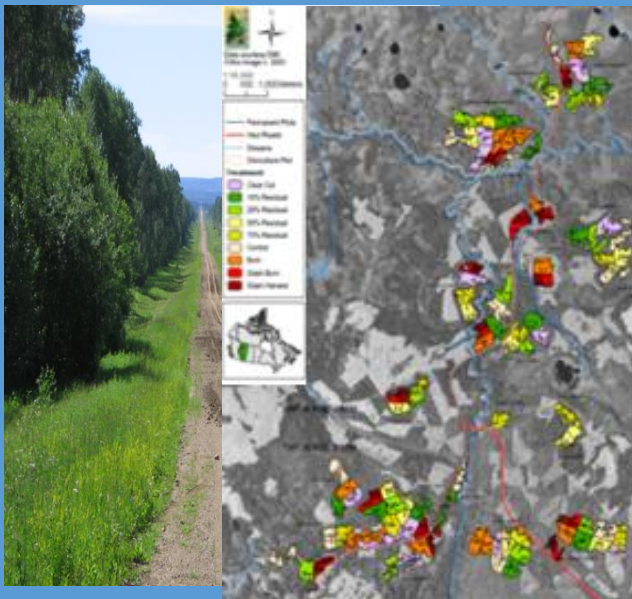


# THE EMEND PROJECT

## 2016 Annual Report

Including the April 2016-March 2017 Fiscal Reports



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UNIVERSITY OF ALBERTA

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## Executive Summary

2016 was another full year of field research at EMEND combined with analyses and writing, and behind the scenes efforts to secure the future of the project. Highlights include: a very successful spring graduate student tour and presentations to the GoA, DMI, and Canfor; an EMEND Applications workshop with Canfor staff; and a determined/dedicated 14 person core crew. Early in the 2016 field season the site was closed due to extreme fire risk. Then we had to close the camp in mid-to-late-May due to a heavy snow fall which blanketed the area (thankfully this decreased the fire risk). This snow took down several large trees and bent many of the young trees that had already leafed out. As a result, the core crew spent eight full days clearing trails and making the site safe for all users. Overall, weather events and the associated responses reduced the time available for core crew work by c. 25%.

The EMEND Management Committee (EMC) saw a small change in representation with the retirement of Bill Tinge from fRI, and his replacement by Ryan Tew. Dr. John Spence announced a firm retirement date of June 30, 2017, with Dr. Ellen Macdonald to take over gradually during early 2017 as the UofA lead. David Langor will continue to represent NRCan as its lead scientist for EMEND. Amanda (Amy) Hayden continues to serve as Project Coordinator; however her present funding will expire in March 2018. Fuse Consulting, under Matthew Pyper, continues to provide an excellent Knowledge Exchange Program, and to assist in directing the EMC meetings.

Our core crew was large this year, starting with 14 members (8 (ended with 5) Lead Field Assistants (Jeff Anderson, Julien Appleby-Millette, Micki Baydack, April Cromack, Claire Kisco, Ryan James, Michael Rudy, and Even Schiedt), and 6 field assistants (Alexandria Burns-Bye, Nicholas Kozakovich, Janelle Lee, Jessica Newman, Daniel Simard, and Daniel White) given hopes of completing the 15-yr assessment. However, as mentioned above, progress was limited by poor spring weather and heavy precipitation in July and August. As a result, only about half the Shrub Assessment, and a third of the assessments for both Snags and Coarse Woody Materials (CWM) were completed. However, our highest priority for 2016, the bryophyte assessment and collection, was completed.

Seung-Il Lee and Hosen Alam both successfully defended their theses while our other graduate students continued to advance their projects. Five grad students (Robinson (MSc), Franklin (PhD), MacKenzie (MSc), Sewell (MSc), Domahidi (MSc)) finished their field work and the remaining six did lab work/analysis/writing (Echieverri (MSc), Ronzani (MSc), Amos (MSc), Bartels (PDF), Wu (PhD), Xing (PDF)). Eight thesis defenses are expected during 2017 or early 2018. The search for a student to fill the Trade-off (PhD. # 5) work under the CRD is still in progress. Drs. Bergeron and Pinzon, assisted by Dr. Lee, continued to work on the Carbon work and EMEND 10<sup>th</sup> Year Synthesis under the FRIAA funding. All present funding to support graduate students will be exhausted in 2017 or early in 2018. If additional graduate students and this sort of research is desired by the EMC it is essential that further funding and willing supervisors be secured.

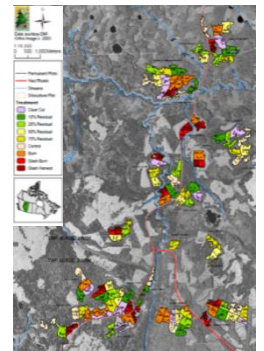
At the field camp, repairs and upgrades were necessary in 2016. The lab roof was replaced, because of the health and safety issues, and the roof of the kitchen trailer was also replaced to fix a leak in the pantry. The cost of these two repairs were paid for through camp fees. Such expenses are an ongoing challenge. For example, all three roofs on the main building are disintegrating and will need to be replaced in 2017. One of our EMEND vehicles was written off in the winter of 2015 and therefore it was necessary for us to rent 3 vehicles to get all of our field assistants into the field. Several of the ATVs are showing signs of wear and tear and will need to be replaced in the near future. Because power has been out for extended periods over the past few years, causing massive losses of food and supplies, we recommend purchase of a back-up generator to run freezers, fridges and water.

The EMEND Health & Safety Program was successfully implemented to good effect again during 2016. The reported incidents and near misses (based on person days) decreased again this year. We expect that the University of Alberta Environmental Health & Safety Department will perform an internal audit of our Emergency Response Plan during 2017.

## Project Introduction

The EMEND (Ecosystem-Based Management Emulating Natural Disturbance) Project, is a valuable and highly relevant resource to sustainable forestry in the western boreal region. It is remotely located northwest of Peace River, Alberta, Canada. The heart of EMEND is a large-scale (1000 ha) variable retention harvest experiment set within a 7000 hectare forested landscape, protected for long-term ecological research. EMEND was designed to answer questions about how retention of green-tree residuals affects harvest cost, forest regeneration, patterns of succession, biodiversity, nutrient cycling, ground water characteristics and public perception of forestry activities, and to be a resource for developing science-based policies about forest management. EMEND is the first of its kind and is believed to be the largest single site, manipulative forestry experiment in the world. It is used by the Canadian government to illustrate the modern Canadian approach to forest management. Since its inception it has inspired other research efforts around the globe.

The experimental site has been developed through significant industrial and public investment. Project design and planning occurred during 1996-97. These meetings featured a scientific committee involving both federal and provincial governments, research bodies, and industry. The experiment was laid out in previously un-harvested forest in 1997-98, and harvest treatments were executed during in the winter of 1998/99. Collection of the experiment-wide or “core” data required to monitor EMEND has been conducted at 5 year intervals, with 2-3 years required to collect these data. The plan is to collect data for at least one stand rotation, or approximately 80-100 years. The experiment allows scientists to study a real industrial forest, from initial harvest through a first rotation harvest. This will provide unique insights into processes over an entire woodland life cycle.



EMEND funded research consists of two main components: 1) a core research program, designed to elucidate long-term patterns of response to disturbance on the research site; and 2) a graduate student program that seeks to answer a broad range of focused scientific questions about the responses of biodiversity, productivity, and social values to variable retention harvesting through original scholarly research. Work under component #2 connects EMEND to a vibrant international research culture and provides exceptional educational opportunities to secure the interests of university-based scientists, while that under component #1 assists industry and governments directly with knowledge upon which to develop scientifically-defensible operating rules and policy for forestry in Alberta and elsewhere. Taken together these efforts comprise the double edges of the research and development sword, which we aim to keep as sharp as possible, given the resources available.

The project is comprised of an ‘experimental site’; a ‘remote field research facility’ (camp & field lab), and some limited equipment (trucks, ATVs, chainsaws, etc.). The research facility, and some of the equipment, was purchased through contributions from our industry partners and the University of Alberta together with a large grant from the Canada Foundation for Innovation. The research site is readily accessible by an all-weather forest road that facilitates both research and demonstration of the benefits of EMEND to a wide variety of audiences. The project consequently enjoys regular visitors as well as a growing national and international reputation for its design, credibility, long-range view and its longevity as a model partnership among industry, government and academic collaborators.

EMEND continues to inform management applications and policy in a way that balances social, environmental and economic values; thus the project remains relevant across northern boreal landscapes. While the program’s roots are founded in forest management questions, the fundamental knowledge of the structure and function of boreal ecosystems holds distinct value beyond the forest sector, and should be of significant value to any group attempting to manage boreal forest land.

## The Management Committee

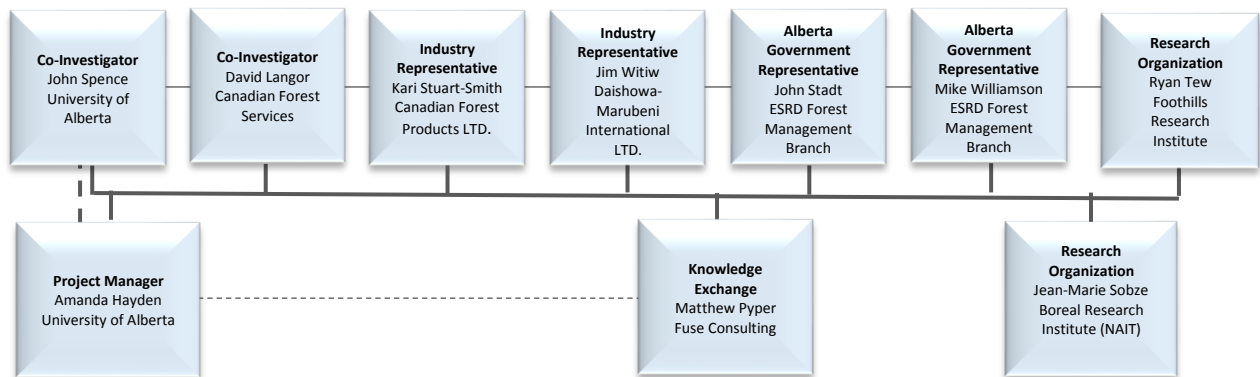
EMEND continues to take direction through an EMEND Management Committee (EMC) which is comprised of representatives from our central partner organizations. Management of the research and extension program occurs through the University of Alberta (UA), with scientific leadership shared between the University of Alberta and Natural Resources Canada (through the Canadian Forest Service (CFS)). There was a small change in EMC representation in 2016 with Ryan Tew taking over for Bill Tinge at the Foothills Research Institute (fRI). The EMC members in 2016 included:

- John Spence (UofA, Science Co-Lead)\*
- Dave Langor (NRC, NoFC, CFS, Science Co-Lead)
- Jim Witiw (DMI)
- Kari Stuart-Smith (Canfor)
- John Stadt (Alberta ESRD –Forest Management Branch)
- Mike Williams (Alberta ESRD –Forest Management Branch, Peace River)
- Bill Tinge / Ryan Tew (Foothills Research Institute)
- Jean-Marie Sobze (novaNAIT Boreal Research Institute, AFEX) (Associate Member)

\* Dr. Ellen Macdonald, Chair of the Department of Renewable Resources, was brought into EMC deliberations starting in September 2016, to facilitate transition of the UofA Co-Lead to her as John Spence heads into formal retirement, effective 1 July 2017.

Fuse Consulting, continues to be contracted by the EMC to facilitate the knowledge exchange program with external contract support, as determined by the EMEND partner organizations. Matthew Pyper, Fuse Consulting President and manager, is also contracted to assist in facilitating EMC meetings.

### a) Management Committee Structure



### b) EMEND Management Committee Activities

There have been fewer EMC activities during this transition year than in previous years. EMC activities have included: two EMC meetings; a student-partner engagement tour during which students presented on their research to Alberta Agriculture & Forestry, Canfor, and DMI; a Workshop with Canfor Representatives to discuss pertinent EMEND Research; and a presentation to the DMI Public Advisory Committee. The University Renewable Resources Administration continues to be in contact with partner representatives regarding establishment of an NSERC Industrial Research Chair (IRC) position. This individual will be expected to take on scientific leadership for EMEND while developing a research program on ecosystem-based forest management addressing key questions of high relevance to Alberta and western Canada.

### c) Plans for 2017

- Dr. John Spence's retirement from the University of Alberta
- Partner engagement tour with DMI and Canfor's PACs
- EMEND Workshop
- Continued forward movement on establishment of the NSERC Industrial Research Chair (IRC) (FRIAA Application, candidate selection)

## Core Project Personnel

### PROJECT COORDINATOR

Amanda (Amy) Hayden continues in the position of EMEND Program Coordinator. She coordinates the EMEND Program Activities, working closely with Drs. Spence, Macdonald, and Langor (NoFC), to support development of the science and educational programs at EMEND. This position tackles a number of components of the project alleviating pressures on Lead Scientists and EMC members in: reporting, funding and financial reconciliation, health and safety program management, equipment and infrastructure management, graduate student and PDF liaison, EMC liaison, core program management and planning, human resources needs, knowledge exchange contact, training, camp and site management, and answering correspondence and requests. Her formal supervisor is the UofA Science Co-Lead (Spence in 2016).

