Flammulated Owl Survey in Tolko Industries Ltd. Heffley Creek Operating Area, Spring 2007

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Abstract

The Flammulated Owl (*Otus flammeolus*) is a secondary cavity nester generally associated with mature interior Douglas-fir and ponderosa pine stands. This species is blue-listed in British Columbia and is federally listed by COSEWIC as a species of special concern. In order to provide Tolko Industries Ltd with information on breeding Flammulated Owl habitat within their Heffley Creek operating area, an acoustic-lure call-playback survey was conducted during the spring of 2007. The objectives of the study were to carry out a presence not detected survey for Flammulated Owls and to identify active breeding areas. The establishment of call-playback stations were guided by a Flammulated Owl breeding suitability model, which stratified the study area into suitable and non-suitable breeding habitat. The breeding suitability model could be refined to reflect current stand level conditions through incorporating habitat associations from the 2007 detections. Further refinements to the model could be made through a cluster analysis of select attributes in GIS and by incorporating habitat information from systematic nest searches conducted during the breeding window.

A total of 214 call-playback stations were carried out detecting a total of 24 Flammulated Owls, with an average response time of 6 minutes from the first broadcast call. The mean detection rate for Flammulated Owls was 0.11 SE±0.02 (Owl/Station) and 30% of those detections were of owls calling spontaneously. It appears large contiguous suitable breeding habitat identified during the 1998 Booth and Merkens inventory remains of high importance for Flammulated Owls. In particular, the South Sullivan area featured three Flammulated owl detections in 1998 and four detections during the 2007 survey. Other owls encountered included 12 Barred Owls (*Strix varia*; BOW), 6 Great Horned Owls (*Bubu virginianus*; GHOW), 4 Northern Saw-whet Owls (*Aegolius acadicus*; NSWO), 1 Northern Pygmy Owl (*Glaucidium gnoma*; NPOW) and 1 unidentified Owl. The detection of Barred and Great Horned Owls are of concern, as these species have been known to predate upon Flammulated Owls.

Further assessments of overlapping deer winter range with Flammulated Owl breeding habitat and whether management for deer winter range meets the breeding requirements for Flammulated Owls is recommended. Further management under the *Forest and Range Practices Act* is recommended through the establishment of two Wildlife Habitat Areas. Additional stand-level management for Flammulated Owl breeding habitat include the use of Wildlife Tree Patches, designs as such should try and retain connectivity between suitable breeding habitats.
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1.0 Introduction

The Flammulated Owl (*Otus flammuleolus*: FLOW) is a neo-tropical migrant to British Columbia (B.C.), whose reliance on mature interior Douglas-fir and ponderosa pine forests renders this species susceptible to habitat change through timber harvest (Van Woudenberg, A.M. and D.A. Kirk. 1999). Additional threats include the loss of grass and shrub components by livestock grazing during the breeding window, use of Bt to control Lepidoptera outbreaks, and fire suppression leading to a reduction in foraging habitat (Van Woudenberg, A.M. and D.A. Kirk. 1999). Based on the assessment of these threats the provincial government has placed the Flammulated Owl on the blue-list as a species considered at risk. In addition, a technical review on the status of the Flammulated Owl by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) led to the owl being federally designated as a species of Special Concern (COSEWIC 2001).

The long-term sustainability of the Flammulated Owl within British Columbia is dependent upon the documentation of its breeding range and distribution (Woudenberg, A.M. and D.A. Kirk. 1999). Flammulated Owls are known to occupy very dry ponderosa pine and interior Douglas-fir forests from the International Border to as far north as McLeese Lake, on the west side of the Fraser River north of Williams Lake (M.J. Waterhouse pers. Comm. 1996), and west to Alexis Creek on the south side of the Chilcotin River (Wundenberg, A.M. and D.A. Kirk 1999; Fig 1).

To address management needs for Flammulated Owl an acoustic-lure call-playback survey was conducted during the spring of 2007. The spring 2007 survey represents a joint partnership between Tolko Industries Ltd., the Ministry of Environment and the British Columbia Conservation Corps (BCCC). The objectives of the survey were to carry out presence not detected surveys for Flammulated Owls and to identify active breeding areas. The establishment of field transects were guided by a Flammulated Owl breeding suitability model, which stratified the study area into breeding and non-breeding habitat. The Heffley Creek landscape has experienced significant changes since the 1998 Booth and Merkens Flammulated Owl survey and this survey will provide Tolko Industries Ltd with current information regarding the breeding distribution of Flammulated Owls. Breeding habitat is comprised of large ponderosa pine and smaller Interior Douglas-fir snags usually in an advanced state of decay and classified as three-six under the B.C. wildlife tree classification system (Buckland et al. 1996; British Columbia Ministry of Water, Land and Air Protection 2004).

