

5- YEAR LONG-TERM MONITORING OR OPERATIONAL ACTIVITY WORK PLAN

Changes to this Work Plan are only accepted via an Approved Addendum.

General Information		
<p>*Decision Pool C: Activity paused.</p> <p>* Activity paused pending outcomes of the Biological Monitoring Integration Workshop</p> <p>* It is a requirement of funding that key members of the project team participate in a Biological Monitoring Integration Workshop to be informed by the Oil Sands Monitoring Secretariat.</p> <p>*Funding in 2018/19 is dependent upon the findings of the Biological Monitoring Integration Workshop</p>		
<p>Monitoring Category:</p> <p><i>(From OSM long-term plan; choose from drop-down menu)</i></p>	Biotic Response Monitoring	
<p>Strategic Monitoring Objective:</p> <p><i>(From OSM long-term plan; choose from drop-down menu)</i></p>	<p>Objective: Detect and report biotic response in relation to Oil Sands Developments</p> <p>Objective: Detect and report changes in wetland ecosystem in relation to Oil Sands Developments and related Point and Non-point source emissions</p> <p>Objective: Investigate the causal mechanisms of a known important biotic relationship in relation to Oil Sands Developments</p>	
<p>Work Plan Unique Identifier:</p>	B1-1-2-1718	
<p>Monitoring Activity Title:</p>	Biotic response of focal wildlife species to oil sands activity	
<p>Geographic Location <i>(choose from drop-down menu, if Project Location is in more than one area choose from second drop-down)</i></p>	Athabasca Oil Sands Region Cold Lake Oil Sands Deposit Peace River Oil Sands Region	More than 2 Locations (Described in Monitoring Schedule)
<p>Monitoring Site(s) Coordinates</p> <p><i>(latitude and longitude)</i></p>	N/A	
<p>Monitoring Organization and Responsible Manager:</p>	Environment and Climate Change Canada	Samantha Song Principle Investigators: Judith Toms, ECCC, Boreal Avian Modelling Project (BAM) Erin Bayne, University of Alberta Bioacoustics Unit (BU), Boreal Avian Modelling Project (BAM)
<p>Date Monitoring initiated:</p>	2012	

<p>Specific Monitoring Objective: <i>(State the monitoring objective addressed through this monitoring)</i></p>	<ol style="list-style-type: none"> 1. Status and trend estimates of focal wildlife species in oil sands areas by monitoring high-priority rare, listed and difficult-to-monitor birds. 2. Effects assessment of habitat disturbances by oil sands activity on focal birds, amphibians and mammals. For selected species groups, provide effects assessment of other documented stressors (noise, light and vegetative recovery). 3. Continued development of existing and new methodologies to improve both status and trend and effectiveness monitoring for focal species.
<p>Deliverables (Annual): <i>What Data Reports will be produced and when?</i></p>	<ol style="list-style-type: none"> 1. Status and trend assessment of focal species in oil sands areas: <ol style="list-style-type: none"> a. Estimates of risks to populations for high-priority rare, listed and difficult-to-monitor bird (ECCC, UofA-BU; YR1-5), mammal (UofA-BU; YR2-5) and amphibian species (UofA-BU; YR1-5). b. Empirical estimates of trend for bird populations, produced every 2 years starting in YR1 (ECCC, UofA-BAM). c. Updated power analysis to assess ability to detect trend in bird populations, produced every five years (i.e., YR5) or more frequently as required (ECCC, UofA-BAM). d. Updated regional status reports (trend, abundance, distribution, habitat use and threats, as feasible) for federal Species at Risk (UofA-BU): Yellow Rail, YR1; Olive-sided Flycatcher, YR2; Common Nighthawk, YR3; Rusty Blackbird, YR5; next priority species of concern, YR5. e. Human observer-based point count dataset (ECCC). Uploaded to JOSM portal annually. f. Automatic recording unit dataset (UofA-BU). Raw data is stored on servers at the University of Alberta. Interpreted data are uploaded into a standardized database also used for ABMI data. Data are publicly available, subject to publication embargos. 2. Effects assessment of the impacts of oil sands exploration and development: <ol style="list-style-type: none"> a. Models and results quantifying responses of bird populations to the individual and cumulative effects of physical disturbances through time (regional scale ECCC, UofA-BU; landscape scale UofA-BU). YR1-5. b. Models and results quantifying behavioural responses of birds (ECCC; YR1, YR2, YR4) and mammals (UofA-BU; YR2, YR4, YR5) to specific disturbance features (e.g., seismic lines, well pads), including responses to local-scale best-practices (e.g., reclamation of well pads, narrowing of linear features) and regeneration of disturbance features. c. Models and results that disentangle the effects of climate, energy-sector disturbances and forestry land use on trends in birds (UofA-BU, BAM, YR4), amphibians (UofA-BU, YR5) and mammals (UofA-BU, YR5). d. Human observer-based point count dataset (ECCC).

