

MLP NO. M62

**JET AIRCRAFT EFFECTS ON
NESTING CANADA GEESE (*BRANTA CANADENSIS*)**

FINAL REPORT

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FINAL REPORT

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1.0 INTRODUCTION

Several literature reviews have been completed related to the potential effects of military aircraft on waterfowl (Sopuck et al. 1979, Spencer Environmental Management Services Ltd. 1989, DND 1994, IEMR 2003). While challenges of identifying appropriate controls in some of these studies were noted, none suggested that waterfowl populations were adversely affected, particularly as the collective experience became available. Although, aircraft disturbance may influence waterfowl behaviour and habitat use, studies have shown that the sensitivity of waterfowl to aircraft noise disturbance differs widely and is influenced by aircraft type, altitude and time of year (Gollop et al. 1974; Ward et al. 1986; Conomy et al. 1998a, 1998b).

Most initial studies relied on an inventory approach (ORNL 1987) that compared population data inside a zone of influence to an adjacent control area. Since that time, the Canadian Wildlife Service (CWS) has conducted a number of population trend and behavioural studies on waterfowl but no significant adverse impacts from military flying activity in the Low-level Training Area (LLTA) of Labrador and Quebec have been identified (Bateman et al. 1999a, 1999b; Chaulk and Turner 2000, 2001, 2002; Turner and Hicks 2002). Other waterfowl researchers have conducted behavioural and physiological studies that indicated temporary effects (Wooley and Owen 1978, Conomy et al. 1998a, Trimper et al. 2003, Goudie 2003). Gunn and Livingston (1974) reported that non-breeding birds appeared more sensitive to aircraft disturbance than nesting birds. Other studies have indicated that birds, including waterfowl, are capable of tolerating some levels of aircraft disturbance (Rylander et al. 1974, Burger 1981, Ellis *et al.* 1991). In an Alaskan study, Ward et al. (1999) reported mean flight and alert responses of Pacific Brant and Canada geese that were greater for rotary-winged aircraft than for fixed-wing aircraft and for high-noise aircraft than for low-noise aircraft. The greater lateral distance of the aircraft from the flock, the lower the probability of a response by the geese.

As with other waterfowl during nesting, Canada geese (*Branta canadensis*) must deal with a variety of predators that may affect attendance and overall nesting success. Arctic fox (*Alopex lagopus*) and red fox (*Vulpes vulpes*) are the most important predators on goose eggs. Other egg predators include gulls (*Larus sp.*), Common Raven (*Corvus corax*), American crow (*Corvus brachyrhynchos*), and black and brown bears (*Ursus sp.*) (Mowbray et al. 2002). In Hudson Bay, predation accounted for 92 percent of recorded nest losses during 2003, with herring gulls (*Larus argentatus*) and Arctic foxes being the principal egg-predators (Cotter et al. 2003). In that same year, nest success at Big Island in Ungava Bay was only 5 percent, with nest failures mostly attributed to black bears (Cotter et al. 2003). A study conducted in southern Alaska from 1997-2000 found that 72 percent of destroyed Dusky Canada geese nests were predated by bald eagle and 13 percent by brown bears (Anthony et al. 2003). Goslings are also vulnerable to predation by gulls, foxes and bald eagles. A 1994 study in the Yukon-Kuskokwim Delta of Alaska estimated a minimum of 34,000 Canada goose goslings [in addition to 21,000 Emperor geese (*Chen canagica*) and 16,000 White-fronted geese (*Anser albifrons*) goslings] were consumed by 12,600 Glaucous Gulls (*Larus glaucescens*) nesting in the delta (Bowman et al. 2004).

The *Environmental Impact Statement on Military Flying Activities in Labrador and Quebec* (DND1994) stated that noise and visual disturbances associated with military training flights could interfere with

reproductive activities of birds through behavioural changes associated with nest initiation and attendance, eventually resulting in a decrease in productivity and reduced abundance of birds. Aircraft effect studies on waterfowl in the LLTA have examined non-nesting stages such as breeding [Harlequin Ducks (*Histrionicus histrionicus*) (Goudie 2003)], moulting [Black Duck (*Anas rubripes*) (Trimper et al. 2003)] and staging [Canada Goose and other waterfowl (Bateman et al. 1999b)]. Incubation-related studies on Osprey (*Pandion haliaetus*) have indicated no significant behavioural reactions as a result of frequent and proximate overflights by military aircraft (Trimper et al. 1998a, 1998b). Based on population scale studies in Labrador that have not detected an effect regarding waterfowl (Chaulk and Turner 2000, 2001, 2002; Turner and Hicks 2002) and other investigations noted above, the likelihood of strong reactions by incubating Canada geese (*Branta canadensis*) to noise events is unlikely. Consistent with the precautionary principle, despite uncertainty regarding the effect of jet noise disturbance on the behaviour and energetics of many waterfowl species in the LLTA, DND, in consultation with the CWS, agreed to place exclusion zones to low-level flying around locations that were identified as having a relatively high number of nesting Canada Geese.

Prior to this study a controlled research experiment to address this issue had not been completed in a wilderness setting. This study, a collaborative effort between the Institute for Environmental Monitoring and Research (IEMR), the Department of National Defence (DND), and the CWS, is designed to address the long-standing issues related to the potential (and the degree of) disturbance to nesting Canada Geese and whether the imposed mitigation is required vis-à-vis nesting Canada Geese, and the potential impacts of military flight training on waterfowl behaviour during incubation.

2.0 HYPOTHESIS

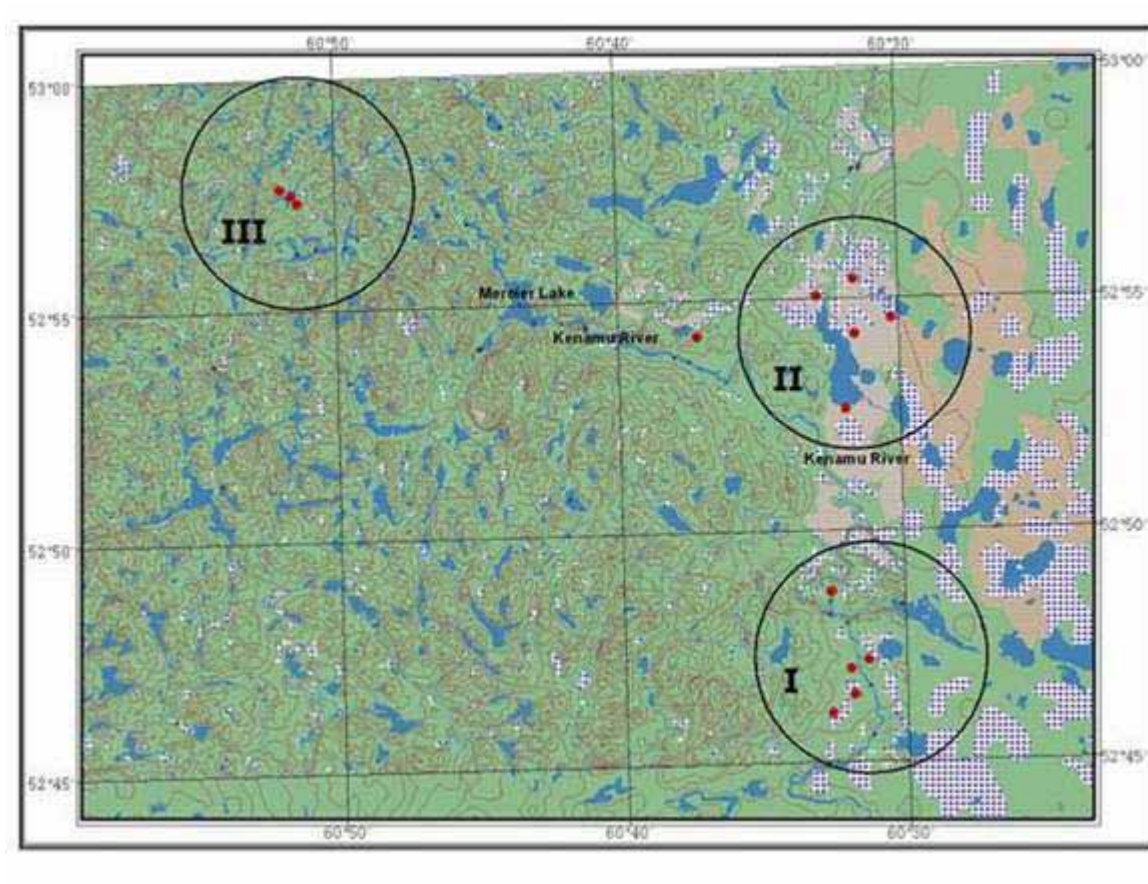
The hypothesis for testing is that disturbance caused by noise and visual stimuli associated with military training flights will interfere with reproductive activities of birds through behavioural changes associated with nest initiation and attendance. Aircraft noise events will elicit startle responses, increased daily movements, escape behaviour, decreased nest or brood attendance, nest abandonment, call masking, and/or disruption of courtship and/or nest initiation. These activities will result in an increased daily energy expenditure; exposure of eggs/young to ambient temperatures, increased predation and/or a disruption in feeding patterns.