1.1 Background

Characterised by their rusty grey plumage, dark eyes and small ear tufts, the Flammulated Owl is the second smallest member of the family Strigidae in North America, weighing approximately 55 grams and ranging in length from 15 to 18 centimetres (B.C. Ministry of Water, Land and Air Protection 2004). The Flammulated Owl’s territorial call is a single or two-noted hoot, with the second note stronger than the first (van Wounderberg 1999); however, upon further listening at a closer distance there is often a series of three notes; first two repeated softly mimicking a stutter, with the third note being the stronger (van Wounderberg 1999; F. Iredale pers. obs. 2006). Preferring to be active during night time hours, this nocturnal owl forages primarily on Lepidopterans, Orthopterans and Coleopterans (Buckland et al. 1996). The Flammulated Owl spends the winter months residing in New Mexico and northern Central America (McCallum 1994).
During the onset of spring, Flammulated Owls migrate from New Mexico and Central America to their breeding areas, with B.C. representing their northern breeding extent (Campbell et al. 1990). The Flammulated Owl is a secondary cavity nester and relies on naturally produced cavities or those excavated by the Pileated woodpecker (*Dryocopus pileatus*) and Northern flicker (*Colaptes auratus*) for nesting sites (Buckland et al. 1996). Breeding generally occurs in May through to August; one clutch consisting of two to four eggs is laid per year (Campbell et al. 1990; British Columbia Ministry of Water, Land and Air Protection 2004). Fledging of young occurs from mid-July through to mid-August (British Columbia Ministry of Water, Land and Air Protection 2004). Home range for Flammulated Owl within British Columbia was estimated to be between 2.2-3.7 hectares, although the sample size used to determine home range was small, n = 2 (van Woudenberg 1992).

1.1 Summary of Existing Information


2.0 Study Area

The 2007 Flammulated Owl study area occurs within the Kamloops Forest District and is predominately restricted to Tolko’s Heffley Creek operating area (Figure 2). Tolko’s Heffley Creek operating area is located approximately 25 kilometres north of Kamloops. The study area is bounded by Heffley Creek to the south, Darfield and Nanak Lake to the north, Forrest Lake to the east, and Skull Mountain and Frog Lakes to the west. The study area lies within the Southern Interior Ecoprovince and incorporates the Northern Thompson Upland, Thompson Basin and Tranquille Upland Ecosystems (Demarchi 1996). Biogeoclimatic zones (BGC) represented within the study area include the Ponderosa Pine (PP), Montane Spruce (MS), Interior Cedar Hemlock (ICH), Engelmann Spruce-Spruce Subalpine Fir (ESSF) and Interior Douglas-fir (IDF). The survey area is categorized as Natural Disturbance Type 4 (NDT4), thus experiencing frequent low intensity fires (Parminter 1995). In 2003 a fire swept through the central portion of the study area burning 26,420 hectares (Filton 2003). Surveys for Flammulated Owl were restricted to the PP and IDF BGC zones and areas not burned by the 2003 fire, with the exception of the Skull/Boulder Mountain transect. Other land use activities within the study area include agriculture in lower lying areas and cattle grazing. Mean annual temperature ranges from 4.8 to 10°C (Hope et al. 1991). However, growing season moisture deficits are common within the IDF and PP BGC zones, with mean annual precipitation ranging from 300 - 750mm and from 280 - 500mm, respectively (Hope et al. 1991).
Figure 1. Distribution and range of Flammulated Owl in B.C. (B.C. Ministry of Water, Land and Air Protection 2004).
Figure 2. Flammulated Owl Heffley Creek Study Area
3.0 Methods

To confirm active Flammulated Owl breeding areas surveyors used acoustic-lure call-playback methodology as described by the Resource Information Standards Committee (RISC). However, due time and budget constraints all sample stations were not repeated three times as required to confirm absence of the target taxa (Hausleitner 2006). In all, 15 days were allocated for Flammulated Owl surveys that coincided with the breeding season. Acoustic-lure call-playback surveys for Flammulated Owl in Tolko’s Heffley Creek operating area were conducted from May 14-16, May 23-31, June 1-2 and on June 8, 2007. Surveys were postponed for six days following three days of null detections in polygons ranked by the model as medium to high breeding habitat suitability. Mt. Knouff, Sullivan Badger Forest Service Road (FSR) and Louis Creek transects were repeated twice to re-assess null detections previously recorded; all other transects were conducted once.

