

MLP NO. M59

**2004 OSPREY MONITORING IN THE LOW-LEVEL
TRAINING AREA OF LABRADOR**

FINAL REPORT

OCTOBER 2004



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1.0 INTRODUCTION

An extensive annual monitoring program of Osprey (*Pandion haliaetus*) within the Low-level Training Area (LLTA) of Labrador and north-eastern Québec by the Department of National Defence (DND) (Trimper *et al.* Submitted; LFA 1992; JWE 1992, 1994, 1995; JWEL 1996a, 1996b, 1997, 1998, 1999, 2001) and by the Institute for Environmental Monitoring and Research (IEMR) (Minaskuat 2003) has been ongoing since 1991. This program was continued during 2004 with the objective, as in previous years, of monitoring the reproductive success of Osprey inside (Experimental) and outside (Control) the LLTA, and to examine potential relationships between breeding success and local climatic conditions.

2.0 STUDY TEAM

Mr. Perry Trimper (Jacques Whitford) was the project manager, lead field researcher, and assisted with the compilation of this report. Ms. Karen Gosse was involved in the field program and served as primary author.

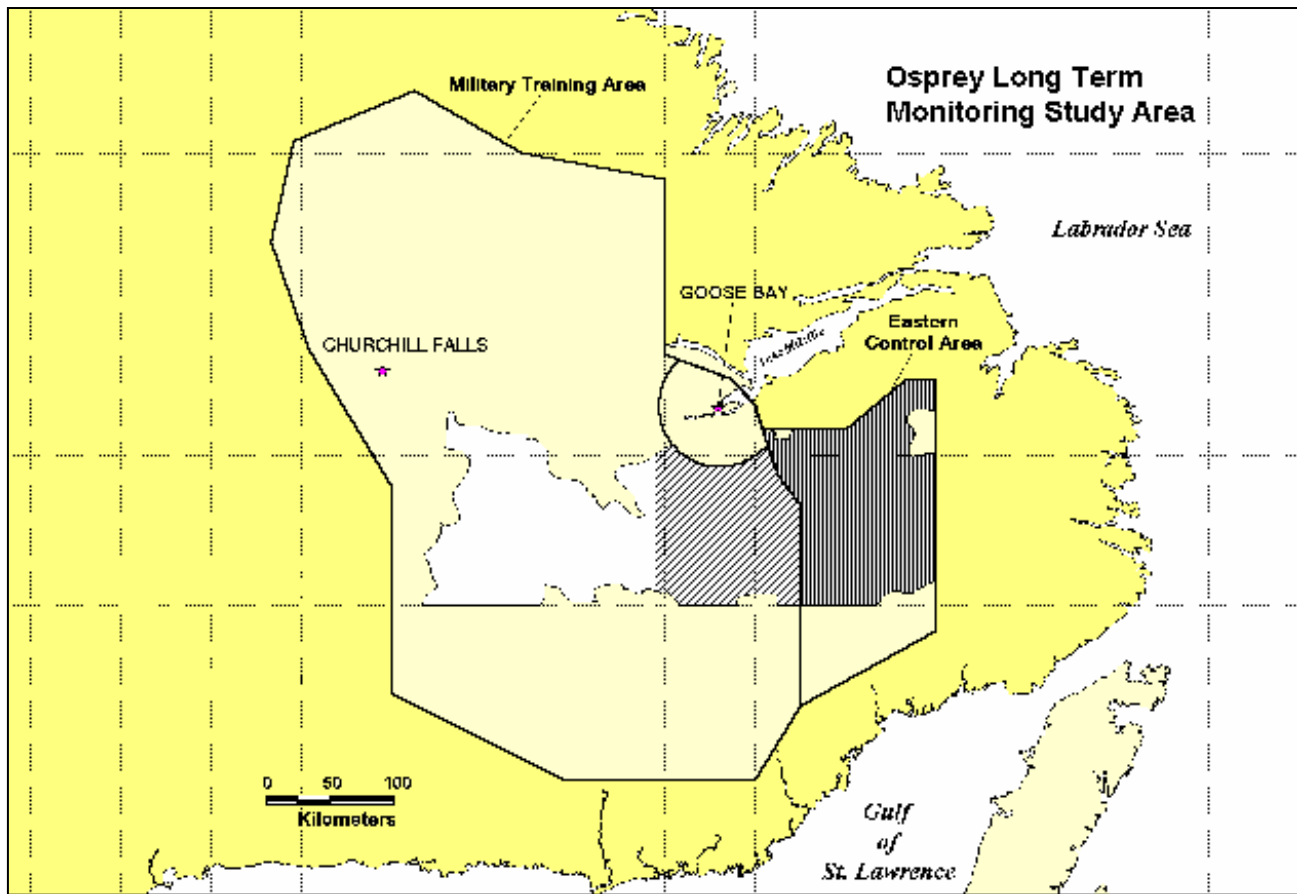
Mr. Corey Cooney (Minaskuat) and Ms. Louisa Whelan (Innu work term placement at Minaskuat, College of the North Atlantic) assisted with data collection (field surveys). Mr. Gerry Parker (IEMR Scientific Review Committee) and Ms. Madelyn Kelly (IEMR Board Member) also participated in the field program. Mr. Geoff Goodyear (Universal Helicopters Newfoundland Limited) was pilot during aerial surveys.

3.0 STUDY AREA

Osprey nests were surveyed within a portion of the LLTA and the Control Area first identified in 1999 (Figure 1). The areas involved in these surveys comprise primarily two ecoregions: Mecatina River and Eagle Plateau (ESWG 1995). Both of these ecoregions are forested with coniferous vegetation, characterized by the study team as forested habitat. Forested habitat occurs throughout the LLTA in less rugged areas with rolling topography, large rivers with forested valleys, and wetland complexes. In terms of habitat for Osprey, the Eagle Plateau tends to exhibit a greater abundance of freshwater fish as potential food source (Chubbs and Trimper 1998).

Both ecoregions in the study area are characterized by a sub-arctic climate (ESWG 1995). The average temperature in January varies from -15°C along the coast to -25°C north of Schefferville. The corresponding average July temperatures are 15°C and 10°C, respectively. Annual precipitation averages 1,200 mm/year at 50°N, decreasing to 500 mm/year at 57°N. Snowfall indicates a similar trend, with 400 cm/year south of Smallwood reservoir and 280 cm/year at 57°N. Average maximum snow depth is 130 cm south of Smallwood Reservoir and 100 cm north of the reservoir, and usually occurs at the beginning of March. Snow cover usually persists from mid-November to the end of April to the south, as compared to the end of October and mid-May in the north. Prevailing winds in the south are from the west and south-west and average 20 km/hr. Frequency of calm winds is 7 percent. To the north, winds predominately flow from the west and the north-west and average 20 km/hr. The frequency of calm winds is 6 percent. Maximum hours of sunshine at Goose Bay occurs in July (206 hrs), and minimum hours of sunshine occurs in November (68 hrs).

Figure 1 Study area for the 2004 Osprey Monitoring Program



4.0 METHODS

4.1 Field Surveys

The approach to monitoring Osprey during 2004 was identical to Trimper *et al.* (1998). A sample of known Osprey nests (DND/Jacques Whitford unpublished data) were surveyed during early June (corresponding to the early incubation period) in the LLTA (n = 30) and a Control area (n = 30) to determine nesting activity (Figure 1). These nests were re-visited in mid-August to determine reproductive success (Appendix A).

Aerial surveys were conducted using a Bell 206L helicopter with the navigator/observer seated beside the pilot. Potential candidate nest sites and their nest history were identified from an extensive database developed by the study team since 1991. Field data sheets (with previous observations) were generated to facilitate relocation and accurate recording of nest activity in areas previously surveyed (Jacques Whitford unpublished data).

Prior to departure, a route was chosen that maximized nests encountered while minimizing travel distance/time (and subsequently cost). The first 30 active nests encountered in each study area were selected. Note that this sample may have included new nests located during the surveys. As such, nests used in any given year may or may not have been included in previous analyses.

Osprey nests were considered active if eggs or young were observed or suspected during the June survey (i.e. adults exhibited aggressive behaviour) in the nest (Van Daele and Van Daele 1982, Poole 1989). Pairs of raptors (adult male and female of the same species), displays of aggressive behaviour by individuals, or an apparent reluctance to leave an area were considered as evidence of an occupied nest whether or not nest contents were observed. Based on continued nestling mortality until fledging observed previously in the study area (Jacques Whitford, unpublished data) and elsewhere (Hagan 1986, Ewins and Miller 1995), a nest was considered successful if one or more young were observed immediately prior to fledging in mid-August (Appendix A).

When active nests were identified during the first survey, the study team immediately left the area to reduce unnecessary disturbance to the nesting raptors. During the second, pre-fledging survey in August, the helicopter approached within 30-50 m to determine the number of nestlings and their condition (i.e. alive or dead).

4.2 Nest Data

Nest activity (available nests actively used by Osprey in June) and *nest success* (number of active or occupied nests identified as having fledged at least one young in August survey) were assessed using a one-tailed Fisher's Exact Test. For consistency, results from all years (1999-2004) were assessed/reassessed using the MINITAB 14 statistical software package. Where differences existed (due to differences in statistical software packages employed since 1999), results were updated accordingly. *Productivity* [number of young fledged per active nest sample (n=30)] was examined using a one-tailed two-sample T-test. If an effect from LLF was present, the Control area (p2) should have higher proportions than the LLTA (p1). The significance level used for all tests was 20%, reflecting the regional variability of Osprey production observed over the previous decade (Jacques Whitford, unpublished data).

To aid the analysis, the overall success for the entire study area was categorized as Poor, Mediocre, Good, or Very Good (Table 1), depending on relative productivity rates, and compared over years.

Table 1 Success Ratings Used to Categorize Osprey Nesting Success

Reproductive Success (No. young fledged/active nest)	Success Rating
<0.8	Poor
0.8-1.2	Mediocre
1.2-1.6	Good
>1.6	Very Good

4.3 Weather Data

As in 2003, mobile weather monitoring stations (Weather Wizard, Davis Instruments), capable of recording temperature, precipitation, wind speed and direction, were deployed in the study area at Park Lake and Anne Marie Lake prior to 2004 Osprey nest surveys (i.e. early June). Weather stations were pre-set to record weather information every 30 minutes. Stations were revisited and data downloaded approximately every 30 days. Weather information collected from the airport at 5-Wing Goose Bay (53°19'N, 60°25'W) was also available for comparison (Environment Canada 2004).

Climate data were processed into a form convenient for plotting and analysis. Available data was examined to generate a record of daily maximum and minimum temperatures, total precipitation, maximum wind gusts, and daily average wind chill temperatures for the period May-August 2004. Parameters were compared (linear regression) with data from the Goose Bay weather station (Environment Canada 2004) to determine similarities and differences between data sets.

4.4 Data Considerations

Spring Break-up (Date of Last Ice)

Osprey arrive in Labrador during early May (Table 2), when most lakes and ponds are still ice covered (Wetmore and Gillespie 1976). Nesting generally begins late May-early June (JWEL 1996a) (Table 2). Wetmore and Gillespie (1976), however, found a significant correlation between nest initiation and the date of open water in spring for Osprey in this region. Factors that delay nest initiation may result in reduced clutch and brood sizes, and a lower number of young fledged per nest (Steeger and Ydenberg 1993, Poole et al. 2002). In years of late ice-out, pairs may not breed (Poole et al. 2002) or may have reduced breeding success (Wetmore and Gillespie 1976).

Date compiled during earlier studies (JWEL 1996a), suggested a possible relationship between the timing of spring break-up in the Terrington Basin/Goose Bay area and Osprey reproductive success in the region during 1991-1996. Available information on day of last ice recorded at Minipi and Eagle Rivers from 1993-2003 (Minaskuat 2004), and unconfirmed reports for 2004, was used to further explore this relationship.

Table 2 Breeding chronology of Osprey in Labrador

	Arrival at nesting area	Egg Laying	Incubation Period	Median Hatch Date	Brooding Period	Fledging
Approximate Date/Duration	Early-mid May	Late May-early June	34-40 days	6 July	Brooded continuously 14 days post-hatch; intermittent thereafter up to 14 weeks.	Late August

(Source: Wetmore and Gillespie 1976, JWEL 1996a, Trimper *et. al.* 1998, Poole *et al.* 2002).

July Hatching/Brooding Period

July is a sensitive month for Osprey as hatching occurs during the first week [median date of hatch was 6 July in 1995 (n=126) and 5 July in 1996 (n=40) (JWEL 1996a)]. During the early post-hatching stages, Osprey young are not able to thermoregulate [*i.e.* generate sufficient body temperature without external (parental) sources]. As such, increased precipitation and lowered temperatures during this period may contribute to a low success rate of young fledged per adult female (JWEL 1996a).

Poor weather during July may also affect survival by limiting food deliveries to the nest. The male osprey is the sole provider of food for the female and nestlings (Poole et al. 2002). Reproductive success therefore depends on his hunting performance (Steeger and Ydenberg 1993). Flemming and Smith (1990) showed that rain decreased the number of Osprey foraging, when compared with cloudy or sunny conditions (Poole et al. 2002). High winds also compromise the hunting success of Osprey (Machmer and Ydenberg 1990) [fish are difficult to spot from the air when surface waters are disrupted by rain and/or wind (Hagan 1986)],

such that at wind speeds >7m/s (25.2km/h), hunting is no longer energetically profitable (Machmer and Ydenberg 1989). Additionally, strong winds have the potential to blow down an entire nest (Hagan 1986).

Available temperature, precipitation, wind and wind chill data were compiled for the period 1-14 July, and relationships between patterns and/or extremes in weather data and Osprey reproductive success considered.

5.0 RESULTS

5.1 Nest Outcomes

Osprey nesting success in 2004 was considered Very Good (Table 1). As in the previous year, 2004 nesting activity in the control and LLTA was relatively high, and indeed the highest recorded during 1999-2004 (Table 3). Nest activity was slightly higher in the LLTA (75 %) than in the control (72.7 %), however this difference was not significant ($p=0.596$) (Table 4). In contrast, nesting success was higher in the control area (0.867 versus 0.700), but this difference was again not significant [$p=0.209$ (Table 4)]. Nesting success in the control area was the highest observed over the past six years (Table 3). In comparison, 2004 nesting success in the LLTA was lower (70 %) than during 2003 [93.3 %; the highest recorded since this parameter was first examined in 1994 (Trimper *et al.* submitted)].

Reproductive output or productivity (number of young fledged per active nest) of the nests sampled in the control area (1.97) was the highest observed (Table 3). Productivity in the LLTA was higher than recorded in 2000-2002, but lower than in 2003, and significantly lower ($p=0.024$) than in the control during 2004 (Table 4). However, both the LLTA and control study areas, exhibited a high reproductive output per successful (vs. active) nest (2.05 and 2.27 respectively) in 2004 (Table 3). Coincidentally, the study team observed relatively poor Osprey reproductive success in the Naskaupi River during 2004. Located approximately 60 km north of Goose Bay, six active nests in June were found to only have a single nest with two young still active in mid-July (Jacques Whitford, unpublished data).

A comparison of all three parameters [nesting activity, success, and productivity (Table 4)], over the previous six years of this study, reveals high variability in the annual results with **no consistent trend evident**. Nest activity was greater in the control during 1999 and 2001, and lower in all other years of this study. Similarly, productivity was greater in the control versus LLTA study area during 2001, 2003 and 2004, but lower in 1999, 2000 and 2002. Overall success ratings also varied between years (Table 5). Note also that 2004 is the first year where a significant difference in nesting productivity has been observed.

