



# Progress Report

---

presented to the  
Strategic Committee  
of the

**NSERC-UQAT  
Industrial Chair on  
Northern  
Biodiversity in a  
Mining Context**

OCTOBRE 8<sup>TH</sup> 2019

---

**Nicole Fenton  
Sophie Laliberté**

Photo credits: Chair team, Pixabay

# Advances

## Context

This report summarizes the advances of the chair during the 2019 field season, and was prepared for the strategic committee of the Industrial Chair NSERC-UQAT on Biodiversity in a mining Context, for the meeting of October 8, 2019.

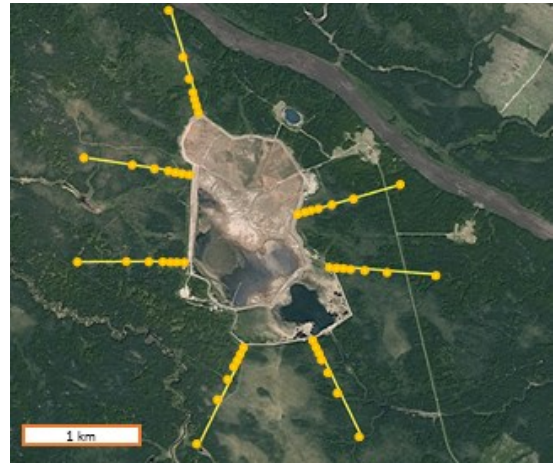
## Objective 1

**Objective 1**  
**Understanding mine footprints over the mine life cycle: strategies to minimize impacts on biodiversity in the short**

### PhD 1 - Determining the footprint of mines on plant diversity: integrating enigmatic impacts and the mine life cycle

Xiangbo Yin continues to advance his project, which aims to better understand the impact of mines on their immediate vegetative environment. He collected a lot of different data in the field during summer 2019, notably on plant diversity on the periphery of several mining sites, but also on microorganisms in order to document the biota of the phyllosphere, i.e. the microbes that co-habit mosses. He will complete his sampling in summer 2020 with the collection of the same data on roadsides, in order to take into account the effect of road dust in his analyses on the overall influence of mines on peripheral vegetation. To analyze this impact throughout the life cycle of a mine, six mines are studied for this project : Akasaba (future site), Malartic (active), Lapa (active), LaRonde (active), Casa Berardi (active) and Joutel (in restoration), which are additionally compared with control sites.

An interesting liverwort was found near Joutel. Part of the genus *Riccardia*, this will be a new observation for Canada for this species, which is different from all the other known species of the genus *Riccardia* in the country. Xiangbo will attempt to identify this species more precisely this fall.



Sampling surrounding Joutel site

### 2019 Fieldwork

Mining Sites	Dates	Nbr of days
Lapa- Agnico Eagle	June 27-28; July 2-4, 6-9	9
LaRonde- Agnico Eagle	July 11-12, 17-20, 22-23	9
Akasaba- Agnico Eagle	July 24-26, 28-30	6
Joutel - Agnico Eagle	August 6-10, 12, 16	7
Malartic	June 4, 6, 7, 11, 12, 14, 16-19, 24, 25	12
Casa Berardi	August 19-23; 26-29	9
3 control transects close to Lapa and LaRonde	August 1-2, 30	3
3 control transects close to Joutel	August 13-15	3

During the upcoming weeks, DNA extraction will be conducted on microorganisms for classification and to study the factors that explain their presence. The probable link between the presence of microorganisms and plant species will also be analyzed.

In addition, Rémi Boisvert, an intern from the University of Sherbrooke, is aiding Xiangbo

and is analyzing the impacts of active mines on 5 common species, *Maianthemum canadense*, *Cornus canadensis*, *Coptis trifolia*, *Linnaea borealis* and *Lysimachia borealis*.

