ARCHIVE OF THE ICE RECORD FROM KNOB LAKE, QUEBEC, 1954 TO PRESENT

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ABSTRACT

Regular measurement of the ice, including snow, cover of Knob Lake, Quebec (192.3 ha, maximum depth 14.8m. 54°47'N; 66°48'W, 497m a.s.l.) began in 1954. Some of the data collected were transmitted to Atmospheric Environment Service, Environment Canada (formerly Meteorological Branch, Department of Transport), where they are on file with other Canadian lake ice records. More data are recorded in the McGill Subarctic Research Papers, the publication of the McGill Subarctic Research Station, Box 790, Schefferville, P.Q. Even more, until recently, were kept on file at the Station.

Now new files (ITKL 3 1,2,3,5,7,8) have been established by the Ice Climatology and Applications Division, 365 Laurier Avenue, W., Journal Tower South, 3rd Floor, Ottawa, Ont. K1A 0H3. These files contain series of lake ice records which are unique in Canada in terms of length of record and richness of detail. Usually such records involve an ice thickness and a snow depth for a single site. In this case, most years are represented by three sites on Knob Lake with a value for snow, white ice, black ice and hydrostatic water level for each. The files also include comparative data from nearby Maryjo Lake, for many years.

The paper contains examples of this record and references to sources of other, less systematic, data for Knob and nearby lakes in Northern Quebec and Labrador.

Introduction

A regular snow and ice survey programme has been conducted on Knob Lake, (192.3 ha., maximum depth 14.8m, 54°47'N, 66°48'W, 497m a.s.l.) near Schefferville, Quebec since 1954 by the McGill Subarctic Research Station, Schefferville. In the early years the survey included snow depth and the thicknesses of white ice, black ice and total ice. Since 1961, hydrostatic water level (depth of water in or above the drill hole) has also been recorded. For the first three years, measurements were made at a single site but since 1957, with few exceptions, three official sites have been used. Dates of freeze-up and break-up are also recorded.

Beginning in 1959, a similar programme has been maintained on nearby Maryjo Lake. This too involved three sites until 1971, a single site since then.

At various times during the period 1954 to present, a great deal of other lake cover information has been gathered in the Schefferville region. This includes lake-wide ice and snow mapping projects, particularly for late winter, on Knob Lake and a wide variety of other water bodies in the area. The results of this work are available from journal articles and reports in the McGill Subarctic Research Papers, the official publication of the McGill Subarctic Research Station (Box 790, Schefferville, Quebec). Useful entrées to this literature are Adams (1970), Adams (1984a), and Jones (1969).

The Knob Lake & Maryjo Lake Ice Archive

Almost all lake ice survey programmes in North America (in contrast for example, to Finland, see Kuusisto 1984) are based on observations of only snow depth and total ice

thickness at a single site. As white ice is an important component of lake cover, especially in snowier regions, one which is, for example, a serious complication in ice thickness prediction (see Lepperanta 1983, Michel 1978), longterm records which differentiate it from black ice are very valuable. Also, as observations at a single site on a lake may be quite atypical of the lake as a whole (see Adams 1984b, Adams and Roulet 1984), simultaneous measurements at other locations on the lake provide a useful perspective on the single site ice survey data.

In the case of Knob Lake, a longterm record of all major snow and ice components is available from three distinct sites (Fig. 1) which have not changed greatly over the years. This record is enhanced by the parallel record from the nearby Maryjo Lake and by the great deal of data obtained over many years, from other lakes in the region on both the Quebec and Labrador sides of the border. The value of the record is further increased by the fact that the official Atmospheric Environment Service Weather Station for Schefferville is located beside Knob Lake.

The Ice Climatology and Applications Division, Ice Centre, Environment Canada (365 Laurier Avenue West, Journal Tower South, 3rd Floor, Ottawa, Ontario K1A 0H3), through Philip W. Cote, agreed to create a special 'historical' archive of the Knob Lake and Maryjo data. This archive consists of the files listed in Table 1. These are available in the same way that routine Environment Canada ice survey records are available.

