



MINASKUAT LIMITED PARTNERSHIP

**FIELD TESTING OF NESTMONITORS™
BALD EAGLE AND OSPREY COMPONENT –
FINAL REPORT**

MIN0287
2007



FINAL REPORT NO. MIN0287

REPORT TO **Institute for Environmental Monitoring and Research**

ON **Field Testing of NestMonitors™
Bald Eagle and Osprey Component**

July 26, 2007

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1.0 INTRODUCTION

Environmental Effects Monitoring (EEM) related to low-level sub-sonic military aircraft training activities at 5 Wing Goose Bay, Labrador, has addressed a variety of issues dealing with several species of avifauna. With support from the Department of National Defence (DND) and the Institute for Environmental Monitoring and Research (IEMR), parameters of interest were selected according to their ability to be measured objectively and based on the biological significance of the effect being measured. Typically, behavioural monitoring studies were designed to investigate whether aircraft events influenced either A) incubation (or brooding), with eggs (or nestlings) exposed to ambient temperatures, or B) the nest site to be temporarily undefended. Observers have used Sound Level Meters (SLMs) located at the blind (i.e., some distance from the nest) and the noise energy dosage at the nest was subsequently calibrated/estimated. Recently, however, TenXsys Inc., in consultation with the IEMR, has developed an egg-shaped NestMonitor™ device, suitable for placement in birds' nests for monitoring purposes (see <http://www.tenxsys.com/nestmonitor.htm>). This device was designed to help researchers determine if and for how long an adult remains off a nest following a disturbance, using changes in ambient temperature as an indicator. With this device, parameters of interest (e.g., ambient temperature and noise exposure) can be measured directly from the nest and accuracy verified by field observations.

In November 2005, IEMR requested that Minaskuat Limited Partnership (Minaskuat) submit a protocol for the field-testing of the NestMonitors™ for the 2006 field season, focused on Canada Geese (*Branta canadensis*), Bald Eagle (*Haliaeetus leucocephalus*) and Osprey (*Pandion Haliaeetus*). This report presents the results of the Osprey and Bald Eagle study component.

2.0 BACKGROUND

In 2005, ten monitors with different shells of a size and color comparable to either a Bald Eagle and/or an Osprey (five of each species) were ordered through TenXsys. The shells were designed for interchangeability depending on the availability of either species. The NestMonitor™ size, color and texture were based on information summarized in Poole et al. (2002) and Buehler (2000) for Osprey and Bald Eagle, respectively.

Table 1 Osprey and Bald Eagle Egg Characteristics Used to Develop NestMonitors™

Characteristic	Osprey	Bald Eagle
Length	59.5 ± 2.46 mm ¹	67.38 + 0.14 x Latitude (~54° for the Study Area) = 74.94 mm ²
Width	45.0 ± 1.3 mm ¹	53.09 + 0.07 x Longitude (~63°) = 57.5 mm ²
Description ³	Ground color, creamy white to pinkish cinnamon; usually heavily wreathed and spotted with reddish browns, especially at larger end.	Dull white with no markings.

Notes:

1. Based on eggs sampled in New Jersey; Note, Harrison (1978) stated 61 x 46 mm.
2. ** Harrison (1978) provided a generic size of 71 x 54 mm across the range for this species.
3. Egg size is ultimately determined by the volume required to accommodate internal logging devices and batteries.

The devices developed for this study were capable of measuring noise (dB) levels and nest temperature (at the surface of the 'egg'). Each device was equipped with a VHF signal (to facilitate relocation should the nest be raided by a predator). Specifically, the TenXsys NestMonitor™ features the following:

- Ambient sound level and waveform recording;
- Temperature at surface of the egg;
- VHF beacon;
- Data storage SD card;
- Noise event capture capability;
- Temperature change capture capability;
- Battery powered: Operational life of 4 weeks;

- Real time clock for accurate duty cycling and data collection; and
- Software to allow viewing of data and data storage for data analysis.

2.1 Night Monitoring

Night flying exercises [e.g., Exercise Night Strike 2007 (see <http://www.night-strike.net/exercisenightstrike.asp>)] have been proposed as a future training option at 5 Wing Goose Bay. In anticipation of such activities, this EEM study [and others, e.g., Golden Eagle (Minaskuat 2006a)] was designed to include night observations. Two Bushnell Prowler Night Vision Monoculars (model 26-4050) were purchased with the following specifications:

- Magnification: 4x
- Objective lens: 50 mm
- Range of built-in infrared illuminator: 100 yards
- Viewing range (range at which a human figure can be recognized): 5-700 feet / 1.5-213 meters
- Field of view: 70 ft. at 100 yards
- Operating time: up to 20 hours
- Temperature range: -30°C to +40°C

The Bushnell Prowler is known as a 'Generation 1 Unit' which works by amplifying existing light several thousand times to produce an image that can be seen in the dark.

3.0 STUDY OBJECTIVES

As this technology is highly experimental, it was proposed to test the NestMonitors™ in combination with visual observations (i.e., with an observer present at the nest throughout the monitoring period). The goal was to locate five active Bald Eagle and/or Osprey nests in the Churchill Falls area that were accessible from the ground and provided suitable helicopter/boat landing and observer vantage points. While a stimulus was not directly introduced in this study, exposure to helicopter disturbance during pick-up and drop-off of field crew may have resulted in egg exposures at some or all nests (Minaskuat 2004, 2005a and 2005b), allowing for field testing of noise capture capabilities and resultant temperature changes of the NestMonitor.

Specifically, the primary objectives of the proposed 2006 monitoring program were:

- to measure noise dosage and temperature at the nest during incubation;
- to observe the behaviour of nesting Osprey and/or Bald Eagle in response to the NestMonitor™;
- to determine whether a response to a disturbance (e.g., flushing) can be detected by the NestMonitors™, using field observations to measure accuracy;
- to examine the effectiveness of NestMonitors™ in future EEM studies involving avifauna in Labrador;
- to document Osprey and/or Bald Eagle behaviour at a nest during the night.

4.0 METHODS

Prior to the start of the field program, a permit was obtained from the Department of Wildlife and Conservation, Wildlife Division, and the Canadian Wildlife Service (CWS), Environment Canada.

