1200	3		nil	nil	1, 2	snow cover, 13 cm
11-Nov-92	1000	4		nil	nil	3, 4	river up 2 cm
16-Nov-92	1200	5		nil	nil	5, 6	air T 0, river down 4 cm
21-Nov-92	1330	3		nil	nil	7, 8	light snow, river up 5 cm
24-Nov-92		1		shell cover, 100% overnight	frazil, shore to shore	9, 10	air T 11, river up 7.5 cm
25-Nov-92		1		100%	.75 cm thick	11	river dropped 2.5 cm, air T 14
28-Nov-92		1		shore to shore	ice 8 cm thick 60 cm from shore	12, 13	shell ice at shore, river down 2 cm, hard rain on 26th
6-Dec-92				100%	6 cm at shore	14, 15	river dropped 40 cm in 7 days
9-Dec-92				100%	21 cm 3 m from shore		river up 18 cm
12-Dec-92				100%	31 cm 3 m from shore	16, 17	up 12 cm, light snow
23-Dec-92				100%		18, 19	snow fall to date is 34 cm, air T -14
29-Dec-92				100%	33 cm 10 m from shore	20	8 cm overflow, 31cm snow, air T -23

NOTE:

OBSERVER: L. LaRocque

LOCATION: #4 - Fort Fraser (km 95)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
4-Jan-93				top overflow is 6 cm, under is 36 cm		21, 22	water between ice 2 cm, air T -18. 14 cm new snow
12-Jan-93				39.5 cm		23, 24	clear and cold, air T -38
21-Jan-93				43 cm		25, 26	sunny and clear, air T -18, no new snow
26-Jan-93				43 cm		27	air T 6, 2.75 cm new snow
1-Feb-93						28, 29	
5-Feb-93		0.1		61.25 cm		30, 31	mild weather, air T 3, some overflow
7-Feb-93						32, 33	
10-Feb-93		0.1		62 cm		34, 35	air T -20
16-Feb-93		0.1		63.5 cm		36, 37	air T ranged between -21 and -33, clear and cold
20-Feb-93						38	
25-Feb-93		0.1		61 cm		39 - 42	sunny all day, air T -30 at 0700
28-Feb-93		0.1		2 cm water over	soft	43 - 45	mild, no frost, air T 11 at 1330

NOTE:

OBSERVER: L. LaRocque

LOCATION: #4 - Fort Fraser (km 95)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
4-Mar-93		0.1		100%	honeycomb	46 - 49	no frost, air T -13
8-Mar-93				100%	honeycomb	50 - 53	air T - 6
10-Mar-93				at 18 m, shore 62 cm, some overflow			air T at 0700 is -6
29-Mar-93					soft, candle	54 - 57	river ice out at 1900H
8-Apr-93		6		10%	shore	58 - 61	water level rising Alcan spilling 2000 cfs
10-Apr-93		3		10%	shore	62 - 64	
15-Apr-93		7	up 11cm	1%	shore	65,66	
20-Apr-93		8	up 12.7cm	nil	nil	67,68	water clear, air T 0°C
28-Apr-93		7.8	up 3.8cm	nil	nil	69,70	air T at 600 is 0°C
Unknown						71,72	

NOTE: Photographic record only available for this site.

OBSERVER: L. Fromme

LOCATION: #5 - River Ranch (km 27)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
6-Dec-92						1,2	
7-Dec-92						3	
8-Dec-92						4	
9-Dec-92						5	
10-Dec-92						6	
11-Dec-92						7	
12-Dec-92						8	
14-Dec-92						9	
15-Dec-92						10	
16-Dec-92						11	
17-Dec-92						12	
18-Dec-92						13	
19-Dec-92						14	
20-Dec-92						15	

NOTE: Photographic record only available for this site.

OBSERVER: L. Fromme

LOCATION: #5 - River Ranch (km 27)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
21-Dec-92						16	
23-Dec-92						17	
24-Dec-92						18	
25-Dec-92						19	
26-Dec-92						20	
27-Dec-92						21	
28-Dec-92						22	
29-Dec-92						23	
30-Dec-92						24	
25-Jan-93						25	
27-Jan-93						26	
28-Jan-93						27	
29-Jan-93						28	
30-Jan-93						29	

NOTE: Photographic record only available for this site.

OBSERVER: L. Fromme

LOCATION: #5 - River Ranch (km 27)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
1-Feb-93						30	
2-Feb-93						31	
5-Feb-93						32	
7-Feb-93						33,34	
8-Feb-93						35	
9-Feb-93						36	
10-Feb-93						37	
11-Feb-93						38	
13-Feb-93						39	
15-Feb-93						40	
16-Feb-93						41	
17-Feb-93						42	
18-Feb-93						43	
20-Feb-93						44	

NOTE: Photographic record only available for this site.

OBSERVER: L. Fromme

LOCATION: #5 - River Ranch (km 27)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
21-Feb-93						45	
23-Feb-93						46	
25-Feb-93						47	
26-Feb-93						48,49	
27-Feb-93						50	
28-Feb-93						51	
1-Mar-93						52,53	
2-Mar-93						54	
3-Mar-93						55	
6-Mar-93						56	
7-Mar-93						57	
8-Mar-93						58	
9-Mar-93						59	
10-Mar-93						60	

NOTE: Photographic record only available for this site.

OBSERVER: L. Fromme

LOCATION: #5 - River Ranch (km 27)

DATE	TIME	WATER TEMP (°C)	STAGE	ICE PRESENCE/AMOUNT	ICE TYPE	PHOTOGRAPHS	COMMENTS
11-Mar-93						61,62	
12-Mar-93						63	
14-Mar-93						64	
15-Mar-93						65	