### DATABASE MANAGER

Brad Tomm, of CFS, continues to be the database manager. Brad is responsible for the proper running and functioning of the EMEND data base. He provides appropriate access to the database upon request; enters, cleans and organizes data; updates information; and provides clarification on data to those who need it. Brad reports to Dave Langor and liaises with John Spence and Amy Hayden.

### WEBSITE MANAGER

Jon Elofson, of CFS, continues to be the website manager with administrative access by Amy Hayden and Matthew Pyper. Jon is responsible for designing and maintaining the website as well as making any major changes that are requested. Jon reports to Dave Langor and liaises with John Spence and Amy Hayden.

### CAMP FACILITIES COORDINATOR

Sandy Bjorgan was brought back this season to manage camp needs including: first contact with contractors, managing supplies and food on site, general camp cleaning and cooking. The camp facilities coordinator reports directly to Amy Hayden and is formally supervised by the UofA lead.

### CAMP COOKS

Jane Irving was brought on as a full time camp cook, while Lavern Cuff was brought on as a relief cook to cover days off. Camp cooks were responsible for ensuring that quality food was prepared, and health and safety guidelines were followed. Camp cooks reported directly to Sandy Bjorgan, with Amy Hayden as immediate supervisor.

### CORE CREW

#### *Lead Core Crew*

Seven Lead core crew field assistants were hired, including Jeff Anderson, Micki Baydack, Ryan James, Evan Scheidt, April Cromack, Michael Rudy, and Claire Kisko. After losing April, Mike, and Claire mid-season (due to full-time work opportunities elsewhere) Julien Appleby-Millette was brought on as a lead.



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Lead field assistants were responsible for creating daily work plans, reporting hours, and leading field work. Leads reported directly to Amy Hayden with John Spence as formal UofA supervisor.

### Field Assistants

Six field assistants were hired in 2016 with the hopes that at least 2 more would be brought on if additional funding was made available. Our field assistants were: Alexandria Burns-bye, Nicholas Kozakevich, Janelle Lee, Jessica Newman, Danielle Simard, and Daniel White. Field assistants reported directly to Amy Hayden with John Spence as formal UofA supervisor

## Core Activities

Core Activities are mainly the collection of research wide data and maintenance of the experimental site and field research facilities. Core Activities are prescribed seasonally by the EMC and managed the day-to-day by the Lead Assistants and the Project Coordinator. Due to an anticipated funding deficit in 2016 it was decided that compartments in the forest type “Aspen Dominant with Spruce Understory (ADOMU)” would be left out of all remaining assessments; ADOMU stands have shown a correlation with Mixedwood stands.

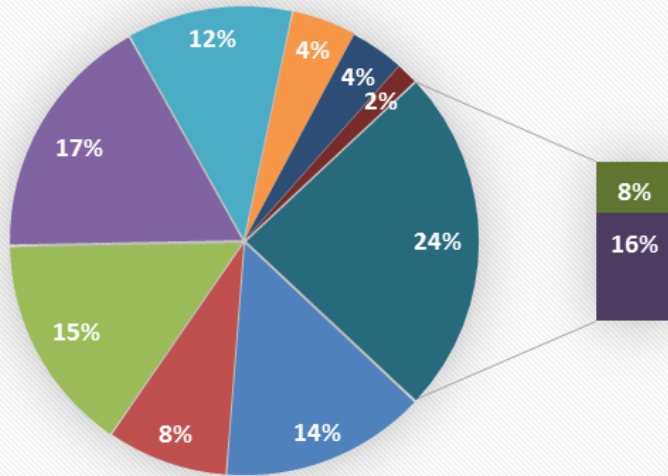
### a) 2016 Core Activity Summary

Core activity during 2016 focused on collection of core data with the goal of completing the 15<sup>th</sup> year Assessment. Unfortunately, due to funding shortfalls, higher than anticipated times required for collection, and extreme weather conditions the assessment was not completed during 2016 as planned. The tables, charts and graphs below depict: (1) core hours spent on each core related project; (2) allocated time based on funding; (3) time allocations to types of work completed; and (4) split between each of the funding agencies. As noted in the chart a total of 7557 hours were worked by core staff this field season. Approximately 54% of the core work was funded by a FRIAA-FRIP Grant, 34% was funded by direct DMI funds, 4% funded by the GoA, and 8% funded by others in 2016.

Project	Core Allocation	Other	Total	FRIAA Funded Staff	DMI Funded Staff	GoA Funded Staff	Other Funded Staff
CWM & Snags	1075	0	1075	575.75	246.00	77	118
Shrub Biomass	631.25	0	631.25	529.75	59.8	0	30
Understory Vegetation	1137.25	0	1137.25	466.75	573.75	0	96.75
Trail and Camp Maintenance	1295	0	1295	658.5	484	62	99
Orientation, Training, Safety	864	18	882	448.75	312	36.875	63
Prep in Edmonton	336	0	336	160.0	152	20	0
Office Work	283	0	283	196.5	65	77.75	17
Other	111.25	0	111.25	73.25	27	22	7.00
Commuting Camp to Site	589.25	0	589.25	314	197	21.25	47.75
Commuting Edm. to Camp	1217	0	1217.00	612	443	17.5	98.5
Commuting Total	1806.25	0	1806.25	926	640	38.75	146
<b>Total</b>	<b>7539</b>	<b>18</b>	<b>7557.00</b>	<b>4035.25</b>	<b>2559.63</b>	<b>333.88</b>	<b>576.75</b>

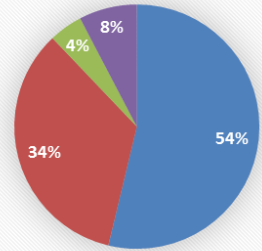


## EMEND Core Activity Breakdown



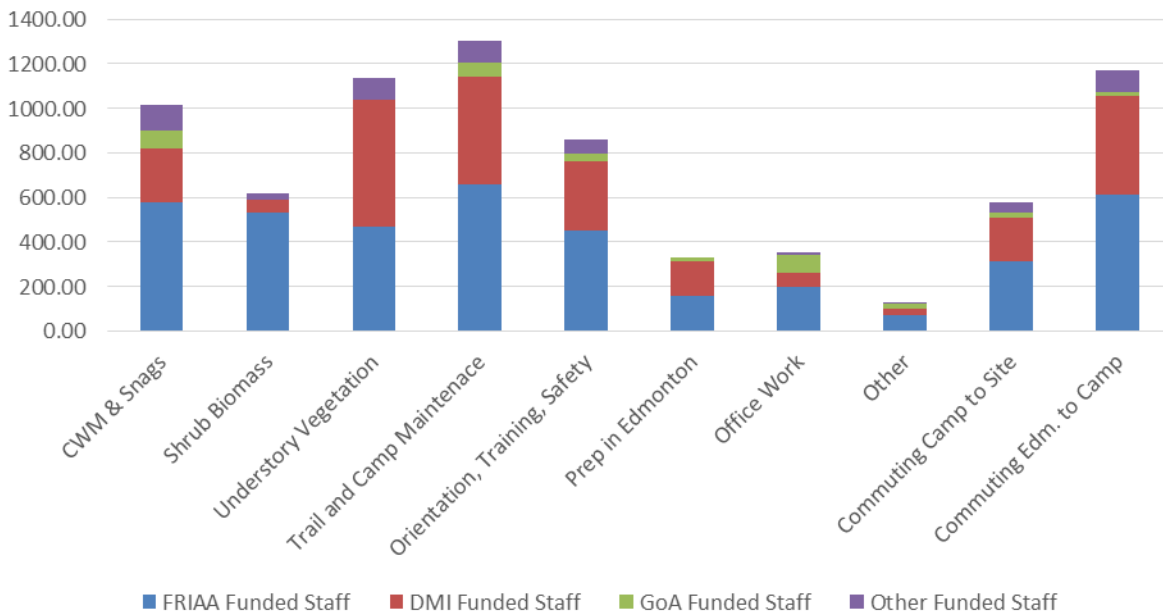
- CWM & Snags
- Trail and Camp Maintenance
- Office Work
- Shrub Biomass
- Orientation, Training, Safety
- Other
- Understory Vegetation
- Prep in Edmonton
- Commuting Camp to Site

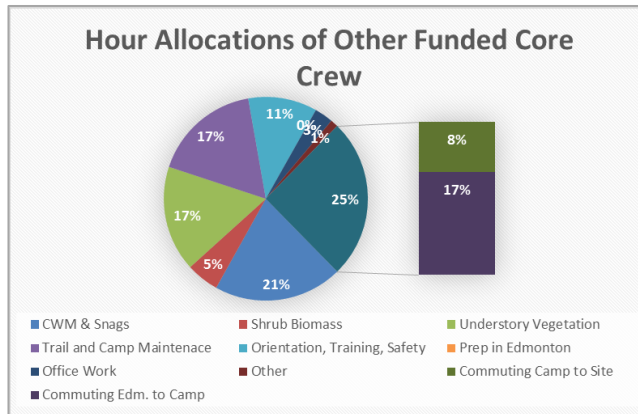
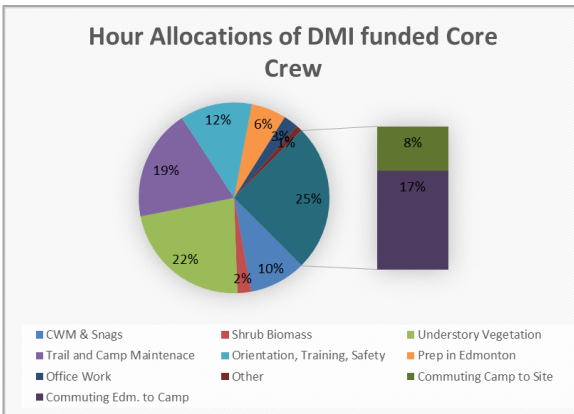
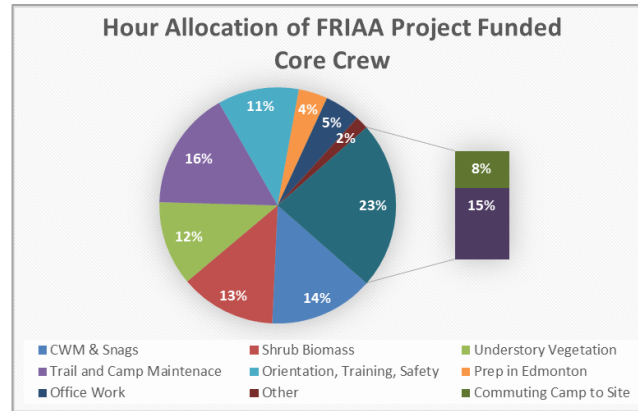
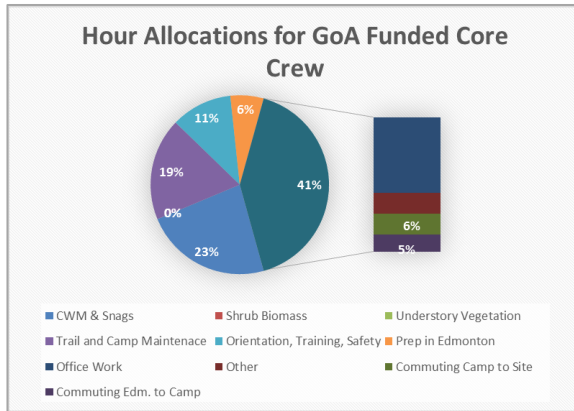
### Total Hours by Funding



- FRIAA Funded Staff
- DMI Funded Staff
- GoA Funded Staff
- Other Funded Staff

### Total Core Hour Allocation Based on Funding





Just over 33% (1/3) of the sampling was completed for both the coarse woody material and snag collections through investment of 1075 total core hours (14%). This fell short of our expectations, given the snow in May, high winds, and general ageing of the stands leading to greater numbers snags and CWM in the plots than in previous collections. For example in many of the sites where only 1-3 snags were found in previous collections, 25 or more trees were found in this collection; a similar trend is also occurring for CWM. With the assistance from Drs. Colin Bergeron, and Jaime Pinzon we updated the protocols for sampling CWM and Snags to ensure a more standardized sampling in future years.

A total of 8% of core time or 631 hours was spent completing more than 45% of the Shrub Biomass assessment. Once again this total is lower than what we initially anticipated we could finish in this field season. However, mid-season we lost one of our lead field assistants to a full-time position with another organization and with little opportunity to replace her we were required to go on with only one team doing Shrub Biomass collections. With the assistance of Drs. Colin Bergeron and Jaime Pinzon we clarified the Shrub Biomass Sampling protocol to ensure that sampling practices are standardized in future years.

The Understory Vegetation survey was completed in 2016 as we finished collecting the Bryophyte data. Overall, 1137 hours or 15% of core time was spent completing sampling of the last 495 PSPs for the Bryophyte collection. Two specialized team leads were hired to ensure high quality data collection. With assistance from Dr. René Belland, Dr. Richard Caners (Alberta Provincial Museum), Dr. Ellen Macdonald and



Ryan James (U of A—Renewable Resources) we clarified the sampling protocol to ensure sampling practices are better standardized in future years. The positive effect of this is already being seen in much less time required in the lab to identify species from the samples collected in the field.

