

A Review of the 2014 Diavik Diamond Mine Wildlife Monitoring Report

Prepared for

Environmental Monitoring Advisory Board

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Prepared by



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Executive Summary

Summary and Recommendations

In this review on behalf of The Environmental Monitoring Advisory Board (EMAB or the Board), Management and Solutions in Environmental Science (MSES) assesses the procedures and results of the 2014 Wildlife Monitoring Report (WMR; Golder 2014a). The annual data collection is mandated to follow a Wildlife Monitoring Program (WMP), developed in 2002, which determined the testable questions and the objectives that need to be addressed through the life of the project. In the course of the past 12 years, MSES reviewed the WMRs to evaluate how the WMP was and is adhered to. In the course of 2010, MSES participated in several communications with Diavik Diamond Mine Inc. (DDMI) and other parties where a number of recommendations were discussed in workshops and other venues to adapt the data collection in light of current information (Handley 2010). These recommendations, in part, altered the objectives of the 2002 WMP which are now reflected in the WMRs since 2011. Below we have summarized our key review findings for the 2014 WMR for each of key wildlife species considered in this report.

Direct loss of caribou habitat is still in line with the original predictions. However, the Project may be contributing to indirect loss of caribou habitat through changes in vegetation next to the mine site. Indirect habitat loss for caribou was not specifically addressed in the 2014 WMR.

Aerial surveys for caribou were not completed in 2014. Based on previous detailed analyses, the general findings for caribou remain relatively unchanged, namely that there appears to be a zone of influence (ZOI) for caribou occurrence; where caribou are more likely to occur at about 14 km from the mine than closer to the mine. A Government of the Northwest Territories (GNWT) Caribou Zone of Influence (ZOI) Technical Task Group is still determining under what conditions aerial surveys should be resumed.

Caribou behaviour data were collected but not analyzed in the 2014 WMR. DDMI will undertake additional analyses of ground-based behavioural data when sufficient data are available.

In 2014, caribou distribution followed the predicted pattern for the northern (spring) migration; caribou mostly deflected west of East Island. However, for the southern migration, female collared caribou travelled west around Lac de Gras, which does not support the prediction in the EER. The methods applied for this part of monitoring are adequate, but in general, a constructive discussion, taking the most recent data and analyses into account, would be useful for future project-specific and regional management of caribou impacts.

For grizzly bears, no particular new information was found compared to previous years. Both mortality and habitat loss remain at or below the levels predicted. The 2014 monitoring data seem to suggest that the occurrence of grizzly bears is higher near the mine than farther away. Future detailed data analyses should test whether these observations indicate a real trend. The grizzly bear hair-snagging program DNA results should address a regional scale question about the bear population. The hair-snagging

program was not undertaken in 2014, though results of the 2012 and 2013 hair snagging program can be found in ERM Rescan (2014).

For wolverine, mortality remains at or below the levels predicted. A visual comparison of annual results of the hair snagging and snow track programs is presented in the 2014 WMR. The results generally correspond and indicate a declining trend in wolverine in the study area. Based on previous detailed analyses, the attraction of wolverine to the mine seems to have decreased, indicating that mitigation measures (on site management of food and waste to minimize attractants) have likely been effective in more recent years. The 2014 WMR hair snagging results estimated 17 wolverines in the study area and suggests a declining trend in the wolverine population size since 2005.

There do not appear to be any new findings or changes of note regarding the presence and productivity of falcons. No falcon or bird mortalities were recorded on the mine site in 2014. We concur with DDMI's recommendation to continue Pit Wall/Mine Infrastructure monitoring for nesting raptors and to continue providing nest site occupancy and productivity data to the Canadian Peregrine Falcon Survey (CPFS).

Attractants at the Waste Transfer Area (WTA) and Landfill area in 2014 appear to be more or less consistent with 2013 levels. In 2014, the number of fox observations appears to have decreased since 2013. Any trend should be confirmed with continued monitoring.

As expected, there was no new information regarding the abundance and species composition of waterfowl and shorebirds in the 2014 WMR. It was agreed that the waterfowl monitoring program would be discontinued in December 2013, but CWS did recommend that DDMI consider re-starting the waterbird/shorebird monitoring program at the mine reclamation stage.

As expected, no wind farm associated bird mortality information was presented in the 2014 WMR. Given the low likelihood of avian-turbine strikes, due to location and size of the wind farm, and the absence of bird mortalities in 2013, we agreed with DDMI's recommendation to discontinue monitoring the wind farm using 2013 methods and to instead monitor for bird mortalities as part of the overall site compliance monitoring program.

Overall, the measurements adequately address the predictions at hand. The analysis of the data yields a great deal of credible information about the effectiveness of mitigation measures. We generally agree with DDMI's recommendations submitted in their 2014 WMR. There are, however, some highlights for the Boards' consideration; several are re-stated here from previous yearly reviews as they await future detailed data analyses. We recommend that the following issues be addressed:

1. Please consider how the information gained from various caribou datasets could be used in terms of mitigation for the Diavik mine in particular and for other future projects in the region in general.
2. Please give careful consideration to the interpretation of the 14 km ZOI presented in Boulanger et al. (2012). The 14 km distance may actually demonstrate an aggregation of caribou that would not exist without the mines.