Table 3 2004 Osprey Survey Results Compared to 1999-2002 DND Surveys

Parameters	1999		2000		2001		2002		2003		2004	
	LLTA	Control	LLTA	Control	LLTA	Control	LLTA	Control	LLTA	Control	LLTA	Control
# Surveyed	99	98	77	82	75	74	81	112	40	53	44	44
# Active (%)	57 (57.6)	59 (60.2)	35 (45.4)	32 (39.0)	31 (41.3)	35 (47.3)	34 (42.0)	35 (31.3)	30 (75.0)	32 (60.4)	33 (75.0)	32 (72.7)
Active Sample	30	30	30	30	30	30	30	30	30	30	30	30
# Successful (%)	27 (90.0)	25 (83.3)	16 (53.3)	10 (33.3)	9 (30.0)	13 (43.3)	15 (50.0)	13 (43.3)	28 (93.3)	25 (83.3)	21 (70.0)	26 (86.7)
# Young Fledged	53	47	31	17	18	21	30	28	52	57	43	59
# Young Fledged/ Active Nest	1.77	1.57	1.03	0.57	0.60	0.70	1.00	0.93	1.73	1.90	1.43	1.97
# Young Fledged/ Successful Nest	1.96	1.88	1.94	1.70	2.00	1.62	2.00	2.15	1.86	2.28	2.05	2.27
% Successful (#/active sample)	90.0	83.3	53.3	33.3	30.0	43.3	50.0	43.3	93.3	83.3	70.0	86.7

Notes:

1. 1999-2003 data from Trimper *et. al.* submitted.

Table 4 Osprey Nesting Activity, Nesting Success and Productivity in the Low-level Training Area and Control Area of Labrador, 1999-2004

<i>Nesting Activity</i>								
Year	Low-level Training Area			Control			P Value of Fishers Exact Test	Reject at 20 %
	Nests Available	Nests Active	P ₁	Nests Available	Nests Active	P ₂		
1999	99	57	0.576	98	59	0.602	0.354	No
2000	77	35	0.455	82	32	0.390	0.794	No
2001	75	31	0.413	74	35	0.473	0.231	No
2002	81	34	0.420	112	35	0.313	0.937	No
2003	40	30	0.750	53	32	0.604	0.936	No
2004	44	33	0.750	44	32	0.727	0.596	No

<i>Nesting Success</i>								
Year	Low-level Training Area			Control			P Value of Fishers Exact Test	Reject at 20 %
	Nests Available	Nests Successful	P ₁	Nests Available	Nests Successful	P ₂		
1999	30	27	0.900	30	25	0.833	0.777	No
2000	30	16	0.533	30	10	0.333	0.945	No
2001	30	9	0.300	30	13	0.433	0.140	Yes
2002	30	15	0.500	30	13	0.433	0.698	No
2003	30	28	0.933	30	25	0.833	0.889	No
2004	30	21	0.700	30	26	0.867	0.209	No

<i>Productivity</i>								
Year	Low-level Training Area			Control			P Value of Two-sample t-test	Reject at 20 %
	Nests Available	Young Fledged	Standard Deviation	Nests Available	Young Fledged	Standard Deviation		
1999	30	53	0.897	30	47	0.935	0.799	No
2000	30	31	1.129	30	17	0.898	0.959	No
2001	30	18	1.037	30	21	0.877	0.344	No
2002	30	30	1.140	30	28	1.170	0.588	No
2003	30	52	1.029	30	57	0.774	0.286	No
2004	30	43	0.964	30	59	1.073	0.024	Yes

Notes:

1. 1999-2002 DND surveys (Trimper *et. al*/submitted).
2. 2003 IEMR surveys (Minaskuat 2004).

Table 5 Osprey reproductive success within and adjacent to the Low-Level Training Area in Labrador, 1993-2004

Year	Success Rating	# Young Fledged/Active Nest		
		LLTA	Control	Combined
1993	Poor	N/A	N/A	N/A
1994	Good	N/A	N/A	1.34
1995	Good	N/A	N/A	1.46
1996	Poor	N/A	N/A	0.32
1997	Mediocre	N/A	N/A	0.87
1998	Very Good	N/A	N/A	1.54
1999	Very Good	1.77	1.57	1.67
2000	Poor	1.03	0.67	0.85
2001	Mediocre	0.60	0.70	0.65
2002	Poor	1.00	0.93	0.97
2003	Very Good	1.73	1.90	1.82
2004	Very Good	1.43	1.97	1.70

Egg Failures

Consistent with previous years (Trimper *et al.* submitted), eggs that failed to hatch were noted in Osprey nests during the mid-August surveys. One nest, Nest 13C/10-21 (Appendix A) in the LLTA, had at least one egg remaining in the nest when checked on 16 August 2004. This nest was considered successful, as 2 young were also present in the nest during checks. Note, however, that these young [and young of three other nests in the LLTA (Appendix A)] were considered relatively small in comparison to those of the majority of Osprey nesting in the study area and may face greater challenges in terms of fledging successfully before the onset of winter.

5.2 Weather and Osprey Nesting

Weather Station Data

Data from Anne Marie Lake were available between 05 May-03 September, and from Park Lake between 11 May-03 September* 2004. Mean daily temperatures at Goose Bay appeared similar to those recorded at Park Lake (linear regression, June $R^2 = 0.905$, July $R^2 = 0.864$, August $R^2 = 0.816$) and Anne Marie Lake (June $R^2 = 0.852$, July $R^2 = 0.670$, August $R^2 = 0.761$) between June and August 2004 (Appendix B).

* Data were not available from Anne Marie Lake for 23 June, and from Park Lake between 22-25 June 2004.

In contrast, the weather station at Goose Bay recorded more precipitation than either of the remote stations (Figure 2, Appendix B). Cumulative precipitation recorded at Park Lake was also higher than recorded at Anne Marie Lake (Figure 2). A problem identified at the Anne Marie Lake Station, however, may account for this difference. When the study team dismantled the station in early September, the rain collector appeared obstructed (*i.e.* rainwater had built up inside the collector nozzle), and may explain why little rainfall (<15 mm) was recorded in that area during August and September (Figure 2).

Similar results (*i.e.* comparable temperatures recorded at all three stations, but greater precipitation recorded at Goose Bay versus local weather stations) were found during 2003 (Minaskuat 2004). The variation in precipitation amounts observed between the three weather monitoring stations (Figure 2) may result from a malfunctioning of the precipitation gauges (Minaskuat 2004). However, observed differences may reflect variation in local weather conditions. As such, when data were available, weather information from Goose Bay and the local stations were considered separately.

Spring Break-up

Historic hydrometric data collected from Minipi River (below Minipi Lake) and Eagle River (above falls) provided an indirect indication for the day of last ice each spring (Table 6). Unfortunately, no such data was available for 2004. Both Park Lake and Anne Marie Lake were still frozen when weather stations were assembled on 11 and 20 May respectively. One outfitter indicated he had been able to land in a float plane at Park Lake on 5 June, and that ice out had probably occurred one week earlier (D. Hollett, pers. comm.). This suggests that spring break-up occurred between 20 May-5 June, presumably during late May – later than 1993-2001 but similar to 2002 (Table 6).

Mean day of ice out was plotted against the average number of young fledged per active Osprey nest during 1994-2002 with no obvious relationship (Figure 3). During years of relatively early ice out (*e.g.* 1998 and 1999), reproductive success rates were high (1.54 and 1.67, respectively). However, poor success rates also occurred in years with similar, or earlier, timing of thawing (*e.g.* 1996 and 2001) (Table 2, Figure 3). Overall, timing of spring break-up provided little indication of a relationship with Osprey nesting success.

Figure 2 Cumulative precipitation recorded from local weather stations at Park and Anne Marie Lakes compared with Goose Bay, Labrador, June-August 2004.

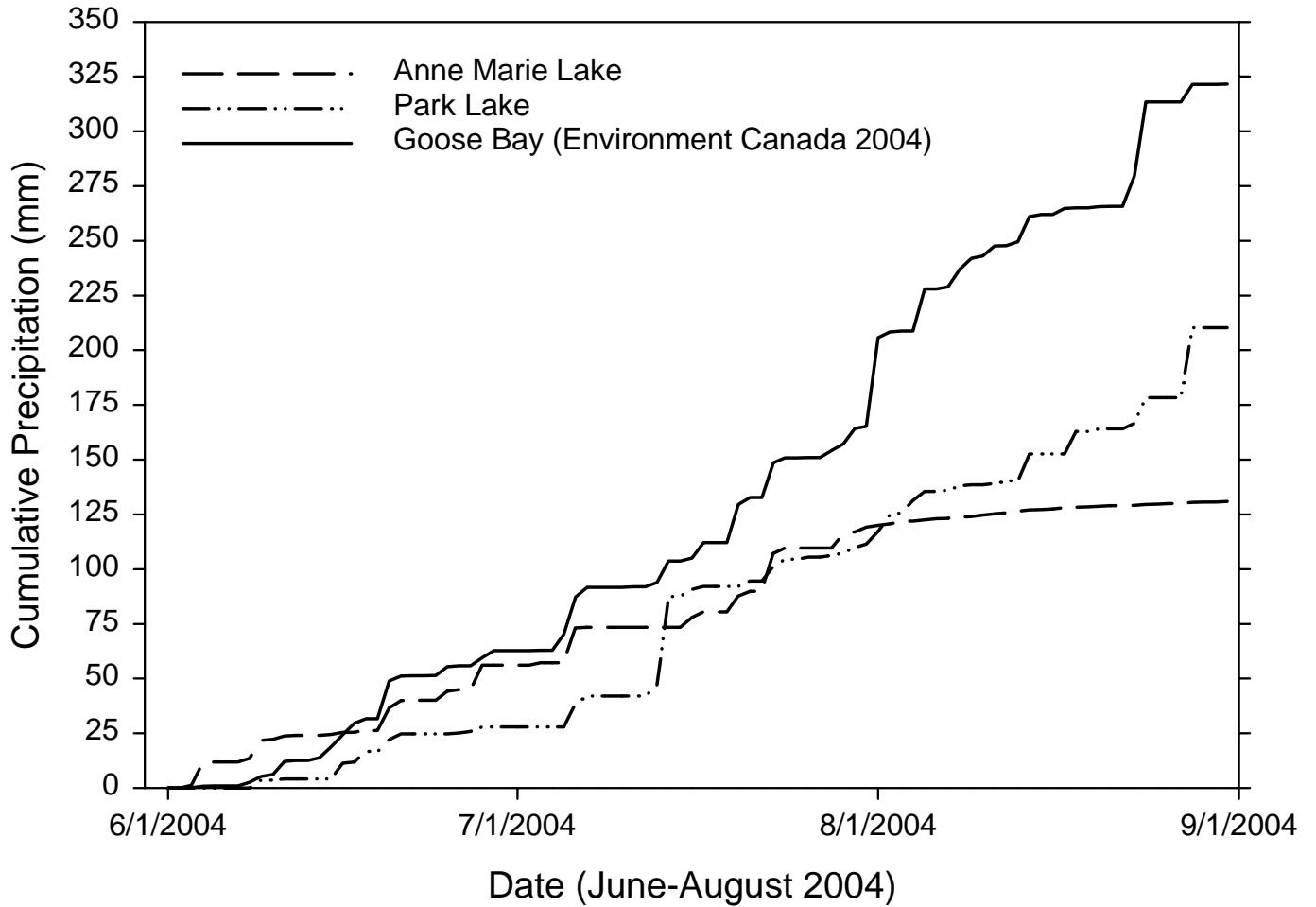
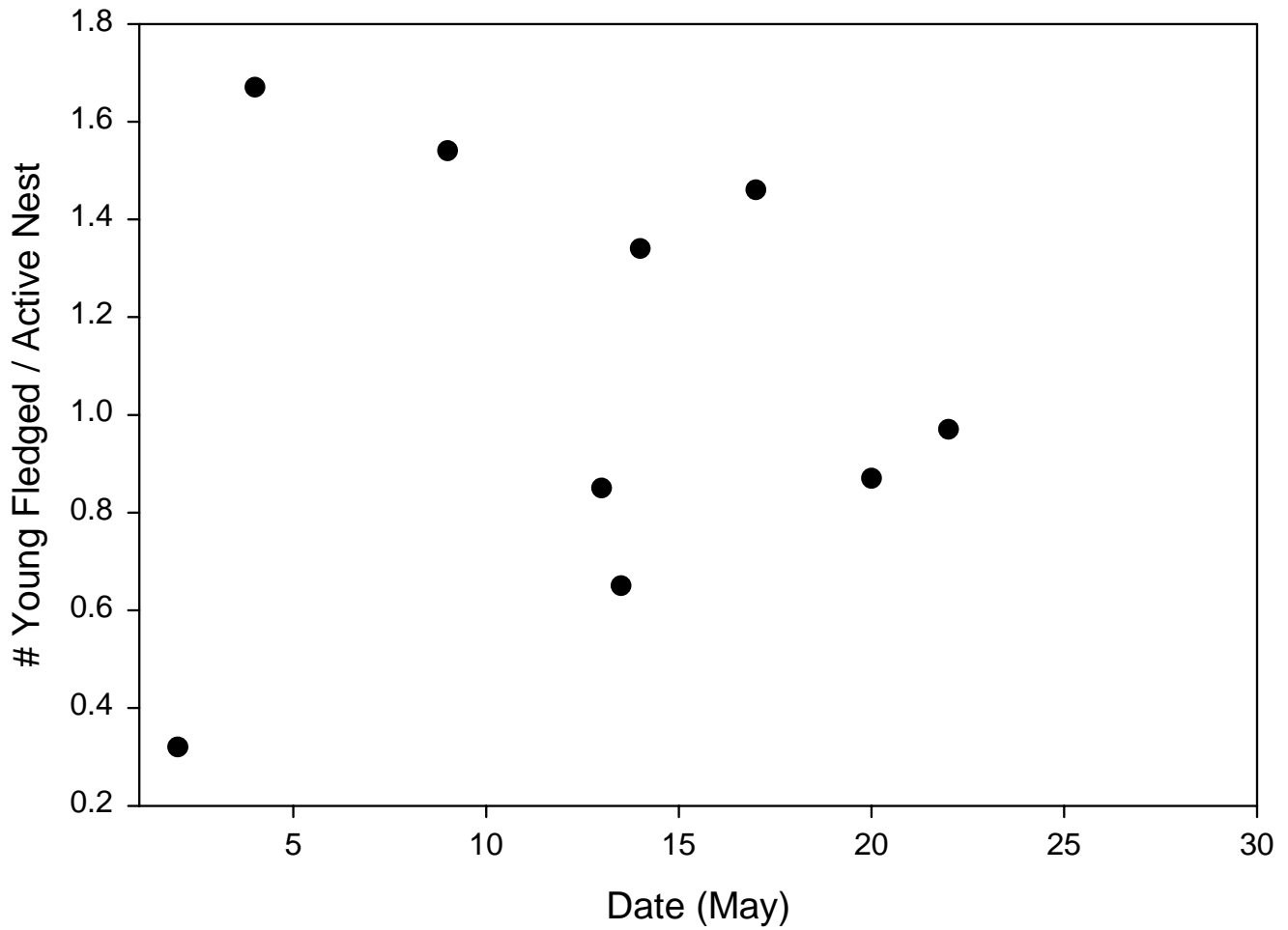


Figure 3 Osprey Reproductive Success in Relation to Mean Day of Last Ice, 1994-2002



Notes:

1. Day of last ice recorded at Minipi and Eagle River weather stations (Minaskuat 2004).

Table 6 1993-2004 Osprey Reproductive Success Compared with Date of Last Ice Recorded at Minipi and Eagle Rivers, Labrador.