To increase the likelihood of positive Flammulated Owl detections surveyors were guided by the 1998 Flammulated Owl breeding suitability model (Christie 1998). BCCC members reviewed the 1:30,000 habitat suitability maps prior to commencing surveys to ensure: 1) call-playback stations were distributed throughout Tolko’s operating area, 2) transects captured moderate and high habitat suitability polygons, 3) where possible transects included previous Flammulated Owl detections by Booth and Markens, 4) accessible by vehicle, and 5) transects did not overlap the 2003 fire. Where vehicle access was restricted surveyors accessed suitable breeding habitat polygons by foot, Huff Lake-three stations and Genier Lake-six stations. Transects were established during the day to allow for surveyors to become familiar with the survey route and make notes regarding habitat. Surveyors used a Nexxtech 15 Watt megaphone and CD player to broadcast calls. When continuous Flammulated Owl habitat occurred, broadcast stations were spaced 500 meters apart. Walk-in stations, the Boulder/Skull Mountain and South Sullivan transects deviated from the 500 meter standard. Stations along the Boulder/Skull Mountain transect were spaced greater than 500 meters in some areas due to discontinuous habitat as a result of urbanization and the 2003 McClure fire. South Sullivan transect was divided into two sections to sample high suitable breeding habitat. A two minute passive listening survey was conducted to detect spontaneously calling Flammulated Owls prior to broadcasting the Flammulated Owl’s call. If no Flammulated Owls were detected during this time a 15 minute survey occurred. This survey involved three, one minute broadcast calls given at four minute intervals for a combined survey time of 15 minutes. Broadcast calls were directed over 360 degrees from chest height. Surveyors noted general weather conditions before and after the owl survey: rain, beaufort wind scale, percent cloud cover and air temperature. Time of sunset was also recorded. To calculate survey effort, the total time spent surveying for Flammulated Owls was noted for each survey. The total survey effort for walk-in surveys included time between stations, which accounts for time surveyors spent passive listening for Flammulated Owls. Broadcast station coordinates (i.e., Universal Transverse Mercator units (UTMs) were captured using a Garmin 60cx Global Positioning System (GPS). The North American Datum (NAD) 83 was used to record UTMs. If no owl was detected during a survey, surveyors recorded a null detection on the owl survey form and moved on to the next station. If an owl was detected, surveyors noted the type of owl, call type, sex, time of response, direction and approximate distance the owl called from the survey station, projected UTM for the owl’s location using the GPS and other station comments (e.g., general vegetation, dominate tree species, land-use). This information was noted on an owl detection data form.

Call-playback stations and Flammulated Owl detections were mapped using Geographic Information Systems, ARCMap 9.0. Additional owl detections were mapped using iMAPBC (Government of B.C. 2007). Descriptive statistics of survey data was calculated using Microsoft Excel.
4.0 Results

Two hundred and fourteen call-playback stations were conducted over a 15 day period for a total survey effort of 3312 minutes. Twenty four Flammulated Owls were detected, 30% by spontaneous calls. Of the 24 detections, 18 occurred in the IDF, 5 occurred in the PP and 1 bordered the PP and IDF BGC zones. UTM’s of Flammulated Owl occurrences are listed in Appendix 1. According to habitat suitability model results, 6 Flammulated Owls were detected within suitable habitat polygons, 9 were detected outside suitable habitat polygons and 9 were detected bordering suitable habitat polygons. Other owls encountered included 12 Barred Owls (*Strix varia*; BDOV), 6 Great Horned Owls (*Bubo virginianus*; GHOW), 4 Northern Saw-whet Owls (*Aegolius acadicus*; NSWO), 1 Northern Pygmy Owl (*Glaucidium gnoma*; NPOW) and 1 unidentified Owl (Figure 7 & 8, Appendix 2). Flammulated Owl detections and broadcast stations from Booth and Merkens (1998) and the BCCC’s 2007 survey are illustrated in Figures 3, 4, 5 and 6. Four Flammulated Owl detections occurred within less than one kilometre of the 1998 Flammulated Owl detections. Flammulated Owl detection rates and distance to owls are provided in Table 4-1. Mean response times for all owls are noted in Table 4-2.

