



MINASKUAT LIMITED PARTNERSHIP

2006 OSPREY MONITORING IN THE
LOW-LEVEL TRAINING AREA (CYA 731) OF
LABRADOR

**PROJECT MIN0286
2006**



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GLOSSARY

Active Nest – One in which eggs or young are observed or suspected and/or if the associated adults exhibit aggressive behaviour

Available Nest – One in which the structure was deemed capable of supporting breeding activity

CYA 731 – refer to LLTA

CYA 732 – one of the air ranges over CYA 731 from 5,000 feet to 28,000 feet above sea level

EEM – Environmental Effects Monitoring

ESWG – Ecological Stratification Working Group

'Good' Year – productivity of Osprey sample at 1.2-1.6

IEMR – Institute for Environmental Research and Monitoring

JWEL – Jacques Whitford Environment Limited

LLTA – Low-level Training Area, also known as CYA 731 represents a military air range associated with 5 Wing Goose Bay that covers an area of approximately 130,000 km², from surface to 5,000 feet above sea level

'Mediocre' Year – productivity of Osprey sample at 0.8-1.2

Nest Activity – the percentage of active nests compared to the number of available nests. Note that only a single available nest was counted from a single territory. Osprey often establish a second 'frustration' nest nearby following some type of nest failure (e.g. predation, hatch failure, nest collapse)

Nest Success – the percentage of successful nests compared to the number available at the start of the breeding season

'Poor' Year – productivity of Osprey sample < 0.8

Productivity – or reproductive output, refers to the total number of young in successful nests divided by the number of active nests

Successful Nest – One in which one or more young were observed immediately prior to expected fledging date beginning in mid-August.

'Very Good' Year – productivity of Osprey sample >1.6



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TABLE OF CONTENTS

Page No.

1.0	INTRODUCTION.....	1
2.0	STUDY TEAM.....	1
3.0	STUDY AREA.....	1
4.0	METHODS.....	3
4.1	Field Surveys.....	3
4.2	Data Summarization / Analysis.....	4
4.3	Weather Data.....	4
4.4	Data Considerations.....	5
4.4.1	Spring Break-up (Date of Last Ice).....	5
4.4.2	July Hatching/Brooding Period.....	5
4.4.3	Nest Success – July/August Period.....	6
5.0	RESULTS.....	6
5.1	Nest Outcomes.....	6
5.1.1	Nest Parameters.....	6
5.1.2	Comparison with Tadoussac Data.....	15
5.2	Egg/Nest Failures and Status of Young.....	16
5.3	Weather Conditions and Osprey Nest Success.....	17
5.3.1	Spring Break-up.....	18
5.3.2	General Trends and Adverse Weather Events.....	19
5.3.3	Weather Conditions and Osprey Hatching/Brooding.....	20
6.0	DISCUSSION.....	29
6.1	Nest Parameters.....	29
6.2	Weather and Osprey Nest.....	30
6.3	Other Influences on Osprey Reproductive Success.....	31
6.3.1	Small Mammal Abundance.....	31
6.3.2	Fratricide.....	31
6.3.3	Parasites.....	31
6.3.4	Contaminants.....	31
7.0	SUMMARY AND CONCLUSIONS.....	32
8.0	REFERENCES.....	33



APPENDIX A 2006 Osprey Data

APPENDIX B Results of Statistical Analyses

APPENDIX C Results of Regression Analyses

APPENDIX D Monthly Summaries of Weather Data Recorded at Ann Marie Lake, Park Lake and Goose Bay

LIST OF TABLES

	Page No.
Table 1 Success Ratings Used to Categorize Osprey Nest Success	4
Table 2 Breeding chronology of Osprey in Labrador	5
Table 3 2006 Osprey Survey Results Compared to 1999-2006.....	8
Table 4 Osprey Nest Activity, Nest Success and Productivity in the Low-Level Training Area and Control Area of Labrador, 1999-2006	9
Table 5 Osprey reproductive success within and adjacent to the Low-Level Training Area in Labrador, 1993-2006.....	12
Table 6 Adverse Weather Events During the Incubation, Brooding and Pre-fledging Periods Recorded at Ann Marie Lake, Park Lake and Goose Bay, June–August 2006	19
Table 7 Summary of Climate Statistics Recorded from Local Weather Stations at Ann Marie Lake and Park Lake, Labrador, 1-14 July 2003-2006.....	21
Table 8 Osprey Productivity and Climate Statistics at Goose Bay, Labrador, 1-14 July, 1993-2006.	22
Table 9 Summary of Temperature and Precipitation Data in Relation to Osprey Nest Success, 1993-2006	24
Table 10 Osprey Reproductive Success and Total Hours of Relatively High Wind Speeds, 1-10 July 1996-2006	28



LIST OF FIGURES

	Page No.
Figure 1 Study area for the 2006 Osprey Monitoring Program.....	2
Figure 2 Osprey Nest Activity in the Low-Level Training Area and adjacent Control Area, 1999-2006 7	7
Figure 3 Osprey Nest Success in the Low-Level Training Area and adjacent Control Area, 1999-2006	11
Figure 4 Osprey Productivity in the Low-level Training Area and adjacent Control Area, 1999-2006.13	13
Figure 5 Number of Osprey Young per Active (Productivity) and Successful Nest in the Low-level Training Area and adjacent Control Area, 1994-2006.....	14
Figure 6 Osprey Nest Activity, Nest Success and Productivity, 1999-2006	15
Figure 7 Osprey Productivity in Labrador Compared with Data Collected at the Tadoussac Migration Station, Tadoussac, Quebec, 1993-2006.....	16
Figure 8 Cumulative Precipitation Recorded from Local Weather Stations at Park and Ann Marie Lakes Compared with Goose Bay, Labrador, May – August 2006	18
Figure 9 Average Maximum and Minimum Temperatures and Total Precipitation Compared with Nest Success (Productivity) during 1-7 and 8-14 July, 1994-2006	23
Figure 10 Osprey Reproductive Success Compared With Average Maximum and Minimum Temperatures, 1-7 July, 1994-2006	26
Figure 11 Osprey Reproductive Success Compared With Average Maximum and Minimum Temperatures, 8-14 July, 1994-2006	26
Figure 12 Osprey Reproductive Success Compared With Cumulative Precipitation During 1-7 July, 1994-2006	27
Figure 13 Osprey Reproductive Success Compared With Cumulative Precipitation During 8-14 July, 1994-2006	27
Figure 14 Osprey Reproductive Success Compared With Total Hours of Strong (i.e., >20 km/h) Winds During 1-10 July, 1996-2006	29

1.0 INTRODUCTION

An extensive annual monitoring program of Osprey (*Pandion haliaetus*) within the Low-level Training Area (LLTA, known as CYA 731) of Labrador and north-eastern Québec by the Department of National Defence (DND) (Trimper *et al.* in prep.; LFA 1992; JWE 1992, 1994, 1995; JWEL 1996a, 1996b, 1997, 1998, 1999, 2001) and subsequently by the Institute for Environmental Monitoring and Research (IEMR) (Minaskuat 2003, 2004, 2005) has been ongoing since 1991. This program was continued during 2006 with the objective, as in previous years, of monitoring the reproductive success of Osprey inside (Experimental) and outside (Control) the LLTA, and to further examine potential relationships between breeding success and local climatic conditions. However, unlike previous years, there were no scheduled military training flights within the LLTA for the first time in the history of this long-term monitoring program; Osprey received the same treatment (i.e., nil) in both the experimental and control areas.

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 Rashleigh was involved in the field program and served as primary author. Aboriginal and non-aboriginal staff assisted these individuals and included Ms. Caroline Hong, Ms. Mary Ann Aylward (Innu), Mr. Marcel Gahbauer, Ms. Jolene Ashini (Innu), Mr. Apenam Pone (Innu), Ms. Gladys Lambourne (Metis), and Mr. Corey Cooney (member of the Labrador Inuit Association). Mr. Geoff Goodyear or Mr. Peter Jefford (Universal Helicopters Newfoundland Limited) were selected as pilots, given their experience during previous aerial surveys for Osprey.