4.1 Study Team

Mr. Perry Trimper was the project manager for this study and was responsible for project management and quality control. Behavioural observations were carried out by two-person field teams comprising aboriginal and non-aboriginal staff that included Mr. Trimper, Ms. Mary Ann Aylward (Innu), Ms. Caroline Hong, Mr. Corey Cooney (Inuit), Mr. Donald Blake (Innu), Mr. Chris Gregoire (Innu), Mr. Gary Gregoire (Innu) and Mr. Max Pone (Innu) of Minaskuat, Mr. Geoff Goodyear (also serving as helicopter pilot) and Ms. Alison Goodyear (volunteer). Ms. Lisa Stepnuk completed the temperature monitoring experiments in 2007. Ms. Hong provided technical support for the deployment and downloading of data from the NestMonitors™, as well as coordinated logistical support for the field program. Data analyses and report writing were the responsibility of Ms. Karen Rashleigh, Ms. Lisa Stepnuk and Ms. Jennifer Mitchell (Inuit) with technical review and other support provided by Mr. Trimper. In addition, Minaskuat worked closely with staff at TenXsys (e.g., Frank Risky and Curt Rideout) throughout the planning and preparation stages of this program.

4.2 Nest Location and NestMonitor™ Deployment

On 6 June 2006, the Study Team completed an aerial inventory of known Bald Eagle and Osprey nests in the Study Area – located in an area of the military air range known as CYA 731 (JWEL 1999, 2000 and Minaskuat 2005a and 2005b). While generally lacking in suitable trees for supporting large raptor nests, the area is known to have several nest sites established on rock outcrops or islands (Minaskuat 2005a and 2005b). Nest sites visited were recorded using GPS and on 1:50,000 topographic map sheets. NestMonitors, pre-programmed to record data every second and/or in response to a noise stimuli established at 80 dB, were subsequently deployed at suitable nest sites (i.e., with a vantage of 50-150 m and accessible by helicopter at >500 m). Thereafter, access to the nests was provided by canoe or on foot. At each location, the helicopter landed distant from the nest (>100 m) to minimize disturbance to the nesting birds.

NestMonitors™ were positioned in four active Bald Eagle nests and one active Osprey nest in the vicinity of the Smallwood Reservoir (Appendix A). One Bald Eagle nest site was empty (i.e., no eggs) during the initial survey, but was presumed to be active based on the aggressive nature of the adults present. Note that young were found in two other Bald Eagle nest sites (not used in this investigation) visited on 6 June. These young were estimated to be approximately two to three days to one week old.

4.3 NestMonitoring

Consistent with Corporate procedures dealing with Health & Safety, all field staff were presented with the Project's Safety Checklist and participated in 'Tool box' meetings prior to departing for the field. Following several weather delays, observations commenced on 17-18 June 2006, with a two-person team designated for each of the five nest sites (10 observers in total). Upon arrival on 17 June however, two of the five nests were found empty/abandoned. Given the great distance back to Goose Bay, the extra Study Team members deployed (doubled (or tripled)) at the three active sites. Each team was equipped with a tri-pod mounted video camera, binoculars or spotting scope (including night vision capabilities), required safety and camping equipment, and customized data sheets.

Observations commenced as each team arrived on site and prepared their blind and supporting camp between 1500–1800 hrs and continued the next morning until 0900 hrs. Rain through the night precluded effective monitoring from approximately 2300 hrs until 0430 hrs the next morning. In terms of behavioural parameters under investigation, priority was given to recording the time (in seconds) when incubation was not occurring (i.e., eggs were exposed) and when the nest may be unprotected by an adult. Nests were considered protected when one or both adults were in the field of view of the observer and, though somewhat subjective, appeared vigilant. Secondary behaviours such as alarm calls or other startle response by the incubating adults were also recorded. Although the focus was the adult at the nest (believed to be female for the majority of observations), behaviour such as the number and duration of visits to the nest by the male, was also recorded.

Information on any random/unscheduled aircraft activities in the vicinity of a nest during the observation period was recorded.

4.4 NestMonitor™ Testing

The NestMonitors™ were also evaluated for their ability to accurately measure temperature at the surface of these devices in May 2007. Ultimately, this insight would determine the ability of the devices to describe the ambient temperature in the nest bowl.

The apparatus was organized externally (i.e., outside) allowing the natural daily temperatures to control the lower limits of the temperature range. Days with precipitation and/or extreme wind were avoided. Three individual NestMonitors™ for each of the three species under consideration in 2006 (Bald Eagle, Osprey, and Canada Goose) were placed upon assembled materials similar to that used by each species (i.e. organic material such as moss in a bowl, small sticks/moss in a shallower bowl, and down respectively) simulating the nest materials for each of these species. An electric blanket (as a heat source similar to that of an incubating adult) was applied over the 'nests' and NestMonitors™. This was set at the typical incubation temperature (for each species) and thus used to control the upper limits of the temperature range (Huggins 1941, Webb 1987). Two digital thermometers were placed in each nest to record the ambient nest temperature.

On Day 1, three trials of two hours each were conducted with the heat source remaining on the NestMonitors (i.e., consistent with an attentive adult with no recesses).

On Day 2, the three, two-hour trials involved two 'recesses' of 15 minutes and 60 minutes, by removing the heat source at the same instant.

Temperature measurements from the digital thermometers were randomly (Zar 1974) recorded at 15 intervals (over the 120 minutes of each trial). Corresponding temperatures as measured by the NestMonitor™ Subject sensors (i.e., the "core" sensor) for these randomly identified intervals were downloaded as data from the SD cards. The data sets were compared using a two-tailed, paired t-test to determine if the differences between the temperatures recorded by the NestMonitor™ and the digital thermometers were significant. The data were also plotted as temperature over time as a visual comparison of the temperature changes.

5.0 RESULTS

5.1 Behavioural Observations

Five nests were identified during the initial deployment of the NestMonitors™. Upon arrival to commence observations, only three nests (all Bald Eagle) were found to be active. The three active nests were observed over a two-day (one overnight) period. As a result of fading daylight and rainfall, the overnight observations ceased at approximately 2300 hrs. At that point, it was difficult to discern movement and whether the female was incubating or brooding.

