

MIN 112

**2005 OSPREY MONITORING IN THE LOW-LEVEL
TRAINING AREA OF LABRADOR**

28 October 2005

REVISED

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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, 2004) has been ongoing since 1991. This program was continued during 2005 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

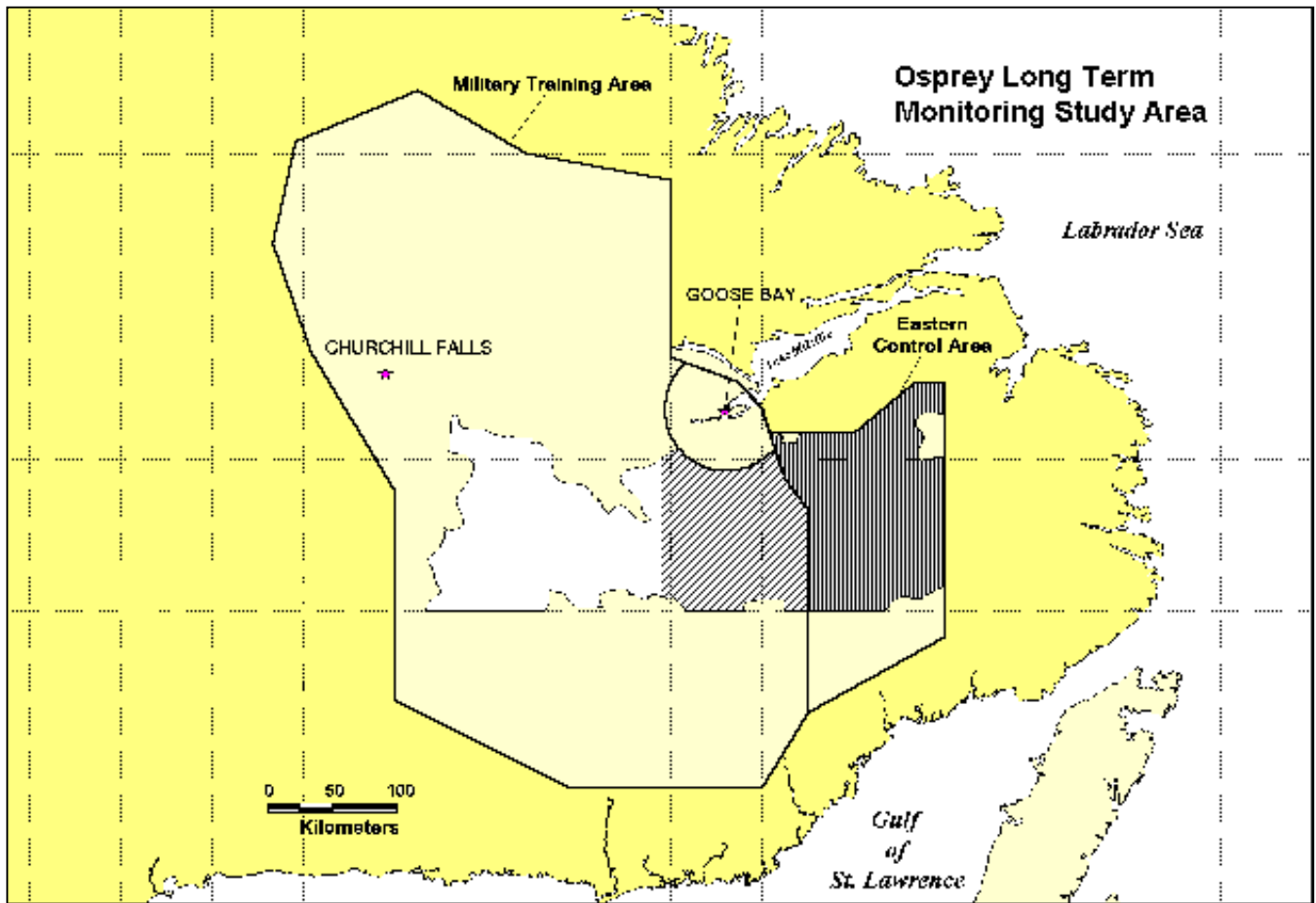
Mr. Perry Trimper (Jacques Whitford) was the project manager, lead field researcher, and assisted with the compilation of this report. Ms. Karen Gosse was involved in the field program and served as primary author. Mr. Corey Cooney (Minaskuat), Mr. Michael Batchelor (summer student with Minaskuat) and Mr. Tony Parr (IEMR) assisted with data collection (field surveys). Mr. Geoff Goodyear or Mr. Peter Jefford (Universal Helicopters Newfoundland Limited) were selected as pilots given their experience during previous 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 2005 Osprey Monitoring Program



4.0 METHODS

4.1 Field Surveys

The approach to monitoring Osprey during 2005 was identical to Trimper *et al.* (1998). A sample of known Osprey nests (DND/Jacques Whitford unpublished data) were surveyed during 8-10 June (corresponding to the early incubation period) in the LLTA and a Control area to determine nesting activity (Figure 1). The goal was to locate 30 nests in each of the LLTA and Control areas. These nests were re-visited on 10 August 2005 to determine reproductive success (Appendix A).