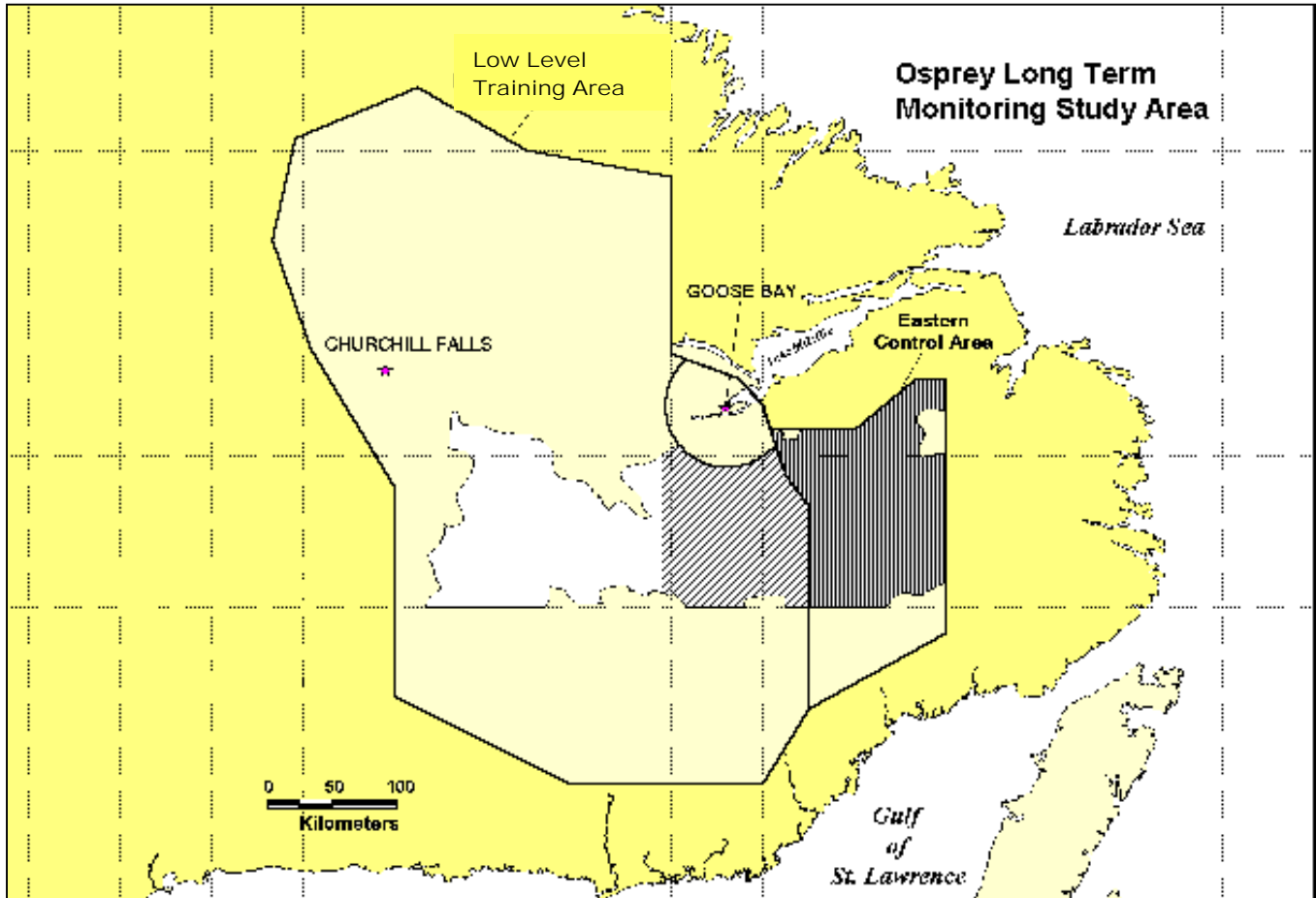
3.0 STUDY AREA

Osprey nests were surveyed within a portion of the LLTA and the Control Area first identified in 1999 (JWEL 1999) (Figure 1). The areas comprise primarily two forested ecoregions: Mecatina River and Eagle Plateau (ESWG 1995). Throughout the LLTA, forested habitat typically occurs 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 in the interior. 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 2006 Osprey Monitoring Program



4.0 METHODS

4.1 Field Surveys

The approach to monitoring Osprey during 2006 was identical to JWEL (2001). A sample of known Osprey nests¹ (DND/Jacques Whitford unpublished data) were surveyed during 5-15 June (corresponding to the early incubation period) in the LLTA and a Control area to determine nest activity (Figure 1). The goal was to locate 30 nests in each of the LLTA and Control areas. These nests were re-visited between 17 and 18 August 2005 to determine reproductive success (Appendix A). Field data sheets were generated to facilitate relocation and accurate recording of nest status.

Aerial surveys were conducted using a Bell 206L helicopter (or equivalent) with the navigator/observer seated beside the pilot. Consistent with Minaskuat procedures, a health and safety checklist was completed with daily toolbox meetings to ensure the Study Team was aware of potential hazards and appropriate Safe Work Practices. Prior to departure, a route was chosen that maximized nests encountered (by chance) while minimizing travel distance/time (and associated 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 2006 may or may not have been included in previous monitoring years.

Osprey nests were considered active if eggs or young were observed or suspected in the nest during the June survey or if adults exhibited aggressive behaviour (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. As nestlings may continue to suffer high rates of mortality until fledging in some years in Labrador (JWE 1995, JW unpublished data) and elsewhere (Hagan 1986, Ewins and Miller 1995), a nest was only considered successful if one or more young were observed immediately prior to expected fledging date in mid-August (Appendix A).

When active nests were identified during the first nest activity 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., whether alive and indication of age).

¹ Potential candidate nest sites and their nest history were identified from an extensive database maintained by the study team since 1991.

4.2 Data Summarization / Analysis

Information collected was summarized in terms of *Nest Activity* - available nests actively used by Osprey in June; *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 or completely collapsed nests were omitted from analysis.
2. Any new (i.e., previously unidentified) nests encountered during the survey in June were included.
3. Approximately 23 nests are required from each of the Control and LLTA for statistical purposes (JWEL 2001) but the Study Team has traditionally attempted to locate 30 in each area. Where >30 active nests were located, a table of random numbers was used to select nests to omit from detailed analyses.

Nest Activity and *Nest Success* were assessed using a Binary Logistic Regression and the MINITAB 14 statistical software package. This contrasts with previous years (e.g., 2005), when a one-tailed Fishers Exact Test had been used (JWEL 2001, Minaskuat 2003, 2004b, 2005). As such, results from all years (1999-2006) were reassessed in 2006. Where differences existed (due to differences in statistical methods and/or software packages employed since 1999), results were updated accordingly. As in the past, *Productivity* was examined using a one-tailed two-sample T-test (MS Excel). If an effect from military training activity 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 Nest Success

Reproductive Success (“Productivity”) – 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 previous years (2003-2005), 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 Ann Marie Lake, prior to nest surveys on 29 May 2006 at 1030 h and 1230 h, respectively. Weather stations were pre-set to record weather information every 30 minutes. Stations were revisited and data downloaded approximately every 45 days. Weather stations were disassembled and removed during the final visit on 27 September 2006.

Weather data were 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-September 2006. 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. Additionally, the Study Team evaluated whether extreme weather events occurred that could have influenced Osprey reproductive output.

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 (Steger 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). Indeed, data collected in Labrador [and 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 the 1991-1996 period.

Given this, available information on day of last ice will be used to further explore possible relationships between spring conditions and nest success.

Table 2 Breeding chronology of Osprey in Labrador

Arrival at nesting area	Egg Laying	Incubation Period	Median Hatch Date	Brooding Period	Fledging
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, Minaskuat, unpublished).

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-hatch stages, Osprey young are not able to thermoregulate, or 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).

In addition, 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, Trimper *et al.* 1998). 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 compromised the hunting success of Osprey (Machmer and Ydenberg 1990), as fish are difficult to spot from the air when surface waters are disrupted by rain and/or wind (Hagan 1986). At wind speeds >7m/s (25.2km/h), hunting is no longer energetically profitable (Machmer and Ydenberg 1989) and even stronger winds have the potential to blow down an entire nest (Hagan 1986, JWEL 1995, Minaskuat unpublished).

Given the above, available temperature, precipitation, wind and wind chill data will be compiled for the period 1-14 July 2006 and relationships between patterns and/or extremes in weather data and Osprey reproductive success considered.

4.4.3 Nest Success – July/August Period

In 1994, JWEL (1995) monitored 10 Osprey nests periodically throughout the nestling season (26 July – 12 September, 1994) to assess nest 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." Reproductive success surveys in Labrador are therefore to better estimate of nest productivity at this northern extreme of their range.

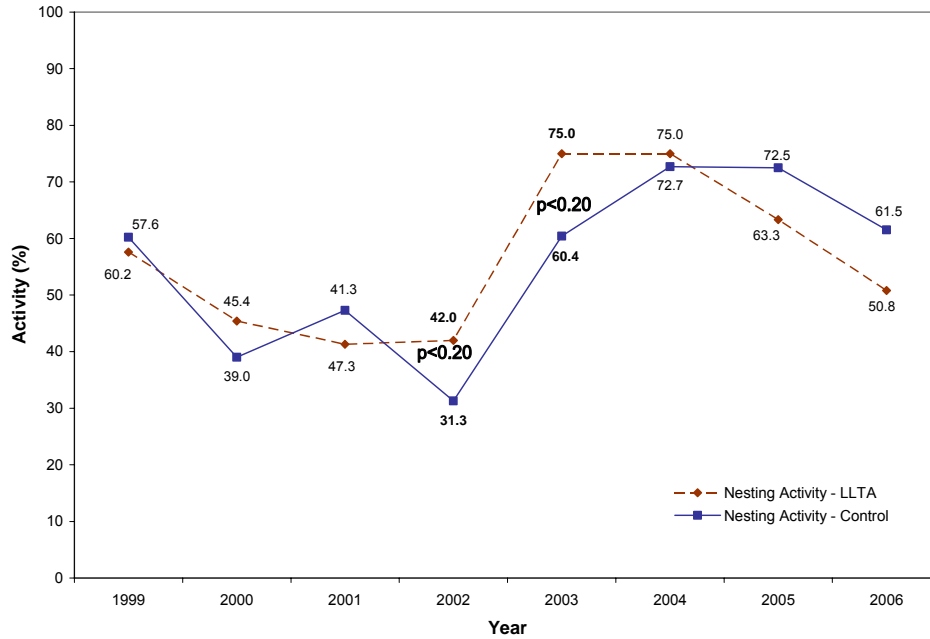
5.0 RESULTS

5.1 Nest Outcomes

5.1.1 Nest Parameters

Nest Activity in 2006 was lower than in 2004 and 2005, for both the Control Area and LLTA (Figure 2, Table 3). Nest Activity was greater in the Control Area (61.5%) in 2006 than in the LLTA (50.8%), but this difference was not significant at $\alpha=0.20$ ($p=0.252$, Table 4). Nest Activity has been similarly greater in the Control Area in some previous years (i.e., 1999, 2001, 2005), however significant differences have only been identified in favour of Activity in the LLTA, occurring in 2002 and 2003, prior to the cessation of Low Level Flying (LLF) (Table 3, Table 4).

Figure 2 Osprey Nest Activity in the Low-Level Training Area and adjacent Control Area, 1999-2006



Notes:

- 1) Statistical Analyses were performed using a Binary Logistic Regression at the 20% significance level (Table 4, Appendix B). Years where statistical differences were found have been indicated using $p < 0.20$.
- 2) Nest Activity = # Nests Active/# Nests available and surveyed.
- 3) Study Areas are show in Figure 1.

