PROJET DE MINE DE SPODUMÈNE WHABOUCHI

Plan de compensation des milieux humides

N/Réf. : CA #3214-14-052

Octobre 2018 - Condition 12

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NEMASKA LITHIUM
nemaskalithium.com

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INFORMATIONS GÉNÉRALES

REQUÉRANT ET PROMOTEUR DU PROJET

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1 PRÉSENTATION GÉNÉRALE DU PROJET WHABOUCHI

1.1 APERÇU ET LOCALISATION

Le projet Whabouchi de Nemaska Lithium Whabouchi Mine Inc. (ci-après, « Nemaska Lithium ») consiste en l'exploitation et le développement d'un gisement de spodumène, un minéral riche en lithium. Le projet vise à extraire et à traiter le minerai du gisement présent sur la propriété Whabouchi afin de produire un concentré de spodumène directement sur le site minier. Le concentré sera ensuite envoyé à l'usine de transformation que Nemaska Lithium construit actuellement à Shawinigan et où il sera transformé en hydroxyde et en carbonate de lithium. Ces produits seront principalement destinés au marché des batteries au lithium.

Le projet Whabouchi est localisé sur le territoire du gouvernement régional d'Eeyou Istchee Baie-James (GREIBJ) à 30 kilomètres à l'est de Nemiscau et 280 kilomètres au nord de Chibougamau (carte 1.1). Les coordonnées géographiques centrales de la propriété sont les suivantes : longitude 75° 51' O et latitude 51° 40' N. E La propriété Whabouchi est accessible directement via la Route du Nord, soit en provenance de l'est par Chibougamau, ou en provenance de l'ouest par la Route de la Baie-James par Matagami (carte 1.1). Le site est également accessible par avion; l'aéroport de Nemiscau est situé à 19 km à l'est de la propriété.

Selon l'étude de faisabilité révisée (DRA Canada, 2018), les réserves prouvées et probables combinées (fosse à ciel ouvert pendant 24 ans et ensuite opérations souterraines) sont de 37 millions de tonnes (Mt) et d'une teneur (diluée) de 1,40 % Li_2O. À ces tonnes de minerai qui seront traitées au concentrateur s'ajoutent la gestion de quelque 72 Mt de stériles.

Le projet comprend l'exploitation d'une fosse à ciel ouvert et de galeries souterraines, d'une halde de co-disposition des stériles et résidus miniers, d'un concentrateur de minerai ainsi que de bâtiments administratifs et d'entretien. L'exploitation permettra de produire quelque 213 000 t de concentré de spodumène annuellement, et ce pour une durée de vie actuellement estimée à 33 ans.

1.2 HISTORIQUE DU POSITIONNEMENT DES INFRASTRUCTURES DU PROJET

En février 2013, Nemaska Lithium déposait officiellement la version révisée de son étude économique préliminaire (PEA) pour le projet Whabouchi (Met-Chem Canada, 2013). L'étude des impacts sur l'environnemental et le milieu social (EIEMS; Nemaska Lithium, 2013) était quant à elle déposée en avril 2013 à l'ACEE et au sous-ministre du MELCC (l'Administrateur provincial de la CBJNQ), lequel représente le Comité d'examen (COMEX).

Suite au dépôt de ces documents, le développement du projet Whabouchi s'est poursuivi de manière à optimiser celui-ci autant du point de vue technique que des points de vue social et environnemental. Entre autres, les commentaires émis et les préoccupations soulevées par les utilisateurs cris du territoire lors des consultations tenues suite au dépôt de l'EIEMS ont été pris en considération. En effet, une insatisfaction générale relative à la localisation de la halde à stériles et résidus miniers à proximité du lac des Montagnes s'était alors manifestée, et ce tant à propos des effets potentiels que cette proximité aurait pu avoir sur la qualité de l'eau que sur les habitats fauniques présents dans ce lac et ses baies (sauvagine). Certains commentaires portaient aussi sur l'impact visuel de cette halde pour les utilisateurs du territoire dont les camps saisonniers sont situés aux abords de l'embouchure de la rivière Nemiscau dans le lac des Montagnes. Ces préoccupations (proximité avec le lac des Montagnes, qualité de l'eau en cas d'incident, etc.) ne se

limitaient pas à la halde, mais s'étendaient aussi à la localisation des bassins de sédimentation et aux deux effluents finaux qui leur étaient à l'époque associés.

Conséquemment, afin de répondre à ces préoccupations, la localisation des haldes, des bassins et des effluents a été entièrement revue de manière à les éloigner du lac des Montagnes. Du même coup, d'autres modifications ont été apportées au projet afin de :

- Éviter la perte de milieux humides autrefois associée à la localisation de la halde à mort-terrain;
- N'avoir qu'un seul effluent final au sens de la Directive 019, dorénavant dans la rivière Nemiscau, et ce suite à des discussions spécifiques sur ce sujet avec les utilisateurs cris du territoire;
- Éloigner l'entrepôt d'explosifs des digues du bassin de sédimentation;
- Éviter toute déviation de la Route du Nord et ainsi conserver son tracé actuel;
- Réduire la superficie totale (empreinte) du projet dans son ensemble et du même coup son impact sur les milieux humides.

La carte 1.2 permet de comparer l'empreinte du site minier telle que proposée initialement dans le PEA (Met-Chem Canada, 2013) et l'EIEMS (Nemaska Lithium, 2013) à celle aujourd'hui considérée et élaborée dans le cadre de l'étude de faisabilité finale (DRA Canada, 2018).

La carte 1.3 illustre, quant à elle, le plan d'aménagement global des infrastructures et des installations minières projetées pour la mise en œuvre du projet Whabouchi.

Le tableau 1.1 présente les différences en termes de superficies impactées par type de communautés végétales entre la version du plan d'aménagement des infrastructures de 2013 et celle aujourd'hui considérée. On y remarquera que les différentes itérations réalisées au cours de ces cinq années d'optimisation du projet ont permis une réduction de l'impact du projet Whabouchi sur les milieux humides de l'ordre de 2,17 ha, ou 23 %.

1.3 CONTEXTE LÉGAL

Le 8 septembre 2015, après avoir suivi la procédure d'évaluation et d'examen des impacts sur l'environnement et le milieu social prévu au chapitre II de la *Loi sur la qualité de l'environnement* (LQE), Nemaska Lithium a obtenu du MELCC, en vertu de l'article 164 de la LQE, un certificat d'autorisation (CA ; réf. 3214-14-052) pour la mise en œuvre du projet Whabouchi.

Parmi les conditions incluses au CA susmentionné figure :

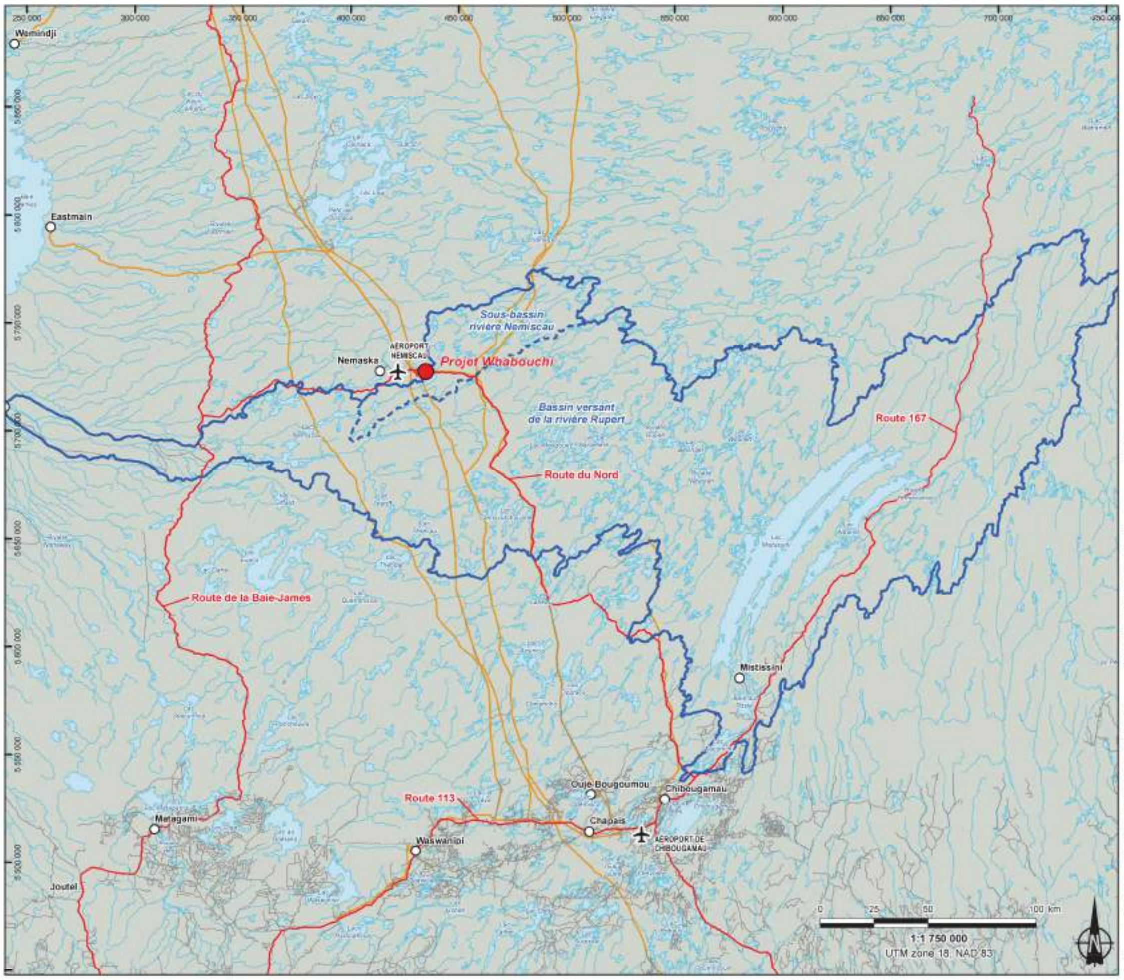
> ***Condition 12***[1] *: Le promoteur déposera à l'Administrateur, pour approbation, six (6) mois après le premier rejet à l'effluent final, un programme de compensation des pertes en milieu humides.*

Le présent document a donc pour objectif de répondre à cette condition.

[1] Version modifiée, 26 avril 2018.

Tableau 1.1 Superficies impactées par les infrastructures – Comparaison 2013 vs. 2018

		Bog arbustif	Fen	Myricaie	Aulnaie	Sous-total : milieux humides	Brûlis récent	Peulement forestier	Milieu perturbé	Total (ha)
	Conditions existantes (zone d'étude; 2012)	154,17	10,25	17,82	19,88	**202,12**	672,69	83,24	29,23	**987,28**
Phase construction										
Infrastructures	Fosse + bâtiment de ventilation	0,99	0,04	-	-	**1,04**	19,12	5,27	10,47	**35,90**
	Chemins miniers	0,21	-	-	-	**0,21**	8,72	1,21	0,63	**10,77**
	Halde de mort-terrain	-	-	-	-	-	3,30	-	-	**3,30**
	Halde de stériles et de résidus miniers-Phase 1	2,34	-	-	2,07	**4,42**	39,11	2,86	0,48	**46,87**
	Halde de stériles et de résidus miniers-Phase 2	0,85	-	-	0,21	**1,06**	22,48	0,37	-	**23,91**
	Dépôts d'explosifs + entrepôt d'explosifs, amorces et détonateurs	-	-	-	-	-	0,05	-	-	**0,05**
	Bancs d'emprunts	0,05				**0,05**	3,05	1,31		**4,41**
	Sous-total infrastructures	**4,39**	**0,04**	**-**	**2,28**	**6,71**	**92,78**	**9,71**	**11,58**	**125,21**
Bâtiments	Garage, bureaux et aires connexes	-	-	-	-	-	9,43	-	0,01	**9,44**
	Usine et aires connexes, incluant halde minerai	-	-	-	-	-	4,32	-	0,04	**4,36**
	Usine DMS	-	-	-	-	-	1,04	0,56	0,29	**1,89**
	Sous-total bâtiments	**-**	**-**	**-**	**-**	**-**	**14,79**	**0,56**	**0,34**	**15,69**
Gestion de l'eau	Bassins et fossés + digues	0,20	-	-	0,21	**0,41**	17,66	1,52	2,44	**22,03**
	Puits d'eau fraîche	0,06	-	-	-	**0,06**	0,30	-	-	**0,36**
	Conduite de rejet de l'effluent final	0,04	-	-	-	**0,04**	0,78	0,83	0,45	**2,10**
	Sous-total gestion de l'eau	**0,30**	**-**	**-**	**0,21**	**0,51**	**18,74**	**2,35**	**2,89**	**24,49**
	Total impacté (ha)	**4,69**	**0,04**	**-**	**2,49**	**7,22**	**126,31**	**12,62**	**14,81**	**165,39**
	EIES 2013	7,01	-	-	2,38	**9,39**	141,24	10,98	47,17	**208,78**
	Différences (ha)	***(2,32)***	***0,04***	***-***	***0,11***	***(2,17)***	***(14,93)***	***1,64***	***(32,36)***	***(43,39)***
	Différences (%)	***-33%***	***+***	***0%***	***5%***	***-23%***	***-11%***	***15%***	***-69%***	***-21%***