Aerial surveys were conducted using a Bell 206L helicopter (or equivalent) 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 as the sample. 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 Data Summarization / Analysis

Information collected was summarized in terms of *Nest Activity* - available nests actively used by Osprey in June/July; *Nest Success* - the number of active or occupied nests identified as having fledged at least one young in August survey; and *Productivity* – the number of young fledged per active nest sample (n=30). The following points were considered when summarizing the data:

1. Partially collapsed or any collapsed nests were omitted from analysis.
2. Any new (i.e., previously unidentified) nests that were located (empty or active) were included.
3. The goal was to locate 30 nests from each of the Control and LLTA. Thirty-one (31) active nests were located in the LLTA in 2005. The last nest located was rechecked for nest success in August, but was omitted from statistical considerations.
4. Due to error in calculating the number of active nests in the Control area, only 29 active nests had been located during initial surveys in June.

Nest Activity and *Nest Success* were assessed using a one-tailed Fisher's Exact Test. For consistency, results from all years (1999-2005) 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* 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 2003-2004, 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 (PL) and Anne Marie Lake (AML) prior to 2005 Osprey nest surveys on 6 May 2005. Weather stations were pre-set to record weather information every 30 minutes. Stations were revisited and data downloaded every 30-50 days. Weather stations were disassembled and removed during the final visit on 6 September 2005.

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 2005. Parameters were then compared (linear regression) with data collected from the airport at 5-Wing Goose Bay [53°19'N, 60°25'W (Environment Canada 2005)] to determine similarities and differences between the data sets.

4.4 Data Considerations

4.4.1 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 will be used to further explore this relationship. Note that observations by the Study Team and others (e.g., B. Turner, pers. comm.) indicate that the Spring of 2005 was relatively early, by approximately 2-3 weeks.

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 4 weeks.	Late August

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

4.4.2 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 will be compiled for the period 1-14 July, and relationships between patterns and/or extremes in weather data and Osprey reproductive success considered.

4.4.3 Nesting Success – July/August Period

In 1994, Jacques Whitford Environment monitored 10 Osprey nests periodically throughout the nestling season (26 July – 12 September, 1994) to assess nesting success and the number of young fledged (JWEL 1995). This study found that "the number of potentially successful nests and fledglings decreased on each successive survey after 26 July." Specifically, it was found that nesting success dropped from 70% on 7 August, to 50% on 12 September. Active and empty nests located on 14 July were identified prior to the main "drop-off" period, and thus were included in a separate data analyses (i.e., data were analyzed both with and without the addition of information collected in July).

5.0 RESULTS

5.1 Nest Outcomes

Nesting Activity in 2005 was lower in both the LLTA (63.3%) and Control (65.2%) areas, when compared with 2004 (Tables 3 and 4). Nest Activity was, however, greater in both areas when compared with data from 1999 through 2002 (inclusive). Statistical analysis indicated that Nesting Activity is significantly greater in the Control area than in the LLTA ($p=0.175$) in 2005 (Table 4).

Nesting Success was also lower in the LLTA and Control areas in 2005, and indeed the lowest observed over the past 7 years (Tables 3 and 4). Similar to results obtained in 2001, only 30% of nests in the LLTA and 37.9% of nests in the Control area were successful – a marked decrease from the previous year. Results of statistical analysis indicate that differences between Nesting Success in the LLTA and Control areas are insignificant [$p>0.20$ (Table 4)].

In terms of Productivity (reproductive success, or number of young fledged per active nest), 2005 was an overall Poor year. Being one of the lowest years on record, only 0.43 young fledged per active nest was recorded in the LLTA and 0.72 young per active nest in the Control area. Productivity in the LLTA was the lowest year on record and was significantly lower ($p=0.078$) than in the control during 2005 (Table 4). Note that Productivity was also significantly lower in the LLTA in 2004. However, numbers were higher for both the LLTA and Control study when considering reproductive output per successful (vs. active) nest (1.44 young per successful nest in the LLTA and 1.91/1.92 in the Control).

A comparison of all three parameters [nesting activity, success, and productivity (Table 4)], over the previous seven years of this study, reveals high variability in the annual results with **no consistent trend evident**. Nest activity was greater in the Control area during 1999, 2001 and 2005, but lower in all other years of this study. Similarly, productivity was greater in the Control versus LLTA study area during 2001 and 2003-2005, but lower in 1999, 2000 and 2002. Overall success ratings also varied between years (Table 5). Note also that 2004 (a Very Good year) and 2005 (a relatively Poor year) are the only two years where a significant difference in nesting Productivity has been observed.

Table 3 2005 Osprey Survey Results Compared to 1999-2004.