**MSc 1 - Spatial footprint of particulate pollutants around active and restored mines: bryophyte growth and bioaccumulation**



*Pleurozium schreberi* marking

For this project, which has been transformed into a post-doctorate, preliminary results obtained by Dr. Mélanie Jean suggest that the influence of the mine on metal concentrations in mosses extends about 200 m from the mine boundary. Metal concentrations around Joutel (closed in 1998) are lower than at LaRonde (active). Data from other mines within and outside the Cadillac Fault Zone will be required to assess the impact of the life cycle stage of the mine and regional differences. Extractions of heavy metals from dried and ground mosses, carried out in collaboration with Dr. Benoit Plante at IRME, are still in progress

for moss collected at other mining sites. It is suspected that the ambient level of metals is higher on the Cadillac Fault. As a result, additional sampling was conducted in the summer of 2019 to include one more control site on the Fault.

The information obtained from this project will provide new data on the extent and distribution of particulates. All this information can then be integrated into the environmental assessments of mining projects to better take into account these impacts and thus better mitigate them. Integrating this information into planning is the subject of the MSc 3 project to be recruited in 2020.

**2019 Fieldwork**

Mining Sites	Dates	Nbr of days
1 control transect close to Lapa and LaRonde	August 13	1



*Pleurozium schreberi* marker

**MSc 2 - Using bryophytes to restore mine tailings impoundments: humid sites**

The MSc 2 project entitled "Use of Bryophytes for the Restoration of Wet Mine Sites" led by Dave Tremblay is completed. His dissertation was submitted in September 2019. This project analyzes the utility of transferring disturbed organic matter residues (forest windrows) produced by the forest industry to mining sites to promote revegetation. The results show that, in the zone with a neutral pH, the addition of organic matter allows revegetation to more than 50% after two years and that this addition does not increase the CO2 emissions of the tailings pond. On the other hand, in the zone with an acidic pH, there was a short vegetative development (~ 18 months), followed by a regression and a loss of organic matter. These data are very interesting because they suggest a potential synergy between two important industries in Jamésie, which could have little effect on the carbon footprint of operations.



Carbon dioxide sensor

**PhD 5 - Regional Importance of Tailings for the plant biodiversity**

For this project, the Chair recruited Nils Ambec, who has just joined the team this fall session. He began writing his research proposal as part of his PhD. For the moment, he is focusing on the literature review and is planning to establish a methodology for the collection of data as soon as the different secondary issues are well defined. As biodiversity is a complex issue, considering mining sites as a contributor to biodiversity in the landscape is a challenge in the design of the project itself.

Nils also attended a bryology workshop in New Brunswick to continue his personal training in this area and to be more effective in his future identification work.

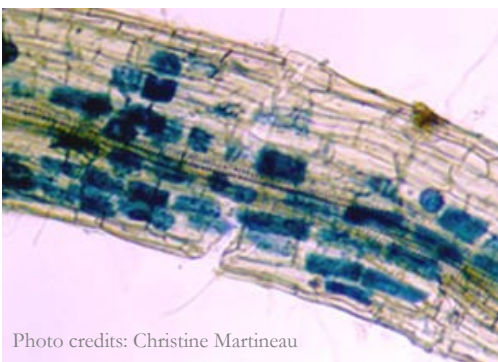


Photo credits: Christine Martineau

**Mycorrhized root**

will identify existing mycorrhizae. This part of the project will send Supun to Toulouse for part of the autumn, at Paul Sabatier University, to collaborate with professors Mélanie Roy and Monique Gardes, specialists in mycology.

The leaf and soil samples are ready for nutrient and heavy metal analyses, which will be conducted in various laboratories in France and Quebec. Analyses of these and mycorrhizal data are expected to begin in January 2021.

**MSc 6 - Spatial relationships of plants and mycorrhizae on tailings**

Over the past year, Supun Madhumadhawa has worked primarily on his project proposal and has been able to complete field data collection and initial laboratory testing, which will continue over the next year. The analysis of his data will aim to understand how the trees have colonized the former tailings sites of the Beattie Mine (Duparquet), and especially to see if facilitation exists underground, by studying the presence of mycorrhizal fungi. To do this, Supun measured growth parameters of the trees and took leaves and fine roots from the trees as well as soil samples. Extractions of DNA from root soil samples

**2019 Fieldwork**

Mining Sites	Dates	Nbr of days
Beattie, Duparquet	July 29 juillet to August 9	10

**MSc 7 - Regional Importance of Tailings for Waterfowl Compared to Beaver Ponds**

Émilie Desjardins continued her project, which began in the winter of 2018. During the last two summers, Émilie conducted waterfowl observations on 14 mine sites and 39 control sites (active and inactive beaver ponds) to better understand the waterfowl’s use of these sites. Other habitat properties (such as water pH, nearshore depth, etc.) were measured for each site for consideration in the analyses.