Approximately 17% of the core time was spent doing trail and camp maintenance (1295 hours). While the fieldsite was closed due to fire hazard, the core crew worked on camp maintenance. After the late season snow melted, many of our ATV and site-access walking trails were left unpassable. In order to make the site safe for both the core crew and our graduate students we spent 8 days clearing trails. We re-established clear lines of sight, and removed large woody debris that had fallen on trails, as well as many potential head/eye injury hazards. This work category also includes a few hours allocated for lawn maintenance throughout the summer. Brandon Bjorgan volunteered approximately 60 hours (not calculated in the totals) during 2016 to aid us in completing some projects around camp, including: building a wall to the water tank structure to limit light exposure, cutting the grass, moving furniture, assisting with floor maintenance, building a bigger garden box, and other odds and ends.

A total of 882 total core hours (approximately 12% of core time) was allocated to “Orientation, Training, and Safety”. This work category includes: several days of orientation to the EMEND project and skills required to effectively collect data; ATV, Bear Awareness, First Aid, Shrub identification, and EMEND Health and Safety Training; daily safety tailgate meetings; and monthly safety meetings (including both graduate students and their field assistants).

A total of 336 (4%) core hours were spent in Edmonton doing preparation for field work. During this all Lead Field Assistants worked on protocols, training, preparing and ordering supplies, and updating data sheets. Office work absorbed approximately 283 person-hours (~ 4% of core time) and included data entry, data amalgamation, updates to sampling methods/policies, pressing/drying samples, inventorying, and tidying the lab. From early-July to the end of the season this absorbed the attention of one field assistant on limited duty due to a leg injury.

The ‘Other’ category includes, but is not limited to: supply runs, vehicle cleaning, assisting graduate students, and moving equipment. Approximately 111 hours or 1% of the core time was spent in this section. The last category is commuting. This category includes a total of 1806 total core hours or 24% of core time. This can further be broken down into daily commuting to the site at 589 total core hours, 8% of core time and commuting between Edmonton and camp at 1217 hours 16% of core time.

Unfortunately, we were unable to meet our goal of collecting the data from 450 PSPs for CWM, Snags, and Shrub Biomass this season because of the extreme weather events discussed above.

## b) 10<sup>th</sup> YEAR SYNTHESIS

Progress continues to be made on the 10 Year Synthesis report as described below:

**Chapter 1: Introduction** (Spence)—will be written once all other chapters are closer to completion.

**Chapter 2: The EMEND Landscape** (Bergeron)—is nearly complete and ready for Spence’s first read.

**Chapter 3: The Experiment** (Pinzon, Solarik, Spence, Tomm)—is ready for first editorial read. The chapter was revised this year to include a description of the EMEND database. Brad Tomm (NofC) was invited as a co-author to deal with this last piece, which is now part of the draft version of the chapter.

**Chapter 4: Productivity and Silviculture** (Solarik)—is mostly completed and ready for first editorial read.

**Chapter 5: Forest Structure Dynamics** (Pinzon, Macdonald, Langor, & Spence)—is completed and ready for first editorial read.

**Chapter 6: Biodiversity** (Pinzon, Dabros, Bartels, Macdonald, & Spence)—is still in progress (~70%). Although intended to be completed by now, analyses of such complex data are challenging and we decided to simplify this chapter by pushing several aspects of this work forward into several papers in high profile scientific journals first. One is now published in *Ecological Applications*, another is accepted for *Oikos*, and a third is under what we hope will be final review in *Journal of Applied Ecology*. We also decided to split this chapter into separate treatments of the animal and plant data, and these efforts are largely complete.

**Chapter 7: Coarse Woody Materials** (Williams, Langor)—This paper is in quite rough shape at present. We have a draft ready for a first editorial read; however, initial efforts suggest that extensive revision will be required.

**Chapter 8: Soils, Carbon and Nutrient Fluxes** (Bergeron, Kishchuk, Lee and Quideau)—is still in progress (~40%) with analysis and writing still in progress.

**Chapter 9: Synthesis, Conclusions & Recommendations** (Spence et al.)—will be written once all other chapters have been reviewed and are in the hands of primary authors for revision.

### c) Planned Core Activities (2017)

Since the 15<sup>th</sup> Year Re-measurement was not completed in 2016 as explained above, 2017 has been allocated to complete the remaining assessments: Shrub Biomass, Coarse Woody Materials, and Snags. We expect to need four core crew field technicians, six core crew field assistants, a field program coordinator, and at least 2 Post-Doctoral Fellows/Research Associates to finish the work as allocated in the table below.

Collection	Number of PSPs	Estimated hours/PSP	Total person's needed
Shrub Biomass	180(360)	1 hr/PSP (60 days)	2
Coarse Woody Materials	300	1.75 hr/PSP (87.5 days)	6
Snag Assessments	300	.75 hr/PSP (37.5 days)	2

## Graduate Studies Activities

EMEND provides a rich and uncommon educational opportunity for domestic and international graduate students, and their connections to EMEND expand the profile of the project. We offer them simultaneous exposure to policy and management challenges associated with the Canadian boreal forest across sectors, through interaction with EMEND partners during the course of their research. Graduate research projects are reviewed and approved by the EMC and managed by academic supervisors under the rules of participating institutions. Approved research focuses on questions/topics deemed relevant to northern boreal forest conservation and management, or on interesting topics for which the EMEND landscape provides an exemplary template. For a schedule of Graduate work to be done and a list of all the students, please see Appendices 1 and 2.

### a) 2016 Graduate Studies Summary

During 2016 we continued our annual partner/graduate student engagement tour. Five students visited the DMI Woodland Office Building in Peace River as well as the Canfor office and mill in Grand Prairie. Five students also participated in a session with Alberta Agriculture & Forestry in Edmonton. Graduate students presented: a) proposed work; b) work that has been completed; or c) work that has been completed along with their proposed work moving forward. Employees from our partner organizations participated to become more informed about EMEND and, especially, to help grad students develop rich perspectives about potential applications of their research. Appendix 3 (EMEND Publications) lists

EMEND published articles from 2016. Overall, we argue that the EMEND graduate student program has provided our sponsors with exceptional and most uncommon scientific, educational and reputational results. Without this EMEND ‘family’ and the scientific independence of graduate work, the project can be easily dismissed as somebody’s pet research project initiated to corroborate policies already in place.

Both the NSERC CRD and NSERC Strategic funds will expire in 2017, although we may request a no-cost extension to the CRD to invest funds allocated to an economic analysis if a suitable student can be identified. We have reached a critical point for EMEND research as it has been developed through and contributed to the work of graduate students. If this approach is to be continued, new funding must be found and additional willing academic supervisors must be attracted. No new graduate projects have been initiated for two years, and essentially no fieldwork by graduate students will be conducted in 2017.

#### DISSERTATIONS COMPLETED IN 2016

*Dr. Seung-Il Lee, Ph.D. (Supervisors: Dr. John Spence and Dr. David Langor)—Influence of variable retention and deadwood characteristics on saproxylic beetles in boreal white spruce stands.*

Retention forestry aims to maintain a significant level of continuity in forest structure, composition and complexity so as to support conservation and recovery of biodiversity and ecological function on managed landscapes; however, the amount and distribution of retention that best meets conservation goals remains unclear. The problem of biodiversity loss through direct effects of forestry seems most demonstrably acute for the saproxylic biota (i.e., species associated with deadwood). Dr. Lee sought to understand how deadwood characteristics and variable retention harvest influence the composition and diversity of saproxylic beetle assemblages in boreal white spruce (*Picea glauca*) stands on the western boreal plain of Canada. He worked in both the EMEND experiment and in nearby industrial harvest blocks. His general thesis is that forest management can be adjusted to be more sensitive to saproxylic biodiversity, and particularly, that mixing dispersed and aggregated retention on cut-blocks leads to better outcomes than traditional clear-cutting.



Dr. Lee’s database included records of 75,719 saproxylic beetles representing 377 species in 44 families collected using window traps, emergence traps, and rearing drums. Most were identified to the species level. He has demonstrated that the structure of saproxylic beetle assemblages changes progressively over the decompositional stages of white spruce deadwood, emphasizing that retention of the entire range of decay classes is necessary to conserve the associated saproxylic beetle fauna on post-harvest landscapes. Beetle assemblages also responded to retention patch size and to different levels of dispersed retention surrounding retention patches. Although small retention patches maintained or attracted representative populations of ‘initial colonizers’ 10 years post-harvest, beetle assemblages in patches  $\leq 3$  ha were strongly influenced by edge effects and less similar to those in intact forests than in larger patches. He also showed that relatively small retention patches (0.20 ha and 0.46 ha) surrounded by higher levels of dispersed retention (i.e., 20% and 50%) provided conditions sufficient to retain assemblages of early colonizing species that are broadly similar to those in intact forests.

*Mr. Hosen Alam, M.Sc. (Supervisors: Drs. Soung Ryu and Philip Comeau) — Predicting duff moisture in a boreal forest ecosystem at various retention levels.*

The Canadian Fire Weather Index (FWI) system is used across Canada and worldwide to provide numerical ratings of fuel moisture based on the fine fuel moisture code (FFMC), duff moisture code (DMC) and drought code (DC). DMC is related to dryness of the duff layer. While DMC has been widely calibrated and





validated in different stand types, it has not yet been calibrated for mixedwood sites harvested to retention prescriptions.

The objective of this research was to explore whether duff characteristics (duff load) and stand parameters (leaf area index, basal area) could be used in predicting duff moisture and whether the standard-DMC estimated by the FWI system matches with field-DMC. This study was conducted in conifer-dominated mixedwood stands that had received a range of variable retention harvesting in 1998/1999 (clear-cut, 20%, 50%, 75% - retentions and control) at EMEND. Duff moisture, duff characteristics and vegetation parameters were measured in the field and DMCs were estimated for June, July and August in 2014 across retention levels. A trenching experiment was conducted to see if transpiration losses were related to duff moisture across retention levels. The results indicated that duff characteristics were influenced by litter deposition during harvesting and addition of fresh leaf litter from regenerated aspen. However, duff moisture was influenced by slope and elevation more than tree species composition. Among the duff variables, duff load was the best predictor of duff moisture ( $R^2=0.60$ ). A three-way ANOVA revealed that standard DMC-MC relationships underestimate both field and sensor DMC in June and July.

## PROGRESS AND WORK PLANS OF OTHER STUDENTS

### 1. NSERC Collaborative Research & Development (CRD) Grant

*a. Dr. Samuel Bartels-Post-Doctoral Fellow (Supervisor: Dr. Ellen Macdonald) —Thresholds of resilience and recovery for understory plants*

Dr. Bartels (PDF) spent the past year analyzing the bryophyte and vascular plant data, preparing manuscripts and publications, and attending and presenting his findings at our partner engagement sessions as well as at the 101<sup>st</sup> Ecological Society of America Annual Meeting in Fort Lauderdale, Florida. Dr. Bartels intends to use 2017 to analyze the newly entered EMEND Core Data, analyze data from the EMEND-WAM study, and continue to write and submit manuscripts for publication and attend and present findings at the student/partner engagement sessions as well as conferences.

*b. Caroline Franklin—PhD Candidate (Co-Supervisors: Dr. Ellen Macdonald and Dr. Scott Nielsen) —Ms Franklin's work embraces two topics as laid out below.*

*-- Thresholds of resilience and recovery for understory plants*

During the past year Ms. Franklin has been finishing her field data collection, finalizing her data set, identifying her plant samples, analyzing her data, and preparing for and completing her candidacy exam. Ms. Franklin also presented some of her early results at the Canadian Society for Ecology and Evolution conference in St. John's Newfoundland (July).

*-- Fur bearers use of landscapes harvested by variable retention*

Ms. Franklin serviced her motion-triggered cameras (November 2015 & May 2016), conducted pellet counts along transects (May 2016 & September 2016), as well as entered and cleaned her data. Ms. Franklin intends to finish her analysis and prepare her dissertation for defense during spring 2018. Along the way she plans to publish her work in academic journals.

*c. Cassandra McKenzie (Supervisor: Dr. Sylvie Quideau)—Forest floor processes responses to variable retention harvesting*

Ms. McKenzie started her project in February 2016. She spent the first eight months becoming acquainted with her sub-project as well as the EMEND Project as a whole. She participated in the student engagement sessions, and performed her first season of field work. Miss McKenzie will conduct laboratory and statistical analysis of her data during 2017 and plans to write her thesis chapters and to present her findings at a soils conference.

*d. Jared Amos—MSc Candidate (Supervisor: Dr. John Spence)—Effects of retention harvesting on pollinator population assemblages in the boreal forest of Alberta*

Mr. Amos has used the past year for writing, editing, and re-analyzing his data. He completed his first chapter, and this is now back in his hands for revision after extensive comment from his supervisor. Mr. Amos plans to complete his second chapter and defend by the end of 2017.