	<p>Uploaded to JOSM portal annually.</p> <ul style="list-style-type: none"> e. Automatic recording unit dataset (UofA-BU). Raw data is stored on servers at the University of Alberta. Interpreted data are uploaded into a standardized database also used for ABMI data. Data are publicly available, subject to publication embargos. f. Digital images from cameras and extracted data, starting in 2018-19 (UofA-BU). Images and data will be stored on servers at the University of Alberta. Data will be publicly available, subject to publication embargos. g. Breeding landbird territory mapping dataset (ECCC). Uploaded to JOSM portal when each sub-project is complete. <p>3. Methodological improvements:</p> <ul style="list-style-type: none"> a. Statistical models that can be used to integrate acoustic recording data and visual data from Ducks Unlimited Canada's waterfowl monitoring program (WE1-1-3), with application to improve estimates of waterfowl distribution and abundance (UofA-BU, DUC). YR1. b. Improved and extended statistical models to standardize data collected using different methodologies, that will be used to: <ul style="list-style-type: none"> – Integrate camera and audio recording data of vocalizing mammals (UofA-BU). YR3. – Integrate bird data collected by automatic recording units and human observers (UofA-BAM, BU). YR1. – Optimize methods to automate species identification in audio recording data (UofA-BU, BAM). YR5. c. Assessment of the relative costs and benefits of using automated radio-telemetry, automated recording units and human observers to monitor behavioural responses of landbirds to specific disturbance features (ECCC, UofA-BU). YR5. <p>All deliverables are expected to result in both public presentations and submission of papers to peer-reviewed journals.</p>
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Monitoring Plan Summary: *Please summarize the monitoring including relevant information such as background, objectives, monitoring area, methods/monitoring design, assumptions, outcomes, and references. These should align with the information provided in Appendix 1: Annual Monitoring Schedule.*

Work plan history and funding

This work plan represents integration of three associated wildlife monitoring projects: Status and trend monitoring of listed, rare, and difficult-to-monitor landbirds; Cause effects assessment of oil sands activity on migratory landbirds – these were merged into B1-1-3 in 2016-17; and Wetland condition and biodiversity, WE1-1-2. This project continues past monitoring efforts (most monitoring was initiated in 2012) and is enhanced with two extensions: integration of acoustic monitoring data for waterfowl with that collected by Ducks Unlimited Canada (B-IC-3-1718 Waterfowl effects-based assessment), and addition of cameras to monitor mammals at existing sampling sites (starting in 2018-19).

The monitoring project has returned to historic staffing levels from years prior to 2016-17. The 5-year budget for this project ramps back to historical funding levels in 2018-19, with minor increases thereafter to maintain pace with staffing costs.

2017-18: \$1,137,872 (fully staffed)

2016-17: \$1,137,872 (WE1-1-2-1617; B1-1-3-1617)

2015-16: \$1,412,560, adjusted down to \$1,179,900 with late-year departure of staff and move of some activities to U of A (2.2 Status and trend monitoring of listed, rare, and difficult-to-monitor landbirds; 4.3 Cause effects assessment of oil sands activity on migratory landbirds; part of 1.1 Biodiversity monitoring)

2014-15: \$1,444,560 (fully staffed; same projects as 2015-16)

This project complements monitoring by the Alberta Biodiversity Monitoring Institute (B-LTM-10-1718 Status and trends of biodiversity) by identifying and addressing gaps relevant to assessment of impacts of oil sands activity.

Project framework

The goal of this project is to monitor the responses (positive, negative or neutral) of terrestrial wildlife (including species associated with vegetated wetlands) to activities associated with economic development of oil sands.

The project includes both a status and trends monitoring component to document changes in the distribution and abundance of species, and an effects assessment monitoring component to identify causal mechanisms (why things are changing; National Research Council 1995, Mulder et al. 1999, Stadt et al. 2006, Haughland et al. 2010, Gardner 2010, Burton et al. 2014). The focal wildlife species monitoring project follows the principles of adaptive monitoring (e.g., Burton et al. 2014).

For status and trend assessment, the project has focused on ensuring that high-priority, rare and listed species are adequately monitored. The ABMI's monitoring project uses a systematic design that provides trend monitoring for common species of birds, mammals and other taxa. However, it was not designed to provide adequate monitoring of rarer species, rarer habitats or species not easily detected by standard monitoring protocols (e.g., clustered species, nocturnal species, irregularly or non-vocalizing species; AITF et al. 2012, Huggard 2013). This project addresses these monitoring gaps by (1) evaluating performance through power analysis, and (2) developing and implementing designs for priority species. Species were prioritized for monitoring based on regulatory commitments, current monitoring status, likelihood of being impacted by oil

sands development, expected sensitivity to oil sands development, and cultural and ecological values (Ball et al. 2014a). To date, two groups of birds have been selected for monitoring (old-forest associates and vegetated wetland associates; Ball et al. 2014a). We will continue to evaluate the potential to integrate monitoring of other high priority groups into this project in the future.