**2019 Fieldwork**

Mining Sites	Dates	Nbr of visits
Preissac A		
Stadacona		
Darius (O'Brien)		
Terrains Aurifères		
East Sullivan		
Bouchard-Hébert -Nyrstar		
Lac Herbin - QMX Gold		
Norbec - First Quantum Minerals	Between May 16 and August 18	4 visits per site
Camflo - Monarques Gold		
Westwood - Iamgold		
Joutel - Agnico Eagle		
Yvan Vézina - Iamgold		
Aumaque - Eldorado Gold		
Beacon - Monarques Gold		
39 Control Sites (Beaver ponds across Abitibi-Témiscamingue)		

Preliminary results from observations made in 2018 showed that mining sites appear to be used at least as much as beaver ponds for the four duck species analyzed. Among the latter, it has also been shown that the Golden-eyed Darter, a species of diving duck, uses the mining sites more significantly in comparison with beaver ponds. For the moment, however, it has not been possible to explain these observed patterns, so new variables will be included in the analyses this year. To this end, an inventory of fish at each site was conducted during the summer of 2019, and Émilie also hopes to be able to add other measures concerning the vegetation present at the sites. After this field season, the data is being processed and the final analyses will be done in the coming months.



Photo credits : Raymond Ladurantaye

Golden-eyed Darter

# Objective 2

Objective 2  
Avoiding risk for biodiversity: developing tools for ecological planning

This objective seeks to understand the distribution of wetland biodiversity from multiple angles in the Eeyou Istchee James Bay in order to provide a classification adapted to the region.

## PhD 2 Analysis and modeling of the dynamics of bryophyte and tracheophyte communities in wetlands of northwestern Quebec

Marc-Frédéric Indorf (PhD 2) is leading the project on the plant biodiversity of Jamesian wetlands, a project entitled "Analysis and Modeling of the Dynamics of Bryophyte and Tracheophyte Communities of Wetlands in Northwestern Quebec". Some nice surprises have been observed on the ground this summer, including the orchid *Arethusa bulbosa* in several sites around Casa Berardi. After this second year of fieldwork, we note that the sites are distinguished more by their degree of decomposition of peat than by pH of water, a relatively unexpected result since the traditional classification of these environments, between ombrotrophic and minerotrophic, is normally accompanied by marked differences in pH levels. The results of the analyses of the water and peat samples are currently awaited. In addition, the identification of collected plant specimens will be Marc-Frédéric's primary objective for the fall of 2019. It should be noted that Marc-Frédéric is continuing his collaboration with Ouranos to integrate the effects of climate change into his analyses.

Lilian Car, an intern from France, has expressed interest in the project and is currently working on the functional traits of the plants observed. He seeks to document how plant functional groups could evolve with climate change.

### 2019 Fieldwork

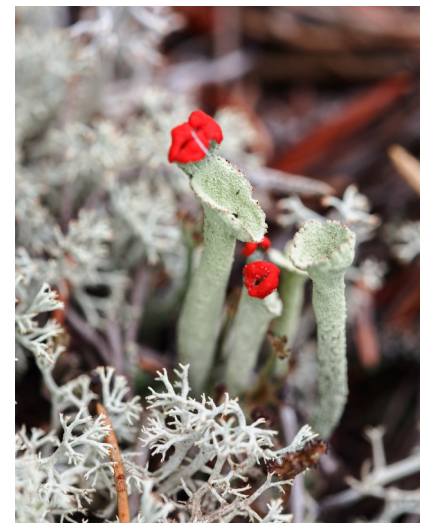
Nbr of sites	Mining Sites	Communities	Dates	Nbr of days
14	Casa Berardi	Pikogan	June 17-28	6
15	Wabouchi	Nemaska	July 29 to August 4	6
15	Renard	Mistissini	July 13-21	6