Parameters	1999		2000		2001		2002		2003		2004		2005	
	LLTA	Control	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	49	40
# 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)	31 (63.3)	29 (72.5)
Active Sample #	30	30	30	30	30	30	30	30	30	30	30	30	30	29
Successful #	27	25	16	10	9	13	15	13	28	25	21	26	9	11
# Young Fledged	53	47	31	17	18	21	30	28	52	57	43	59	13	21
# Young Fledged/Active Nest Sample	1.77	1.57	1.03	0.57	0.60	0.70	1.00	0.93	1.73	1.90	1.43	1.97	0.43	0.72
# 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	1.44	1.91
% Successful	90.0	83.3	53.3	33.3	30.0	43.3	50.0	43.3	93.3	83.3	70.0	86.7	30.0	37.9

Notes:

1. 1999-2003 data from Trimper *et. al.* submitted.
2. 2003-04 IEMR surveys (Minaskuat 2004a, 2004b).
3. Study Areas are shown in Figure 1.



Table 4 Osprey Nesting Activity, Nesting Success and Productivity in the Low-level Training Area and Control Area of Labrador, 1999-2005.

<i>Nesting Activity</i>								
Low-level Training Area				Control			P Value of Fishers Exact Test	Reject at 20 %
Year	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
2005	49	31	0.633	40	29	0.725	0.175	Yes

<i>Nesting Success</i>								
Low-level Training Area				Control			P Value of Fishers Exact Test	Reject at 20 %
Year	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
2005	30	9	0.300	29	11	0.379	0.741	No

<i>Productivity</i>								
Low-level Training Area				Control			P Value of Two-sample t-test	Reject at 20 %
Year	Active Nest Sample	Young Fledged	Standard Deviation	Active Nest Sample	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
2005	30	13	0.774	29	21	1.006	0.078	Yes

Notes:

1. 1999-2002 DND surveys (Trimper *et. al* in prep); 2003-04 IEMR surveys (Minaskuat 2004a, 2004b).
2. Study Areas are shown in Figure 1.

Table 5 Osprey reproductive success within and adjacent to the Low-Level Training Area in Labrador, 1993-2005.

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	Poor	0.60	0.70	0.65
2002	Mediocre	1.00	0.93	0.97
2003	Very Good	1.73	1.90	1.82
2004	Very Good	1.43	1.97	1.70
2005	Poor	0.43	0.72	0.58

Notes:

1. Success ratings are provided in Table 1.

5.2 Egg/Nest Failures

In previous years (e.g. 2004), eggs that failed to hatch were noted in Osprey nests during the mid-August surveys. No eggs were observed in remaining in nests during August 2005 surveys. However, in at least one nest, one of the young had died suggesting possible fratricide that has been observed previously (JWEL 1995). Also, the Study Team observed variability in the size of young among successful nests, ranging from “very small” to “very large”. Note that the smaller young may face greater challenges in terms of fledging successfully before the onset of winter.

5.3 Weather Conditions and Osprey Nesting Success

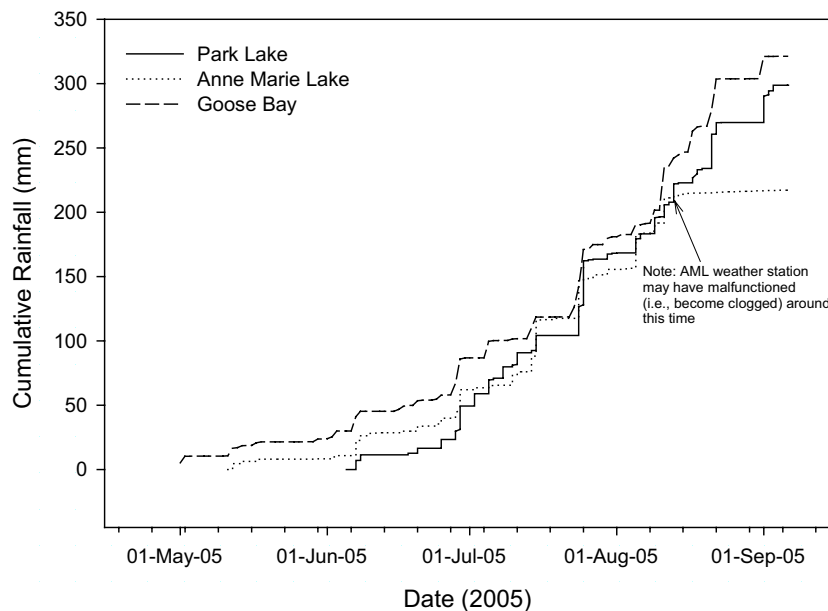
Weather stations were positioned at PL and AML on 6 and 11 May 2005, respectively, and removed on 6 September 2005. Data are available throughout this time period from AML, however due to technical problems, data are only available from the PL weather station beginning on 5 June 2005. Data from the Goose Bay weather station were also compiled for the 11 May-6 September 2005 time period.