3.0 STUDY AREA

Helicopter surveys of high potential nesting habitat for Canada Geese were conducted during 2003, covering areas near (*i.e.* 25-50 nm radius) 5 Wing Goose Bay within the Low Level Training Area (LLTA). The Lac Mercier/Kenamu River Study Area (Figure 1) was identified as having several active Canada Goose nests during 2003 and was subsequently selected for the 2004 monitoring program. This area is also located en route to the Practice Target Area (PTA) and was thus expected to enhance co-operation from participating pilots.

The study team returned to the Lac Mercier/Kenamu River Study Area on 10 June 2004 to locate a minimum of five active nests in three sub-areas (nest areas I, II, and III) within the Study Area (Figure 1).

Figure 1 Lac Mercier/Kenamu River study area and Canada Goose nesting locations.



4.0 METHODS

4.1 Study Team

Mr. Perry Trimper (JW) was the project manager for this study and was responsible for project design and quality control. Ms. Kathy Knox (JW), Ms. Karen Gosse (Minaskuat), Ms. Shirley Hill (Minaskuat), and Mr. Tony Parr (IEMR) participated in the field study. Ms. Caroline Hong (JW) coordinated logistical support for the field program. Military aircraft flight schedules and sortie times were provided by the 5-Wing Goose Bay Military Coordination Centre (MCC). Mr. Hans Lindner, Mr. Mike Mealey and Mr. Kelly Barr all of the MCC were particularly helpful. Maps were produced by Mr. Tony Parr.

4.2 Field Study

Nest observations occurred from 11-16 June 2004. The schedule of events and field requirements were based on the collective experience of the study team and advisors, and the timing of nesting observed during a reconnaissance of the study area in 2003. On 10 June, the proposed study area was surveyed to identify 15 nests for study and to determine the best approach for observations. All nests were recorded on 1:50,000 topographic map sheets and confirmed with a Global Positioning System (GPS). The study team landed (distant from the active nests) and determined observer locations (approximately 50-100 m from the nest), and deployed equipment. To minimize disturbance, incubating/nesting adult geese were not banded or otherwise handled.

Within the Lac Mercier/Kenamu River study site, three discrete areas, each with five active Canada goose nests, were studied for a period of two days respectively (11-16 June 2004). At each nest site, the two-day observation period consisted of one day of pre-treatment (*i.e.* no military aircraft activity within a 2.5 nm radius) and one day of treatment (*i.e.* military aircraft encouraged to overfly a point in the middle of each group of nests) scenario. The schedule of pre-treatment and treatment scenario for each of the three sub-areas within the study area is summarized in Table 1. It should be noted that due to the congestion of traffic at this vicinity (deconfliction zone for approaching the airport), exclusion zones were only possible on the day of non-overflight activity.

Table 1 Schedule of pre-treatment and treatment observations for Canada Goose nesting areas, Lac Mercier/Kenamu River, 11-16 June 2004.

		Nesting Area 1 (52°47N/-60°31W)	Nesting Area 2 (52°55N/-60°32W)	Nesting Area 3 (52°57N/-60°51W)
Pre-treatment (no overflights)	Date	12 June 2004	13 June 2004	15 June 2004
Treatment (overflights)	Date	11 June 2004	14 June 2004	16 June 2004

Notes:

1. For Area 1, treatment occurred before pre-treatment surveys due to scheduling constraints of cooperating military aircraft.
2. Nesting areas are shown in Figure 1.

The field crew of five observers were each positioned at a nest location and equipped with a video camera, binoculars or spotting scope, sound level meter, and customized data sheets (Appendix A). During treatment days, observers arrived at the study area and were at observation sites prior to the first launch of ITAF (Italian Air Force) and RAF (Royal Air Force) Tornado aircraft. Schedules varied and in order to encompass predicted sortie schedules, close contact with the MCC was maintained. Transport propeller-driven aircraft (C-130 or Transaal) were also involved in some of the exercises.

In terms of behavioral parameters that were used in the testing of the hypothesis, priority was given to recording the time (in seconds) when incubation was not occurring, and when the nest was unprotected by an adult (>20 m from the nest) after Trimper *et al.* (1998a, 1998b). Alarm calls or other startle response by the incubating adults were also recorded. Aircraft noise events were recorded in terms of aircraft type, direction, maximum sound level (L_1), noise event duration (from initiation until decibel level returns to ambient), and the average sound level over the course of the noise event (Leq). Noise events defined as an overflight occurred when an LLF aircraft passed within 0.75 nm (1.39 km), representing an L_1 of approximately 90 dB or higher (Trimper *et al.* 1998a, 1998b). While the noise level which might precipitate a strong reaction from nesting Canada Geese was not known prior to conducting the study, 90 dB is an approximate L_1 value shown to elicit consistent physiological responses in other waterfowl (Trimper *et al.* 2003). However, research by Trimper *et al.* (2003) indicated that physiological reactions in black ducks might occur at noise levels as low as 70 dB. Therefore, the study team recorded all noise levels and approximate distances of aircraft events from each nest under observation regardless of the noise threshold level. Ambient noise levels, weather and other stimuli were also recorded throughout each observation period.

4.3 Data Analyses

Using a combination of video footage and data recorded by the study team for all nests, the amount of time spent by adults on (and off) nests, number of egg exposure events and duration of exposure, and the frequency of changes in incubation duties by the adults during the sample period was calculated. As well, the appearance of possible threats, and aircraft activity in relation to incubation activity was also identified. The data collected was considered in 15-minute periods before and after an aircraft event, following methods consistent with Trimper *et al.* (1998a, 1998b). Daily summaries without and during aircraft events were also compared for each of the 15 nests.

Data was examined in terms of before and after a noise event as well as in terms of whether there would be biologically significant consequences affecting the viability of the eggs or hatching success. Reactions before, during and after a noise event were examined for each nest. Data from nests was grouped in terms of noise intensity (dB level) versus intensity of aircraft events (numbers of overflights). The influence of observer presence and subsequent observations, and arrival and departure by helicopter on the behaviour of the geese, were also considered.

5.0 RESULTS

During nest surveys on 10 June 2004, the study team encountered >50% snow cover in most nesting areas. Numbers of Canada Goose in the study area (Figure 1) appeared low and nests were difficult to locate, compared to 2003 surveys. Nonetheless, five active nests were located, per nest study area (*i.e.* 15 nests total) (Figure 1). Nests were widely spaced (*i.e.*, at least several hundred metres apart) and suitable nesting sites (*i.e.*, small vegetated islands) did not appear to be limited within the study area.

In this study, 14 of 15 nests were located on small islands (Figure 2) within large wetland complexes dominated by lichen and heathland ground cover and stunted black spruce (*Picea mariana*) and tamarack (*Larix laricina*). The single exception (Nest IE) was located on a string of solid ground with low shrub vegetation within a large string bog complex (Figure 2).

Figure 2 Island and String Bog Habitats Used by Nesting Canada Geese, Lac Mercier/Kenamu River Study Area, June 2004





5.1 Military Aircraft Effects

The study team observed over 88 military aircraft noise events over a combined (15 nests) total of 98 hours of observation between 11-16 June 2004 (Table 2; Appendix B). Peak sound levels of 97.5 dB were recorded but varied greatly (Figure 3), depending on nest location, location of event in relation to the nest, aircraft height, and on other conditions such as wind speed and direction.

In the absence of any other stimulus (e.g. helicopter or fox, see below), one or both adults were present at or near (<20m) the nest throughout observations. During an aircraft overflight, the female would generally remain at the nest and display no overt reaction to the military aircraft disturbance (Table 2). On two occasions (Nests ID and IID), the female stood in the nest and checked/rotated eggs, 2-10 minutes post-overflight, leaving eggs exposed for approximately 30 and 12 seconds respectively (Figure 3). This accounted for 0.7 minutes, or <0.01%, of the total observation time (Figure 4).

During one series of treatment observations (Nest site IIIE), eggs were exposed during aircraft overflights (Table 2). However, note that although the adults appeared alert, they were initially disturbed by helicopter stimuli and had abandoned the nest 2h 11min. prior to the first overflight.