Infrastructures et installations existantes

- Aéroport
- Route principale
- Route secondaire
- Route locale
- Ligne électrique

Territoires et communautés

- Communauté autochtone / Ville

Hydrographie

- Cours d'eau
- Plan d'eau
- Limite du bassin versant de la rivière Rupert

Projet de mine de spodumène Whabouchi

Localisation du projet Whabouchi

JUIN 2016

Fichier : 107034_C1-1_localisation_gen_160314.mxd

Base carto. : BNDT, Gouvernement du Canada, 2012

Carte 1.1

Préparé : CV Dessiné : YR Vérifié : KB

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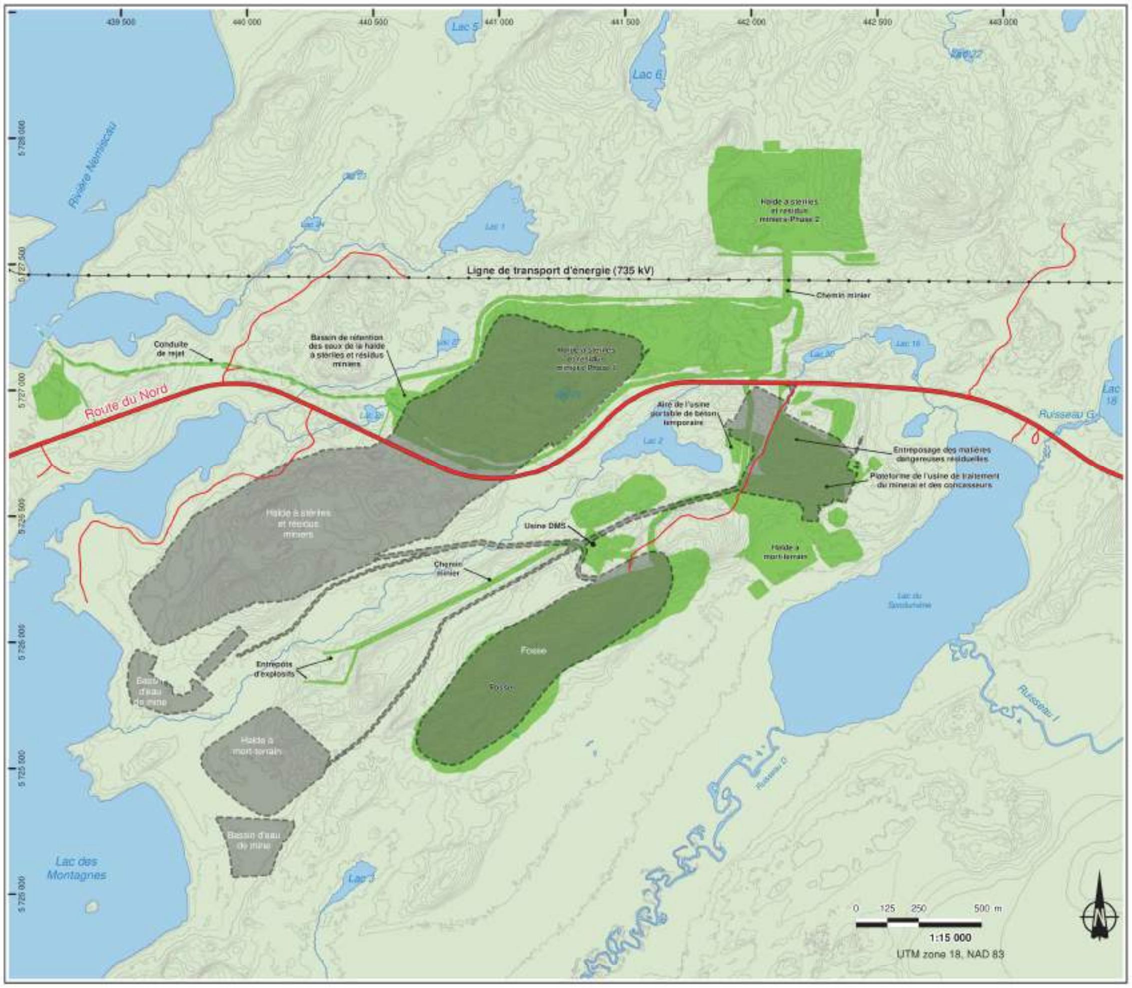

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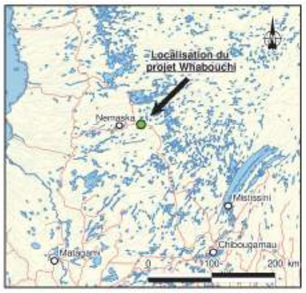
Infrastructures existantes et projetées

- Route du Nord
- Chemin forestier
- Ancienne emprise
- Conduite de rejet *
- Infrastructures projetées **

Environnement

- Rivière
- Lac

Sources :
* Emissaire Model_2 mars 2018 (modifié)
** W00068-49-0D0-D0100-01_R04.dwg, 25 janvier 2018 (modifié 180814)



Projet de mine de spodumène Whabouchi

PROGRAMME DE SUIVI ENVIRONNEMENTAL ET SOCIAL

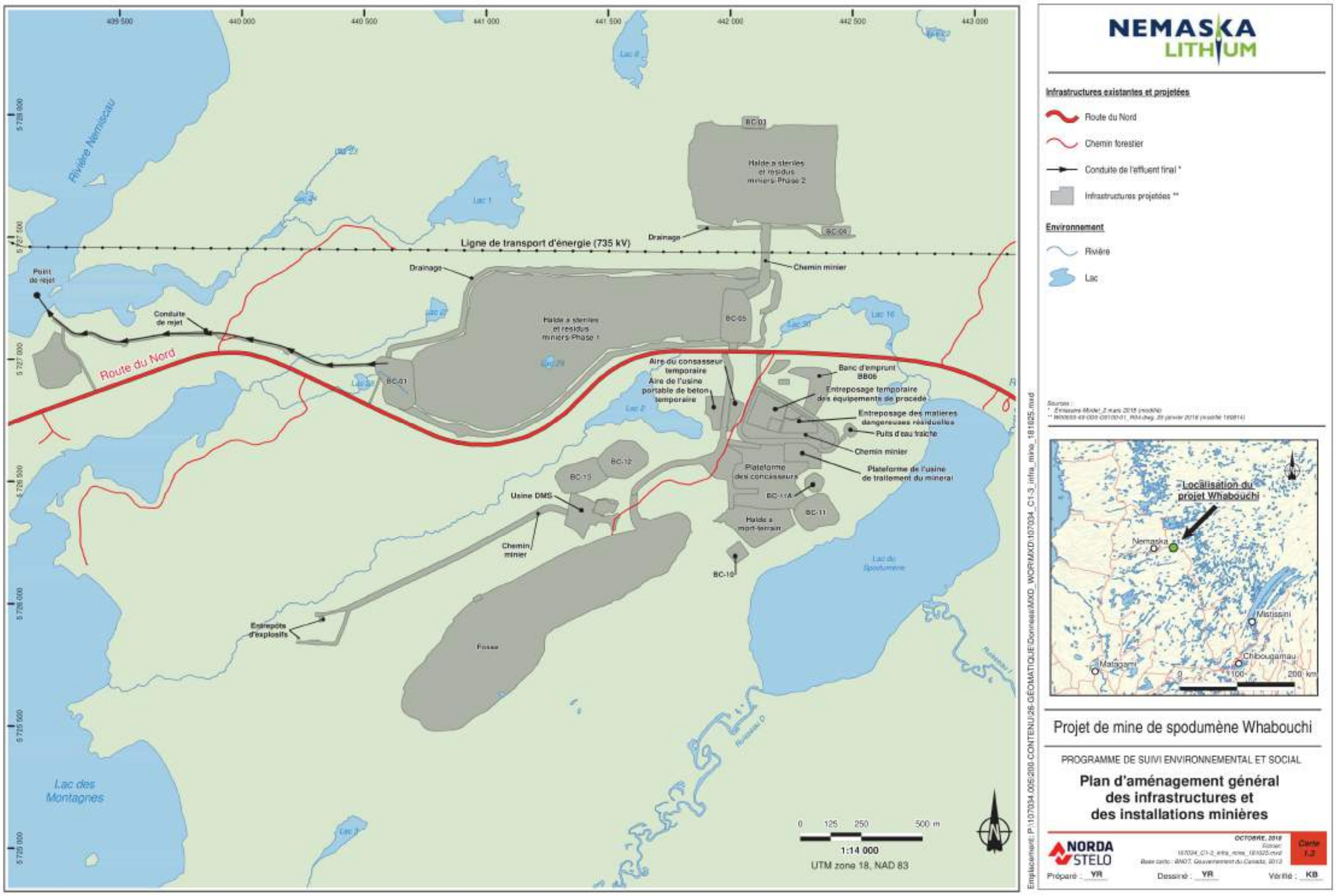
Comparaison entre l'empreinte du projet présentée lors du PEA et de l'EIES et celle actuellement prévue

NORDA STELO

OCTOBRE, 2018
Fichier: 107034_C1-2_Comparatif_layout_181025.mxd
Base carto : BNDT, Gouvernement du Canada, 2013

Carte 1.2

Préparé : YR Dessiné : YR Vérifié : KB



Rivière Nemiscau
Lac 1
Ligne de transport d'énergie (735 kV)
Drainage
Chemin minier
Halde à stériles et résidus miniers Phase 2
Halde à stériles et résidus miniers Phase 1
Point de rejet
Conduite de rejet
Route du Nord
BC-01
BC-03
BC-04
BC-05
BC-10
BC-11
BC-11A
BC-12
BC-13
Aire du consasseur temporaire
Aire de l'usine portable de béton temporaire
Banc d'emprunt BB06
Entreposage temporaire des équipements de procédé
Entreposage des matières dangereuses résiduelles
Puits d'eau fraiche
Plateforme de l'usine de traitement du minéral
Plateforme des concasseurs
Halde à mort-terrain
Usine DMS
Entrepôts d'explosifs
Fosse
Lac des Montagnes
Lac du Spodumène
Lac 2
Lac 16
0 125 250 500 m
1:14 000
UTM zone 18, NAD 83
NEMASKA LITHIUM
Infrastructures existantes et projetées
Route du Nord
Chemin forestier
Conduite de l'effluent final *
Infrastructures projetées **
Environnement
Rivière
Lac
Localisation du projet Whabouchi
Nemaska
Mistissini
Chibougamau
Matagami
0 100 200 km
Projet de mine de spodumène Whabouchi
PROGRAMME DE SUIVI ENVIRONNEMENTAL ET SOCIAL
Plan d'aménagement général des infrastructures et des installations minières
NORDA STELO
OCTOBRE, 2018
Carte 1.2
Préparé : YR
Dessiné : YR
Vérifié : KB

2 DESCRIPTION DU MILIEU NATUREL IMPACTÉ

La description détaillée du milieu ambiant est présentée dans l'étude des impacts sur l'environnement et le milieu social (EIEMS) du projet minier Whabouchi (Nemaska Lithium, 2013), ainsi que dans les documents de réponses aux questions et commentaires du COMEX (Roche, 2014a) et de l'ACEE (Roche, 2014b) qui ont suivi. La sous-section suivante présente un résumé de l'information disponible concernant les milieux humides recensés dans la zone d'étude du projet.