Year	Success Rating	# Young Fledged/ Active Nest	Day of Last Ice	
			Minipi River	Eagle River
1993	Poor	--	12 May	14 May
1994	Good	1.34	12 May	16 May
1995	Good	1.46	19 May	15 May
1996	Poor	0.32	NA	02 May
1997	Mediocre	0.87	NA	20 May
1998	Very Good	1.54	NA	09 May
1999	Very Good	1.67	03 May	05 May
2000	Mediocre	0.85	10 May	16 May
2001	Poor	0.65	18 May	09 May
2002	Mediocre	0.97	21 May	24 May
2003	Very Good	1.82	N/A	N/A
2004	Very Good	1.70	N/A	N/A

(Source: Minaskuat 2004)

Weather Conditions

Monthly temperature and precipitation data (Appendix C), maximum wind gusts, and wind chill temperatures (Appendix D) were examined for evidence of storm events (*i.e.* relatively heavy rain accompanied by high winds and/or cold temperatures). Generally, when precipitation occurred over consecutive days, daily rainfall amounts were < 10 mm (Appendix C). Daily rainfall amounts of <1 mm were recorded at Anne Marie Lake on all but three days in August, however this may be indicative of the mechanical problem related to this parameter at this station (discussed above). As expected, temperatures fluctuated throughout May-August (Appendix C). The last day subzero temperatures were recorded on 26 May (Goose Bay) and 6 June (Anne Marie and Park Lake Stations) (Table 7). Similarly, average wind speeds varied considerably each day, but maximum wind gusts of >20 km/h were recorded on most days throughout the sampling period (Appendix D).

Table 7 Summary of Temperature and Precipitation Data in Relation to Osprey Nesting Success, 1993-2004.

Year	Success Rating	# Young Fledged/ Active Nest	Description of Weather (July)
1993	Poor	Unknown	Near zero temperatures 4-5 July after 25-30°C on 3 July. Relatively dry, some rain on 4 July. Cool, wet period 21-24 July.
1994	Good	1.34	Latest subzero temperature mid-June. Min. temperatures >3°C for 1-7 July.
1995	Good	1.46	Latest subzero temperature early June. Min. temperatures >4°C for 1-7 July. Significant rainfall between 3-13 July.
1996	Poor	0.32	Latest subzero temperature early June. Min. temperatures >3°C for 1-7 July. Cool average temperatures 3-8 July. Light rain most days during 1-7 July. Relatively heavy rain on 10 July.
1997	Mediocre	0.87	Latest subzero temperature early June. Min. temperatures >5°C for 1-7 July. Relatively cool days 1-2, 14-15 July. Minimal rain most days 1-14 July, heavy rain on 2, 10 July.
1998	Very Good	1.54	Latest subzero temperature early June. Min. temperatures >5°C for 1-7 July. Cool, wet day 2 July. Relatively heavy rain 2 and 7 July.
1999	Very Good	1.67	Latest subzero temperature early June. Min. temperatures >5°C for first week of July. High temperatures 12-13 July. Relatively heavy rain on 3 July, cool wet period 4-10 July.
2000	Mediocre	0.85	Latest subzero temperature early-mid June. Min. temperatures >=5°C throughout July. Max. temperatures fell <10°C mid-July after >15°C for some time. Relatively high rain on 5-6,9 July. Cool wet period on 20-22 July.
2001	Poor	0.65	Latest subzero temperature early June. Min. temperatures >5°C throughout July. Rain almost every day during 1-7 July. Cool wet period 12-13 July.
2002	Mediocre	0.97	Latest subzero temperature mid-June. Min. temperatures >5°C between 1-7 July. Cooler min. on 13,18,29 July. Max. temperatures >30°C in early July, with relatively cooler period 11-13 July. Rain most days between 5-13 July.
2003	Very Good	1.82	Latest subzero temperature early June. Min. temperatures >5°C for 1-7 July. Min. near 0°C at Anne Marie Lake on 8 July. Rain on most days 5-10 July. Cool wet period from 5-10 July.
2004	Very Good	1.70	Latest subzero temperature 6 June. July min. and max. temperatures of >9°C and >21°C respectively, at all stations. Large rainfall (>45mm) on 14 July at Park Lake (no rain at Anne Marie Lake on same day). Daily rainfall between 5-7 July. Rain on most days 16-24 July.

Notes:

- 1993-2002 summaries based on information collected from the Environment Canada weather station at Goose Bay, Labrador.
- 2003-2004 summaries based on information collected at Goose Bay and local weather stations at Anne Marie and Park Lakes, Labrador (available online at <http://www.climate.weatheroffice.ec.gc.ca/climateData>).

Visual analysis of the data revealed the following notable (i.e. relatively high rainfall accompanied by cooler temperatures and/or relatively high wing gusts) weather events:

05-07 July (Approximate hatch date) – Total precipitation 16 mm recorded at Anne Marie Lake. Accompanied by high winds at times (gusts of 54 km/h) and 6-16°C temperatures. Followed a relatively warm period of maximum temperatures up to 29°C.

-Precipitation recorded over 6-7 July at Park Lake (14.2 mm total accumulation). Wind gusts between 40-53 km/h. Minimum temperatures as low as 4.2°C (maximum 17.8°C).

-Total precipitation 24.4 mm between 5-7 July recorded in Goose Bay. Temperatures dropped to a maximum of 16°C on 6 July, from a high of 26°C on 5 July. Maximum wind gusts of >40 km/h (exceeding 50 km/h).

14 July (Brooding Period) – High precipitation (>40 mm) recorded at Park Lake. Minimum temperature 14°C, maximum 21°C. Maximum wind speeds <25 km/h, however relatively high winds (>50 km/h) recorded at times throughout 13 July.

Annual Weather Conditions (July) and Osprey Nesting Success

Temperature, precipitation and wind data collected between 1-14 July at Anne Marie and Park Lakes during 2003-2004, and at Goose Bay during 1993-2004 are summarized in Table 8 and Table 9 respectively. Higher temperatures were recorded during July 2004 then in 2003 at the Anne Marie and Park Lake weather stations (Table 8). Total precipitation and daily maximum wind gusts were also greater in 2004 then 2003 at these sites (Table 8). Despite differences in weather conditions during this time, both 2003 and 2004 were considered “Very Good” years in terms of Osprey nesting success.

Table 8 Summary of Climate Statistics Recorded from Local Weather Stations at Anne Marie Lake and Park Lake, Labrador, 1-14 July 2003-2004.

Time Period		Overall Success Rating	Avg. Min. Temperature (°C)		Avg. Max. Temperature (°C)		Avg. Max. Wind speed (km/h)		Avg. Min. Wind Chill		Total Precipitation (mm)	
			AML	PL	AML	PL	AML	PL	AML	PL	AML	PL
2003	01-07 Jul	Very	9.7	10.2	11.3	10.9	13.6	21.5	6.8	no	7.5	14.9
	08-14 Jul	Good	10.9	10.8	11.9	11.6	20.0	17.8	3.6	data	0.6	30.9
2004	01-07 Jul	Very	9.6	10.0	22.6	21.3	32.2	36.3	9.7	9.4	17.3	14.2
	08-14 Jul	Good	9.0	9.2	24.7	22.4	27.6	33.1	9.1	8.4	0	45.5

Notes:

1. AML = Anne Marie Lake; PL = Park Lake

Table 9 Summary of Climate Statistics at Goose Bay, Labrador, 1-14 July, 1993-2004

Time Period		Success Rating	# Young Fledged/ Active Nest	Avg. Min. Temperature (°C)	Avg. Max. Temperature (°C)	Total Rainfall (mm)
1993	01-07 Jul	Poor	N/A	6.6	20.5	5.4
	08-14 Jul			10.1	19.6	4.0
1994	01-07 Jul	Good	1.34	8.2	19.9	15.7
	08-14 Jul			9.7	22.1	17.4
1995	01-07 Jul	Good	1.46	8.4	18.6	46.6
	08-14 Jul			12.1	21.5	57.8
1996	01-07 Jul	Poor	0.32	9.0	15.4	16.2
	08-14 Jul			8.3	20.6	43.2
1997	01-07 Jul	Mediocre	0.87	9.6	18.1	51.2
	08-14 Jul			8.5	16.8	52.4
1998	01-07 Jul	Very Good	1.54	8.6	19.0	45.0
	08-14 Jul			9.8	23.5	1.6
1999	01-07 Jul	Very Good	1.67	8.8	15.4	64.8
	08-14 Jul			10.2	20.4	25.0
2000	01-07 Jul	Mediocre	0.85	8.9	16.6	44.0
	08-14 Jul			7.6	17.4	29.2
2001	01-07 Jul	Poor	0.65	8.3	17.1	45.6
	08-14 Jul			9.0	13.8	74.8
2002	01-07 Jul	Mediocre	0.97	11.4	22.4	32.0
	08-14 Jul			7.1	17.0	43.6
2003	01-07 Jul	Very Good	1.82	9.3	15.0	41.6
	08-14 Jul			8.4	19.0	36.8
2004	01-07 Jul	Very Good	1.70	11.0	23.2	28.8
	08-14 Jul			9.6	23.5	12.0

Notes:

1. Criteria for determining Overall Success Ratings are provided in Table 1.
2. AML = Anne Marie Lake, PL = Park Lake.
3. Environment Canada weather data is available online at <http://www.climate.weatheroffice.ec.gc.ca/climateData>

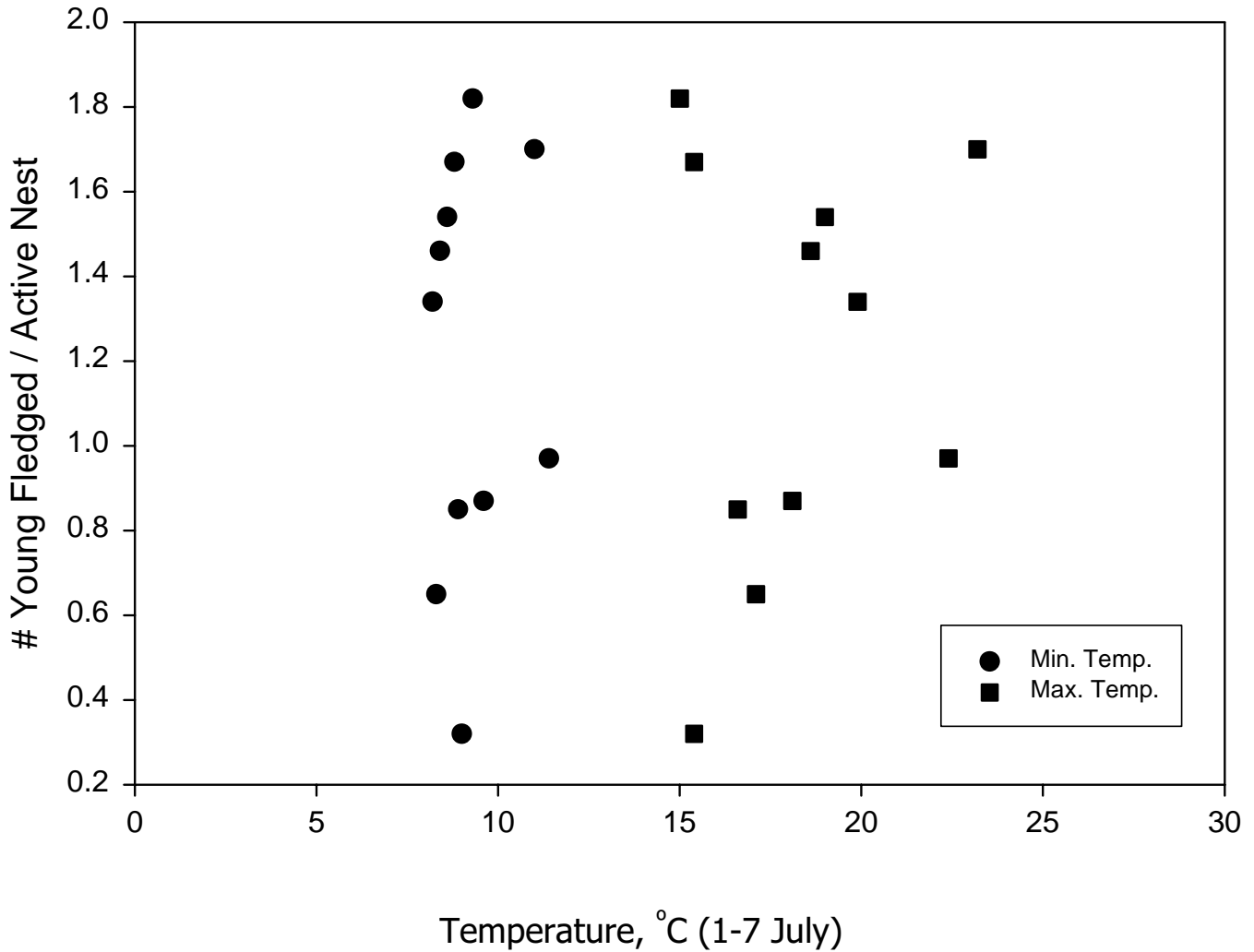
Average maximum temperatures recorded during early July (1-14) at the Goose Bay weather station in 2004 were the highest recorded throughout 1993-2004 (Table 9). Temperatures recorded during 1998, also considered a “Very Good” year, were similarly high. Average minimum temperatures of 15°C, however, were recorded during other “Very Good” years (e.g. 1999, 2003) and during 1996, a relatively “Poor” year.

The lowest temperatures throughout 1993-2004 occurred in 2001, when the average maximum temperature dipped 13.8°C during the second week of July. This “Poor” year also experienced the highest total rainfall of all years (Table 9). Minimal rainfall and relatively high temperatures, however, characterized other “Poor” years (e.g. 1993) (Tables 7 and 9).

Precipitation occurred daily throughout the hatch period [5-7 July (Table 2)] during “Poor” (e.g. 2001), “Mediocre” (e.g. 2002), and “Very Good” (e.g. 2003) years, with relatively heavy rainfall during years 2000, 1998, and 1995 (“Very Good”, “Good”, and “Mediocre” years, respectively) (Table 7). Likewise, no correlation was found between relatively dry periods and nesting success (Tables 7 and 9).

To further assess potential relationships between temperature and precipitation during the critical hatching and early brooding period in early June, and Osprey reproductive success, scatter plots of minimum and maximum temperatures and cumulative precipitation in comparison with overall reproductive success were generated (Figures 4-7). The time periods between 1-7 July and 8-14 July were separated for more detailed assessment. No strong relationship was obvious in most data sets; however, some relationship was evident between average daily maximum temperatures during the second week of July and reproductive success (Figure 5). This relationship between high average temperature and high success is stronger when data from 1996 is omitted from analysis (Figure 5). But note that 1993, a relatively “Poor” year, maximum temperatures were higher than in 2003 (a “Very Good” year) (Table 9). Accurate productivity values were unavailable for 1993 and are not represented in Figure 5.