For effects assessment monitoring, we focus on taxa that (1) have strong evidence of individual and cumulative impacts of land disturbance from oil sands activity, such as birds and mammals (Bayne et al. 2005a, Machtans 2006, Habib et al. 2007, Bayne et al. 2008, Van Wilgenburg et al. 2013, Tigner et al. 2014, Nelitz et al. 2015, Sólymos et al. 2015, Tigner et al. 2015, Toews 2016, Holloway et al. in review); (2) are indicators for condition and function of forest ecosystems; and, (3) exhibit a broad range of sensitivities to habitat disturbance. For focused studies, we target species with a range of sensitivity to impacts of oil sands activity (i.e., vulnerable to robust species). We use field techniques that allow us to monitor multiple species, so we can simultaneously assess community-level responses and responses of individual species. Where field efficiencies exist, we will also incorporate camera-trapping surveys for mammals into our sampling protocols to provide more data for collaborative work with the ABMI (starting in 2018-19). We will continue to evaluate the potential to expand monitoring to other taxa in the future.

Effects assessment monitoring focuses on habitat disturbances (e.g., roads, pipelines, seismic lines, well pads) due to their documented influence on bird populations (Nelitz et al. 2015), but for selected species groups, monitoring extends to other documented stressors such as sound (owls, landbirds and bats; Habib et al 2007, Bayne et al 2008, Francis and Barber 2013, Bunkley et al. 2015), light (bats and amphibians; Wise 2007, Longcore and Rich 2004), hydrological changes (wetland species; Bocking 2015) and vegetative recovery (landbirds and mammals; Lankau et al. 2013, Tigner et al 2014). We emphasize assessment of the effects of SAGD developments because the ecological footprint of *in situ* development greatly exceeds that of surface mining (Jordan et al. 2009, ERCB 2010). In order to understand the total impact of multiple stressors and predict their effects in future developments, we assess both the impacts of individual stressors as well as their combined impact, because multiple stressors can interact synergistically (Holloway et al. in review).

Previous work under this monitoring project has produced numerous statistical models of focal wildlife species' responses to stressors (e.g., Mahon 2014, Sólymos et al. 2015, Holloway et al. in review, Leston et al. in review). These models are continually being reassessed and improved upon as additional data are collected (e.g., we are currently working on the third iteration of analyses to estimate power to detect trends in landbird species).

The project also includes methodological improvements, which will be used to expand and improve the efficiency of monitoring for this and other projects.

Status and trends monitoring

This project targets priority species in under-sampled habitats, sites where selected species have previously been detected (to increase sampling of rare species), and additional survey periods (to sample species not well detected using standard protocols). Monitoring has been ongoing since 2012.

We will regularly provide empirical assessments of status and trend of focal wildlife species (preliminary assessment of trend for some bird species in 2017-18, with regular updates as we collect additional data). The ABMI's monitoring project will require up to 20 years before it will be able to produce reliable estimates of trend for any but the most common bird species (AITF et al. 2012, Huggard 2013). Our project revisits previous survey locations (Cumming et al. 2010) because temporally-repeated samples give much greater power to assess trend compared to additional samples at novel locations. In addition, they can be used to assess how land-use changes from oil sands affect bird communities (see next section). This analysis framework could be used to rapidly estimate trend for other taxa where similar data exist from historical or future supplemental sampling (e.g., collation and resampling of camera trapping sites for mammals).

We also provide regular updates of the power to detect trend in bird populations under current monitoring designs. We are currently updating this analysis (AITF et al. 2012, Huggard 2013), prompted by changes in sampling design, methodologies and ARU technologies, as well as newer data that can be used to improve estimates of key variables (e.g., inter-annual variability) in the power analysis. Power analyses will be updated every five years, or more frequently if needed to assess future planned changes in sampling design or protocols. Power analyses will be used to inform and improve design of monitoring projects and reassess species prioritizations.

Effects assessment monitoring

We conduct long-term effects assessment monitoring across the entire region (Athabasca, Peace River and Cold Lake oil sands areas). Effects assessment monitoring is long-term (i.e., repeated) so we can assess whether relationships hold under new environmental conditions and levels of disturbance (e.g., as oil sands exploration continues and subsequent regeneration occurs). Monitoring spans disturbance gradients, and models both the impacts of individual stressors and the combined effects of multiple stressors (e.g., Mahon 2014, Sólymos et al. 2015, Holloway et al. in review). Sampling occurs at many more sites than ABMI's targeted sampling (B-LTM-10-1718), but surveys only birds and other vocalizing taxa. Monitoring has been ongoing since 2012.

We also conduct long-term effects assessment monitoring on entire landscapes (40 km²) to directly quantify the cumulative impact of typical energy-sector disturbance patterns on bird and mammal populations. Landscapes are selected to cover a spectrum of energy-sector disturbances and include fully-developed SAGD sites, sites that are likely to become developed by SAGD in the near future, and areas that we do not expect to be developed (e.g., parks) as controls. Monitoring has been ongoing since 2014.

Focused studies assess the behavioural response of landbirds (and mammals starting in 2018-19) to specific disturbance features, including responses to local-scale best-practices (e.g., narrowing of linear features) and regeneration of disturbance features. Data on behavioural responses of landbirds and mammals will give us a better understanding of the mechanisms that affect population-level responses, and could explain some of the complex results seen in studies to date (e.g., Bayne et al. 2008, Lankau et al 2013, Tigner et al. 2015, Carpenter et al. in prep). Some historical data exists for landbirds (compiled by the Boreal Avian Modelling project), but it is biased to certain habitat types (mature and old deciduous forest) and was not designed to assess the effects of energy-sector disturbances. Additional sampling for birds focuses on collecting data from under-sampled habitats (e.g., lowland and regenerating forests) to complement the historical data collection.