TABLE 1

Files in the Knob Lake Ice Archive

ITKL1 :	IC : 21	Knob Lake (west)	ITKL5 :	IC : 21	Maryjo Lake (centre)
ITKL2 :	IC : 21	Knob Lake (centre)	ITKL7 :	IC : 21	Knob Lake (mean of three sites)
ITKL3 :	IC : 21	Knob Lake (east)	ITKL8 :	IC : 21	Maryjo Lake (mean of three sites)

The designations West, Centre, etc. refer to the official measuring sites not strictly, to position on the lake.

A sample of the output of one of these files forms Table 2.

Table 3 is a summary of particular aspects of the Knob Lake record and Figs. 2-6, with their captions, give an indication of the richness of the record.

We are most grateful to staff members of the McGill Subarctic Research Station over the years. We also acknowledge the creative support of Philip W. Cote of the Ice Climatology and Applications Division, Environment Canada. This work was supported by NSERCC, DIAND, Trent University and McGill University.

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TABLE 2 - Summary of winter cover data from Knob Lake 1954-83 (thickness in cm; length of season in days)

The year in which the thickest ice was recorded had almost twice the thickness of the thinnest year. Maximum white ice ranged from 10 to 76 cm, black ice from 42 to 118 cm. The date of freeze-up varied by almost a month, that of break-up by over six weeks. The length of the ice season also varied by six weeks. The year in which most "official" drillings occurred is reported by Bryan, 1964.