Table 2 Canada Goose Nest Observations Collected During Directed Military Aircraft Overflights, Lac Mercier/Kenamu River Study Area, 11-16 June 2004

Nest	Obs. (min.)	Noise Events	L1 (dB)	Natural Threats	Resultant Exposure / Response of CAGO		Comments
					<15 Minutes Post-stimulus	Other	
IB Pre-treatment	240	0	-	RLH	CAGO flattened in nest		RLH flew over nest and called 2X
IB Treatment	300	5	64.2-95.7		No apparent response to aircraft activity		
IC Pre-treatment	222	0	-	BAEA	CAGO flattened in nest		
IC Treatment	296	4	67.2-83.5		No apparent response to aircraft activity		
ID Pre-treatment		0	-				Pair flushed from nest by helicopter; nest unattended for 960 sec.
ID Treatment	295	5	76.3-88.3	BAEA	CAGO at nest occasionally lifted head when BAEA in area, but mostly lay flat in nest; Male went to nest when 2 nd eagle entered area; 10 min. after an overflight, CAGO stood and rotated eggs; exposed for 30 sec.		Second BAEA arrived in area 25 min. after the first; presence of BAEA in area for 50 min., until arrival of helicopter
IE Pre-treatment	220	0	-	Red Fox	Female CAGO moved off at 2 m, male stayed for >135 min; when fox returned a second time, the female moved off sooner; eggs exposed a total of 1830 sec.		Fox stole eggs from nest on 2X in 25 min.; Nest was abandoned and empty when checked 3 days later, on 14.06
IE Treatment	285	4	85.5-97.7		No apparent response to aircraft activity		
IF Pre-treatment	217	0	-				
IF Treatment	303	4	93.4-94.7	BAEA	Male CAGO appeared near nest No apparent response to aircraft activity		
IIA Pre-treatment	215	0	-				
IIA Exp.	435	5	85.4-92.9	BAEA	CAGO laid head flat in nest when BAEA flew by; CAGO alert and/or lowered head during 2 jet overflights; looked towards noise when a C-130 passed over.		BAEA flew west of nest
IIB Pre-treatment	290	0	-	Silver Fox	Male CAGO chased away		Pair flushed by helicopter; nest unattended for 3120 sec.

Nest	Obs. (min.)	Noise Events	L1 (dB)	Natural Threats	Resultant Exposure / Response of CAGO		Comments
					<15 Minutes Post-stimulus	Other	
IIB Treatment	445	8	78.5-82.5	Herring Gull	CAGO female flattened in nest as gulls calling nearby and lifted head when calling ended; Gulls flew past nest on 2 other occasions and female flattened or showed no response; No response to aircraft		
IIC Pre-treatment	236	0	-				
IIC Treatment	421	6	54.2-90.9	CAGO	No apparent response to CAGO in area; Female crouched low in nest as C-130 passed over		One flock of 6, 3 min. later one other CAGO flew over nest
IID Pre-treatment	240	0	-	RLH	CAGO flattened in nest		RLH flew through area
IID Treatment	363	5	74.9-95.4	Herring Gull and an unknown stimulus	Female watched as gull flew over nest; <2min after aircraft passed, female stood and checked eggs; eggs exposed for 12 sec.	On 2X, female flattened with no apparent stimulus	
IIE Pre-treatment	240	0	-				
IIE Treatment	445	5	54.9-65.7	RLH, CAGO	No response to natural threats on either occasion; No apparent response to aircraft activity		
IIIA Pre-treatment	300	0	-	Herring Gull	No response		
IIIA Treatment	378	11	62.7-83.3	Common Raven	Female lowered head when raven passed by; No apparent response to aircraft activity		Raven flew 100m N of nest, calling
IIIB Pre-treatment	295	0	-	CAGO, Black Bear	No response from female CAGO to either stimulus		Geese in area for 100 min; Bear approached from N, driven off by helicopter

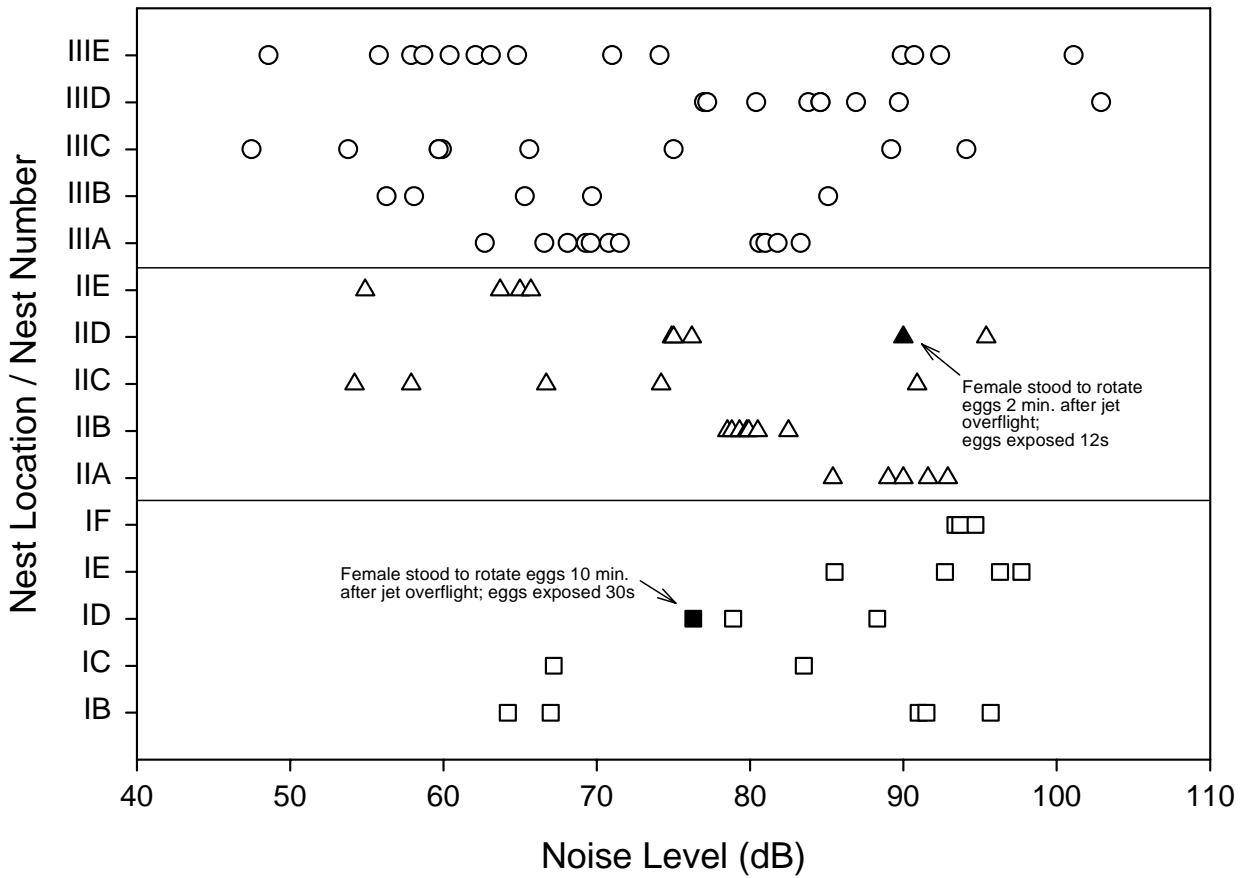
Nest	Obs. (min.)	Noise Events	L1 (dB)	Natural Threats	Resultant Exposure / Response of CAGO		Comments
					<15 Minutes Post-stimulus	Other	
IIIB Treatment	355	8	Ambient-85.1	CAGO, Red fox	Female CAGO appeared alert when other CAGO entered nest area; <i>Male came to nest as fox was 70-90 m away, female crouched low;</i> Male flew to nest 4 min. after aircraft event		Four other CAGO flew nearby
IIIC Pre-treatment	245	0	-	CAGO	No response when CAGO flew over; flock of 8 passed and female became alert, male began calling		Pair flushed from nest by helicopter; nest unattended for 2100 sec.; 2X other CAGO in nest area
IIIC Treatment	370	9	47.5-94.1	Gull sp., CAGO	Female CAGO lowered in nest and appeared alert when gull flew by; Male chased away intruding CAGO Female raised head during 5 and lowered head during 2 overflights, but displayed no reaction to 2 other aircraft overflights		Gull sp. Flew around nest 7 other CAGO in area
IIID Pre-treatment	215	0	-	RLH	CAGO flattened in nest when RLH flew nearby (<50m from nest)		
IIID Treatment	348	8	77.0-102.9	SEO	<i>CAGO lowered head in nest and/or flattened in the nest when SEO nearby;</i> Generally no reaction to aircraft overflights; during 2 overflights CAGO lowered head as aircraft passed		SEO flew S of nest, 1-hour later flew directly over nest
IIIE Pre-treatment	241	0	-	CAGO	No response to presence of CAGO		Pair flushed by helicopter; nest unattended for 1440 sec.; Flock of 7 CAGO flew over nest

Nest	Obs. (min.)	Noise Events	L1 (dB)	Natural Threats	Resultant Exposure / Response of CAGO		Comments
					<15 Minutes Post-stimulus	Other	
IIIE Treatment	343	14	48.6-101.1	RLH, Red fox	<p><i>No reaction during first RLH sighting, pair were calling during second sighting; CAGO pair motionless when fox in area;</i></p> <p>Generally no reaction when incubating; pair alert during overflights when initially disturbed by helicopter (and displaced from the nest) and either flew near the nest (<80m) or were observed head-bobbing</p>		Pair flushed by helicopter; nest unattended for 9540 sec.