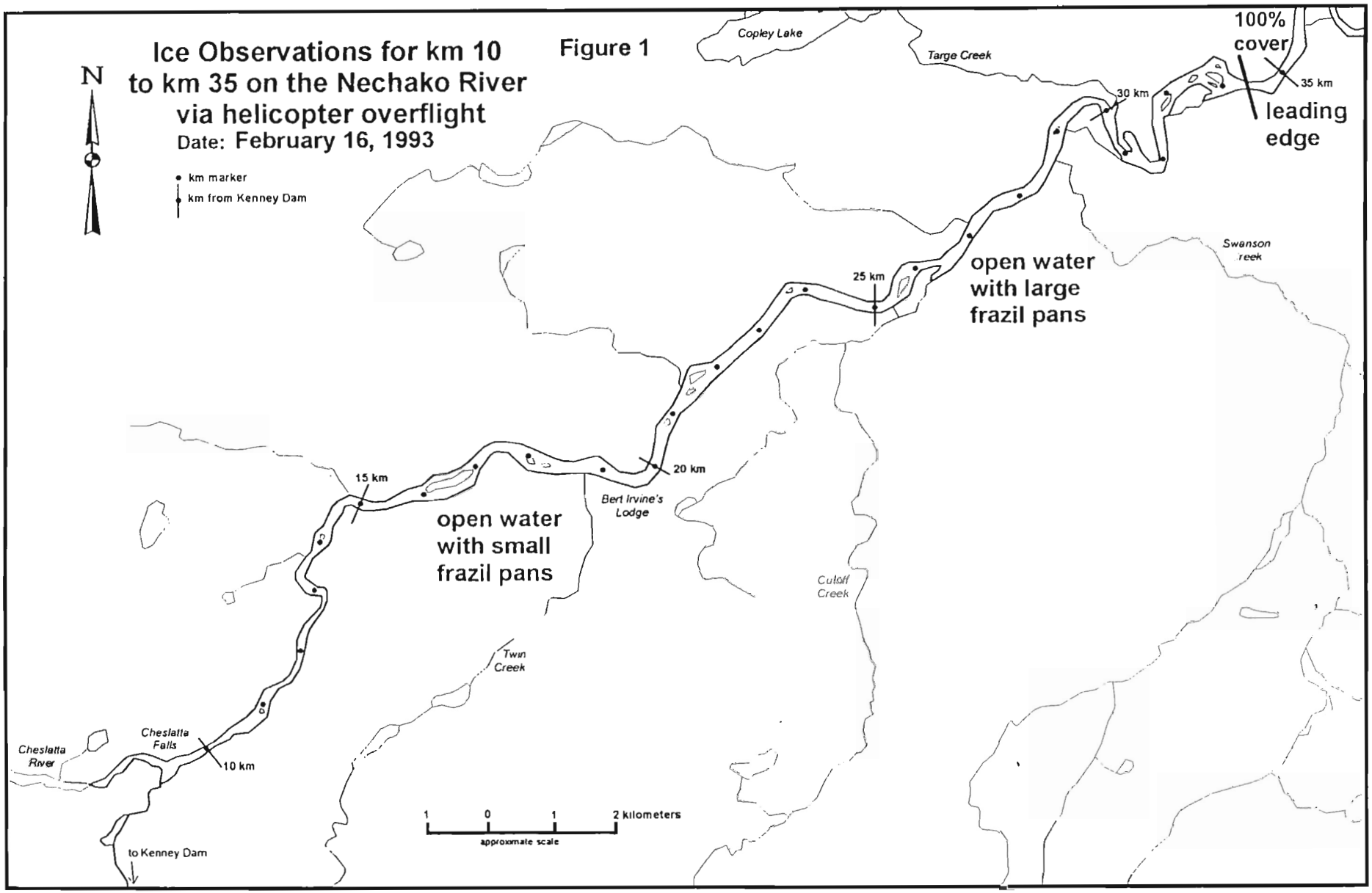
APPENDIX 2
Ice Cover Maps

Appendix 2
Ice Cover Maps

These maps were compiled during aerial overview flights made by fixed wing aircraft and helicopters. Photographs and notes were taken on these flights by 2 or 3 individuals, and are on file at the Department of Fisheries and Oceans.

Figure Numbers:

Figures 1 - 7	Ice observations on the Nechako River, February 16, 1993
Figures 8 - 14	Ice observations on the Nechako River, March 23, 1993


Ice Observations for km 10 to km 35 on the Nechako River via helicopter overflight
Date: February 16, 1993
Figure 1
N
km marker
km from Kenney Dam
Copley Lake
Targe Creek
100% cover
leading edge
30 km
35 km
Swanson Creek
25 km
open water with large frazil pans
15 km
20 km
Bert Irvine's Lodge
open water with small frazil pans
Cutoff Creek
Twin Creek
Cheslatta River
Cheslatta Falls
10 km
to Kenney Dam
1 0 1 2 kilometers
approximate scale

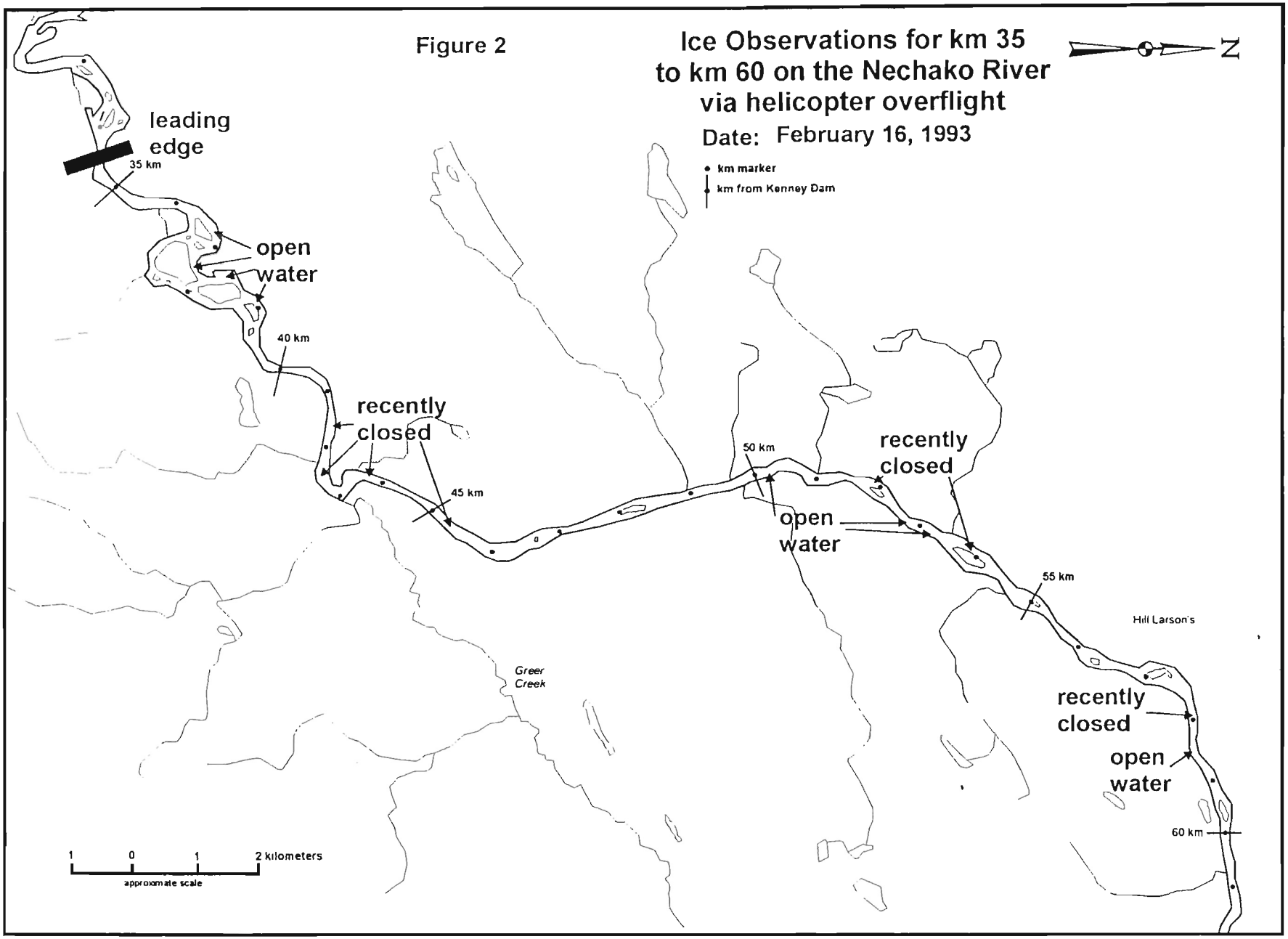


Figure 2
Ice Observations for km 35
to km 60 on the Nechako River
via helicopter overflight
Date: February 16, 1993
N
km marker
km from Kenney Dam
leading
edge
35 km
open
water
40 km
recently
closed
45 km
50 km
recently
closed
open
water
55 km
Hill Larson's
Greer
Creek
recently
closed
open
water
60 km
1 0 1 2 kilometers
approximate scale