*e. Zoltan Domahidi—MSc Candidate (Co-Supervisors: Drs. Scott Nielsen & John Spence)—Fur bearers use landscapes harvested by variable retention (CRD support for stipend) + Retention harvest and populations of Boreal and Saw-whet Owls (expenses from NSERC Discovery (Spence))*

Mr. Domahidi completed three winter track surveys on 22 transects, approximately 3.6KM (2 in 2015, 1 in 2016), as well as entered and cleaned his data. Mr. Domahidi conducted both field and lab work for the owl project. He set up five clusters of Autonomous Recording Units, checked his nestboxes for occupancy and productivity of the cavity nesting owls (approximately 350 checks). During these checks he assessed the number of eggs, number of hatched chicks, and number of fledged nestlings for each occupied nest box. At the end of the season he then cleaned the nestboxes and prepared them for the next breeding season. Mr. Domahidi and his field assistant built several additional nest boxes in hopes of expanding the project. In the lab he was able to do data entry, perform a literature search, develop a bird call recognizer (using an existing program) to identify woodpecker and owl presence at EMEND, and build a database with environmental and climate variables that will be used to model distribution and habitat of owls. During 2017 Mr. Domahidi intends to write up his data about winter tracking on furbearers and provide it to Ms. Franklin for inclusion within her paper and to prepare a MSc thesis about his owl work for defense in late 2017 or early 2018.

*f. Matthew Robinson—MSc. Candidate (Supervisor: Dr. Scott Nielsen)—Variable retention forestry's effect on amphibian populations*

Mr. Robinson completed his field work during May and June 2016, and spent the rest of the year entering, validating, and analyzing his data, as well writing his thesis chapters, which are well underway. Mr. Robinson plans to complete his analysis for his two main data chapters (tadpole growth and development in ephemeral breeding pools) and to defend his thesis during 2017.

*g. Linhao Wu—PhD Candidate (Co-Supervisors: Drs. John Spence and Fangliang He)—Incorporating succession into understanding temporal variation in post-harvest recovery after variable retention harvest.*

Mr. Wu, worked to finished identification of his extensive collections, entered and validated his data, analyzed both his own dataset and those from the overall EMEND Project. He also attended and presented papers at two international meetings: the European Carabidologist's Meeting in Croatia, and an IUFRO Regional Congress in Beijing. Mr Wu has passed his candidacy exam and is working full-time on development of his dissertation. He will continue to work on preparing his dissertation for defense which is presently on track for defense in November 2017.

*h. Student sought either as a PhD student or a PDF. —Trade-offs between flow of wood products and conservation biology*

Good progress was being made on this project by Mrs. Khan, however in late September she decided to leave the program over disagreement with her project supervisor, Dr. Glen Armstrong. There has been no response from Mrs Khan to requests from Amanda Hayden, Dr. Spence, or the University of Alberta Graduate Student program regarding the work she had done. Some unexpended funds remain and attempts are being made to achieve something toward this work through recruiting another student to work with another supervisor.



*i. Dr. Jaimie Pinzon—Post Doctoral Fellow (now Research Associate) with Dr. John Spence*

Dr. Pinzon was initially brought onto this project as a Post-Doctoral Fellow co-supervised by Dr. Spence and Dr. He. During 2016 his position was upgraded to that of a Research Associate associated with Dr. Spence's Laboratory. Pinzon is an essential member of the broader EMEND research team, assisting most students with the analysis and use of the EMEND database that he understands very well. His central task in the EMEND work is responsibility for the integrated overview of the exceptional 10-yr biodiversity dataset that has resulted from the project, including results achieved under the CRD. In late 2016 he secured a permanent position with the Canadian Forest Service, but has permission to continue his contribution to the Synthesis from that post.

## 2. NSERC Strategic Grant (Wet Areas Mapping)

*a. Paul Sewell—M.Sc. Candidate (Co-Supervised by Drs. Sylvie Quideau and Miles Dyck)—Assessment and investigation of the soil ecosystem and the underlying processes controlling the differences in carbon fluxes, soil moisture, terrain gradients, and vegetation*

Mr. Sewell had a busy year. He did several graduate level courses and presented a poster at the Alberta Soil Sciences Workshop. He summarized his field notes and processed the samples from his 2015 field season. During his field season Sewell sampled the forest floor and top 7.5cm of mineral soil in the WAM plots; he also measured the in situ carbon flux along a slope and moisture gradient. Mr. Sewell plans to continue work with his samples from 2016 during the upcoming year. He will also perform biomarker analysis to investigate changes in the chemical composition of the forest floor materials along a decomposition gradient, and begin a second round of incubations on the soils samples.

*b. Silvia Ronzani—MSc Candidate (Supervised by Dr. John Spence) — Variation in carabid beetles along moisture gradients as predicted using WAM*

Ms. Ronzani has used the past year to sort and identify specimens collected in 2015. To date she has identified more than 7000 individual carabids. She is also entering data and doing preliminary analysis as she goes. Late in 2016 she switched to an MSc program from her original PhD program. Ms. Ronzani participated in the "Girls in Science" project—a one day event that exposes young girls to science in order to inspire them to pursue their aspirations. Ms. Ronzani spent two weeks in the field with Ms. Echiverri cleaning up sites used for their projects. Ms. Ronzani intends to analyze her data and prepare her thesis for defense by December 2017.

*c. Laureen Echiverri—MSc Candidate (Supervised by Dr. Ellen Macdonald)—assessing the relationship between remotely sensed predictor variables and vascular plants*

Ms. Echiverri has spent the past year focused on identifying difficult specimen, doing data analysis, and writing her first chapter. She spent 2 weeks in September cleaning her field sites. Ms. Echiverri also participated in both poster and oral presentations of her work at several workshops and conferences this past year, and plans a thesis defense early in 2017 (successfully defended May 2017).

*d. Dr. Samuel Bartels—Post-Doctoral Fellow (Supervised by Dr. Ellen Macdonald)—Variation in bryophytes biodiversity along moisture gradients as predicted using WAM.*

Dr. Bartels has used the past year to clean and error-check the existing EMEND bryophyte data and perform preliminary analysis on the EMEND and WAM data. Dr. Bartels contributed data and results towards an oral presentation at a workshop organized by Alberta Agriculture and Forestry. He also spent a few days in the field getting acquainted to the EMEND Site. Dr. Bartels plans to compile the complete understory vascular plant and bryophyte database to incorporate into the broader EMEND database during 2017. He will complete analysis of the WAM bryophyte data, produce at least two manuscripts for publication, and participate in conferences and workshops.

*e. Dr. Dingliang Xing—Post-Doctoral Fellow with Dr. Fangliang He—Forest productivity and tree mortality as predicted using WAM*

Dr. Xing was very productive this past year analyzing his data and writing several publications which are in the process of being submitted. He also participated in the GoA workshop in Edmonton. Although Dr. Xing's PDF's funding under this project finished in 2016, he is intent on publishing his remaining papers.

### 3. FRIAA Forest Resource Improvement Program (FRIP) Grant

*Drs. Colin Bergeron & Seung-Ill Lee—Research Associate and Post-Doctoral Fellow (Supervised by Dr. John Spence)—Local carbon dynamics associated with coarse woody debris*

#### *Integration of EMEND post-harvest carbon data*

Allometric equations to estimate above- and below-ground tree biomass were updated in collaboration with biostatistician Dr. Dingliang Xing from the University of Alberta. A scientific manuscript is in progress presenting the local EMEND allometric equations and showing that using equations developed from a nation-wide dataset can result in up to 40% error in biomass (and therefore carbon) estimation for specific forest areas. All analyses for this manuscript are done and introduction, methods, results are written. The paper is presently under review by other members of the team.

Post-harvest above- and below-ground biomass in living trees was calculated using the aforementioned allometric equations. Biomass of coarse woody material was also calculated in post-harvest compartments. Soil carbon, as well as shrub and above-ground snag biomass data, were integrated and compiled for the pre-harvest year of 1998. Below-ground dead woody material data compilation and analysis was started for the pre-harvest year of 1998. Drs. Bergeron and Lee will use the remainder of the FRIAA funding during 2017 to complete and analyze the dataset for a report to the partners and funding agency. Publications are planned as time and other responsibilities permit.

#### *Root decay assessment*

Protocol was developed for sampling below-ground root decay and four of each aspen and spruces stumps were sampled so far. For each stump, we sampled a cross section of the main stump below the highest roots and dug out one major root. We sampled a root cross section at 30cm from the stump and another where the diameter of the root was half of the cross-section and recorded decay class for each of these sections. By then end of the field season, samples were collected from replicate stumps of each species. This work is planned for publication.

*2. Dr. Jaime Pinzon—Research Associate with Dr. John Spence—Quantification of Carbon and Biodiversity-based ecosystem services associated with core re-measurements and tenth year synthesis*

Dr. Pinzon has been responsible for ensuring the completion of several chapters of the Tenth Year Synthesis. He is currently finishing the analysis of the large and challenging database. He finished with co-authors the completion of Chapters 3 and 5. Dr. Pinzon has several manuscripts ready to be submitted for publication.

## Knowledge Exchange Activities

### a) 2016 KE Activities Summary

The EMEND Knowledge Exchange program was active and productive during 2016, with a number of core deliverables produced for the project partners. Specific activities included:

- **EMEND Research Notes:** During three EMEND Research Notes (i.e., briefing notes) summarizing project results will have been completed. These research notes present core findings and management implications to project partners in an easily accessible format and writing style. The notes completed to date can be found here: <http://emendproject.org/pages/read/emend-insights>. The topics have included: gastropod response to harvesting at EMEND (Abele), the response of saproxylic insects to coarse woody debris and a general look at coarse woody debris patterns on the EMEND landscape (Lee). An additional note, to be completed in 2016, will summarize fire risk modelling work (Alam).
- **Student-Partner Engagement Tours with the Alberta Government, Daishowa-Marubeni International and Canfor:** This year we delivered a total of three student partner engagement sessions. These sessions are intended to facilitate open interaction between students and their research sponsors. By encouraging interaction and informal discussion about research applications, students and partners build important connections that allow them to interact on a regular basis throughout the year. In addition, these sessions help students understand operational realities and pressing questions facing their research partners. In 2016, students visited the offices of the Alberta Government, Daishowa Marubeni International and Canadian Forest Products. The students presented brief summaries of their work to date, heard about possible application of their work from partners, and engaged in discussions with partners about connecting science and applications. Feedback from these sessions was very positive and this program has become a key staple in our knowledge exchange program. In short, we believe this program is proving to be extremely beneficial for both students and partners, and is increasing both the relevance and scientific quality of the work at EMEND.



- **EMEND Applications Workshop with Canfor:** In the spring of 2016, we held a facilitated workshop with staff at Canadian Forest Products to consider how core research findings from EMEND could be included in their operational planning. The session covered three core topics from EMEND and capitalized on the work of this CRD. The specific topics included the relation of retention levels to achieving multiple outcomes, the influence of retention harvest on migratory

birds, and information about deadwood from EMEND. The session included a summary report identifying key takeaways and applications from the discussion.

- **Peace River Museum Archives & Mackenzie Centre, EMEND Boreal Exhibit and Presentation:** On April 14, 2016 Amy Hayden, Matthew Robinson, and Zoltan Domahidi presented a series of talks including a sort of 'EMEND 101' and two examples of the type of research that occurs at EMEND. Jim Witiw of DMI was also present and provided a brief introduction and prizes for the audience. This EMEND information was a part of the "When a Tree Falls in the Forest..." Exhibit at the Museum held between November 21, 2015 and June 24, 2016. Our session consisted of the viewing of the EMEND video, and several posters providing information on EMEND Science.



Photo credit Laura Love Peace River Museum Collections Technician

- **DMI Public Advisory Meeting Presentation:** During May 2016 Ellen Macdonald and Colin Bergeron traveled to Peace River to give the EMEND 101 presentation to the DMI Public advisory meeting. It is anticipated that a site tour will occur during 2017.
- **Move Up Magazine Article:** EMEND was featured in *Move Up* Magazine Issue 12 (Fall 2016), pp. 25-28 (see: <http://www.moveupmag.com/archives>). *Move Up* is a local Peace River area magazine.

These efforts in 2016 show that the EMEND program continues to achieve core objectives, while being flexible to accommodate specific requests from our partners and ensure products are relevant to their needs.

## b) Planned KE Activities (2017)

Proposed Knowledge Exchange Activities for 2017 are:

- Seven Research Notes featuring work by Caroline Franklin, Matthew Robinson, Linhao Wu, Samuel Bartels, Cassandra McKenzie, Jared Amos, + one.
- Partner Engagement Tour (August 2017)
- With 4 Additional Options for the EMC to choose from:
  - Final Wrap Up Workshop
  - Strategic Summary Note
  - Video from the perspective of the CRD information
  - An Infographic depicting learned CRD information

## Infrastructure & Capital Investments

The EMEND project is supported by a range of infrastructure representing capital investments that support field activities and promotion. These include a base camp and field lab (equipment, buildings) originally purchased through a successful CFI grant and built on land purchased by the University. The University of Alberta has put additional significant funds into maintenance of the site through special grants that have become available from the Vice-President (Research) Office. The project also depends on a temporary camp site, the research forest site compartments, all-weather road access, All Terrain Vehicles (ATV), and a visitor staging area. Our website and CFS-supported database for storing and sharing data and project information is also critical for the project. It is important that the EMC give ongoing attention to these fundamental elements supporting the research effort. Appendix 5 provides a list of proposed maintenance and development of these resources and their estimated costs.