Notes:

1. A minimum of five nests were located per study area; Nest IA was omitted from surveys.
2. Nesting areas are shown in Figure 1.
3. Natural Threats: RLH = Rough-legged Hawk, BAEA = Bald Eagle, CAGO = Canada Goose, SEO = Short-eared Owl.
4. Overflights include jet and other military aircraft. Noise levels for some aircraft events were not recorded.

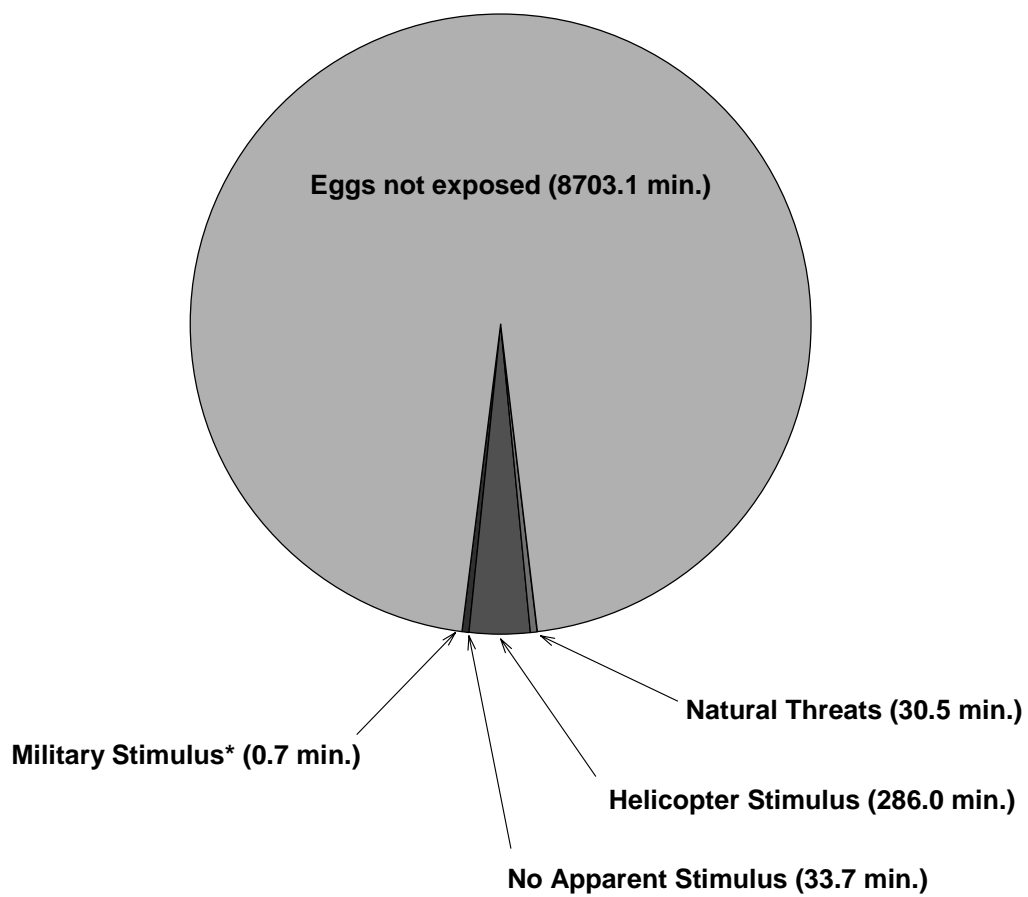
Figure 3 Military Aircraft L1 (dB) Events Recorded at Canada Goose Nest Sites, 11-16 June 2004



Notes:

1. Nest areas are shown in Figure 1.
2. Overflights include jet and other military aircraft. Noise levels for some aircraft events were not recorded.
3. Each point represents an individual noise event; Solid (bolded) objects indicate an apparent response by one or both adults.

Figure 4 Total Observations of 15 Canada Goose Nests in Terms of Egg Exposures



5.2 Natural Threats

Pairs of geese were on constant vigil for avian and mammalian predators. Predators and induced responses identified (Table 2; Appendix B) during nest monitoring included:

Canada Goose – were noted during seven (3 pre-treatment, 4 treatment) observation periods (Table 2). The adult(s) at the nest occasionally appeared alert, most notably when flocks of geese entered the nest area (Table 2). On one occasion, the male goose appeared to chase an intruding flock from the area. However, no adverse reactions were noted and the eggs remained protected by one or more adults at all times.

Gull sp. – were noted during four (1 pre-treatment, 3 treatment) observation periods (Table 2). Adult Canada geese were alerted by the presence of Gulls in the nest area. The female generally lowered her head and/or flattened in the nest, but did not leave the nest. On one occasion when the female was alerted, within seconds the male was seen chasing an intruding goose, suggesting that the geese may use the presence of gulls as indicator of other natural threats. No obvious adverse reactions were noted and the eggs remained protected by one or more adults at all times.

Short-eared Owl (*Asio flammeus*) – during the one experimental observation period when a Short-eared Owl flew near the nest, the female goose responded by lowering her head and/or flattening in the nest (Table 2). No response was elicited from the male.

Rough-legged Hawk (*Buteo lagopus*) – were noted during four pre-treatment observation periods (Table 2). The female generally lay flat in the nest when a hawk was sighted. On one occasion when male was present, the pair began calling after the intruder returned to the nest area a second time.

Bald Eagle (*Haliaeetus leucocephalus*) – were noted during four (1 pre-treatment, 3 treatment) observation periods (Table 2). The female generally lay flat in the nest when an eagle flew by and the male did not respond. However, when two eagles were present near the nest for 50 min. during one observation period, the male went to the nest, appearing after a long absence from the area.

Common Raven – During one experimental observation period, a raven flew by the nest (<100m) calling (Table 2). The female lowered her head in the nest, but did not appear startled.

Black Bear – A single black bear entered a nest territory on one occasion during pre-treatment observations (Table 2). Despite the presence of the bear and several other geese in the nest area, the female remained at the nest and no adverse reactions were noted. Note that the bear was downwind and moving in the direction of several Canada geese adjacent to the nest.

Red Fox (*Vulpes fulvus*) – Obvious reactions were noted when fox were present near a nest during four (2 pre-treatment, 2 treatment) observation periods (Table 2). At nest site IIIB, the female remained at the nest, but crouched low in the nest, when a fox entered the nest area. During another sighting (Nest site IIIE), the pair “sat motionless” at the nest when a fox was present. At another site (Nest site IIB), a silver fox was chased away by the male goose, while the female remained tight to the nest. The strongest reaction was noted at nest site IE. When this nest was predated by a red fox, the male goose (initially >100m from the nest) began honking, and the female expressed distress through elongation of the neck, standing in the nest, and flapping of wings. When the fox was <1m from the nest, the female abandoned the nest. The fox took one egg before retreating, and the female goose returned to the nest and settled within 30 seconds. Approximately 25 minutes later, the red fox returned, took another egg, and retreated. This time, the female joined the male on a wetland area approximately 30 m away and remained off the nest for >30 min. (1830 sec.) (Table 2). A subsequent check of the nest two days later on 14 June 2004, showed the nest was abandoned and empty. It is very likely that the red fox continued to predate the eggs.

Note that the 30.5 min. duration that eggs at this nest site were exposed was the only time throughout observations that eggs had been exposed due to a natural threat, and accounted for <1% of the total observation time (Figure 4).

5.3 Helicopter Effects

Despite attempts to distance landing areas as far as possible from a nest, approximately 20% of the pairs flushed due to the presence of the ‘hovering’ helicopter (during crew pickup or drop off). Generally, the female flushed from the nest during drop-off of field observers on the first day of observations, leaving the nest unattended for an average of 60 min. The most extreme case involved a pair displacing from nest IIIE for approximately 2h (9450 sec.) on the second observation day (Table 2), even though the helicopter had landed > 400m away. This pair had also been flushed from the nest the previous (pre-treatment) day, for 24 min. Resultant egg exposures from all helicopter disturbance events totaled 286 minutes (17,160 sec.), and accounted for the greatest percentage of time eggs were left unattended (Figure 4).

5.4 Unknown Stimuli

Periodically, the female would stand, shift position, occasionally rotating eggs, and settle again, usually facing in a different direction. On other occasions, the female stood in the nest as the male was calling nearby, in the absence of any apparent stimulus. Egg exposures resulting from such unknown stimuli totaled 33.7 min. (2019 sec.) (Figure 4).