Table 3 2006 Osprey Survey Results Compared to 1999-2006

Parameter	1999		2000		2001		2002		2003		2004		2005		2006	
	LLTA	Control	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	61	52
# 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)	31 (50.8)	32 (61.5)
Active Sample	30	30	30	30	30	30	30	30	30	30	30	30	30	29	30	30
# Successful	27	25	16	10	9	13	15	13	28	25	21	26	9	11	16	23
# Young Fledged	53	47	31	17	18	21	30	28	52	57	43	59	13	21	30	40
# Young Fledged/ Active Sample	1.77	1.57	1.03	0.67	0.60	0.70	1.00	0.93	1.73	1.90	1.43	1.97	0.43	0.72	1.00	1.33
# 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	1.88	1.74
% 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	53.3	76.7

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 Nest Activity, Nest Success and Productivity in the Low-Level Training Area and Control Area of Labrador, 1999-2006

Nest Activity								
	Low-level Training Area			Control				
Year	Nests Available	Nests Active	P ₁	Nests Available	Nests Active	P ₂	P Value of Binary Logistic Regression	Reject at 20 %
1999	99	57	0.576	98	59	0.602	0.708	No
2000	77	35	0.455	82	32	0.390	0.412	No
2001	75	31	0.413	74	35	0.473	0.508	No
2002	81	34	0.420	112	35	0.313	0.126	Yes
2003	40	30	0.750	53	32	0.604	0.135	Yes
2004	44	33	0.750	44	32	0.727	0.808	No
2005	49	31	0.633	40	29	0.725	0.353	No
2006	61	31	0.508	52	32	0.615	0.252	No
Nest Success								
	Low-level Training Area			Control				
Year	Nests Available	Nests Successful	P ₁	Nests Available	Nests Successful	P ₂	P Value of Binary Logistic Regression	Reject at 20 %
1999	30	27	0.900	30	25	0.833	0.445	No
2000	30	16	0.533	30	10	0.333	0.117	Yes
2001	30	9	0.300	30	13	0.433	0.283	No
2002	30	15	0.500	30	13	0.433	0.605	No
2003	30	28	0.933	30	25	0.833	0.221	No
2004	30	21	0.700	30	26	0.867	0.113	Yes
2005	30	9	0.300	29	11	0.379	0.520	No
2006	30	16	0.533	30	23	0.767	0.056	Yes
Productivity								
	Low-level Training Area			Control				
Year	Nests Available	Young Fledged	Standard Deviation	Nests Available	Young Fledged	Standard Deviation	P Value of Two-sample t-test	Reject at 20 %
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	0.107	Yes
2006	30	30	0.959	30	40	1.050	0.102	Yes

Notes:

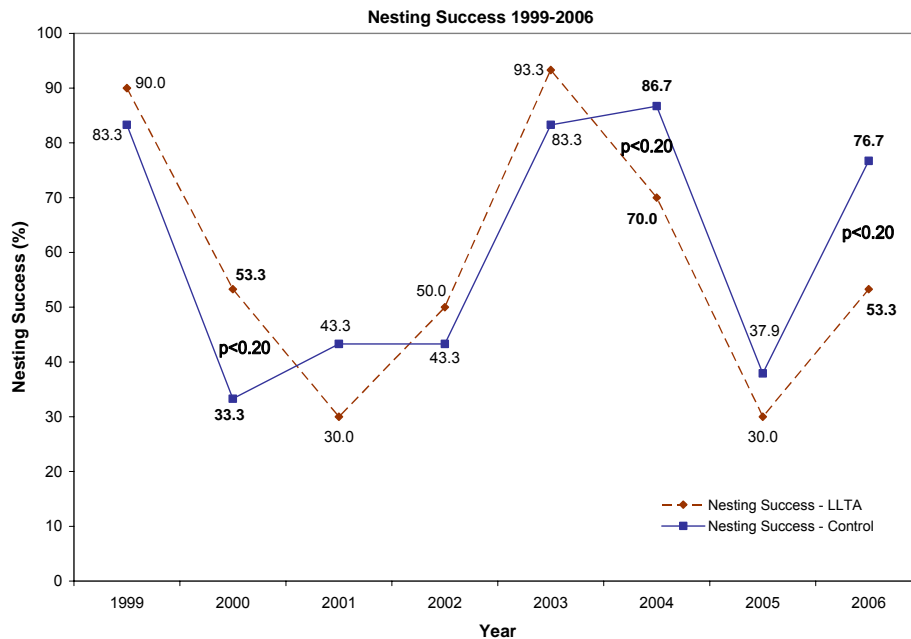
- 1) 1999-2002 DND surveys (JWEL 1999, 2001); 2003-2005 IEMR surveys (Minaskuat 2004a, 2004b, 2005).
- 2) Study Areas are shown in Figure 1.

Figure 2 indicates how Nest Activity has fluctuated over the past eight years and demonstrates the inconsistent pattern between the Control and LLTA. Overall, Nest Activity was lowest between 2000 and 2002 when Low Level Flying (LLF) was ongoing at 5 Wing Goose Bay. Since the cessation of LLF at the end of the 2003 flying season, Nest Activity has actually decreased in the LLTA (relative to 2003). It is also interesting to note that in three of the five years with ongoing LLF activities, Nest Activity was greater in the LLTA than in the Control (Figure 2).

A Binary Logistic Regression (BLR) was used to assess Nest Activity over the eight years included in the dataset (Appendix B). Results indicate that significant differences exist in overall Activity among years ($p < 0.20$), but differences between the LLTA and Control Areas are not significant between years ($p = 0.338$). Comparing total nest activity and total nest availability, over all years combined, indicates that the odds of activity inside the LLTA are 1.09 times that of in the Control Area. This difference is not significant at $\alpha = 0.20$ (BLR, $p = 0.494$)

Nest Success was also greater in the Control Area (76.7%) versus the LLTA (53.3%) in 2006 (Figure 3, Table 3). This difference was significant at $\alpha = 0.20$ ($p = 0.056$) (Table 4). Overall, this parameter has varied considerably over the past eight years, with Success greater in the LLTA in some years (e.g., 1999, 2003) and the reverse situation in other years (e.g., 2004-2006), and with significant differences in favor of both the LLTA (2000) and Control (2004) Areas (Table 4). Figure 3 indicates this variability in Nest Success since 1999. Note that some of the highest levels of Nest Success were recorded in 1999 and 2003, when LLF was ongoing at 5 Wing Goose Bay

Figure 3 Osprey Nest Success in the Low-Level Training Area and adjacent Control Area, 1999-2006



Notes:

- 1) Statistical Analyses were performed using a Binary Logistic Regression at the 20% significance level (Table 4, Appendix B). Years where statistical differences were found have been indicated using $p < 0.20$.
- 2) Nest Success = # nests successful/# nests active and surveyed.
- 3) Study Areas are show in Figure 1.

Results of statistical analysis indicate that significant differences exist in overall Nest Success among years as well as between the LLTA and Control Areas between years (BLR, $p < 0.20$) (Appendix B). The odds of being successful inside the LLTA are 0.91 times that of in the Control Area, however this difference is not significant at $\alpha = 0.20$ (BLR, $p = 0.602$)

In terms of **Nest Success** or **Productivity**, 2006 was considered a “mediocre” year (Table 5). Productivity was greater in 2006 then in 2005 (one of the lowest years on record) with 1.0 young fledged per active nest in the LLTA and 1.3 young per active nest in the Control area (Table 3, Figure 4). As in 2004 and 2005, Productivity was significantly greater in the Control Area then in the LLTA (Two-sample T-test, $p < 0.20$) (Table 4). Note that in the years where significant differences in Productivity were observed, overall success ratings ranged from “Very Good” (2004) to “Moderate” (2006) to “Poor” (2005) (Table 5).

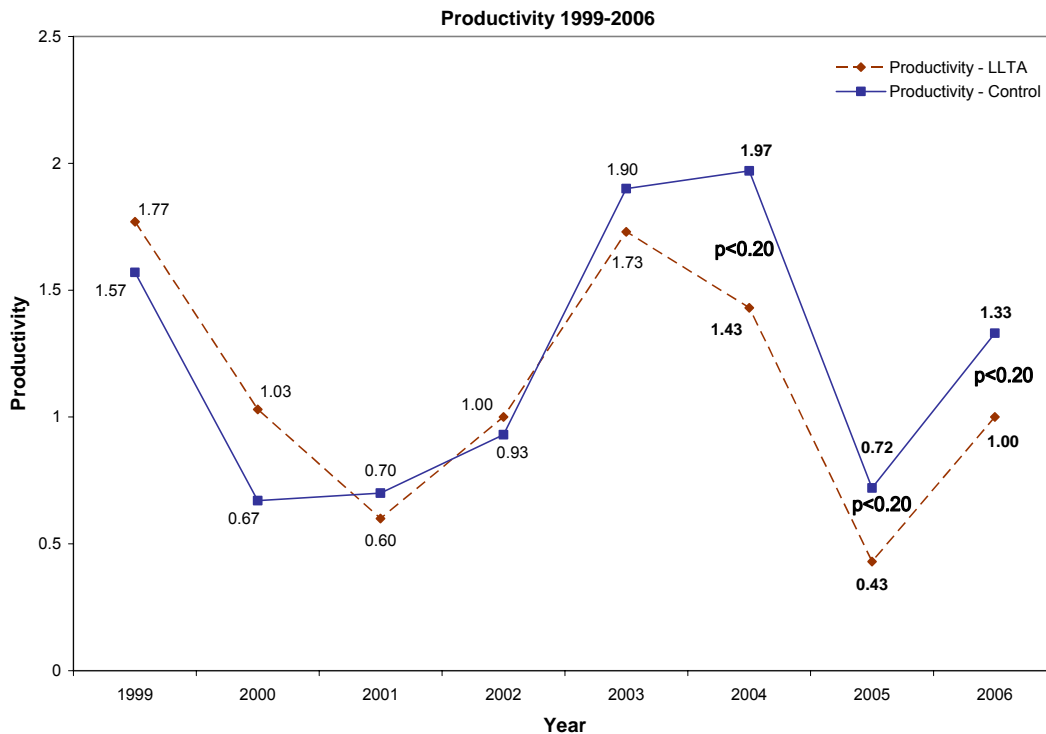
Table 5 Osprey reproductive success within and adjacent to the Low-Level Training Area in Labrador, 1993-2006

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
2006	Mediocre	1.00	1.33	1.17

Notes:

- 1) Success ratings are provided in Table 1
- 2) Success ratings are based on combined results
- 3) In 1993, surveys were completed in late July, but few active nests were encountered (JWE 1994)

Figure 4 Osprey Productivity in the Low-level Training Area and adjacent Control Area, 1999-2006