2.1 IMPACT SUR LES MILIEUX HUMIDES

2.1.1 Conditions existantes

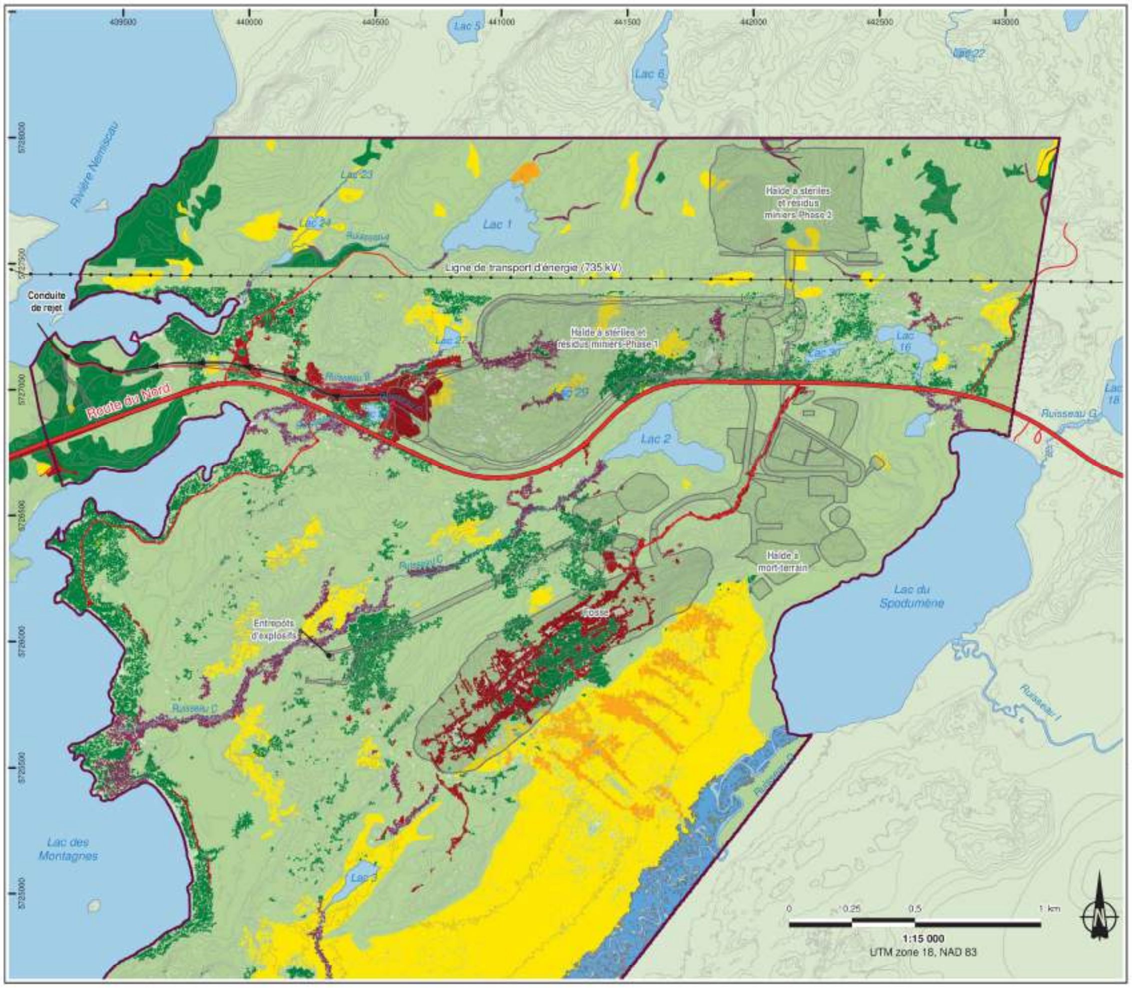
Le projet Whabouchi est situé à la limite nord du domaine de la pessière à mousses, dans la sous-zone de la forêt boréale continue. Dans cette région, l'épinette noire domine le couvert forestier, mais d'autres espèces sont également présentes tels le bouleau blanc, le peuplier faux-tremble et le peuplier baumier.

Les feux de forêt ont façonné la dynamique forestière de cette région. Le milieu terrestre de la zone d'étude est en effet occupé à 68 % par un brûlis récent (carte 2.1; tableau 1.1). Les peuplements forestiers (incluant la pessière noire à mousses, la pinède grise et la bétulaie) épargnés par le feu occupent 8,4 % de la zone d'étude alors que les milieux perturbés représentent environ 3 % de cette superficie.

Les milieux humides de la zone d'étude occupent pour leur part un peu plus de 20 % de la superficie. Les tourbières ombrotrophes (bog arbustifs) composent la plus grande partie des milieux humides, couvrant 16 % de la zone d'étude. Outre de petits îlots de tourbières ombrotrophes répartis ici et là, une tourbière ombrotrophe de grande superficie, soit la tourbière du lac du Spodumène, est présente au sud-est de la zone d'étude. Le long des lignes d'écoulement des eaux au sein de la tourbière du lac du Spodumène, des secteurs de tourbière minérotrophe (fen) sont présents. Finalement, les rives des cours d'eau sont généralement occupées par des marécages riverains arbustifs qui appartiennent à deux communautés végétales : l'aulnaie et la myriçaie.

Parmi les plantes d'usage traditionnel susceptibles d'être présentes dans la zone d'étude, 20 espèces ont été observées lors des inventaires effectués en juin 2012. Plusieurs d'entre elles présentent un intérêt au niveau de la consommation de petits fruits (bleuet, airelle, thé des bois, chicouté et canneberge commune) et de l'infusion (thé du Labrador, andromède glauque, cassandre caliculé et les kalmias), alors que les espèces arborescentes seraient plutôt utilisées pour leur bois et leurs usages médicinales. Les secteurs plus riches en espèces végétales d'usage traditionnel seraient les milieux forestiers et les tourbières.

Dans la zone d'étude, 26 espèces floristiques à statut particulier pourraient potentiellement être présentes. En raison des caractéristiques du site, deux de ces espèces à statut particulier seraient susceptibles d'être présentes dans les tourbières, soit le droséra à feuilles linéaires et l'utriculaire à scapes géminés. Malgré les efforts de recherche déployés lors des inventaires réalisés dans le cadre de la procédure d'évaluation environnementale et ceux en 2018 dans le cadre du programme de suivi environnemental, lesquels couvraient tous la grande tourbière du lac du Spodumène, aucune espèce à statut particulier n'a été observée.



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Zone d'étude

Infrastructures existantes et projetées

- Route du Nord
- Chemin forestier
- Conduite de l'effluent final *
- Infrastructures projetées **

Hydrographie

- Lac
- Rivière

Végétation et milieux humides

- Bog arbustif
- Fen
- Marécage arbustif riverain, Myricaie
- Marécage arbustif riverain, Aulnaie
- Brûlis récent
- Peuplement forestier
- Milieu perturbé

Projet de mine de spodumène Whabouchi

PROGRAMME DE SUIVI ENVIRONNEMENTAL ET SOCIAL

Communautés végétales et milieux humides

NORDA STELO

OCTOBRE, 2018

Carte 2.1

Préparé : CV Dessiné : YR Vérifié : KB

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2.1.2 Description de l'impact projeté

La préparation et l'aménagement des sites comprennent le déboisement complet des surfaces terrestres qui accueilleront la halde à stériles et résidus miniers, la halde à mort-terrain, la fosse, les bassins de rétention d'eau et de sédimentation, les chemins miniers, les fossés de drainage, l'aire de stationnement, la ligne de distribution électrique, l'usine ainsi que toutes les autres infrastructures minières connexes. Certaines de ces infrastructures devront également être excavées ou remblayées. Tel que précisé au tableau 1.1, au total, 158,17 ha de milieux terrestres et 7,22 ha de milieux humides seront perdus lors de cette phase. La vaste majorité du milieu terrestre impacté, soit plus de 75 %, est occupée par le brûlis récent.

Il est important de noter que suite aux modifications apportées à la disposition prévue des infrastructures de la mine depuis le dépôt initial de l'EIES en avril 2013, 41,22 ha de milieux terrestres et 2,17 ha de milieux humides ont été évités. L'impact direct du projet sur les milieux terrestres et humides a donc diminué de 20 % et 23 %, respectivement (tableau 1.1).

Les activités de préparation et d'aménagement des sites entraîneront une réduction de la superficie couverte par ces habitats au sein de l'aire d'étude. Or, étant donné l'abondance et le caractère commun à l'échelle régionale des peuplements recensés au sein de l'aire d'étude, les pertes encourues n'auront pas d'impact significatif sur la richesse végétale spécifique que ce soit à l'échelle locale ou régionale.

Ceci dit, en ce qui a trait aux milieux humides, il importe de déterminer leur valeur écologique afin d'adéquatement compenser les pertes occasionnées par le projet minier Whabouchi.

2.2 VALEUR ÉCOLOGIQUE DES MILIEUX HUMIDES IMPACTÉS

Dans le cadre de la procédure d'évaluation des impacts environnementaux et sociaux du projet Whabouchi, des réponses furent fournies au COMEX et au MELCC suite à diverses questions (réponses aux questions et commentaires du COMEX; Roche, 2014a). On référera à cet effet aux informations fournies en réponse aux QC130 et QC131, tout particulièrement au tableau 131.2 (repris ici au tableau 2.1), lequel présentait la valeur écologique des milieux humides impactés[2]. Ce tableau présente les résultats de l'évaluation pour tous les milieux humides impactés, regroupés par catégories de même type de milieu humide (tourbière ombrotrophe et aulnaie), à l'exception de la grande tourbière au sud-ouest du lac du Spodumène et du marécage arbustif à myrique baumier adjacent (myriçaie) qui ont été évalués séparément en raison de leurs caractéristiques uniques. Ces milieux étant toujours les mêmes, les informations fournies au tableau 2.1 sont conséquemment toujours valides.

L'évaluation indique que les tourbières ombrotrophes et les marécages arbustifs impactés par le projet sont de valeur écologique moyenne, à l'exception de la tourbière du lac du Spodumène et du marécage arbustif à myrique baumier adjacent qui sont de valeur écologique élevée. Cette différence s'explique par la taille plus importante de ces deux milieux, de même que par leur lien hydrologique direct avec un cours d'eau et l'utilisation de ces secteurs par la communauté crie pour des activités récréatives (notamment la chasse à la sauvagine). Toutefois, malgré l'importance de ces milieux humides pour la biodiversité locale et leur intégrité

[2] La méthodologie utilisée pour déterminer la valeur écologique des milieux humides a été fournie à l'annexe 131 de Roche (2014a). Cette méthode d'évaluation a été adaptée à partir d'une grille d'évaluation initialement établie conjointement avec la Direction régionale du MELCC de Chaudière-Appalaches, selon les critères du Guide d'élaboration d'un plan de conservation des milieux humides. Sept dimensions d'étude ont été retenues, soit le type de milieu, la dimension spatiale, le caractère exceptionnel, la fragilité du milieu, la dimension biotique, l'hydrologie et le caractère social. Tous les critères représentant ces dimensions sont associés à une pondération qui est définie selon l'importance du critère sur la viabilité du milieu humide. La valeur écologique finale associée aux milieux humides peut ainsi être qualifiée de négligeable, faible, moyenne, élevée ou exceptionnelle.

actuelle, il n'en demeure pas moins que ces écosystèmes ne sont pas rares dans le Nord-du-Québec et dans la région de la Baie-James plus particulièrement. Les milieux humides recouvrent en effet 7,3 % de la superficie de la province naturelle des hautes-terres de Mistassini, alors que le bassin versant de la rivière Rupert contient plus de 7 % des milieux humides de toute la région du Nord-du-Québec (CIC, 2009). Au total, 6,4 % du bassin versant de la rivière Rupert et 8,6 % de celui de la rivière Nemiscau sont occupés par des milieux humides non classifiés. Ainsi, leur valeur écologique est élevée, mais non exceptionnelle.

Conséquemment, une perte de 6,19 ha de milieux humides à valeur écologique moyenne et de 1,03 ha de milieux humides à valeur écologique élevée, pour un total de 7,22 ha, est considérée pour le projet minier Whabouchi (tableau 1.1).

Nemaska Lithium s'est engagée dès 2014 à ce que ces pertes soient compensées, ce qui a été officialisé par l'inclusion de la Condition 12 au CA global du projet, tel que mentionné à la section 1.3 du présent document.