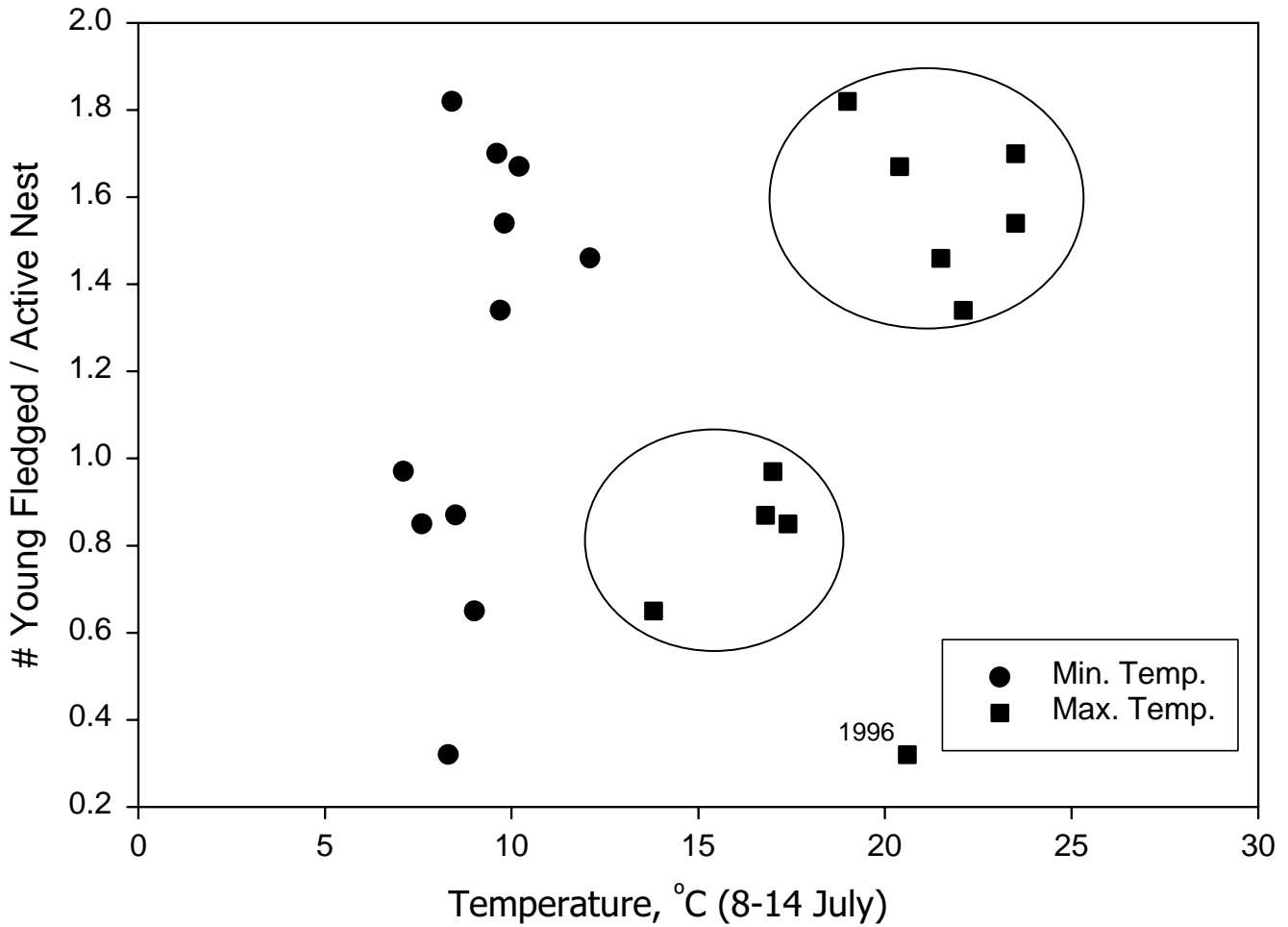
Figure 4 1994-2004 Osprey Reproductive Success Compared with Average Minimum and Maximum Temperatures During 1-7 July



Notes:

1. All data recorded at the Environment Canada weather station in Goose Bay
2. 1994-2003 data from Minaskuat 2004
3. 2004 data available online at <http://www.climate.weatheroffice.ec.gc.ca/climateData>.

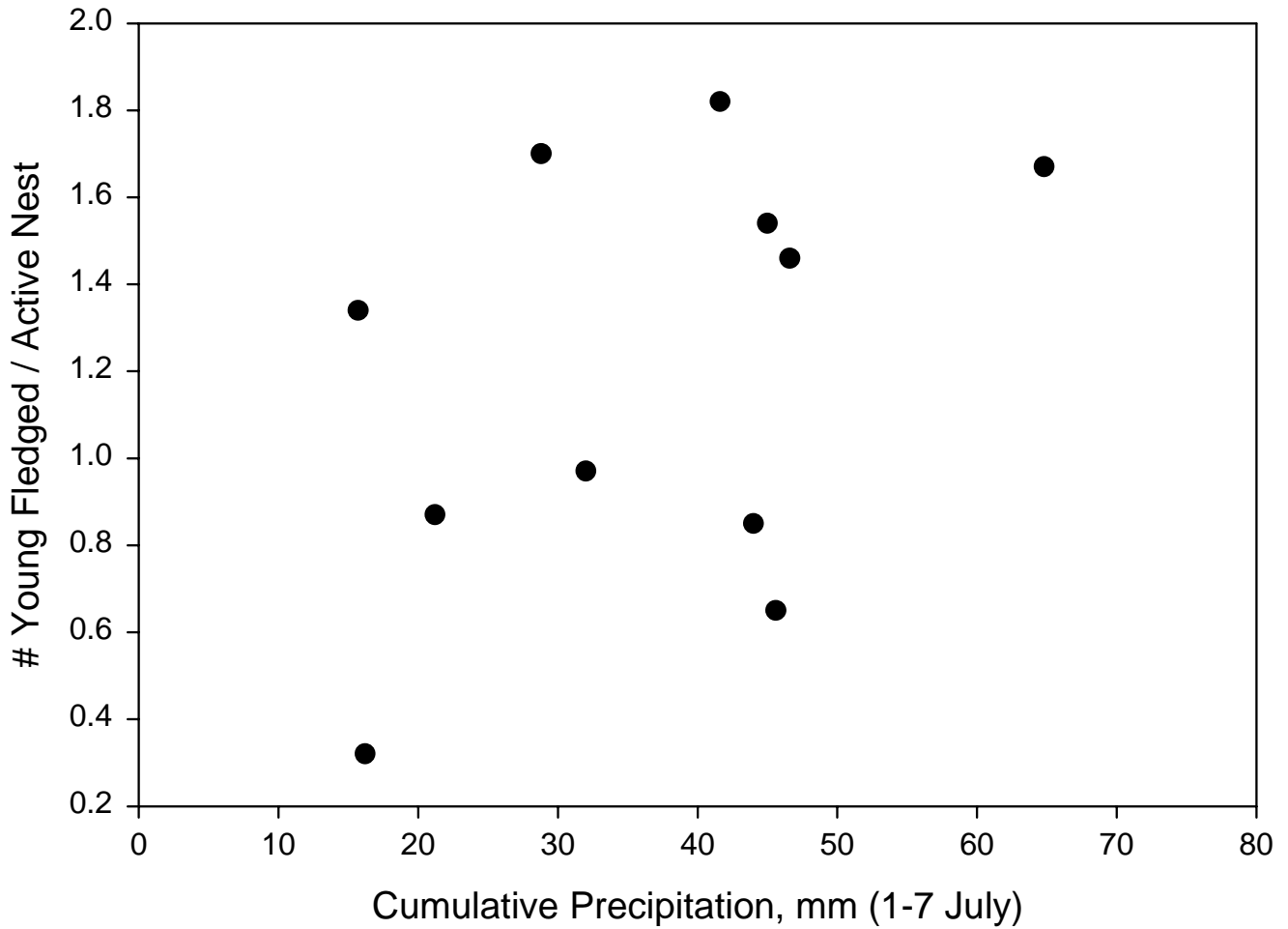
Figure 5 1999-2004 Osprey Reproductive Success Compared with Average Minimum and Maximum Temperatures During 8-14 July.



Notes:

1. All data recorded at the Environment Canada weather station in Goose Bay
2. 1994-2003 data from Minaskuat 2004
3. 2004 data available online at <http://www.climate.weatheroffice.ec.gc.ca/climateData>.

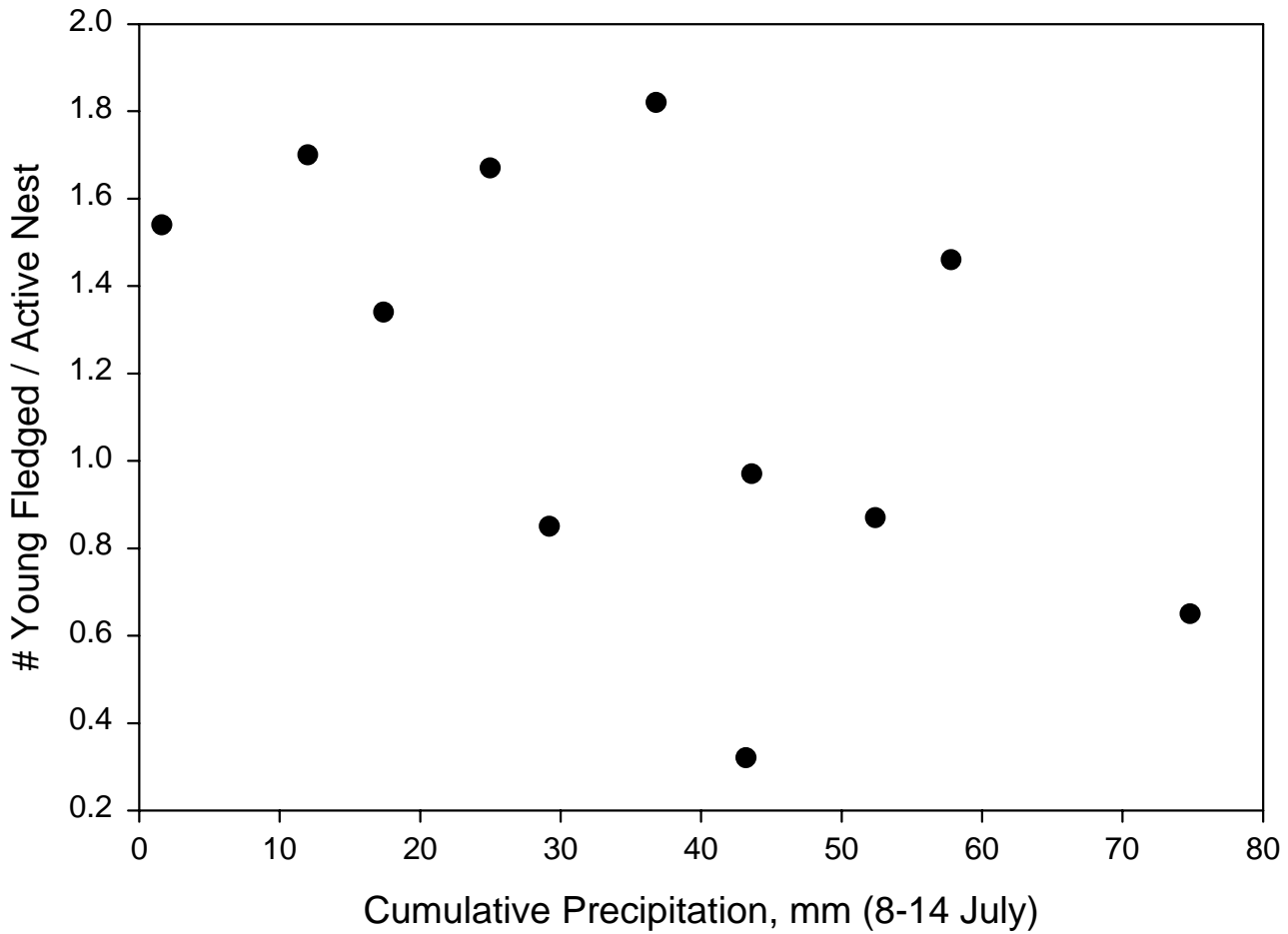
Figure 6 1994-2004 Osprey Reproductive Success Compared with Cumulative Precipitation During 1-7 July



Notes:

1. All data recorded at the Environment Canada weather station in Goose Bay
2. 1994-2003 data from Minaskuat 2004
3. 2004 data available online at <http://www.climate.weatheroffice.ec.gc.ca/climateData>.

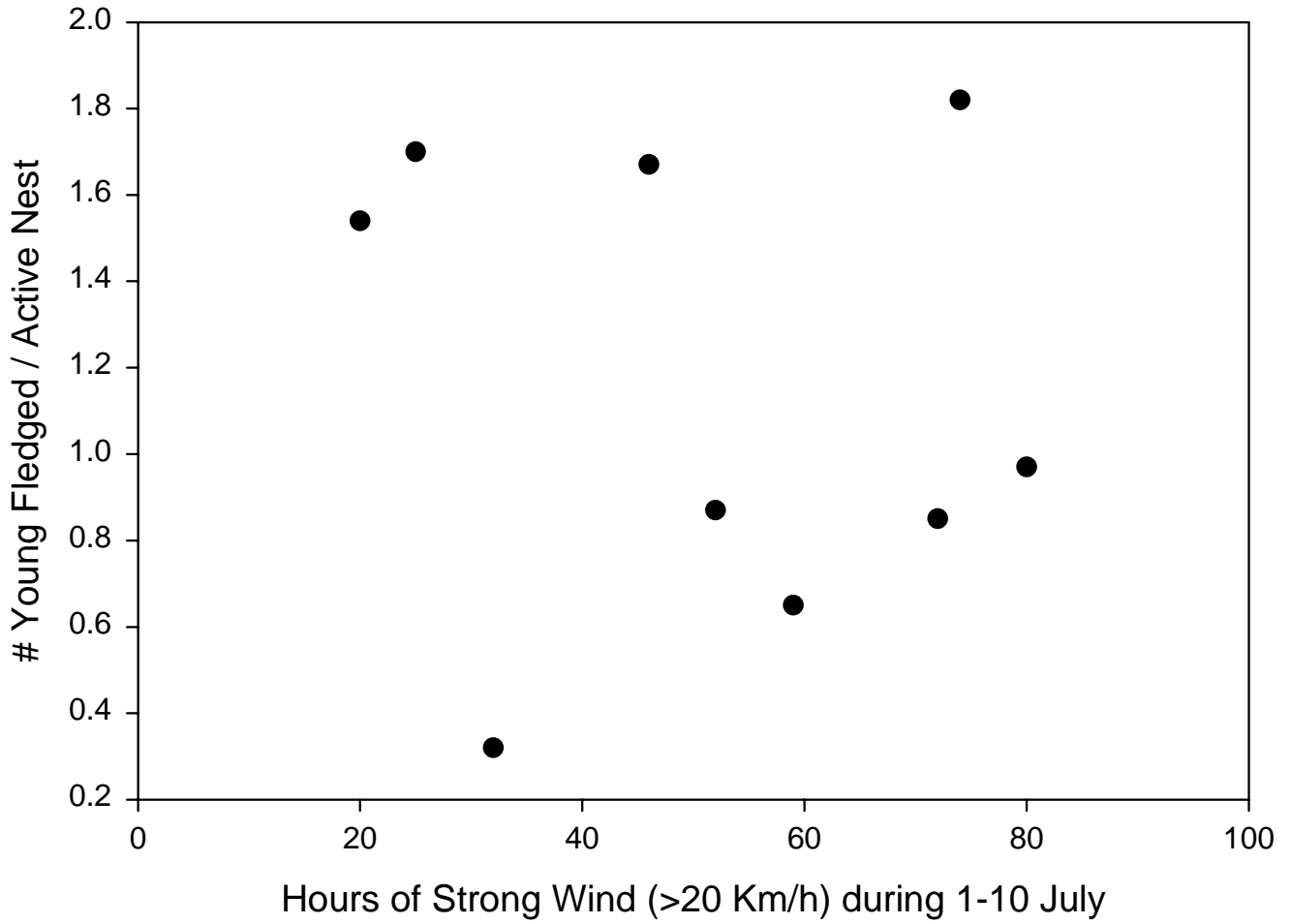
Figure 7 1994-2004 Osprey Reproductive Success Compared with Cumulative Precipitation During 8-14 July



Notes:

1. All data recorded at the Environment Canada weather station in Goose Bay
2. 1994-2003 data from Minaskuat 2004
3. 2004 data available online at <http://www.climate.weatheroffice.ec.gc.ca/climateData>.

Figure 8 1996-2004 Osprey Reproductive Success Compared with Total Hours of Strong Winds (>20 km/h) During 1-10 July



Notes:

1. All data recorded at the Environment Canada weather station in Goose Bay
2. 1996-2003 data from Minaskuat 2004
3. 2004 data available online at <http://www.climate.weatheroffice.ec.gc.ca/climateData>.