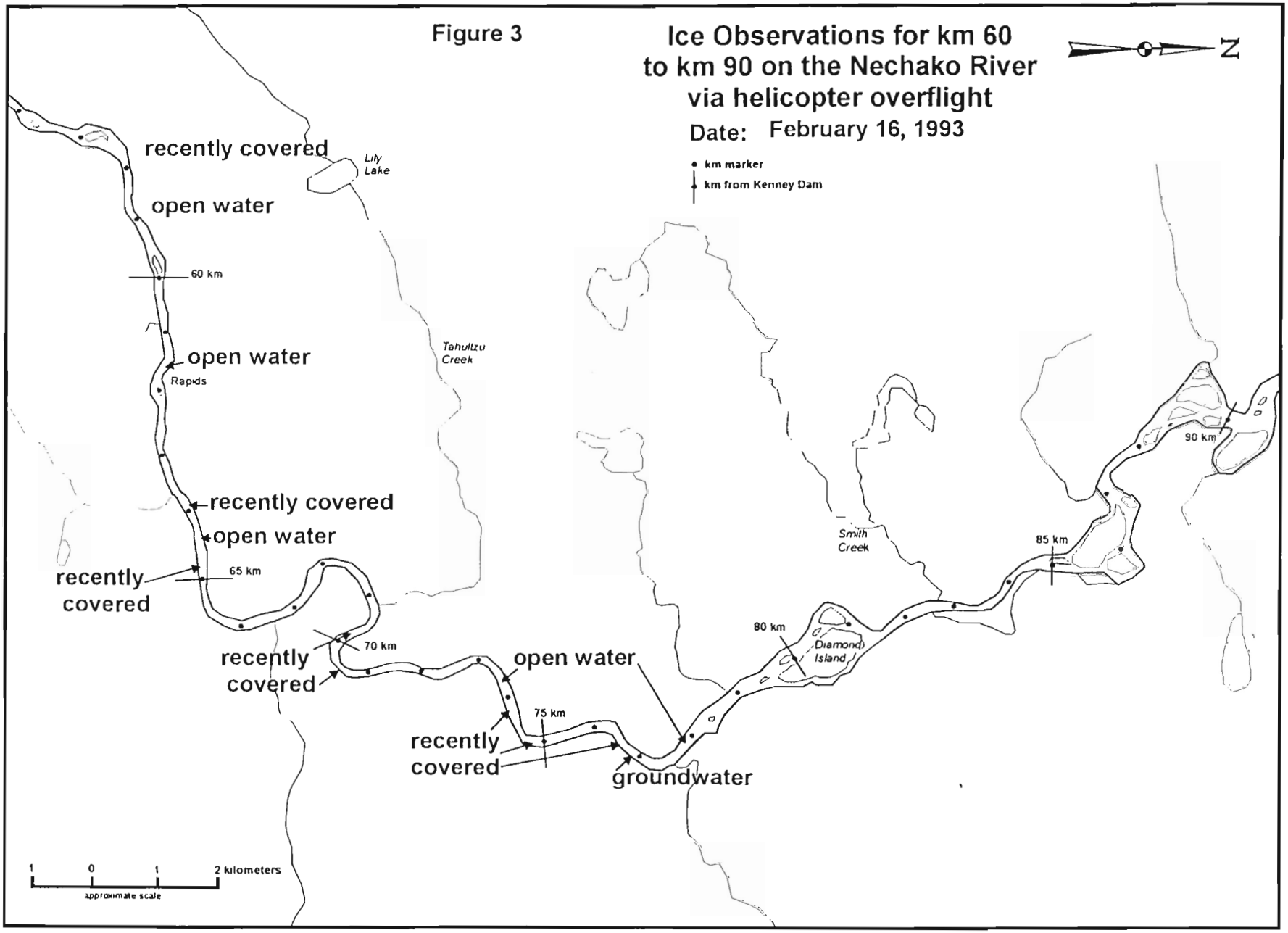


Figure 3
Ice Observations for km 60 to km 90 on the Nechako River via helicopter overflight
Date: February 16, 1993
N
km marker
km from Kenney Dam
recently covered
Lily Lake
open water
60 km
open water
Rapids
Tahultzu Creek
recently covered
open water
recently covered
65 km
70 km
recently covered
open water
75 km
recently covered
groundwater
80 km
Diamond Island
Smith Creek
85 km
90 km
1 0 1 2 kilometers
approximate scale

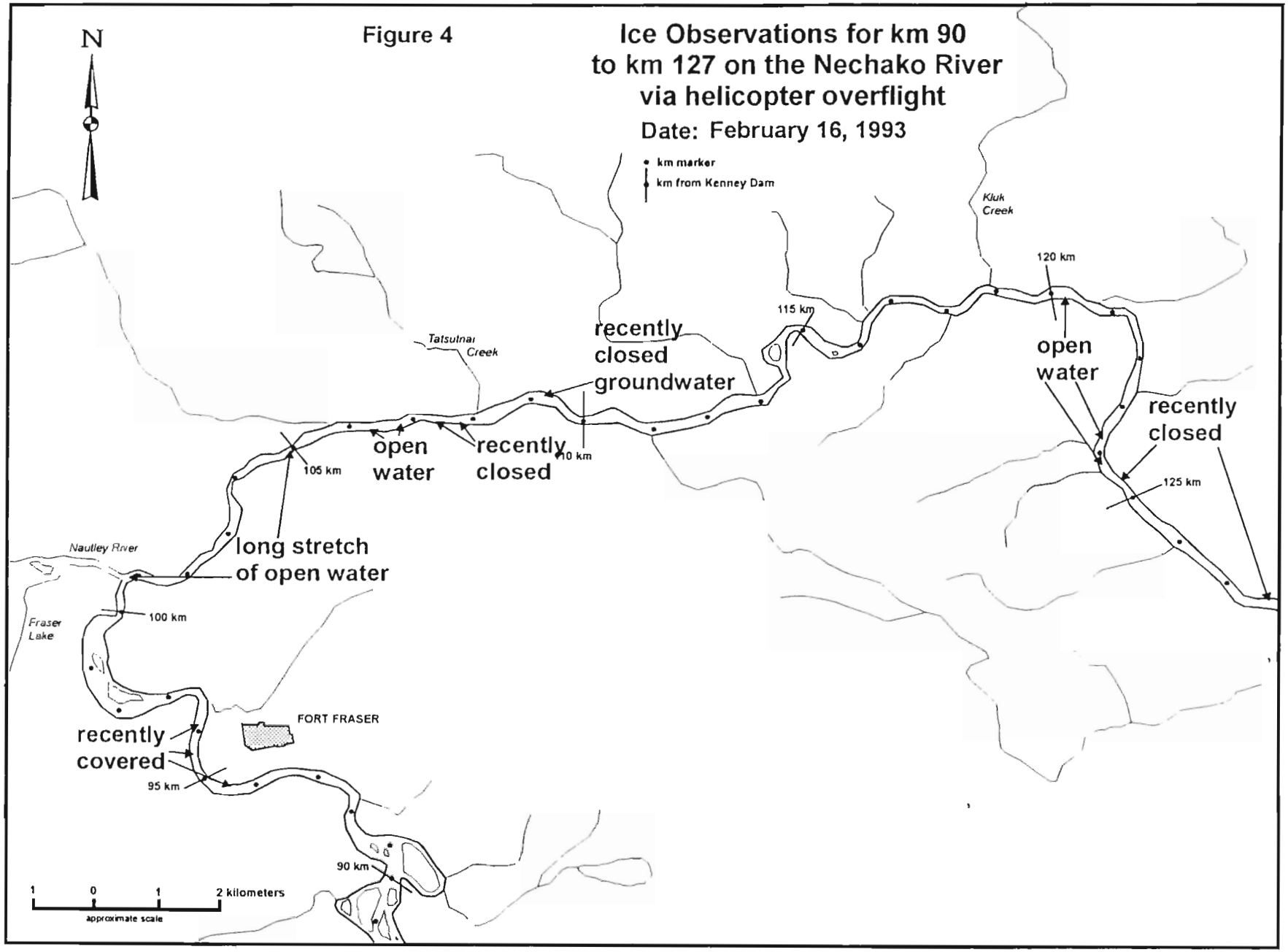


Figure 4
Ice Observations for km 90
to km 127 on the Nechako River
via helicopter overflight
Date: February 16, 1993
N
km marker
km from Kenney Dam
Kluk
Creek
120 km
115 km
Tatsutnai
Creek
recently
closed
groundwater
open
water
recently
closed
110 km
105 km
open
water
recently
closed
125 km
Nautley River
long stretch
of open water
Fraser
Lake
100 km
FORT FRASER
recently
covered
95 km
90 km
1 0 1 2 kilometers
approximate scale