Mean daily temperatures recorded at Goose Bay appeared similar to those recorded at PL ($R^2=0.88$) and AML ($R^2=0.90$) between May/June and September 2005 (Appendix B). However, differences between average daily maximum and minimum temperatures recorded at Goose Bay were greater than differences recorded from either AML or PL (Appendix C).

Total daily precipitation recorded at Goose Bay was weakly correlated with total precipitation at PL ($R^2=0.58$) or AML ($R^2=0.64$) weather stations during the same period (Appendix B). Despite this weak correlation, cumulative precipitation at Goose Bay (321.3 mm) was similar to PL (298.7 mm) and, up until mid-August, AML (Figure 2). As in 2005, however, a problem was identified at the AML weather station, wherein which the rain collector was found obstructed (i.e., rainwater had built up inside the collector nozzle) when dismantled in early September. This obstruction could explain the lack of precipitation recordings since mid-August at this station.

Data collected in previous years (i.e., 2003 and 2004) demonstrated similar relationships between stations with respect to temperature, but showed greater variability with respect to precipitation, with higher daily rainfall recorded at Goose Bay versus AML or PL (Minaskuat 2004b). The variability observed in 2004 was believed to have been related to a malfunctioning of the stations and/or reflective of variability in local weather conditions (Minaskuat 2004b).

Figure 2 Cumulative Precipitation Recorded from Local Weather Stations at Park and Anne Marie Lakes Compared with Goose Bay, Labrador, May – September 2005.



5.3.1 Spring Break-up

Historic hydrometric data collected from Minipi River (below Minipi Lake) and Eagle River (above falls) provide an indirect indication for the day of last ice each spring. Available data were presented and discussed in Minaskuat (2004b). Briefly, during years of relatively early ice out in the Minipi and Eagle Rivers (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). Overall, the timing of spring break-up was believed to provide little indication of a relationship with Osprey nesting success. Note however, that previous studies by Wetmore and Gillespie (1976) found a significant correlation between nest initiation and the date of open water in spring for Osprey in Labrador.

5.3.2 General Trends and Adverse Weather Events

Daily maximum and minimum temperatures and total precipitation (Appendix C), daily maximum wind gusts and daily minimum wind chill temperatures (Appendix D) during June, July and August, were examined for evidence of storm events (i.e., relatively heavy rain accompanied by high winds and/or cold temperatures), revealing the following trends:

- Generally, when precipitation occurred over consecutive days, daily rainfall amounts were <10 mm;
- Essentially no rainfall at PL in July, with up to 20 mm of rain recorded on 1-2 days at AML and GB;
- Maximum wind gusts were commonly >20 km/h (often >30 km/h);
- Latest subzero temperatures recorded on 9 June at PL, 13 May at AML, and 5 May at Goose Bay;

In addition, several notable weather events occurred, summarized in Table 6.

Table 6 Weather Events During the Incubation, Brooding and Pre-fledging Periods Recorded at Anne Marie Lake, Park Lake and Goose Bay, June–August 2005

	Incubation Period	Brooding Period	Pre-fledging Period
AML	<ul style="list-style-type: none"> • 28-29 June: some rainfall on 28 June with max. temp. 27.7°C, followed by approx. 20mm of rain and max. temp. down to 13.6°C on 29 June, accompanied by wind gusts of up to >30 km/h. 	<ul style="list-style-type: none"> • 10-11 July: max. temp. down from 30.8°C on 10 July to 15.3°C on 11 July; some rainfall both days. • 13-15 July: max. temp. decreased from 24.7°C to 14.8°C over 3-day period, with rainfall amounts >20 mm on 14 July, and wind gusts up to 45km/h. • 23-25 July: Relatively high rainfall (~30 mm) on 24 July, and gusts >20 km/h on all 3 days; max. temp. decreased from 21.1°C to 11.6°C over 3-day period. 	<ul style="list-style-type: none"> • 8-14 August: Rain almost every day, with 18.5 mm falling on 11 Aug.; max. temp. around 20°C for most days but dropped to 13.5°C on 15 Aug. • 21-22 August: temp. down 8-14°C from high of 23.8 on 20 Aug.; no rainfall but winds gusting to 25-35 km/h.
PL	<ul style="list-style-type: none"> • 28-29 June: some rainfall on 28 June with max. temp. 23.0°C, followed by approx. 20mm of rain and temp. down to 12.7°C on 29 June, accompanied by wind gusts of up to 43.5 km/h. 	<ul style="list-style-type: none"> • 10-11 July: max. temp. down from 27.0°C on 10 July to 15.1°C on 11 July; minimal rainfall and gusts >38km/h on both days. • 13-15 July: max. temp. decreased from 20.6°C to 14.6°C over 3-day period and gusts up to >40km/h. • 23-25 July: max. temp. decreased from 19.8°C to 9.4°C over 3-day period; wind gusts >40 km/h on all days. 	<ul style="list-style-type: none"> • 8-14 August: Rain almost every day, with >10mm falling on 9 and 13 Aug.; max. temp. ~20°C from 8-10 Aug, but dropped to 13.1°C on 15 Aug; max. wind gusts >35 km/h recorded on all days. • 21-22 August: max. temp. dropped to 8.7°C on 22 Aug.; wind gusts of 48.8-53.1 km/h recorded. Relatively high rainfall (26.7mm) on 21 Aug. and 8.9mm on 22 Aug.
GB	<ul style="list-style-type: none"> • 28-29 June: some rainfall on 28 June with max. temp. 24.4°C, followed by approx. 20mm of rain and temp. down to 13.8°C on 29 June, accompanied by wind gusts of up to 32 km/h 	<ul style="list-style-type: none"> • 10-11 July: Temp. decreased from 25.7°C on 10 July to 13.5°C on 11 July; minimal rain but max. wind gusts 30-33 km/h. 	<ul style="list-style-type: none"> • 8-14 August: Rain almost every day, with 33.2mm falling on 11 Aug.; max. temp. of 26.7°C on 9 Aug., and 14.8°C on 14 Aug; max. wind gusts of 19-43 km/h. • 21-22 August: max. temp. dropped to 9.1°C on 22 Aug.; max. wind gusts 40 km/h; total rainfall 36.6mm over 2-day period.

