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

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

General Information		
Monitoring Category: *(From OSM long-term plan; choose from drop-down menu)*	Biotic Response Monitoring	
Strategic Monitoring Objective: *(From OSM long-term plan; choose from drop-down menu)*	Objective: Detect and report biotic response in relation to Oil Sands Developments	
Work Plan Unique Identifier:	*B-LTM-E-10-1718*	
Monitoring Activity Title:	Monitoring Targeted Biodiversity	
Geographic Location (*choose from drop-down menu, if Project Location is in more than one area choose from second drop-down***)**	Other Region (Described in Monitoring Schedule)	More than 2 Locations (Described in Monitoring Schedule
Monitoring Site(s) Coordinates *(latitude and longitude)*	Described in Monitoring Schedule	
Monitoring Organization and Responsible Manager:	Alberta Environment and Parks	Dan Farr
Date Monitoring initiated:	**2007**	
Specific Monitoring Objective: *(State the monitoring objective addressed through this monitoring)*	1) Assess how biodiversity are affected by energy disturbances throughout the Oil Sands region (Athabasca deposit, Peace River deposit, and Cold Lake deposit). 2) Create modeling tools/information that stakeholders can use to predict future biotic condition in simulated landscapes in the Oil Sands region. 3) Assess the degree to which other industries (forestry, agriculture) and other human development stressors (urban development, roads) have synergistic effects with Oil Sands development on biodiversity.	

Deliverables (Annual): *What Data Reports will be produced and when?* Topics subject to change	Year	
	2017-18	Effect of adjacent industrial development on wetlands. (for submission to peer-reviewed journal). March 31, 2018
	2018-19	How does sub-sampling of bird recordings influence species detection? (for submission to peer-reviewed journal). December 31, 2018
	2019-20	Is there redundancy among taxa in human disturbance relationships? (for submission to peer-reviewed journal). December 31, 2019
	2020-21	Can species co-occurrence be used to identify ecological guilds? (for submission to peer-reviewed journal). December 31, 2020
	2021-22	Optimal sampling design to monitor changes in species distribution and abundance. (for submission to peer-reviewed journal). December 31, 2021
	Annual	• Annual report summarizing monitoring activities and findings from the prior year; print and online versions, with links to uploaded data. November 30th each year. • Presentation at an international scientific conference. • Updates to the ABMI data portal to disseminate relationships between species abundance and industrial development.

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.*

1. **Background**

Human activities stress natural ecosystems and the species that live there by changing the vegetation, topography, hydrology, and substrate that are present. In the minable and *in situ* Oil Sands region of Alberta, exploration and petroleum extraction are common and widely distributed with footprints from these activities growing over time (Alberta Biodiversity Monitoring Institute 2014). Some types of disturbance (e.g., seismic lines) are designed as temporary removal of native vegetation, with the expectation that these will recover to native

habitats within a few decades (Zedler and Callaway 1999). Other disturbances like mines, industrial facilities, and well-pads result in changes to the vegetation, soils, and hydrology that are expected to remain on the landscape for decades, although they will be reclaimed after resource extraction has been completed. These disturbances are expected to eventually recover to natural ecosystems, but recovery periods will be long.

In addition to energy related disturbances, forestry, agriculture, and urban development alter the Oil Sands landscapes, and through this affect the biota living there (e.g., Schieck et al. 2014). Roads, agriculture, and urban footprints are expected to be permanent changes to the landscapes. Areas that have been harvested are expected to partially recover within a couple of decades, and completely recover within a century (e.g., Schieck and Song 2006).

To understand how biota respond to energy and other human development, it is important to sample the gradient from low (ideally no) development through to high intensity development, and model biotic change along this gradient (Gotelli and Ellison 2004, Nichols and Williams 2006). Targeted sampling is critical so that the complete range of conditions are incorporated in the models. In addition, since ecological impacts occur at a variety of spatial scales, modeling needs to incorporate information from local areas, through landscapes to the regional level (Wintel et al. 2010, Burton et al. 2014).