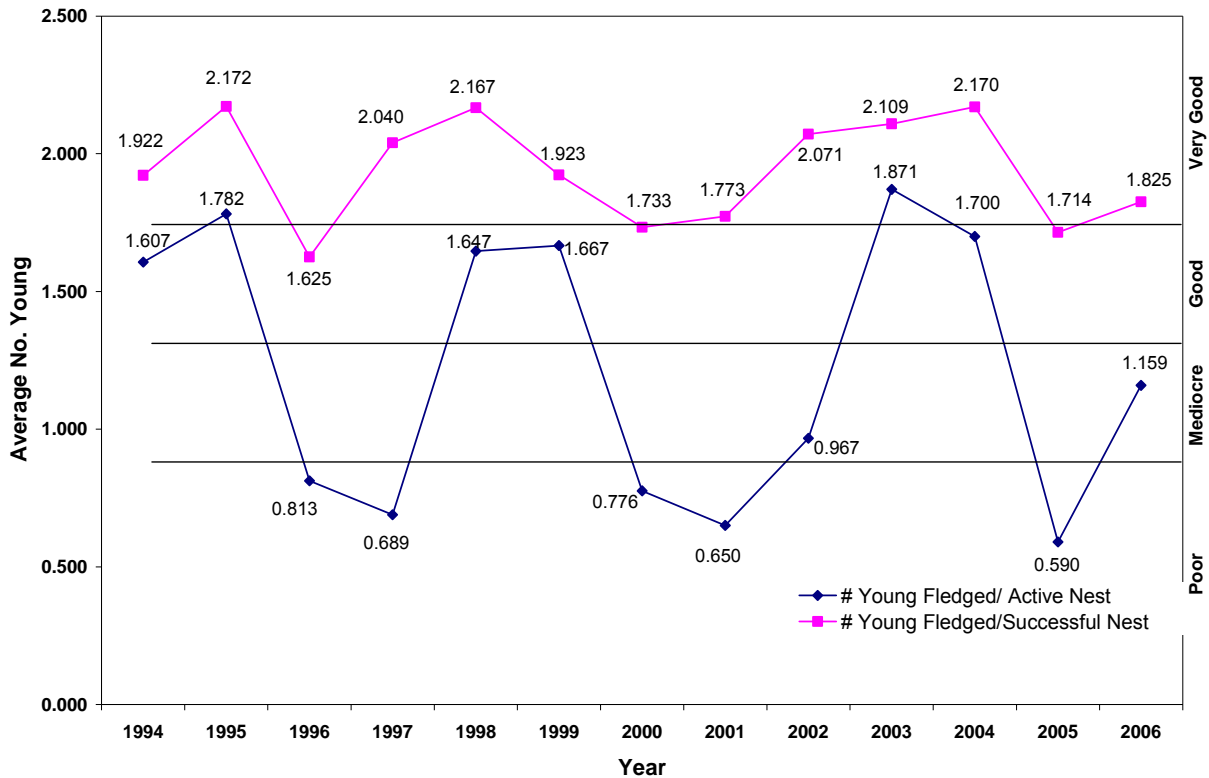
Notes:

- 1) Statistical Analyses were performed using a one-tailed two-sample T-test at the 20% significance level (Table 4, Appendix B). Years where statistical differences were found have been indicated using $p < 0.20$.
- 2) Productivity = # young fledged/active nest sample.
- 3) Study Areas are show in Figure 1.

Consistent with Nest Activity and Nest Success, Productivity has fluctuated markedly over the past eight years (Figure 4). During 1999-2002, productivity in the LLTA was similar to or higher than the Control. Since that time, productivity has been consistently higher in the Control each year, despite the decline in Low Level Flying over this period.

While the trend is similar, the same extremes in lows-highs in Productivity were not evident when considering the reproductive output per successful (versus active) nest (Figure 5).

Figure 5 Number of Osprey Young per Active (Productivity) and Successful Nest in the Low-level Training Area and adjacent Control Area, 1994-2006

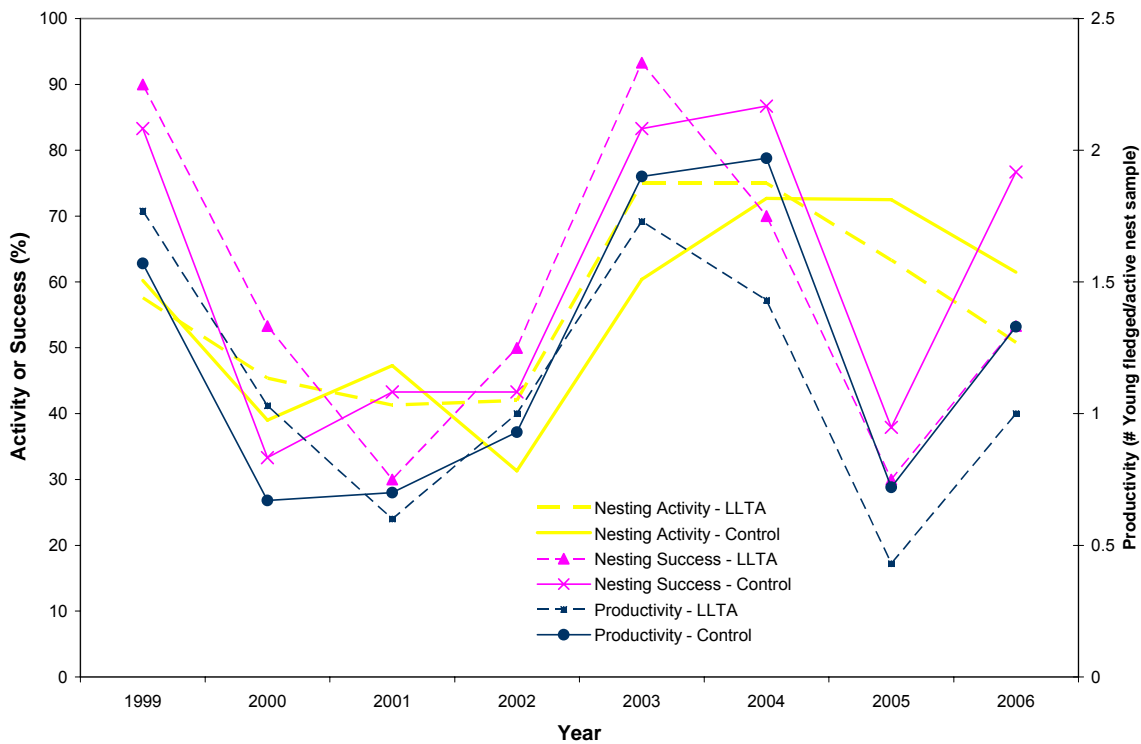


Notes:

- 1) Study Areas are show in Figure 1.

Relationships between Nest Activity, Nest Success and Productivity were further considered for the years 1999-2006 (Figure 6). All three parameters exhibit the same pattern of highs and lows, the exception being 2005 when Nest Activity remained relatively high while Nest Success and Productivity decreased.

Figure 6 Osprey Nest Activity, Nest Success and Productivity, 1999-2006



Notes:

1) Study Areas are show in Figure 1.

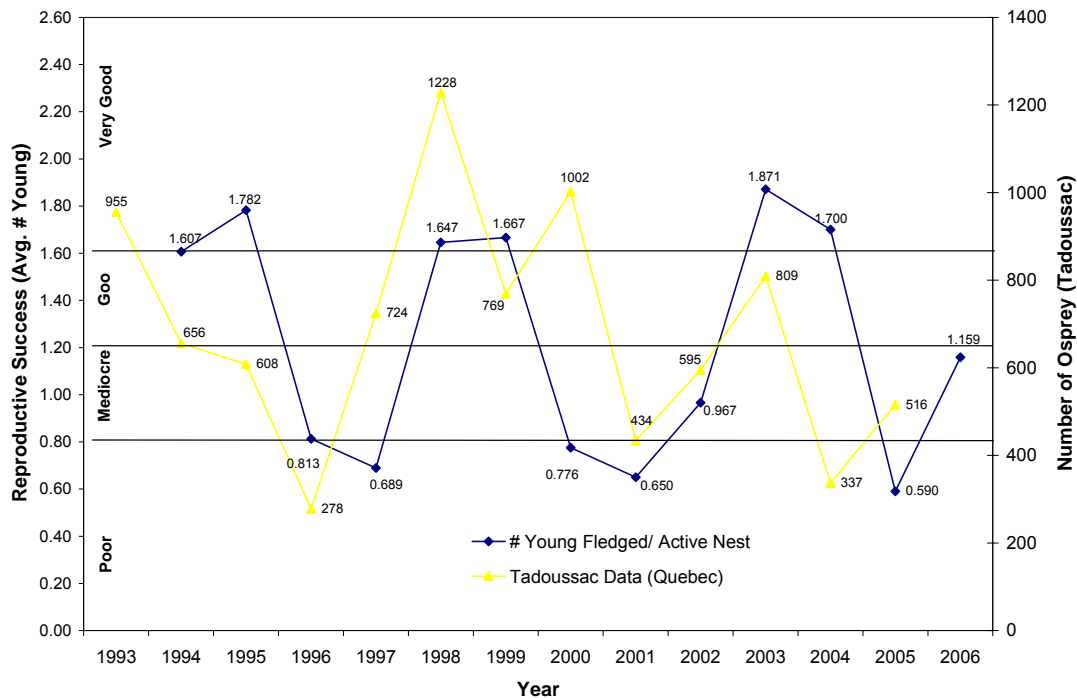
Overall, Nest Activity and Nest Success have been greater in the LLTA during four out of the eight years of this study (1999, 2001, 2005, 2006 and 2001, 2003, 2004, 2005, respectively). Productivity has been greater in the LLTA during three out of eight years, further confirming the lack of a consistent trend in favor of higher reproductive success in the Control Area or improved success since the decline of LLF in 2003 and its cessation in 2006.

Results from statistical analyses are presented in Appendix B.