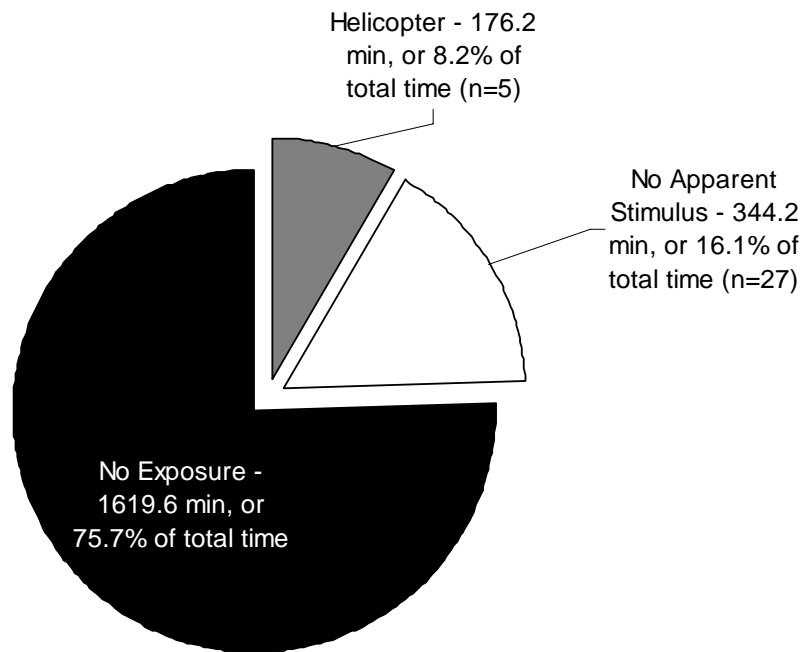
5.1.1 Nest Attentiveness

In the absence of apparent stimuli, one or both Bald Eagle adults were generally present at the nest throughout 2,140 combined minutes of observation time. For 75.7% of the total observation time the female remained at the nest, incubating eggs or brooding young. Throughout observations, eggs were exposed a total of 520.4 minutes (or 24.3 % of the total observation time). Egg exposures were generally unprovoked (i.e., no apparent stimulus). Such egg exposures accounted for 16.1 % of the total observation time (344.2 minutes). This included situations when the female would periodically stand and shift position, occasionally rotating eggs. The remaining egg exposure time, 8.2% or 176.2 min, was attributed to helicopter activity.

5.1.2 Aircraft (Helicopter) Effects

Aside from the drop-off and pick-up of observers, no other scheduled or unscheduled aircraft events occurred. There were five egg exposures attributed to helicopter presence. In four of the five exposures, the adult departed the nest and returned within a maximum time of 439 seconds (7.32 minutes). In the fifth exposure, the adult stood on the edge of the nest, preening and observing for an extended period of time – 9,332 seconds or 155.5 minutes. As illustrated in Figure 1, egg exposures resulting from helicopter stimuli accounted for 8.2% of the total observation time and 33.9% of the total egg exposure time.

Figure 1 Nest Attendance of Bald Eagles During 2006 Observations



5.1.3 Natural Threats

Upon the conclusion of the field program, only three (3) NestMonitors™ were recovered from the nests (Table 5.2). A Herring Gull (*Larus argentatus*) was observed at Nest 1 (Bald Eagle) on the day of retrieval and only the NestMonitor™ was observed in the nest. Nest 2 (Bald Eagle) was found abandoned by the adults. One egg plus the NestMonitor™ was observed in the nest, however upon return in the afternoon no eggs were observed in the nest and evidence existed that the Bald Eagle egg had been broken on a rock. In addition, four Herring Gulls were observed in the area of Nest 2. Nest 3 (Bald Eagle) and 4 (Osprey) were found empty prior to the end of the field program. Nest 5 (Bald Eagle) was found empty except for the components of the NestMonitor and the jawbone of a Northern Pike. Notably, although no egg exposure time was logged as a result of natural threats, seven potential stimuli classified as natural threat occurrences were observed. In three of those occurrences – all at Nest 5 - gulls were observed flying by, however the Bald Eagle exhibited no reaction. A similar event occurred at Nest 1, except that the gulls were exhibiting aggressive behaviour, although the Bald Eagle demonstrated no overt reaction.

Table 2 Status of Bald Eagle and Osprey Nests, 6 June – 25 June 2006

	Status 6 June	Status 17 June	Status 25 June
Nest 1 Bald Eagle	Active – Two eggs in nest. NestMonitor™ deployed approx. 1310h.	Active – 1 egg + NestMonitor™ in nest	Herring Gull on nest when approached. Retrieved NestMonitor™ from nest @ ~1415h. No other eggs in nest.
Nest 2 Bald Eagle	Active – One egg in nest. NestMonitor™ deployed approx. 1430h.	Active	Nest abandoned – One egg + device remaining in nest when initially checked. Both missing when rechecked later in afternoon. Egg appears to have been broken on nearby rock. NestMonitor not located; possibly predated by herring gulls (n=4) that were observed in area.
Nest 3 Bald Eagle	Considered Active – two adults in area acting aggressive, no eggs in nest; NestMonitor™ deployed approx. 1530h.	Empty – Retrieved NestMonitor™	---
Nest 4 Osprey	Active – Two eggs in nest. NestMonitor™ deployed approx. 1620h.	Empty – Predated and abandoned. NestMonitor™ not located.	---
Nest 5 Bald Eagle	Active – Two eggs in nest. NestMonitor™ deployed approx. 1715h.	Active – Observations began at 1515h. >1 young in nest.	Empty – NestMonitor™ components identified in nest. Returned on 26 June to retrieve components (including SD card and data). Jaw bone of Northern Pike found in nest.

5.1.4 Observer Effects

Bald Eagles monitored during this Program seemed aware but tolerant of the presence of observers and under no circumstances was the presence of an observer believed to result in the failure of the nest. There were however, two occasions when egg exposure was attributed to the presence of a helicopter that had occurred within 15 minutes of arriving or departing. In situations where the helicopter event was a drop-off, the presence of the observer after the departure of the helicopter may have also played a role in the adult remaining away from the nest.

5.1.5 Timing of Nesting/Nest Status

The advance of Spring was considered by the Study Team to be early in 2006, approximately one week later than in 2005.

5.2 NestMonitors™

NestMonitors™ were readily accepted by the females, as indicated from their presence back on the nest, incubating eggs, during subsequent observations. As well, for 75.7% of the total observation time the eggs were not exposed. Additionally, egg temperature data (Section 5.2.1) suggest that females returned to the nest shortly after the NestMonitors™ were placed in the nest.

NestMonitors™ were recovered from three (Bald Eagle) nests only; Nest 1, Nest 3 and Nest 5 (see Table 3 below).

Table 3 Data Available from NestMonitors

Nest	NestMonitor™ Status	NestMonitor™ Data	Observer Data
Nest 1	Retrieved 25 June	6 – 25 June – Available	17 June – Available 18 June – Available 25 June – Available
Nest 2	NestMonitor™ not located	---	17 June – Available 18 June – Available 25 June – Available
Nest 3	Retrieved 17 June	6 – 17 June – Available	---
Nest 4	NestMonitor™ not located	---	---
Nest 5	Retrieved 26 June	6 – 25 June – Available	17 June – Available 18 June – Available 25 June – Available

5.2.1 Temperature Data

Temperature data recorded included:

- Subject temperature – recorded from the egg core. The subject temperature thermister is a highly accurate biomedical sensor, designed to operate over animal temperatures only.
- Ambient temperature – recorded from the egg surface (i.e., exposed to outside air).