Resource planners often wish to predict the degree to which ecosystems will be affected by different development scenarios (Alberta Environment and Parks 2015). In addition, industries often wish to predict the magnitude of cumulative effects that will be expected from their proposed developments, after accounting for the background human development due to other activities (e.g., Schieck et al. 2014). To simulate future conditions, models from species-response gradients are applied to the focal landscape where future development(s) have been simulated. These scenario predictions are not actual assessments of future ecological condition; the predictions are only as good as the information used to build the models, and only apply to areas that are similar to where the modeling data were collected (Burton et al. 2014). As such, cumulative effects monitoring is required to confirm the predictions, and in places where the models are found to be inaccurate additional research and adaptive management are used to improve management over time.

In the present initiative, we will combine information from targeted sampling with information from ABMI systematic sites, to create mathematical models that describe how species are affected by mining and *in situ* footprints. The influence of other types of human development (forestry, agriculture, urban development, and transportation) on these relationships will also be identified. Finally, tools will be created so that stakeholders can predict future biotic condition in simulated landscapes throughout the Oil Sands region. Targeted sites will be selected to survey habitats that are under-represented by the ABMI systematic sites. All sampling will be conducted using the suite of protocols that has been deployed by ABMI since 2007 (Alberta Biodiversity Monitoring Institute 2016d & 2016e).

Targeted and systematic sampling by the ABMI to date is summarized in Table 1. Due to relatively low levels of energy and other industrial development in northern Alberta, approximately 70% of the ABMI systematic sites (565 of 793 sites) do not have human disturbance. The other 228 systematic sites, and all 99 targeted sites, had human disturbance of various types (Table 2). Based on this information, coarse models of how species respond

to industrial developments have been created (Alberta Biodiversity Monitoring Institute 2016c). The present monitoring initiative will target data collection at sites that are presently under-represented in the sample, and use the resulting information to refine the models.

Table 1. History of biodiversity monitoring (2007-2016) at ABMI systematic and targeted sites in the Oil Sands Region, and in the remainder of the Boreal, Shield and Lower Foothills Natural Regions.

	Oil Sands Region		Boreal, Shield, and Lower Foothills Outside the Oil Sands Region	
	Systematic sites	**Targeted sites**	**Systematic sites**	**Targeted sites**
2007	44	0	19	0
2008	27	0	35	0
2009	36	0	9	0
2010	25	0	28	26
2011	38	10	28	3
2012	59	7	36	2
2013	97	15	28	4
2014	74	12	37	6
2015	54	13	7	1
2016	106	0	6	0
Total	**560**	**57**	**233**	**42**

Note: Information from sites in the Boreal, Shield and Lower Foothills Natural Regions, but outside the Oil Sands Region, are used to increase statistical power in the models and to extend the range of conditions that are incorporated in the models.

Table 2. Number of sites (systematic plus targeted) with each type of human disturbance. This information, plus information from the 565 ABMI systematic sites that had no human disturbance, were used to create coarse models describing how species response to industrial activity.

Industrial Sector	Number of Sites
Sites with Energy Footprint (Seismic)	13
Sites with Energy Footprint (Pipeline)	44
Sites with Energy Footprint (Wellsite)	18
Sites with Energy Footprint (Mine)	15
Sites with Energy Footprint (Facility)	57
Sites with Forestry Footprint	119
Sites with Agriculture Footprint	82
Sites with Urban Footprint	8
Sites with Transportation Footprint	26
Total	**327**

2. Objectives

i. Assess how biodiversity are affected by energy disturbances throughout the Oil Sands region.
ii. Create modeling tools/information that stakeholders can use to predict future biotic condition in simulated landscapes in the Oil Sands region.

iii. Assess the degree to which other industries (forestry, agriculture) and other human development stressors (urban development, roads) have synergistic effects with Oil Sands development on biodiversity.