Methodological improvements

We will develop statistical models to integrate data from this focal species monitoring project with data from B-IC-3-1718 Waterfowl Effects-based Assessment (Ducks Unlimited Canada). In 2016-2017, we initiated a collaborative study to compare waterfowl detections from automated recording units with detections on helicopter surveys. We will complete this project in 2017-18.

We will continue to develop ways to better integrate data collected using different sampling methodologies and designs in order to further improve estimates of status and trend (e.g., integrate camera surveys with mammalian detections on automated recording units, further develop methods for integrating human based point counts with automated recording units).

We will also assess the potential of new technologies (networks of automated recording units and automated radio-telemetry towers) to collect data on behavioural responses of landbirds to specific disturbance features (starting in 2018-19). Such technology would allow us to carry out such surveys in habitats that are difficult for human surveyors to work in (e.g., wetlands, dense forests). We will also conduct a cost-benefits analysis to

determine whether these technologies might be cost-effective across a broader range of habitat types (i.e., in habitats where it is feasible to use standard human-based survey techniques).

Appendix 1 – Annual Monitoring Schedule

(Please provide detailed information on the specifics of your monitoring schedule including – **locations, schedule, methods, SOPs, QA/QC data release, references**)

<u>Sampling Locations/Sites</u>	<u>Sampling Schedule (timing/frequency)</u>	<u>Compounds to be Analyzed</u>	<u>SOPs to be Consulted</u> <i>(hyperlinks accepted)</i>	<u>QA/QC Complete & Date Data to be Released</u>
Human-based point counts for birds, across the three oil sands areas	Annually, May and June		Ball et al. 2014b Bruinsma et al 2014a, 2014b	Q4 (ECCC)
ARU-based point counts for birds and vocalizing amphibians, across the three oil sands areas	Annually, March – November		Lankau 2015a, 2015b Lankau et al. 2015 Camera trapping SOP for mammals to be developed (BU)	Q3 (BU)
Territory mapping surveys for birds, focused in one region in any given year but moving between years	Annually, May - July		Carpenter and Toms 2016 Toms and Carpenter 2016a, 2016b, 2016c Lankau 2015c SOP for radio-telemetry to be developed (ECCC) SOP for ARU arrays to be developed (BU)	Q4 (ECCC)

References:

Alberta Innovates – Technology Futures et al. 2012. Assessment of Existing and Alternative Landbird Monitoring Programs for the Oil Sands Areas in Alberta and Saskatchewan. Unpublished report produced for Environment Canada.

Ball, J., S. Song, D. Bruinsma, and C.L. Mahon. 2014a. Joint Oil Sands Monitoring: Environment Canada's framework for prioritizing landbird species for status and trend monitoring in the oil sands region.

Ball, J., D. Bruinsma, C.L. Mahon, J. Martin-DeMoor and T. Carpenter. 2014b. Standard Operating Procedure (SOP) 3: Field Data Collection. Joint Oil Sands Monitoring: Environment Canada Status and Trend Monitoring for Rare and Difficult to Monitor Landbird Species.

Bayne, E.M., S.L. Van Wilgenburg, S. Boutin and K.A. Hobson. 2005a. Modeling and field-testing of Ovenbird (*Seiurus aurocapillus*) responses to boreal forest dissection by energy sector development at multiple spatial scales. *Landscape Ecology* 20:203–216.