Hourly wind speeds of 20-25 km/h and >25 km/h were lowest in 2004 and 1998, two “Very Good” years (Table 10). Some of the highest wind speeds, however, occurred during a “Very Good” year (*i.e.* 2003) (Table 10). Hours of relatively high wind speeds during “Poor” years (1996 and 2001) were comparable to other years (Table 10). Similarly, no relationship was evident when data were combined (total hours of winds >20 km/h) and compared with average reproductive success between 1-10 July, 1996-2004 (Figure 8).

Table 10 1996-2004 Osprey Reproductive Success and Total Hours of Relatively High Wind Speeds

Year	Success Rating	# Young Fledged/ Active Nest	Hours of high wind at Goose Bay, 1-10 July	
			20-25 km/h	>25 km/hr
1996	Poor	0.32	22	10
1997	Mediocre	0.87	38	14
1998	Very good	1.54	15	5
1999	Very good	1.67	29	17
2000	Mediocre	0.85	44	28
2001	Poor	0.65	39	20
2002	Mediocre	0.97	49	31
2003	Very good	1.82	50	24
2004	Very good	1.70	17	8

Notes:

1. All data recorded at the Environment Canada weather station in Goose Bay
2. 1996-2003 data from Minaskuat 2004
3. 2004 data available online at <http://www.climate.weatheroffice.ec.gc.ca/climateData>.
4. Success ratings from Table 1.

6.0 DISCUSSION

6.1 Nest Parameters

No differences in nesting activity were observed between the control and LLTA study areas. However, the results from 2004 represented the third of the last six years in which reproductive output per active nest was higher in the control sample than the LLTA. Reproductive success was similarly higher in the control. Although results favour the control area during 2004, one would expect to find similar results in the past if a strong relationship ($\alpha = 0.20$) existed. However, **considerable variability in these parameters has been observed over the past six years.** These inconsistent differences between control and experimental areas, combined with apparent contradictions between reproductive output and success during some years (e.g. 2003) suggest that LLF activity is not related to Osprey reproductive success over these large areas (Table3).

Variability in nesting activity and nesting success during each of the six years suggests the possibility of a 3-5 year high/low trend in these parameters (Tables 3 and 5). Although not significant (at $\alpha = 0.20$), reproductive success has been higher in the LLTA in four of the last six years, further emphasizing not only this variability (within a given year) but also the lack of evidence that LLF is affecting Osprey in this regard (despite the significant difference to the contrary in 2004).

Variation in Osprey nesting success and reproductive output may occur over a large geographic area such as the LLTA. Researchers have documented differences in population growth between adjacent or nearby colonies (Bowman *et al.* 1989; Steeger *et al.* 1992; Castellanos and Ortega-Rubio 1995) as influenced by a variety of regional habitat factors. Results of the 1999-2004 investigations and the findings of others indicate that Osprey nesting success may be more closely tied to factors other than low-level jet aircraft training.

6.2 Weather and Osprey Nesting Success

The influence of weather on conclusions about the effects of military training on raptors has been cited as an important determinant for behaviour and abundance studies (Schueck and Marzluff 1995). The relationship between climate and breeding success was considered during 2003, however results of this preliminary investigation did not suggest a relationship between climate and osprey breeding success (Minaskuat 2004).

Results of this analysis suggest the possibility of a weak relationship between lower reproductive output per active Osprey nest and low maximum temperatures during the second week of July [early post-hatching period (JWEL 1998)]. Below normal temperatures during the early nesting period has been identified as influencing reproductive success of Osprey in the study area (Chubbs and Trimper 1998). However, little information is available on the early developmental stages of Osprey in the northern extremes of its breeding range, and of the impacts such temperature differences might have on productivity.

Several environmental factors may act in combination with below normal temperatures to influence success. Chubbs and Trimper (1998) suggested that a decrease in mean temperatures of only 2°C in July could make fish less available as prey, thus lowering productivity. Other factors may include the position of a nest relative to foraging grounds, nest microclimate, adult behaviour, and influence of predators and/or fratricide. As such, a multivariate approach should be considered in future investigations before conclusions regarding any relationships between climate and Osprey reproductive success in the study area can be made.

7.0 SUMMARY AND CONCLUSIONS

- I. No significant differences in 2004 nesting activity ($p=0.601$, $\alpha=0.20$) were observed between the control and LLTA study areas.
- II. Reproductive success and reproductive output per active nest (productivity) was higher in the control sample than the LLTA. These differences were significant ($p=0.104$ and $p=0.024$, respectively) at the 20% confidence level. However, one would expect to find similar results in the past if a persistent and strong relationship existed.
- III. **Considerable variability in nest activity, nest success and productivity has been observed over the past six years.** Observed variability suggests the possibility of a 3-5 year high/low trend in these parameters.
- IV. Osprey reproduction since the removal of exclusion zones in the LLTA starting in 1999 appears consistent with a control area not subjected to LLF. Annual productivity monitoring during 1999-2004 suggests that reproductive success is related more to other external factors in Labrador and northeastern Québec.
- V. A weak relationship may exist between average maximum temperatures during the early post-hatching period, when Osprey young are not able to thermoregulate, and reproductive success. However, more detailed (multivariate) analyses are required to confirm relationships between climate and productivity of Osprey nesting in the study area.

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APPENDIX A

2004 OSPREY NESTING DATA

APPENDIX A 2004 Osprey Nesting Data

Area	Observation	Nest Latitude	Nest Longitude	Status	Initial Survey Date	Final Survey Date	Nest Fate	Number of Young	Number of Adults	Comments
Control	13B/14-06	52 51.47	-59 27.04	Active	24-Jun-04	not checked	-	-	-	-
Control	13B/14-28	52 51.33	-59 27.20	Active	24-Jun-04	not checked	-	-	-	-
Control	13B/14-34	52 59.26	-59 01.64	Active	24-Jun-04	18-Aug-04	Success	2	1	Large Feathered
Control	13B/14-39	52 58.97	-59 05.94	Active	24-Jun-04	18-Aug-04	Success	3	1	Large Feathered
Control	13B/14-48	52 57.33	-59 08.07	Active	24-Jun-04	18-Aug-04	Success	2	1	Large Feathered
Control	13B/14-56	52 55.05	-59 12.04	Active	24-Jun-04	18-Aug-04	success	2	1	Large Feathered
Control	13B/14-71	52 59.472	59 03.280	Active	24-Jun-04	18-Aug-04	failed	0	1	Nest in good condition
Control	13B/15-01	52 59.94	-58 47.62	active	21-Jun-04	18-Aug-04	success	3	1	Large Feathered
Control	13B/15-03	52 59.57	-58 48.90	Active	21-Jun-04	18-Aug-04	success	2	1	Large Feathered
Control	13B/15-29	52 56.46	-58 47.90	Active	21-Jun-04	18-Aug-04	success	3	1	Large Feathered
Control	13B/15-31	52 54.23	-58 45.13	Active	21-Jun-04	18-Aug-04	success	3	1	2 Large Feathered, 1 Small
Control	13B/15-46	52 52.90	-58 40.20	Active	21-Jun-04	18-Aug-04	success	2	2	Large Feathered
Control	13B/15-50	52 51.40	-58 43.40	Active	21-Jun-04	18-Aug-04	success	2	0	Large Feathered
Control	13B/15-64	52 58.019	58 33.485	Active	21-Jun-04	18-Aug-04	success	2	1	Feathered
Control	13B/15-65	52 54.895	58 38.281	Active	21-Jun-04	18-Aug-04	success	1	1	Feathered
Control	13B/15-66	52 53.747	58 44.398	Active	21-Jun-04	18-Aug-04	success	3	1	Large Feathered
Control	13B/15-67	52 57.795	58 49.132	Active	21-Jun-04	18-Aug-04	success	2	1	Large Feathered
Control	13B/15-68	52 54.70	58 52.35	Active	21-Jun-04	18-Aug-04	success	2	1	Large Feathered
Control	13G/1-15	53 10.60	-58 23.25	active	21-Jun-04	18-Aug-04	success	1	1	Large Feathered
Control	13G/2-24	53 00.40	-58 54.81	Active	21-Jun-04	18-Aug-04	success	2	1	Large Feathered
Control	13G/2-38	53 01.58	-58 54.73	active	21-Jun-04	18-Aug-04	success	2	1	Feathered
Control	13G/2-41	53 04.88	-58 36.72	active	21-Jun-04	18-Aug-04	success	2	1	Large Feathered
Control	13G/2-43	53 02.804	58 51.001	active		18-Aug-04	success	3	1	Large Feathered
Control	13G/2-44	53 03.082	58 41.040	active		18-Aug-04	success	3	1	Large Feathered
Control	13G/2-46	53 08.126	58 30.298	active	21-Jun-04	18-Aug-04	failed	0	0	Nest in good condition
Control	13G/3-02	53 07.30	-59 13.68	active	21-Jun-04	18-Aug-04	failed	0	1	Nest in good condition
Control	13G/3-04	53 05.91	-59 08.19	active	21-Jun-04	18-Aug-04	success	3	1	Large Feathered
Control	13G/3-21	53 03.84	-59 12.56	active	21-Jun-04	18-Aug-04	failed	0	2	Nest in good condition
Control	13G/3-29	53 05.594	-59 16.690	active	21-Jun-04	18-Aug-04	success	2	1	Feathered
Control	13G/3-48	53 03.75	-59 05.60	active	21-Jun-04	18-Aug-04	success	2	1	Large Feathered
Control	13G/3-50	53 05.52	-59 17.73	active	21-Jun-04	18-Aug-04	success	3	1	Large Feathered
Control	13G/3-54	53 03.19	-59 02.15	active	21-Jun-04	18-Aug-04	success	2	2	Large Feathered
LLTA	13B/12-04	52 39.51	-59 39.64	active	24-Jun-04	Not checked				

Area	Observation	Nest Latitude	Nest Longitude	Status	Initial Survey Date	Final Survey Date	Nest Fate	Number of Young	Number of Adults	Comments
LLTA	13C/10-15	52 38.00	-60 49.02	Active	22-Jun-04	16-Aug-04	success	1	1	Large Feather
LLTA	13C/10-16	52 37.04	-60 54.45	active	22-Jun-04	16-Aug-04	success	2	1	Large Feather
LLTA	13C/10-21	52 44.70	-60 54.71	active	22-Jun-04	16-Aug-04	success	2	1	1 egg unhatched; young were small
LLTA	13C/11-04	52 37.34	-61 26.67	active	22-Jun-04	20-Aug-04	failed	0	0	Nest partially collapsed
LLTA	13C/15-08	52 59.66	-60 37.39	active	24-Jun-04	16-Aug-04	success	2	1	Appear young (~10 days)
LLTA	13C/15-12	52 50.79	-60 36.38	active	24-Jun-04	16-Aug-04	success	2	0	Feather
LLTA	13C/15-13	52 52.12	-60 45.04	active	24-Jun-04	16-Aug-04	failed	0	0	Nest in good condition
LLTA	13C/15-14	52 54.36	-60 33.97	active	24-Jun-04	16-Aug-04	failed	0	1	Nest in good condition
LLTA	13C/15-16	52 53.47	-60 37.30	active	24-Jun-04	16-Aug-04	success	2	2	Bring trout to nest
LLTA	13C/15-19	52 56.81	-60 31.68	active	24-Jun-04	16-Aug-04	success	2	1	Bring trout to nest
LLTA	13C/15-20	52.59.34	-60.4483	active	24-Jun-04	16-Aug-04	failed	0	1	Flushed as approached nest
LLTA	13C/15-21	52 56.418	60 38.666	active	24-Jun-04	16-Aug-04	success	3	1	Bird held in nest during checks
LLTA	13C/15-23	52 52.98	-60 45.65	active	24-Jun-04	16-Aug-04	failed	0	0	Aggressive
LLTA	13C/16-08	52 58.24	-60 18.87	active	24-Jun-04	16-Aug-04	success	3	1	
LLTA	13C/16-14	52 58.72	-60 16.32	active	24-Jun-04	16-Aug-04	success	1	1	
LLTA	13C/16-22/24	52 46.03	-60 13.80	active	25-Jun-04	16-Aug-04	success	2	1	Aggressive
LLTA	13C/16-32	52 57.621	60 22.243	active	24-Jun-04	16-Aug-04	success	2	1	
LLTA	13C/2-03	52 07.36	-60 30.24	active	25-Jun-04	16-Aug-04	failed	0	1	Nest in good condition
LLTA	13C/2-08	52 13.783	-60 37.642	active	25-Jun-04	16-Aug-04	success	2	1	Feather
LLTA	13C/3-05	52 13.76	-61 23.93	active	25-Jun-04	20-Aug	success	2	1	large feathered
LLTA	13C/6-08	52 18.97	-61 22.53	active	25-Jun-04	20-Aug	failed	0	1	
LLTA	13C/6-09	53 20.13	61 21.62	active	24-Jun-04	20-Aug-04	success	2	1	large, feathered
LLTA	13C/7-07	52 20.15	-60 40.88	active	25-Jun-04	16-Aug-04	success	1	1	Feather
LLTA	13C/7-08	52 56.021	-60 42.992	active	25-Jun-04	16-Aug-04	success	3	1	Feather
LLTA	13C/9-03	52 35.54	-60 27.45	active	24-Jun-04	Not checked				
LLTA	13C/9-10	52 36.52	-60 19.37	active	24-Jun-04	Not checked				
LLTA	13F/1-01	53 02.42	-60 21.73	active	24-Jun-04	20-Aug-04	success	3	0	fully feathered and large
LLTA	13F/1-07	53 03.54	-60 05.28	active	24-Jun-04	20-Aug-04	success	2	1	large feathered
LLTA	13F/1-09	53 00.28	-60 24.613	active	24-Jun-04	20-Aug-04	failed	0	1	collapsed nest 0.25nm away

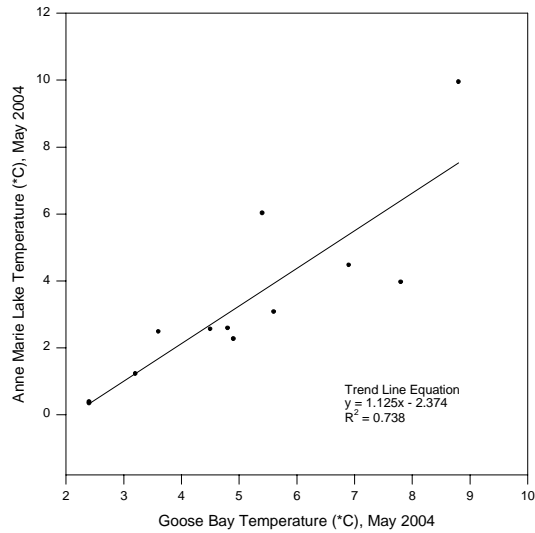
Area	Observation	Nest Latitude	Nest Longitude	Status	Initial Survey Date	Final Survey Date	Nest Fate	Number of Young	Number of Adults	Comments
LLTA	13F/1-10	53 03.77	60 26.23	active	24-Jun-04	20-Aug-04	success	2	1	medium, feathered
LLTA	13F/1-11	53 01.982	60 23.569	active	24-Jun-04	20-Aug-04	success	2	1	2 small young
LLTA	13F/2-17	53 11.57	-60 31.60	active	24-Jun-04	20-Aug-04	failed	0	0	small nest

APPENDIX B

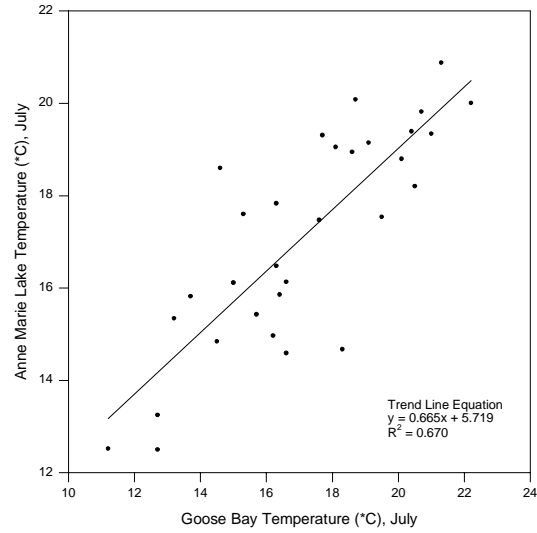
**2004 TEMPERATURE AND PRECIPITATION DATA
RECORDED AT ANNE MARIE AND PARK LAKE WEATHER STATIONS
COMPARED WITH GOOSE BAY, LABRADOR**

Appendix B 2004 temperature and precipitation data recorded at Anne Marie and Park Lake weather stations compared with Goose Bay, Labrador

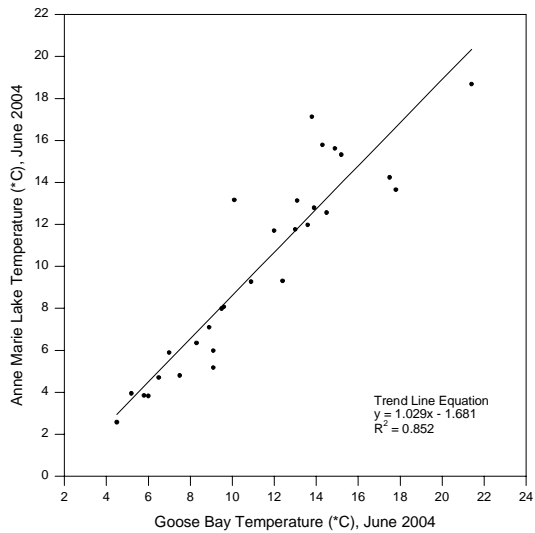
Mean daily temperatures at Anne Marie Lake compared to Goose Bay, May 2004.