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Year	Number	Max. Mean Total Ice Thickness	Date Of	Max. Mean White Ice Thickness	Date Of	Max. Mean Black Ice Thickness	Date Of	Max. Mean Snow Depth	Date Of	Freeze Up Date	Break Up Date	Length Of Season	Number Of Drillings
1954-55	1	94.0	Apr. 24	50.8	Apr. 24	71.1	Mar. 28	63.5	Feb. 14	-	June 1	-	20
1955-56	2	88.9	May 7	45.7	Apr. 24	61.0	Jan. 27	50.8	Feb. 25	Oct. 3	June 15	255	9
1956-57	3	118.1	Mar. 1	63.5	May 21	118.1	Mar. 1	50.8	Mar. 15	Nov. 11	June 20	220	10
1957-58	4	110.9	May 12	40.6	Apr. 11	77.0	Apr. 27	38.1	Mar. 10	Nov. 3	June 12	221	84
1958-59	5	124.4	Apr. 15	29.6	Apr. 8	107.9	Apr. 15	61.0	Apr. 8	Oct. 7	May 28	232	70
1959-60	6	118.1	Apr. 25	55.9	Apr. 25	67.3	Mar 21-28 Apr. 11	53.3	Apr. 25	Oct. 29	June 1	215	66
1960-61	7	121.9	Apr. 7	27.9	Apr 21-28	94.9	Mar. 31	38.1	Jan. 27	Nov. 3	June 11	220	87
1961-62	8	110.5	May 4	40.6	May 4	90.2	May 4	40.6	Dec. 29	Nov. 7	June 13	218	87
1962-63	9	132.1	May 10	36.8	May 10	96.5	Apr. 26	41.9	Feb. 15	Oct. 31	June 18	229	85
1963-64	10	114.3	Mar. 27	41.9	Apr 3-17	83.8	May 1	45.7	Mar 6-Apr 3	Nov. 2	June 12	222	211
1964-65	11	125.7	Apr. 16	44.5	Apr. 16	83.8	Apr. 2	45.7	Feb26-Mar19	Oct. 31	June 17	228	96
1965-66	12	104.1	Apr 15-22	45.7	Apr 1-15	64.8	Mar. 18	50.8	Mar. 11	Oct. 7	June 16	251	96
1966-67	13	124.5	Apr. 28	21.6	May 5	105.4	Apr. 28	34.3	Feb. 24	Oct. 29	June 12	225	87
1967-68	14	116.8	Apr. 19	36.8	Apr. 5	85.1	Feb. 16	49.5	Apr. 5-12	Nov. 6	June 6	212	85
1968-69	15	104.1	Apr 18-25	52.1	Mar. 28	57.2	Apr. 25	48.3	Apr. 11	Nov. 12	June 18	217	84
1969-70	16	90.2	Feb. 6	62.2	Jan. 17	41.9	Dec. 19	47.0	Feb. 6	-	-	-	46
1970-71	17	96.5	Apr. 1	14.0	Jan. 16	82.6	Apr.1-May20	41.9	Apr. 1	Nov. 14	June 14	211	38
1971-72	18	127.0	May 5	31.8	Mar. 24	105.4	May 5	59.7	Apr. 7	Nov. 3	June 25	234	51
1972-73	19	133.4	Apr. 27	26.7	Feb. 23	113.0	Mar. 30	35.6	Feb9-Apr27	Oct. 12	June 5	235	38
1973-74	20	125.7	Apr. 19	21.6	Feb. 5	105.4	Apr.19-May3	30.5	Apr. 5	Nov. 9	June 13	215	35
1974-75	21	152.4	Apr. 26	22.9	Mar. 7	109.2	Apr. 12	66.0	Apr. 12	Oct. 19	June 19	242	44
1975-76	22	115.6	Mar26-Apr.10	10.2	Nov. 24	106.7	Mar. 26	58.4	Apr. 23	Nov. 5	June 19	226	34
1976-77	23	138.4	May 5	22.9	Jan23-Feb4	86.4	Feb. 22	57.2	Feb. 14	-	June 13	-	39
1977-78	24	129.6	Apr. 28	40.3	Mar. 17	97.4	Apr. 21	49.3	Feb. 24	Nov. 16	June 19	214	87
1978-79	25	150.5	Apr. 13	46.3	Mar. 2	99.0	Apr. 6	45.7	Feb. 9	Oct. 17	June 5	230	88
1979-80	26	124.0	Apr. 25	53.0	Apr. 4	84.0	Apr. 11	39.3	Mar. 21	Oct. 29	June 9	223	83
1980-81	27	116.0	Mar. 15	76.0	Apr. 24	48.3	Mar. 20	42.0	Apr. 24	Oct. 20	June 19	242	73
1981-82	28	137.0	May 7	57.0	May 7	98.0	Apr. 16	44.0	Apr. 9	Oct. 30	June 18	231	75
1982-83	29	126.0	Apr. 8	19.0	Apr. 8	114.0	Apr. 15	83.5	Apr. 8	Oct. 27	June 10	225	61
Mean		119.7		39.2		88.1		48.7		Oct. 29	June 13	226.6	67.9
Max. Earliest		152.4		76.0		118.1		83.5		Oct. 3	May 28	255	211
Min. Latest		88.9		10.2		41.9		30.5		Nov. 16	June 25	211	9
Range		63.5		65.8		76.2		53.0		44 Days	28 Days	44 Days	202

TABLE 3 - Sample of output from one of the files. The columns are, respectively: date; total ice thickness (cm); snow depth (cm); Julian calendar date; black ice thickness (cm); white ice thickness (cm); hydrostatic water level (to 0.1 cm). The rows in which date is followed by 200 and the Julian calendar value indicate freeze-up or break-up dates.