5.5 Behavioural Observations

Both individuals of the pair defended the nest against terrestrial and avian predators. The female was often quite visible during incubation while the male patrolled the nest site at variable distances depending on habitat and nest density. Both birds tended to be secretive when near the nest site (Mowbray et al. 2002).

In this study, male Canada geese tended to remain some distance (>50m) from the incubating female unless there appeared to be a direct threat. Both members of the pair generally exhibited great caution when re-approaching the nest following a flushing event.

6.0 DISCUSSION

The level of nest attentiveness appears related to body size and small-bodied subspecies which store smaller reserves of energy, tend to take more incubation breaks than do larger-bodied subspecies (Mowbray et al. 2002) such as this *B.c. canadensis*, a large-bodied subspecies, nesting in Labrador. Previous studies of other large-bodied subspecies such as *B.c. moffitti* and *B.c. maxima*, recorded incubation breaks of 36 and 23 minutes/day, respectively, while smaller subspecies were off the nest for an average of 80 to 90 minutes/day (*B.c. minima* and *B.c. hutchinsii*) (Mowbray et al. 2002).

The results of this research have demonstrated high nest attentiveness by female Canada geese nesting in the study area. At two nest sites, during two different treatment observations, eggs were exposed when the female stood and rotated eggs 2 and 10 minutes following an aircraft overflight, which may or may not have been related to such activities. **Eggs were exposed during an overflight only when the pair had been initially been displaced from the nest due to helicopter disturbance.**

Several natural threats were identified during observations, the most important predator being red fox. When one of the study nests was predated by a red fox, both geese were displaced from the nest, leaving the nest unattended for >30 minutes. Geese at several other nests exhibited responses to avian predators, generally by stretching of the neck and flattening of the body and neck to the ground, however, the eggs remained protected at all times.

It is suggested that if a strong reaction to aircraft had been observed, the natural threats in evidence could have manifested in a more significant effect.

7.0 SUMMARY AND CONCLUSIONS

1. As a result of 88 aircraft (jet and C-130 transal) events, with noise levels (Lmax) ranging from ambient-97.5 dB; the only overt response (other than tucking head in nest or looking towards source of noise) was on two occasions when 2-10 minutes after an aircraft overflight, the nesting female stood in the nest to check/rotate eggs. These reactions may have been related to an aircraft event but it should be noted the same activity had been noted in the absence of aircraft events as well.
2. The greatest time spent off the nest (i.e. eggs exposed to predators/other) relate to a stimuli resulted from helicopter disturbance.
3. A variety of natural stimuli resulted in behavioral response, including avian species such as Gull sp., Bald Eagle and other Canada Goose but most pronounced was in association with mammalian predators (i.e. red or silver red fox).

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APPENDIX A

Sample Data Collection Sheet

APPENDIX B

**Data collected during Canada Goose monitoring program,
11-16 July 2004**

Appendix B. Data collected during Canada Goose monitoring program, 11-16 July 2004.

Nest	Date	Day	Total Time (min.)	# Noise Events	Time of Day	Lmax	# Adults	Egg exposure s (sec.)	Natural Threats	Observer	Comments
IB	12.06.04	Con.	240	0	1021	NA	1	0	0	PGT	start of session
IB	12.06.04	Con.	240	0	1137	NA	1	0	Rough-legged Hawk	PGT	Flew over nest & called twice, CAGO flattened
IB	12.06.04	Con.	240	0	1333	NA	1	3	0	PGT	Shifted position
IB	11.06.04	Exp.	300	5	938	NA	1	0	0	PGT	start of session
IB	11.06.04	Exp.	300	5	1400	64.2	1	0	0	PGT	Jet unknown direction
IB	11.06.04	Exp.	300	5	1408	67.0	1	0	0	PGT	Jet - SE, unknown distance NE, N wind
IB	11.06.04	Exp.	300	5	1341	91.0	1	0	0	PGT	Tornado - SE, 1.0 km S, N wind
IB	11.06.04	Exp.	300	5	1343	91.5	1	0	0	PGT	Tornado - S, 1.5 km S, N wind
IB	11.06.04	Exp.	300	5	1342	95.7	1	0	0	PGT	Tornado - SE, 0.25 km S, N wind
IB	11.06.04	Exp.	300	5	1307	NA	1	5	0	PGT	Shifted position
IB	11.06.04	Exp.	300	5	1320	NA	1	5	0	PGT	Shifted position
IC	12.06.04	Con.	222	0	1018	NA	1	0	0	SH	start of session
IC	12.06.04	Con.	222	0	1257	NA	1	0	Bald Eagle	SH	CAGO flattened
IC	12.06.04	Con.	222	0	1125	NA	1	5	0	SH	Shifted position
IC	12.06.04	Con.	222	0	1340	NA	1	10	0	SH	Rotating eggs
IC	11.06.04	Exp.	296	4	950	NA	1	0	0	SH	start of session
IC	11.06.04	Exp.	296	4	1406	67.2	1	0	0	SH	Jet unknown direction, N wind
IC	11.06.04	Exp.	296	4	1350	83.5	1	0	0	SH	Jet unknown direction, N wind
IC	11.06.04	Exp.	296	4	1403	Unknown	1	0	0	SH	Jet - SE, unknown distance, N wind
IC	11.06.04	Exp.	296	4	1407	Unknown	1	0	0	SH	Jet unknown direction, N wind
ID	11.06.04	Exp.	295	5	910	NA	1	0	0	KG	start of session
ID	11.06.04	Exp.	295	5	1346	76.3	1	0	0	KG	Follows 1345 above
ID	11.06.04	Exp.	295	5	1409	78.9	1	0	0	KG	Jet unknown direction
ID	11.06.04	Exp.	295	5	1401	88.3	1	0	0	KG	Jet unknown direction, N wind
ID	11.06.04	Exp.	295	5	1115	NA	1	5	0	KG	Rotating eggs
ID	11.06.04	Exp.	295	5	1207	NA	1	0	Bald Eagle	KG	Occasionally lifts head but mostly flat in nest
ID	11.06.04	Exp.	295	5	1232	NA	1	0	Bald Eagle	KG	2nd Eagle enters area
ID	11.06.04	Exp.	295	5	1238	NA	2	0	Bald Eagle	KG	Mate goes to the nest after 2nd eagle returns
ID	11.06.04	Exp.	295	5	1355	NA	1	30	0	KG	Related to overflights at 1345 /1346? Rotating eggs
ID	11.06.04	Exp.	295	5	1345	Unknown	1	0	0	KG	Jet - SE, unknown distance,

Nest	Date	Day	Total Time (min.)	# Noise Events	Time of Day	Lmax	# Adults	Egg exposures (sec.)	Natural Threats	Observer	Comments
											N wind
ID	11.06.04	Exp.	295	5	1408	Unknown	1	0	0	KG	Jet unknown direction, N wind
ID	12.06.04	Con.	256	0	1004	NA	1	960	0	KG	female flushed from nest by helicopter at start of session
ID	12.06.04	Con.	256	0	1020	NA	1	0	0	KG	female back on eggs
ID	12.06.04	Con.	256	0	1048	NA	1	5	0	KG	Shifted position
ID	12.06.04	Con.	256	0	1103	NA	1	5	0	KG	Shifted position
ID	12.06.04	Con.	256	0	1128	NA	1	5	0	KG	Shifted position
IE	12.06.04	Con.	220	0	1024	NA	1	0	0	KK	start of session
IE	12.06.04	Con.	220	0	1037	NA	1	10	unknown	KK	Mate was calling, female stood
IE	12.06.04	Con.	220	0	1135	NA	1	5	unknown	KK	Mate was calling, female stood
IE	12.06.04	Con.	220	0	1145	NA	2	30	Red Fox	KK	Fox stole egg, female moved off at 2 m, male stayed for >135 min
IE	12.06.04	Con.	220	0	1223	NA	2	1800	Red Fox	KK	Fox steals another egg, female moved off sooner
IE	12.06.04	Con.	220	0	1242	NA	0	see 1223	see 1223	KK	Pair moved off from nest 35 m
IE	12.06.04	Con.	220	0	1251	NA	2	see 1223	see 1223	KK	Female finally returns to nest
IE	11.06.04	Exp.	285	4	937	NA	1	0	0	KK	start of session
IE	11.06.04	Exp.	285	4	1407	85.5	1	0	0	KK	Jet unknown direction
IE	11.06.04	Exp.	285	4	1401	92.7	1	0	0	KK	Jet unknown direction
IE	11.06.04	Exp.	285	4	1405	96.3	1	0	0	KK	Jet unknown direction
IE	11.06.04	Exp.	285	4	1349	97.7	1	0	0	KK	Jet unknown direction
IF	12.06.04	Con.	217	0	1011	NA	1	0	0	TP	start of session
IF	12.06.04	Con.	217	0	1113	NA	2	0	0	TP	Male present for 67 minutes
IF	12.06.04	Con.	217	0	1134	NA	2	5	0	TP	Shifted position
IF	11.06.04	Exp.	303	4	903	NA	1	0	0	TP	start of session
IF	11.06.04	Exp.	303	4	1406	93.4	1	0	0	TP	Jet - W, N wind
IF	11.06.04	Exp.	303	4	1403	93.7	1	0	0	TP	Jet - W, N wind
IF	11.06.04	Exp.	303	4	1405	94.7	1	0	0	TP	Jet - W, N wind
IF	11.06.04	Exp.	303	4	1210	NA	2	0	Bald Eagle	TP	Male appeared and chased Eagle ??
IF	11.06.04	Exp.	303	4	1355	Unknown	1	0		TP	Jet - W, N wind
IIA	13.06.04	Con.	215	0	1030	NA	1	0	0	TP	start of session
IIA	13.06.04	Con.	215	0	1307	NA	1	2	0	TP	Shifted position
IIA	13.06.04	Con.	215	0	1405	NA	1	480	0	TP	No apparent stimulus
IIA	14.06.04	Exp.	435	5	900	NA	1	0	0	TP	start of session
IIA	14.06.04	Exp.	435	5	1044	85.4	1	0	0	TP	Jet directly overhead @ 1,000', Adult alert
IIA	14.06.04	Exp.	435	5	1156	89	1	0	0	TP	C-130/Transal not detectable
IIA	14.06.04	Exp.	435	5	1423	90	1	0	0	TP	Jet - SW, 250' agl