### a) Camp Facilities

The EMEND Camp Facilities were used in during the entire year during 2016. The winter and spring seasons included 48 person days, 1441 person days were accumulated during the regular field season (May to August), and the fall-winter season accounted for 89 person days. User fees, which are based on person days, were again implemented for all users of the camp facilities to support costs associated with catering, utilities, and maintenance needs; completing the move to a self-sustaining camp model. Basic operation of the camp is no longer supported by any direct funding, and thus camp operation now depends entirely on funds coming to the project through research grants and contracts. Future camp activities depend on future research grants. During 2016, camp fees were approximately \$125/night per person.

Our two years of experience with running camp ourselves under the University umbrella, instead of contracting these services out, has reduced costs. However, maintenance issues stemming from ageing infrastructure are beginning to stacking up and these issues demand attention. For example, it was necessary to fix the roof of the lab trailer, which was about to cave in. Furthermore, the kitchen roof also started leaking in late summer 2016 and need to be fixed. While fixing the kitchen roof, the contractor noted that the rest of the main building roof will need to be replaced within the next year. The lengthy power outage at camp that left our fridges and freezers without power for three days brought another issue to our attention. Health and safety guidelines required that we dispose of most of the food in the fridges after the outage at considerable expense. Fortunately, a local grocery store (Grimshaw Freason Brothers) allowed us to store much of our frozen food in their walk-in freezers. In light of this experience the EMC should consider the purchase of a back-up generator with minimum capacity to run necessary camp functions (fridges, freezers, water pumps) in the event of future power outages.

This year two cooks and a Kitchen Coordinator were hired. The Kitchen Coordinator was responsible for: interactions with contractors, ordering food, managing kitchen staff, managing the menu, meeting with Alberta Health personnel, water samples, and cleaning. The Kitchen Coordinator position reduced much of the line of camp responsibilities, formerly carried by the Program Manager, which allowed Amy to focus on managing the Core-research and associated matters like the safety program. Nonetheless, approximately ten days (75 hours) of the Program Managers time was allocated to camp business including hiring the cooks, contractor paperwork, invoice management, and finances.

This year we were required to invoice projects monthly to ensure that funds were accessible for camp use within our accounts. As we are moving over to a monthly invoicing, we must require that camp users



provided 7- day notice to cancel/change their booking with us or their projects will be charged for the nights as originally booked. This is required because: 1) food is ordered 1 week in advance and therefore sudden reductions in size of the group causes food waste; and 2) there have been an increasing number of late-notice cancellations, postponing arrivals. This complicates management of camp resources. Although we intended to run the camp with a 'cushion' from modest yearly profit, due to the unexpected additional costs, all 'profits' that were to have been made this year were used to accommodate unexpected costs. We may also want to consider a minimal cost for camp use during the off season because costs to run camp in the off-season may be greater than during the main field season.

Something else for the EMC/University to consider is opening the Camp Buildings Facilities to the public for use. This may allow for additional incomes during slow summer seasons or during the off-season. We can easily put together packages for services that can be offered.

Construction and use of a new larger garden box made it possible to provide most of the salad greens for camp from late-May to late-July, and fresh tomatoes were also enjoyed through late August. The heritage log picnic table, which has been with the project from the start accumulating the carved names of most EMENDers, was disassembled. Most of its base was too rotten to be moved, however the top has been kept, and we intend to make a new base for it.

Given impact of heavy winds and sun exposure, we are considering making a shed to store the water dispenser water bottles. A fire wood pile cover is also being considered to keep fire materials in one spot, to keep the fire pit area cleaner and easier to mow the grass. A ride on lawn mower or pull behind a quad attachment would reduce the time spent on mowing the grass and this seems like a reasonable expense to consider.

## b) Field Infrastructure

As outlined above core field assessments were delayed during 2016 to clear debris and down fall from trails after the late-May snow storm. New growth was removed from the middle of many ATV and some walking trails as was the over-hanging growth that had been broken by the heavy snow. During this time we also cut some new ATV trails to replace seriously rutted and dangerous trails.

New bridges and bridge repairs are needed throughout the site. The present structures are safety hazards and investments should be considered high priority by the EMC. Partners should be aware of the spread of prohibited and/or noxious weeds into the site and at camp. Canada Thistle, Scentless Chamomile, and Knapweed (all designated under the Alberta Weed Control Act) have all been sighted at EMEND and all have the ability to rapidly take over disturbed sites. This year Scentless Chamomile was identified within at least one PSP in C, this is coming into the site from the old-Canfor Road.

Our core Permanent Sample Plots (PSPs) and Site markings such as boundaries, baselines, ellipse, and other markings are rapidly degrading. As these markings are essential to project continuity, their renewal must be considered for core crew attention in near future. Fortunately, all the PSPs were re-labeled and marked in the fall of 2015 when GPS coordinates were reassessed. It is essential that funding be put into having all the other site markings renewed as soon as possible. Additional issues with PSPs and site marking are becoming evident include: (1) obvious trampling of understory plots; (2) obvious walking trails through the mid line of PSPs; (3) non-core work established too close to PSPs (digging/marketing trees, etc.); and, (4) the persistent problem of managing flagging tape. Attention to these issues is a task that might be considered for a small core crew during 2018, once the 15-year assessment is completed. Field research at EMEND will become increasingly difficult if these matters go unresolved.

### c) Core Field Equipment

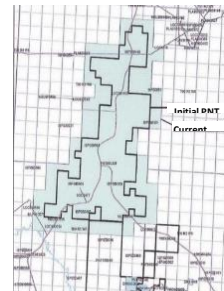
The core field equipment was heavily used in 2016. The decision to purchase tablets for the core work instead of using data sheets has worked out rather well. After ironing out a few wrinkles in the formatting of the Excel sheets, the tablets were an invaluable asset to the program. In addition to being more efficient and effective for recording and entering the data, they gave us increased ability to document the field season in photos.

All of the ATVs were used heavily during 2016, supplemented by use of 4 additional ATVs from the Macdonald lab. We used our single remaining UA vehicle (#260) heavily in addition to 3 rented trucks. All our radios were in use; 2 hypsometers were used by core crew and 2 were used by grad students; all the GPSs were used.

Most of our field gear is in good shape and ready for the 2017 field season. However, unfavorable site conditions put extra strain on our equipment and result in extra costs associated with maintenance and repair. Our vehicle fleet has been compromised by the loss of #290 last year, and really should be replaced and extended through a renewed cycle of grants for research infrastructure; however, until a new EMEND leader is recruited it is unlikely that such efforts can be undertaken. From the start, we have requires that graduate student researchers and other users arrange their own vehicles through grants to their supervisors. However, this is becoming increasingly difficult for many supervisors who do not have the extra funding or lab fleets to provide this much needed equipment to their students, and these restrictions are seriously constraining our ability to recruit new research at EMEND. Appendix 6 provides a prioritized list of Equipment and Infrastructural needs and Appendix 4 provides the present inventory of the EMEND Core Vehicle Fleet and Field Equipment.

### d) EMEND PNT

Our focal research forest (7000ha) and the collective EMEND research investments in this site continues to be protected under a fairly strict PNT. However, as the EMC has considered, this protection does not assure protection from development by pre-existing sub-surface rights holders. Nonetheless, all surface land applications received by Alberta on the EMEND landscape will be initially screened by Edmonton A&F staff, and alert the EMC of developments that could affect the project. Although this is a perrential issue for the EMC, it remains relevant for the EMC to explore possibilities for stricter protection.



### e) Website & Database

The Canadian Forestry Service (CFS) continues to host the EMEND website and database and provide the time and services of: Brad Tomm who maintains the database and Jon Elofson who maintained the EMEND website in 2016. During 2017 the project website will migrate to the University Servers, as Natural Resources Canada is no longer hosting third party websites, and through this move we can have better security for our information. A SharePoint site is in the process of being designed and will hopefully improve our ability to share files, photographs, videos, and information, both among EMEND researchers and members of the public seeking information about the project.



## Health & Safety Program

Now in the third full year of implementation, the living document that describes present EMEND Health & Safety Program continues to adapt and grow to meet the needs of the project and the objectives of the EMC. The plan addresses Cardinal Rules, Required Work Practices, Critical Procedures, Certification and Training, Standard Operating Procedures, Reference Procedures as well as numerous appendices related to safety at EMEND. Our plan standardizes all Safety Protocols and ensures that all staff, students and users of the EMEND Site and Camp Facilities have the knowledge required to work safely and be prepared for situations that we can anticipate. A standardized Safety Orientation has also been prepared and attendance and participation is mandatory for all those who use the EMEND infrastructure. An initial 3-4 hour presentation, a returnee refresher presentation, and a Foreign Student/New Canadian presentation have all been designed and are currently in use. The refresher orientation, offered to those with experience at EMEND, is shorter, highlights updates to the Health & Safety Program, and reminds returnees of the most important aspects of the Plan. The Foreign Student/New Canadian orientation allows employees and students who have little knowledge of the Canadian Workers Health and Safety program to become more familiar with our legislation and regulations. We are currently working on an online course of the orientation complete with quizzes for testing retention of the information. This course is envisioned as a series of videos that capture each section of the safety plan. This program allows the director to customize the class for each participant so to focus on the components of the safety program that are necessary for their work at EMEND. It can also be set up to allow access by non-University staff and students.

A continuing concern is the ever increasing costs of training required by our researchers as well as purchase and maintenance of necessary safety equipment. Although requirements for training and safety equipment increase steadily, most research funding does not allow for these costs as sanctioned budget items. This is a matter that all field-oriented projects are being forced to consider, and if projects like EMEND are going to be run into the future this general problem must be resolved.

Below you find a summary of the incidents and Near-Misses that occurred in 2016, a look at trends in recent EMEND history as well as recommendations to the program.

### a) 2016 Near-Miss/Incident Summary

Following partner suggestions Incidents have been split into three sections:

2016 Incident & Near Miss Totals					
Type	Incidents			Near Miss	2016 Total
	I	PD	↓ E		
ATV/Snowmobile	0	0	7	2	9
Camp Activities	3	0	0	1	4
Driving	0	0	0	4	4
Extreme Weather Events**	0	0	0	1	1
Field Work	6	0	0	7	13
Health & Fitness***	0	0	0	0	0
Infrastr./Equip. Failure*	0	0	0	1	1
Interpersonal***	0	0	2	0	2
Other	0	0	0	0	0
Transport. of Equip.*	0	0	0	1	1
Wildlife	0	0	4	2	6
<b>Total</b>	<b>9</b>	<b>0</b>	<b>13</b>	<b>19</b>	<b>41</b>
Person Days	1495				
Per capita	0.007	0.000	0.008	0.013	0.027
* Added in 2013 ** Added in 2014 *** Added in 2015					

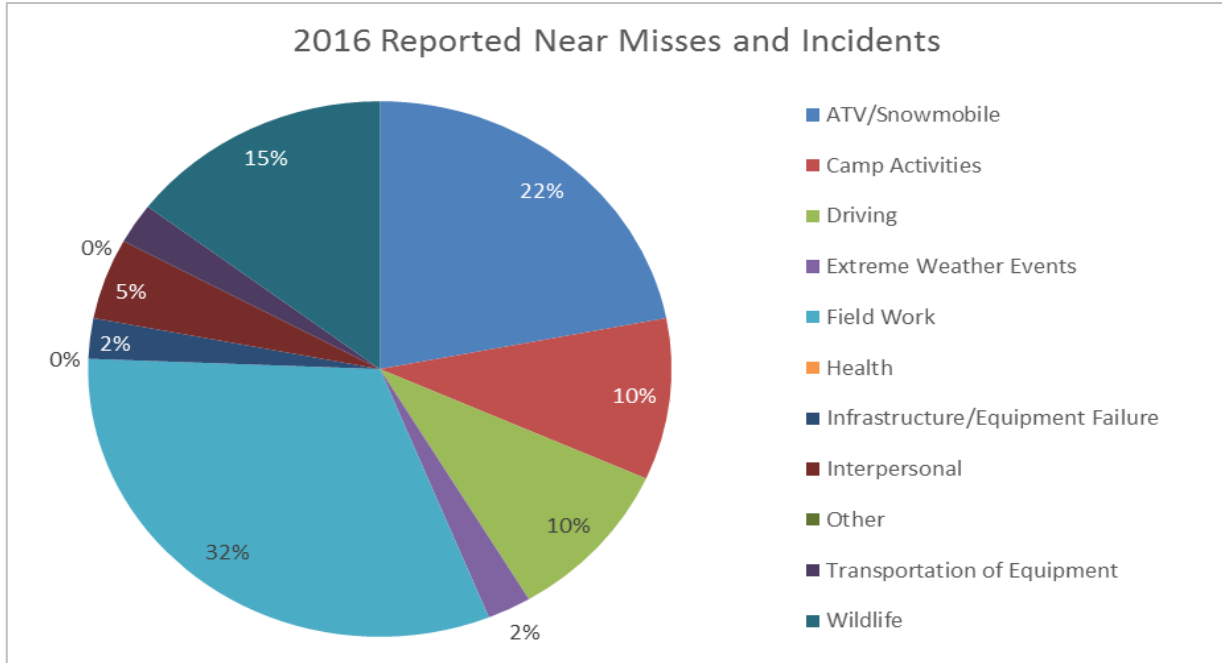
1. Personal Injury (I): this includes the need for first aid, medical treatment (visit to doctor or hospital), and fatality;
2. Property Damage (PD): this includes any damage to equipment or infrastructure, or any incident that incurred a cost; and,
3. Decreased Efficiency (↓E): this includes, the need to use a winch, interpersonal issues, health & fitness issues, need of using wildlife deterrents/wildlife within a 5 meter proximity. Appendix 7 lists all reported Incidents and Near-Misses.