The NestMonitors™ were able to record temperatures with a high degree of sensitivity. Figure 2 provides an example of this sensitivity, showing how temperatures increased from the time a NestMonitor™ was activated/deployed until the female returned and continued incubating.

Figure 2 Subject and Ambient Temperatures Recorded by the NestMonitor™ at Bald Eagle Nest 1 During Deployment on 6 June 2006

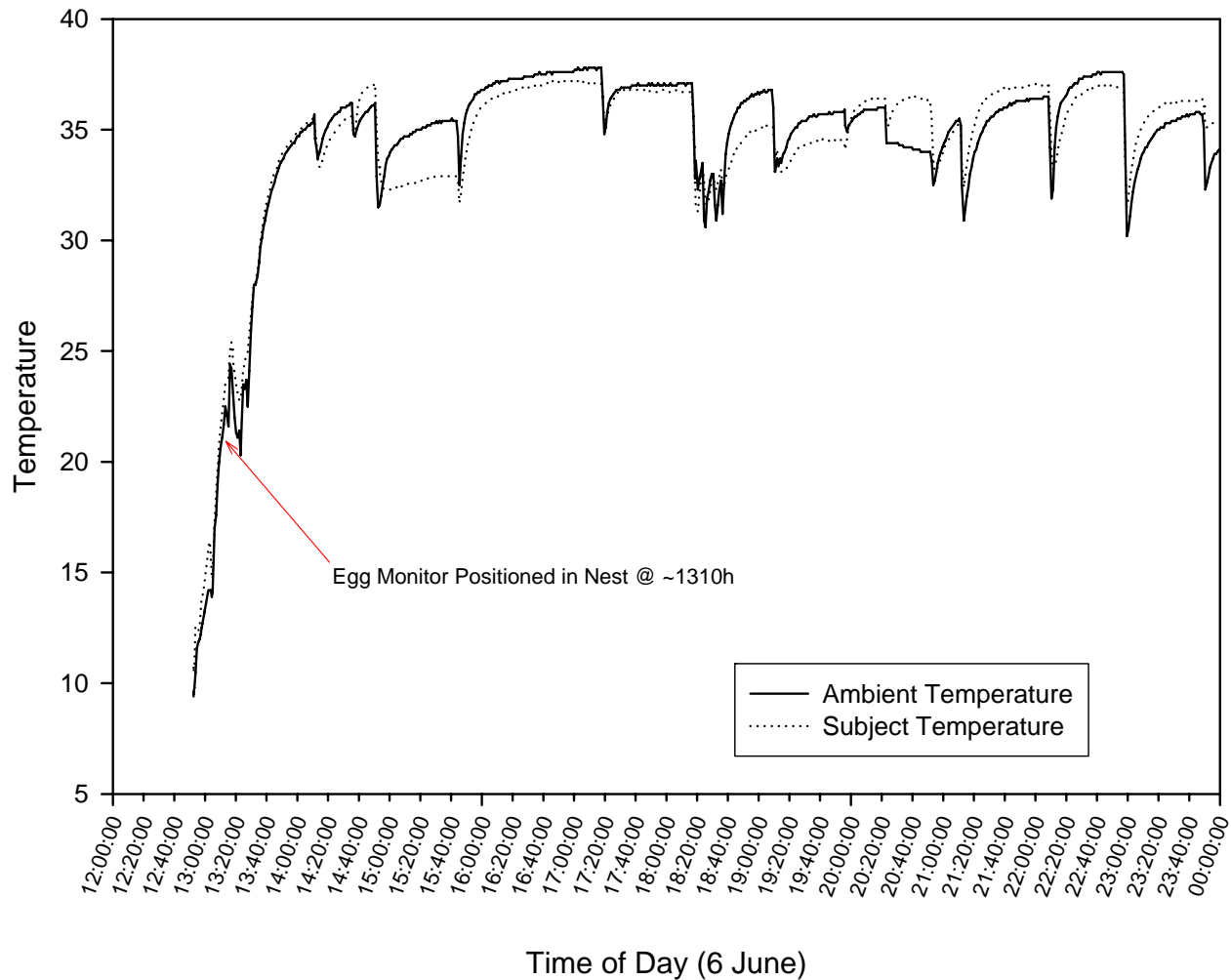
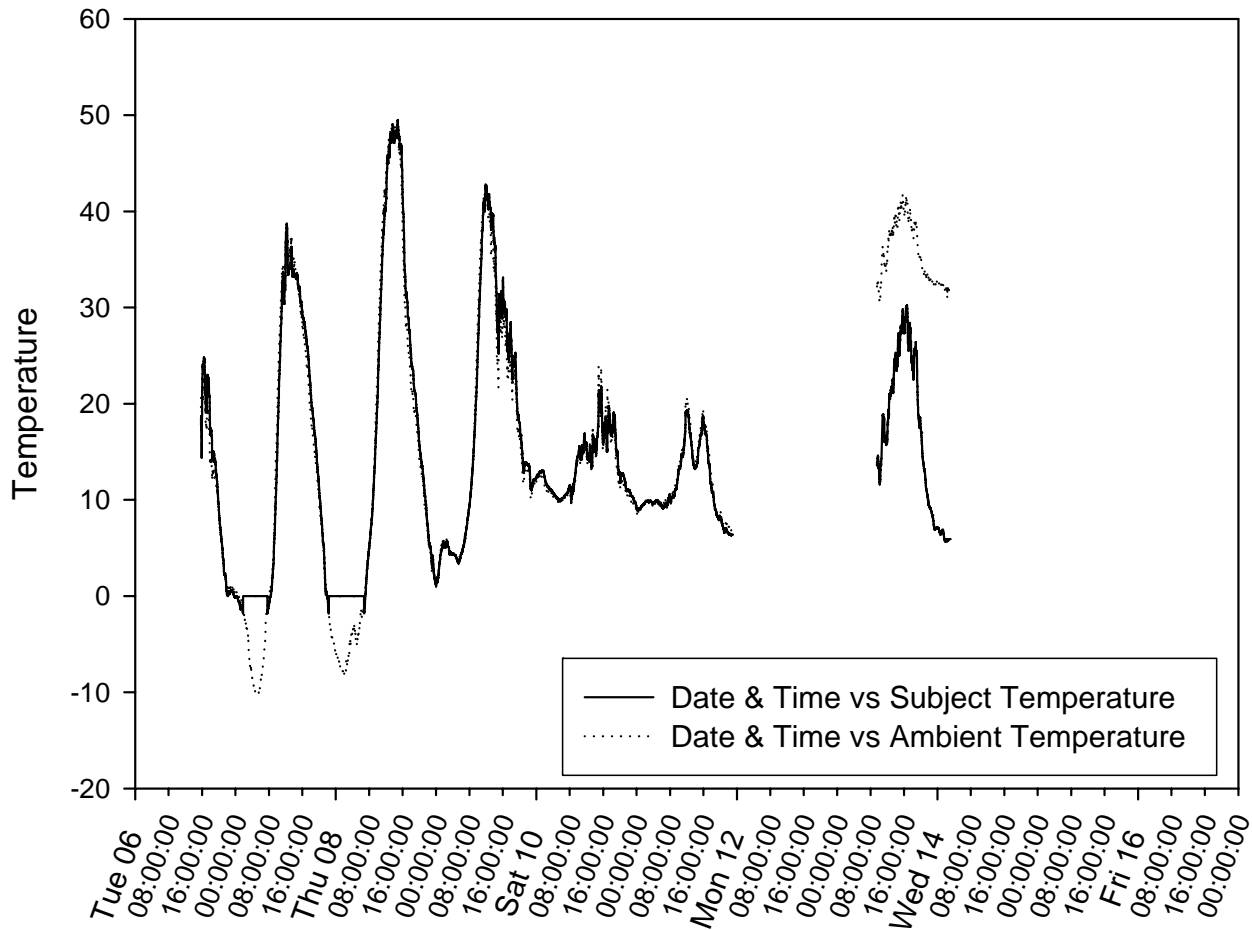