Nest	Date	Day	Total Time (min.)	# Noise Events	Time of Day	Lmax	# Adults	Egg exposure s (sec.)	Natural Threats	Observer	Comments
IIA	14.06.04	Exp.	435	5	1039	91.6	1	0	0	TP	Jet directly overhead @ 500', Adult lowered head
IIA	14.06.04	Exp.	435	5	1538	92.9	1	0	0	TP	C-130/Transal - N, 100' agl, female watched
IIA	14.06.04	Exp.	435	5	1054	NA	1	0	Bald Eagle	TP	Eagle flew west of nest, adult layed head flat
IIA	14.06.04	Exp.	435	5	1111	NA	1	120	0	TP	Adult repositioning, no stimulus?
IIA	14.06.04	Exp.	435	5	1218	NA	1	45	0	TP	Shifted position
IIA	14.06.04	Exp.	435	5	1222	NA	1	30	0	TP	Shifted position
IIA	14.06.04	Exp.	435	5	1229	NA	1	35	0	TP	Shifted position
IIA	14.06.04	Exp.	435	5	1321	NA	1	65	0	TP	Shifted position
IIA	14.06.04	Exp.	435	5	1455	NA	1	15	0	TP	Shifted position
IIA	14.06.04	Exp.	435	5	1555	NA	1	420	0	TP	Shifted position
IIA	14.06.04	Exp.	435	5	1604	NA	1	20	0	TP	Shifted position
IIB	13.06.04	Con.	290	0	940	NA	0	3120	0	KK	Pair flushed from nest by helicopter
IIB	13.06.04	Con.	290	0	1002	NA	0	see 0940	Silver Fox	KK	Male chased away
IIB	13.06.04	Con.	290	0	1115	NA	2	5	0	KK	Shifted position
IIB	13.06.04	Con.	290	0	1412	NA	1	5	0	KK	Shifted position
IIB	14.06.04	Exp.	445	8	1044	78.5	1	0	0	KK	Jet flying NE
IIB	14.06.04	Exp.	445	8	1013	78.8	1	0	0	KK	3 Jets visible, no response
IIB	14.06.04	Exp.	445	8	1115	79.3	1	0	0	KK	Unseen A/C
IIB	14.06.04	Exp.	445	8	1421	79.8	1	0	0	KK	Jet, no response
IIB	14.06.04	Exp.	445	8	1029	79.9	1	0	0	KK	Jet unseen, no response
IIB	14.06.04	Exp.	445	8	1038	80.5	1	0	0	KK	Jet to east, no response
IIB	14.06.04	Exp.	445	8	1537	82.5	1	0	0	KK	C-130, 300', 500 m E, no response
IIB	14.06.04	Exp.	445	8	850	NA	1	0	0	KK	start of session
IIB	14.06.04	Exp.	445	8	1046	NA	1	0	Herring Gull	KK	Female flattened as gulls calling nearby,
IIB	14.06.04	Exp.	445	8	1049	NA	1	0	Herring Gull	KK	Female lifts head as gulls stop calling
IIB	14.06.04	Exp.	445	8	1124	NA	1	3	0	KK	Shifted position
IIB	14.06.04	Exp.	445	8	1311	NA	1	0	Herring Gull	KK	Gull flew over nest, no response
IIB	14.06.04	Exp.	445	8	1343	NA	1	0	Herring Gull	KK	Gull calling, female lowered head
IIB	14.06.04	Exp.	445	8	1349	NA	2	10	0	KK	Male swims by, female shifts position
IIB	14.06.04	Exp.	445	8	1519	NA	1	5	0	KK	Shifted position
IIB	14.06.04	Exp.	445	8	1042	unknown	1	0	0	KK	2 jets to the N
IIC	13.06.04	Con.	236	0	1030	NA	1	0	0	SH	start of session
IIC	13.06.04	Con.	236	0	1120	NA	1	5	0	SH	Shifted position
IIC	13.06.04	Con.	236	0	1223	NA	1	5	0	SH	Shifted position
IIC	14.06.04	Exp.	431	6	1105	54.2	2	0	0	SH	Jet unseen, no response

Nest	Date	Day	Total Time (min.)	# Noise Events	Time of Day	Lmax	# Adults	Egg exposure s (sec.)	Natural Threats	Observer	Comments
IIC	14.06.04	Exp.	431	6	1043	57.9	2	0	0	SH	Jet unseen, no response
IIC	14.06.04	Exp.	431	6	1039	66.7	2	0	0	SH	Jet unseen, no response
IIC	14.06.04	Exp.	431	6	1423	74.2	2	0	0	SH	Jet in area, no response
IIC	14.06.04	Exp.	431	6	1539	90.9	1	0	0	SH	C-130 over nest, female crouched low
IIC	14.06.04	Exp.	431	6	900	NA	1	0	0	SH	start of session
IIC	14.06.04	Exp.	431	6	921	NA	1	0	Canada Goose	SH	6 geese, ,no response
IIC	14.06.04	Exp.	431	6	924	NA	1	0	Canada Goose	SH	1 goose flew over, no response
IIC	14.06.04	Exp.	431	6	951	NA	2	0	0	SH	Male nearby
IIC	14.06.04	Exp.	431	6	1011	NA	2	5	0	SH	Shifted position
IIC	14.06.04	Exp.	431	6	1030	NA	2	41	0	SH	Shifted position
IIC	14.06.04	Exp.	431	6	1102	NA	2	11	0	SH	Shifted position
IIC	14.06.04	Exp.	431	6	1227	NA	2	28	0	SH	Shifted position
IIC	14.06.04	Exp.	431	6	1333	NA	2	21	0	SH	Shifted position
IIC	14.06.04	Exp.	431	6	1404	NA	2	17	0	SH	Shifted position
IIC	14.06.04	Exp.	431	6	1501	NA	2	16	0	SH	Shifted position
IIC	14.06.04	Exp.	431	6	1514	NA	1	0	0	SH	Male moved off <150 m
IIC	14.06.04	Exp.	431	6	1031	Unknown	2	0	0	SH	Jet high, no response
IID	13.06.04	Con.	240	0	1031	NA	1	0	0	PGT	start of session
IID	13.06.04	Con.	240	0	1117	NA	2	0	0	PGT	Male flew in, saw me, circled for 10 sec and left
IID	13.06.04	Con.	240	0	1220	NA	1	5	0	PGT	Shifted position
IID	13.06.04	Con.	240	0	1255	NA	1	0	RLH	PGT	CAGO flattened
IID	13.06.04	Con.	240	0	1358	NA	1	5	0	PGT	Shifted position
IID	14.06.04	Exp.	363	5	1155	74.9	1	0	0	PGT	C-130 2 km distant, no response
IID	14.06.04	Exp.	363	5	1044	75	1	0	0	PGT	Jet at 1,300' overhead, no response
IID	14.06.04	Exp.	363	5	1538	76.2	1	0	0	PGT	C-130, female lowered head then raised
IID	14.06.04	Exp.	363	5	1421	90	1	0	0	PGT	Wind carried noise away from Tornado at 700', no response
IID	14.06.04	Exp.	363	5	1038	95.4	1	0	0	PGT	Jet at 1,000' overhead, no response
IID	14.06.04	Exp.	363	5	912	NA	1	0	0	PGT	start of session
IID	14.06.04	Exp.	363	5	936	NA	1	5	0	PGT	Shifted position
IID	14.06.04	Exp.	363	5	1000	NA	1	35	0	PGT	Shifted position
IID	14.06.04	Exp.	363	5	1107	NA	1	0	Herring Gull	PGT	Female watched gull fly over
IID	14.06.04	Exp.	363	5	1108	NA	1	25	0	PGT	Shifted position
IID	14.06.04	Exp.	363	5	1124	NA	1	150	0	PGT	Female stood, pulled feathers and lined nest
IID	14.06.04	Exp.	363	5	1132	NA	1	3	0	PGT	Shifted position
IID	14.06.04	Exp.	363	5	1139	NA	1	3	0	PGT	Shifted position