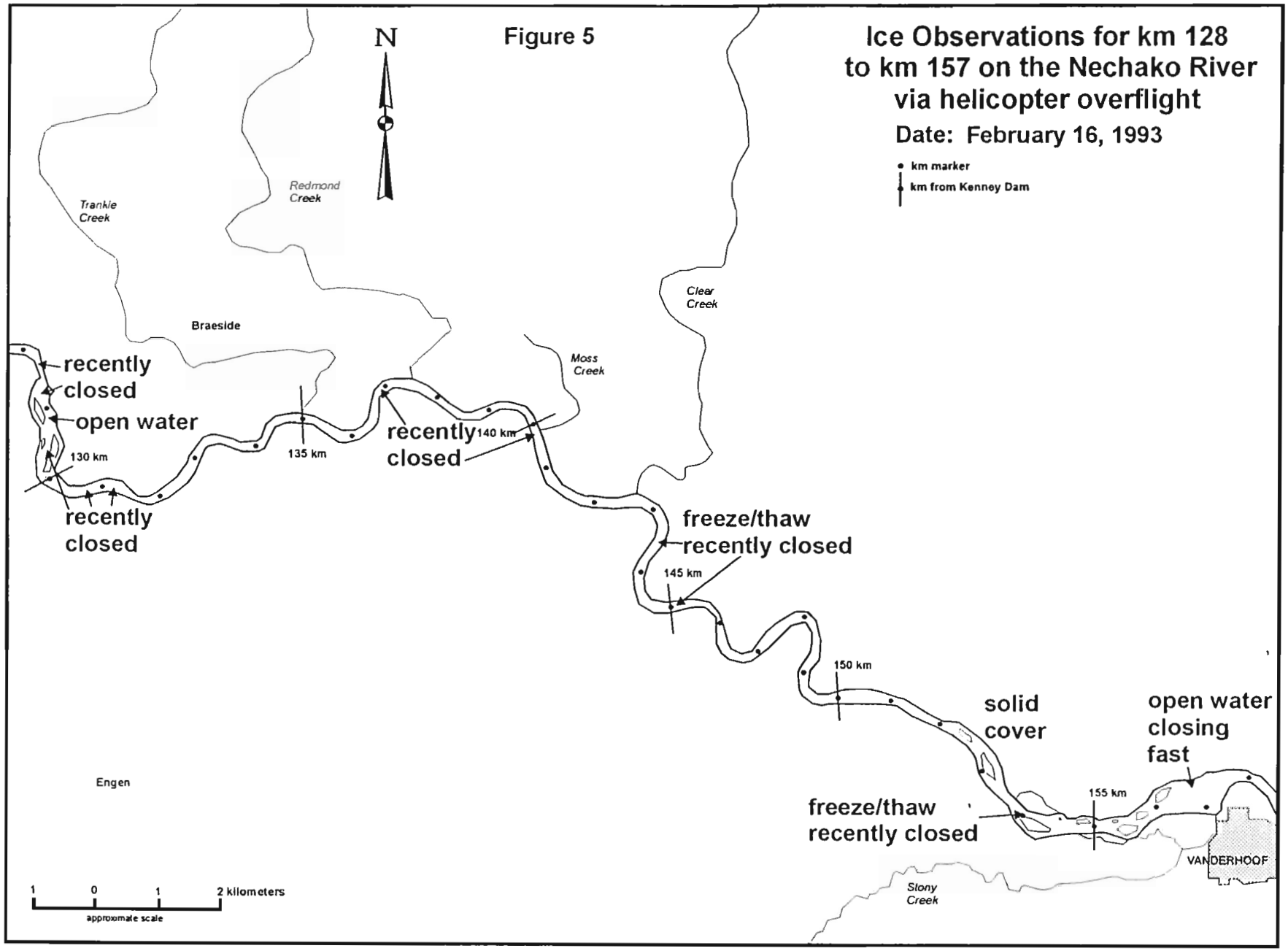
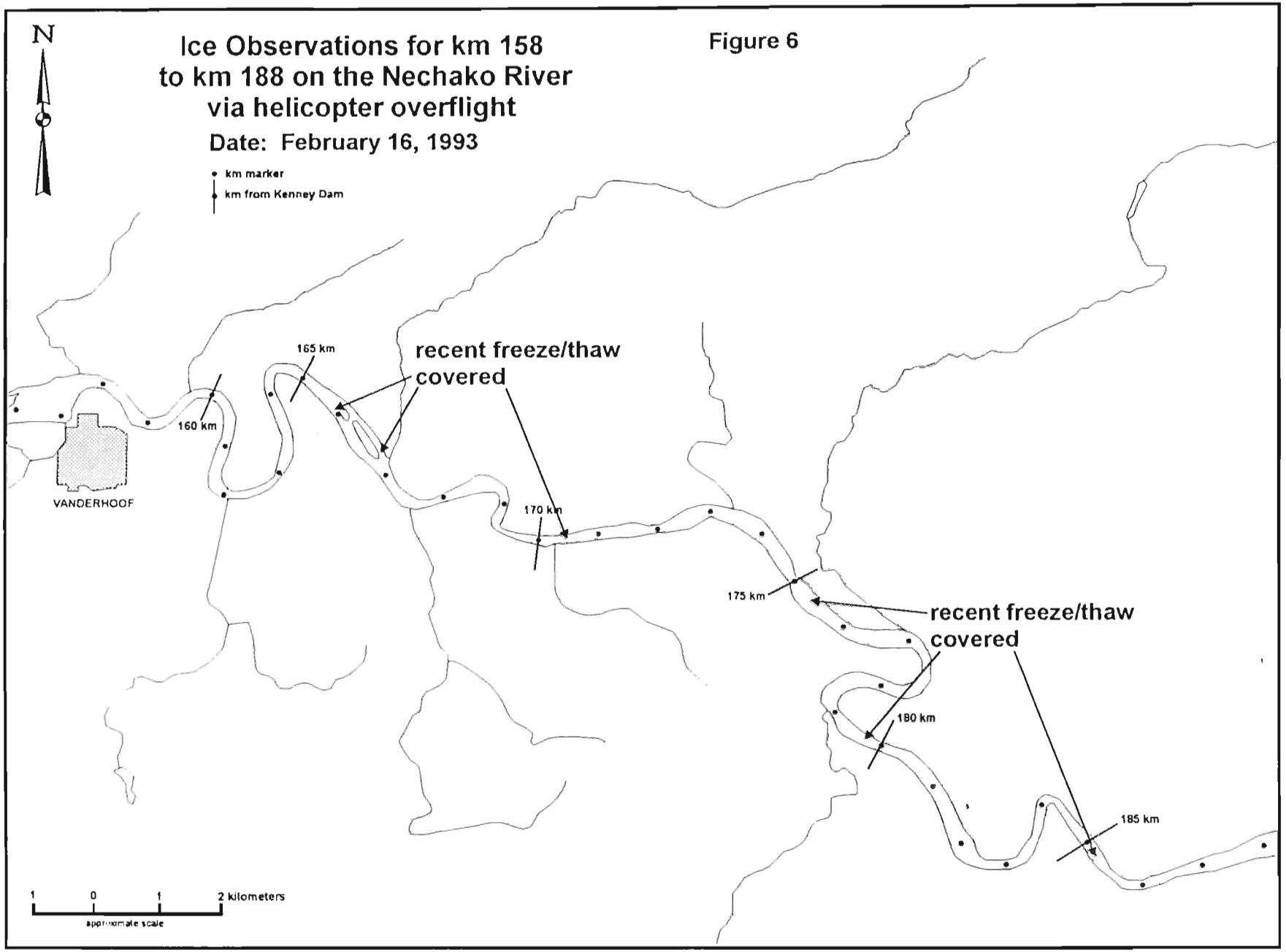
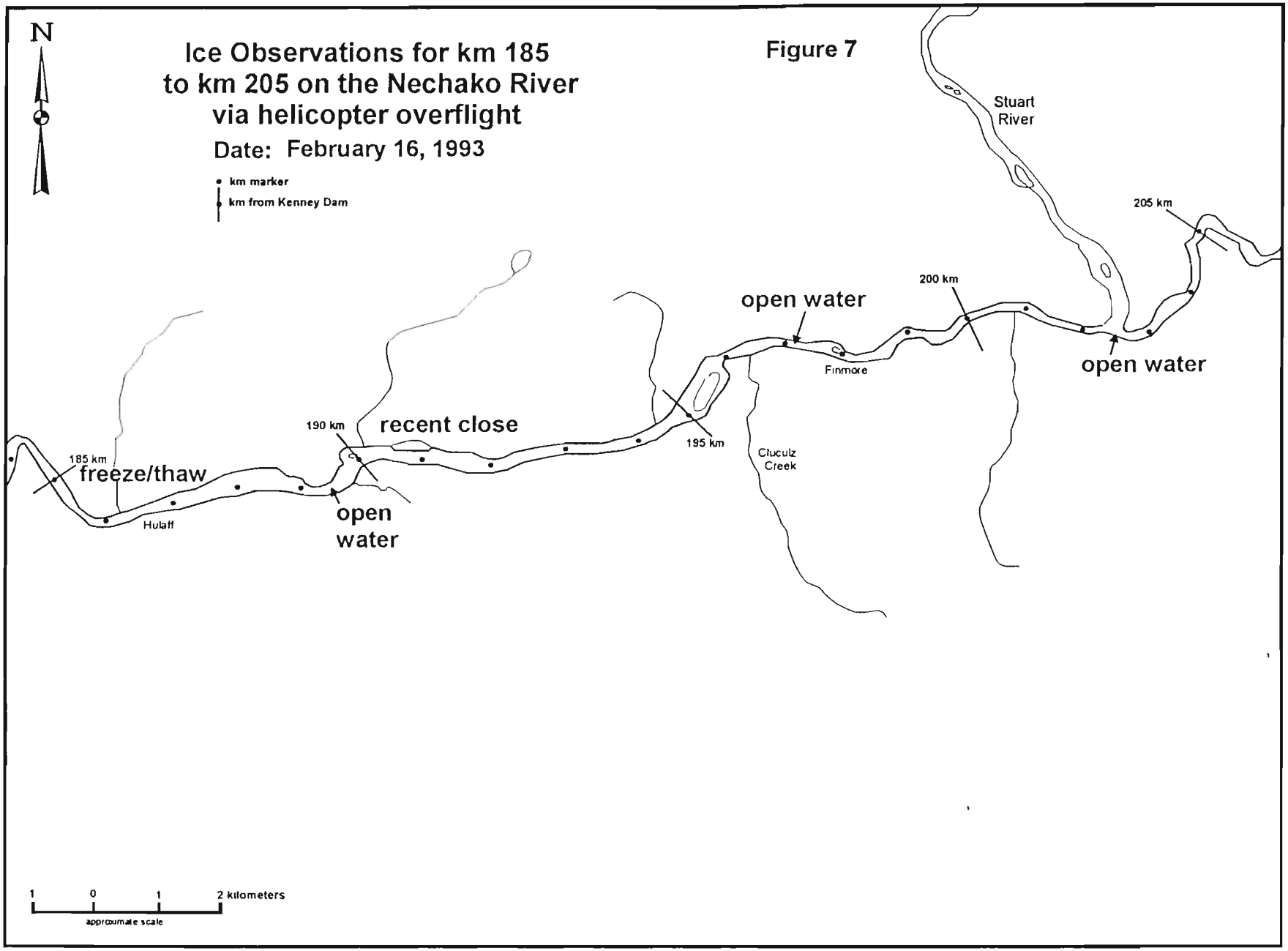
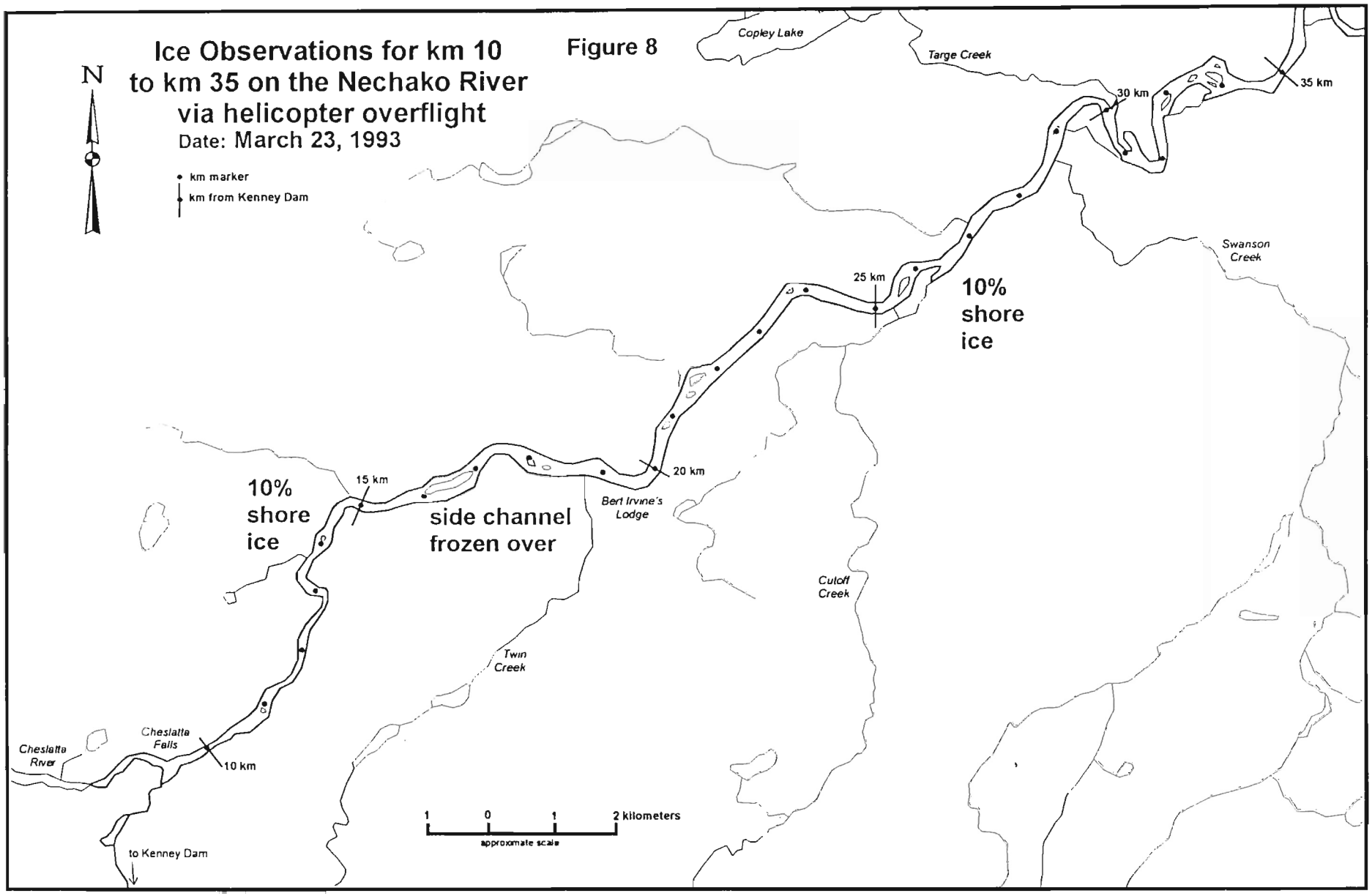