Tableau 2.1 Valeur écologique des milieux humides impactés

Dimensions	Critères[1]	Tourbière du lac du Spodumène	Tourbières ombrotrophes	Aulnaies	Myriçaie du ruisseau D
Spatiale	Type de milieu humide	Tourbière mixte	Tourbière ombrotrophe	Marécage arbustif	Marécage arbustif
	Pondération (1)	*5*	*5*	*3*	*3*
	Superficie totale (ha)	136 ha	Entre 0,5 et 1,2 ha	Entre 0,1 et 2,2 ha	18 ha
	Pondération (1)	*5*	*2*	*2*	*5*
	Connectivité au milieu naturel (% dans une bande tampon de 30 m)	Plus de 81 %	Plus de 81 %	Plus de 81 %	Plus de 81 %
	Pondération (2)	*5*	*5*	*5*	*5*
Caractère exceptionnel	Présence d'espèces menacées ou vulnérables (faune et flore)	Aucune occurrence ; habitat potentiel pour certaines espèces susceptibles d'être désignée menacée ou vulnérable	Aucune occurrence ; habitat potentiel pour certaines espèces susceptibles d'être désignée menacée ou vulnérable	Aucune occurrence ; habitat potentiel pour certaines espèces susceptibles d'être désignée menacée ou vulnérable	Aucune occurrence ; habitat potentiel pour certaines espèces susceptibles d'être désignée menacée ou vulnérable
	Pondération (3)	*2*	*2*	*2*	*2*
	Rareté relative	Aucune données précise n'existe actuellement sur les proportions des différents milieux humides dans le Nord-du-Québec. Cependant, les tourbières représentent le type de milieu humide dominant dans cette région administrative[2].			
	Pondération (3)	*2*	*2*	*4*	*4*
Fragilité du milieu	Fragmentation	Intensité des perturbations faible (moins de 20 %)			
	Pondération (-2)	*1*	*1*	*1*	*1*
	Espèces exotiques envahissantes	Moins de 20 % (aucune espèce exotique envahissante recensée)			
	Pondération (-1)	*1*	*1*	*1*	*1*
	Intensité des perturbations anthropiques	Nulle ou faible	Nulle ou faible	Nulle ou faible	Nulle ou faible
	Pondération (-3)	*1*	*1*	*1*	*1*
Biotique	Représentativité territoriale de la composition floristique	Milieu humide arbustif ou arboré ayant atteint le stade de végétation de fin de sucession	Milieu humide arbustif ou arboré ayant atteint le stade de végétation de fin de sucession	Milieu humide arbustif en transition vers le stade de climax	Milieu humide arbustif en transition vers le stade de climax
	Pondération (2)	*5*	*5*	*3*	*3*
	Richesse spécifique ou relative (biodiversité)	Milieu humide présentant au moins trois types d'habitats	Milieux humides présentant au moins deux types d'habitats	Milieux humides présentant un type d'habitat	Milieu humide présentant un type d'habitat
	Pondération (3)	*3*	*2*	*1*	*1*
Hydrologique	Connectivité hydrologique	Lien hydrologique avec un cours d'eau (ruisseau D)	Présence de cours d'eau d'ordre 1 dans une zone tampon de 30 m*	Lien hydrologique avec un cours d'eau	Lien hydrologique avec un cours d'eau (ruisseau D)
	Pondération (2)	*5*	*2*	*5*	*5*
	Capacité de rétention	Profondeur de tourbe supérieure à 30 cm ; drainage très mauvais ; plantes obligés des milieux humides	Profondeur de tourbe supérieure à 30 cm ; drainage très mauvais ; plantes obligés des milieux humides	Profondeur de matière organique de 20 cm ; drainage très mauvais ; moins de 25 % d'eau libre	Profondeur de matière organique de 40 cm ; drainage très mauvais ; eau libre entre 25 et 40 %
	Pondération (1)	*5*	*5*	*3*	*4*
Sociale	Activités récréatives	Secteur de chasse à la sauvagine ; sentier de motoneige	Aucune activité spécifique recensée	Aucune activité spécifique recensée	Canotage ; secteur de chasse à la sauvagine
	Pondération (1)	*4*	*1*	*1*	*4*
	Existence de projets de conservation	Aucun			
	Pondération (1)	*1*	*1*	*1*	*1*
	total brut:	65	50	51	58
	total normalisé:	75	60	61	68
	Valeur écologique du milieu humide	**Élevée**	**Moyenne**	**Moyenne**	**Élevée**

1: Critères basés sur le Guide d'élaboration d'un plan de conservation des milieux humides du MDDEP (Joly, *et al.*, 2008)
2: CIC, 2009
* À l'exception d'une tourbière impactée par le déplacement de la route du Nord, qui possède un lien hydrologique avec le ruisseau B et le lac 27.

Chaque critère est associé à une pondération. Cette pondération (positive ou négative) est inscrite entre parenthèses et varie de 1 à 3. Une valeur de 1 à 5 peut être associée à chaque critère. Chaque milieu humide se voit accorder une valeur écologique qui est le produit de la pondération du critère et de la valeur associée. Un total de -10 à 94 points peut être accumulé. Ces valeurs ont été normalisées de 0 à 104 afin de faciliter l'interprétation des données: négligeable (0 à 20), faible (21 à 41), moyenne (42 à 62), élevée (63 à 83) et exceptionnelle (84 à 104).

3 PLAN DE COMPENSATION

3.1 CONTEXTE DU PROJET DE COMPENSATION PROPOSÉ

Dans le cadre de la procédure d'évaluation des impacts environnementaux et sociaux du projet Whabouchi, des réponses furent fournies au COMEX et au MELCC suite à diverses questions (réponses aux questions et commentaires du COMEX; Roche, 2014a). Entre autres, en réponse à la QC130, il avait été mentionné que la compensation des pertes de milieux humides associées au projet minier Whabouchi serait fort probablement faite via la mise en place d'un programme d'acquisition de connaissances (biophysiques, sociales) sur les milieux humides de la région valorisés par les Cris et/ou la population non-autochtone de la région de la Baie-James. L'approche alors proposée avait ainsi été autorisée par la délivrance, en septembre 2015, du CA global pour le projet minier Whabouchi.

L'objectif d'un tel programme est non seulement la valorisation écologique future de ces milieux dans le cadre d'autres projets de développement (minier, récréotouristique, etc.), mais aussi une meilleure connaissance écologique du milieu à l'échelle régionale, laquelle est aujourd'hui gravement manquante, ne permettant pas une évaluation adéquate de la valeur écologique des milieux humides boréaux. À ce sujet, la méthodologie décrite à la section 2.2 du présent document en est la preuve évidente : les biologistes ayant déterminé en 2014 la valeur écologique des milieux humides sur le site Whabouchi ont dû utiliser une grille élaborée pour la région Chaudière-Appalaches!

Cela confirme aussi les appréhensions d'organismes tels Canards Illimités Canada (CIC) qui, au même titre que de nombreux autres organismes non-gouvernementaux impliqués dans le domaine, déplore le fait que les milieux humides présents sur le territoire de la région du Nord-du-Québec sont immensément méconnus (CIC, 2009). On notera aussi à ce sujet la présentation récemment faite par Quinty *et al.* au cours de l'édition 2017 du congrès annuel de l'International Association for Impact Assessment ayant eu lieu à Waskaganish, intitulée « Need for a Wetland Guide in Northern Quebec » et qui concluait :

> *« In such conditions, it becomes obvious that a wetland identification and delineation guide should be developed properly for the northern portion of Quebec to take into account the specificity of soil, hydrology and vegetation of cold regions. […] Hydrological and soil criteria should also be adapted to boreal, subarctic and arctic conditions found in northern Québec and consider the influence of the global warming on the dynamic of wetland and permafrost. The increase of knowledge about northern plant species, geomorphology and arctic environmental conditions are leading to the preparation of such a guide. This work should be conducted by a team of specialists with experience in cold regions including biologists and geomorphologist specialized in periglacial environment. »*

Ceci prend d'autant plus d'importance dans le contexte de l'adoption récente de la *Loi concernant la conservation des milieux humides et hydriques*. Ces récentes modifications législatives ont introduit des concepts très intéressants pour la conservation des milieux humides boréaux, et ce bien qu'elles aient été développées dans une perspective très centrée sur le Sud du Québec et son contexte particulier. Entre autres, la nécessité de développer et d'adopter des plans régionaux identifiant, entre autres, les milieux humides à conserver, c.-à-d. ceux qui sont « rares, exceptionnels, à grande valeur écologique, de grande superficie, se distinguant régionalement ou nationalement par leur niveau d'intégrité, etc. ». De plus, lors de l'analyse d'une demande d'autorisation environnementale, le MELCC devra porter une attention particulière à l'importance régionale d'un milieu humide impacté.

Toutefois, pour ce faire, il est de la plus haute importance que des connaissances particulières sur les milieux humides boréaux soient acquises – sur leurs fonctions écologiques, leurs usages traditionnels, l'importance des milieux terrestres adjacents (surtout dans le contexte d'un objectif de « zéro perte nette »), etc. – sans quoi les objectifs visés par ces changements législatifs ne pourront fort malheureusement tout simplement pas être mis en application dans la région du Nord-du-Québec, tout particulièrement dans la région Eeyou Istchee Baie-James, là où la majorité des projets associés au Plan Nord se situent. D'ailleurs, dans ce contexte particulier de développement industriel et autres, l'importance que revêt une bonne connaissance des milieux humides qui pourraient ainsi potentiellement être impactés n'en est que plus grande.

3.2 DESCRIPTION DU PROJET DE COMPENSATION PROPOSÉ

Le projet de compensation proposé est un programme d'acquisition de connaissances (biophysiques, sociales) sur les milieux humides de la région boréale afin de tenir compte des caractéristiques uniques du Nord québécois, tout particulièrement en ce qui a trait à l'utilisation crie du territoire, au rôle biogéochimique et hydrologique important qu'y jouent les milieux humides et à la biodiversité particulière de ces milieux.

Le projet que nous proposons ici a pour but de colliger un maximum de connaissances sur les particularités des milieux humides boréaux et de les intégrer à une nouvelle méthode permettant une évaluation adaptée de leur valeur écologique. Dans une optique où le gouvernement du Québec souhaite développer le Nord québécois dans le cadre de son vaste projet qu'est le Plan Nord, il est primordial, selon nous, qu'une telle méthode soit rapidement développée et adoptée.

Le présent projet est en fait le résultat de deux processus menés en parallèle : tout d'abord, en octobre 2014, une première rencontre eut lieu entre Les Diamants Stornoway, Nemaska Lithium et les principales parties prenantes concernées par la conservation des milieux humides à l'échelle locale et régionale, soit :

- Des représentants des directions régionales du MELCC et du MFFP pour le Nord-du-Québec (à l'époque regroupées sous l'égide du MDDEFP), ainsi que des experts de la faune du MFFP et des milieux humides du MELCC;
- Les responsables de l'analyse des projets miniers Renard et Whabouchi au COMEX;
- Les *Local Environmental Administrator* (LEA) des communautés cries de Nemaska et Mistissini;
- Des représentants du Gouvernement de la Nation crie;
- Des chercheurs des universités du Québec à Montréal (UQAM) et en Abitibi-Témiscamingue (UQAT);
- Un représentant de Canards Illimités Canada (CIC).

Parallèlement, la professeure Nicole Fenton de l'UQAT constatait elle-aussi l'actuel manque de connaissances sur les milieux humides boréaux et amorçait donc des démarches auprès de compagnies minières présentes en territoire algonquin (Abitibi) et cri (Baie-James). Parmi elles, Agnico-Eagle, Mine Canadian Malartic et Hecla Mining. Elle concentrait alors son attention sur les aspects liés à la diversité des plantes vasculaires et des bryophytes ainsi qu'aux aspects fauniques (oiseaux, amphibiens) dans ces milieux.

Toujours à l'UQAT, le professeur Hugo Asselin, titulaire de la Chaire de recherche du Canada en foresterie autochtone, travaille déjà avec les communautés cries, algonquines et atikamekw en milieux forestiers, mais souhaite élargir la portée de ses travaux aux milieux humides boréaux, et ce afin de permettre la prise en compte de la perspective autochtone dans l'évaluation de la valeur écologique de ces milieux. La Pr. Fenton et lui décident donc de collaborer au développement d'un projet de recherche répondant à leurs préoccupations.

Finalement, à l'UQAM, la professeur Michelle Garneau, titulaire de la Chaire DÉCLIQUE (Dynamique des Écosystèmes tourbeux et changements CLImatiQUEs; Chaire industrielle du CRSNG), concentre depuis de nombreuses années déjà ses travaux sur les caractéristiques biogéochimiques (dynamique du carbone) et hydrologiques des milieux humides boréaux, principalement en partenariat avec Hydro-Québec et le consortium Ouranos.

Ce n'est toutefois qu'au cours de la seconde moitié de 2015 que tous ces acteurs se sont regroupés pour mener à bien l'élaboration d'un projet de recherche commun. Ainsi, à la fin 2015, ce nouveau partenariat mena à la mise en place de deux projets de recherche préliminaires, financés par le CRSNG via le programme de subvention d'engagement partenarial (SEP), chacun d'une durée de six mois et muni d'un budget de 25 000 $. Ces projets de type SEP avaient pour objectif d'établir les bases sur lesquelles a été établi le plus large projet de recherche regroupant tous les acteurs susmentionnés.