In 2016, there were 10 Incidents involving Personal Injury, and 12 incidents that caused decreased efficiency (totaling 22

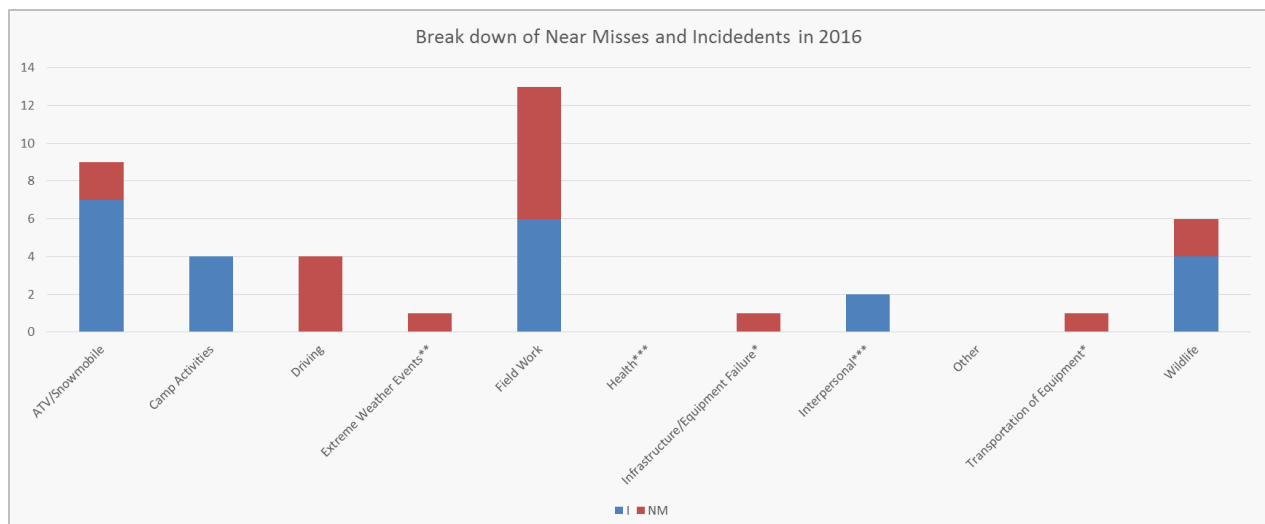
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Incidents); there were 19 Near-Misses making a total of 41 Incidents and Near-Misses. All incidents were minor in nature with only one resulting in a visit to medical facilities (the injury actually occurred during a period of time-off, but field work exacerbated the symptoms of injury).

The tables, graphs and charts below split the reported Incidents and Near-Misses into various categories. Discussion of these data follows.



**Transportation of equipment** includes the hauling, loading, unloading and strapping of any equipment; **Wildlife Encounters** includes anything related to wildlife (bear, grouse, and moose); **ATV/Snowmobile** include anything related to use or maintenance of the ATV/snowmobile; **Driving** includes all incidents occurring while using a vehicle (exhaustion, distraction, wildlife, other drivers); **Camp Activities** includes anything that occurred while at the camp facilities; **Infrastructure/Equipment Failure** includes bridges breaking, radios malfunctioning, and SAT phone lost calls; **Extreme Weather Events** includes: high temperatures, smoke, dust, wind, lightning, etc.; **Interpersonal** includes anything that results in negative interactions between two or more individuals/groups; **Field Work** includes anything related to doing field work; **Health or Personal Fitness** includes anything that results from an individual's personal health and



The most recorded Incidents and Near-Misses during 2016 (n= 13) was in the Field Work category. There were six personal injuries, one of which required medical attention, and two which required first aid. Four resulted from trail clearing, something that is not a normal field task, but which was required during 2016; two could have been prevented by wearing appropriate PPE (safety glasses) while in the field; one Incident resulted from a student forgetting to sign-in after they returned from field work, and another from another student not returning to camp before their expected check-in time. The injury that resulted in a hospital visit resulted from a off-work running injury which was exacerbated by climbing into the back of a pick-up to get equipment during work time. This person was put on limited duty for the remainder of the summer while they did physiotherapy.

The second largest (n=9) recorded number of Incidents + Near- Misses was in the category of ATV/Snowmobiles. Two of these were Near-Misses where the person could push themselves out of mud holes; seven involved individuals getting their ATVs stuck and needing a which to get them out.

Wildlife encounters resulted in 6 reported Incidents/Near- Misses. One Near-Miss involved employees leaving an area in response to vocalizations of what was thought to be a moose, at an unknown distance (but within close proximity); the other Near-Miss involved an injured black bear that was seen several times at old camp. When the bear started showing signs of habituation (third encounter), Fish and Wildlife were notified and a file was started to assess the bear. Of the four incidents resulting in decreased efficiency, three involved early spring bears foraging on Right of Ways (ROWs) that would not leave without discharge of bear bangers. The other involved a grouse which flew at people's faces, causing the group to trip over each other in their startle responses.

Camp Activities and Driving each had Four Near-Misses/ were reported for both Camp Activities and Driving. The three reported Camp incidents were a burned finger, debris in an eye, and a Frisbee to the face (swollen lip). The Near-Miss that was recorded involved all camp users. One July water sample detected coli-form bacteria in the sample. In response, camp was put on an immediate boil order, the water tanks were shocked (using chlorine), then the system was flushed and the water was tested again with no detection of coli-forms. No one reported illness due to water borne bacteria. Four Near-Misses were recorded under Driving. Two involved white tail deer in tall grass long the road. One involved a faulty tire pressure gauge on vehicle 260, which constantly read as low tire pressure. And the fourth, was a combination of speed and poor road conditions which caused a 'fish tail', fortunately the driver was able to keep the vehicle on the road.

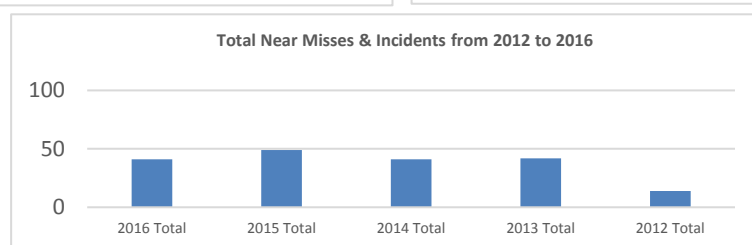
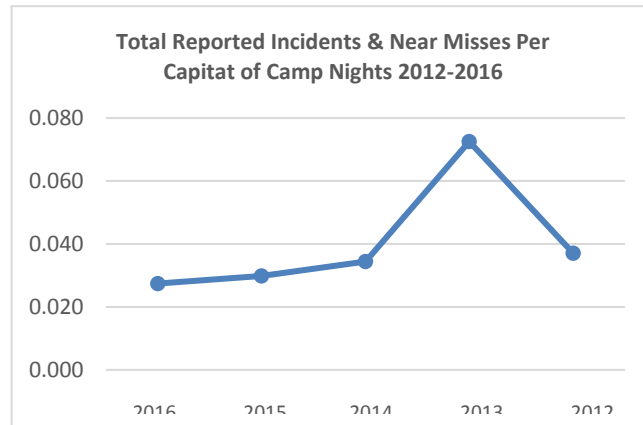
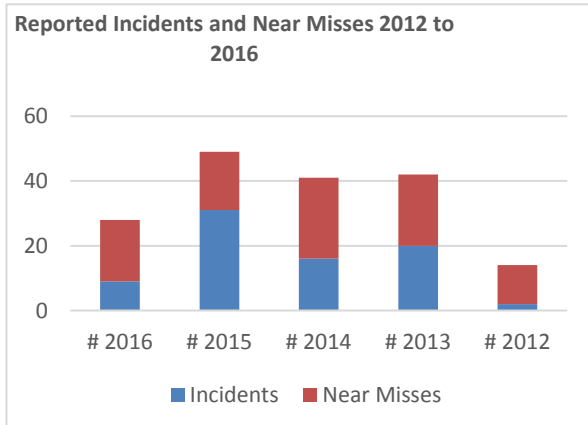
Two incidents recorded in the Interpersonal category resulted from an individual being unnecessarily aggressive and rude to coworkers. A third flowed from a team lead who had concerns regarding field assistants who were uncomfortable working with another team lead. The group was asked to bring any concerns they had to Amy Hayden. No one else did. There had been difficulties with the concerned person regarding other made-up issues prior to this event. A policy has been put in place to ensure interpersonal issues do not become a major. This policy is the 3-strike policy. Strike one verbal, strike 2 written, strike three removal.

One Near-Miss each was reported in the Transportation of Equipment, Extreme Weather Events, and Infrastructure/Equipment Failure categories. Under Transportation of Equipment, a trailer was hauled without a D-Link to secure that it stayed attached. Under Extreme Weather Events, the site was closed due to extremely hot temperatures, high winds, fire hazard, and other fires occurring in the province. The Near-Miss under Infrastructure/Equipment Failure involved a wash-out of a new bridge in the back of H-block, while workers were in that part of the compartment. They were able to find a beaver dam to cross further upstream.

## b) Trends in Near Miss/Incidents

The Table and Figure below provide a comparison useful in determining the trends of reported Near-Misses and Incidents over the period of 2012 to 2016. Observations of these trends assist us in making changes to the Health and Safety Program. It is important to note that the current reporting system was adopted in 2013. Incidents and Near Misses were recorded after the field season in 2012, and therefore may not be as accurate as data for the following years. The last row adjusts the figures for Near-Misses and Incidents based on the person days in the field. This provides a more accurate view of changes over large periods of time.

Type	2016			2015			2014			2013			2012		
	I	NM	TTL	I	NM	TTL	I	NM	TTL	I	NM	TTL	I	NM	TTL
ATV/Snowmobile	7	2	9	5	2	7	2	6	8	6	2	8	0	1	1
Camp Activities	3	1	4	6	0	6	0	0	0	4	1	5	0	3	3
Driving	0	4	4	5	8	13	1	1	2	1	2	3	0	6	6
Extreme Weather Events**	0	1	1	1	3	4	7	2	9	0	3	3	0	0	0
Field Work	6	7	13	2	1	3	2	3	5	2	1	3	2	1	3
Health & Fitness***	0	0	0	3	1	4	0	0	0	0	0	0	0	0	0
Infra./Equip. Failure*	0	1	1	0	0	0	0	3	3	3	6	9	0	0	0
Interpersonal***	2	0	2	2	0	2	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	1	1	0	4	4	0	0	0	0	0	0
Transport. of Equipment*	0	1	1	2	0	2	2	3	5	0	4	4	0	0	0
Wildlife	4	2	6	5	2	7	2	3	5	4	3	7	0	1	1
<b>Total</b>	<b>22</b>	<b>19</b>	<b>41</b>	<b>31</b>	<b>18</b>	<b>49</b>	<b>16</b>	<b>25</b>	<b>41</b>	<b>20</b>	<b>22</b>	<b>42</b>	<b>2</b>	<b>12</b>	<b>14</b>
Person Days	1495			1640			1193			579			378		
<b>Per capita</b>	<b>0.015</b>	<b>0.013</b>	<b>0.027</b>	<b>0.019</b>	<b>0.011</b>	<b>0.030</b>	<b>0.013</b>	<b>0.021</b>	<b>0.034</b>	<b>0.035</b>	<b>0.038</b>	<b>0.073</b>	<b>0.005</b>	<b>0.032</b>	<b>0.037</b>
* Added in 2013															
** Added in 2014															
*** Added in 2015															
<b>Definitions:</b>															
<b>Incident:</b> an unplanned event causing personal harm/injury, results in damage to equipment/infrastructure, or where other expenses were incurred.															
<b>Personal Injury (I):</b> the need for first aid/medical treatment (doctor visit), and fatality;															
<b>Property Damage (PD):</b> any damage to equipment or infrastructure, or any incident that incurred a cost; and,															
<b>Decreased Efficiency (↓E):</b> need to use a winch, interpersonal issues, health & fitness issues, wildlife deterrent use/wildlife within 5m proximity.															
<b>Near Miss (NM):</b> an unplanned event that interrupts normal procedure and could have precipitated an incident															



The data suggest a general downward trend in total reported Incidents and Near-Misses since 2013. We believe that this trend reflects continued efforts of staff and students to ensure that they are assessing hazards regularly while in the field. However, during the 2016 field season there seemed to be pushback from users not wanting to report Incidents and Near-Misses, even though it was stressed early and often that reporting is not a form of finger pointing. Thus, the project Manager suggests that everyone should be specifically asked daily about Incidents, Near-Misses and hazards encountered in the field, even though this extra level of scrutiny could temporarily distort the data we have as providing a useful comparison.