3. Please provide detailed explanation and justification as to why aerial surveys have been postponed “in favour of other studies”. Please provide details on what “other studies” would examine mechanisms that may cause caribou to avoid the mine.
4. Please address the following in future detailed analysis of caribou occurrence and behavioural data:
 - a. Please justify the pooling of caribou behavioural data across years and any assumptions made in future analyses.
 - b. Why does occurrence of caribou appear to be lower at distances farther than 14 km?
 - c. Why is there the same effect before Diavik was built (given that the years 1998/99 show the same ZOI “effect” as the years after the mine was built)?
 - d. Clarify if “probability of occurrence” indicates caribou densities, as opposed to simply the number of caribou in each distance category.
 - e. Testing changes in caribou behaviour over time. This will require an increased sample size of behavioural observations to allow for an analysis of behavioural changes over time.
5. Please justify the use of maximum average number of employees to reflect level of mining activity, possibly through correlation analyses with noise, construction, vehicle, and aircraft variables.
6. Please consider an analysis of the indirect (in addition to the currently presented direct) footprint effect on caribou habitat for understanding the true effects on caribou and for determining future mitigation measures. This is particularly relevant given the effects of dust deposition on local plant species composition and elevated metal concentrations in lichen near the mine.
7. Please provide a discussion of the potential causes of the departure from the prediction regarding the southern migration of caribou and potential response actions.
8. Please consider maintaining a schedule for surveying the mine site, roads, rock piles, and Processed Kimberlite for caribou presence.
9. In future detailed data analyses, please relate caribou track densities to the land area in each distance category.
10. Please give careful consideration to the possibility that grizzly bears may be becoming habituated and their presence on the site may be on the rise. Please provide a detailed analysis of grizzly bear data.
11. EMAB should consider reviewing the results of ERM Rescan (2014), which contains results of the 2012 and 2013 grizzly bear hair snagging program, to determine if and how results are relevant to grizzly bear monitoring for the Diavik mine.
12. Please evaluate whether the decrease in fox observations in the WTA in 2014 persists in future years.
13. Please discuss the results showing an effect of the mine on vegetation structure in reclamation and revegetation studies and discuss the implications for wildlife recolonization in terms of the

likelihood for re-establishment of natural or pre-disturbance vegetation and wildlife communities.

14. Please provide details of future monitoring plans for lichen, such as frequency and timing of monitoring.
15. Please provide responses to the detailed questions and comments (presented in bold font) in the body of this review report.
16. Except for our recommendations listed above, we are in agreement with the recommendations listed in the 2014 WMR and do not recommend any actions additional to providing the information requested above.
17. We recommend that the Board accept the 2014 WMR with the understanding that the above listed questions and recommendations will be addressed in communications and workshops by DDMI in the coming year. Furthermore, we understand that detailed data analyses are required, as identified in our review, and that these analyses will be conducted in the near future.

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1.0 Introduction

The Environmental Monitoring Advisory Board (EMAB or the Board) for the Diavik Diamond Mine Inc. (DDMI) Project requested that Management and Solutions in Environmental Science Inc. (MSES) review and assess the procedures and results of the 2014 Wildlife Monitoring Report (WMR; Golder 2014a). The WMR communicates the findings of surveys conducted during 2014 as well as DDMI's recommendations for future activities.

The annual data collection is mandated to follow a Wildlife Monitoring Program (WMP), developed in 2002, which determined the testable questions and the objectives that need to be addressed through the life of the project. In the course of the past 12 years, MSES reviewed the WMRs to evaluate how the WMP was and is adhered to. In the course of 2010, MSES participated in several communications with DDMI and other parties where a number of recommendations were discussed in workshops and other venues to adapt the data collection in light of current information (Handley 2010). These recommendations, in part, altered the objectives of the 2002 WMP which are now reflected in the WMRs since 2011.

Based on its annual reviews of past WMRs and detailed data analyses, MSES submitted numerous recommendations for EMAB and DDMI to consider. The present report takes past recommendations and discussions as well as the altered WMP objectives into account. Here, we review how DDMI addressed the above discussions and previous recommendations in the 2014 WMR.

In our review below, for the ease of identifying our recommendations and requests, we highlight the **text in bold** where we specifically request actions from DDMI.

2.0 General Observations

2.1 Objectives of the Wildlife Monitoring Program

The objectives of the WMP v.2 were developed in 2002 and DDMI has anchored its monitoring reports on these objectives. For more clarity, below we re-state the objectives set forth in the WMP v. 2 of 2002 to emphasize that these objectives are the foundation and focus of our review, and that the methods and results in the 2014 WMR, are reviewed in light of these objectives, as amended in 2010.

“The objectives of the wildlife monitoring program are to:

- a. Verify the accuracy of the predicted effects determined in the Environmental Effects Report (Wildlife 1998) and the Comprehensive Study Report (June 1999); and*
- b. Ensure that management and mitigation measures for wildlife and wildlife habitat are effective in preventing significant adverse impacts to wildlife.”*

These objectives are the foundation and focus of our past and current reviews, relating the methods and results in the 2014 WMR to what we believe is the ultimate goal of monitoring, namely the understanding and alleviating of effects of the project. However, a number of specific questions that have been tested in the course of the years of monitoring have been found to be either largely answered or

ineffective for the testing of mitigation effectiveness, prompting discussions about adapting the objectives of data collection in light of current information (Handley 2010). Specific to grizzly bear, the monitoring objective was revised once again at a March 2013 Wildlife Monitoring Workshop hosted by the GNWT (GNWT 2013). DDMI addressed the new objectives of the program in the WMR 2014, where appropriate. Specifically, the new barren ground caribou monitoring program objective is to test whether or not caribou occurrence changes with changes in mine activity. The new grizzly bear and wolverine objectives are to provide estimates of grizzly bear and wolverine abundance and distribution in the Diavik Wildlife Study Area over time. The new objectives of the falcon monitoring program are to contribute data to the Canadian Peregrine Falcon Survey (CPFS), determine nest success and deterrent effectiveness, and determine cause of any mine-related raptor mortalities.

2.2 The State of Current Information

The WMR 2014 did not present any new detailed wildlife data analyses. Detailed analyses for barren-ground caribou and wolverine were completed in 2014 (Wildlife Comprehensive Analysis Report (WCAR) - Golder 2014b) and other analyses are awaiting the availability of sufficient data to perform the appropriate analyses (e.g., caribou behaviour). Grizzly bear DNA analyses for the 2012 and 2013 hair snagging program were conducted outside of the WMR (see ERM Rescan 2014).