Figure 3 illustrates subject and ambient temperatures recorded by the NestMonitor™ at Bald Eagle Nest 3 throughout the duration of deployment. Note that this nest, upon initial deployment did not contain any eggs, however it was believed to be active based on the observation of adults within the area. When observers returned to begin the overnight observation period, the nest was found to be abandoned. The NestMonitor™ was retrieved and upon analysis of data it was determined that the monitor recorded weather data in the absence of Bald Eagles or eggs. The spikes in the graph show the rise in temperature during the day, while the drop in temperature during overnight period is also illustrated. Note that data from 11 June 2006 at 22:51:48 to 13 June 09:31:25 was determined to be corrupt because of extreme out of range values.

Figure 3 Subject and Ambient Temperatures Recorded by the NestMonitor™ at Bald Eagle Nest 3, 06 – 16 June 2006

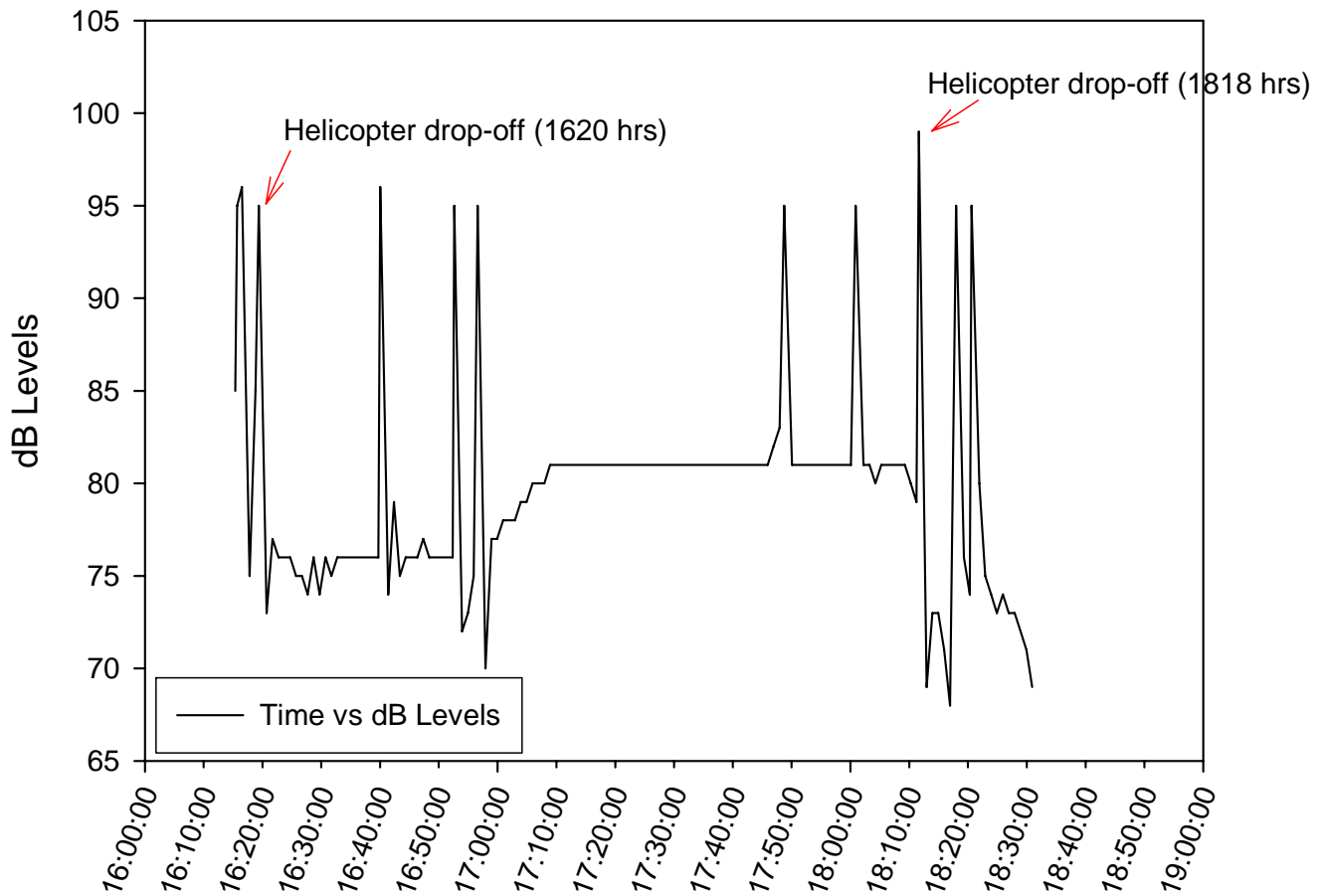


5.2.2 Noise Data

Noise data (decibel levels) were collected from the surface of the monitors (adjacent to the ambient temperature thermister) every 60 seconds. In addition, sounds greater than or equal to 95 dB triggered a 10 second audio recording, with information transferred to a data storage card.

NestMonitors™ were sensitive to proximate surrounding noise and frequently recognized such events as comfort movements by the adult or calls by the adult and later the young. Decibel levels recorded within the nest were typically greater than or equal to 80 dB (minimum > 60 dB, maximum 101 dB).

Figure 4 Audio (dB) Levels Recorded by the NestMonitor™ at Bald Eagle Nest 1 During Observation Day 17 June 2006



5.2.3 Nest Data vs. Observer Data

Comparison of temperature data recorded in a nest with observations by the Study Team did not reveal a consistent pattern of decreasing nest/egg temperatures with egg exposures (e.g., Figures 5 and 6). This is similar to the findings of the Canada Goose component study, also conducted in 2006 (Minaskuat 2006b).