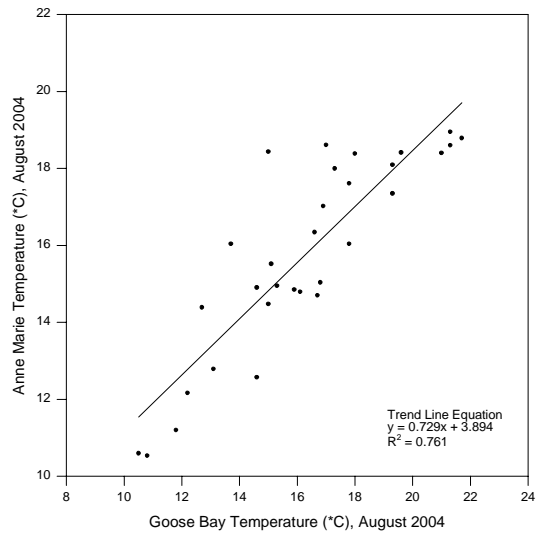
Mean daily temperatures at Anne Marie Lake compared with Goose Bay, July 2004.



Mean daily temperatures at Anne Marie Lake compared with Goose Bay, June 2004.

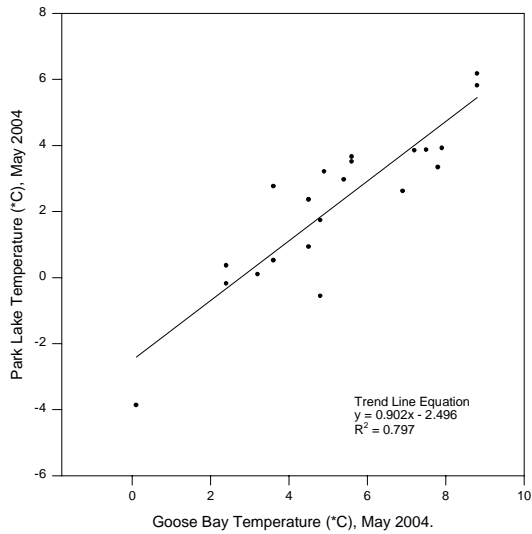


Mean daily temperatures at Anne Marie Lake compared with Goose Bay, August 2004.

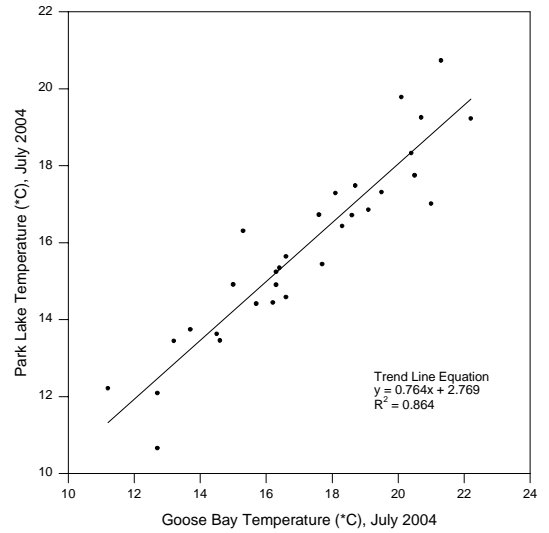


Appendix B (Continued)

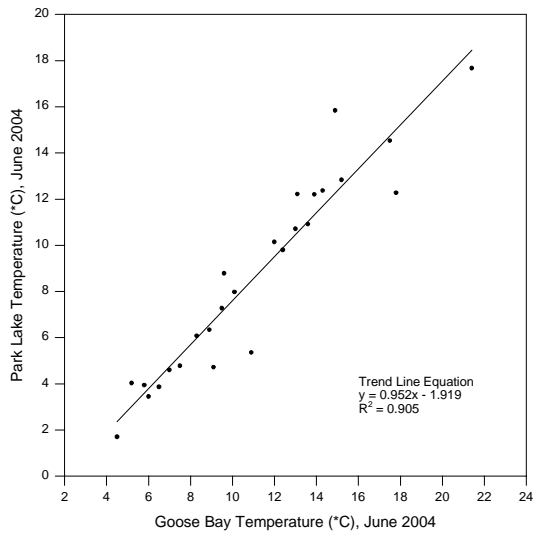
Mean daily temperatures at Park Lake compared with Goose Bay, May 2004.



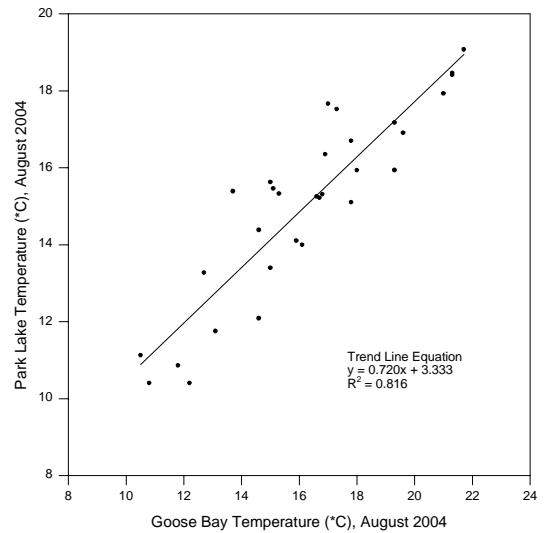
Mean daily temperatures at Park Lake compared with Goose Bay, July 2004.



Mean daily temperatures at Park Lake compared with Goose Bay, June 2004.

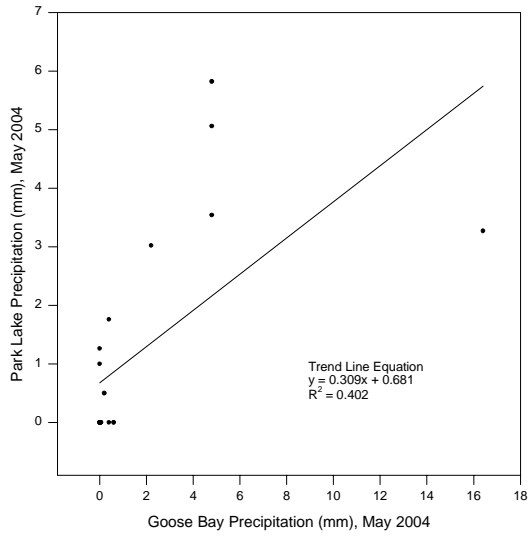


Mean daily temperatures at Park Lake compared with Goose Bay, August 2004.

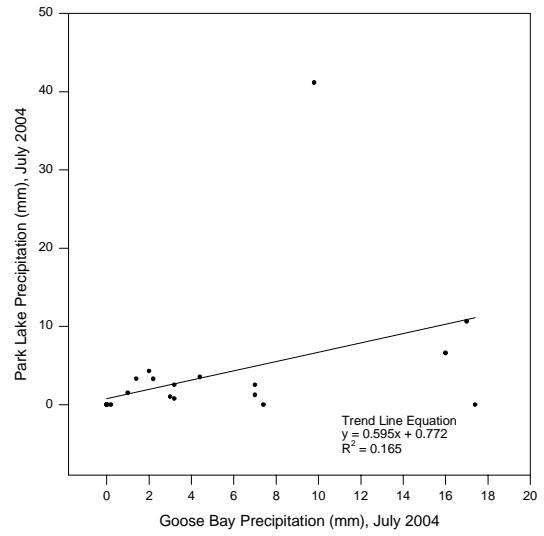


Appendix B (Continued)

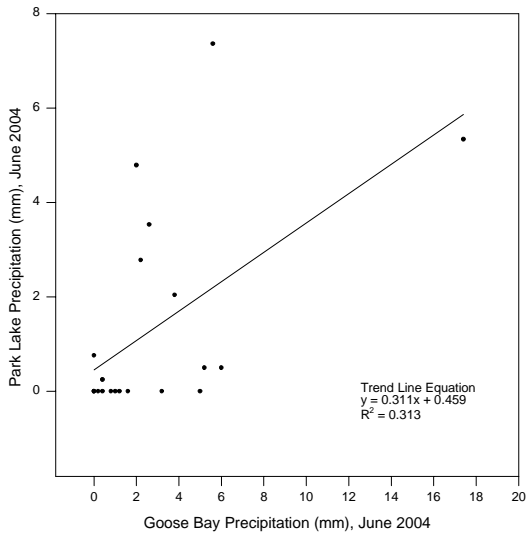
Total daily precipitation (mm) at Park Lake compared with Goose Bay, May 2004.



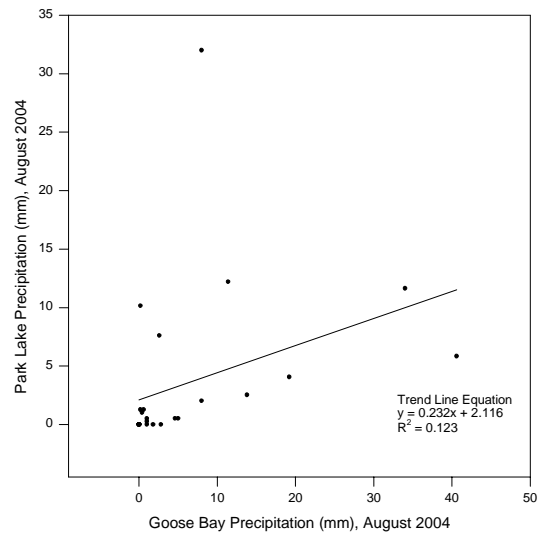
Total daily precipitation (mm) at Park Lake compared with Goose Bay, July 2004.



Total daily precipitation (mm) at Park Lake compared with Goose Bay, June 2004.



Total daily precipitation (mm) at Park Lake compared with Goose Bay, August 2004.

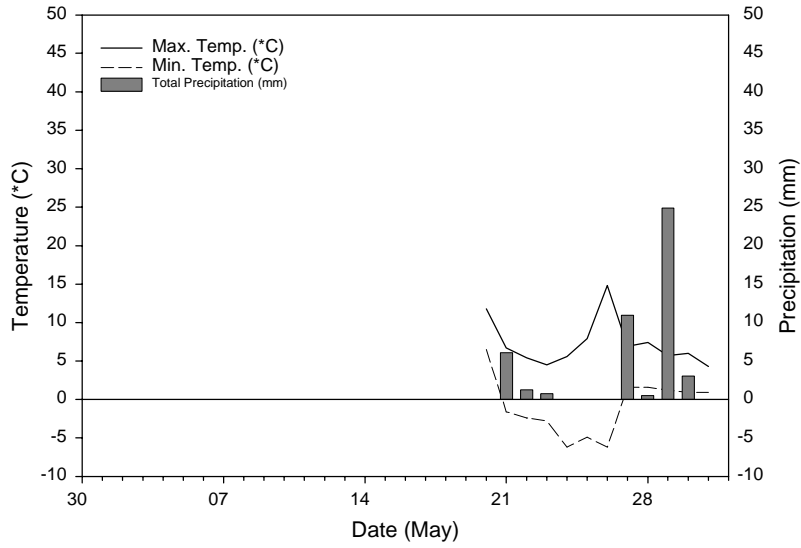


APPENDIX C

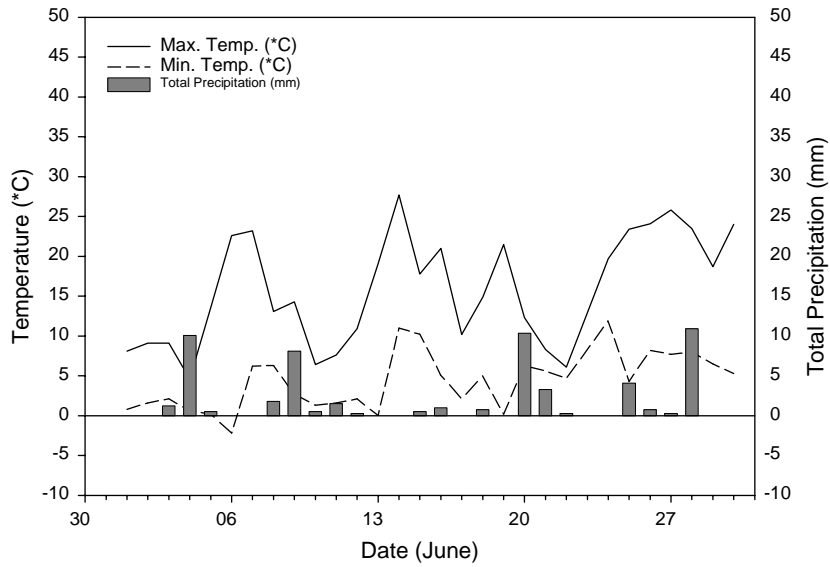
**2004 TEMPERATURE AND PRECIPITATION DATA
RECORDED AT GOOSE BAY AND
ANNE MARIE AND PARK LAKES, LABRADOR.**

Appendix C 2004 Temperature and Precipitation Data Recorded at Goose Bay and Anne Marie and Park Lakes, Labrador.

Daily maximum and minimum temperatures and total precipitation recorded at Anne Marie Lake, May 2004.