Dans un premier temps, sous la responsabilité de la Pr. Garneau, le projet « Identification des variables environnementales responsables des changements hydrologiques dans les tourbières du Centre-Nord du Québec » visait une évaluation de la dynamique écohydrologique des tourbières de la région du projet Renard et une modélisation de l'effet potentiel d'un éventuel déséquilibre (ex. phénomène d'aqualyse) sur leur intégrité écologique. L'équipe de la Pr. Garneau réalisa ainsi un projet de six mois afin de tester, à l'aide d'un modèle, des données déjà acquises dans la région de Laforge, dans le bassin versant de la rivière La Grande, où les tourbières sont similaires à celles de la région au nord des monts Otish. À l'aide de la version la plus récente du modèle DigiBog, les interactions entre le climat, la saison de croissance, l'accumulation de la tourbe, les propriétés hydrauliques et les variations de la nappe phréatique ont été évaluées. Le travail débuta par une réanalyse des données entrant dans le modèle et qui provenaient des échantillons préalablement récoltés par la Pr. Garneau, entre autres ceux colligés pour la région de Laforge. Ces données incluent des reconstitutions de la hauteur de la nappe phréatique, de la végétation locale et du taux d'accumulation de la tourbe au fil du temps. Plusieurs cycles de simulations ont été nécessaires afin de calibrer le modèle et effectuer une analyse de sensibilité. Ce projet a ainsi permis l'identification des paramètres environnementaux influençant le plus l'équilibre écohydrologique de ces tourbières du Québec boréal. L'objectif est donc d'acquérir une meilleure compréhension de la sensibilité de ces écosystèmes aux variations climatiques et aux pressions anthropiques qui risquent de perturber leur équilibre dans un contexte de milieu changeant. Ce premier projet a fait l'objet de contributions en nature par Les Diamants Stornoway.

Dans un second temps, sous la responsabilité de la Pr. Fenton, le projet « La conservation des lichens des milieux humides dans le contexte du développement du Nord québécois : pré-terrain et développement des compétences » a permis une première évaluation (pré-terrain) de la diversité des lichens des milieux humides de la Jamésie afin de mettre à niveau les faibles connaissances actuellement disponibles dans ce domaine. Les lichens, comme les bryophytes, sont des organismes difficiles à identifier à l'espèce. L'expertise lichénologique est rare au Québec et au Canada, avec peu d'experts pour couvrir le vaste territoire, ce qui a pour conséquence que la flore des lichens est très peu décrite comparée aux flores européennes ou même américaines. Ce projet est novateur sur plusieurs plans puisqu'il propose non seulement le développement d'un nouveau noyau d'expertise en lichénologie dans la zone boréale québécoise, mais aussi une approche par habitat spécifique, ce qui permettra de développer une expertise plus rapidement.

Ce second projet a fait l'objet de contributions en nature par Nemaska Lithium à l'appui des coûts directs de la recherche de l'ordre de 8 040 $, lesquels s'additionnent à la subvention de 25 000 $ du CRSNG (annexe 3-1).

De plus, dans le cadre d'un projet financé par le Fonds d'initiative du Plan Nord (FIPN), Nemaska Lithium a permis l'acquisition par l'Herbier Louis-Marie de l'Université Laval d'un système macrophotographique botanique qui sera utilisé dans le cadre du projet de Flore nordique des lichens. Cette contribution en argent

est évaluée à 7 300 $ (annexe 3-2) et a été confirmée suite à l'octroi par le FIPN de la subvention demandée par l'Herbier Louis-Marie. L'acquisition d'un tel système par l'Herbier permettra non seulement une identification plus précise des espèces recensées dans le Nord du Québec, mais aussi une meilleure diffusion des informations ainsi colligées étant donné la qualité et le format des images prises avec cet appareil.

À la suite de ces projets initiaux, un projet plus ambitieux a été élaboré afin de développer un indice de valeur écologique pour les différents types de milieux humides présents en territoire boréal québécois. Pour ce faire, deux demandes de subvention de recherche et développement coopérative (RDC) ont été déposées et, dans les deux cas, les fonds demandés ont été octroyés (annexes 3-3 et 3-4).

La première, sous la responsabilité de la Pr. Fenton de l'UQAT, vise la mise en place d'une Chaire de recherche industrielle sur la biodiversité nordique dans un contexte minier. Cette Chaire, dont le budget total sur cinq années consécutives est de près de 1,65 M$, tirera avantage de la collaboration de nombreux acteurs universitaires (dix chercheurs de l'UQAT et de l'université Laval), gouvernementaux (MFFP et MELCC), industriels (Nemaska Lithium, Les Diamants Stornoway, Agnico-Eagle, Mine Canadian Malartic, Hecla Mining et le consortium Ouranos) et autochtones (Première Nation Abitibiwinni et le Gouvernement de la Nation crie).

Ce vaste projet mènera à la graduation de cinq étudiants à la maîtrise, quatre doctorants et un stagiaire postdoctoral, en plus de solliciter la participation d'étudiants au niveau baccalauréat et de professionnels de recherche. C'est en fait une expertise importante et unique que ce projet permettra de développer au Québec boréal.

De manière générale, ce projet se divise en trois grands volets, ou objectifs :

1. Mieux définir et comprendre l'empreinte écologique du cycle de vie d'un projet minier, et ce dans le but d'élaborer des stratégies permettant d'atténuer les impacts sur la biodiversité à court terme. Pour ce faire, les environs de divers projets miniers à différents stades d'avancement seront inventoriés en Abitibi et dans le Nord-du-Québec, et ce afin de bien caractériser ces milieux et de mesurer les divers impacts déjà observables. De plus, l'utilisation des bryophytes dans la restauration des sites miniers et les impacts économiques des mesures d'atténuation que le projet proposera seront évalués.
2. Développer des outils de gestion écologique dans le but d'éviter les risques à la biodiversité. C'est dans le cadre de ce volet qu'un indice de valeur écologique sera élaboré pour les milieux humides boréaux, et ce sur la base de critères liés à leur biodiversité et aux priorités des utilisateurs autochtones du territoire. En ce qui a trait à la biodiversité, des études seront menées afin de mieux la définir d'un point de vue floristique (plantes vasculaires, lichens et bryophytes) et faunique (faune aviaire, amphibiens, mammifères). La perspective autochtone sera prise en compte par l'évaluation de leur utilisation et valorisation de ces milieux, ainsi que par l'étude de la vulnérabilité aux impacts cumulatifs de certaines espèces valorisées par les autochtones.
3. Évaluer la vulnérabilité aux effets cumulatifs des espèces d'intérêt pour les communautés autochtones. Les utilisateurs traditionnels du territoire ont déjà mentionné leurs inquiétudes face à l'effet cumulé du développement de projets et les changements climatiques sur les principales espèces d'intérêt pour eux. Deux espèces parmi celles-ci seront ainsi identifiés avec les partenaires autochtones du projet et étudiées plus en détails afin de bien comprendre les effets cumulés potentiels sur leur habitat, leur diversité génétique, leur répartition et les services traditionnels qu'elles rendent.

Les contributions en argent et en nature de Nemaska Lithium totalisent pour la durée de ce projet :

- Contributions en argent : 70 000 $ sur cinq ans
- Contributions en nature : 112 800 $ sur cinq ans

Celles-ci s'ajoutent bien sûr aux contributions des autres partenaires du projet, lesquelles sont détaillées à l'annexe 3-3. Cette annexe fournit d'ailleurs aussi un état d'avancement de ce projet en date du 4 octobre 2018.

La seconde demande de subvention RDC a été élaborée par la Pr. Garneau de l'UQAM et a pour budget total sur trois années consécutives un peu plus de 235 000 $. Ce projet a été rendu possible grâce à la collaboration de nombreux acteurs universitaires (six chercheurs des universités du Québec à Montréal et en Abitibi-Témiscamingue, Laval et Leeds [Royaume-Uni]) et industriels (Nemaska Lithium et Les Diamants Stornoway).

Ce projet a pour principal objectif la réalisation d'une évaluation plus détaillée de la dynamique écohydrologique et biogéochimique des tourbières boréales afin que ces aspects soient eux-aussi pris en compte dans l'indice de valeur écologique qui sera élaboré dans le cadre de la Chaire de la Pr. Fenton (second volet/objectif). Ces aspects sont d'une importance capitale dans le contexte climatique actuel puisque les changements climatiques auront, en territoire boréal québécois, pour principale conséquence une hausse des précipitations et des températures, ce qui aura définitivement un impact sur le régime hydrologique et le bilan de carbone des tourbières boréales, et donc sur les services écosystémiques qu'ils rendent et par le fait même leur valeur écologique.

Le projet, d'une durée de trois ans, aura pour objectif spécifique d'utiliser divers outils communs aux études paléoclimatiques (palynologie, paléobotanique, paléo-hydrogéologie, etc.) afin de recréer la dynamique des tourbières du Centre-Nord québécois et ainsi identifier les paramètres ayant eu la plus grande influence au cours du dernier millénaire. Ces informations permettront ensuite de mieux comprendre les rôles que jouent ces écosystèmes à l'échelle régionale et ainsi fournir des informations importantes pour l'évaluation future de leur valeur écologique.

La réalisation de ce projet requerra la graduation de trois étudiants à la maîtrise et d'un stagiaire postdoctoral, en plus de solliciter la participation d'étudiants au niveau baccalauréat et de professionnels de recherche. Ce projet permet aussi de poursuivre les travaux initiés par la Pr. Garneau et son équipe au sein de la Chaire DÉCLIQUE (Dynamique des Écosystèmes tourbeux et changements Climatiques; Chaire industrielle du CRSNG).

Les contributions en argent et en nature de Nemaska Lithium totalisent pour la durée de ce projet :

- Contributions en argent : 45 000 $ sur trois ans
- Contributions en nature : 28 800 $ sur trois ans

Celles-ci s'ajoutent bien sûr aux contributions des autres partenaires du projet, lesquelles sont détaillées à l'annexe 3-4.

Conséquemment, Nemaska Lithium aura, au terme des projets susmentionnés, investit 271 940 $ dans le projet de compensation des milieux humides ici proposé.

3.2.1 Milieux humides d'intérêt régional

Dans une lettre datée du 19 septembre 2017, la Direction de l'évaluation environnementale des projets nordiques et miniers et de l'évaluation environnementale stratégique (DEEPNMEES) du MELCC demandait à ce

que Nemaska Lithium identifie des milieux humides connus à l'échelle régionale et présentant un intérêt pour leur mise en valeur.

Tel que précisé à la section 3.1 du présent document, l'absence de connaissances sur les milieux humides de la région Eeyou Istchee Baie-James rend d'entrée de jeu difficile une telle identification puisque très peu de données existent dans la région hormis celles colligées par Hydro-Québec dans le cadre du Projet de centrale de l'Eastmain-1-A et dérivation Rupert. Cela dit, un inventaire des milieux humides présents dans un rayon de 10 km du site minier a été réalisé par Nemaska Lithium dans le cadre de la procédure d'évaluation environnementale du projet menée par le COMEX et l'ACEE. Ainsi, la tourbière du lac du Spodumène avait été identifiée comme étant celle qui présentait la valeur écologique la plus élevée dans la région immédiate du projet, tel que précisé à la section 2.2 du présent document. Toutefois, sa proximité avec le site minier rend difficile sa mise en valeur. Ainsi, par exemple, un projet de belvédère au sommet de la colline située au nord-est du lac du Spodumène et de trottoir en bois y menant a par le passé déjà été discuté avec le maître de trappage M. James Wapachee Sr., mais lorsque nous avions proposé que ce même trottoir donne aussi accès à un réseau de trottoirs en bois qui borderait ladite tourbière du côté est, ce dernier s'y était opposé considérant la trop forte proximité avec les opérations minières dans la fosse à ciel ouvert

Au-delà de ce secteur, l'identification de milieux humides d'intérêt a surtout été réalisée via différentes discussions informelles avec les Cris de Nemaska, entre autres les utilisateurs du territoire (maîtres de trappage) et le Département Environnement et Territoire (DET) du Conseil de bande de Nemaska. Ces rencontres n'ayant pas été réalisées dans un cadre officiel tel celui des rencontres du Comité Environnement mis en place par l'Entente Chinuchi signée en 2014, il n'est malheureusement pas possible de fournir de documents écrits attestant de ces discussions et de leur teneur. Toutefois, M. Matthew Tanoush, directeur du DET de Nemaska, a accepté de confirmer par courriel la conclusion des propos échangés à cet effet (annexe 3-5).