### c) Recommendations & Anticipated Changes for 2017

The following changes/additions to the EMEND Health and Safety Program are recommended in response to reviewing the 2016 Near-Misses and Incident reports:

- Add protocols for clearing trails to work practice/safety policy
- Add to Orientation: stress watching where put feet while walking through the forest
- Add daily check in with field assistants and field techs individually for hazards, Near-Misses and Incidents, instead of waiting for them to bring them forward.
- UoA has suggested that someone within EMEND get ATV trainer training to perform the types of training we want in house
- Make electronic versions of all the safety forms for the tablets to ensure that all forms are available for staff at all times
- Stress the need for Field Techs to constantly ask how their Field Assistants are doing as part of the morning tail gate meeting
- Build a wall to protect the water tanks from the sun

The EMC provided only one suggestion for a change for 2017:

- Make changes to reporting to ensure adequate information by breaking up Incident category into three sections: Personal Injury, Property Damage, and Lost Efficiency. (Complete)

Progress on past suggestions for changes to the EMEND Health and Safety Program.

- Policy and Procedure Changes (FAP)
  - Equipment
    - (2015) Update equipment policy to incorporate when to remove equipment from use. (Complete)
  - Driving and Vehicles
    - (2015) Consider closing the road to EMEND users during the spring season (once road thaw starts) until road conditions improve (Not Complete)
    - (2015) Add a reminder about keeping keys in pockets, gas tank, etc., before they lock doors (Complete)
    - (2015) Ensure interior and exterior lights are off, charging stuff out of lighter/etc. before leaving vehicle (Complete)
    - (2015) Before starting the vehicle ask "all ready" and wait for a response from all passengers before starting the vehicle and putting it in gear (Complete)
    - (2015) Add check road reports to SOP, FAP, etc. (Complete)
  - ATV Operation
    - (2015) Walk through wet or muddy areas in new sites or if unsure of their depth (Complete)
    - (2015) Speed limits for types of trails (slowdown in wet areas, etc.) (Complete)

- Field Work
  - (2015) Regular check-ins with field assistants about physiological condition in case of heat, exposure, higher than normal levels of exercise. (Complete)
  - (2015) Ensure that all field assistants are aware, at time of interview, of the difficulty of field work (Complete)
  - (2015) Ensure clear communication of appropriate work attire even while at camp (Complete)
  - (2015) Stress the need to keep an appropriate pace for all workers, depending on the task at hand (slower in dense bush, carrying addition weight, heat, etc.) (Complete)
  - (2015) Increase awareness of surrounding CWD, take extra precautions and time when the need to climb over CWD (Complete)
  - (2015) When in doubt about the ability of a field assistant to perform field work due to illness or physical fitness have them bring in a doctor's note approving field work (Complete)
  - (2015) Mark ditches and trails for debris that could impede snowmobile use before snow falls (fall) (Complete)
- (2014) Clarification form University of Alberta on religious traditions and field work (In-Progress)
- Site Safety, Protection, and Integrity
  - (2015) Continued monitoring of site integrity and safety risks resulting from wild fire and other natural disturbances (Ongoing)
  - (2015) Trail maintenance high priority (put policy in place) (Not Complete)
- Camp
  - (2015) 'Pranking': (1) Pranking must be mutually acceptable by all parties involved; (2) Cannot affect people's personal spaces (beds); (3) Cannot be of a sexual nature; and, (4) It must end if anyone at camp becomes uncomfortable with what is occurring (Complete)
- Other
  - (2015) Policy to protect staff, students, users, visitors from hunting incidents within the site (Not Complete)
  - (2015) Develop an approach for dealing with interpersonal issues between staff, students, etc. (In Progress)
- (2014) Sign off on the EMEND Health and Safety Plan by the University of Alberta Environmental Health & Safety Department (EH&S). (Complete)
- Auditing:
  - (2013) The University should consider engaging some form of annual 3rd\_party audit of the Health and Safety Program to encourage cycles of continual improvement and documentation and field-evidence level. Such audits are a standard-of-practice enhancing credibility and promoting due diligence (In Progress, date set for July 2017)
  - (2013) Re-initiate tests of the Emergency Response Plan with assessment and feedback. (In Progress, Plans made with UoA EH&S)
- Changes and Additions to Training and Safety Meeting
  - (2015) Lead eye time [the time and distance a rider visually scans ahead of their atv] (Not Complete)
  - (2015) Picking routes through wet areas (Not Complete)
  - (2015) Weight distribution on uneven terrain (Complete)
  - (2015) How to do a vehicle inspection (Complete)
  - (2015) How to fill out paperwork (Complete)

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- (2015) Mid-season review about procedures for wildlife encounters to ensure staff are still following policies (**Not Complete**)
- (2015) Improve the training with bear spray and bear banger use (**Complete**)
- (2015) Add scenarios (ERP tests) to the safety meetings not just demonstrations (**In Progress**)
- (2013) In addition to mandatory safe rider training for ATV use and defensive driving for drivers, incorporate EMEND-based training information about differences between standard training sites and the conditions at EMEND into orientation. (lead-eye time, mapping routes, maneuvering in mud, etc.) (**Complete**)
- (2014) Enhanced Safety Orientations for foreign staff and students who are not used to Canadian Safety Standards/English as a 2<sup>nd</sup> language, etc. (**Complete**)
- Training/Certification
  - (2015) Record keeping form with individual sign-off on un-documented trainings and certifications (**Complete**)
- Other
  - (2015) Consider reducing vehicular speeds within the site (**Complete, cannot be done due to need for chip/log trucks need to gain speed to get up the hills**)
  - (2015) Talk to DMI about radio usage policies (**Complete**)
  - (2015) Create a system for tracking road radio use problems and perhaps some sort of penalties to those who continually break them (DMI) (**Dealt with, not easily tracked so cannot be firmly implemented**)
  - (2015) Simplify forms: use check-marks, initials, and signatures better to reduce/simplify forms (**Complete**)
  - (2013) Proposed changes to the EMEND maps (**Not complete**),
  - (2013) Proposal for ATV storage at Camp Facilities (**Not completed**),
  - (2013) Suggestion for motion censored lights or better lighting in parking lot at EMEND camp facilities (**In progress, to be installed in spring**)
  - (2014) Contracted trail maintenance and bridge building plan and proposal (**In-Progress**)

Increased attention to safety will not be cheap. Our ability to bring on new safety equipment and upgrade what we have in place will likely face financial constraint, given the present funding model for EMEND. Nonetheless, some needs are urgent. For example, the number of Near-Misses resulting from ratchet straps loosening while ATVs are in transport suggests that new straps should be purchased annually. We know that ATV helmets should be replaced any time a helmet sustains a fall, or significant hit, or is older than 5 years. These sorts of expenses and mandatory training costs are not covered by the university, and are not allowable items in most competitive research grant applications. Allocating Core Crew time to trail maintenance or bridge building in busy data collection years is almost impossible; and our crews do not generally have the experience and expertise to build safe bridges. Bear spray now expires annually or biannually and needs to be replaced regularly even if not used (bear bangers are similar). It is essential that safety trainings, equipment, and PPE be considered and included/added to future funding applications where they are permitted; however, we cannot expect that all safety and infrastructure needs can be covered by research grants. The EMC must consider developing alternative sources of funding in this area. This is a category of expense that can be reasonably tasked to the Science Leads to meet on their own. In the early days of EMEND, these sorts of expenses were met from company-allocated FRIAA-FRIP funds and with the virtual disappearance of this alternative, a new solution is needed.



## Appendices

Appendix 3: EMEND 2016 Publications

Appendix 4: Core Vehicle Fleet & Field Equipment Inventory

Appendix 5: Proposed EMEND Projects / Costs

Appendix 6: Prioritized Infrastructure/Equipment Needs

Appendix 7: Documented Near Misses & Incidents 2016

### Appendix 3: EMEND 2016 Publications

- Amos, J., J. Spence, and D. Langor. 2016. The impact of retention harvesting on bee and hoverfly assemblages in the boreal forest of Alberta. Paper presented at the R.E. Peter Biology Conference, Edmonton, AB.
- Amos, J., J. Spence, and D. Langor. 2016. Environmental variables and their effect on bee and hoverfly assemblages following harvesting in the boreal forest of northern Alberta. Paper presented at the CONFORWest conference, Kananaskis, AB.
- Bartels, S.F., and S.E. Macdonald (2016). Bryophyte abundance, diversity and composition following variable-retention harvesting in boreal mixedwood forest: Evidence from the EMEND study. 101<sup>st</sup> Ecological Society of America (ESA) Annual Meeting, Fort Lauderdale, FL, USA.
- Franklin, C., Macdonald, S.E., and Nielsen, S. 2015. Effects of variable retention harvesting on understory vegetation. CONFORWest Interdisciplinary Forestry and Environmental Studies Conference. Friday Harbor, Washington, United States of America (International Conference, Oral Presentation)
- Franklin, C., Macdonald, S.E., and Nielsen, S. 2016. Responses of understory vegetation to green-tree retention harvesting. Canadian Society for Ecology and Evolution Meeting. St. John's, Newfoundland (National Conference, Oral Presentation)
- Macdonald, S.E., Bartels, S.F., Echiverri, L., and S. Ronzani (2016). Understanding spatial patterns of biodiversity at the EMEND site using wet areas mapping. Workshop: Towards the goal of environmental excellence: Alberta's Wet Areas Mapping initiative at year ten. Biodiversity and Forestry Workshop, Alberta Agriculture & Forestry, March 17, Edmonton, AB. *Oral presentation* ~150 attendees.
- Macdonald, S.E., Bartels, S.F., and A. Dabros (2016). The EMEND experiment – impacts of variable retention harvesting on plant biodiversity. Biodiversity and Forestry Workshop, Alberta Agriculture & Forestry, March 16, Edmonton, AB. *Oral presentation* ~160 attendees.
- Robinson, M. (2015) Alberta Biodiversity Conservation Chairs Annual Science Advisory Meeting (April 21, 2015). Poster Title: "Effects of forest disturbance and green tree retention on upland habitat suitability of wood frogs"
- Robinson, M. (2016) Alberta Biodiversity Conservation Chairs Annual Science Advisory Meeting (February 23, 2016). Poster Title: "Influence of forest disturbance and green tree retention on upland distributions of wood frogs in the boreal mixedwood forest"
- Robinson, M. (2016) Forest Industry Lecture Series and Poster Presentation - Department of Renewable Resources, University of Alberta. (March 3, 2016). Poster Title: "Influence of forest disturbance and green tree retention on upland distributions of wood frogs in the boreal mixedwood forest"
- Robinson, M. (2016) Peace River Museum – Boreal Forest Speaker Series (April 14, 2016). Oral Presentation Title: "Wood frog habitat use and reproduction in post-harvest retention forest stands"

## Appendix 4: EMEND Core Vehicle Fleet &amp; Field Equipment Inventories

**EMEND Vehicle Fleet**

Type	Brand	Year	Description	Colour	Condition
Quad	Honda	2003	Fourtrax 250 (Spence Lab)	Red	Poor
Quad	Honda	2003	Fourtrax 250 (Spence Lab)	Red	Poor
Quad	Honda	2004	TE2564 (DMI Donated)	Red	Good
Quad	Honda	2004	TE2564 (DMI Donated)	Red	Good
Quad	Honda	2005	TRX500FES	Yellow	Good
Quad	Honda	2005	TRX500FES	Yellow	Good
Quad	Honda	2005	TRX500FES	Yellow	Good
Quad	Honda	2005	TRX500FES	Yellow	Good
Quad	Honda	2008	Fourtrax 250 (Spence Lab)	1998	Poor
Quad	Honda	2013	TRX420FPE	Red	Excellent
Quad	Honda	2013	TRX420FPE	Red	Excellent
Quad	Honda	2015	TRX420 (NRC)	Red	Excellent
Quad	Honda	2015	TRX420 (NRC)	Red	Excellent
Quad	Honda	2015	TRX420 (NRC)	Red	Excellent
Quad	Honda	2015	TRX420 (NRC)	Red	Excellent
Trailer	RT Trailers	2005	ATV trailer, 16' Long (4 ATV)	Black	Great
Trailer	Scona	1997	10' ATV Trailer (2 ATV)	Black	Good-Fair
Trailer		2015	ATV trailer, 18' foot long (4 ATV)	Black	Excellent
Truck	Chevrolet	2008	Chevrolet Silverado 2500 HD 4x4	White	Great
Truck	GMC	2005	GMC Yukon XL SLE 2500 4x4	White	Good
Snowmobile	Polaris	2015	Indy 550 ES, Electric Start	Red	Excellent
Snowmobile	Polaris	2015	Indy 550 ES, Electric Start	Red	Excellent

**EMEND Core Field Equipment**

Amount	Type	Brand	Condition	Need/Replace
1	Chainsaw	Husquvarna	Good	No
1	Chainsaw	Stihl	Good	No
6	Handheld GPS	Garmin	Excellent	No
1	Snowmobile Ramp		Excellent	No
1	ATV Ramp		New	No
2	Digital Measuring Sticks		Great	2 more
1	Computer	Dell	Poor	Yes
1	Printer	Brother	New	No
1	Laptop	Dell	Poor	Yes
7	Tablets	Samsung (Tab A)	New	No
4	Digital Clinometers	Vertex	Excellent	No
7	Handheld Radios	iComm	New	No
2	Calipers		Poor	Yes
5	Handheld Radios	Kenwood/Motorola	Poor	No
1	Repeater		New	No
12	Field First Aid Kits		Great	No
4	Emergency ATV Tire Repair Kit		Great	Yes
6	Winch Kits		Great	No
12	Fire Extinguishers		Good	Yes