## MSc 4 Lichen communities of peatlands in Eeyou Istchee James Bay: Biodiversity and environmental factors

Tana Route (MSc 4), continued her project entitled "Lichens of the Eeyou Istchee James Bay: Biodiversity and Key Environmental Factors". Preliminary results show that uniform ombrotrophic peatlands and uniform black spruce bogs are more diverse in terms of lichen species than uniform fens. The microhabitat with the most diversity of lichens are trees with diameters of 7.6 cm or more at breast height. Tana is continuing her analysis to reach the final results that will confirm these trends and lead to their interpretation. In total, 82 species of lichens have been identified.

### 2019 Fieldwork

Nbr of sites	Mining Sites	Communities	Dates	Nbr of days
9	Renard	Mistassini	August 5-6	2
9	Casa Berardi	Pikogan	June 24, 26, July 4, Sept 25	4
9	Wabouchi	Nemaska	July 29 to August 4	6



**PhD 3 - Vertebrate community diversity in small wetlands**

Over the past year, Mariano Javier Feldman (PhD 3) has been able to analyze the images taken by camera traps for all of his 50 study sites, i.e. around small beaver ponds and peatland ponds, common habitat in Eeyou Istchee James Bay. In all, 35 bird species and 11 mammal species were observed. In addition, he began analyzing audio tapes recorded for his sites, which aim to document the presence of anurans, with recordings at dusk, and the presence of birds, with records at dawn.

For his second year in the field, in 2019, Mariano added two more taxons to his project by catching fish with minnow traps and dragonflies with butterfly nets. All the records for these two taxa were shared on the iNaturalist citizen science platform in order to feed this powerful database of observations, but also to validate identifications with the community of specialists. Some specimens of captured dragonflies were sent to an expert in Chicoutimi for species confirmation.

In the coming year, analyses of photos and audio files taken in 2019 will be conducted and these data can then be analyzed in order to contribute to the Jamésie wetland classification.

**2019 Fieldwork**

Nbr of sites	Mining Sites	Communities	Dates	Nbr of days
14	Casa Berardi	Pikogan	June 17-28	6
15	Wabouchi	Nemaska	July 29 to August 4	6
15	Renard	Mistissini	July 13-21	6



**MSc 5 - Aboriginals' use and importance of wetlands and assessment of moose stress near mines in Eeyou Istchee**

The fourth component of Objective 2 is a classification of these same wetlands according to their value to Aboriginal communities. Éliane Grant, a student recruited last year for this project, has already contacted Aboriginal communities in the study area, namely the communities of Pikogan, Nemaska and Mistassini. To document Aboriginal uses and values, she will conduct interviews with members of the different communities. These interviews will begin in the spring of 2020.

Because of Éliane's expertise and interests, and since moose are intimately linked to wetlands and are of critical importance to Aboriginal communities, an additional component has been added to this project, namely, analysis of the cumulative impact of anthropogenic disturbances on moose. An analysis will be done, in partnership with Gabriela Mastro Monaco, a specialist in animal physiology at the Toronto Zoo, to analyze the stress hormones present in the hairs of moose. To do this, she has distributed sampling kits to hunters in the community of Pikogan, and these kits will be distributed to the communities of Nemaska and Mistassini in the future. The location where the animal was hunted will help to find explanations for the level of cortisol, a stress hormone, which will be extracted from the hairs collected by hunters.