Figure 5 Subject and Ambient Temperatures by the NestMonitor™ at Bald Eagle Nest 1 During Observation Day 17 June 2006

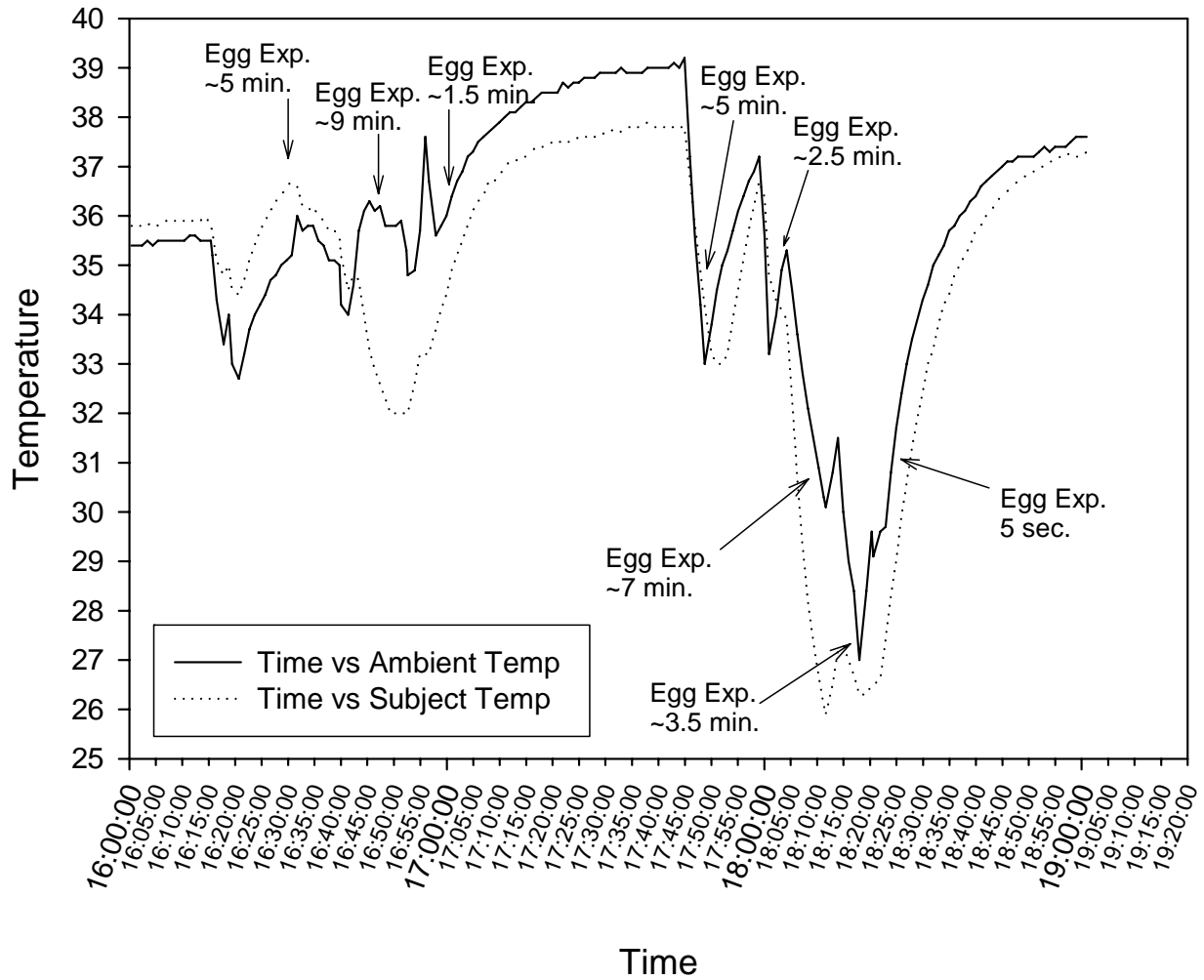
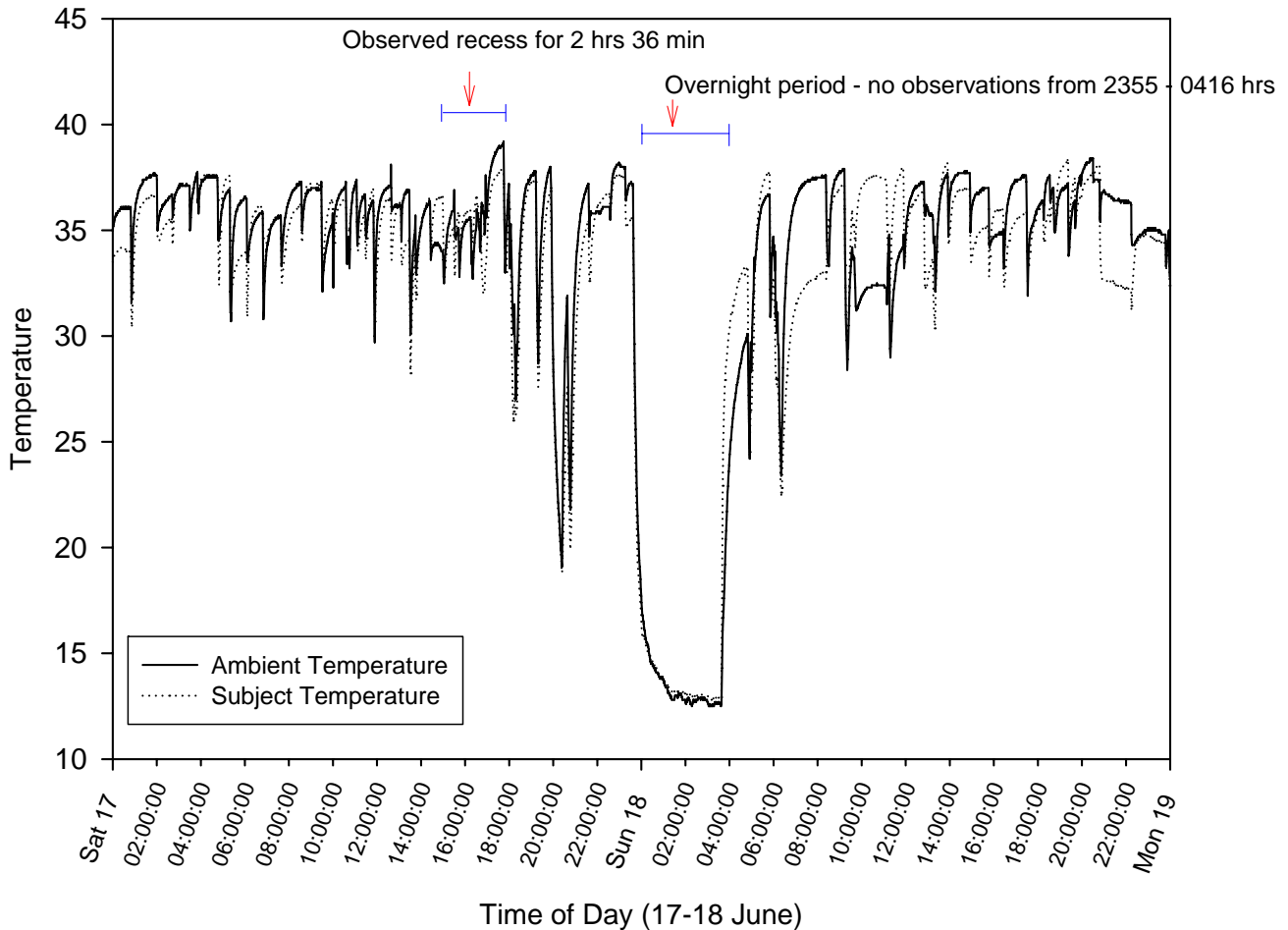