- Bayne, E.M., L. Habib and S. Boutin. 2008. Impacts of chronic anthropogenic noise from energy-sector activity on abundance of songbirds in the boreal forest. *Conservation Biology* 22:1186–1193.
- Bocking, E. 2015. Analyzing the impacts of road construction on the development of a poor fen in Northeastern Alberta, Canada. M.Sc. Thesis, University of Waterloo. 70 pp.
- Bruinsma, D., J. Ball, C.L. Mahon, J. Martin-DeMoor and T. Carpenter. 2014a. Standard Operating Procedure (SOP) 2: Training Observers. Joint Oil Sands Monitoring: Environment Canada Cause and Effects Assessment and Status and Trend Monitoring for Landbird Species.
- Bruinsma, D., J. Ball, C.L. Mahon, J. Martin-DeMoor and T. Carpenter. 2014b. Standard Operating Procedure (SOP) 4: Data Entry and Verification. Joint Oil Sands Monitoring: Environment Canada Status and Trend Monitoring for Rare and Difficult to Monitor Landbird Species.
- Bunkley, J.P., C.J.W. McClure, N.J. Kleist, C.D. Francis, J.R. Barber. 2015. Anthropogenic noise alters bat activity levels and echolocation calls. *Global Ecology and Conservation* 3:62-71.
- Burton, A.C., D. Huggard, E. Bayne, J. Schieck, P. Sólymos, T. Muhly, D. Farr and S. Boutin. 2014. A framework for adaptive monitoring of the cumulative effects of human footprint on biodiversity. *Environmental Monitoring and Assessment* 186:3605-3617.
- Carpenter, T. and J.D. Toms. 2016. Standard Operating Procedure: Conducting Territory Mapping. Environment and Climate Change Canada Joint Oil Sands Landbird Monitoring Program.
- Carpenter, T., C.L. Mahon, E.M. Bayne, and S.E. Nielsen. In prep. Avian responses to in situ energy extraction in peatlands. M.Sc. Thesis, University of Alberta.
- Cumming S.G., K.L. Lefevre, E. Bayne, T. Fontaine, F.K.A. Schmiegelow and S.J. Song. 2010. Toward conservation of Canada's boreal forest avifauna: design and application of ecological models at continental extents. *Avian Conservation and Ecology* 5(2):8.
- Energy Resources Conservation Board. 2010. Alberta's Energy Reserves 2009 and Supply/Demand Outlook 2010-2019. ST98-2010. Energy Resources Conservation Board. Calgary, AB.
- Francis, C.D., and J.R. Barber. 2013. A framework for understanding noise impacts on wildlife: an urgent conservation priority. *Frontiers in Ecology and the Environment* 11: 305-313.
- Gardner, T. 2010. Monitoring Forest Biodiversity: Improving Conservation through Ecologically-responsible Management. Earthscan Ltd. London, UK. 360 pp.
- Habib, L., E.M. Bayne and S. Boutin. 2007. Chronic industrial noise affects pairing success and age structure of ovenbirds *Seiurus aurocapilla*. *Journal of Applied Ecology* 44:176–184.
- Haughland, D.L., J.-M. Hero, J. Schieck, J. G. Castley, S. Boutin, P. Solymos, B. E. Lawson, G. Holloway and W. E. Magnusson. 2010. Planning forwards: biodiversity research and monitoring systems for better management. *Trends in Ecology and Evolution* 25:199-200.
- Holloway, G.L., C.L. Mahon and E.M. Bayne. In review. Additive and interactive effects on boreal landbirds: a cumulative effects analysis in a multi-stressor landscape. *Landscape Ecology*.

Huggard, D. 2013. Expected Precision of Trends from Bird Monitoring in the Oil Sands Area. Update. Unpublished report produced for Environment Canada.

Jordan, S. M., D. W. Keith, and B. Stelfox. 2009. Quantifying land use of oil sands production: a life cycle perspective. *Environmental Research Letters* 4(2):024004.

Lankau, H.E., E.M. Bayne and C.S. Machtans. 2013. Ovenbird (*Seiurus aurocapilla*) territory placement near seismic lines is influenced by forest regeneration and conspecific density. *Avian Conservation and Ecology* 8(1):5.

Lankau, H.E. 2015a. Autonomous Recording Unit (ARU) Deployment Protocol Version: 1 May 2015. Bioacoustic Unit, University of Alberta and Alberta Biodiversity Monitoring Institute. Edmonton, Alberta. http://bioacoustic.abmi.ca/wp-content/uploads/2015/09/Lankau_2015_ARU_Deployment_Protocol.pdf

Lankau, H.E. 2015b. SongMeter (SM2) Maintenance Protocol. Bioacoustic Unit, University of Alberta and Alberta Biodiversity Monitoring Institute. Edmonton, Alberta. <http://bioacoustic.abmi.ca/wp-content/uploads/2016/01/BU-SM2-Maintenance-Protocol-2016.pdf>

Lankau, H.E. 2015c. SongMeter (SM3) Maintenance Protocol. Bioacoustic Unit, University of Alberta and Alberta Biodiversity Monitoring Institute. Edmonton, Alberta. <http://bioacoustic.abmi.ca/wp-content/uploads/2016/01/BU-SM3-Maintenance-Protocol-2016.pdf>

Lankau, H.E., MacPhail, A., Knaggs, M. and E. Bayne. 2015. Acoustic Recording Analysis Protocol. Bioacoustic Unit, University of Alberta and Alberta Biodiversity Monitoring Institute. Edmonton, Alberta. http://bioacoustic.abmi.ca/wp-content/uploads/2015/11/BU_Acoustic_Recording_Analysis_Protocol-V10-23Nov2015-2.pdf

Leston, L., E. Bayne, C.L. Mahon, P. Sólymos, J. Ball, J. Schieck, F. Schmiegelow and S. Song. In review. How well do local-scale habitat models from forestry and energy sector control-impact studies predict boreal bird abundance at larger spatial extents?

Longcore, T., and C. Rich. 2004. Environmental light pollution. *Frontiers in Ecology and the Environment* 2:191-198.

Machtans, C.S. 2006. Songbird response to seismic lines in the western boreal forest: a manipulative experiment. *Canadian Journal of Zoology* 84: 1421–1430

Mahon, C.L. 2014. Local, landscape, and regional scale impacts of in situ energy development on boreal bird species and species assemblages. Internal Environment Canada Report.