KNOB LAKE (SITE 3)/LAC KNOB (SITE 3). OBSERVATION SITE CENTRE OF KNOB LAKE

201254	46	20	354	31	15	-99.0	140355	77	43	73	69	8	-99.0	090356	63	25	69	38	25	-99.0	010357	118	25	60	118	0	-99.0
271254	50	33	361	39	11	-99.0	210355	79	38	80	43	36	-99.0	230356	77	20	83	41	36	-99.0	150357	97	51	74	94	3	-99.0
030155	53	42	3	43	10	-99.0	280355	91	31	87	71	20	-99.0	060456	82	20	97	41	41	-99.0	080457	107	46	98	102	5	-99.0
100155	57	61	10	52	5	-99.0	040455	89	31	94	51	38	-99.0	240456	84	25	115	38	46	-99.0	100557	108	5	130	99	9	-99.0
170155	64	57	17	47	17	-99.0	110455	89	15	101	46	43	-99.0	070556	89	25	128	53	36	-99.0	210557	112	5	141	48	64	-99.0
240155	72	53	24	55	17	-99.0	180455	86	23	108	43	43	-99.0	150656	0	0	167	0	0	0.0	200657	0	0	171	0	0	0.0
310155	56	58	31	48	8	-99.0	240455	94	23	114	43	51	-99.0	111156	0	0	316	0	0	0.0	031171	0	0	307	0	0	0.0
070255	66	51	38	51	15	-99.0	020555	51	1	122	36	15	-99.0	201256	59	15	355	51	8	-99.0	191171	26	10	323	20	6	-99.0
140255	73	64	45	41	32	-99.0	010655	0	0	152	0	0	-99.0	040157	66	10	4	58	8	-99.0	261171	36	24	330	22	14	-99.0
210255	58	61	52	43	15	-99.0	031055	0	0	276	0	0	-99.0	170157	66	15	17	58	8	-99.0	051271	38	15	339	23	15	-99.0
280255	84	38	59	46	38	-99.0	301255	45	3	364	25	20	-99.0	030257	91	23	34	91	0	-99.0	101271	43	22	344	20	23	-99.0
070355	79	46	66	48	31	-99.0	270156	84	36	27	61	23	-99.0	200257	99	29	51	96	3	-99.0	171271	38	29	351	15	23	-99.0
							120256	70	31	43	-99	-99	-99.0														
							250256	71	51	56	33	38	-99.0														

TABLE 4 - Example of routine statistical processing of the record by the Ice Climatology and Applications Division

KNOB LAKE (SITE 5) / LAC KNOB (SITE 5)
TOTAL NUMBER OF OBSERVATIONS USED = 513
PERIOD COVERED : 311057 TO 210483

PERIOD	ICE THICKNESS(CM) MEAN	S.D.	MAX	MIN	# OF OBS	SNOW DEPTH(CM) MEAN	S.D.	# OF OBS
AUG20-AUG26	0.0	0.0	0	0	0	0.0	0.0	0
AUG27-SEP02	0.0	0.0	0	0	0	0.0	0.0	0
SEP03-SEP09	0.0	0.0	0	0	0	0.0	0.0	0
SEP10-SEP16	0.0	0.0	0	0	0	0.0	0.0	0
SEP17-SEP23	0.0	0.0	0	0	0	0.0	0.0	0
SEP24-SEP30	0.0	0.0	0	0	0	0.0	0.0	0
OCT01-OCT07	0.0	0.0	0	0	0	0.0	0.0	0
OCT08-OCT14	0.0	0.0	0	0	0	0.0	0.0	0
OCT15-OCT21	8.0	0.0	8	8	1	0.0	0.0	1
OCT22-OCT28	11.0	1.4	12	10	2	2.0	2.8	2
OCT29-NOV04	18.2	4.4	23	11	5	4.4	5.8	5
NOV05-NOV11	22.0	5.5	31	14	9	3.1	2.5	9
NOV12-NOV18	25.8	6.8	40	14	15	5.2	5.6	15
NOV19-NOV25	31.8	7.6	46	21	15	10.8	9.8	15
NOV26-DEC02	36.7	11.6	68	20	18	11.9	10.9	18
DEC03-DEC09	42.9	11.7	73	29	18	14.8	9.3	18
DEC10-DEC16	49.5	11.6	74	36	19	14.7	9.2	19
DEC17-DEC23	55.1	10.1	79	39	19	14.8	6.3	19
DEC24-DEC31	62.4	9.8	87	46	25	18.3	8.5	25
JAN01-JAN07	67.9	8.4	87	58	16	18.9	7.7	16
JAN08-JAN14	72.6	10.2	97	55	20	22.0	7.2	20
JAN15-JAN21	77.3	10.4	97	61	19	26.0	7.4	21
JAN22-JAN28	81.3	10.0	101	65	18	26.9	7.5	18
JAN29-FEB04	85.9	8.4	102	68	18	30.0	9.2	19
FEB05-FEB11	91.5	11.1	120	72	19	29.8	9.1	20
FEB12-FEB18	96.3	8.6	113	83	17	31.6	8.2	17
FEB19-FEB25	97.1	9.8	114	83	19	30.3	10.0	19
FEB26-MAR04	98.6	9.5	122	83	17	31.1	10.1	17
MAR05-MAR11	103.8	7.9	118	91	16	33.6	9.5	16
MAR12-MAR18	106.5	9.0	122	92	18	31.8	8.5	18
MAR19-MAR25	108.6	9.7	123	86	16	30.3	9.5	16
MAR26-APR01	110.3	9.1	126	96	18	31.8	7.6	18
APR02-APR08	112.4	11.8	137	95	13	33.4	12.9	14
APR09-APR15	112.9	8.2	126	98	15	34.1	12.8	16
APR16-APR22	116.5	9.9	143	104	16	25.2	14.0	16
APR23-APR29	114.4	12.7	133	91	14	18.6	12.4	14
APR30-MAY06	109.4	11.3	127	93	14	13.0	13.4	15
MAY07-MAY13	109.3	11.3	132	94	15	7.8	10.2	15
MAY14-MAY20	94.6	10.4	122	83	14	2.8	3.4	14
MAY21-MAY27	83.8	14.2	108	60	12	2.1	2.3	12
MAY28-JUN03	71.9	14.0	99	50	11	3.1	7.4	11
JUN04-JUN10	58.3	7.6	67	53	3	3.7	3.5	3
JUN11-JUN17	0.0	0.0	0	0	0	0.0	0.0	0
JUN18-JUN24	0.0	0.0	0	0	0	0.0	0.0	0
JUN25-JUL01	0.0	0.0	0	0	0	0.0	0.0	0
JUL02-JUL08	0.0	0.0	0	0	0	0.0	0.0	0
JUL09-JUL15	0.0	0.0	0	0	0	0.0	0.0	0
JUL16-JUL22	0.0	0.0	0	0	0	0.0	0.0	0
JUL23-JUL29	0.0	0.0	0	0	0	0.0	0.0	0
JUL30-AUG05	0.0	0.0	0	0	0	0.0	0.0	0
AUG06-AUG12	0.0	0.0	0	0	0	0.0	0.0	0
AUG13-AUG19	0.0	0.0	0	0	0	0.0	0.0	0