Figure 5
Ice Observations for km 128 to km 157 on the Nechako River via helicopter overflight
Date: February 16, 1993
km marker
km from Kenney Dam
N
Trankle Creek
Redmond Creek
Clear Creek
Braeside
Moss Creek
recently closed
open water
130 km
135 km
recently closed
140 km
recently closed
freeze/thaw
recently closed
145 km
150 km
solid cover
open water closing fast
155 km
freeze/thaw
recently closed
VANDERHOOF
Stony Creek
Engen
1 0 1 2 kilometers
approximate scale


N
Ice Observations for km 158
to km 188 on the Nechako River
via helicopter overflight
Date: February 16, 1993
Figure 6
km marker
km from Kenney Dam
165 km
recent freeze/thaw
covered
160 km
VANDERHOOF
170 km
175 km
recent freeze/thaw
covered
180 km
185 km
1 0 1 2 kilometers
approximate scale


N
Ice Observations for km 185
to km 205 on the Nechako River
via helicopter overflight
Date: February 16, 1993
km marker
km from Kenney Dam
Figure 7
Stuart
River
205 km
200 km
open water
Finmore
open water
190 km
recent close
195 km
185 km
freeze/thaw
Cluculz
Creek
Hulaff
open
water
1 0 1 2 kilometers
approximate scale


Ice Observations for km 10 to km 35 on the Nechako River via helicopter overflight
Figure 8
Date: March 23, 1993
N
km marker
km from Kenney Dam
Copley Lake
Targe Creek
30 km
35 km
Swanson Creek
25 km
10% shore ice
10% shore ice
15 km
20 km
side channel frozen over
Bert Irvine's Lodge
Cutoff Creek
Twin Creek
Cheslatta Falls
Cheslatta River
10 km
1 0 1 2 kilometers
approximate scale
to Kenney Dam