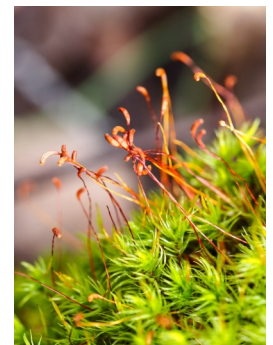
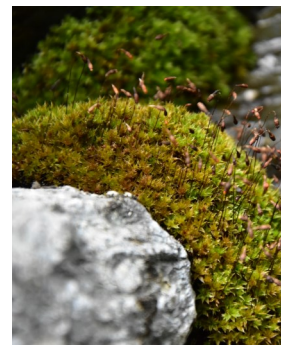
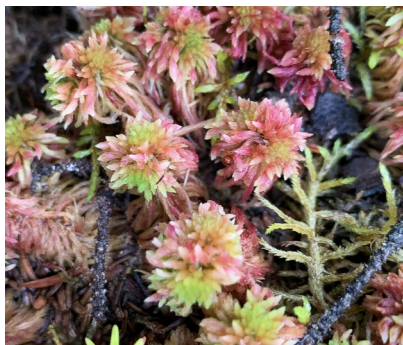
The post-doctoral project planned for the integration of all wetland classification results, both in terms of biodiversity and the native aspect, is not yet started since it depends on the results of the other projects named above. This project will provide an opportunity to better understand the link between biodiversity and Aboriginal land use and ecosystem services. In addition, the classification obtained will serve as a decision-making aid in the Eeyou Istchee James Bay land use planning.

These projects will be used to establish a classification of wetlands in relation to their biodiversity. This knowledge is all the more important since Northern Québec has a great abundance of wetlands for which very little knowledge exists. In addition to the planned development in the coming years (Plan Nord), climate change is also strongly affecting these environments. It is therefore important to better understand these relatively unaffected environments. Moreover, by classifying them, this will allow better consideration of the richest and most critical environments in terms of biodiversity.

---

**PhD - Bryophyte Biodiversity and Rare Species Estimation in Boreal Forests Using Remote Sensing**

This project, led by Carlos Cerrejon, Ph.D. student, is in addition to the other projects that aim to better understand the biodiversity in Jamésie. The project is funded by UQAT and Environment and Climate Change Canada. Its main objective is to develop medium- and high-resolution predictive models for three aspects of bryophyte biodiversity (alpha diversity, beta diversity, and probability of occurrence of rare species) in remote boreal forests in northern Canada. Carlos now has several preliminary results that show that his predictive models have a very high efficiency rate. This means that this tool can be added to the analyses during territorial planning.





# Objectif 3

**Objective 3**  
Vulnerability of key species for Aboriginal communities to cumulative impacts

Maxime Thomas first started the PhD project related to this objective in the fall of 2019. He was recruited following an internship at the UQAT bryology laboratory during the winter and summer of 2019 in the framework of his Master's degree courses.

The purpose of this project is to understand the effect of cumulative impacts on boreal ecosystems and what this implies for Aboriginal communities living on the land. In other words, the effects of climate change and human pressures (forestry, mining, roads, etc.) will be considered for their influence on the resilience and services provided by boreal ecosystems. To do this, two plant species of cultural and ecosystem importance will be selected in collaboration with the communities of Pikogan, Nemaska, and Mistissini.

These species will then be studied for their current and future ranges, the genetic diversity of their populations (resilience) and the quality of the ecosystem services they provide based on the two previous criteria.

For this project, the addition of Mebarek Lamara, a new professor at the IRF specializing in plant genetics, will bring a new dimension to the project, integrating the evolution and differentiation of the populations studied.



# Chair's team

With its many different projects, the Chair involves many people, particularly during the summer with the addition of field assistants.

Employees/Students	Number	% Time Dedicated to Project
Professors	12	Not applicable
Undergrad Students	4	33
Master's Students	4	100
PhD Students	5	100
Postdoctoral Researchers	1	100
Research Associates	1	100
Technicians	0	0
Liasion Agent	1	33
College Students	1	33
Administrative Aids	1	20



# Transfer, communication and liaison with stakeholders

## First Annual Symposium of the Chair

On April 8, 2019, the first Symposium for the CSRNG-UQAT Industrial Chair on Northern Biodiversity in Mining Context took place. It was an opportunity for students to present their projects and some preliminary results for some, to their colleagues, partners and a series of interested people who were at the rendezvous. The partners were also able to introduce themselves and explain some of their projects related to the environment, and more specifically, to biodiversity. The [poster](#), the [schedule](#) and the [recordings of the presentations](#) are all accessible on-line.