Although vegetation plots and associated habitat attributes were not formally recorded according to standards, observers did note the following. Habitat associated of Flammulated Owl detections along Agate Bay Road featured dry rocky outcrops, mature ponderosa pine and interior Douglas-fir trees, snags, and open grassy areas (Figure 9, Appendix 3). Habitat associated with the Louis Creek detections featured a mature interior Douglas-fir and ponderosa pine forest with snags, on a southwestern aspect and a hay field at the toe of the slope (Figure 10, Appendix 3). The Skull/Boulder Mountain Flammulated Owl detection featured burnt trees amongst mature interior Douglas-fir trees, limited ponderosa pine snags and steep rocky scree sections (Figure 11, Appendix 3).
Table 4-1. Flammulated Owl detection rate, time and distance per transect.

<table>
<thead>
<tr>
<th>Transect</th>
<th>Date</th>
<th>Number of FLOW detected</th>
<th>Number of stations</th>
<th>Detection rate (Owl/Station) (Minutes)</th>
<th>Average Detection Time (Minutes)</th>
<th>Average Distance to FLOW (Meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knouff Lake Road</td>
<td>14/05/2007</td>
<td>0</td>
<td>15</td>
<td>0.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mt. Knouff</td>
<td>15/05/2007</td>
<td>0</td>
<td>16</td>
<td>0.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sullivan/Badger FSR</td>
<td>16/05/2007</td>
<td>0</td>
<td>16</td>
<td>0.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sullivan/Badger FSR</td>
<td>23/05/2007</td>
<td>0</td>
<td>17</td>
<td>0.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wilson Road</td>
<td>24/05/2007</td>
<td>4</td>
<td>14</td>
<td>0.29 SE±0.12</td>
<td>5.25 SE±2.56</td>
<td>328 SE±72.25</td>
</tr>
<tr>
<td>Louis Creek</td>
<td>25/05/2007</td>
<td>0</td>
<td>16</td>
<td>0.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Agate Bay</td>
<td>26/05/2007</td>
<td>5</td>
<td>12</td>
<td>0.41 SE±0.15</td>
<td>4.60 SE±2.44</td>
<td>506 SE±61.77</td>
</tr>
<tr>
<td>Leonie Lake FSR</td>
<td>27/05/2007</td>
<td>0</td>
<td>16</td>
<td>0.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Barriere/Genier Lake</td>
<td>28/05/2007</td>
<td>0</td>
<td>19</td>
<td>0.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Genier Lake</td>
<td>29/05/2007</td>
<td>0</td>
<td>6</td>
<td>0.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Boulder/Skull</td>
<td>30/05/2007</td>
<td>1</td>
<td>15</td>
<td>0.07 SE±0.00</td>
<td>13.00 SE±0.00</td>
<td>500 SE±0.00</td>
</tr>
<tr>
<td>Louis Creek</td>
<td>31/05/2007</td>
<td>2</td>
<td>14</td>
<td>0.17 SE±0.11</td>
<td>11.00 SE±4.00</td>
<td>350 SE±150.00</td>
</tr>
<tr>
<td>South Sullivan</td>
<td>1/06/2007</td>
<td>5</td>
<td>8</td>
<td>0.63 SE±0.38</td>
<td>4.80 SE±3.15</td>
<td>210 SE±50.99</td>
</tr>
<tr>
<td>Mt. Knouff</td>
<td>2/06/2007</td>
<td>2</td>
<td>15</td>
<td>0.13 SE±0.09</td>
<td>5.00 SE±2.00</td>
<td>175 SE±75.00</td>
</tr>
<tr>
<td>Sullivan Valley</td>
<td>8/06/2007</td>
<td>5</td>
<td>15</td>
<td>0.33 SE±0.13</td>
<td>6.60 SE±2.93</td>
<td>342 SE±25.52</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>214</td>
<td></td>
<td>Total Average: 0.11 SE±0.02</td>
<td>Total Average: 6.08 SE±1.15</td>
<td>Total Average: 343.8 SE±30.98</td>
</tr>
</tbody>
</table>

Table 4-2. Owl species response time to call-playback surveys (Minutes).