For the reader of this review, however, we re-state some of the highlights in the previous years' reviews (MSES 2014a and MSES 2014b), in addition to results from the current review, as this is the currently best available information on trends and data quality:

- The detailed analyses conducted in past years are generally well presented and informative. We would like to note that some of the recommendations made in previous years have been incorporated into past analyses. We would like to commend the authors for including more detail in the analytical results than in previous years.
- Based on previous detailed analyses, the general findings for caribou remain relatively unchanged, namely that there appears to be a ZOI for caribou occurrence where caribou are more likely to occur at about 14 km from the mine than closer to the mine. A potentially important finding was that caribou groups with calves spend less time feeding and resting within 5 km of the mine than farther away. This suggests that caribou behaviour and potentially the energy balance of young caribou is affected within that distance. DDMI will undertake additional analyses of ground-based behavioural data when sufficient data are available.
- For grizzly bears, no particular new information was found compared to previous years. Both mortality and habitat loss remain at or below the levels predicted. The most recent monitoring data seem to suggest that the occurrence of grizzly bears is higher near the mine than farther away. Future detailed data analyses should test whether these observations indicate a real trend. The grizzly bear hair-snagging program DNA results should address a regional scale question about the bear population.
- For wolverine, mortality remains at or below the levels predicted. The most recent monitoring data (Golder 2014b) seem to suggest that the relationship between wolverine occurrence and distance to the mines has become weaker, indicating that mitigation measures (on site

management of food and waste to minimize attractants) have likely been effective in more recent years. The 2014 WMR hair snagging results summary estimated 17 wolverines in the study area and suggests a declining trend in the wolverine population size since 2005.

- Past monitoring data seemed to indicate that fox presence at the WTA may be levelling off at a higher occurrence than has been recorded in early years. However, in 2014, the number of fox observations appears to have decreased compared to 2013. This should be confirmed with continued monitoring.
- For falcons the new objectives seem reasonable as they potentially contribute to a better regional understanding of falcon populations.

While DDMI has incorporated some of our recommendations or questions from previous years, others remain unaddressed. Table I summarizes the current status of our 2014 recommendations.

Table I: Actions by DDMI in Response to 2014 Recommendations

Recommendations/Questions Unresolved in 2014	Action by DDMI
Vegetation and Wildlife Habitat	
Discuss the revegetation program in light of the current findings [initially high plant productivity of some plots in which productivity did not seem to lead to the highest plant density and cover; the majority of shrub cuttings died]. Will it be possible to reclaim disturbed areas as expected (or desired), or does the information of lower than expected vegetation performance imply that vegetation may not return as expected?	The 2011 revegetation report provided some very useful information. The experimental set and data analyses are adequate and proved credible results. DDMI should take the recommendations in the revegetation report as guidance in reclamation planning. There is no 2014 update regarding revegetation.
The issues investigated in the Dust Deposition to Lichen study should be integrated with the WMR lichen study. We recommend that details of future monitoring plans for lichen be provided, such as frequency and timing of monitoring, and integrated with the results provided in the WMR to form a comprehensive vegetation monitoring program.	A 2013 Comprehensive Vegetation and Lichen Monitoring Program report was provided in Appendix A of the 2013 WMR, which appears to address this recommendation. While the report recommends that monitoring of permanent vegetation plots continue and that methods for the lichen sampling remain consistent, some concerns remain outstanding. Please see Appendix A of this report for a high-level summary of the current status of issues and concerns (raised in 2011) with the dust deposition to lichen study.
The 2013 Comprehensive Vegetation and Lichen Monitoring Program report concludes that “ <i>the Mine may be having local-scale effects on plant species composition</i> ”. The report does not suggest any strategies that could mitigate these effects. Please consider if and how these potential project effects could be mitigated.	A comprehensive analysis of vegetation and lichen data is completed every 3 years and was last completed in 2014. As such, no discussion was provided.
The 2013 Comprehensive Vegetation and Lichen Monitoring Program report stated that mercury concentrations were statistically lower near the mine than farther away in both 2010 and 2014. No discussion on this finding was presented. Please discuss possible	A comprehensive analysis of vegetation and lichen data is completed every 3 years and was last completed in 2014. As such, no discussion was provided.