MAXIMUM ICE THICKNESS= 143 OCCURED ON 1 OCCASION(S)
DATE(S) : 20/04/79

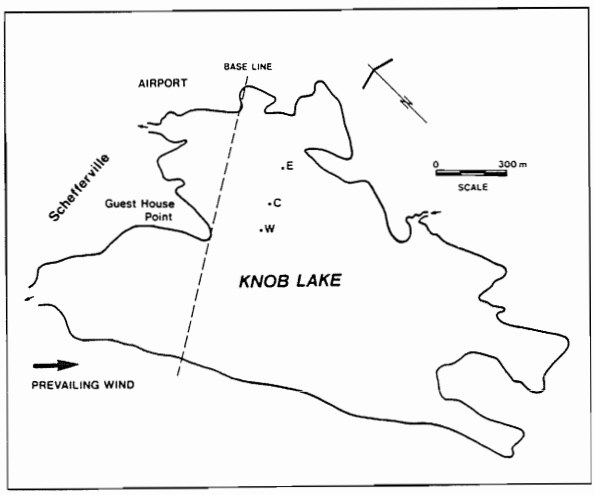

Figure 1
The official ice survey sites on Knob Lake ice survey in 1965. "The base line is perpendicular to railroad track near large rock passing through tip of Guest House Point. West 116°, 210.3m; Centre 139°, 283.5m; East 153°, 429.8m." In fact, the locations vary somewhat during the period of the record.