Mulder, Barry S., B.R. Noon, T.A. Spies, M.G. Raphael, C.J. Palmer, A.R. Olsen, G.H. Reeves, and H.H. Welsh. 1999. The strategy and design of the effectiveness monitoring program for the Northwest Forest Plan. General Technical Report PNW-GTR-437. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 138 pp.

National Research Council. 1995. Review of EPA's environmental monitoring and assessment program: overall evaluation. National Academy Press, Washington, D.C.

Nelitz, M.A., et al. 2015. Addressing complexity and uncertainty: conceptual models and expert judgements applied to migratory birds in the oil sands of Canada. *Ecology and Society* 20(4):4.

Sólymos, P., C.L. Mahon, T. Fontaine and E.M. Bayne. 2015. Predictive models for estimating the cumulative effect of human development on migratory landbirds in the oil sands areas of Alberta. *Joint Oil Sands*

Monitoring: Cause-Effects Assessment of Oil Sands Activity on Migratory Landbirds, Edmonton, AB. pp. 38.
http://www.borealbirds.ca/files/Technical_Reports/JOSM_report_Solymos_et_al_2015_final_2.pdf.

Stadt, J.J., J. Schieck, and H.A. Stelfox. 1996. Alberta Biodiversity Monitoring Program -Monitoring Effectiveness of Sustainable Forest Management Planning. Environmental Monitoring and Assessment 121:33-46.

Tigner, J., Bayne, E.M., and Boutin, S.A. 2014. Black bear use of seismic lines in northern Canada. Journal of Wildlife Management 78:282–292.

Tigner, J., Bayne, E.M., and Boutin, S.A. 2015. American marten respond to seismic lines in northern Canada at two spatial scales. Plos One: <http://dx.doi.org/10.1371/journal.pone.0118720>

Toews, M. 2016. Managing human footprint with respect to its effects on large mammals: implications of spatial scale, divergent responses and ecological thresholds. M.Sc. Thesis, University of Victoria. 205 pp.

Toms, J.D. and T. Carpenter. 2016a. Standard Operating Procedure: Training Observers for Spot-mapping and Territory Mapping. Environment and Climate Change Canada Joint Oil Sands Landbird Monitoring Program.

Toms, J.D. and T. Carpenter. 2016b. Standard Operating Procedure: Surveying Disturbances, Habitat Types and Vegetation for Spot-mapping and Territory Mapping Projects. Environment and Climate Change Canada Joint Oil Sands Landbird Monitoring Program.

Toms, J.D. and T. Carpenter. 2016c. Standard Operating Procedure: Data Entry and Verification for Spot-mapping-based Projects. Environment and Climate Change Canada Joint Oil Sands Landbird Monitoring Program.

Van Wilgenburg, S.L., K.A. Hobson, E.M. Bayne and N. Koper. 2013. Estimated avian nest loss associated with oil and gas exploration and extraction in the Western Canadian Sedimentary Basin. Avian Conservation and Ecology 8(2):9.

Wise, S. 2007. Studying the ecological impacts of light pollution on wildlife: amphibians as models. P. 107-116 in C. Marin and J. Jafari, eds. StarLight: a Common Heritage. Proceedings of the StarLight 2007 Conference; International Initiative in Defence of the Quality of the Night Sky and the Right to Observe the Stars. La Palma, Canary Islands, Spain: StarLight Initiative; Instituto de Astrofísica de Canarias.

Appendix 2 – Detailed Multi-Year Financial Breakdown: if changes are to be made then an Addendum must be Complete and Approved.

(Complete the following detailed financial breakdown; add or delete categories as required)

Overall budget: all collaborators combined

Budget requirements	Year 1 (2017- 2018)		Year 2 (2018- 2019)		Year 3 (2019- 2020)		Year 4 (2020- 2021)		Year 5 (2021- 2022)	
	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding
1) Salaries and benefits										
a) Appendix 3 – Totals	\$820,522	\$325,520	\$1,000,728	\$259,040	\$1,061,267	\$214,540	\$1,064,984	\$214,540	\$1,067,807	\$229,280
2) Operations and Maintenance										
a) Vehicles and Transportation	\$45,418	\$19,600	\$61,885	\$21,420	\$65,534	\$22,491	\$68,703	\$23,616	\$72,032	\$24,796
b) Helicopter	\$0	\$0	\$89,260	\$0	\$94,949	\$0	\$99,457	\$0	\$104,197	\$0
c) Lab analysis	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
d) Data management	\$4,303	\$10,000	\$5,951	\$10,000	\$6,330	\$10,000	\$6,630	\$10,000	\$6,946	\$10,000
e) Field work	\$121,424	\$10,073	\$243,956	\$15,537	\$218,162	\$16,314	\$228,562	\$17,129	\$239,494	\$17,986
f) Capital expenses	\$63,000	\$20,778	\$63,000	\$30,250	\$63,000	\$24,139	\$63,000	\$24,139	\$63,000	\$24,139
3) Consumable Materials and supplies										
a) Batteries, SD cards, external hard drives	\$11,055	\$11,055	\$11,607	\$11,607	\$12,188	\$12,188	\$12,797	\$12,797	\$13,437	\$13,437