Figure 6 Subject and Ambient Temperatures Recorded by the NestMonitor™ at Bald Eagle Nest 5 During Observation Period 17-18 June 2006



The decline in temperature observed during the night of 17-18 June (Figure 6) was unusual in that observers reported the adult eagle at the nest throughout the evening – albeit weather conditions (rain, cool temperatures) were similarly unusual.

In regards to noise events, the only aircraft events of significance (i.e., above ambient noise levels) reported during observations were of the helicopter during dispersal of personnel. As indicated in Figure 4, such helicopter noise events appeared to be picked up by the NestMonitor™ in the nest. However, such peaks in the data were also recorded when no aircraft were reported. These findings are again similar to the findings of the Canada Goose component study (Minaskuat 2006b).

5.2.4 NestMonitor™ Testing Results

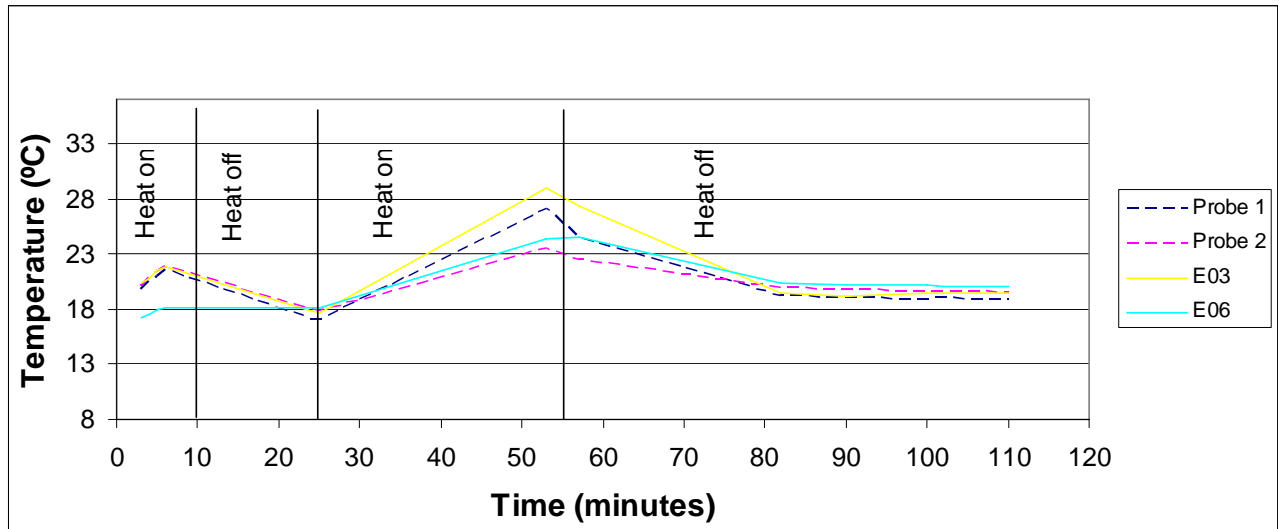
The temperature experiments in May 2007 involved NestMonitors™ for three species, namely Bald Eagle, Osprey and Canada Goose. Some aspects of the findings for the other species are reported here as the devices involve the same technology. Otherwise, refer to MIN0288 (Minaskuat 2007). The temperature values from the Bald Eagle and Osprey NestMonitors™ showed a significant difference between the temperature data collected and the temperatures recorded from the digital thermometers on Day 1 (constant application of heat for a two hour period) but did not show a significant difference on Day 2 (Table 4). When the data was presented graphically, the NestMonitors™ reflect the temperature trends recorded by the digital thermometers (Figure 7). Graphs for all monitors are presented in Appendix B.

Table 4 Indication of Significant Difference Between Probe 1A and NestMonitor™ (A) and Probe 2 and NestMonitor™ (B).

NestMonitor™																		
Test	E03		E06		E07		S03		S04		S06		S03		S04		S06	
	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2	Day 1	Day 2
A	ND	Yes	Yes	No	Yes	ND	Yes	ND	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No
B	ND	No	Yes	No	No	ND	No	ND	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	No

ND=No data

Figure 7 NestMonitor™ and Digital Thermometer Temperature Readings Recorded at Randomly Selected Intervals for Bald Eagle Day 2 Trial



Inconsistencies in the internal clocks on some electronic boards of the NestMonitors™ were corrected when matching data with digital thermometer readings recorded at known standardized times. There were three occasions (16.7%) when the NestMonitors™ failed to collect temperature data on the SD cards (Table 5). When downloading data for Bald Eagle Day 1 NestMonitor™ E03, no files were present on the SD card. The downloaded data for Bald Eagle Day 2 NestMonitor™ E07 indicated that temperature readings “flatlined” at 0°C (far below ambient temperature) for the duration of the trial. The reasons for this are unknown all protocols were followed with regard to the startup, shutdown and data retrieval of the NestMonitors™ with LED lights confirming proper procedures where appropriate. All wire connections appeared intact and battery level was sufficient. Prior to the Osprey Day 2 trial, the wires on the Osprey NestMonitor™ S03 temperature sensor were repaired, and would thereafter not properly connect to the electronic board. The trial was attempted regardless as replacement (2007 model) Osprey NestMonitors™ were unavailable. However, no data was retrieved from this NestMonitor™ for this trial.