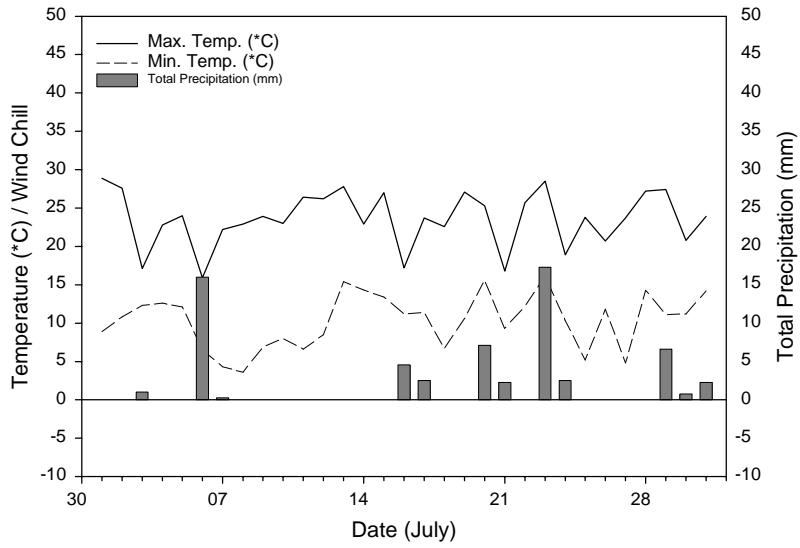


Daily maximum and minimum temperatures and total precipitation recorded at Anne Marie Lake, June 2004.

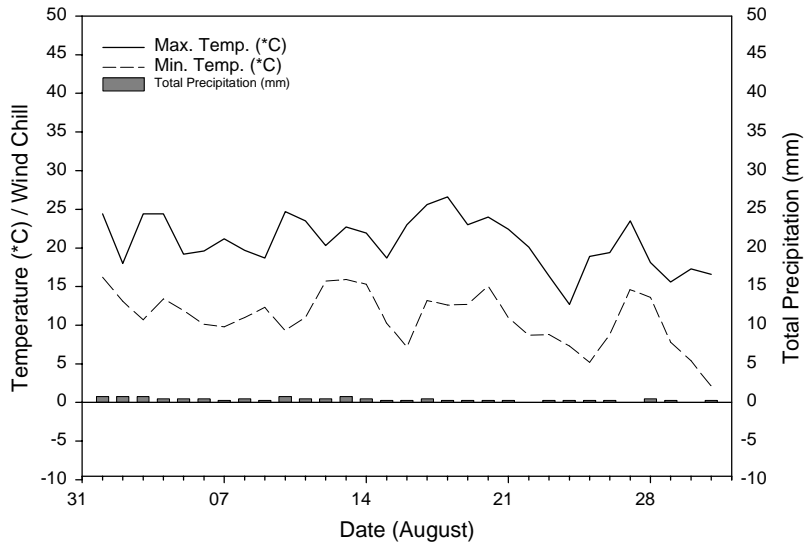


Appendix C (Continued)

Daily maximum and minimum temperatures and total precipitation recorded at Anne Marie Lake, July 2004.

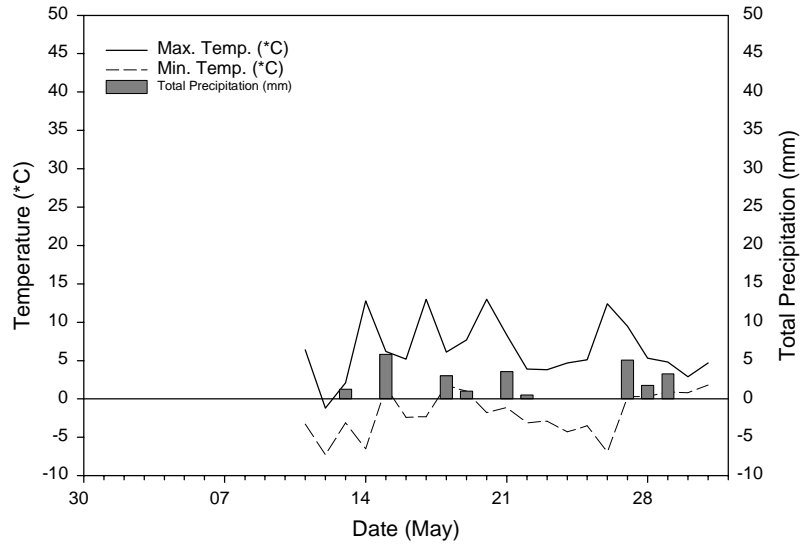


Daily maximum and minimum temperatures and total precipitation recorded at Anne Marie Lake, August 2004.

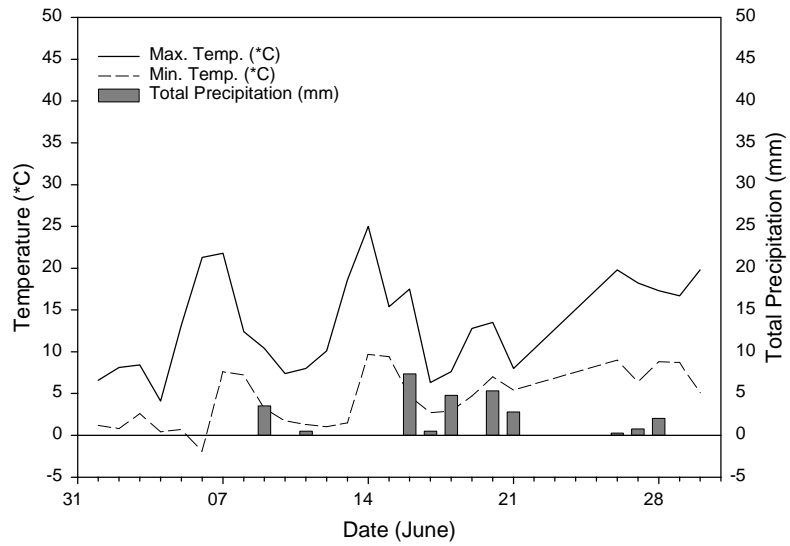


Appendix C (Continued)

**Daily maximum and minimum temperatures
and total precipitation recorded at Park Lake, NL, May 2004.**

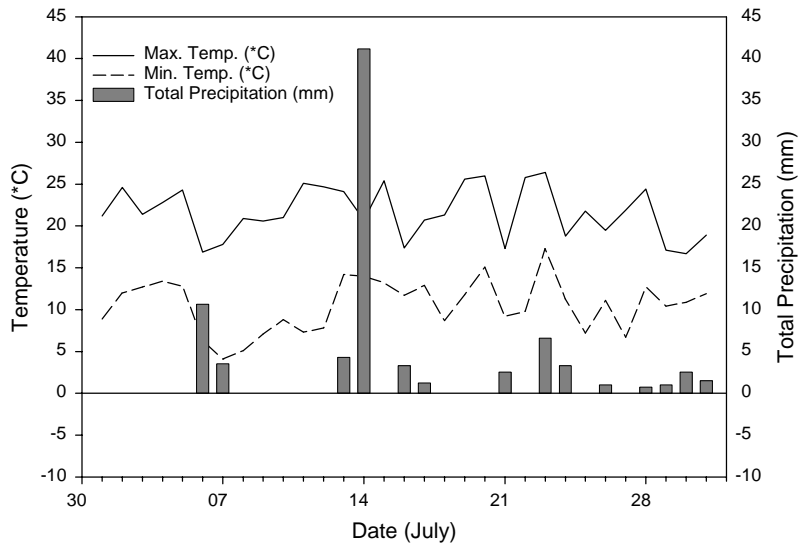


**Daily maximum and minimum temperatures
and total precipitation recorded at Park Lake, NL, June 2004.**

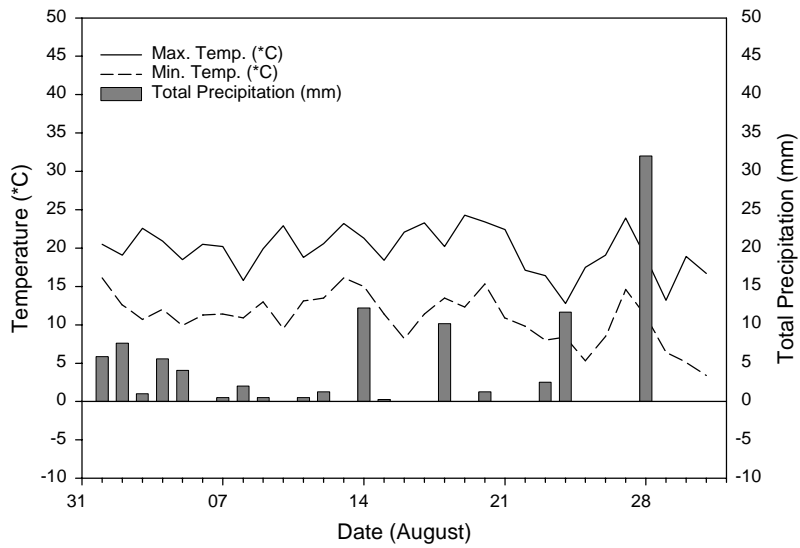


Appendix C (Continued)

**Daily maximum and minimum temperatures
and total precipitation recorded at Park Lake, NL, July 2004.**

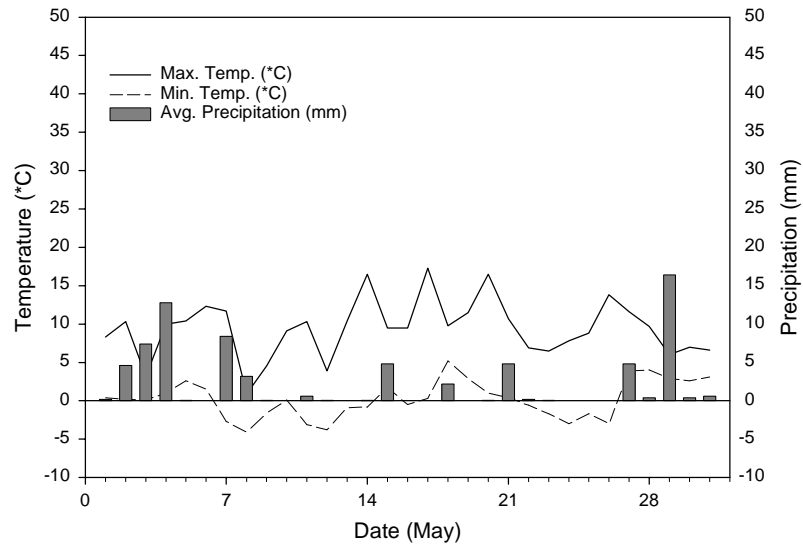


**Daily maximum and minimum temperatures
and total precipitation recorded at Park Lake, NL, August 2004.**

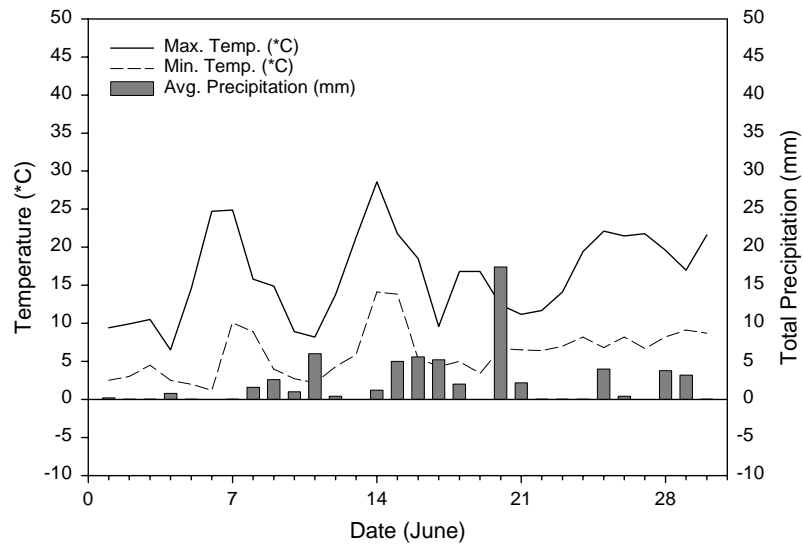


Appendix C (Continued)

**Daily maximum and minimum temperatures
and total precipitation recorded at Goose Bay, NL, May 2004.**

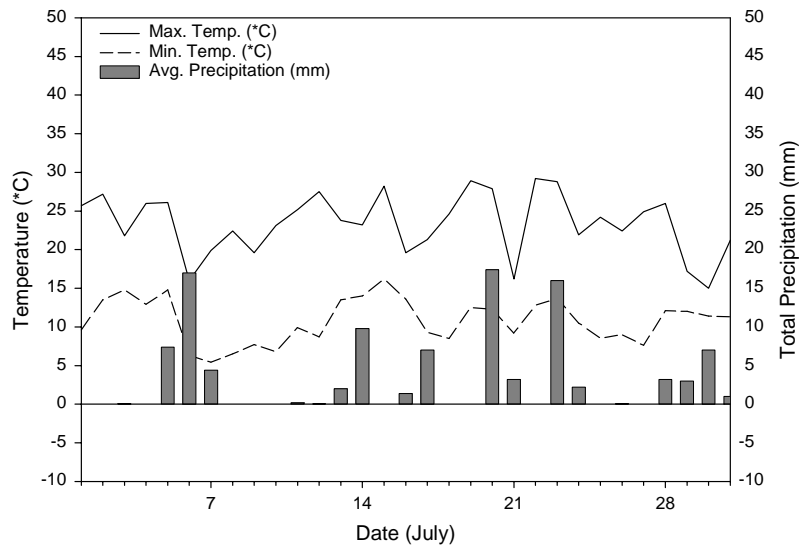


**Daily maximum and minimum temperatures
and total precipitation recorded at Goose Bay, NL, June 2004.**

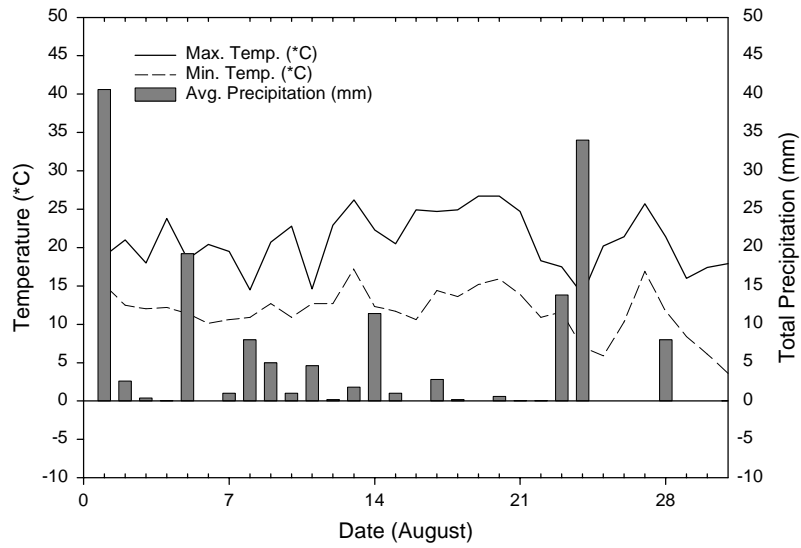


Appendix C (Continued)

**Daily maximum and minimum temperatures
and total precipitation recorded at Goose Bay, NL, July 2004.**



**Daily maximum and minimum temperatures
and total precipitation recorded at Goose Bay, NL, August 2004.**

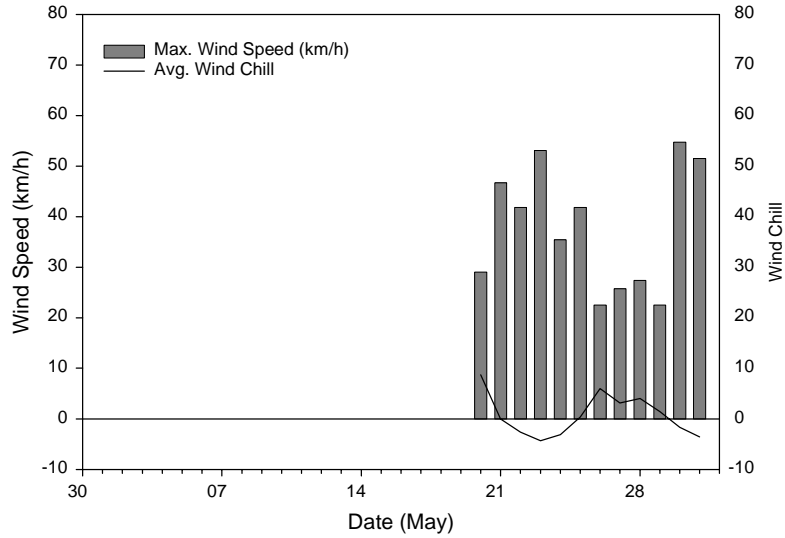


APPENDIX D

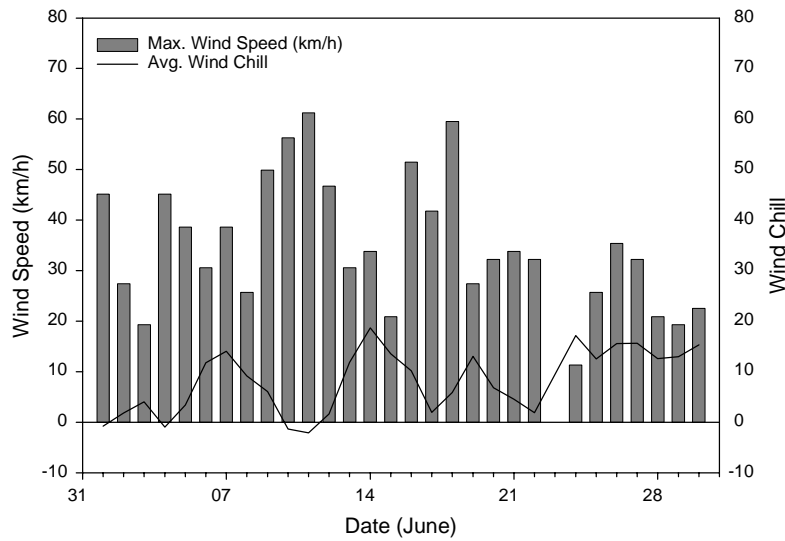
**2004 WIND CHILL DATA AND MAXIMUM WIND GUSTS RECORDED AT
GOOSE BAY AND PARK AND ANNE MARIE LAKES, LABRADOR**

Appendix D 2004 Wind Chill Data and Maximum Wind Gusts Recorded at Goose Bay and Park and Anne Marie Lakes, Labrador

Average daily wind chill and maximum wind gusts recorded at Anne Marie Lake, NL, May 2004.