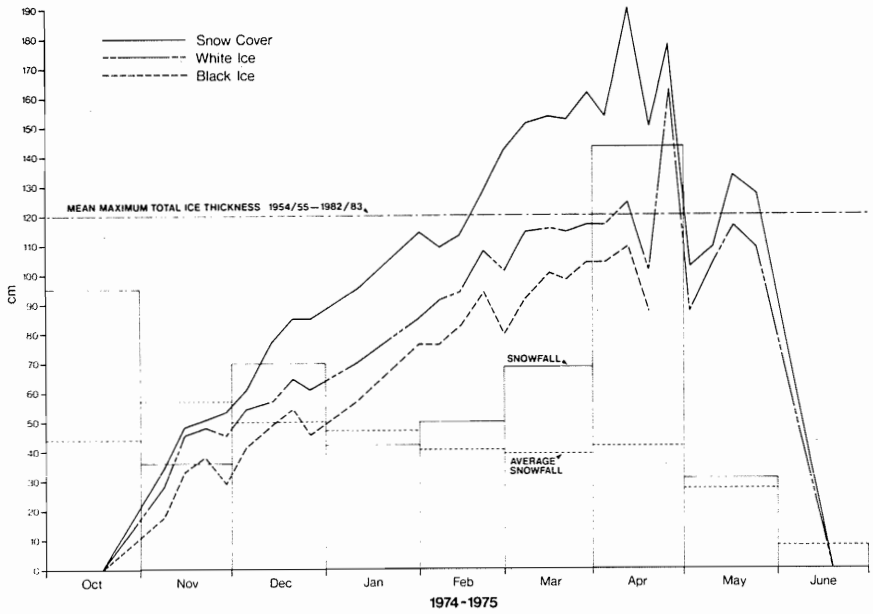

Figure 2
Knob Lake, 1974-75, the winter with maximum total ice thickness. Note major white ice event, associated with record (143.5) snowfall, in an unusually cold, -10.1°C, April (monthly snow receipts are compared with long-term means).

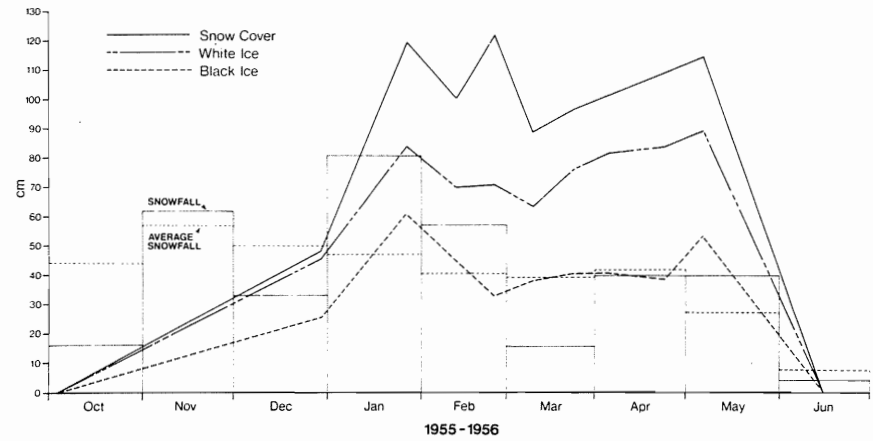

Figure 3
Knob Lake, 1955-56, the winter with minimum total ice, snowfall was above average in December and January. The October-January period was 4.4°C above normal, then there was little white ice formation after January.