On notera par ailleurs que dans le cadre du projet de recherche de la Pr. Fenton (UQAT) décrit à la section précédente, des entrevues et visites de terrain ont été réalisées et sont prévues au cours des prochaines étapes du projet avec les utilisateurs cris du territoire – entre autres les maîtres de trappage MM. James Wapachee Sr., Walter Jolly, Luke Tent et Charles Cheezo – justement afin d'identifier des milieux humides d'intérêt pour eux sur leur territoire respectif. Une première rencontre à cet effet eut lieu le 24 mai 2018 à Nemaska, dans les bureaux du Gouvernement de la Nation crie (GNC). Cette rencontre fut organisée par les étudiants à la maîtrise et au doctorat sous la responsabilité des Pr. Fenton et Imbeau, et avec la participation de Mme Emily Sinave du GNC. Les résultats de cette première rencontre furent utilisés pour identifier les secteurs ayant été priorisés lors de la première année d'inventaires floristiques et fauniques dans la région, lesquels ont été réalisés de la fin mai à la mi-août 2018.

Dans sa lettre de septembre 2017, la DEEPNMEES mentionne que « l'identification des milieux humides d'intérêt pour la mise en valeur à l'échelle régionale est un élément essentiel à une réflexion globale [sur] la compensation des milieux humides perdus. » Cette affirmation est on-ne-peut-plus juste; toutefois, dans le contexte actuel, le large déficit de connaissances sur les milieux humides régionaux est tel qu'il s'avère très difficile autant pour le promoteur d'un projet de développement industriel que pour les parties prenantes concernées, y compris les Cris, d'identifier de tels milieux. Ceci n'est pas un indice de l'absence de tels milieux devant être valorisés et/ou conservés; au contraire, cela met plutôt en lumière l'urgence de colliger les connaissances scientifiques et traditionnelles qui permettront leur identification dans le cadre de futurs projets, voire en amont au sein de plan régionaux de conservation, tel que le préconise la *Loi concernant la conservation des milieux humides et hydriques*. Ceci n'est en fait qu'un rappel de l'importance d'un projet tel celui ici proposé.

3.2.2 Consultation avec les parties prenantes autochtones

Dans la lettre susmentionnée et datée du 19 septembre 2017, la DEEPNMEES du MELCC demandait à ce que Nemaska Lithium fournissent de plus amples informations sur les rencontres et discussions tenues à ce jour en lien avec le projet de compensation ici proposé.

À cet effet, l'annexe 3-6 fournit les comptes-rendus des rencontres du Comité Environnement au cours desquelles la compensation des milieux humides fut discutée. De plus, cette même annexe fournit les présentations faites par l'équipe de la Pr. Fenton lors des rencontres listées au tableau 3.1, et lesquelles sont aussi mentionnées dans le rapport d'avancement fourni à l'annexe 3-3.

Tableau 3.1 Liste des rencontres organisées par l'équipe de la Pr. Fenton avec les représentants Cris en lien avec le projet de Chaire de recherche sur la biodiversité nordique en contexte minier

Date	Lieu	Personnes présentes
27 mars 2018	Rouyn-Noranda	Rencontre de démarrage de la Chaire avec les représentants de tous les partenaires, incluant Nemaska Lithium (M. Simon Thibault) et le Gouvernement de la Nation crie (Mme Emily Sinave).
16 avril 2018	Val-d'Or	• Équipe de recherche de la Pr. Fenton • Membres du Comité Environnement Whabouchi[3]
24 mai 2018	Nemaska	• Équipe de recherche de la Pr. Fenton • Membres du Comité Environnement Whabouchi[4] • Walter Jolly, Luke Tent et Charles Cheezo

Il importe aussi de noter que les représentations de la part de Nemaska Lithium auprès du GNC en lien avec ce projet de recherche ont en fait débuté dès l'automne 2014, tel que mentionné à la section 3.2 du présent document. D'autres rencontres et discussions sur ce sujet ont aussi eu lieu, entre autres en avril 2016 au bureau de Montréal du GNC (présentation fournie à l'annexe 3-6).

Dans tous les cas, les Cris ont dès les premières rencontres démontré un intérêt certain envers le projet, reconnaissant d'emblée la problématique décrite dans le présent document, alors que leurs principales inquiétudes étaient en fait liées non pas au sujet de recherche, mais plutôt à la protection d'éventuelles informations sensibles sur l'utilisation traditionnelle faite du territoire par les maîtres de trappage et leur famille et qui pourraient être dévoilées lors des entrevues. À cet effet, autant l'UQAT que l'UQAM, les deux universités responsables de mener à bien les projets de recherches décrits dans les pages précédentes, ont adopté des politiques et processus ayant pour objectif la protection de la confidentialité des informations sensibles qui seront colligées dans le cadre des projets proposés, et ce à la satisfaction des Cris. À ce sujet, on notera que l'UQAT possède une grande expérience en la matière, et ce tout particulièrement avec l'implication dans le projet du Pr. Hugo Asselin, titulaire de la Chaire de recherche du Canada en foresterie autochtone et directeur de l'École d'études autochtones de l'UQAT.

[3] Voir les comptes-rendus des rencontres du Comité Environnement fournis à l'annexe 3-6 pour la liste des membres de ce Comité.

4 CONCLUSION

En conclusion, l'approche préconisée par Nemaska Lithium afin de compenser les pertes de milieux humides que causera son projet minier Whabouchi a cela de louable qu'elle permet non seulement de respecter les exigences légales et réglementaires applicables, mais en fait d'en faire beaucoup plus en permettant le développement d'un outil d'évaluation de la valeur écologique des milieux humides boréaux qui sera profitable pour l'ensemble de la société québécoise alors que celle-ci projette de mettre en valeur les nombreuses ressources naturelles présentes sur son territoire, tout particulièrement sur le territoire du Plan Nord. Notre approche permet par ailleurs cela en mettant à profit les connaissances des diverses parties prenantes déjà présentes sur ce territoire : les universités, les promoteurs industriels, les autorités gouvernementales ainsi que les utilisateurs du territoire, autochtones et non-autochtones. Il est donc à espérer que cette approche sera reconnue à sa juste valeur, surtout aux yeux du fort soutien qu'elle a déjà obtenu de la part des communautés autochtones concernées par son projet, dorénavant parties prenantes au projet, des chercheurs universitaires et experts dans le domaine ainsi que des organismes subventionnaires et de leurs comités d'évaluation qui ont attesté de la forte pertinence de ces projets en octroyant des sommes significatives permettant aujourd'hui leur réalisation.

5 RÉFÉRENCES

Canards Illimités Canada (CIC). 2009. Plan de conservation des milieux humides et de leurs terres hautes adjacentes de la région administrative du Nord-Du-Québec.

DRA Canada. 2018. NI 43-101 Technical Report Feasibility Study on the Whabouchi Lithium Mine and Shawinigan Electrochemical Plant. Rapport final préparé pour Nemaska Lithium Inc. 464 pages + annexes.

Met-Chem Canada Inc. 2013. NI 43- NI 43-101 Technical Report - Preliminary Economic Assessment of the Whabouchi Lithium Deposit and Hydromet Plant. 27 février 2013. Préparé pour Nemaska Lithium Inc. Préparé par : Met-Chem Canada Inc., SGS Canada Inc., BBA Inc., Journeaux Assoc., Equapolar Consultants Limited et Lamont Inc. 282 pages + annexes.

Nemaska Lithium. 2013. Développement et exploitation d'un gisement de spodumène sur le territoire de la Baie-James – Étude des impacts sur l'environnement et le milieu social. Mars 2013. Pagination multiple.

Roche ltée, Groupe-conseil. 2014a. Réponses aux questions et commentaires du COMEX. Étude des impacts sur l'environnement et le milieu social – Projet Whabouchi. Rapport présenté à Nemaska Lithium. Avril 2014. Pagination multiple.

Roche ltée, Groupe-conseil. 2014b. Réponses aux questions et commentaires de l'ACEE. Étude des impacts sur l'environnement et le milieu social – Projet Whabouchi. Rapport présenté à Nemaska Lithium. Avril 2014. Pagination multiple.

Annexe 3-1

Avis d'octroi et Description de projet – CRSNG-SEP – La conservation des lichens des milieux humides dans le contexte du développement du nord québécois : pré-terrain et développement des compétences (UQAT)

Conseil de recherches en sciences naturelles et en génie du Canada
Natural Sciences and Engineering Research Council of Canada

Bureau régional du Québec
Québec Regional Office

505 boulevard de Maisonneuve Ouest
Bureau 255
Montréal (Québec)
H3A 3C2

505 Maisonneuve Boulevard West
Suite 255
Montréal, Québec
H3A 3C2

Montréal, le 5 novembre 2015

Dossier : EGP 487390 - 15
NIP : 213817
Année financière : 2015-2016

PROTÉGÉ

Madame Nicole Fenton
Institut de recherche sur les forêts
Québec en Abitibi-Témiscamingue
445 BOUL DE L'UNIVERSITE
ROUYN-NORANDA (QC) J9X 5E4

Objet : Demande de subvention d'engagement partenarial (SEP) intitulée « La conservation des lichens des milieux humides dans le contexte du développement du nord québécois: pré-terrain et développement des compétences »

Madame,

J'ai le plaisir de vous informer que le CRSNG a évalué la demande indiquée ci-dessus et qu'une subvention a été approuvée.

Date de début de la subvention : 2015/12/01

Année	Montant accordé	Année financière	Montant du paiement	*Total pour l'année financière (à l'usage du CRSNG seulement)*
1	25 000.00 $	2015	25 000.00 $	*25 000.00 $*

Les modalités de paiement des versements en vigueur au CRSNG et les conditions qui s'appliquent à cette subvention sont indiquées dans le texte ci-joint intitulé ***Modalités de la subvention***.

Les ***Modalités de la subvention*** indiquent aussi que vous et votre partenaire industriel devez présenter un rapport de projet au plus tard un mois après la fin de la période de validité de la subvention. Une note de rappel et un modèle du rapport vous parviendront environ quatre semaines avant la date de remise du rapport. Veuillez noter que le CRSNG communiquera aussi avec vous et votre partenaire industriel vers la fin du projet pour discuter de la progression du projet et de vos plans de collaboration future.

Canada

En vous prévalant de cette subvention ou en participant aux activités appuyées par la subvention, vous acceptez de respecter les politiques et les lignes directrices suivantes et de vous conformer à toute modification que le CRSNG pourrait y apporter :

- le Cadre de référence des trois organismes sur la conduite responsable de la recherche qui est affiché dans le site Web du Secrétariat sur la conduite responsable de la recherche à http://www.rcr.ethics.gc.ca/fra/policy-politique/framework-cadre/;
- le *Guide des programmes destiné aux professeurs* qui se trouve dans le site Web du CRSNG à http://www.nserc-crsng.gc.ca/Professors-Professeurs/Index_fra.asp;
- le *Guide d'administration financière des trois organismes* à http://www.nserc-crsng.gc.ca/Professors-Professeurs/FinancialAdminGuide-GuideAdminFinancier/index_fra.asp.

De plus, au moment de présenter votre demande, vous avez accepté qu'en cas de violation grave des politiques du CRSNG (comme qu'il est énoncé dans le *Cadre de référence des trois organismes sur la conduite responsable de la recherche*), ce dernier ait le droit de divulguer publiquement votre nom, la nature de la violation, le nom de l'établissement où vous travailliez au moment de la violation et le nom de l'établissement où vous travaillez actuellement. En vous prévalant des fonds de subvention versés à l'établissement ou en participant aux activités appuyées par la subvention, vous confirmez votre consentement à cet égard.

Afin d'accroître la visibilité du CRSNG, je vous encourage à reconnaître l'appui du CRSNG lorsque vous traiterez avec les médias au sujet de ce projet. Je vous encourage également à ajouter le logo du CRSNG (identificateur visuel) aux pages Web de votre université qui présentent le projet. Vous trouverez le logo du CRSNG à http://www.nserc-crsng.gc.ca/NSERC-CRSNG/VisualIdentity-IdentiteVisuelle_fra.asp.

Je vous souhaite tout le succès possible dans ce projet de recherche.

Veuillez agréer, Madame, mes meilleures salutations.