causes of this pattern in mercury concentrations and what effects this may have on caribou ingesting lichen far from the mine.	
Barren-Ground Caribou	
Discuss the implications of a larger than expected effect on caribou for future environmental management.	No discussion was provided. The discussion of potential adaptive management measures is still open.
What is the actual size of the larger caribou ZOI, 14 or 28 km?	Boulanger et al. (2012) conclude a zone of influence of 14 km. We do not criticise the analysis completed by Boulanger et al. (2012) in terms of the validity of the 14 km ZOI. However, we question the interpretation of the “zone of influence”. We think the 14 km distance actually demonstrates an aggregation of caribou that would not exist without the mines. No further discussion provided.
What is the effect of mine closure on caribou range re-establishment? Are data collected to date sufficient to show a change of caribou distribution in light of the uncertainty of the size of the large ZOI? Also current baseline (pre-disturbance) information is poor, rendering conclusions on changes from pre- to post-disturbance inconclusive. Does DDMI believe that the current data quality is sufficient to show a potential reversal of the effects after closure?	A ZOI of 14 km has been established, as presented in Boulanger et al. (2012). The issue was discussed verbally in 2013 and DDMI admitted that it is possible that the currently observed ZOIs may have always existed. DDMI confirmed that true baselines do not exist. Using TK instead was suggested for discussion. No further discussion provided in 2014 WMR.
Testing the changes in caribou behaviour will be critical for the new approach to testing the effects within the small (3-7 km) ZOI. Please provide an analysis of the behavioural data and comment on whether or not behavioural data collected previously can be used. How can the information on behaviour be used to adapt management actions at the mine and in the region? A detailed technical side-bar discussion may be useful for us to better understand the assumptions and expectations by DDMI.	Analysis of caribou behavioural data was undertaken in 2010 using data from all years. Caribou with young feed and rest less with 5 km of the mine. Analyses or discussion supporting the combination of all years of caribou behavioural data were not provided. Assumptions were not provided. A discussion on “How can the information on behaviour be used to adapt management actions at the mine” was not provided. There was no 2013 or 2014 update regarding caribou behaviour. Data were insufficient for analysis.
We recommend DDMI provide a more detailed explanation and justification as to why they propose postponement of aerial surveys “in favour of other studies”. DDMI should also indicate what “other studies” would examine mechanisms that may cause caribou to avoid the mine.	The WCAR (Golder 2014b) makes reference to a GNWT Caribou ZOI Technical Task Group that will determine the best approaches to ZOI monitoring with recommendation due in 2015. We have requested clarification on if these approaches will be relevant to the Diavik mine specifically.
We recommend that the ideas to evaluate caribou health and to ask traditional knowledge holders about the behaviours that should be included in the observation protocol should be carefully considered, particularly from the point of view that the health of wide ranging animals are a result of many factors that occur in the region through which they range. Future discussions about these ideas could be fruitful.	No discussion was provided.
Is group composition data not collected anymore?	Group composition data were collected in 2014. Further analysis will be undertaken when sufficient data are available. Data were insufficient within 5 km of

	mining activities. Diavik should continue to collect data on caribou within 5 km of the mine.
Testing the distribution and abundance of caribou with careful consideration of the confounding factors of land area and land pattern in each of the zones would be beneficial. A useful number to interpret the caribou abundance results may be a density of caribou on the land area. Is DDMI willing to present such numbers during the next presentation of results?	Caribou density does not appear to have been used in any of the analyses in 2014, particularly in relation to land area. The issue was discussed verbally in 2013 and DDMI had agreed to provide density numbers for caribou. We have not seen these numbers yet.
DDMI concludes that 2,549 caribou were observed in the Diavik wildlife study area (in 2009). Please clarify if this number is based on the 15 % coverage. If so, then wouldn't this mean that there was a higher density of caribou observed in 2009 compared to previous years because in previous years a larger area was surveyed (having used a 4 km interval between transects before 2009)?	DDMI acknowledge verbally (phone conversation in Summer 2010) that this may be the case but no discussion of this potential confounding issue was presented in the 2014 WMR.
We suggest that an analysis of the indirect (in addition to the currently presented direct) footprint effect on caribou habitat may be useful for understanding the true effects on caribou and for determining future mitigation measures.	The WCAR (Golder 2014b) objective was to complete a comprehensive analysis of radio-collared caribou data to examine indirect Mine-related effects. Consideration of caribou habitat (resource selection function (RSF) values) was guided heavily by previous research on caribou. As we have not had the opportunity to review these documents, we cannot determine whether or how indirect habitat loss from the Mine was addressed.
DDMI should justify the use of maximum average number of employees to reflect level of mining activity, possibly through correlation analyses with noise, construction, vehicle, and aircraft variables.	No discussion was provided.
DDMI should discuss potential causes and response action, if necessary, for a slight departure from predictions regarding caribou migration patterns.	The 2014 WCAR analysis appears to begin to address this recommendation by evaluating factors that may affect caribou movement. However, no discussion of potential response actions was presented. Future proposed analyses may further this discussion on the necessity and type of response action.
DDMI recommended a reduced survey frequency for the assessment of caribou occurrence relative to the mine site, roads, rock piles, and Processed Kimberlite Containment (PKC). We suggest that these surveys continue at least bi-weekly to ensure no caribou are present in areas that are visually obstructed to on-site staff.	DDMI recommended reducing survey frequency because of the ineffectiveness of the surveys at detecting caribou at the Mine that were not already detected by other employees and pilots. In 2014, DDMI did not conduct road, PKC, and rock pile surveys on a scheduled basis because of their apparent ineffectiveness. We reiterate our previous recommendation to continue the surveys.
Grizzly Bear	
We recommend that the hair sampling program be continued, even if other mines do not commit to it.	The long-term duration and frequency of this program will be determined through review and discussion of program objectives and results at a wildlife monitoring workshop hosted by ENR and proposed for November 2015.
Please give careful consideration to the possibility that bears may be becoming habituated and their presence	There appears to be an increasing trend in the number of incidental grizzly bear observations over time, the