5.1.2 Comparison with Tadoussac Data

Figure 7 compares Productivity data from Labrador with the number of adults observed during fall migratory counts (August-November) collected at the Tadoussac migration monitoring station (Observatoire d'oiseaux de Tadoussac) located southwest of the Study Area, in Tadoussac, Quebec (http://www.explos-nature.qc.ca/oot/index_e.htm). This Figure shows how the number of migrating Osprey has fluctuated during 1993-2006, and that the observed high/lows in numbers of migrating adults at Tadoussac are comparable to such fluctuations in reproductive parameters in Labrador.

Figure 7 Osprey Productivity in Labrador Compared with Data Collected at the Tadoussac Migration Station, Tadoussac, Quebec, 1993-2006



Note: Used with permission granted by the Tadoussac Migration Station

5.2 Egg/Nest Failures and Status of Young

In previous years (e.g., 2004), eggs that failed to hatch were noted in Osprey nests during the mid-August surveys. Whenever possible, these eggs were collected and provided to Environment Canada. No eggs were observed remaining in nests during August 2006 surveys.

The Study Team observed variability in the size of young among successful nests, representing 2-3 weeks difference in age. In nest 13B/14-35 sampled on 17 August 2006, the single juvenile had already fledged from the nest and was observed flying in the area, carrying a fish. This is relatively early compared with expectant fledging dates in late August (Table 2). While recorded as successful, the relatively small young observed in some nests (e.g., 13C/16-17) may face greater challenges in terms of fledging successfully before the onset of winter.

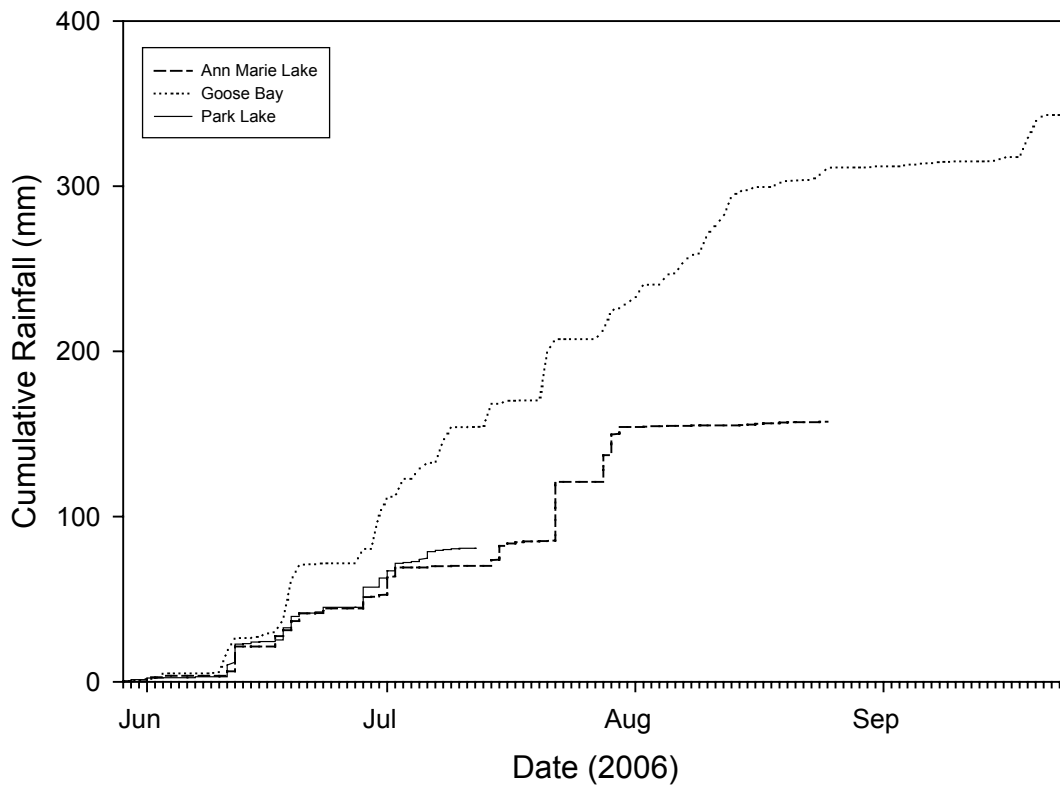
5.3 Weather Conditions and Osprey Nest Success

Weather stations at Park Lake and Ann Marie Lake collected continuous data from 29 May 2006 to 27 September 2006. However, due to technical issues, data are unavailable for the 12-31 July period at Park Lake. Further, at the time of writing, data were only available up until 25 August 2006. Data from the Goose Bay weather station were compiled for the 29 May – 25 August period.

Mean daily temperatures recorded at Goose Bay appeared similar to those recorded at Park Lake ($R^2=0.75$) and Ann Marie Lake ($R^2=0.74$) between May and August 2006 (Appendix C). This is similar to 2005 findings, however stronger relationships were evident in 2005 ($R^2=0.88$ and 0.90 , respectively). Park Lake and Ann Marie Lake temperatures were similarly strongly correlated ($R^2=0.89$).

Total daily precipitation recorded at Goose Bay did not correlate with total precipitation at Park Lake ($R^2=0.12$) or Ann Marie Lake ($R^2=0.06$) weather stations, nor were any correlations found between Park Lake and Ann Marie Lake ($R^2=0.35$), during the same period (Appendix C). Figure 8 illustrates cumulative precipitation at Goose Bay compared with Ann Marie Lake and Park Lake. Overall, precipitation was greater at Goose Bay than either of the two temporary weather stations in the Study Area. This contrasts with 2005 when similar rainfalls were found at Goose Bay, Park Lake and Ann Marie Lake (Minaskuat 2005). Note that the lack of precipitation recordings at Ann Marie Lake since the end of July (Figure 8) indicates that there may have been a problem with the rain collector at this station, as was the case in 2005 (i.e., the rain collected may have become obstructed). Variability in results between locations may also be reflective of local weather conditions.

Figure 8 Cumulative Precipitation Recorded from Local Weather Stations at Park and Ann Marie Lakes Compared with Goose Bay, Labrador, May – August 2006



Notes:

- 1) Data shown represents: 29 May - 25 August Ann Marie Lake; 29 May – 12 July Park Lake; and 29 May – 24 September Goose Bay

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 previously presented and discussed in a report submitted to the IEMR (Minaskuat 2004b). During years of relatively early ice out in the Minipi and Eagle Rivers (e.g., 1998 and 1999), Productivity was 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). Contrary to the earlier work of Wetmore and Gillespie (1976) in Labrador, the timing of spring break-up was believed to provide little indication of a relationship with Osprey reproductive success in recent years.

Observations by Minaskuat personnel suggest that both 2005 and 2006 were earlier (by 1-3 weeks) in terms of the onset of Spring, when compared to average conditions. Despite this, 2005 was considered a relatively poor year and 2006 only a moderate year in terms of Osprey productivity.

5.3.2 General Trends and Adverse Weather Events

Average daily maximum and minimum temperatures, total precipitation, average high wind speeds, and average daily wind chill temperatures during May, June, July and August (Appendix D) at Park Lake and Ann Marie Lake were examined, revealing the following trends:

- Generally, when precipitation occurred over consecutive days, daily rainfall amounts were <10 mm, and often <5 mm, at Ann Marie Lake and Park Lake;
- Rainfall recorded almost daily at Park Lake in August, but almost no rainfall at Ann Marie Lake;
- Maximum gusts of wind were frequently recorded at greater than 30 km/h at Ann Marie Lake and Park Lake; and
- Latest subzero Spring temperatures occurred on 6 June at Ann Marie Lake. Lowest temperature of 0.3°C recorded on 31 May at Park Lake.

In addition, data from Ann Marie Lake, Park Lake and Goose Bay weather stations were examined for evidence of storm events (i.e., relatively heavy rain accompanied by high winds and/or cold temperatures). Several notable weather events were identified and are summarized in Table 6.

Table 6 Adverse Weather Events During the Incubation, Brooding and Pre-fledging Periods Recorded at Ann Marie Lake, Park Lake and Goose Bay, June–August 2006

	Incubation Period <i>late-May/early-June to early July</i>	Brooding Period <i>early July to early August</i>	Pre-fledging Period <i>mid- to late-August</i>
Ann Marie Lake	<p>29-30 May High winds (~30-40 km/hr) accompanied by relatively cool temperatures (<5°C);</p> <p>12 June Wind gusts >30 km/hr and 15 mm of rain, with max. temp. <10°C;</p> <p>17-20 June Rain on all days (4-6 mm) with winds >30 km/hr.</p>	<p>1-2 July Rainfall 5-10 mm and wind gusting 20-30 km/hr;</p> <p>14-18 July Some rain on all days (max. 8.5 mm on 15 July) with wind gusts approaching 50 km/hr on 17 July;</p> <p>22 July High rainfall (35.8 mm) and wind gusts approaching 30 km/hr, with max. temp. down to 16.6°C from a high of 29.6°C the previous day;</p> <p>28-30 July 16 mm on 28 July with max. temp. below 20°C. Rain also on 29-30 (5-12 mm) accompanied by wind gusts of ~40-45 km/hr;</p> <p>2 August Max. temp. of 10°C, wind gusts up to 27 km/hr;</p> <p>10-15 August Max. temps. 10-16°C following high of 26°C on 9 August and followed by high of 24°C on 16 August.</p>	<p>19-20 August Minimal rainfall with gusts >40 km/hr on 19 August;</p> <p>23-25 August Max. Temps. decreasing from high of 31°C on 18 August to low of 10°C on 25 August, accompanied by trace rainfall amounts on 24 August.</p>