François Santerre, Ph.D., MBA
Agent de développement de la recherche et de l'innovation
Bureau régional du CRSNG du Québec

Téléphone : 514-496-4741
Télécopieur : 514-496-4755
francois.santerre@nserc-crsng.gc.ca

FS/td

p. j. Modalités de la subvention

c. c. : M.D. Delisle, Recherche, Québec en Abitibi-Témiscamingue
G. Girard, Finances, Québec en Abitibi-Témiscamingue
S. Thibault, Nemaska Lithium Inc.
J. Wong, Finances, CRSNG

Conseil de recherches en sciences naturelles et en génie du Canada | Natural Sciences and Engineering Research Council of Canada

FORMULAIRE 101
Demande de subvention
PARTIE I

Code de l'établissement	
ID système (à l'usage exclusif du CRSNG)	376081871
Date	2015/09/18

Nom de famille du candidat	Prénom	Initiale(s) de tous les prénoms	N° d'identification personnel (NIP)
Fenton	Nicole	J	**Valide** 213817

Département	Établissement qui administrera la subvention
Institut de recherche sur les forêts (IRF)	Québec en Abitibi-Témiscamingue

La demande est rédigée [X] en français [ ] en anglais

Temps (heures par mois) qui sera consacré à la recherche / l'activité proposée: 20

Type de subvention demandé: Subventions d'engagement partenarial pour les universités

Pour les projets stratégiques, indiquez le domaine cible et le sujet de recherche; pour les réseaux stratégiques, indiquez le domaine cible.

Titre de la proposition
La conservation des lichens des milieux humides dans le contexte du développement du nord québécois: pré-terrain et développement des compétences

Décrivez la proposition en utilisant au plus 10 mots-clés. Utilisez des virgules pour les séparer.
écologie des lichens, milieux humides, boréale, distribution, richesse spécifique, conservation

Code(s) de sujet de recherche		Code(s) de domaine d'application	
Principal	Secondaire	Principal	Secondaire
4707	4704	400	407

EXIGENCES EN MATIÈRE D'ATTESTATION

Si cette proposition comprend l'un des éléments suivants, cochez la ou les cases appropriées et présentez un protocole au comité d'attestation de l'université ou du collège.

Recherche : avec des sujets humains [ ] avec des cellules souches pluripotentes humaines [ ] avec des animaux [ ] présentant des risques biologiques [ ]

Indiquer si la recherche proposée aura lieu à l'extérieur et si vous répondez OUI à la question a), b) ou c), remplissez l'annexe A (formulaire 101).

[X] NON [ ] OUI

MONTANT TOTAL DEMANDÉ AU CRSNG

1re année	2e année	3e année	4e année	5e année
25,000	0	0	0	0

J'atteste que les participants au projet seront uniquement des partenaires industriels avec qui aucun partenariat de recherche antérieur n'a été établi (SEP) : Oui

SIGNATURES (consultez les instructions « Ce à quoi engagent les signatures »)

Il est entendu que les conditions générales régissant les subventions, telles qu'elles sont décrites dans le *Guide des programmes destiné aux professeurs* du CRSNG, s'appliquent à toute subvention accordée à la suite de cette demande. Le candidat et les autorités de l'établissement qui l'emploie s'engagent à les respecter.

Candidat

Département, établissement d'enseignement, n° de tél. et n° de téléc. et courriel du candidat

Institut de recherche sur les forêts (IRF)
Québec en Abitibi-Témiscamingue
Tel.: (819) 7620971 ext. 2312
nicole.fenton@uqat.ca

Directeur du département

Doyen de la faculté

Recteur de l'établissement d'enseignement (ou son représentant)

Les renseignements personnels figurant dans ce formulaire et dans les annexes seront intégrés dans le fichier de renseignements personnels du programme approprié.

English version available

Canada

PROTÉGÉ UNE FOIS REMPLI

N° d'identification personnel (NIP)	Nom de famille du candidat
Valide 213817	Fenton

RÉSUMÉ DE LA PROPOSITION AUX FINS DE DIFFUSION PUBLIQUE (en langage courant).

Ce résumé en langage courant sera mis à la disposition du public si votre proposition est financée. Même si ce n'est pas obligatoire, vous pouvez choisir de fournir votre numéro de téléphone au travail et votre adresse de courriel afin que le public et les médias puissent communiquer facilement avec vous au sujet de vos travaux de recherche.

N° de téléphone au travail (facultatif) : 1 (819) 7620971 Poste 2312

Adresse de courriel (facultatif) : nicole.fenton@uqat.ca

Les vastes étendues de milieux humides du nord du Canada, et plus précisément de la Jamésie au Québec, représentent une richesse commune. Ces milieux humides fournissent de multiples services écologiques incluant la fixation du carbone, la régulation du cycle hydrologique et constituent l'habitat d'une variété d'espèces végétales et fauniques. Puisque les milieux humides sont omniprésents sur le territoire de la Jamésie, tout projet de développement risque de perturber un milieu humide, en partie ou en entier. Par contre, en plus d'être omniprésents, les milieux humides sont de types très variés, notamment sous forme de tourbières, de fens, de marais et d'étangs de castors. Les milieux humides hébergent une grande diversité de plantes incluant les lichens. Par contre, en contraste avec les milieux humides de l'ouest du Canada, nos connaissances des lichens des milieux humides du territoire boréal au Québec sont fragmentaires. Cette lacune pose un défi pour les industries qui souhaitent développer le territoire d'une façon responsable en suivant "la hiérarchie de mitigation" qui prône la stratégie "éviter, mitiger et compenser" des impacts industriels sur l'environnement. Un manque d'information sur la richesse et la répartition des espèces rares empêche les industries de mitiger leur impact en évitant les milieux avec le plus de valeur écologique. Ceci est d'autant plus vrai pour les milieux humides, dont les industries ont l'obligation légale de compenser la destruction. Ce projet permettra de faire une première évaluation (pré-terrain) de la diversité des lichens des milieux humides de la Jamésie (Québec) afin de mettre à niveau les compétences de mon laboratoire et de bien planifier tout futur projet. Par la suite, un projet plus ambitieux sera élaboré pour développer un indice de valeur écologique pour les différents types de milieux humides.

Version du résumé dans l'autre langue (facultatif).

Canada

N° d'identification personnel (NIP)	Nom de famille du candidat
Valide 213817	Fenton

Lisez les instructions pour obtenir de plus amples renseignements.

DÉPENSES PRÉVUES

	En espèces	En nature
1) Salaires et avantages sociaux		
a) Étudiants	1,000	
b) Stagiaires postdoctoraux	0	
c) Adjoints techniques ou professionnels	19,075	3,000
d)	0	
2) Appareillage ou installation		
a) Achat ou location	0	0
b) Coûts de fonctionnement et d'entretien	0	
c) Frais imputés aux utilisateurs	0	0
d)	0	
3) Matériaux et fournitures		
a) identification lichens	750	0
b)	0	
c)	0	0
4) Déplacements		
a) Conférences	0	
b) Travaux sur le terrain	1,500	5,040
c) Déplacements relatifs aux travaux	0	
d) atelier lichen	2,675	
5) Diffusion des résultats		
a) Frais liés aux publications	0	
b)	0	
6) Activités de transfert de technologie		
a) Essais sur le terrain	0	
b) Prototypes	0	
c)	0	
TOTAL DES DÉPENSES PRÉVUES	25,000	
Appui total offert par l'industrie	0	
Appui total offert par l'université		
Appui total offert par d'autres sources		
MONTANT TOTAL DEMANDÉ AU CRSNG	25,000	

N° d'identification personnel (NIP)	Nom de famille du candidat
Valide 213817	Fenton

En vertu de cette subvention, les organismes d'appui ne sont pas tenus d'apporter des contributions en espèces ou en nature. S'il y a lieu, indiquez toute contribution des organismes d'appui dans le tableau ci-dessous, et décrivez les contributions en nature dans la justification du budget.

Nom de l'organisme d'appui

Nemaska Lithium

CONTRIBUTIONS DES ORGANISMES D'APPUI

Contributions en espèces affectées aux coûts directs de la recherche (Reportez ces montants à la page 3; à l'exception des montants pour le Programme de temps-navire.)	0
Contributions en nature affectées aux coûts directs de la recherche	
1) Salaires du personnel scientifique et technique	3,000
2) Dons d'appareillage, de logiciels	0
3) Dons de matériaux	0
4) Logistique liée aux travaux sur le terrain	5,040
5) Prestation de services	0
6)	0
Total des contributions en nature à l'appui des coûts directs de la recherche	8,040
Contributions en nature affectées aux coûts indirects de la recherche (ne pouvant être égalées)	
1) Utilisation des installations de l'organisme	
2) Salaires du personnel cadre et administratif	0
3)	0
Total de toutes les contributions en nature	8,040
Contributions aux frais généraux de l'université	0

PROTÉGÉ UNE FOIS REMPLI

English version available

Canadä

Contribution des organismes

Nemaska Lithium

La compagnie minière Nemaska Lithium contribuera au projet pendant la période de pré-terrain.

Salaires du personnel scientifique et technique :

Pendant la période de développement du plan d'échantillonnage du pré-terrain, l'équipe, à Nemaska Lithium, sera impliquée quant au choix du site et la planification opérationnelle (génération des cartes, connaissances terrain, accès) à raison de 25 heures à 125 $/heure = 3000 $.

Logistique liée aux travaux sur le terrain :

Hébergement pendant le pré-terrain (2 semaines) au montant de 180$/personne*2 personnes * 14 nuits = 5040$

Total : 7 040 $

Justification du budget

1) Salaires et avantages sociaux

a) Étudiants. Une étudiante au doctorat en bryologie (Marion Barbé) sera versé une bourse de **1000$** pour aider au préterrain avec Julie Arseneault.

c) Adjoints techniques et professionnels

1) *Catherine Boudreault, PhD (Lichenologue).* Mme Boudreault concevra et livrera une formation sur mesure de 5 jours pour mon laboratoire (4-5 participants) sur l'identification à l'espèce des macros lichens. Son contrat inclus 20 heures de préparation et 50 heures pendant la formation (taux horaire 70$/heure).
*Totale en salaire Mme Boudreault **4900$***

2) *Julie Arseneault, MSc (Bryologue et auxiliaire de recherche).* Mme Arseneault travail comme auxiliaire de recherche dans mon laboratoire. Elle organisera l'atelier de formation dans nos locaux (achats des matériaux etc), participera à la formation et organisera et exécutera la campagne de préterrain et identifiera les échantillons de lichens par la suite. Mme Arseneault est payé selon l'échelle salariale pour les professionnels à l'UQAT (catégorie auxiliaire de recherche), soit 26,87$ + avantages sociaux = 33,83/heure.
Atelier lichens (35 heures + 14 heures préparation) = 1657,67$; Préterrain (90 heures) = 3044,70$; Identification des lichens (280 heures) = 9472,40$
*Totale en salaire Mme Arseneault **14 175$***

3) Matériaux et fournitures

Matériaux pour la collecte et l'identification des lichens
Produits chimique : 300$; Livres (flores) : 400$; Matériaux généraux : 50$
*Totale **750$***

4) Déplacements

b) Travaux sur le terrain – campagne préterrain. La plus grande partie des coûts du préterrain seront assumés par notre partenaire industrielle (hébergement, déplacements). Ici nous incluons simplement les coûts associés avec le transport entre Rouyn et le site d'étude.
Location de véhicule (2 semaines) 1000$; Essence 500$
*Totale **1500$***

d) Atelier lichen. Pendant l'atelier sur l'identification des lichens, Mme Boudreault viendra à Rouyn par avion et sera logé sur place. Pendant trois jours de l'atelier nous serons sur le terrain à proximité de Matagami, où nous logerons 1 nuit.
Québec-Rouyn (Air Liaison) 1000$; Hôtel 3 nuits Mme Boudreault à Rouyn (Hotel Deville) 450$; Location camion 3 jours et essence 725$; Hébergement Matagami (1 nuit + per diem 5 personnes) 500$
*Totale **2675$***

Nicole Fenton

Rapport avec d'autres sources de financement

Ce projet diffère de toute autre demande de financement reçu ou demandé. Ici, je développe les capacités de mon laboratoire en lichenologie, et je fais une première évaluation de la biodiversité des lichens dans les milieux humides de la Jamésie. Mes autres demandes de subventions ciblent les bryophytes uniquement, à part ma demande stratégique (en évaluation) dans lequel nous proposons d'évaluer la capacité de la télédétection à prédire la richesse spécifique des lichens (et les bryophytes). La valeur ajouté de la présente demande est donc multiple : (1) établir des liens étroites avec un nouveau partenaire dans le domaine minier, (2) consolider mes démarches pour inclure les lichens dans ma programmation de recherche, et (3) ouvre la porte sur un plus grand projet sur les milieux humides dans la Jamésie avec plusieurs partenaires miniers. Ce dernier se démarre suite au projet de mon étudiante Bois-Charlebois sur les milieux humide autours de la communauté Wemindji.

Mes projets en cours sont :
Découverte Fenton (2015-2020) Towards bryophyte landscape ecology in boreal eastern Canada: bryophyte population and community dynamics at the landscape scale. Je suis en recrutement d'un(e) étudiant(e) au doctorat sur le sujet de la dispersion des bryophytes au niveau du paysage.