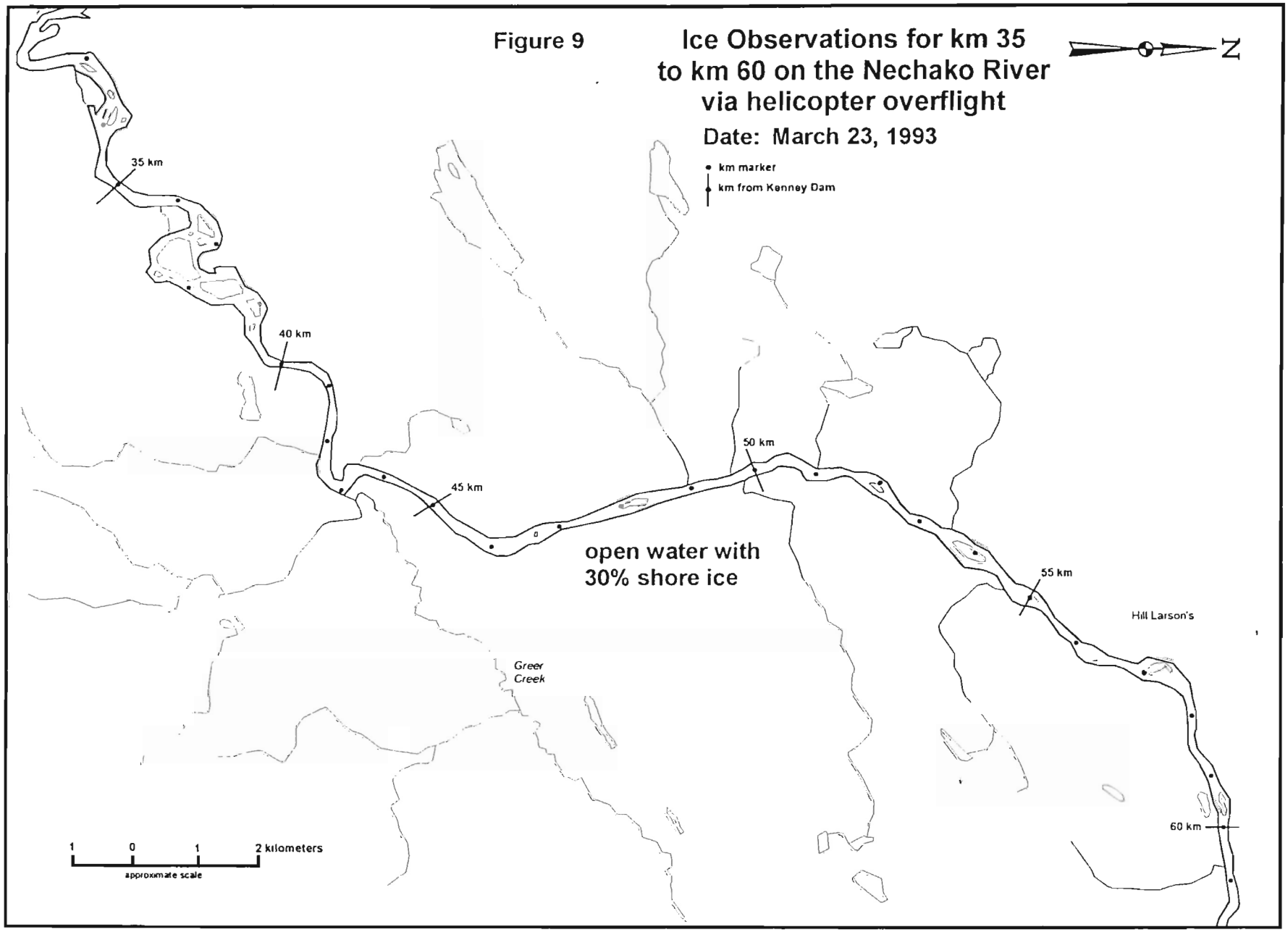
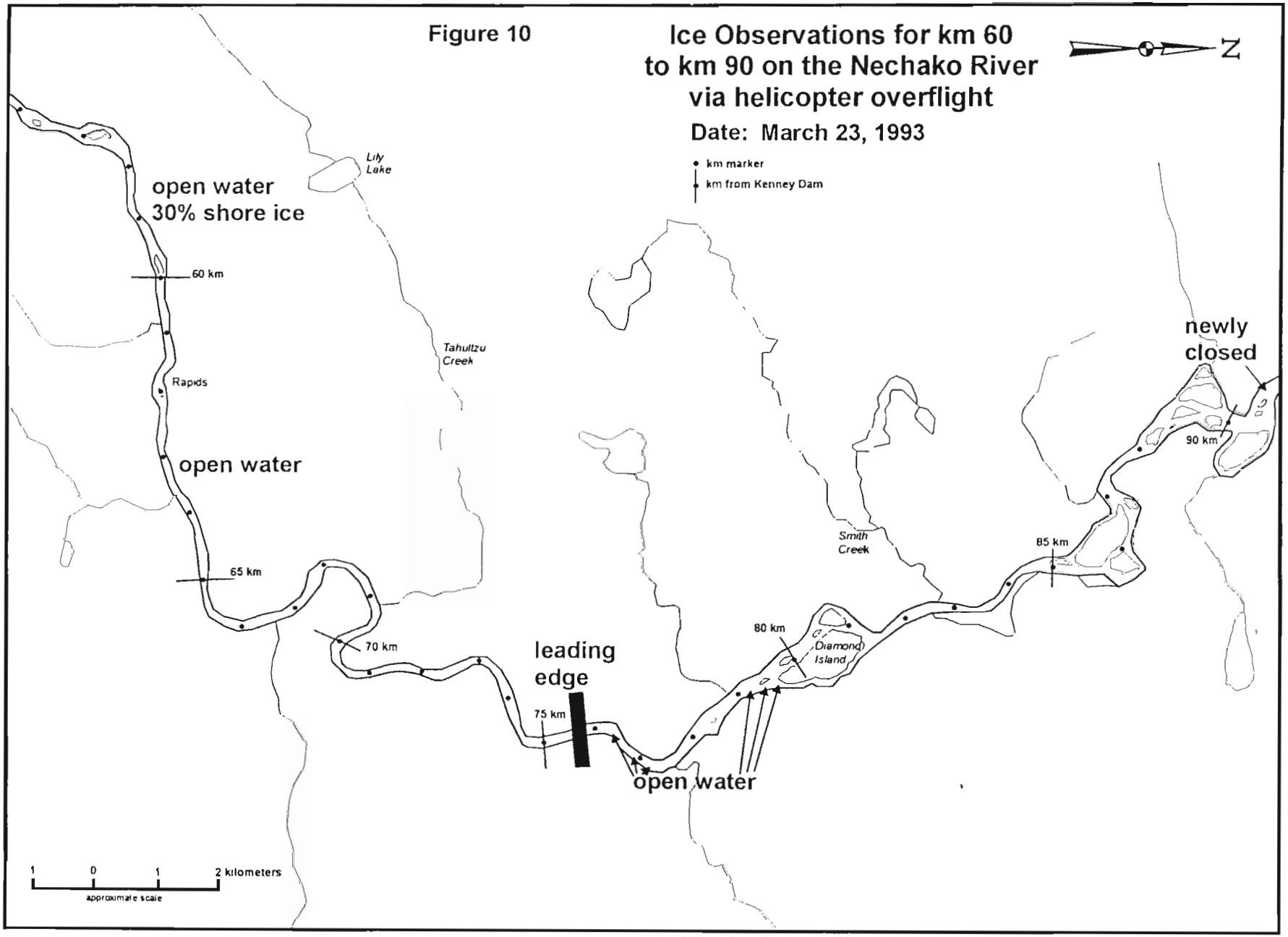


Figure 9
Ice Observations for km 35 to km 60 on the Nechako River via helicopter overflight
Date: March 23, 1993
N
km marker
km from Kenney Dam
35 km
40 km
45 km
50 km
55 km
60 km
open water with 30% shore ice
Greer Creek
Hill Larson's
1 0 1 2 kilometers
approximate scale

Figure 10

Ice Observations for km 60 to km 90 on the Nechako River via helicopter overflight