	Incubation Period <i>late-May/early-June to early July</i>	Brooding Period <i>early July to early August</i>	Pre-fledging Period <i>mid- to late-August</i>
Park Lake	<p>29-30 May Hi winds (~30-40 km/hr) accompanied by relatively cool temperatures (<5°C);</p> <p>18-19 June Max. gusts of >50 km/hr with 6-7 mm of rain each day;</p> <p>28 June Rainfall 12 mm with wind gusts >20 km/hr and max. temp. of 20°C.</p>	<p>1-10 July Some rain on all days with max. temp. ~20°C and wind gusts >25 km/hr;</p> <p>1-21 August Some rain on all days, max. temp. often <20°C, wind gusts frequently >30 km/hr.</p> <p>**No data available for 13-31 July</p>	<p>1-21 August Some rain on all days, max. temp. often <20°C, wind gusts frequently >30 km/hr. Rainfall amounts of 10-15 mm on 17-18 August.</p>
GB	<p>11-12 June Rainfall 13 mm and 8 mm, respectively, accompanied by drop in max. temps. down to 8°C on 12 June;</p> <p>15-21 June Rain on all days, with 24 mm on 19 June and max. temp. down to 16°C;</p> <p>30 June 21 mm rain with max. temp. 18°C, down from a high of 28°C the previous day.</p>	<p>1-18 July Some rain most days with >10 mm on 3,8,14 July;</p> <p>21-22 July Rainfall amounts 29 mm and 8 mm, respectively. Max. temp. decreased from 28°C to 18°C;</p> <p>28-31 July Rainfall most days with max. temp. down to 13°C on 31 July;</p> <p>1-16 August Some rainfall all days, with >10 mm on 10,13 August. Low max. temps. of 12-14°C during 10-13 August inclusive.</p>	<p>25 August Max. temp. of 11°C and 4 mm rain. Rain throughout 24-26 August.</p>

5.3.3 Weather Conditions and Osprey Hatching/Brooding

Temperature, precipitation and wind data collected between 1-14 July at Ann Marie Lake and Park Lake during 2003-2006, and at Goose Bay during 1993-2006 are summarized below in Table 7 and Table 8 respectively. Daily maximum and minimum temperatures in 2006 were similar to temperatures reported previously in 2004-2005, but greater than temperatures in 2003 (Table 7). Wind chill temperatures were low during the second week of July, comparable to 2003. Total precipitation was generally comparable to or less than that recorded in previous years, with the greatest precipitation occurring during the first week of July (Table 7). As in previous years, average daily wind gusts in 2006 were generally greater at Park Lake versus Ann Marie Lake, but were comparable between years (Table 7).

In terms of nest success, weather conditions in 2006, a relatively “Mediocre” year, were similar to 2004, a “Very Good” year, and comparable to 2005, a relatively “Poor” year.

Table 7 Summary of Climate Statistics Recorded from Local Weather Stations at Ann Marie Lake and Park Lake, Labrador, 1-14 July 2003-2006

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)	
Year	July		Ann Marie Lake	Park Lake	Ann Marie Lake	Park Lake	Ann Marie Lake	Park Lake	Ann Marie Lake	Park Lake	Ann Marie Lake	Park Lake
2003	01-07	Very	6.6	8.1	15.1	13.6	25.5	32.9	6.8	--	7.5	14.9
	08-14	Good	6.4	5.9	17.1	17.2	34.3	32.4	3.6	--	0.6	30.9
2004	01-07	Very	9.6	10.0	22.6	21.3	32.2	36.3	9.7	9.4	17.3	14.2
	08-14	Good	9.0	9.2	24.7	22.4	27.6	33.1	9.1	8.4	0	45.5
2005	01-07	Poor	9.0	9.3	24.9	22.5	30.6	40.4	8.9	8.4	3.5	21.6
	08-14		11.7	10.4	24.4	21.4	24.8	35.4	11.5	9.4	22.3	21.5
2006	01-07	Mediocre	9.2	10.2	20.0	19.2	29.4	35.9	9.2	9.5	17.4	16.7
	08-14 ²		6.9	7.6	24.3	22.7	32.9	42.1	6.1	6.4	3.8	1.25

Notes:

- 1) Ann Marie Lake = Ann Marie Lake (within the LLTA); Park Lake = Park Lake (Control Area).
- 2) Data are only available for Park Lake from 1-12 July 2006, due to a malfunctioning of the weather station.
- 3) Numbers presented are the average of the daily maximum/minimum value recorded on each day, over each 7-day period.

Average maximum temperatures recorded during 1-14 July at the Goose Bay weather station in 2006 (a “Mediocre” year) appeared average/normal for that period (Table 8, Figure 9). Temperatures were comparable to 2004, a “Very Good” year, but slightly lower than 2005, a “Poor” year in terms of nest success (Figure 9). Similarly, rainfall amounts in 2006 were comparable to “Very Good” years (e.g., 2004) and mediocre years (e.g., 2002). Rainfall in 2006 was also much higher than in 2005, a relatively “Poor” year.

Table 8 Osprey Productivity and Climate Statistics at Goose Bay, Labrador, 1-14 July, 1993-2006

Time Period		Success Rating	# Young Fledged/ Active Nest	Avg. Min. Temperature (°C)	Avg. Max. Temperature (°C)	Total Rainfall (mm)
Year	July					
1993	01-07	Poor	N/A	6.6	20.5	5.4
	08-14			10.1	19.6	4.0
1994	01-07	Good	1.34	8.2	19.9	15.7
	08-14			9.7	22.1	17.4
1995	01-07	Good	1.46	8.4	18.6	46.6
	08-14			12.1	21.5	57.8
1996	01-07	Poor	0.32	9.0	15.4	16.2
	08-14			8.3	20.6	43.2
1997	01-07	Mediocre	0.87	9.6	18.1	51.2
	08-14			8.5	16.8	52.4
1998	01-07	Very Good	1.54	8.6	19.0	45.0
	08-14			9.8	23.5	1.6
1999	01-07	Very Good	1.67	8.8	15.4	64.8
	08-14			10.2	20.4	25.0
2000	01-07	Mediocre	0.85	8.9	16.6	44.0
	08-14			7.6	17.4	29.2
2001	01-07	Poor	0.65	8.3	17.1	45.6
	08-14			9.0	13.8	74.8
2002	01-07	Mediocre	0.97	11.4	22.4	32.0
	08-14			7.1	17.0	43.6
2003	01-07	Very Good	1.82	9.3	15.0	41.6
	08-14			8.4	19.0	36.8
2004	01-07	Very Good	1.70	11.0	23.2	28.8
	08-14			9.6	23.5	12.0
2005	01-07	Poor	0.58	11.3	25.8	13.5
	08-14			10.6	22.1	9.65
2006	01-07	Mediocre	1.17	10.8	19.8	30.9
	08-14			8.0	21.5	35.8

Notes:

- 1) Criteria for determining Overall Success Ratings are provided in Table 1.
- 2) Data from Environment Canada (2006).

Figure 9 Average Maximum and Minimum Temperatures and Total Precipitation Compared with Nest Success (Productivity) during 1-7 and 8-14 July, 1994-2006

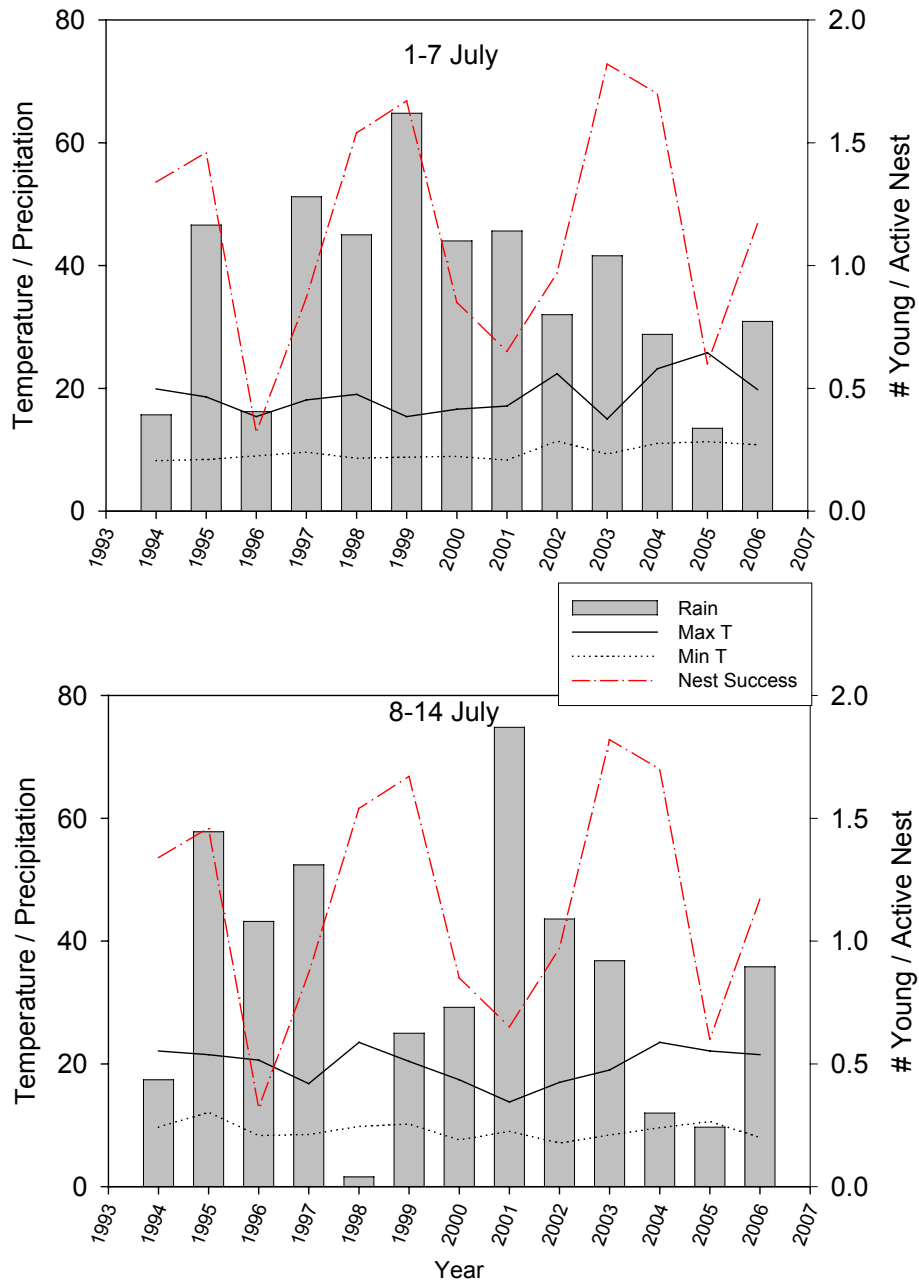


Table 9 Summary of Temperature and Precipitation Data in Relation to Osprey Nest Success, 1993-2006

Year	Success Rating	# Young Fledged/ Active Nest	Description of Weather, 1-14 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 Ann 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 Ann Marie Lake on same day). Daily rainfall between 5-7 July. Rain on most days 16-24 July.