6.0 DISCUSSION

6.1 Measurement of Noise and Temperature at the Nest

Based on these trials with nesting Bald Eagle and Osprey and a related study dealing with nesting Canada Goose (Minaskuat 2006b), the technological capabilities of the NestMonitor™ to record both noise and temperature at the surface of this device were demonstrated. For the three NestMonitors™ that could be retrieved, audio and temperature files were stored within the SD cards and were readily discerned using the associated software. Note that one of these (Nest 5) continued to function after the site had been predated and the monitor had been severely damaged.

In terms of noise, the device was set to record an event once the sensor detected sound energy in excess of 80 dB. However, the NestMonitor™ did not distinguish between distal sounds (e.g. an aircraft) that were the target of the trials and proximate sounds often on the surface of the device. This problem had been encountered previously by the Study Team using other noise monitoring equipment in the Naskaupi River in 1996 (Trimper et al. 1998a). In this instance, frequently calling songbirds, for example, were able to initiate a recording event if they were located next to the SLM. Therefore, it was necessary to sort through several hundred audio files to identify those that may have been initiated by an aircraft. On this latter point, the only aircraft-related files were those associated with helicopter support of the field observers. The low number of aircraft events was related to the relatively quiet military training season in 2006 and possible insulative nature of the device beneath the incubating female.

The NestMonitor™ recorded subtle changes within the nest bowl but did not serve as a means for detecting when the nest was not being incubated or temporarily unattended ('recesses'). Recorded temperatures were often within a range of 4-5°C and usually much warmer than ambient values recorded concurrently by observers with this study or of a companion study on Canada Goose (Minaskuat 2006b). The recorded values were within the range [28.3-35.4°C for Northern Harrier (*Circus hudsonicus*)] and other avian species (Note that Ellis and Varney (1973) in Webb (1987) indicated that Golden Eagle (*Aquila chrysaetos*) exhibited a range of approximately 10-38 °C) reported by others (Huggins 1941, Webb 1987). Osprey eggs must be kept at 29-36 °C to remain viable (Spitzer 1977). Van Daele and Van Daele (1982) reported that successful Osprey nests are incubated 99.5-100% of the daylight hours. Trimper et al. (1998a) reported that Osprey incubated 91.8-99.4% during daylight hours in Labrador during June. Bald eagle eggs can tolerate some cooling but exactly how much before death of the embryo is unknown (Buehler 2000).

Marked decreases in temperature in relation to recesses in incubation were not obvious due to in part to the embryonic heat production that facilitates heating while retarding cooling (White and Kinney 1974, Poussart et al. 2000).

In terms of temperature, the NestMonitor™ recorded subtle changes within the nest bowl but did not serve as a means for detecting when the nest was not being incubated or temporarily unattended – as

marked declines in temperature were not evident. Recorded temperatures were often within a range of 4-5°C and usually much warmer than ambient values recorded concurrently by observers. The recorded values were within the range (31.7-36.1°C) reported by others (Huggins 1941, Webb 1987). Marked decreases in temperature in relation to recesses in incubation were not obvious due in part to the embryonic heat production that facilitates heating while retarding cooling (White and Kinney 1974, Poussart et al. 2000). White and Kinney (1974) referred to the release temperature (the temperature at which the bird could leave the nest) as being reached progressively faster as embryonic production proceeds. This effect was suggested to cause a decrease in attentiveness over the incubation period.

The temperature trials conducted in May 2007 determined that the NestMonitors™ were functioning properly with temperature data reflecting the trends of ambient “nest” temperatures recorded by digital thermometers. Although readings between the digital thermometers and the NestMonitors™ were not consistently statistically significant, the trends of the increases and decreases in temperature readings by the two methods were evident when displayed graphically. These trends are clearly related to application and removal of the heating pad during Day 2 trials conducted on cloudy days. However, the trends were less clear on sunny days, when removal of the conductive heat source exposed the eggs to solar radiation. As the temperature of the nest microclimate is sensitive to conditions such as direct sunlight, wind, and proximity to a heat source, readings observed in real time on the digital thermometers could increase by 10°C when moved from the shade to the sun. Readings were also observed to decrease with a gust of wind or even a sustained breeze. Therefore, a small fluctuation in temperature readings cannot determine the absence or presence of an incubating bird. If left exposed in direct sunlight, the ambient nest temperature may not decrease and may even rise.

It is also important to note that the digital thermometers could not be calibrated but were compared to the readings of a glass thermometer and were within one or two degrees. The placement of the digital thermometer probes within the simulated nest affected the temperature readings, with the one that settled closer to the heating pad recording a higher temperature throughout the trial. The differences in readings could vary from 1 to 14°C, which clearly affected the statistical conclusions regarding the data. The probes would sometimes be jostled or their placement adjusted with the removal and application of the heating pad, but generally, readings of one probe were consistently higher throughout a trial due to its proximity to the heating pad. Therefore, the graphic analysis proved to be more useful when assessing the ability of the NestMonitors™ to describe ambient nest temperatures.

6.2 Behaviour of Nesting Bald Eagle and Osprey to the NestMonitor™

As expected the Bald Eagles in this study readily accepted the NestMonitor™ as part of their natural clutch. As the device was introduced, incubating females held until an observer was approximately 60 m from the nest. Upon retrieval, the device was always arranged with the natural eggs – confirmed by the recorded temperature values.

6.3 Comparison of Data within and Adjacent to the Nest

As described above, a consistent pattern did not emerge from recesses (egg exposures) and declining temperatures as recorded by the NestMonitor™. Recesses by Bald Eagle in particular, were common (as compared to Osprey) that may explain the variability in temperature depicted by the NestMonitor™. Unlike the findings of the Canada Goose component (Minaskuat 2007), the temperature values were not as consistent, perhaps lacking the exothermic benefits of a larger clutch and a more efficient nest bowl.

7.0 SUMMARY AND CONCLUSIONS

The NestMonitors™ were readily accepted by the adults. After the initial location of five active nests, egg data was collected from three Bald Eagle nests over a two-day period in mid-June. The eggs efficiently recorded temperature, however there were problems with the audio recordings; the NestMonitors™ could not differentiate between proximal and distal noise events as the devices frequently record noise in the nest. With the current setup, an on-site observer is required to validate when a significant noise event, such as an aircraft fly-over occurs. If the egg monitors could be configured to differentiate between proximal and distal noise dosage, the NestMonitors™ could provide useful information about the nest.

Temperature changes are not an accurate indicator of an adult leaving the nest as changes in temperature were only observed after a long period of time had passed. The NestMonitors™ recorded no change in temperature, suggesting that the eggs in the nest do not experience a low-temperature environment as a result of heat loss. Without factoring in possible predation, temperature may not be a critical factor to nest success when a female flushes or leaves the nest.

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