For all three objectives:

- Biotic responses will be modeled across a diversity of taxa (mammals, birds, vascular plants, bryophytes, lichens, mites, wetland plants, and aquatic invertebrates) to understand how life history characteristics influence the effects.
- Biotic responses will be modeled throughout the Oil Sands region (Athabasca deposit, Peace River deposit, and Cold Lake deposit) so that differences among landscapes are incorporated in the models. Biotic responses are expected to differ based on landscape context, and habitat type (see above).
- Targeted sampling will be focused on habitats that are under-represented in the regional long-term biodiversity monitoring network (i.e., within the ABMI systematic network of sites).
- To reduce costs, analyses and reporting will be integrated with that being done as part of the regional long-term biodiversity monitoring initiative.

3. **Monitoring Area**

The monitoring area for this initiative includes all three Oil Sands Deposits (Athabasca, Cold Lake, Peace River). In addition, information collected from other sites in the Boreal, Shield and Lower Foothills Natural Regions, but outside the Oil Sands Region, will be used to increase modeling power, and extend the range of conditions that are incorporated in the models.

4. **Methods and Monitoring Design**

As suggested by Haughland et al. (2010), we will minimize costs and maximize value by integrating samples between the ABMI long-term monitoring program and the present targeted monitoring to describe how biota are affected by footprints created by the energy industry. To maximize use of existing information, survey methods at targeted sites will be the same as those used by ABMI, and will include mammals, birds, vascular plants, bryophytes, lichens, mites, wetland plants, and aquatic invertebrates. To extend the range of conditions sampled, all data collected by ABMI during the past decade will be included in the analyses (Table 1, above). This includes samples form the Boreal, Shield, and Lower Foothills natural regions since species-habitat associations are similar throughout these regions (Alberta Biodiversity Monitoring Institute 2016c).

Each year an ABMI panel of systematic sites will be surveyed in the Oil Sands region (approximately 110 sites, see “Long-term biodiversity monitoring initiative” for a description of this work). In addition, to create robust models, we will target sampling to habitats that are under-represented at ABMI systematic sites. The goal is to have at least 100 sites spanning the intensity of development for each type of disturbance; 200 sites are needed for forest harvest because biotic impacts differ among forested stand types, and these effects recover gradually over time as trees regrow in the cutblocks. Targeted samples will be in areas that have high intensity development, because that data is missing from the systematic samples. Targeted sampling will be dispersed throughout the Oil Sands region, so that the resulting models are applicable across the region. In addition, targeted sampling will

encompass all natural habitats so that modeling includes the complete range of biotic response. 12 targeted sites are will be selected each year (types of human footprints to be selected are described in Table 3). Where possible, we will opportunistically survey additional sites with human footprint each year. Annual adjustments may be required to accommodate the disruption of monitoring activities due to wildfire, and other unforeseen circumstances, and to optimize travel costs. This project leverages ABMI sampling at systematic sites, and past ABMI investments at systematic and targeted sites, to increase efficiency of the modeling.

Table 3. Planned biodiversity monitoring at targeted sites in the Oil Sands Region, 2017-2021.

	Number of Targeted Sites to be Sampled				
Industrial Sector	**2017/18**	**2018/19**	**2019/20**	**2020/21**	**2021/22**
Sites with Energy Footprint (Seismic)	2	3	2	2	2
Sites with Energy Footprint (Pipeline)	2	2	1	1	1
Sites with Energy Footprint (Wellsite)	2	4	2	2	2
Sites with Energy Footprint (Mine)	2	1	2	2	2
Sites with Energy Footprint (Facility)	4	2	1	1	1
Sites with Forestry Footprint			2	2	2
Sites with Agriculture Footprint				1	1
Sites with Urban Footprint			1	1	
Sites with Transportation Footprint			1		1
Total	**12**	**12**	**12**	**12**	**12**

At all targeted sites, will be surveyed using the same suite of protocols as used at ABMI the systematic sites (these protocols have been deployed since 2007; Alberta Biodiversity Monitoring Institute 2016d, & 2016e).