## Synthetic sheets

In order to explain the current projects and to present the team in a simple and accessible way, synthetic files have been prepared during the last year. Projects are grouped into 3 topics: [What is the impact of mine dust on plants?](#), [What is the biodiversity that can be found on mining sites?](#) and [To better know our wetlands](#)

## Communities and Partners Meetings

With the synthetic sheets in hand, the team presented the research carried out by the Chair to the communities of Pikogan and Nemaska. As for her, the community of Mistassini will be met this autumn. Some of the projects and preliminary results were presented to the MELCC regional team as well as to the Nemaska Lithium environment committee as well as the environmental and sustainable development officers of the Quebec Mining Association.

Communities and Partners Meetings	Dates
Environment ministry (MELCC): Chair general presentation and discussions about the projects <ul style="list-style-type: none"><li>Nicole Fenton</li></ul>	April 9, 2019
Quebec Mining Association (QMA): General presentation of the Chair to environmental and sustainable development managers <ul style="list-style-type: none"><li>Nicole Fenton, Éliane Grant, Marc-Frédéric Indorf, Sophie Laliberté, Supun Pawuluwage, Tana Route, Xiangbo Yin</li></ul>	May 29, 2019
Abitibiwinni First Nation of Pikogan: General presentation of the Chair and discussion of the next steps of the MSc 5 and PhD 4 projects <ul style="list-style-type: none"><li>Nicole Fenton, Sophie Laliberté, Maxime Thomas</li></ul>	June 10, 2019
Environment committee - Nemaska Lithium <ul style="list-style-type: none"><li>Marc-Frédéric Indorf, Sophie Laliberté, Tana Route</li></ul>	June 12, 2019
Cree Community of Nemaska <ul style="list-style-type: none"><li>Marc-Frédéric Indorf, Sophie Laliberté, Tana Route</li></ul>	June 12, 2019
Whabouchi Mine <ul style="list-style-type: none"><li>Marc-Frédéric Indorf, Tana Route</li></ul>	August 4, 2019
Liaison committee of Casa Berardi mine	October 8, 2019

## Presence in the research community

The Chair's projects have also raised the interest of the research community during the different presences of students and researchers in various conferences and congresses.

Presentations and Poster	Dates
<p>Carlos Cerrejon  <a href="#">Prédiction de la diversité alpha des bryophytes en forêt boréale par modélisation à partir de données de télédétection</a> [Poster]            20e Annual Symposium of the NSERC/UQAT/UQAM Industrial Chair in Sustainable Forest Management</p>	<p>November 30, 2018            Lorrainville</p>
<p>Tana Route  <a href="#">Les communautés de lichens des tourbières de l'Eeyou Istchee Baie-James: biodiversité et facteurs environnementaux qui les influencent</a> [Affiche]            20e Annual Symposium of the NSERC/UQAT/UQAM Industrial Chair in Sustainable Forest Management</p>	<p>November 30, 2018            Lorrainville</p>
<p>Émilie Desjardins  <a href="#">Utilisation des parcs à résidus miniers par la sauvagine en Abitibi-Témiscamingue en comparaison avec des étangs de castors</a> [Poster]            13e Annual Symposium of the Center for Forest Research</p>	<p>May 1-3, 2019            Chicoutimi</p>
<p>Mariano Feldman  <a href="#">Diversité des communautés de vertébrés utilisant les étangs de faible superficie du Nord-du-Québec</a>. [Poster]            13e Annual Symposium of the Center for Forest Research</p>	<p>May 1-3, 2019            Chicoutimi</p>
<p>Marc-Frédéric Indorf  <a href="#">Les communautés végétales dans les tourbières du moyen nord du Québec: Déterminismes, fonctionnement et vulnérabilité écologiques</a> [Poster]            13e Annual Symposium of the Center for Forest Research</p>	<p>May 1-3, 2019            Chicoutimi</p>
<p>Tana Route  <a href="#">Diversité et facteurs environnementaux influençant les communautés de lichens des tourbières du nord-ouest du Québec</a> [Poster]            13e Annual Symposium of the Center for Forest Research</p>	<p>May 1-3, 2019            Chicoutimi</p>
<p>Carlos Cerrejon et Henrique Hernandez Rodriguez            Selection of indicator species – Introduction to the R package <i>Indicspecies</i> [Workshop]            13e Annual Symposium of the Center for Forest Research</p>	<p>May 1-3, 2019            Chicoutimi</p>
<p>Carlos Cerrejon            Modélisation prédictive de la richesse des bryophytes dans les forêts boréales à partir de données de télédétection [Conference]  <a href="#">40e Canadian Symposium on Remote Sensing &amp; Gematics Atlantic 2019</a></p>	<p>June 4 to 6, 2019            Fredericton,            New-Brunswick</p>