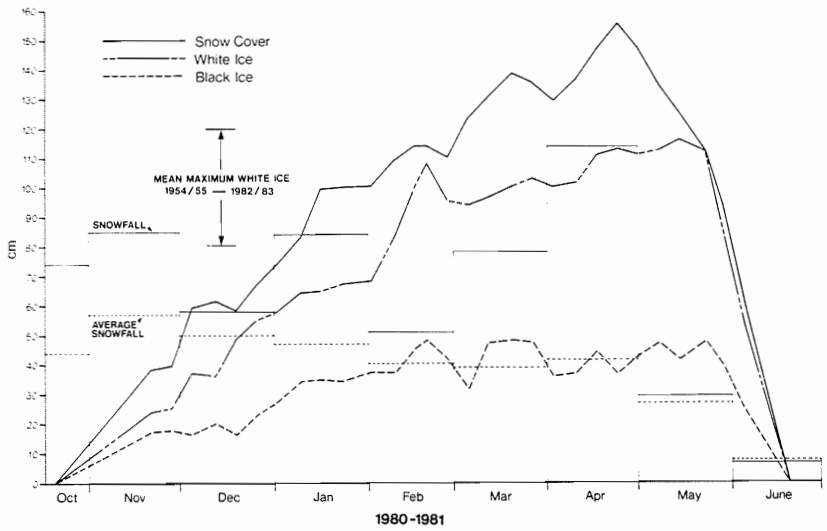

Figure 4
Knob Lake, 1980-81, the winter with maximum white ice. Note above average snowfall every month. October-December was cold, January-June was warm.

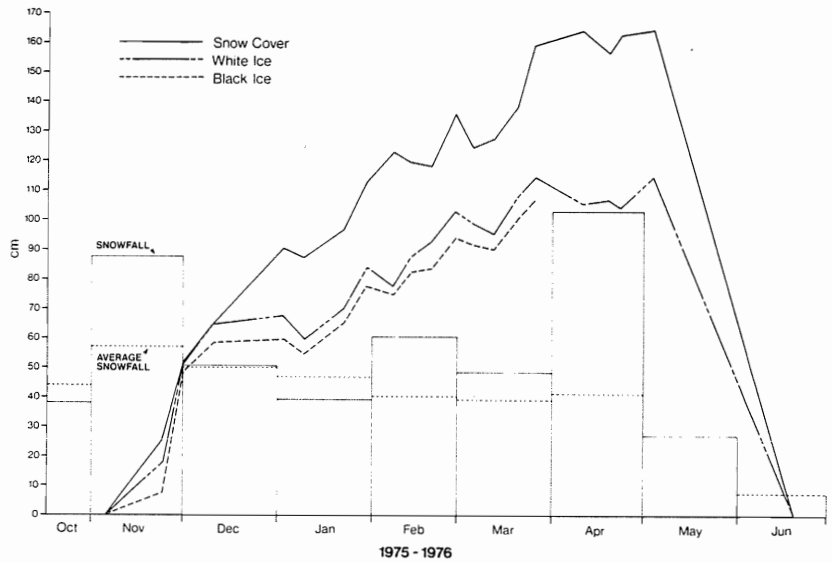

Figure 5
Knob Lake, 1975-76, the winter with minimum white ice. Generally average snowfall, November - April was 2.2°C below normal.

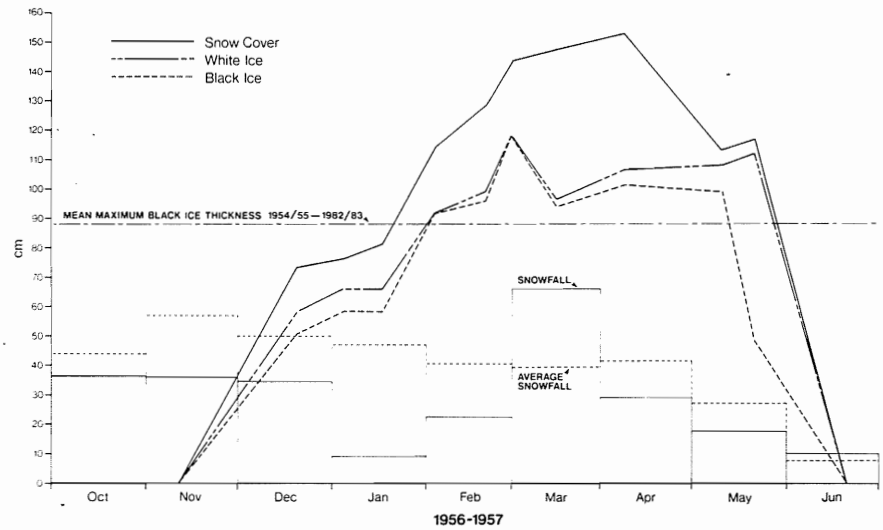

Figure 6
1956-57, the winter with maximum black ice. Note below average snowfall in most months. Early winter (November-January) was 5.1°C below normal including the coldest January (-30.1°C) on record.