<table>
<thead>
<tr>
<th>Species</th>
<th>FLOW</th>
<th>GHOW</th>
<th>BDOW</th>
<th>NSWO</th>
<th>NPOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Response Time</td>
<td>6.08 SE±1.15</td>
<td>4.17 SE±1.80</td>
<td>4.75 SE±2.00</td>
<td>7.25 SE±2.39</td>
<td>11± SE 0.00</td>
</tr>
<tr>
<td>Median</td>
<td>5.0</td>
<td>3.0</td>
<td>1.5</td>
<td>6.0</td>
<td>11.0</td>
</tr>
<tr>
<td>Sample Size</td>
<td>24</td>
<td>6</td>
<td>12</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>
Figure 3. Call-playback station layout 1998 and 2007: southern portion of study area.
1998 Booth and Merkens Call Stations  2007 BCCC Call Stations
Figure 4. Flammulated Owl detections: southern portion of study area.
1998 Booth and Merkens Flam Detections  2007 BCCC Flam Detections
Figure 5. Call-playback station layout 1998 and 2007: northern portion of study area.

1998 Booth and Merkens Call Stations

2007 BCCC Call Stations
Figure 6. Flammulated Owl detection: northern portion of study area.
2007 BCCC Flam Detection  No Flams Detected from Booth and Merkens 1998 Survey
6.0 Discussion

The spring 2007 Flammulated Owl survey provides information to Tolko Industries Ltd regarding the distribution of occupied Flammulated Owl breeding habitat within their Heffley Creek operating area. Given the severity of the 2003 McClure fire and the mountain pine beetle epidemic, the results of this survey provide the framework for the development of a Flammulated Owl management plan based on updated information. The low overall detection rate mirrors the 1998 0.17± 0.07 (Owls/Station) detection rate by Booth and Merkens. Similar surveys that incorporated call-playback methodology for Flammulated Owls rendered greater success ratios. Howie and Ritcey’s (1987) sampling on Wheeler Mountain, located southwest of the Heffley Creek study area, calculated a 0.85 (Owl/Station) detection rate. The lower detection rate for the Heffley Creek survey could be attributed to the study area occurring at the north-eastern limit of the Flammulated Owl’s range within the North Thompson drainage, breeding habitat limitations, cool spring that may have hampered the arrival of migrating owls, and single repetition for the majority of the transects.

The placement of broadcast stations along roadways and bordering suitable polygons combined with the breeding behaviour of Flammulated Owls likely increased the probability of detecting Flammulated Owls within marginal habitat. Due to time constraints and the size of the survey area, it was deemed necessary to use road access as the main means of surveying. In addition, the occurrence of Flammulated Owls outside suitable polygons may be male floaters that were not able to establish temporary residency within suitable polygons. Further, given the owl’s home range, average response time, and radius of broadcast call, it is probably safe to infer that moderate to high valued breeding habitat is being used. An additional error, which may have influenced the location of Flammulated Owl detections, may have resulted when approximating the distance and direction to a detected owl from a broadcast station. Booth and Merkens (1998) state, when the actual distance to a detected owl exceeds 300 meters the surveyor’s estimate of distance to the owl becomes very inaccurate. Only two of the seven transects featuring positive detections for Flammulated Owls had detection averages less than 300m. Future surveys should account for these errors and alternate methods in order to better assess suitable polygons.

The authors acknowledge the model was designed in 1998 and the landscape has since experienced natural and anthropocentric changes. However, large contiguous suitable breeding habitat within the South Sullivan and Sullivan transects featured occupied Flammulated Owl territories. These areas had not experienced the 2003 fire nor appeared to have been recently harvested. In particular, the occupation of suitable polygons by Flammulated Owls in 1998 and again during the spring of 2007, within the South Sullivan transect area, provides surveyors and resource managers with insight pertaining to the suitability of this occupied breeding habitat. Despite efforts to detect Flammulated Owls north of the Barriere River only null detections were recorded. It appears that this area may be the northern limit for Flammulated Owl breeding within the North Thompson drainage. However, null detections within suitable breeding habitat do not signify absence. Government standards suggest three repetitions annually per station to confirm absence (Hausleitner 2006). The Louis Creek Flammulated Owl detections occurred during the second repetition. Also the 2003 fire swept through suitable Flammulated Owl habitat, and therefore possibly reduced the rate of recruitment to the localized population. A positive Flammulated Owl detection within the burnt Skull/Boulder transect was probably the result of remnant patches that are large enough to support Flammulated Owl territories. The Sullivan Badger transect appeared to captured suitable breeding habitat, but surveyors were unable to document the presence of Flammulated Owls after two repetitions of broadcast calls. We
are unable to discern why this was the case as detailed habitat plots within suitable breeding polygons were not conducted. It is possible nesting opportunities were limited by the availability of snags, forage habitat was inadequate to support Flammulated Owls due to the grazed understory, or the habitat lacked sufficient security cover from potential predators such as the Barred or Great Horned Owls. Flammulated Owls tend to behave more cautiously in habitats where Barred Owls are known to occur (Van Woudenberg 1999). Both Barred and Great Horned Owls had the quickest response time to broadcast Flammulated Owl calls and were the leading conspecific species detected.