5.3.3 Weather Conditions and Osprey Hatching/Brooding

Temperature, precipitation and wind data collected between 1-14 July at AML and PL during 2003-2005, and at Goose Bay during 1993-2005 are summarized in Table 7 and Table 8 respectively. Daily maximum and minimum temperatures in 2005 were similar to temperatures reported in 2004, but greater than temperatures in 2003. During the first week of July, total precipitation was greater in 2005 than the preceding two years, but lower during the second week. Average daily wind gusts were generally greater at the Park Lake station, but comparable between years. In terms of nesting success, conditions in 2005, a relatively “Poor” year, were similar to 2004, a “Very Good” year. 2003 was also a “Very Good” year, but with different weather conditions (i.e., lower temperatures and less precipitation) when compared to 2004.

Table 7 Summary of Climate Statistics Recorded from Local Weather Stations at Anne Marie Lake and Park Lake, Labrador, 1-14 July 2003-2005.

Time Period	Overall Success Rating	Avg. of Daily Minimum Temperatures (°C)		Avg. of Daily Maximum Temperatures (°C)		Avg. of Daily Max Wind Gusts (km/h)		Avg. of Daily Minimum Wind Chill		Total Precipitation (mm)	
		AML	PL	AML	PL	AML	PL	AML	PL	AML	PL
2003 01-07 Jul	Very	6.6	8.1	15.1	13.6	25.5	32.9	6.8	--	7.5	14.9
	Good	6.4	5.9	17.1	17.2	34.3	32.4	3.6		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
	Good	9.0	9.2	24.7	22.4	27.6	33.1	9.1	8.4	0	45.5
2005 01-07 Jul	Poor	9.0	9.3	24.9	22.5	30.6	40.4	8.9	8.4	3.5	21.6
		11.7	10.4	24.4	21.4	24.8	35.4	11.5	9.4	22.3	21.5

Notes:

1. -- data not available
2. AML = Anne Marie Lake; PL = Park Lake
3. Numbers presented are the average of the calculated daily maximum/minimum value for each time period (i.e., average of 7 values)

Table 8 Summary of Temperature and Precipitation Data in Relation to Osprey Nesting Success, 1993-2005.

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 AML 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 PL (no rain at AML on same day). Daily rainfall between 5-7 July. Rain on most days 16-24 July.
2005	Poor	0.58	Latest subzero temperatures recorded on 9 June at PL, 13 May at AML, and 5 May at GB; Min. temperatures >9.0°C; Max. temperatures >22°C; No significant rainfall during 1-14 July period (maximum rainfall of approximately 10 mm on 2 days); Largest rainfall approx. 30 mm recorded on 15 and 24 July at AML, and on 25 July at PL and GB.

Notes:

- 1993-2002 summaries based on information collected from the Environment Canada weather station at Goose Bay, Labrador; 2003-2005 summaries based on information collected at Goose Bay and local weather stations at Anne Marie and Park Lakes, Labrador
- Goose Bay weather station data available online at <http://www.climate.weatheroffice.ec.gc.ca/climateData>.
- Criteria for determining Overall Success Ratings are provided in Table 1.

Average maximum temperatures recorded during early July (1-14) at the Goose Bay weather station in 2005 were amongst the highest recorded throughout 1993-2005 (Table 9). For comparison, 2001, also a “Poor” years in terms of nesting success, experienced the lowest temperatures throughout 1993-2004 (maximum temperature of 13.8°C during the second week of July), and also the highest total rainfall of all years (Table 8). Minimal rainfall and relatively high temperatures, however, characterized other “Poor” years (e.g. 1993) (Tables 8 and 9).