on the site may be on the rise.	number of days with bear visitations to East Island over time, and the number of days deterrent actions were utilized over time (see Section 3.3 of this report for more details). No discussion regarding the effectiveness of the deterrent system was provided.
Given the increase in grizzly bear observations near the mine, DDMI should increase vigilance and future years of data collection should be used to evaluate whether the re-instated deterrent system is effective at reducing grizzly bear presence near the mine.	
Preliminary results on the number of hair samples collected in the 2013 season are presented and we await the results of the DNA fingerprinting exercise which would presumably test the revised impact prediction regarding relative abundance and distribution of grizzly bears in the study area over time. We recommend EMAB review the DNA fingerprinting results of the grizzly bear hair snagging program once available.	The grizzly bear hair snagging program was not undertaken in 2014, though results of the 2012 and 2013 hair snagging program can be found in ERM Rescan (2014). EMAB should review this document to determine if and how results of this program might be relevant to ongoing grizzly bear monitoring for the Diavik mine, specifically.
Wolverine	
We do not believe that the data have been analyzed rigorously enough to draw any conclusions on whether or not track density is lower near the mine than farther away. As we noted above for caribou, densities need to be related to the land area in each distance category. We recommend that such an analysis be done in the next report on the comprehensive data analysis.	A comprehensive analysis of wolverine snow track data was completed in 2014 (Golder 2014b) that examined the relationship between wolverine track occurrence and explanatory variables including year, distance to the mine, habitat, and weather. The 2014 WCAR assigns a habitat index to each transect with explanations for the approach based on peer-reviewed literature. This appears to address the issue.
Please give careful consideration to the possibility that wolverine may be becoming habituated and their presence on the site may be on the rise.	The 2014 WCAR (Golder 2014b) presents detailed analyses that conclude that in more recent years the relationship between wolverine occurrence and distance to the mines has become weaker. Our recommendations have been addressed and it appears that mitigation measures (on-site management of food and waste to minimize attractants) have likely been effective in more recent years.
Regarding the 2014 WCAR (Golder 2014b), it was not clear why caribou herd size was related to wolverine occurrence and how this specifically relates to objective of the WCAR “to examine indirect Mine-related effects”. We recommend a brief explanation be provided.	No discussion was provided.
Regarding the 2014 WCAR (Golder 2014b), we asked that DDMI justify the use of maximum average number of employees to reflect level of mining activity, possibly through correlation analyses with noise, construction, vehicle, and aircraft variables.	The 2014 WCAR continues to use average number of employees to reflect level of mining activity without providing supporting justification.
Waste Monitoring	
While fox observations looked to be steadily increasing in the WTA since 2009, they appear to have levelled off in 2013 (the tabular presentation of data in the 2013 WMR makes it difficult to confirm). We recommend DDMI evaluate whether this levelling-off of fox observations in the WTA persists in future years.	In 2014, fox observations appear to have decreased in the WTA and landfill, but data are only presented in tabular form. The trend in the number of foxes should be confirmed with continued monitoring.

Waterfowl	
We have noted that the data collected on waterfowl diversity, abundance, and pond use is very detailed and could potentially be used for adequate effects monitoring, if control sites existed.	In 2013, it was agreed between DDMI and the Canadian Wildlife Service (CWS) that the waterfowl monitoring program would be discontinued. CWS recommended that DDMI consider re-starting the waterfowl monitoring program at the mine reclamation stage.

3.0 Specific Observations

3.1 Vegetation and Wildlife Habitat

There was a very minor change to the Project footprint in 2014. The additional disturbance occurred at the extreme south end of the project footprint. The overall disturbance of vegetation types remained at or below predicted levels in 2014, with three ELC types, riparian shrub, esker complex and bedrock complex, at or slightly exceeding the predicted loss. The exceedences existed from previous years. DDMI will continue to monitor habitat loss.

A comprehensive analysis of vegetation and lichen data is completed every 3 years and was last completed in 2014. As such, no new information is presented in the 2014 WMR regarding dust deposition from the Mine.

3.2 Barren-Ground Caribou

The 2014 WMR indicates that direct summer caribou habitat loss remains at or below predicted levels. With respect to indirect caribou habitat loss, dust fall monitoring data were collected in 2014. A comprehensive analysis of vegetation and lichen data is completed every 3 years and was last completed in 2014. As such, no new information is presented in the 2014 WMR regarding indirect loss of caribou habitat.

The aerial survey schedule, three continuous years followed by two years off, was designed to test whether or not caribou occurrence (zone of influence) changes with changes in mine activity. Ekati and Diavik requested to omit the ZOI requirement for caribou monitoring in 2013. The request was approved by ENR and aerial surveys were last conducted in 2012. No new information is presented in the 2014 WMR on changes to caribou movement. However, a comprehensive analysis of caribou data was completed in 2014 (2014 WCAR - Golder 2014b) and DDMI presented results relating to caribou GPS collaring data with a focus on movement patterns. The following are our recommendations that relate to caribou from our recent review of the WCAR (please see MSES 2014b for a complete review of this material):

- A common concern with GPS collar data is that multiple samples from the same individual may not be independent of each other. That is, one response from an individual affects the probability of another response from that same individual. **Clarification is needed on how caribou GPS data independence was achieved.**
- Clarification is needed on whether the Government of the Northwest Territories (GNWT) Caribou Zone of Influence (ZOI) Technical Task Group is tasked with developing new studies

examining mechanisms that may cause caribou to avoid the mine. **If so, we recommend EMAB review the proposed approaches to ZOI monitoring to determine if and how they might be relevant to ongoing caribou monitoring for the Diavik mine, specifically.**

- **Please give careful consideration to the interpretation of the 14 km ZOI presented in Boulanger et al. (2012).** The 14 km distance may actually demonstrate an aggregation of caribou that would not exist without the mines.

In accordance with recommendations from a workshop in 2009 with ENR and other mines and monitoring boards (Handley 2010), DDMI adapted its monitoring program for caribou in 2010 by coordinating with BHP-Billiton's Ekati mine and implementing ground observations of caribou behaviour for 2010. Ground-based behavioural observations were conducted in 2014 in cooperation with the Ekati Mine; however, behaviour data were not analyzed in 2014. DDMI will undertake analyses of ground-based behavioural data when sufficient data are available. Insufficient data are currently available to assess how caribou behaviour changes with distance from the mine. A summary of the number of caribou groups observed at different distances from the Mine and the size, composition, and location of each caribou group were provided for 2014. DDMI recommended that monitoring of caribou behaviour focus at distances between 2 and 30 km of the mine site. We agree with this recommendation and emphasize the importance of these data in understanding the influence of the mine on caribou. Given that analyses of change in behaviour with distance are still planned for the future, we re-state, for the record, that analyses of data should address the following:

- **Justify any pooling of data across years, or use year as a variable in the analysis, and identify what, if any, assumptions were made.**
- **Reconcile behavioural observations with the occurrence of caribou: does behaviour change with distance as occurrence does, i.e. is behaviour “normalized” past the zone of influence of 14 km?**
- **Why does occurrence of caribou appear to be lower past that distance?**
- **Why is there the same effect before Diavik was built (given that the years 1998/99 show the same ZOI “effect” as the years after the mine was built)?**
- **Clarify if “probability of occurrence” indicates caribou densities, as opposed to simply the number of caribou in each distance category.**
- **How can the information gained from the various caribou analyses be used to adjust or develop mitigation measures if there is a larger than predicted effect of the mine on caribou?**
- **DDMI should justify the use of maximum average number of employees to reflect level of mining activity, possibly through correlation analyses with noise, construction, vehicle, and aircraft variables.**

To evaluate changes in caribou distribution, DDMI used daily data on the geographic location of collared females as provided by ENR. In 2014, female collared caribou distribution followed the predicted pattern for the northern (spring) migration; caribou mostly deflected west of East Island. However, for the 2014 southern migration, female collared caribou travelled west around Lac de Gras, which does not support the prediction in the EER. The WCAR (Golder 2014b) found that for the southern migration from 2009 to 2013, collared caribou females remained further north than previously recorded and remained north

of the mine site through March 31st, 2014 (see MSES 2014b for complete review of this material). As such, we reiterate our previous requested that **DDMI discuss potential causes and whether or not any response action is warranted for this departure from predictions.**

As far as caribou mortality is concerned, the effect remains at or below predicted levels. The methods applied for this part of monitoring are adequate. Overall, the mean population size of the Bathurst caribou herd has decreased between 1996 (349,000) and 2012 (35,000). To support recovery of all barren-ground caribou herds, the NWT barren-ground caribou management strategy was developed. As a component of this strategy, Diavik has provided in-kind support for a study on wolf-caribou dynamics on the summer range of the Bathurst caribou herd.

In 2012, DDMI recommended that alternative survey methods and survey frequency for future assessment of caribou occurrence relative to the mine site, roads, rock piles, and Processed Kimberlite Containment (PKC) be evaluated, and in 2013, DDMI recommended a reduced survey frequency dependent on incidental caribou observations near the mine site. Reasons for the recommendations included: to enable surveyors to visually observe areas with no obstructions and the ineffectiveness of surveys at detecting caribou at the Mine that were not already detected by other employees and pilots, respectively. In 2014, DDMI did not conduct road, PKC, and rock pile surveys on a scheduled basis because of their apparent ineffectiveness. We reiterate our previous recommendation that **these surveys continue at least bi-weekly to ensure no caribou are present in areas that are visually obstructed to on-site staff.**

3.3 Grizzly Bears

As far as grizzly bear habitat loss and mortality is concerned, both effects remain at or below predicted levels. The methods applied for this part of monitoring are adequate.

There is an increasing trend in the number of incidental grizzly bear observations over time (Figure 1A), the number of days with bear visitations to East Island over time (Figure 1B), and the number of days deterrent actions were utilized over time (Figure 1C). DDMI has indicated that the number of incidental observations of grizzly bears does not appear to be influenced by the number of people on site (Section 4.2.2.2). According to the numbers in Table 6, we agree. We reiterate our previous recommendations that, **given the increase in grizzly bear observations near the mine, DDMI should increase vigilance and future years of data collection should be used to evaluate whether the re-instated deterrent system (2013) is effective at reducing grizzly bear presence near the mine.**