## Presence in the research community (end)

Presentations and Poster	Dates
<p>Supun Pawuluwage  <a href="#">Below-ground facilitation between tree species in the re-vegetalization of a degraded site, p.126</a> [Poster]            Plant Canada 2019</p>	<p>July 7 to10, 2019            Guelph, Ontario</p>
<p>Carlos Cerrejon  <a href="#">Predicting bryophyte species diversity in Canadian boreal forests using remote sensing data</a> [Conference]  <a href="#">International Association of Bryologists (IAB) and International Molecular Moss Science Society (iMoss) 2019 Conference</a></p>	<p>July 9 to12, 2019            Madrid, Spain</p>
<p>Marc-Frédéric Indorf            Community assembly patterns of byrophytes and tracheophytes and future ecosystem vulnerability in boreal peatlands of NorthWestern Québec [Poster]  <a href="#">XXIIe Symposium of cryptogamic Botany</a></p>	<p>July 24-26, 2019            Lisbon, Portugal</p>
<p>Tana Route            Lichen communities in northwest Quebec, Canada: biodiversity and influential environmental factors [Poster]  <a href="#">XXIIe Symposium of cryptogamic Botany</a></p>	<p>July 24-26, 2019            Lisbon, Portugal</p>
<p>Mélanie Jean            Spatial footprint of particulate pollutants around active and restored mines: Moss growth and bioaccumulation. [Poster]  <a href="#">Conference of Canadian Society for Ecology and Evolution</a></p>	<p>August 19-21, 2019            Fredericton, New-Brunswick</p>
<p>Émilie Desjardins            Utilisation des parcs à résidus miniers par la sauvagine en comparaison avec des étangs de castors. [Conférence]  <a href="#">North American Duck Symposium</a></p>	<p>August 26 to30, 2019            Winnipeg, Manitoba</p>
<p>Éliane Grant  <a href="#">L'impact de l'activité humaine sur la santé de l'original</a> [Conference]            Indegenious dinner conference of UQAT</p>	<p>September 18, 2019            Val-d'Or</p>

## Media presence

Article / reportage	Date et média
<a href="#"><u>Chronique forêt - Le tout petit vu de l'espace? Est-ce possible?</u></a> [Chronicle] Carlos Cerrejon	August 7, 2019 Radio-Canada Première Des Matins en Or
<a href="#"><u>Deux chercheurs de l'UQAT veulent éclairer le ministère de l'Environnement</u></a> [Interview] Nicole Fenton and Osvaldo Valeria	July 17, 2019 Radio-Canada ICI Abitibi-Témiscamingue
<a href="#"><u>Mieux comprendre la biodiversité en contexte minier</u></a> [Interview] Émilie Desjardin and Nicole Fenton	April 8, 2019 Radio-Canada Première Région Zéro 8
<a href="#"><u>Une réussite pour le premier Colloque de la Chaire CRSNG-UQAT sur la biodiversité en contexte minier</u></a> [Press release]	April 9, 2019 UQAT News
<a href="#"><u>Un premier colloque conciliant développement minier et biodiversité</u></a> [Article]	April 11, 2019 Le Citoyen Newspaper
<a href="#"><u>Orignaux : une biologiste veut prouver l'effet cumulatif des perturbations humaines</u></a> [Reportage] Éliane Grant	18 septembre 2019 Radio-Canada ICI Abitibi-Témiscamingue
<a href="#"><u>Les activités humaines ont-elles un impact sur les orignaux</u></a> [Interview] Éliane Grant	September 18, 2019 Radio-Canada Première Région Zéro 8