Date: March 23, 1993



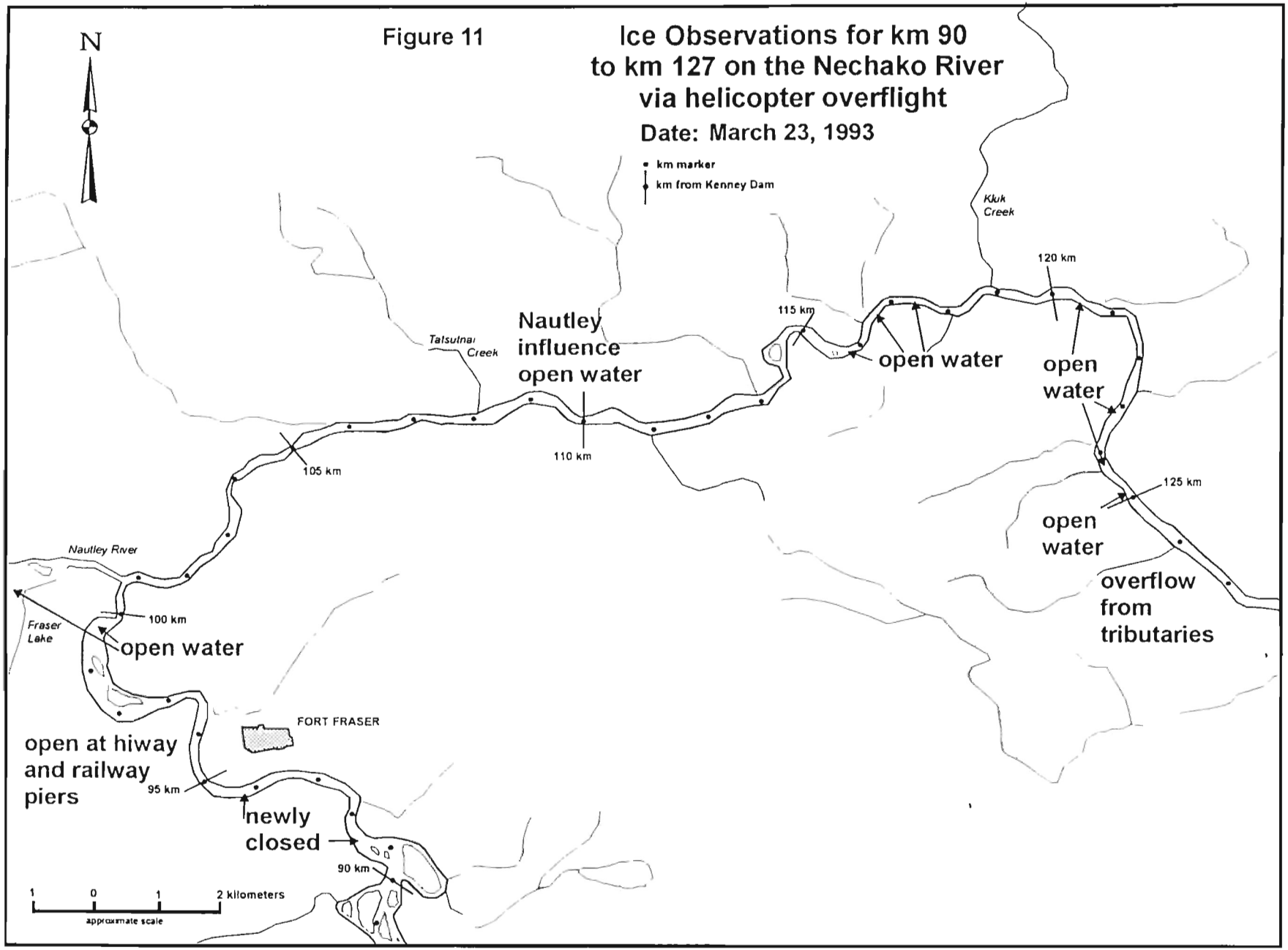


Figure 11
Ice Observations for km 90 to km 127 on the Nechako River via helicopter overflight
Date: March 23, 1993
N
km marker
km from Kenney Dam
Kluk Creek
120 km
115 km
Nautley influence open water
Talsulnai Creek
open water
open water
110 km
105 km
125 km
open water
Nautley River
overflow from tributaries
Fraser Lake
100 km
open water
FORT FRASER
open at hiway and railway piers
95 km
newly closed
90 km
1 0 1 2 kilometers
approximate scale