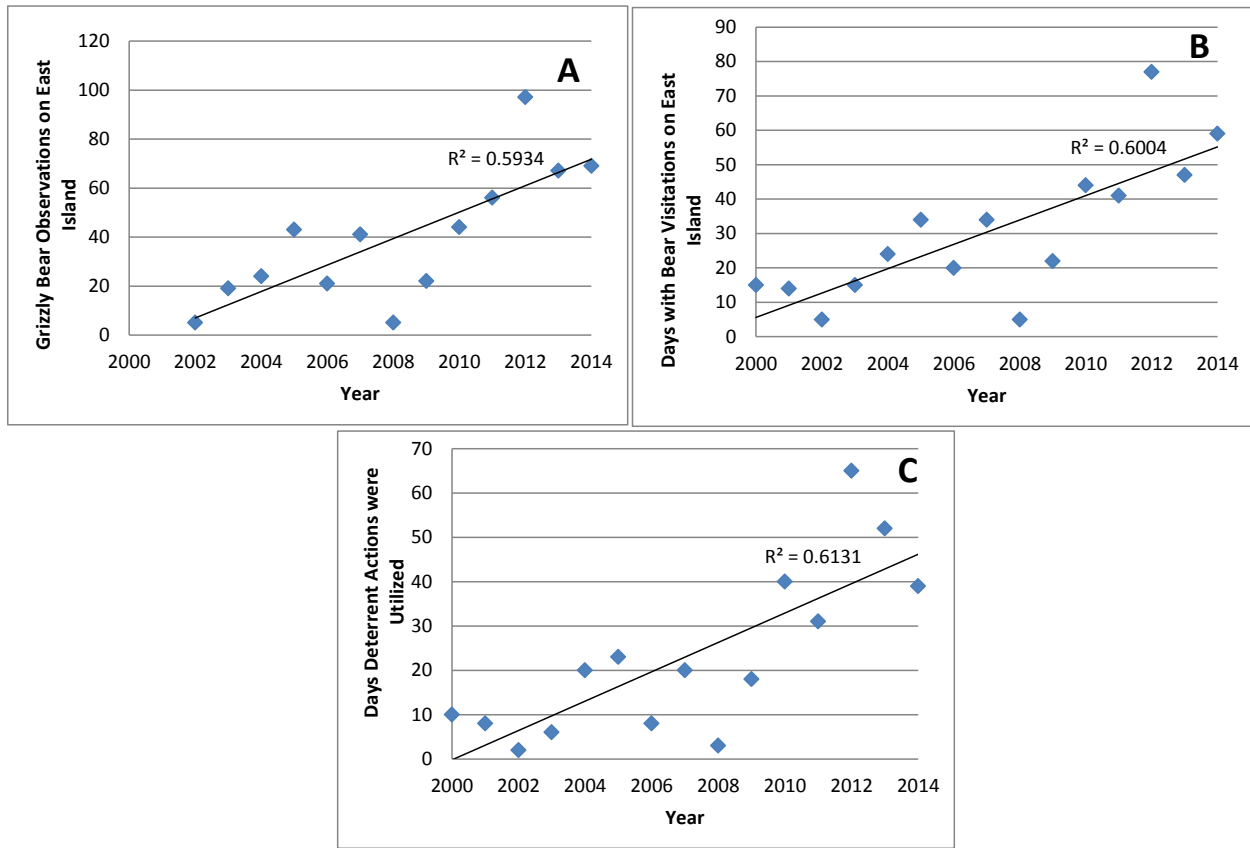


Figure I: A) Grizzly bear observations related to observation year. B) Days with bear visitations to East Island related to observation year. C) Days deterrent actions were utilized related to observation year (data from Tables 6 & 7 of the WMR 2014).

The monitoring objective for grizzly bear has been revised once again from:

To determine if Mine-related activities influence the relative abundance and distribution of grizzly bears in the study area over time (Handley 2010),

to:

To provide estimates of grizzly bear abundance and distribution in the study area over time (GNWT 2013).

A grizzly bear hair snagging program is jointly completed by Ekati, Snap Lake, Gahcho Kue and Diavik mines to address this new objective. The program was not undertaken in 2014, though results of the 2012 and 2013 hair snagging program can be found in ERM Rescan (2014). **We recommend EMAB review this document to determine if and how results of this program might be relevant to ongoing grizzly bear monitoring for the Diavik mine, specifically.** We support DDMI’s continued involvement in the grizzly bear hair-snagging program which is designed to address the new, regional scale question about the bear population, but we also stress that it is important to understand if and how the Diavik mine, in particular, contributes to grizzly bear relative abundance and distribution.

3.4 Wolverine

The most recent objective of the WMP related to wolverine is:

To provide estimates of wolverine abundance and distribution in the study area over time

Wolverine presence around the mine is monitored using snow track surveys, hair-snagging, and incidental observations, which were all conducted in 2014.

Results of the 2014 wolverine snow track and hair snagging surveys are summarized and a visual comparison of annual results from hair snagging and snow track programs is presented. The results generally correspond and indicate a declining trend in wolverine in the study area. A comprehensive analysis of wolverine snow track data was completed in 2014 (Golder 2014b) that examined the relationship between wolverine track occurrence and explanatory variables including year, distance to the mine, habitat, and weather. The analyses from the WCAR (Golder 2014b) indicated that wolverine seem to be attracted to the mine in some years; however, in more recent years the relationship between distance to the mines has become weaker. The 2014 WMR hair snagging results estimated 17 wolverines in the study area and suggests a declining trend in the wolverine population size since 2005. Based on the information presented, it appears that mitigation measures (on-site management of food and waste to minimize attractants) have likely been effective in more recent years. Alternatively, there may be fewer wolverine near the mine because there are fewer wolverine in the region.

No relocations or mortality of wolverine were reported on-site. This appears to support the prediction that mining related mortalities are not expected to alter wolverine population parameters in the Lac de Gras area.

We concur with DDMI's recommendation to increase the number of times that transects are surveyed during wolverine snow track surveys from mid-March to April.

3.5 Falcons

There do not appear to be any new findings or changes of note regarding the presence and productivity of falcons. No falcon or bird mortalities were recorded on the mine site in 2014. We concur with DDMI's recommendation to continue Pit Wall/Mine Infrastructure monitoring for nesting raptors and to continue providing nest site occupancy and productivity data to the Canadian Peregrine Falcon Survey (CPFS).

3.6 Waste Management

The attractants (food and food packaging) on the Waste Transfer Area (WTA) and Landfill area in 2014 appear to be more or less consistent with 2013 levels (though the tabular presentation of data in the 2014 WMR makes it difficult to evaluate any long term trends). The overall effect of waste management

appears to be positive. We commend DDMI for its efforts which probably led to the low attraction effect on wildlife.

Overall, many wildlife observations and sign have been decreasing over time. We previously noted that while fox observations looked to be steadily increasing in the WTA since 2009, they appear to have levelled off in 2013. In 2014, the number of fox observations appears to have decreased (though the tabular presentation of data in the 2014 WMR makes it difficult to evaluate any long term trends). **We recommend DDMI evaluate trends in the number of fox and other wildlife observations to determine whether waste management remains effective at minimizing wildlife attraction.**

We concur with the recommendation to maintain the current inspection frequency at the WTA and landfill.

3.7 Waterfowl

As expected, no waterfowl information was presented in the 2014 WMR. In past years, DDMI has evaluated predictions relating to waterfowl habitat loss, presence, and habitat utilization. The 2012 WMR recommended a review and evaluation of the current waterfowl program to see if any improvements could be implemented. A meeting was held between DDMI and the Canadian Wildlife Service (CWS) in December 2013 to discuss the waterfowl program. It was agreed that the waterfowl monitoring program would be discontinued at this time, but CWS did recommend that DDMI consider re-starting the waterbird/shorebird monitoring program at the mine reclamation stage.

We are in agreement with the recommendation to discontinue the waterbird/shorebird monitoring program and concur with the CWS recommendation regarding reinstating the waterbird/shorebird monitoring program at the mine reclamation stage.