Table 9 Summary of Climate Statistics at Goose Bay, Labrador, 1-14 July, 1993-2005

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
2005 01-07 Jul	Poor	0.58	11.3	25.8	13.5
08-14 Jul			10.6	22.1	9.65

Notes:

1. Criteria for determining Overall Success Ratings are provided in Table 1.
2. Data from Environment Canada (2005).

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 3-6). The time periods between 1-7 July and 8-14 July were separated for more detailed assessment.

Figure 3 Osprey Reproductive Success Compared With Average Maximum and Minimum Temperatures, 1-7 July, 1994-2005

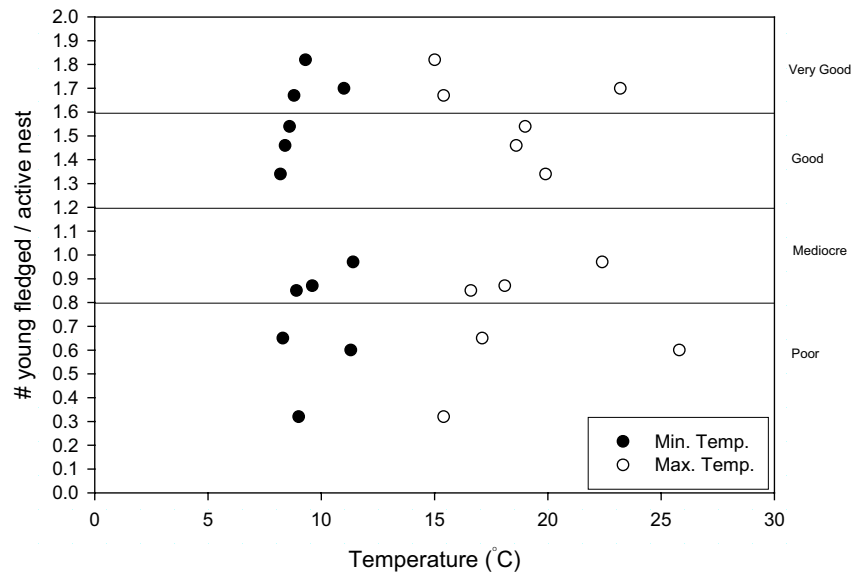


Figure 4 Osprey Reproductive Success Compared With Average Maximum and Minimum Temperatures, 8-14 July, 1994-2005

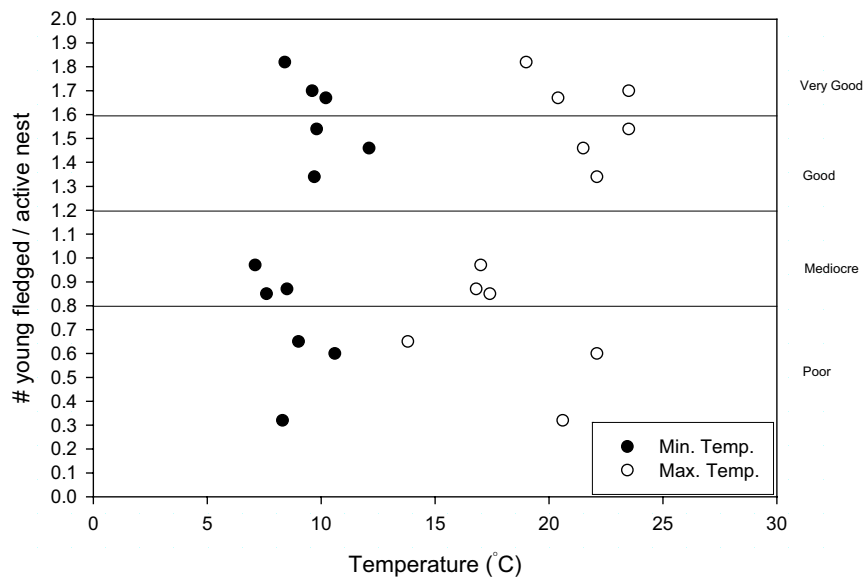


Figure 5 Osprey Reproductive Success Compared With Cumulative Precipitation During 1-7 July, 1994-2005