Year	Success Rating	# Young Fledged/ Active Nest	Description of Weather, 1-14 July
2005	Poor	0.58	Latest subzero temperatures recorded on 9 June at Park Lake, 13 May at Ann Marie Lake, 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 Ann Marie Lake, and on 25 July at Park Lake and GB.
2006	Mediocre	1.17	Latest subzero temperatures recorded on 6 May at Ann Marie Lake; temperatures above zero at Park Lake and GB throughout available data; Min. temps. frequently below 10°C; min. temp. of 3.6°C on 13 July at Ann Marie Lake; Some rain on most days at GB and Park Lake but >10 mm only recorded at GB; rainfall of 10.6 mm on 1 July at Ann Marie Lake.

Notes:

- 1) 1993-2002 summaries based on information collected from the Environment Canada weather station at Goose Bay, Labrador.
- 2) 2003-2006 summaries based on information collected at Goose Bay and local weather stations at Ann Marie and Park Lakes, Labrador.
- 3) Data from Park Lake available only from 1-12 July.
- 4) Goose Bay weather station data available online at <http://www.climate.weatheroffice.ec.gc.ca/climateData>.
- 5) Criteria for determining Overall Success Ratings are provided in Table 1.

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 10-13). The time periods between 1-7 July and 8-14 July (corresponding with the median hatch/early nest period) were separated for more detailed assessment. No strong relationship was obvious in these data sets. Relatively "Poor" years (e.g., 1993 and 2005) have maximum temperatures that were higher than in some "Very Good" years (e.g., 2003), and similarly some relatively "Poor" years (e.g., 2005) have some of the lowest rainfall (Table 8 and Figures 10-13).

Figure 10 Osprey Reproductive Success Compared With Average Maximum and Minimum Temperatures, 1-7 July, 1994-2006

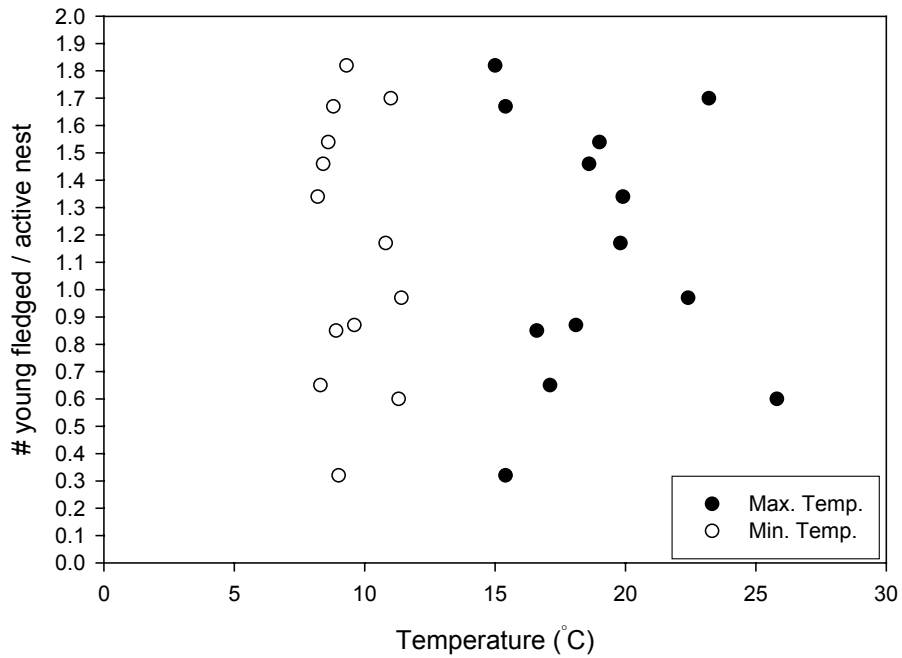


Figure 11 Osprey Reproductive Success Compared With Average Maximum and Minimum Temperatures, 8-14 July, 1994-2006

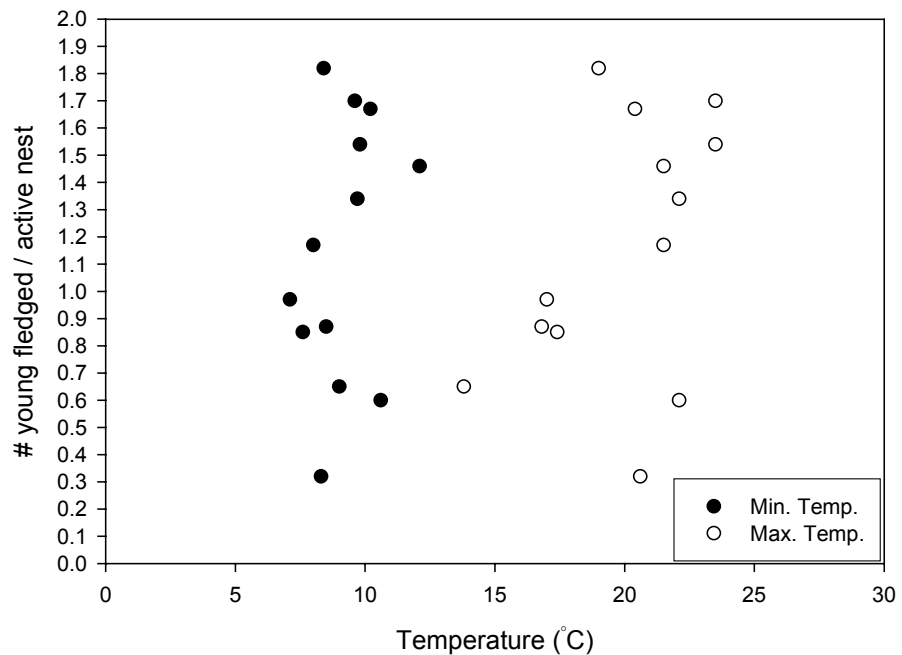


Figure 12 Osprey Reproductive Success Compared With Cumulative Precipitation During 1-7 July, 1994-2006

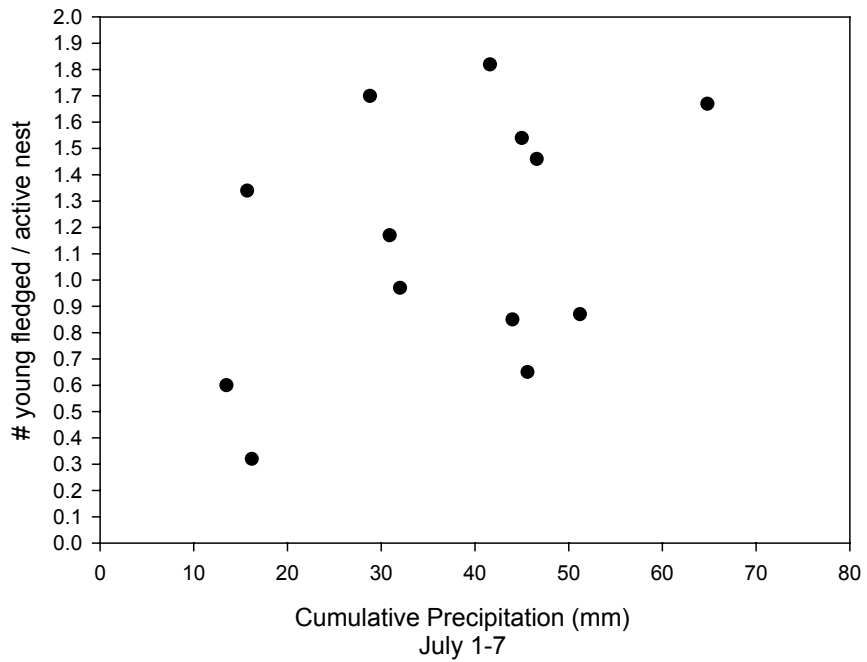
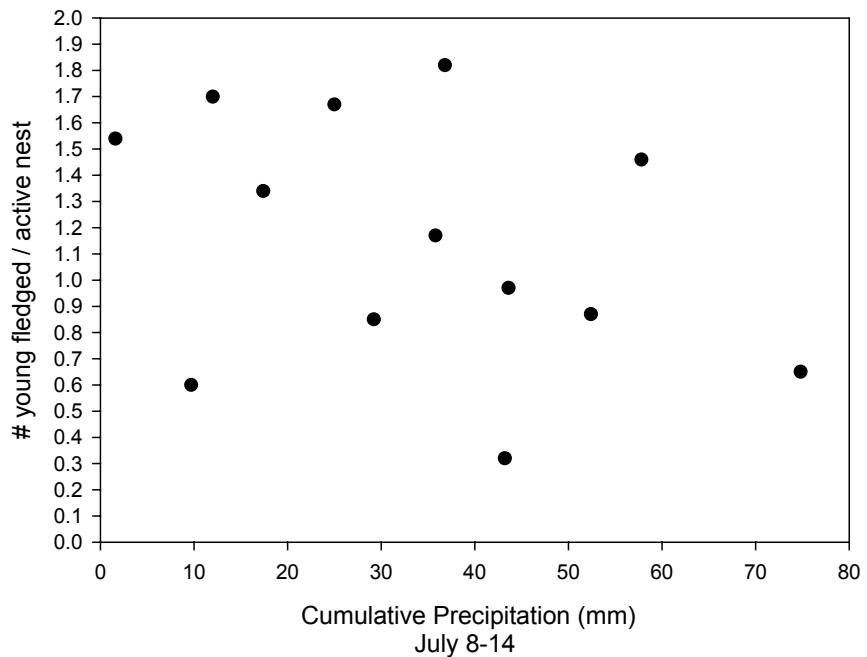


Figure 13 Osprey Reproductive Success Compared With Cumulative Precipitation During 8-14 July, 1994-2006



Hourly wind speeds of 20-25 km/h and >25 km/h in 2006 during 1-10 July were comparable to the majority of years between 1994 and 2005 (Table 10). Again, a scatter plot was generated that depicts hours of high winds (>20 km/h) during the 1-10 July period, 1994-2006, in comparison with overall reproductive success (Figure 14). 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 14), similar to findings in 2005.