Terrestrial monitoring protocols involve 3 visits in a given year at each site (ABMI 2016d). Monitored parameters include:

- % cover of water, bare soil, and low vegetation, shrubs, trees
- Tree density (live, dead, down)
- Soil parameters (LFH, organic, mineral)
- Vascular plant diversity
- Bryophyte diversity
- Lichen diversity (samples collected but not identified in the lab)
- Bird diversity
- Mammal diversity
- Mite diversity

One open-water wetland site near every terrestrial site will be monitored during a single visit at each targeted site (ABMI 2016e). Monitored parameters include:

- Water chemistry, nutrient content, and isotopic signature
- Wetland classes (mineral or organic)
- Area covered by open water, emergent vegetation, graminoid and wooded vegetation.
- % cover of water, bare soil, low vegetation, shrubs, and trees around the wetland
- Area and type of natural and human created disturbance in an around the wetland
- Vascular plant diversity
- Aquatic invertebrate diversity

Specimens of vascular plant, bryophyte, mite and aquatic invertebrate species will be sorted and identified after the field season is complete, under the supervision of taxonomists at the Royal Alberta Museum (Alberta Biodiversity Monitoring Institute 2010, 2011a, 2011b, & 2015). Audio recordings will be processed at the University of Alberta (Bioacoustic Unit 2015, Lankau 2015), and remote camera images will be processed by ABMI staff (Alberta Biodiversity Monitoring Institute 2016a).

Information collected from targeted sites will be subject to the same quality management process that is used for all ABMI data (Sólymos et al. 2015). Data are collected using standardized field and identification protocols (described above), with multiple levels of checking and verification during the data loading, storing, and analyses (Alberta Biodiversity Monitoring Institute 2016b).

Assumptions

Resources for this initiative will be used to support field data collection, and specimen identification. Modeling and reporting will be integrated with the ABMI long-term monitoring initiative to reduce costs.

Assumptions:

- Resources will be available in a timely fashion to conduct the field work and specimen processing.
- Resources will be available in the ABMI long-term monitoring initiative to support modeling and reporting.

Linkages to other OSM projects

Status and trends of biodiversity in the oil sands region: **Long-term biodiversity monitoring at ABMI systematic sites**

- Past ABMI data collection will be integrated into the analyses to evaluate how biota are affected by footprints created by the energy industry in the Oil Sands region. This includes samples form the Boreal, Shield, and Lower Foothills natural regions because species-habitat associations are similar throughout these regions.
- ABMI information collected at systematic sites in the future will also be included in the analyses (see Long-term biodiversity monitoring at systematic sites for a description of this future data collection).
- Targeted sampling for the present initiative will be in habitats that are under-represented at ABMI systematic sites, and previous targeted sites (see description above).

- Survey methods at the targeted sites will be the same as those used by ABMI systematic sites to facilitate integration.

Outcomes

See Deliverables, above.

References

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Nichols, J.D. and Williams, B.K. 2006. Monitoring for conservation. Trends in Ecology & Evolution 21: 668-673.

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Schieck, J., and S.J. Song. 2006. Changes in bird communities throughout succession following fire and harvest in boreal forests of western North America: a literature review and meta-analyses. Canadian Journal of Forest Research 36:1299-1318.

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Wintel, B.A., Runge, M.C., Bekessy, S.A. 2010. Allocating monitoring effort in the face of unknown unknowns. Ecology Letters 13: 1325–1337. doi:10.11 1 1/j. 1461-0248.2010.01514.x.

Zedler, J. B. and Callaway, J.C. 1999. Tracking Wetland Restoration: Do Mitigation Sites Follow Desired Trajectories? Restoration Ecology 7: 69–73. doi: 10.1046/j.1526-100X.1999.07108.x.