Nest	Date	Day	Total Time (min.)	# Noise Events	Time of Day	Lmax	# Adults	Egg exposures (sec.)	Natural Threats	Observer	Comments
IID	14.06.04	Exp.	363	5	1248	NA	1	18	0	PGT	Shifted position
IID	14.06.04	Exp.	363	5	1258	NA	1	5	0	PGT	Shifted position
IID	14.06.04	Exp.	363	5	1259	NA	1	80	0	PGT	Female stood, preened
IID	14.06.04	Exp.	363	5	1337	NA	1	0	Unknown	PGT	Female flattened >1 min
IID	14.06.04	Exp.	363	5	1423	NA	1	12	0	PGT	Female stood. checked eggs, related to A/C?
IID	14.06.04	Exp.	363	5	1515	NA	1	30	0	PGT	Shifted position
IID	14.06.04	Exp.	363	5	1534	NA	1	0	Unknown	PGT	Female flattened for >1 min
IID	14.06.04	Exp.	363	5	1540	NA	1	20	0	PGT	Shifted position
IID	14.06.04	Exp.	363	5	1555	NA	1	33	0	PGT	Shifted position
IID	14.06.04	Exp.	363	5	1557	NA	1	3	0	PGT	Shifted position
IIE	13.06.04	Con.	240	0	1000	NA	1	0	0	KG	start of session
IIE	13.06.04	Con.	240	0	NA	NA	NA	0	0	KG	No incidents to report,
IIE	14.06.04	Exp.	445		1048	54.9	1	0	0	KG	C-130 in distance
IIE	14.06.04	Exp.	445		1043	63.7	1	0	0	KG	Jet flying E, no response
IIE	14.06.04	Exp.	445		1422	65	1	0	0	KG	Jet unseen, no response
IIE	14.06.04	Exp.	445		1038	65.7	1	0	0	KG	Jet flying E, no response
IIE	14.06.04	Exp.	445		855	NA	1	0	0	KG	start of session
IIE	14.06.04	Exp.	445		952	NA	1	0	RLH	KG	Briefly in view, no response
IIE	14.06.04	Exp.	445		1012	NA	1	0	Canada Goose	KG	20 geese flew nearby, no response
IIE	14.06.04	Exp.	445		1442	NA	1	5	0	KG	Shifted position
IIE	14.06.04	Exp.	445		1537	Unknown	1	0	0	KG	Distant C-130, slightly above ambient
IIIA	15.06.04	Con.	300	0	1015	NA	1	0	0	KK	start of session
IIIA	15.06.04	Con.	300	0	1050	NA	1	0	Herring Gull	KK	Gull flew over nest, no response
IIIA	16.06.04	Exp.	378	11	925	62.7	1	0	0	KK	Jet in the north, no response
IIIA	16.06.04	Exp.	378	11	1037	66.6	1	0	0	KK	Jet flying N, no response
IIIA	16.06.04	Exp.	378	11	1010	68.1	1	0	0	KK	Jet flying N, no response
IIIA	16.06.04	Exp.	378	11	1000	69.3	1	0	0	KK	Jey flying NE to SE, no response
IIIA	16.06.04	Exp.	378	11	1024	69.6	1	0	0	KK	Jet flying N, no response
IIIA	16.06.04	Exp.	378	11	1036	70.8	1	0	0	KK	Jet flying N, no response
IIIA	16.06.04	Exp.	378	11	959	71.5	1	0	0	KK	Jet flying N, no response
IIIA	16.06.04	Exp.	378	11	1440	80.6	1	0	0	KK	Jet flying N, no response
IIIA	16.06.04	Exp.	378	11	920	81	1	0	0	KK	Jet unseen flying SE, no response
IIIA	16.06.04	Exp.	378	11	1425	81.8	1	0	0	KK	Jet flying N, no response
IIIA	16.06.04	Exp.	378	11	1443	83.3	1	0	0	KK	Jet flying N, no response
IIIA	16.06.04	Exp.	378	11	857	NA	1	0	0	KK	start of session
IIIA	16.06.04	Exp.	378	11	940	NA	1	0	Raven	KK	Flew over 100m N and calling, female lowered head

Nest	Date	Day	Total Time (min.)	# Noise Events	Time of Day	Lmax	# Adults	Egg exposures (sec.)	Natural Threats	Observer	Comments
IIIB	15.06.04	Con.	295	0	1035	NA	1	0	0	SH	start of session
IIIB	15.06.04	Con.	295	0	1040	NA	1	0	0	SH	Female lowered head as hel. Positions observers
IIIB	15.06.04	Con.	295	0	1226	NA	2	0	0	SH	Male nearby calling
IIIB	15.06.04	Con.	295	0	1238	NA	1	0	0	SH	Male moves off
IIIB	15.06.04	Con.	295	0	1246	NA	1	10	0	SH	Shifted position
IIIB	15.06.04	Con.	295	0	1340	NA	1	0	Canada Goose	SH	1-2 other geese flew over, no response from female
IIIB	15.06.04	Con.	295	0	1406	NA	1	0	Canada Goose	SH	4 geese flew in, landed at pond, no response
IIIB	15.06.04	Con.	295	0	1410	NA	1	0	Canada Goose	SH	1 more (total 5) flew in
IIIB	15.06.04	Con.	295	0	1418	NA	1	0	Canada Goose	SH	5 more (total 10 others) walk into area, female no response
IIIB	15.06.04	Con.	295	0	1432	NA	1	0	Canada Goose	SH	1 more (total 11 others) flew into area
IIIB	15.06.04	Con.	295	0	1442	NA	1	0	Canada Goose	SH	2 more (total of 13 others) flew into area
IIIB	15.06.04	Con.	295	0	1522	NA	1	0	Canada Goose	SH	8 geese swimming near nest, no response from female
IIIB	16.06.04	Exp.	355	8	921	56.3	1	0	0	SH	Jet unseen - no response
IIIB	16.06.04	Exp.	355	8	1319	58.1	1	0	0	SH	Jet unseen and distant, no response
IIIB	16.06.04	Exp.	355	8	1427	65.3	1	0	0	SH	Male gone, jet flew nearby - no relation?
IIIB	16.06.04	Exp.	355	8	1010	69.7	1	0	0	SH	Jet immediately over nest and downwind, no response
IIIB	16.06.04	Exp.	355	8	1034	85.1	1	0	0	SH	Jet nearby, no response
IIIB	16.06.04	Exp.	355	8	925	Ambient	1	0	0	SH	Jet unseen and distant, no response
IIIB	16.06.04	Exp.	355	8	1000	Ambient	1	0	0	SH	Jet unseen and distant, no response
IIIB	16.06.04	Exp.	355	8	1310	Ambient	1	0	0	SH	Jet unseen and distant, no response
IIIB	15.06.04	Con.	295	0	1530	NA	1	0	Black bear	SH	Bear approaching from N, driven off by chopper
IIIB	16.06.04	Exp.	355	8	905	NA	1	0	0	SH	start of session
IIIB	16.06.04	Exp.	355	8	1038	NA	2	0	0	SH	Male flew in about 4 min after jet, related?
IIIB	16.06.04	Exp.	355	8	1150	NA	1	0	0	SH	Male swam off
IIIB	16.06.04	Exp.	355	8	1247	NA	1	0	Canada Goose	SH	4 Geese flew nearby, female alert
IIIB	16.06.04	Exp.	355	8	1330	NA	1	20	0	SH	Shifted position
IIIB	16.06.04	Exp.	355	8	1345	NA	2	0	Red Fox	SH	Male came in to the nest as fox was 70-90 m away, female crouched low