3.8 Windfarm

As expected, no windfarm associated bird mortality information was presented in the 2014 WMR. Given the low likelihood of avian-turbine strikes, due to location and size of the wind farm, and the absence of bird mortalities in 2013, we agreed with DDMI's recommendation to discontinue monitoring the wind farm using 2013 methods and to instead monitor for bird mortalities as part of the overall site compliance monitoring program.

4.0 Closure

The review of the 2014 WMR reported herein presents the conclusions arrived at by MSES. As last year, we note with satisfaction that the communications we were involved in with DDMI, since our review of the past years, were useful in improving our understanding of the monitoring work conducted by DDMI. We note that several recommendations and requests from previous years were not responded to by DDMI (Table I). Some of our recommendations may be best addressed during detailed data analyses using multiple years of new data. We hope that future communications will lead to further clarification on several details of the 2014 WMR. Our views are submitted to EMAB for its consideration of potential recommendations and actions.

5.0 References

- Boulanger J., Poole K.G., Gunn A., and J. Wierzchowski, 2012. Estimating the zone of influence of industrial developments on wildlife: a migratory caribou *Rangifer tarandus groenlandicus* and diamond mine case study. *Wildlife Biology*. 18(2): 164-179.
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- GNWT (Government of the Northwest Territories). 2013. Final Minutes from March 6th 2013 Grizzly Bear Workshop. Department of Environment and Natural Resources. Yellowknife, NT.
- Golder. 2014a. 2014. Wildlife Monitoring Report. Prepared for Diavik Diamond Mines Inc., Yellowknife, NT. Reference No.: I406208-1393-R-Rev0-6000.
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- MSES. 2011. A Review of the 2011 Diavik Diamond Mine Risk Assessment of Caribou Exposure to Metals from Dust Deposition to Lichen. Prepared for Environmental Monitoring Advisory Board. December 2011.
- MSES. 2014a. A review of the 2013 Diavik Diamond Mine Wildlife Monitoring Report. Prepared for EMAB. April 2014.
- MSES. 2014b. A review of the 2014 Diavik Diamond Mine Wildlife Comprehensive Analysis Report. Prepared for EMAB. September 2014.

Appendix A

Table A-1: Actions by DDMI in Response to 2011 Recommendations on the dust deposition to lichen study

Issues and Concerns (MSES 2011)	2014 Status*
<p>The finding that lichens sampled from four locations within 10 km of the EKATI diamond mine had mean metal concentrations greater than others sampled in the far-field suggests that it may be difficult to find locations in the study area that are remote enough to be unaffected by mine emissions. We recommend that cumulative effects of emissions be investigated.</p>	<p>Cumulative effects have not been evaluated.</p>
<p>The study appears to assume that caribou ingest all lichen species at the same rate. Exposure risk values may be affected by caribou ingesting preferentially either high- or low-concentrating lichen species. We recommend that future studies investigate the possibility of selective foraging by caribou and how selective foraging may affect exposure values.</p>	<p>“...the emphasis of the sampling method was to collect lichen that caribou eat, and not necessarily on obtaining the same ratio of species in each sample.” This suggests that the ingestion of different lichen species by caribou was taken into consideration in the sampling methods, to a degree. However, this approach does not allow for a quantitative consideration of caribou ingestion rates for different lichen species. Quantitative data on caribou ingestion rates for lichen should be taken into consideration in the analysis of risk exposure.</p>
<p>We recommend that the rationale be provided for the selection of the far-field sampling area. How was the distance for the far-field sampling area determined? Is the far-field sampling area intended to represent a control area, beyond the limit of Mine dust carried by wind? Are there dustfall monitoring gauges in the far-field sampling area?</p>	<p>No explanation was provided for selection of the far-field sampling area. The 2014 report indicated that the “far-field area is more representative of background conditions”, but it is not clear if this is considered a true control area or not. It does not appear that dustfall monitoring gauges were present in the far-field.</p>
<p>Please discuss the implications of combining different lichen species into a single sample, the effect of the substrate on lichen metal concentrations, and the effect of the removal of lichen during sampling on future sampling/monitoring.</p>	<p>No explanation was provided for how the different species may affect the average metal concentrations in the samples taken. This potentially obscures the exposure risk for caribou.</p>
<p>We recommend that the results of the two-tailed t-tests and Wilcoxon-Mann-Whitney tests be presented in the report. Further discussion regarding the source of variability in the relative percent differences (RPDs) would assist us in understanding whether metal concentrations were measured three times from identical lichen material or from three separate samples with different species mixes.</p>	<p>“At each location, the sample was gently mixed to form a composite, and then split into two separate samples, which were analyzed separately for metals.” Results of statistical analyses for Lichen Chemistry were provided. The methods described confirm the above concern about obscuring exposure risk for caribou.</p>
<p>We recommend that details of future monitoring plans for lichen be provided, such as frequency and timing of monitoring. It is not clear if either the cumulative effects of mine developments in the region or climate change will be assessed in future monitoring.</p>	<p>While the report recommends that monitoring of PVP continue and that methods for the lichen sampling remain consistent, no further details were provided and no indication was given that cumulative effects or climate change will be assessed in the future.</p>
<p>The risk assessment does not include information on any changes in the concentrations of metals present in caribou and humans pre- and post-exposure or how these levels of metals relate to the health of either</p>	<p>This information was not included. The 2014 report concluded that “a follow up risk assessment based on 2014 data is not required, as it is expected that metal concentrations are still within safe levels for caribou”.</p>

caribou or humans. Inclusion of this information would strengthen the report's conclusions.

The expectation that metal concentrations are within safe levels for caribou (and humans) is opinion and unsupported by data.

***Based on MSES (2014a) review of 2013 WMR Appendix A.**