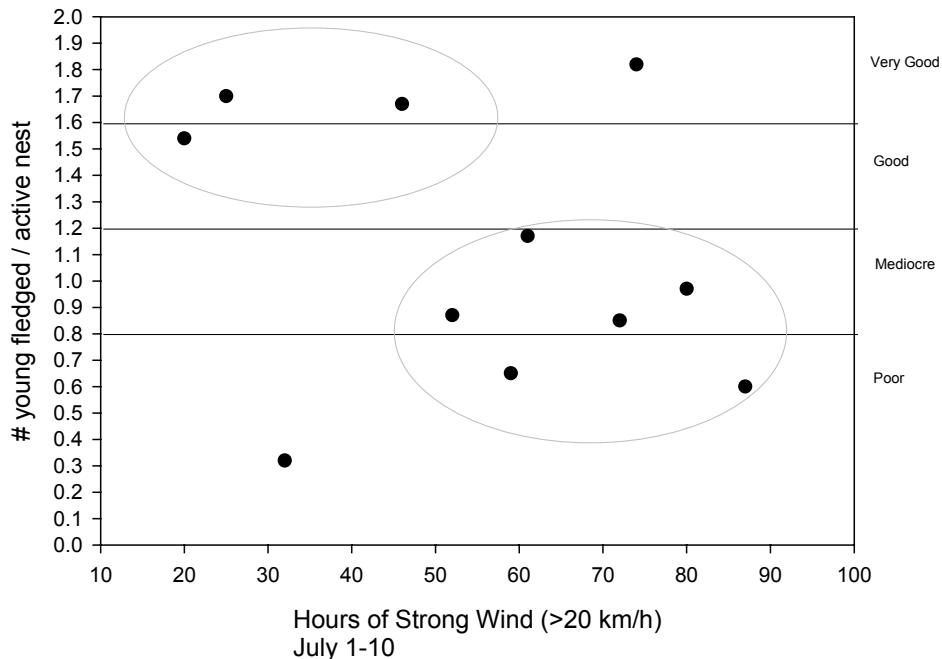
Table 10 Osprey Reproductive Success and Total Hours of Relatively High Wind Speeds, 1-10 July 1996-2006

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
2006	Mediocre	1.17	36	25

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 14 Osprey Reproductive Success Compared With Total Hours of Strong (i.e., >20 km/h) Winds During 1-10 July, 1996-2006



6.0 DISCUSSION

6.1 Nest Parameters

Considerable variability in these parameters has been observed over the past years and inconsistent differences between control and experimental areas, combined with apparent contradictions between reproductive output and success during some years (e.g., 2003, with higher success but lower productivity in the LLTA compared with the Control Area) suggest that LLF activity is not related to Osprey reproductive success over these large areas. The **variability in Nest Activity, Nest Success and Productivity suggests a 4-5 year high/low trend in these parameters**, whereby overall reproductive success declines approximately every 3-4 years, followed by 2-3 years of increased reproductive success.

Despite fluctuation in reproductive parameters described above, throughout this same period, the number of young fledged per successful (vs. active) nest has remained relatively constant. These results are similar to those of Wetmore and Gillespie (1976) who found that although the percentage of productive Osprey nests and the number of young per occupied (i.e., active) nest with known outcome varied greatly over a five year period in east-central Labrador, the number of young per productive (successful) nest did not vary as much. Wetmore and Gillespie (1976) suggested that the observed low number of young per active nest

may have resulted from either (1) limited egg laying by the adults (significantly greater number of eggs were laid in occupied-successful nests versus occupied-unsuccessful nests), or (2) poor hatching success. In this regard, poor hatching success was more pronounced in years of later spring break-up of ice (Wetmore and Gillespie 1976).

Results of the current investigation, which includes data from 1999-2006, indicate that Osprey nest success may be more closely tied to factors other than low-level jet aircraft training. Though not significant, productivity has been higher in the LLTA in three of the last eight years (when LLF was at higher levels), further emphasizing the lack of evidence that LLF is affecting Osprey in this regard (despite the significant difference to the contrary in 2004 through 2006). Results have suggested (but not provided evidence for) links between weather conditions and Osprey nest success (Minaskuat 2004b, this study), however a variety of factors may influence their success over a large geographic area such as the LLTA.

6.2 Weather and Osprey Nest

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 suggested the possibility of a weak relationship between (1) lower reproductive output per active Osprey nest and low maximum temperatures (2004); and (2) between total Nest Success and the total hours of strong winds (2005, 2006), during the early post-hatching period.

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 suggested (but not provided evidence for) possible links between weather conditions and overall nest success, in terms of all three parameters. However, several environmental factors, including (but not limited to) a decrease in mean temperature in July, the position of nests relative to foraging grounds, nest microclimate, adult behaviour, fratricide, parasites, and/or predators and prey availability may act in combination with weather conditions to influence Osprey nesting in Labrador. That Nest Activity, Nest Success and Productivity generally follow the same patterns of highs/lows suggests that some event may occur in some years that results in low levels of (or possibly delayed) nest initiation, leading to decreased Success and Productivity.

6.3 Other Influences on Osprey Reproductive Success

6.3.1 Small Mammal Abundance

The observed periodic decline in Osprey reproductive success, occurring approximately every 4-5 years, does coincide with declines in small mammal populations in the Region. Whether a possible relationship exists between small mammal abundance and Osprey reproductive success includes the following:

- **Osprey may benefit more from the presence of small mammals in their diet than previously believed** – Chubbs and Trimper (1998) found that ‘mammals’ comprised 7.5% of the prey items delivered to Osprey nests of this mainly piscivorous raptor in 1995 (a relatively “Good” year for both Osprey and small mammals), yet such prey deliveries were non-existent during 1996 (a “Poor” year) when there was a regional crash in the small mammal population;
- **the paucity of small mammal populations may result in increased predation of Osprey nests by marten (*Martes Americana*) or other predators** – Gosse and Hearn (2005) found that Meadow Voles (*Microtus pennsylvanicus*) comprised the major portion (70%) of marten diets in Newfoundland. Shrews and other unidentified mammals were also identified in scats and stomach contents. In times of reduced small mammal availability, marten may increase predation on Osprey nests;
- **other perhaps indirect relationships exist between small mammal population cycles and Osprey reproductive success in Labrador.**

6.3.2 Fratricide

Brood reduction – the decrease in the number of nestlings in a nest over the nestling period – may result from fratricide, including the prevention of the youngest nestlings from feeding through aggression by older/larger siblings (Hagen 1986, Minaskuat unpublished). During periods of low food supply, fratricide may be more common, and affect overall Productivity of Osprey nesting in Labrador.

6.3.3 Parasites

Some populations of Red Grouse (*Lagopus lagopus scoticus*) in northern England exhibit 4-6 year cycles (Begon *et al.* 1996). Population declines were predominantly observed during the winter, but could be reduced when individuals were treated with nematocides, leading to the theory that the observed cyclic behaviour results from an interaction between grouse and a parasitic nematode (*Trichostrongylus tenuis*). Similar interactions may also exist that influence Osprey reproductive success in Labrador.

6.3.4 Contaminants

The use of organochlorine pesticides (e.g., DDT) in the past has had a major effect on some populations, having been correlated with lower reproductive success (Poole *et al.* 2002, Minaskuat unpublished). Other

contaminants found in Osprey eggs in Labrador and elsewhere include PCBs, heptachlor, dioxins, dieldrin, chlorodanes, lead, and mercury (Poole *et al.* 2002).

7.0 SUMMARY AND CONCLUSIONS

- 1) 2006 was considered a “Mediocre” year for Osprey production in the Study Area.
- 2) Nest Activity was greater in the Control Area versus the LLTA, based on a target active nest sample size of 30 nests in each Study Area, but this difference was not significant at $\alpha=0.20$ ($p=0.252$).
- 3) Nest Success was greater in the Control versus LLTA study area. This difference was significant at the 20% confidence level ($p=0.056$).
- 4) For the third year in a row, reproductive output per active nest (Productivity) was significantly higher in the Control sample than the LLTA ($p=0.102$). However, in three of the eight years investigated in this study, Productivity was greater in the LLTA (though not statistically significant).
- 5) All three parameters under investigation favoured the Control Area in 2006. However, if this difference was related to LLF and/or local habitat differences, one would expect similar results in previous years and certainly not in 2006 when there was no military flight training in CYA 731.
- 6) Considerable variability in nest activity, nest success and productivity has been observed over the past eight years. Observed variability suggests the possibility of an approximate 3-5 year high/low trend in these parameters.
- 7) Osprey reproduction since the removal of exclusion zones in the LLTA starting in 1999 appears consistent to the Control Area not subjected to LLF. Annual productivity monitoring during 1999-2006 suggests that reproductive success is related more to other external factors in Labrador and northeastern Québec.
- 8) Weak relationships were found between weather conditions [temperature (2004) and wind (2005, 2006)] and reproductive success during the early post-hatching period (i.e., when Osprey young are not able to thermoregulate). More detailed (multivariate) analyses will be required to confirm relationships between climate and productivity of Osprey nesting in the study area.
- 9) Over the last 13 years, Osprey Productivity in the Study Area has followed a 4-5 year cycle of increasing values followed by a sharp decline. If the trend continues, 2007 and possibly 2008 should result in relatively high reproductive output for Osprey.
- 10) As the ‘peaks’ of reproductive output by Osprey coincide with regional ‘peaks’ in small mammal populations it is possible: Osprey may benefit significantly from the presence of small mammals in their diet; the paucity of small mammals may result in increased predation of active nests by such predators as marten; and/or other perhaps indirect relationships exist between small mammal population cycles and Osprey reproductive success in Labrador.

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APPENDIX A

2006 OSPREY DATA

APPENDIX B

RESULTS OF STATISTICAL ANALYSES

APPENDIX C

RESULTS OF REGRESSION ANALYSES

APPENDIX D

**MONTHLY SUMMARIES OF WEATHER DATA
COLLECTED AT ANN MARIE LAKE,
PARK LAKE AND GOOSE BAY**