4) Travel										
a) Conferences and meetings	\$22,958	\$7,000	\$22,900	\$6,500	\$23,977	\$6,500	\$24,831	\$6,500	\$25,728	\$6,500
b) Field work - travel	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
c) Project-related travel	\$3,000	\$0	\$3,000	\$0	\$3,000	\$0	\$3,000	\$0	\$3,000	\$0
5) External Contracts										
a) ARU transcription; spot-mapping software; page charges	\$46,194	\$1,836	\$49,472	\$2,000	\$26,783	\$3,537	\$27,985	\$3,537	\$29,249	\$3,537
Grand Total	\$1,137,872	\$405,861	\$1,551,760	\$356,354	\$1,575,189	\$309,708	\$1,599,949	\$312,258	\$1,624,889	\$329,675

Budget for Environment and Climate Change Canada only

Budget requirements	Year 1 (2017- 2018)		Year 2 (2018- 2019)		Year 3 (2019- 2020)		Year 4 (2020- 2021)		Year 5 (2021- 2022)	
	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding
6) Salaries and benefits										
b) Appendix 3 - Totals	\$498,042	\$0	\$631,768	\$0	\$647,807	\$0	\$651,524	\$0	\$661,087	\$0
7) Operations and Maintenance										
g) Vehicles and Transportation	\$25,818	\$0	\$40,465	\$0	\$43,043	\$0	\$45,087	\$0	\$47,236	\$0
h) Helicopter	\$0	\$0	\$89,260	\$0	\$94,949	\$0	\$99,457	\$0	\$104,197	\$0
i) Lab analysis	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0

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j) Data management	\$4,303	\$0	\$5,951	\$0	\$6,330	\$0	\$6,630	\$0	\$6,946	\$0
k) Field work	\$111,351	\$0	\$228,420	\$0	\$201,849	\$0	\$211,433	\$0	\$221,508	\$0
l) Capital expenses	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
8) Consumable Materials and supplies										
b) (Describe Consumable Supply)	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
9) Travel										
d) Conferences and meetings	\$17,458	\$0	\$16,900	\$0	\$17,977	\$0	\$18,831	\$0	\$19,728	\$0
e) Field work - travel	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
f) Project-related travel	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
10) External Contracts										
b) ARU transcription; spot-mapping software	\$43,029	\$0	\$46,472	\$0	\$25,320	\$0	\$26,522	\$0	\$27,786	\$0
Grand Total	\$700,000	\$0	\$1,059,236	\$0	\$1,037,274	\$0	\$1,059,484	\$0	\$1,088,488	\$0

Budget for the Boreal Avian Modelling Project only

Budget requirements	Year 1 (2017- 2018)		Year 2 (2018- 2019)		Year 3 (2019- 2020)		Year 4 (2020- 2021)		Year 5 (2021- 2022)	
	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding
11) Salaries and benefits										
c) Appendix 3 - Totals	\$72,500	\$32,500	\$72,500	\$32,500	\$105,000	\$0	\$105,000	\$0	\$105,000	\$0

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12) Operations and Maintenance										
m) Vehicles and Transportation	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
n) Helicopter	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
o) Lab analysis	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
p) Data management	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
q) Field work	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
r) Capital expenses	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
13) Consumable Materials and supplies										
c) <i>(Describe Consumable Supply)</i>	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
14) Travel										
g) Conferences and meetings	\$2,500	\$0	\$2,500	\$0	\$2,500	\$0	\$2,500	\$0	\$2,500	\$0
h) Field work - travel	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
i) Project-related travel	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
15) External Contracts										
c) <i>(Describe External Contractor)</i>	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Grand Total	\$75,000	\$32,500	\$75,000	\$32,500	\$107,500	\$0	\$107,500	\$0	\$107,500	\$0

Budget for the Bioacoustics Unit only

Budget requirements	Year 1 (2017- 2018)		Year 2 (2018- 2019)		Year 3 (2019- 2020)		Year 4 (2020- 2021)		Year 5 (2021- 2022)	
	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding
16) Salaries and benefits										
d) Appendix 3 - Totals	\$249,980	\$293,020	\$296,460	\$226,540	\$308,460	\$214,540	\$308,460	\$214,540	\$301,720	\$229,280
17) Operations and Maintenance										
s) Vehicles and Transportation	\$19,600	\$19,600	\$21,420	\$21,420	\$22,491	\$22,491	\$23,616	\$23,616	\$24,796	\$24,796
t) Helicopter	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
u) Lab analysis	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
v) Data management	\$0	\$10,000	\$0	\$10,000	\$0	\$10,000	\$0	\$10,000	\$0	\$10,000
w) Field work	\$10,073	\$10,073	\$15,537	\$15,537	\$16,314	\$16,314	\$17,129	\$17,129	\$17,986	\$17,986
x) Capital expenses	\$63,000	\$20,778	\$63,000	\$30,250	\$63,000	\$24,139	\$63,000	\$24,139	\$63,000	\$24,139
18) Consumable Materials and supplies										
d) Batteries, SD cards, external hard drives	\$11,055	\$11,055	\$11,607	\$11,607	\$12,188	\$12,188	\$12,797	\$12,797	\$13,437	\$13,437
19) Travel										
j) Conferences and meetings	\$3,000	\$7,000	\$3,500	\$6,500	\$3,500	\$6,500	\$3,500	\$6,500	\$3,500	\$6,500
k) Field work - travel	\$0	\$0								
l) Project-related travel	\$3,000	\$0	\$3,000	\$0	\$3,000	\$0	\$3,000	\$0	\$3,000	\$0
20) External Contracts										