Nest	Date	Day	Total Time (min.)	# Noise Events	Time of Day	Lmax	# Adults	Egg exposures (sec.)	Natural Threats	Observer	Comments
IIIB	16.06.04	Exp.	355	8	1430	NA	2	0	0	SH	Male appears
IIIC	15.06.04	Con.	245	0	1055	NA	0	2100	0	KG	Pr flushed by helicopter at start of session
IIIC	15.06.04	Con.	245	0	1124	NA	2	see 1055	0	KG	Pr. Returns to the nest
IIIC	15.06.04	Con.	245	0	1130	NA	2	0	0	KG	Female back on eggs since 1055
IIIC	15.06.04	Con.	245	0	1205	NA	1	0	0	KG	Male calling, moves off somewhat
IIIC	15.06.04	Con.	245	0	1315	NA	1	10	0	KG	Shifted position
IIIC	15.06.04	Con.	245	0	1355	NA	1	0	Canada Goose	KG	1 goose flew into area, no response
IIIC	15.06.04	Con.	245	0	1450	NA	1	0	Canada Goose	KG	7-8 geese flew by, female alert, mate calling
IIIC	16.06.04	Exp.	370	9	900	NA	1	0	0	KG	start of session
IIIC	16.06.04	Exp.	370	9	949	47.5	2	0	0	KG	Jet unseen, female raised head
IIIC	16.06.04	Exp.	370	9	925	53.8	2	0	0	KG	Jet unseen, female raised head, male spotted nearby
IIIC	16.06.04	Exp.	370	9	1001	59.7	2	0	0	KG	Jet unseen, female lowered head
IIIC	16.06.04	Exp.	370	9	1000	59.9	2	0	0	KG	Jet unseen, female raised head
IIIC	16.06.04	Exp.	370	9	1319	60	1	0	0	KG	Jet to the E, no reaction
IIIC	16.06.04	Exp.	370	9	919	65.6	1	0	0	KG	Helicopter caused female to lift head, jet caused it to be lowered
IIIC	16.06.04	Exp.	370	9	1309	75	1	0	0	KG	Jet flew low over area, female raised head
IIIC	16.06.04	Exp.	370	9	1010	89.2	2	0	0	KG	Jet at 100', female raised head
IIIC	16.06.04	Exp.	370	9	1035	94.1	1	0	0	KG	Jet close by, no reaction
IIIC	16.06.04	Exp.	370	8	1440	NA	1	0	0	SH	Male gone
IIIC	16.06.04	Exp.	370	9	1027	NA	1	0	0	KG	Male flew off
IIIC	16.06.04	Exp.	370	9	1144	NA	1	10	0	KG	Shifted position
IIIC	16.06.04	Exp.	370	9	1231	NA	1	0	Gull	KG	Flew around nest, female lowered in nest, appeared alert
IIIC	16.06.04	Exp.	370	9	1325	NA	2	0	0	KG	Male swam in near the nest
IIIC	16.06.04	Exp.	370	9	1328	NA	2	5	0	KG	Shifted position
IIIC	16.06.04	Exp.	370	9	1402	NA	2	5	0	KG	Shifted position
IIIC	16.06.04	Exp.	370	9	1430	NA	2	20	0	KG	Shifted position
IIIC	16.06.04	Exp.	370	9	1442	NA	1	0	Canada Goose	KG	Male chased 7 geese
IIID	15.06.04	Con.	215	0	1125	NA	1	0	0	TP	start of session
IIID	15.06.04	Con.	215	0	1231	NA	1	0	Rough-legged Hawk	TP	Hawk flew within 50 m, female flattened in nest

Nest	Date	Day	Total Time (min.)	# Noise Events	Time of Day	Lmax	# Adults	Egg exposures (sec.)	Natural Threats	Observer	Comments
IIID	16.06.04	Exp.	348	8	930	NA	1	0	0	TP	start of session
IIID	16.06.04	Exp.	348	8	1001	77	1	0	0	TP	Jet flew N, unseen - no reaction
IIID	16.06.04	Exp.	348	8	1002	77.2	1	0	0	TP	Jet flew N, unseen - no reaction
IIID	16.06.04	Exp.	348	8	1318	80.4	1	0	0	TP	Jet unseen to E, no response
IIID	16.06.04	Exp.	348	8	1310	83.8	1	0	0	TP	Jet flew S, female lowered head
IIID	16.06.04	Exp.	348	8	1325	84.6	1	0	0	TP	Jet unseen to E, no response
IIID	16.06.04	Exp.	348	8	1350	84.6	1	0	0	TP	Jet unseen to E, no response
IIID	16.06.04	Exp.	348	8	1011	86.9	1	0	0	TP	Jet flew N, 100' agl - female lowered head
IIID	16.06.04	Exp.	348	8	1036	89.7	1	0	0	TP	Jet flew N, immediately west of nest 100' agl - female lowered head
IIID	16.06.04	Exp.	348	8	1423	102.9	1	0	0	TP	Jet N of nest, unseen - no response
IIID	16.06.04	Exp.	348	8	935	NA	1	0	Short-eared Owl	TP	Flew S of nest, female lowered head
IIID	16.06.04	Exp.	348	8	1034	NA	1	0	Short-eared Owl	TP	Flew over nest, female flattened
IIID	16.06.04	Exp.	348	8	1400	NA	1	27	0	TP	Shifted position
IIIE	15.06.04	Con.	241	0	1114	NA	0	1440		PGT	Pr flushed by helicopter at start of session
IIIE	15.06.04	Con.	241	0	1133	NA	1	see 1114	0	PGT	Female near nest
IIIE	15.05.04	Con.	241	0	1138	NA	2	0	0	PGT	Female back on eggs, male near nest
IIIE	15.06.04	Con.	241	0	1346	NA	2	0	Canada Goose	PGT	7 Geese flew over nest, no response
IIIE	15.06.04	Con.	241	0	1407	NA	2	5	0	PGT	Shifted position
IIIE	16.06.04	Exp.	343	14	912	NA	0	9540	0	PGT	Pr flushed by helicopter at 0912 at start of session
IIIE	16.06.04	Exp.	343	14	1325	48.6	2	0	0	PGT	Jet distant, no response
IIIE	16.06.04	Exp.	343	14	1055	55.8	1	see 0920	0	PGT	Transport plane or other prop. High overhead
IIIE	16.06.04	Exp.	343	14	925	57.9	0	see 0920	0	PGT	Pr flew to within 80 m of the nest as jet passed over at 1,000'
IIIE	16.06.04	Exp.	343	14	1337	58.7	2	0	0	PGT	Jet distant, no response
IIIE	16.06.04	Exp.	343	14	1340	60.4	1	0	0	PGT	Male flew off after jet flew over
IIIE	16.06.04	Exp.	343	14	1317	62.1	2	0	0	PGT	Jet flying S, no response
IIIE	16.06.04	Exp.	343	14	920	63.1	0	see	0	PGT	Pr flushed by helicopter at

Nest	Date	Day	Total Time (min.)	# Noise Events	Time of Day	Lmax	# Adults	Egg exposures (sec.)	Natural Threats	Observer	Comments
								comment s			0912, jet at 1,000'
IIIE	16.06.04	Exp.	343	14	1000	64.8	0	see 0920	0	PGT	Pr at 60 m from nest, remained alert as jet flew nearby
IIIE	16.06.04	Exp.	343	14	1002	71	0	see 0920	0	PGT	One alert the other preened as jet flew over
IIIE	16.06.04	Exp.	343	14	1425	74.1	1	0	0	PGT	Jet flew N, no response
IIIE	16.06.04	Exp.	343	14	1442	89.9	1	0	0	PGT	Jet distant, no response
IIIE	16.06.04	Exp.	343	14	1308	90.7	2	0	0	PGT	Jet flying S, no response
IIIE	16.06.04	Exp.	343	14	1037	92.4	0	see 0920	0	PGT	Pr bobbed heads as jet flew over
IIIE	16.06.04	Exp.	343	14	1011	101.1	0	see 0920	0	PGT	One alert the other lowered head as jet flew immediately overhead
IIIE	16.06.04	Exp.	343	14	1015	NA	0	see 0920	Rough-legged Hawk	PGT	No obvious reaction as Hawk flew over
IIIE	16.06.04	Exp.	343	14	1047	NA	1	see 0920	0	PGT	Ad finally within 20 m of the nest
IIIE	16.06.04	Exp.	343	14	1048	NA	1	see 0920	Rough-legged Hawk	PGT	Pr calling as hawk flew at 300'
IIIE	16.06.04	Exp.	343	14	1103	NA	0	see 0920	0	PGT	Pr moved off to >40 m
IIIE	16.06.04	Exp.	343	14	1110	NA	1	see 0920	0	PGT	ad within 5 m of nest
IIIE	16.06.04	Exp.	343	14	1124	NA	1	see 0920	Red Fox	PGT	Fox 300 m away, pr motionless
IIIE	16.06.04	Exp.	343	14	1145	NA	2	see 0920	0	PGT	Pr near nest
IIIE	16.06.04	Exp.	343	14	1150	NA	2	0	0	PGT	Female finally on nest after 159 min
IIIE	16.06.04	Exp.	343	14	1415	NA	1	5	0	PGT	Shifted position