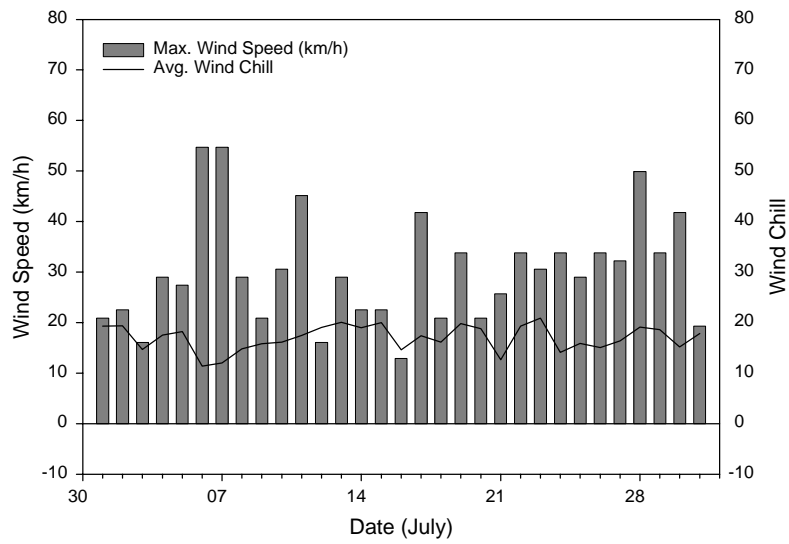


Average daily wind chill and maximum wind gusts recorded at Anne Marie Lake, June 2004.

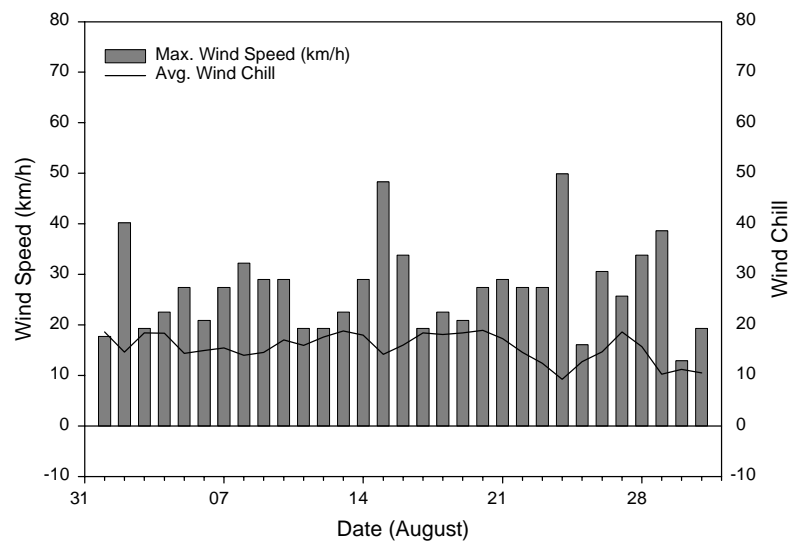


Appendix D (Continued)

Average daily wind chill and maximum wind gusts recorded at Anne Marie Lake, July 2004.

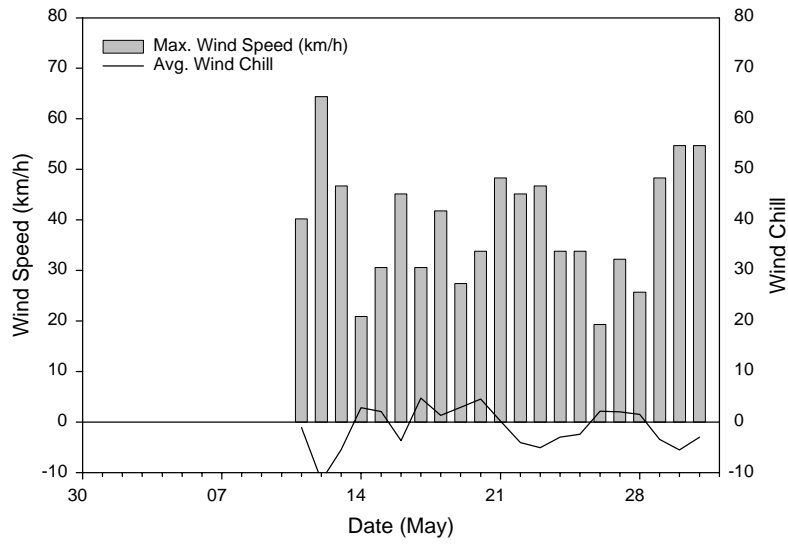


Average daily wind chill and maximum wind gusts recorded at Anne Marie Lake, August 2004.

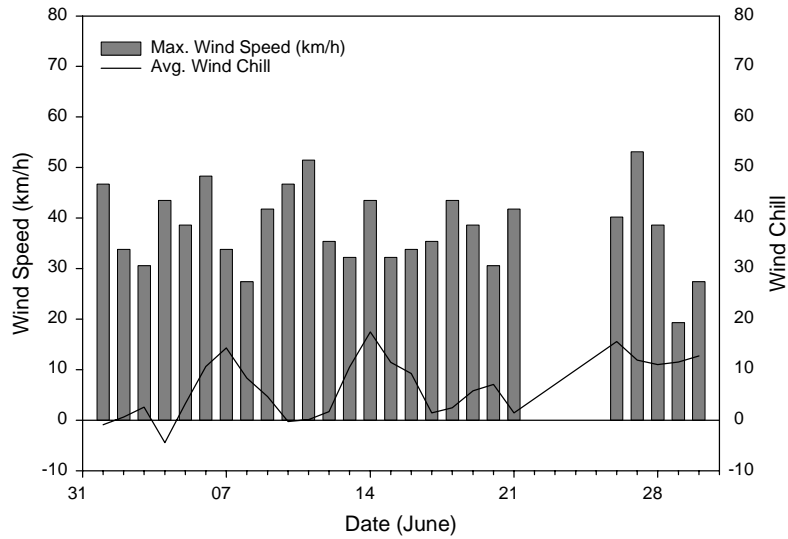


Appendix D (Continued))

Average daily wind chill and maximum wind gusts recorded at Park Lake, NL, May 2004.

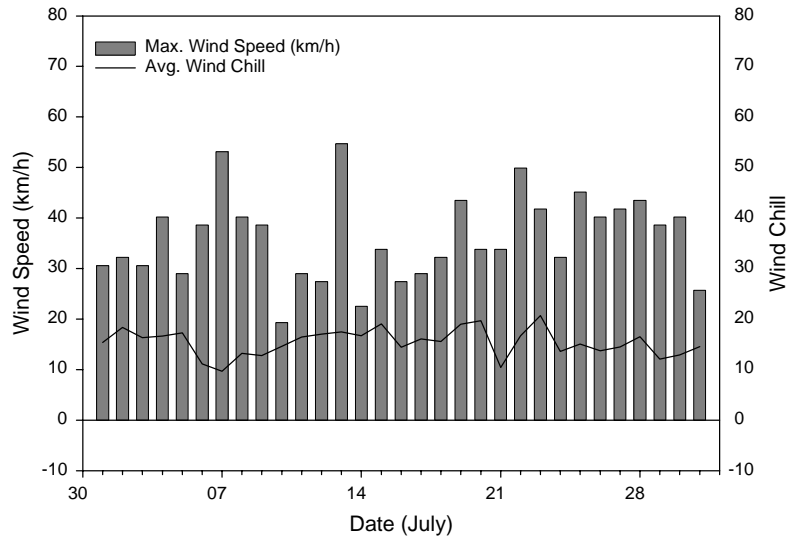


Average daily wind chill and maximum wind gusts recorded at Park Lake, June 2004.

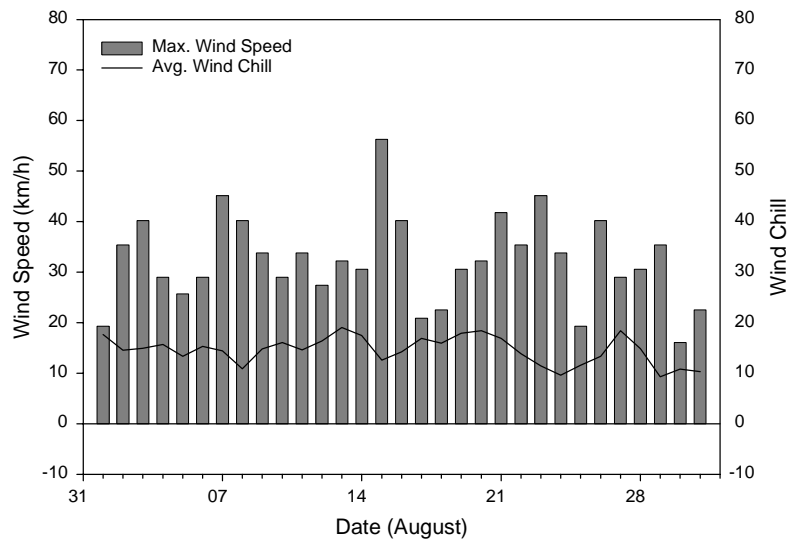


Appendix D (continued)

Average daily wind chill and maximum wind gusts recorded at Park Lake, July 2004.

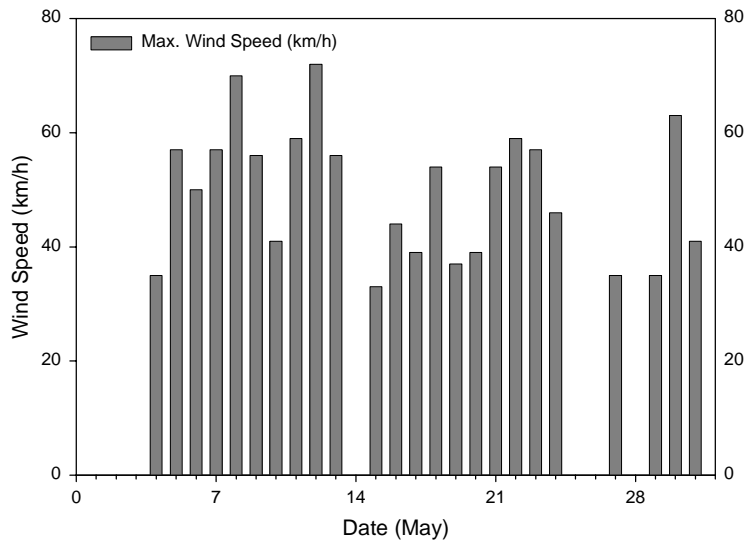


Average daily wind chill and maximum wind gusts recorded at Park Lake, August 2004.

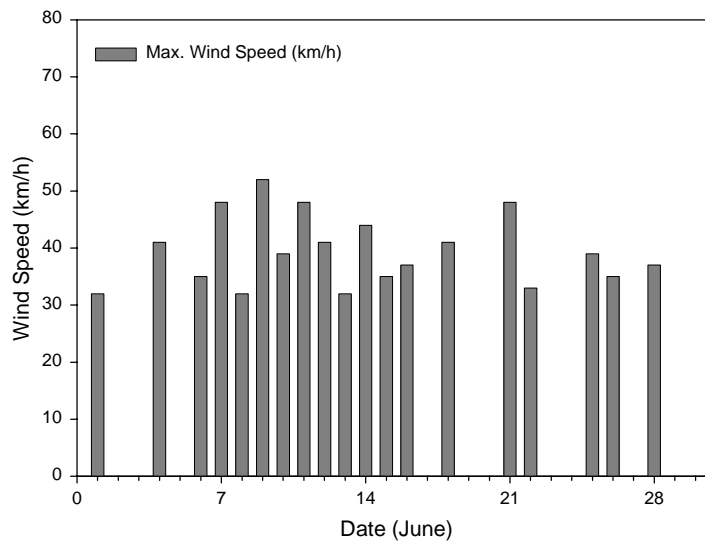


Appendix D (continued)

Average daily maximum wind gusts recorded at Goose Bay, May 2004.

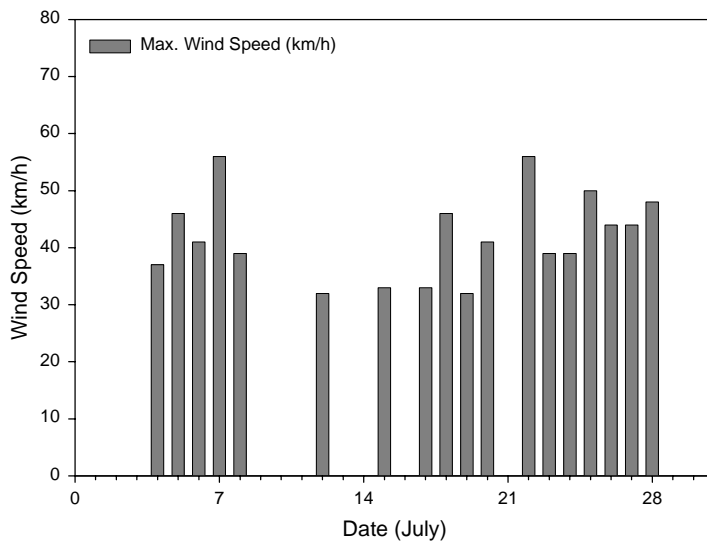


Average daily maximum wind gusts recorded at Goose Bay, NL, June 2004.



Appendix D (Continued)

Average daily maximum wind gusts recorded at Goose Bay, July 2004.



Average daily maximum wind gusts recorded at Goose Bay, August 2004.