d) Page charges	\$3,165	\$1,836	\$3,000	\$2,000	\$1,463	\$3,537	\$1,463	\$3,537	\$1,463	\$3,537
Grand Total	\$362,872	\$373,361	\$417,524	\$323,854	\$430,415	\$309,708	\$432,965	\$312,258	\$428,902	\$329,675

Appendix 3 – Staffing Plan

(Complete the following detailed staffing plan; add or delete categories as required)

Overall staffing plan: all collaborators combined

Responsible Role	Year 1 – Budget Allocation		Year 2 – Budget Allocation		Year 3 – Budget Allocation		Year 4 – Budget Allocation		Year 5 – Budget Allocation	
	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding
Science Expertise	\$459,385	\$310,520	\$525,353	\$247,040	\$573,891	\$214,540	\$582,763	\$214,540	\$585,586	\$229,280
Technical/Field Staff	\$331,137	\$12,000	\$435,376	\$12,000	\$447,376	\$0	\$442,221	\$0	\$442,221	\$0
Administrative and Program Coordination	\$30,000	\$0	\$40,000	\$0	\$40,000	\$0	\$40,000	\$0	\$40,000	\$0
Grand Total <i>(inserted into Appendix 2)</i>	\$820,522	\$322,520	\$1,000,728	\$259,040	\$1,061,267	\$214,540	\$1,064,984	\$214,540	\$1,067,807	\$229,280

Overall staffing plan for Environment and Climate Change Canada only

Responsible Role	Year 1 – Budget Allocation		Year 2 – Budget Allocation		Year 3 – Budget Allocation		Year 4 – Budget Allocation		Year 5 – Budget Allocation	
	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding
Science Expertise (PI, two assistant wildlife biologists, all FT)	\$327,405	\$0	\$368,893	\$0	\$384,931	\$0	\$393,803	\$0	\$403,366	\$0
Technical/Field Staff (6-9 summer field techs)	\$170,637	\$0	\$262,876	\$0	\$262,876	\$0	\$257,721	\$0	\$257,721	\$0
Administrative and Program Coordination	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Grand Total <i>(inserted into Appendix 2)</i>	\$498,042	\$0	\$631,768	\$0	\$647,807	\$0	\$651,524	\$0	\$661,087	\$0

Overall staffing plan for the Boreal Avian Modelling Project only

Responsible Role	Year 1 – Budget Allocation		Year 2 – Budget Allocation		Year 3 – Budget Allocation		Year 4 – Budget Allocation		Year 5 – Budget Allocation	
	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding
Science Expertise	\$72,500	\$32,500	\$72,500	\$32,500	\$105,000	\$0	\$105,000	\$0	\$105,000	\$0

(0.5 FTE data analyst, FT postdoc)										
Technical/Field Staff	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Administrative and Program Coordination	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Grand Total <i>(inserted into Appendix 2)</i>	\$72,500	\$32,500	\$72,500	\$32,500	\$105,000	\$0	\$105,000	\$0	\$105,000	\$0

External funding sources: ABMI, Mitacs

Overall staffing plan for the Bioacoustics Unit only

Responsible Role	Year 1 – Budget Allocation		Year 2 – Budget Allocation		Year 3 – Budget Allocation		Year 4 – Budget Allocation		Year 5 – Budget Allocation	
	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding
Science Expertise (0.5 FTE PI, 4-5 M.Sc. and 4-5 Ph.D. students)	\$59,480	\$278,020	\$83,960	\$214,540	\$83,960	\$214,540	\$83,960	\$214,540	\$77,220	\$229,280
Technical/Field Staff (2 FT staff, 6 summer field techs)	\$160,500	\$12,000	\$172,500	\$12,000	\$184,500	\$0	\$184,500	\$0	\$184,500	\$0

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Administrative and Program Coordination (0.5 FTE program coordinator)	\$30,000	\$0	\$40,000	\$0	\$40,000	\$0	\$40,000	\$0	\$40,000	\$0
Grand Total <i>(inserted into Appendix 2)</i>	\$249,980	\$290,020	\$296,460	\$226,540	\$308,460	\$214,540	\$308,460	\$214,540	\$301,720	\$229,280

External funding sources: University of Alberta, ABMI, AIPac, NSERC

Appendix 4 – Approvals

Project Submitted by:		
Name: Samantha Song		
Organization: Environment and Climate Change Canada	Signature:	Date:
Project Approved by:		
Signature		Signature
Date		Date

Activity Planning Review and Evaluation

To be completed by OSM Administration

Date Completed	Review type	Validated by (insert name and title)
	Scientific expert review completed	
	Program Management review completed	

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