## Appendix 5: Proposed EMEND Projects/Costs

### Camp Facilities:

- More lab space/ATV storage is needed on site;
- Control of the noxious invasive weeds at camp;
- Camp night lighting enhancement or motion sensor to capture site incursions from the roadway beyond the gravel pad
- Increased accommodations, washroom facilities, dining room for increasing number of graduate student needs
- Fire Alarm/Safety system needs to be serviced
- Extra storage (small shed) for grad equipment
- Build protective case for large bottles of water
- Firewood shed to keep all fire making materials in one place and dry
- Pull behind mower/ride-on mower

### Field Infrastructure:

- Trail and bridge maintenance
- Better trail signage
- Repeater antenna up and active
- Spread of prohibited noxious and noxious weeds at the EMEND site. Canada Thistle/Scentless Chamomile,
- Fenced lot at old camp for storage and for overnight safety (perhaps a tent frame or two)
- Plot and Site Marking Maintenance

### EMEND Core Field Equipment:

- Consider bar code scanners to reduce human error
- Small digital cameras for the documentation of samples, and have an image of PSP through time, group photos, etc.
- Renewal of the Core Crew vehicle fleet as the fleet is aging and over the coming years will need to be replaced.
- Winch kits for trucks and ATVs (have all the tools needed to successfully use the winches)

### Safety:

- Creation of a safety video, website, or other medium to standardize participants orientation experience
- External Auditing
- Emergency Response Plan (ERP) Testing

### Other:

- Further and more divers public communications
  - o Online presence (i.e. Facebook, instagram, twitter, etc.)
  - o Magazine/newspaper articles
  - o Public tours/presentations
  - o Community programs

## Appendix 6: Prioritized Infrastructure/Equipment Needs

Complete List						
N	W	Priority	Amount Needed	Item	Approximate Cost (each)	Comment
N		High	7	Hand Radio microphones	\$150	For safety purposes these would allow ATV users to safely use their radios while on their atvs
N		High	1	Radio Gang Charger	\$450	7 radios and their charges take up an large amount of space, the gang charger will allow us to charge 6 radios in less space.
N		High	4-5	PDA's/small tablets with waterproof cases	\$300	Assist in collecting data Remove some human error elements to data collection
N		High	20	Mattresses for tents	\$100-\$200	All the old foam mattresses are starting to disintegrate.
N		High	1	Emergency Generator	\$6000	To be used to keep camp functioning when the power goes out
N		High	1	Roof Maintenance	\$30,000	Maintain the three remaining roof on the main camp building
N		High	2	'Permanent' Tent frames at Old Camp	\$2500	This would provide researchers who need to work late or early to remain at on site. Would also assist in winter field work for a close but safe location to return to
N		High	1	Camper Trailer	\$25000	This would provide researchers who need to work late or early to remain at on site. Would also assist in winter field work for a close but safe location to return to
N		High	1	Small wood burning stove + accessories	\$250	For tent at Old camp for warmth and potentially cooking if outdoor cooking is not possible
N/W		High	1	Small generator		To connect to the trailer to assist in providing researchers who stay at old camp to generate electricity
N		Mod	Assorted	Yearly Field Supplies	\$1000-\$3000 (Approx for all)	Yearly we are required to purchase the necessary field gear needed to run a fully functioning core crew including cruise vests, safety glasses, hard hats, etc.

Complete List						
N	W	Priority	Amount Needed	Item	Approximate Cost (each)	Comment
N		Mod	Assorted	Yearly First Aid/Safety Gear	\$1000-\$2500 (Approx for all)	Yearly the project is required to purchase the necessary safety gear and first aid supplies needed including fire extinguishers, bear spray, bear bangers, ATV helmets, etc.
N		Mod- High	1-2	ATCO trailer Bedrooms (6-10 beds) + washroom	\$80,000-\$100,000	Need more space for researchers to sleep and definitely need more washroom facilities
N/W		Mod-High	1	Small generator	\$2000-\$2500	For old camp use to charge radios, cell phones, sat phones, etc. while working in the field, most specifically in the winter
N		Mod	1	Extra outdoor storage	\$1500	Increase field equipment for graduate students limited lab space and higher than average student numbers are putting a strain on our current storage
N		M	1-2	Microscope	\$3500	
W / N		Mod	2-6	ATVs with winches	\$10,000	Our other ATVs are starting to wear out. Longer field seasons, extensive and difficult terrain, costs to maintain older ATVs are getting higher and higher
W / N		Mod-High	2-3	4X4 Truck with trailer breaks	\$35,000-\$40,000	Our other trucks are starting to wear out. Longer field seasons, travel between Edmonton and the field are putting more strain on them costs to maintain the trucks are getting higher and higher
N / W		Moderate	12+	Sound recorders	\$500-1000	
N / W		Moderate	12+	Trail cameras	\$300-500	
N / W		Moderate	1	Weather station	\$5000	
N / W		Low	1-2	Mist Nets	\$300	
N		High-Mod		Computer / Laptop	\$2500-\$3000	Assist in working away from the office, meetings, etc.
	W	Mod	q	ATV Plow blade and mount	\$550-\$750	Would be nice for fall/winter/spring field work for clearing the driveway and parking lot
	W	Low	1	Ride on Lawn mower	\$2500	Our push lawn mower although it is in fairly good condition is very time consuming to cut the amount of grass we have, this would decrease the amount of time needed

## Appendix 7: Documented 2016 Near Misses &amp; Incidents

#	Date	NM, I, A	Type	Description	Causes			Ways to decrease/eliminate
					Direct	Indirect	Root	
					-At Risk Behaviours -Unsafe Work Conditions	-People -Work Process/task -Materials/Equipment -Environment	-Management System	
1	4/23/16	NM	Field Work	Missed Check in time through DMI Check in service. I was able to contact by cell phone and he called to report in	forgot			
2	5/2/16	I	Camp Activities	While putting up Tents they got a peiece of debris in their eye. Proper first aid measures were taken.	didn't put on PPE		No policy for putting up tents	Make SOP for work at camp
3	5/3/16	NM	Transportation of Equipment	drove a vehicle with a trailer attached with no D-link to secure the trailer to the trailer hitch.	forgetfulness		trailer safety check list was not available	have paperwork ready on time and do second check
4	5/3/16	NM	Driving	While driving down the P2-200 road the driver needed to take defensive measures to not hit a deer that jumped onto the road from the bushline. Deer were the same colour as the dry dead grass and were very difficult to see	Driving too fast for the conditions			
5	5/5/16	I	Field Work	while doing transects in back wood lot of camp they had a stick poke him in the eye.	forgot PPE			



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					Direct	Indirect	Root	
					-At Risk Behaviours -Unsafe Work Conditions	-People -Work Process/task -Materials/Equipment -Environment	-Management System	
6	5/5/16	NM	Extreme Weather Events	Due to extreme temperatures, high winds, site is closed to field work.		uncontrollable fire hazard and weather conditions		
7	5/24/16	NM	Driving	While driving to Camp from Edmonton low tire pressure light continued to come on and off. No problem with air pressure in any tire. Tire pressure had been put on the wrong tire and was causing a glitch	when tires were rotated instrumentation was not updated			
8	5/24/16	E	Wildlife	While clearing trails encountered a grouse that flew up from the brush at their heads. They ran from the grouse tripping on each other. No injuries occurred	Don't run from any wildlife			During Orientation speak to what to do in wildlife encounters including grouse
9	5/25/16	NM	Field Work	While clearing trails one FA cut a small tree (<3DBM) which fell toward the other FA. They were able to step out of the way prior to it falling on them			No SOP for trail clearing	

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10	5/25/16	NM	Field Work	While clearing trails they got caught up in dense regrowth that had been knocked down. No injury occurred			No SOP for trail clearing	
11	5/25/16	NM	Field Work	While clearing trail the FA tripped the small tree they were clearing off the trail			No SOP for trail clearing	
12	5/26/16	I	Field Work	While clearing trails the FA stained neck and shoulders.			No SOP for trail clearing	had LFA add asking how their FAs are feeling during their morning safety briefing
13	6/3/16	NM	Field Work	Tripped walking along a baseline in C due to dense regrowth	not watching where going, walking too fast for conditions			stress importance of watching where they put their feet
14	6/4/16	E	ATV/ Snowmobile	While in J Left side tires got caught in a rut while the right side stayed on firm ground. Caused the ATV to roll to the left. The FA was able to jump away from the ATV. No injury and no damage to the ATV was sustained			Poor trail conditions	still pushing for a better ATV training for our staff that take reading terrain, etc. into consideration

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15	6/9/16	E	Wildlife	Grabbed the wrong carterages for his Bear Banger so when he went to fire the BB it would not go off		Enven though the two types were seperated in the BB container still mixed up the cartrages		I have completely seperated the BB into CF & RF so they should not be mixed up
16	6/10/16	NM	Wildlife	Several reports of a bear with a limp coming close to workers at old camp. Contacted Fish and Wildlife who opened a file to assess the bear		bear territory		
17	6/10/16	E	Wildlife	Grazing bear in ROW did not move as the 4 approached, reved engines, sounded air horn, eventually needed to use bear banger to scare it off		bear territory		
18	6/10/16	NM	Field Work	Missed Check in time had to drive to find them	did not attempt to call to left know they were late			
19	6/13/16	I	Camp Activities	While playing frisbee in their off time a FA got a frisbee to the face causing a big upper lip				

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20	6/13/16	I	Camp Activities	while putting together additional star plots, the FA grabbed the melted plastic with bare fingers, thinking that it had already gone hard and cold. The burn was very minor and did not cause a blister	not wearing PPE, not paying attention			Stress importance of wearing PPE
21	6/20/16	I	Field Work	White spruce to the face while walking, no safety glasses on, but no injury	not wearing PPE, not paying attention			
22	6/22/16	NM	ATV/Snowmobile	ATV stuck in mud in A, was able to push out with help	Did not check mud hole before entering		Poor trail conditions	
23	6/23/16	NM	Infrastructure/ Equipment Failure	While working in the back of G the bridge built next to a beaver dam washed out, the crew was required to search for another place to cross the stream		high water and multiple dams breaking		
24	6/24/16	I	Field Work	While walking over some CWM had foot slip backwards on loose bark and bent foot backwards egagerately. Iced, asked if he wanted to be put on limited duty. Said he was ok to work	not aware of surroundings			stress watching where staff put their fee and testing surfaces before putting full weight on it

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25	6/25/16	E	ATV/Snowm obile	ATV stuck in mud in I, needed to winch out	did not check mud before entering		Poor trail conditions	
26	6/28/16	I	Field Work	Sprained ankle while walking through dense forest	moving too fast for conditions			
27	7/6/16	E	ATV/Snowm obile	ATV stuck in mud in B, needed to winch out	did not check mud before entering		Poor trail condions	
28	7/10/16	I	Field Work	While getting into a the back of a capped truck bed, the FA exasperated a running injury that he had gotten that week. He went on reduced work load for the rest of the summer while doing physio twice a week	did not inform supervisor of previous injury, worked on personal injury			
29	7/10/16	NM	Driving	Had to avoid a deer while on the P2-200 at around KM220.	Driving too fast for the conditions			
30	7/10/16	E	ATV/Snowm obile	Had to winch a FA from a muddy section of trail.	did not check mud before entering		poor trail conditions	
31	7/11/16	E	Interpersona l	two of the cooks were experienceing some difficulty with their colleague who was aggressive, rude, and making work life difficult				

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32	7/13/16	E	ATV/Snowmobile	ATV stuck in mud in I, needed to winch out	did not check mud before entering		poor trail conditions	
33	7/18/16	E	ATV/Snowmobile	ATV stuck in mud in I, needed to winch out	did not check mud before entering		poor trail conditions	
34	7/26/16	E	Interpersonal	A LFA came to me with concerns from other FA regarding them feeling uncomfortable working with another LFA				Stress importance of bringing up issues with supervisor as soon as they are encountered
35	7/26/16	NM	Field Work	have been noticing that people are signing out their return time as very exaggerated.			Ensure sign in time is actual approximate not exaggerated time	Change sign in out policy to ensure that exaggerated check in times are not used
36	7/26/16	NM	Wildlife	While in G this grad student and his FA heard what he thought was a moose making calls. It sounded close but they could not see it so they left the area.		moose habitat		
37	7/26/16	E	Wildlife	While working in 929 P3 saw a mother bear with cubs. They were able to scare off with noise but only after a bluff charge. Left the area immediately after	should have left the area as soon as encountered the mother and cubs			



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38	7/28/16	NM	Camp Activities	Our monthly water sample came back with Col-i-forms present. We retested the water to ensure there was not contamination at the tap source however sample still showed coliform present in the water. Camp went on a no tap water consumption order (July 28, 2016) until we were able to shock the tanks and get a clean water test				After shocking the tanks and having new water brought in, our water truck driver Bruce, suggested that it could be that the water was getting too much sunlight and suggested that we build a wall to inhibit light into the tank.
39	8/2/16	NM	ATV/Snowmobile	ATV stuck in J, was able to push out with others help	did not check mud before entering		poor trail conditions	
40	8/8/16	NM	Driving	While driving back from H went into a skid while coming down the hill at 233. The truck fishtailed a bit but the driver was able to keep the truck on the road		poor road conditions		
41	8/8/16	E	ATV/Snowmobile	ATV stuck in J, needed to winch out	did not check mud before entering		poor trail conditions	