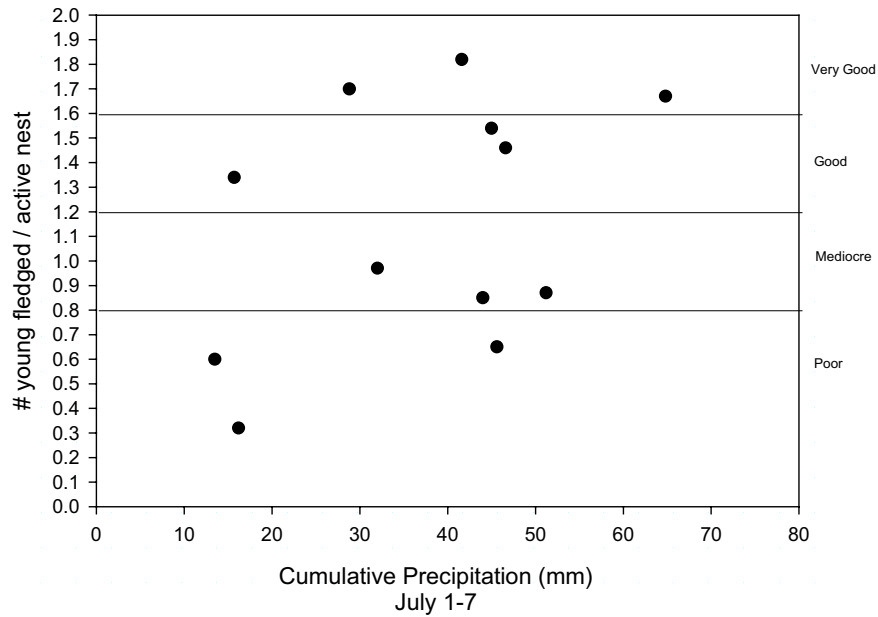
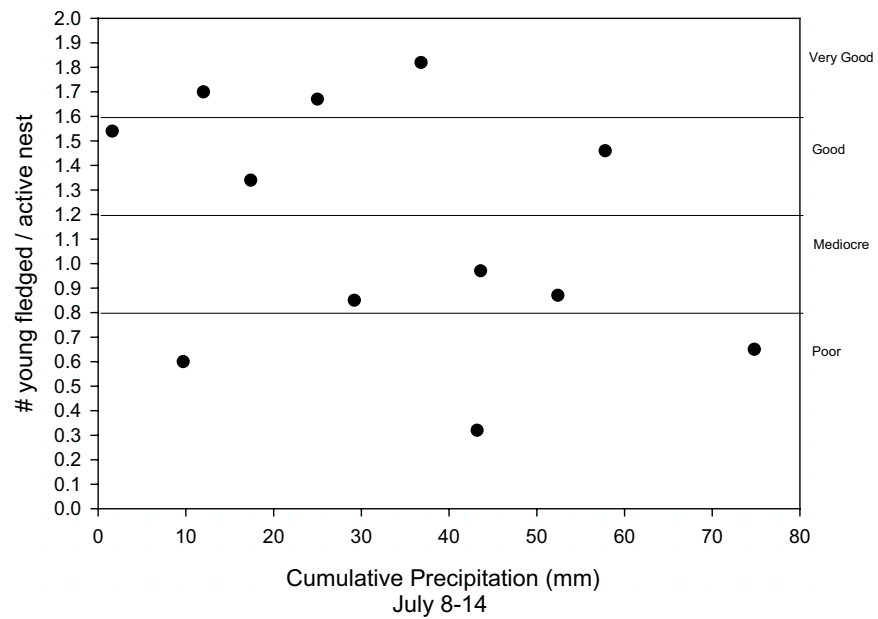


Figure 6 Osprey Reproductive Success Compared With Cumulative Precipitation During 8-14 July, 1994-2005



No strong relationship was obvious in these data sets. Note that with the addition of the 2005 data, the weak relationship between average daily maximum temperatures during the second week of July and reproductive success presented in prior analyses (Minaskuat 2004b) is no longer evident. Relatively “Poor” years (e.g., 1993 and 2005) have maximum temperatures that were higher than in some “Very Good” years (e.g., 2003) (Table 9).

Hourly wind speeds of 20-25 km/h and >25 km/h were high during the 2005 1-10 July period, when compared to 1996-2004 (Table 10). Hours of relatively high wind speeds during other “Poor” years (1996 and 2001), however, were comparable to other “Mediocre” to “Very Good” years (Table 10). Again, a scatter plot depicting hours of high winds (>20 km/h, 1-10 July) in comparison with overall reproductive success (1996-2005) was generated (Figure 7). No strong relationship was evident in the dataset, however, when data from 1996 and 2003 are omitted, a weak relationship may exist wherein which years with higher total hours of strong winds experience lower reproductive success [Figure 7 (below)].