7.0 Recommendations

- With an average response time of six minutes, and a 30% spontaneous detection rate, the authors believe that survey effort can be reduced without compromising the detection rate of Flammulated Owls. The authors recommend a two minute passive listening period followed by a two broadcast calls for a total survey time per station of 12 minutes. This would increase the amount of possible survey opportunities for the target taxa.

- Combine vehicle with walk-in transects to better assess suitable polygons and repeat transect routes three times.

- Large portions of Flammulated Owl habitat occur on Crown Land and therefore the potential to manage for Flammulated Owl habitat exists under the Forest and Range Practices Act. Further assessments should include Flammulated Owl breeding habitat overlap with deer winter range and whether management for deer winter range meets the breeding requirements for Flammulated Owls. For example: Agate Bay Flammulated Owl detections occurred on south facing steep slopes and could possibly be managed through ungulate winter range designations.

- Further management under the Forest and Range Practices Act is recommended through the establishment of two Wildlife Habitat Areas. These designations should overlap suitable Flammulated Owl breeding habitat within the South Sullivan and Sullivan Valley transect. Both areas featured large contiguous breeding habitat with overlapping grazing tenures. Flammulated Owls are insectivores and these designations would manage for the use of pesticides and livestock grazing and their affects on forage species. For associated General Wildlife Measures that will apply within designated Flammulated Owl Wildlife Habitat Areas please refer to the species account at: http://www.env.gov.bc.ca/wld/frpa/iwms/accounts.html

- Wilson Rd and Mt.Knouff detections could be managed through the establishment of Wildlife Tree Patches. Design of Wildlife Tree Patches should try and retain connectivity between suitable breeding habitats.

- Refinements to the 1998 model should include vegetation plots within occupied Flammulated Owl breeding territories. Candidate habitat plots could be based upon low mean response times and shorter distance to calling Flammulated Owls- higher confidence with respect to owl locations. Low values were noted for the South Sullivan and Mt.Knouff transects. Fine scale adjustments to the model could also be made through systematic nest searches during the breeding window and incorporating the results into the model.

Lastly, additional refinements to the model could be made through a cluster analysis of select attributes in GIS that overlap positive 2007 Flammulated Owl detections. Attributes that significantly predict Flammulated Owl breeding habitat will be incorporated into the model.
8.0 Literature Cited


Personal Communication

Appendix 1.

Table A1- Locations of Flammulated Owl detections.

<table>
<thead>
<tr>
<th>Transect Route</th>
<th>Date (dd/mm/yyyy)</th>
<th>Projected UTM (NAD 83)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wilson Rd</td>
<td>24/05/2007</td>
<td>Z10 696392 5657878</td>
</tr>
<tr>
<td>Wilson Rd</td>
<td>24/05/2007</td>
<td>Z10 696237 5657063</td>
</tr>
<tr>
<td>Wilson Rd</td>
<td>24/05/2007</td>
<td>Z10 696287 5657320</td>
</tr>
<tr>
<td>Wilson Rd</td>
<td>24/05/2007</td>
<td>Z10 696595 5658366</td>
</tr>
<tr>
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Note: Locations of Flammulated Owls were projected from call-playback stations.
Appendix 2. Detected Owl Occurrences

Figure 7. Location of owl detections north portion of study area- Barriere
Figure 8. Location of owl detections south portion of study area- Heffley Creek.

Appendix 3. Flammulated Owl Habitat Photos

Figure 9. Agate Bay Flammulated Owl habitat.

Figure 10. Forest structure at the Louis Creek Flammulated Owl detection.
Fig 11. Forest structure at the Boulder/Skull Mountain Flammulated Owl detection.