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**)

Sampling Locations/Sites	**Sampling Schedule** (*timing/frequency)*	**Compounds to be Analyzed**	**SOPs to be Consulted** (*hyperlinks accepted*)	**QA/QC Complete & Date Data to be Released**
Insert location information here. Targeted sites for 2017/18 presently being selected	**Terrestrial:** Winter/Spring/ Summer **Wetland:** Summer	**Terrestrial:** *Winter:* - Breeding Birds (ARUs) - Mammals (Cameras) *Spring:* - Bryophytes - Lichen (collected but not identified in the lab) - Soil Cores* (mineral and LFH; soil arthropods – springtails and mites) - Trees, snags, and stumps - Downed woody material - Site photographs - Incidental *Summer:* - Vascular Plants* - Tree ages* - Shrub and canopy cover - Surface substrate - Incidental species - Camera/ARU retrieval **Wetland:** *Summer:* - Vertebrate species - Wetland characteristics - Water physiochemistry and nutrients* - Aquatic invertebrates* - Vascular plants* - Incidental species	ABMI 2016a *Chapter 3: Monitoring Centre QMP*; Sections 3.2 & 3.3 *Chapter 4: Processing Centre QMP*; Section 4.2 & 4.3 *Chapter 5: Information Centre QMP*; Section 5.2.	**Field Sampling** ***Habitat Data*** 1. QA/QC: February 2018 2. Release: October 2018 ***Species Data*** 1. QA/QC: August 2018 2. Release: October 2018

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)

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	$231,405		$231,405		$233,719		$236,056		$238,417	
2) Operations and Maintenance										
a) Equipment										
b) Helicopter										
c) Lab analysis	$18,595		$18,595		$18,781		$18,969		$19,158	
d) Data management										
e) Field work	$10,000		$10,000		$10,100		$10,201		$10,303	
f) Access Management										
g) Communications										
h) Science Operations (protocol testing, etc.)										
3) Consumable Materials and supplies										
a) Disposable Field Equipment (i.e. batteries, ribbons, etc.)										
4) Travel										
a) Conferences and meetings										
b) Field work – Travel (Fuel,	$40,000		$40,000		$40,400		$41,804		$41,212	

Accommodations, Food)										
c) Access Management Travel										
5) External Contracts										
a) (*Describe External Contractor*)										
Grand Total	$300,000		$300,000		$303,000		$306,030		$309,090	

Note #1: For many of the rows, costs are small and not included in this budget. These costs are integrated into the ABMI systematic data collection project, and funded there.
Note #2: All targeted sites will be accessed using trucks and quads (no helicopter).

Appendix 3 – Staffing Plan

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

	Year 1 – Budget Allocation		Year 2 – Budget Allocation		Year 3 – Budget Allocation		Year 4 – Budget Allocation		Year 5 – Budget Allocation	
Responsible Role	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding	OSM Funding	External Funding
Taxonomists - **all at 0.06 FTE** - Processing Assistant 0.06 FTE - Aquatic Invertebrates 0.06 FTE - Acarologist 0.06 FTE - Vascular Plant Specialist 0.06 FTE - Bryologist 0.06 FTE - Laboratory Techs 9 @ 0.06 FTE	$61,405		$61,405		$62,019		$62,639		$63,266	
Technical/Field Staff - Terrestrial Field Coords 0.25 FTE - Terrestrial Field Technicians 0.25 FTE - Seasonal staff 2 @ 0.33 FTE	$170,000		$170,000		$171,700		$173,417		$175,151	
Grand Total (*inserted into Appendix 2*)	**$231,405**		**$231,405**		**$233,719**		**$236,056**		**$238,417**	

Note: Costs for program management, data management, data analyses, and reporting are not included in this budget. These will be integrated with that for the ABMI systematic data collection and funded there.

Appendix 4 - Approvals

Project Submitted by:		
Name:		
Organization:	Signature:	Date:

Project Approved by:		
Dr. Monique Dubé (AEP)		**Dr. Kevin Cash (ECCC)**
Signature 		Signature 
Date		Date