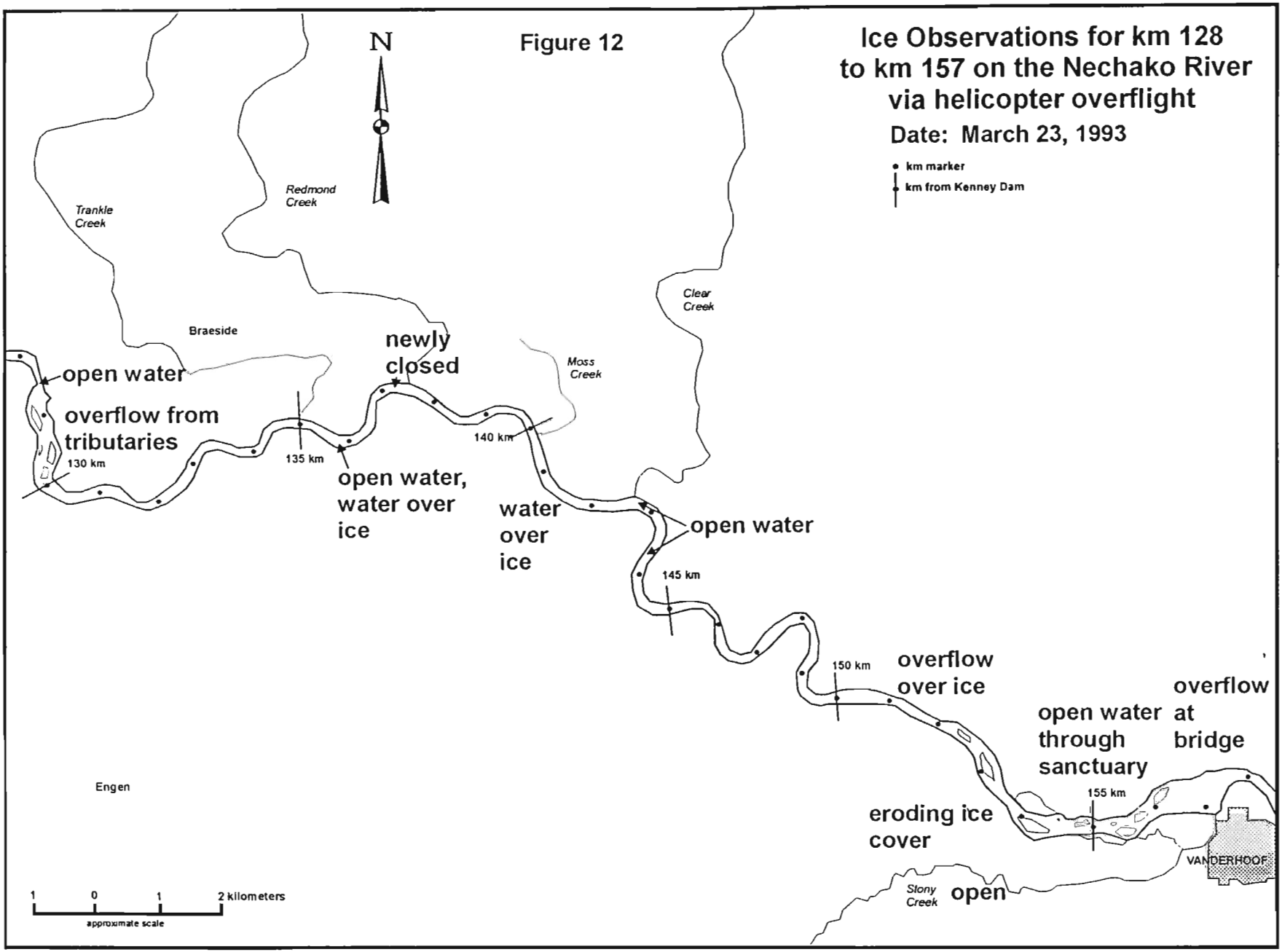
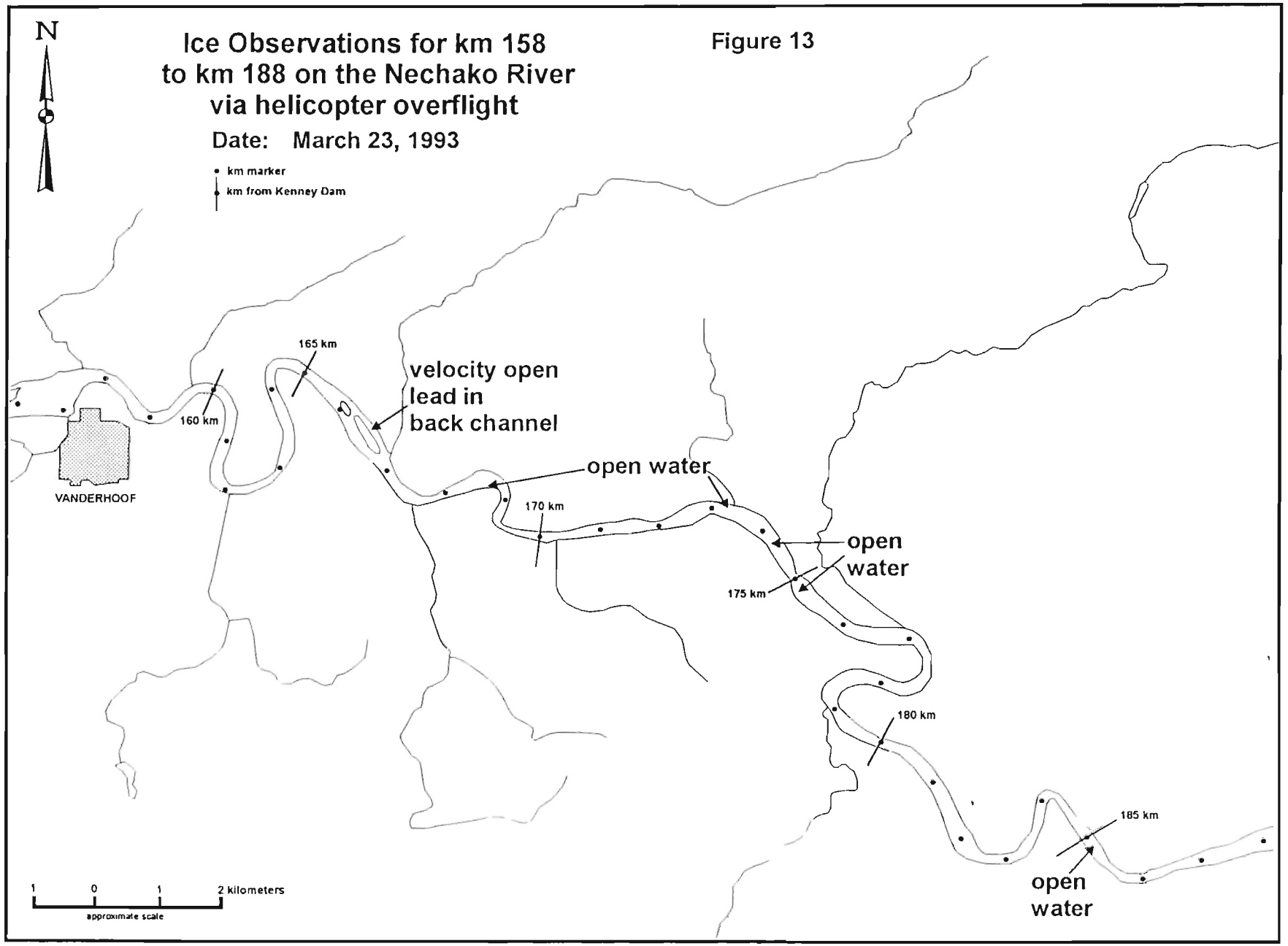
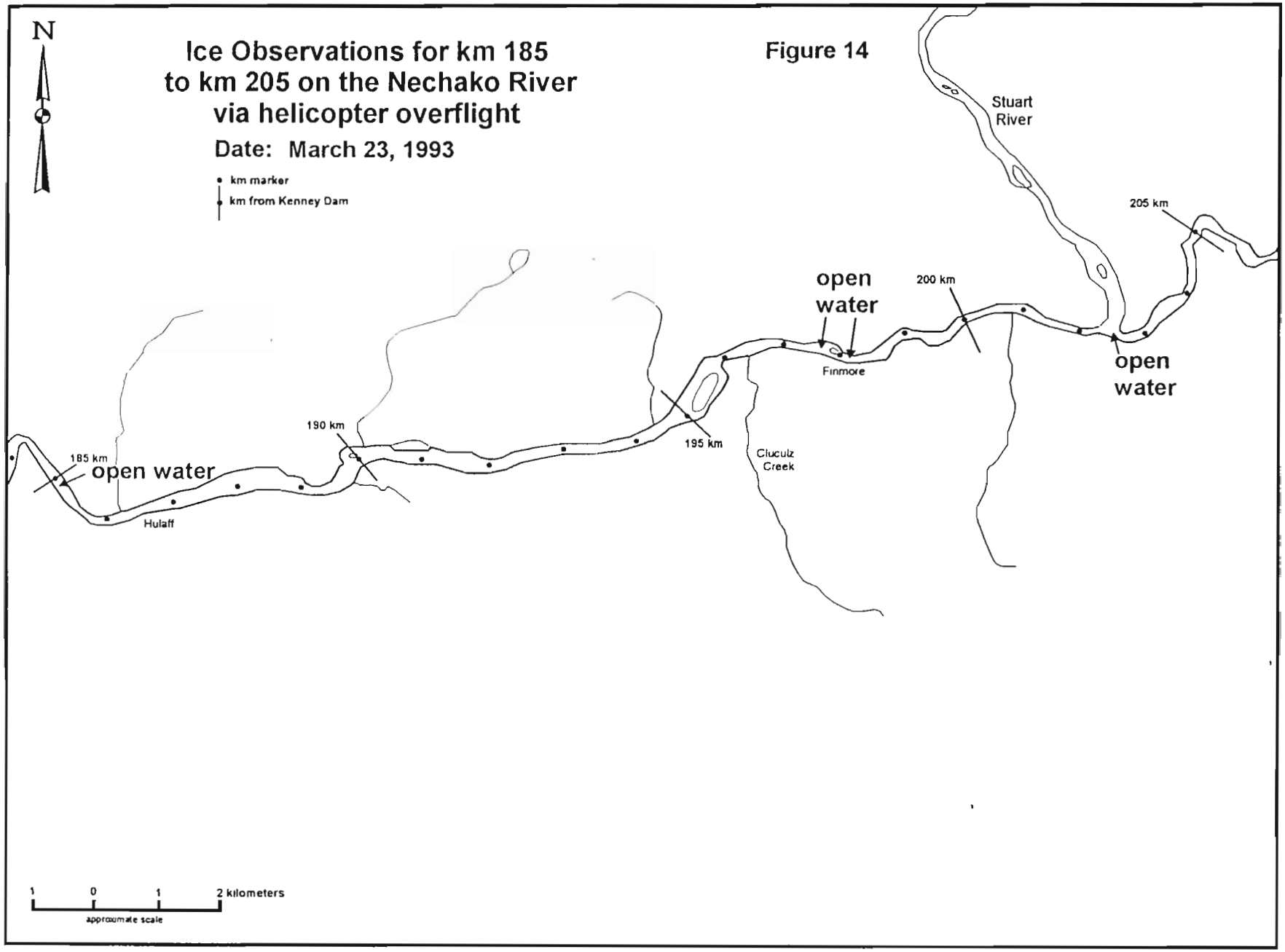


Figure 12
Ice Observations for km 128 to km 157 on the Nechako River via helicopter overflight
Date: March 23, 1993
km marker
km from Kenney Dam
N
Trankle Creek
Redmond Creek
Clear Creek
Braeside
Moss Creek
Engen
open water
overflow from tributaries
130 km
135 km
newly closed
open water, water over ice
140 km
water over ice
open water
145 km
150 km
overflow over ice
open water through sanctuary
155 km
overflow at bridge
eroding ice cover
VANDERHOOF
Stony Creek
open
1 0 1 2 kilometers
approximate scale


N
Ice Observations for km 158
to km 188 on the Nechako River
via helicopter overflight
Figure 13
Date: March 23, 1993
km marker
km from Kenney Dam
165 km
velocity open
lead in
back channel
160 km
VANDERHOOF
open water
170 km
open
water
175 km
180 km
185 km
open
water
1 0 1 2 kilometers
approximate scale


N
Ice Observations for km 185
to km 205 on the Nechako River
via helicopter overflight
Date: March 23, 1993
km marker
km from Kenney Dam
Figure 14
Stuart
River
205 km
open
water
200 km
Finmore
open
water
190 km
195 km
185 km
open water
Cluculz
Creek
Hulaff
1 0 1 2 kilometers
approximate scale