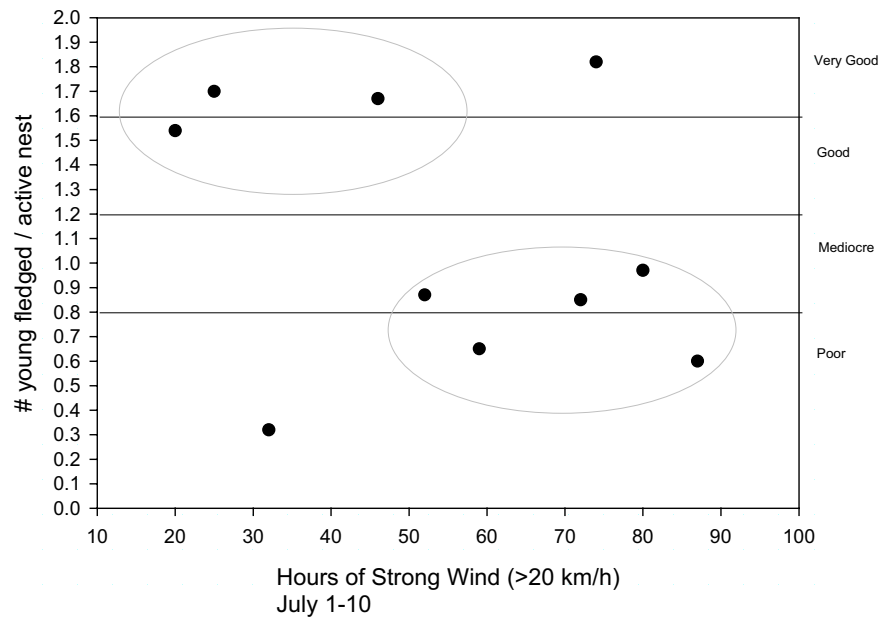
Table 10 Osprey Reproductive Success and Total Hours of Relatively High Wind Speeds, 1-10 July 1996-2005

Year	Success Rating	# Young Fledged/ Active Nest	Hours of high wind at Goose Bay, 1-10 July	
			20-25 km/h	>25 km/h
1996	Poor	0.32	22	10
1997	Mediocre	0.87	38	14
1998	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
2005	Poor	0.58	32	55

Notes:

1. Data collected from the Environment Canada weather station at Goose Bay, Labrador (available online at <http://www.climate.weatheroffice.ec.gc.ca/climateData>)
2. Criteria for determining Overall Success Ratings are provided in Table 1.

Figure 7 Osprey Reproductive Success Compared With Total Hours of Strong (i.e., >20 km/h) Winds During 1-10 July, 1996-2005



6.0 DISCUSSION

6.1 Nest Parameters

Considerable variability in these parameters has been observed over the past years and 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. The **variability in nesting activity and nesting success suggests the possibility of a 3-5 year high/low trend in these parameters**). Although not significant, reproductive success has been higher in the LLTA in three of the last seven 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 and 2005).

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 1999-2005 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 regarding the effects of military training on raptors has been cited as an important determinant for behaviour and abundance studies (Schueck and Marzluff 1995). Results of previous analysis (i.e., 2004) suggested 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). Results of this study in 2005 did not follow this trend, but suggested the possibility of a relationship between total hours of strong winds (during the 1-10 July post-hatch period) and nesting success.

The study of weather and Osprey foraging energetics by Machmer and Ydenberg (1990) suggested that wind speed and water surface conditions (but not cloud cover, sun brightness, or precipitation) had an effect on foraging performance, with wind speeds >7m/s (approximately 25 km/h) believed to result in longer but less successful hunts. However, Steeger *et. al* (1991) compared the feeding ecology and reproductive performance of Osprey in different habitats of southeastern British Columbia and found that hunting duration and success were not linked to the breeding performance.

Results to date have indicated, but not provided evidence for, links between weather conditions and Osprey nesting success. Indeed, several environmental factors (e.g., decrease in mean temperature in July, position of nest relative to foraging grounds, nest microclimate, adult behaviour, predators, fratricide) may act in combination with weather conditions to influence success. Thus, in terms of future investigations, a

multivariate approach should be considered. Such an approach will be necessary before any definitive conclusions regarding any relationships between climate and Osprey reproductive success in the study area can be made.



7.0 SUMMARY AND CONCLUSIONS

Note that the following summary deals only with the analysis of population parameters, as weather information is still being collected.

- I. Significant differences in 2005 Nesting Activity ($p=0.175$) were observed between the Control and LLTA study areas, based on an active nest sample size of 29 and 30 nests, respectively.
- II. Nesting Success was greater in the Control versus LLTA study area. This difference was not significant at the 20% confidence level ($p>0.70$).
- III. Reproductive output per active nest (Productivity) was higher in the Control sample than the LLTA. These differences were also significant ($p=0.078$) at the 20% confidence level. However, one would expect to find similar results recurring in the past if a persistent and strong relationship existed. Regardless, 2005 was considered Poor for Osprey production in the Study Area.
- IV. **Considerable variability in nest activity, nest success and productivity has been observed over the past seven years.** Observed variability suggests the possibility of a 3-5 year high/low trend in these parameters.
- V. 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 1999-2005 suggests that reproductive success is related more to other external factors in Labrador and northeastern Québec.
- VI. Weak relationship between average maximum temperatures (2004) and total hours of relative strong winds (2005) during the early post-hatching period (i.e., when Osprey young are not able to thermoregulate) and reproductive success. However, more detailed (multivariate) analyses will be required to confirm relationships between climate and productivity of Osprey nesting in the study area.

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