RDC Fenton, Valeria, et al. (2015-2019) Bilan de carbone des travaux sylvicoles dans la pessière à mousses du Québec. Dans ce projet nous allons évaluer l'impact des différents traitements sylvicole sur le bilan de carbone des arbres et du sol et prédire leur variation au niveau du paysage. Un étudiant au doctorat est en cours (Henneb, direction Valeria, Thiffault, Fenton comité de direction), d'autres étudiants à la maîtrise sont en recrutement.

RDC Bergeron, Leduc, Fenton. (2012-2015) Îlots résiduels après feu dans la pessière: rôle dans la dynamique forestière et comparaison avec la rétention après coupe. Dans ce projet qui est en sa dernière année, nous avons étudié la structure et la fonction des îlots forestiers résiduels après feu et après coupe. Deux étudiantes au doctorat (forêt et bryophytes) et une étudiante à la maîtrise (bryophytes) sont impliqués.

RDC Leduc, Fenton, et al. (2015-2018) Mécanismes impliqués dans le succès des coupes partielles opérées en pessière tourbeuse. Dans ce projet nous examinons le succès à longue termes des coupes partielles, incluant leurs impacts sur les bryophytes épixyliques. Je suis présentement en recrutement pour un(e) étudiant(e) à la maîtrise pour étudier cette question.

Dans ces projets les budgets servent essentiellement à la formation des PHQ, et le focus de tous les projets était les bryophytes.

Projets demandés :
Projet Stratégique Fenton, Tremblay, Valeria, Bergeron. Using remote sensing in ecological planning at the scale of industrial development in northern Canada (En évaluation). Dans ce projet, nous proposons un outil innovant qui devrait permettre la planification écologique à une échelle spatiale adaptée à celle du filtre fin. Nous proposons d'utiliser la télédétection afin; 1) d'identifier les sites à potentiel élevé pour la richesse en espèces (bryophytes et lichens) à l'échelle de plusieurs dizaines de mètres et 2) d'identifier les sites ayant une forte probabilité d'occurrence d'espèces rares. Ce projet témoigne de mon intérêt d'inclure les lichens dans mon sphère de recherche. Le partenaire minier dans ce projet est le projet Éléonore Goldcorp.

Aperçu du problème : Les vastes étendues de milieux humides du nord du Canada et plus précisément de la pessière à mousse de l'ouest du Québec représentent une richesse commune. Ces milieux humides fournissent de multiples services écologiques, incluant la fixation du carbone, la régulation du cycle hydrologique et constituent l'habitat d'une variété d'espèces végétales et fauniques. Puisque les milieux humides sont omniprésents sur le territoire de la pessière à mousse de l'ouest du Québec, tout projet de développement risque de perturber un milieu humide, en partie ou en entier. Par contre, en plus d'être omniprésents, les milieux humides sont de types très variés, notamment sous forme de tourbières, de fens, de marais et d'étangs de castor. Les milieux humides hébergent une grande diversité de plantes, particulièrement les cryptogames, incluant les lichens (Warner et Asada 2006;7 Cameron et Neily 2008), parce que l'humidité de l'environnement permet à ce groupe poikilohydrique (qui dépend de l'humidité à l'extérieur de leur corps, particulièrement la rosée) de s'épanouir (Gauslaa 2014). Par contre, en contraste avec les milieux humides de l'ouest du Canada (p.ex. Vitt et al. 2003, Doering et Coxson 2010), nos connaissances des lichens des milieux humides du territoire boréal au Québec sont fragmentaires (c.f. Thibault et Payette 2009 pour les lichens terrestre). Cette lacune pose un défi pour les industries incluant Nemaska Lithium qui souhaite développer le territoire d'une façon responsable en suivant « la hiérarchie d'atténuation » qui prône la stratégie « éviter, atténuer et compenser » des impacts industriels sur l'environnement (Gardner et al. 2013). Un manque d'information sur la richesse et la répartition des espèces rares empêche les industries de mitiger leur impact en évitant les milieux avec le plus de valeur écologique. Ceci est d'autant plus vrai pour les milieux humides, dont les industries ont l'obligation légale de compenser la destruction.

Projet de recherche : Ce projet SEP permettra de faire une première évaluation (pré-terrain) de la diversité des lichens des milieux humides de la Jamésie (Québec) afin de mettre à niveau les compétences de mon laboratoire. Les bryophytes (autres plantes cryptogames), pour lesquelles mon équipe a déjà une vaste expertise, seront évaluées dans un projet parallèle. Par la suite un projet plus ambitieux sera élaboré pour développer un indice de valeur écologique pour les différents types de milieux humides (tourbières, fens, marais et étangs de castor), via une demande RDC.

Les lichens, comme les bryophytes, sont des organismes difficiles à identifier à l'espèce. L'expertise lichenologique est rare au Québec et au Canada avec peu d'experts pour couvrir le vaste territoire, ce qui a pour conséquence que la flore des lichens est très peu décrite comparée aux flores européennes ou même américaines. Ce projet est novateur sur plusieurs plans : 1) il propose les premières étapes dans le développement d'un nouveau noyau d'expertise en lichenologie dans la zone boréale, 2) nous proposons une approche par habitat spécifique ce qui nous permettra de développer une expertise plus rapidement, 3) nous proposons de produire à long terme un outil qui pourrait stratifier les milieux humides pour mieux évaluer leur valeur écologique pour la conservation ou la compensation. Les étapes de ce projet consistent à 1) suivre un atelier d'identification de lichenologie créé sur mesure pour mon laboratoire, incluant une sortie sur le terrain (automne 2015); 2) faire un pré-terrain dans les milieux humides proche du site du projet de Nemaska Lithium) pour recueillir des échantillons (automne 2015); 3) identifier les échantillons et développer une liste préliminaire des espèces (hiver 2016).

La contribution en nature de la compagnie sera de participer à la planification et à l'exécution de la campagne d'échantillonnage, spécifiquement fournir des cartes et des données d'information géographique sur le territoire autour du développement minier, et de faciliter l'accès au territoire via l'hébergement sur le terrain. Cette contribution est évaluée à 7040$.

Compétences en recherche : Mon expertise est en écologie, phytogéographie et diversité des cryptogames, avec un accent sur les bryophytes. J'ai développé, exécuté et publié plusieurs projets qui décrivent la répartition des espèces cryptiques dans la pessière à mousses de l'ouest particulièrement dans les écosystèmes tourbeux. En plus j'ai développé une forte expertise en recherche appliquée et en collaboration industrielle. J'ai suscité l'intérêt d'industriels de divers secteurs (forestier, minier, tourbe) pour un programme de recherche sur l'écologie et la conservation des cryptogames. La combinaison de ces compétences fait en sorte que je suis la plus qualifiée pour mener à bien ce projet. En plus je bénéficie de l'expertise de mon auxiliaire de recherche, Julie Arseneault, qui a complété sa maîtrise sous ma direction en 2012 et travaille dans mon laboratoire depuis. Sous ma supervision elle participe à l'encadrement de mes étudiants, à l'identification des spécimens et au développement d'un herbier. Elle sera responsable de la campagne de pré-terrain et, sous ma supervision, fera l'identification des spécimens.

Contribution au transfert de technologie : La communication entre mon laboratoire et Nemaska Lithium sera sur une base régulière via courriel et téléphone au début du projet. Par la suite, nous travaillerons ensemble en personne pendant la campagne de pré-terrain dans leur territoire d'intérêt. Notre personne ressource pour le projet est Simon Thibault, (M.Sc. bio.), Directeur Responsabilité environnementale et sociale chez Nemaska Lithium. L'information générée par ce projet, une liste préliminaire des espèces sera partagée avec Nemaska Lithium, et pourrait être utilisé à court terme pour informer des décisions sur la valeur écologique relative des milieux humides. Suite à ce projet, nous planifions un projet plus ambitieux qui généra à long terme un outil qui pourrait permettre de stratifier les milieux humides pour mieux évaluer leur valeur écologique pour la conservation ou la compensation.

Avantages pour le Canada : Ce projet nous permettra de mettre les bases pour un projet à plus long terme qui bénéficiera au Canada sur plusieurs fronts. Il existe présentement une lacune dans nos connaissances sur les milieux humides de la Jamésie, grand territoire convoité par plusieurs industries, incluant les minières et le tourisme. Une meilleure connaissance du territoire permettra un développement durable, et le vaste territoire nous force à nous tourner vers des indices. Le nord de tout le Canada est similairement peu connu biologiquement et les approches développées en Jamésie pourraient être transférées ailleurs par la suite.

Références

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Annexe 3-2

Lettre d'appui de Nemaska Lithium au projet de Flore nordique des lichens de l'Herbier Louis-Marie de l'Université Laval

Nemaska Lithium
450, rue de la Gare-du-Palais, 1er étage
Québec (Quebec) Canada G1K 3X2
T 418 704-6038 #228 F 418 614-0627
simon.thibault@nemaskalithium.com

Québec, 1er juin 2018

M. Serge Payette
Conservateur et professeur
Herbier Louis-Marie, Université Laval
Pavillon C.-E. Marchand, avenue de la Médecine
Québec (QC) G1V 0A6

Objet : Lettre d'appui au projet *Préparation de la Flore des lichens du Québec nordique* dans le cadre du programme Fonds d'initiatives du Plan Nord (FIPN)

M. Payette,

Nemaska Lithium est une société canadienne de production de lithium inscrite à la bourse TSX sous le symbole NMX. Elle entend devenir un fournisseur d'hydroxyde et de carbonate de lithium pour le marché émergent des batteries Li-ion, lequel dépend principalement de la demande en véhicules électriques et en stockage d'énergie.

Nemaska Lithium, au même titre que l'industrie minière dans son ensemble, fait face à un nombre croissant de défis que ce soit au niveau de l'exploration, de l'exploitation d'une mine ou de sa fermeture. Parmi ceux-ci figurent les défis associés au développement de projet en milieu nordique où les connaissances scientifiques sont encore malheureusement limitées sur divers aspects biophysiques, tout particulièrement en ce qui a trait aux espèces invasculaires telles les lichens.

Nous sommes ainsi d'avis que le projet de *Flore des lichens du Québec nordique* proposé par votre équipe vient combler un besoin important dans le contexte du développement du Plan Nord. Non seulement l'initiative proposée est prometteuse à cet égard, mais elle permet aussi le développement de documents et de compétences au sein même de la communauté scientifique québécoise, assurant l'accès à ces ressources et connaissances pour les futurs promoteurs de projets en milieu nordique.

Nous vous confirmons donc par la présente notre ouverture et notre support dans le développement et la réalisation de ce projet. C'est donc avec un grand intérêt que nous suivons votre projet et que nous accordons notre appui à une telle initiative que nous saluons avec un grand respect.

À titre de Directeur Responsabilité sociale et environnementale de Nemaska Lithium, j'accepte avec enthousiasme votre invitation à soutenir ce projet de *Flore des lichens du Québec nordique* et ainsi permettre de maximiser les bénéfices potentiels que celui-ci pourrait avoir pour l'environnement et la société québécoise dans un contexte de nordicité (Plan Nord). Notre appui se fera par une contribution en argent permettant de couvrir l'achat d'un système de macrophotographie botanique au montant de 7 300 $.

Pour toute question ou commentaire, n'hésitez pas à contacter le soussigné.

Cordialement,

Simon Thibault, M.Sc., biol.
Directeur Responsabilité sociale et environnementale

Annexe 3-3

Avis d'octroi, Description de projet et Rapport d'avancement du 4 octobre 2018 – CRSNG-RDC – Chaire industrielle de recherche sur la biodiversité nordique en contexte minier (UQAT)

Natural Sciences and Engineering Research Council of Canada
Conseil de recherches en sciences naturelles et en génie du Canada

350 Albert Street
Ottawa, Canada
K1A 1H5

350, rue Albert
Ottawa, Canada
K1A 1H5

RECEIVED DEC 08 2017

2017/11/30

Dossier : IRCPJ 514080 - 16
Année financière : 2017 – 2018

PROTÉGÉ

Madame N.J. Fenton
Institut de recherche sur les forêts
Univ. du Québec en Abitibi-Témiscamingue
445 BOUL DE L'UNIVERSITE
ROUYN-NORANDA (QC) J9X 5E4

Objet : Subvention de Professeurs-chercheurs industriels - régulières - recherche (IRCPJ) intitulé NSERC Industrial Research Chair on Northern biodiversity in a mining context, (Titulaire agrégée : Mme N.J. Fenton), avec Ouranos Consortium, Agnico-Eagle Mines Ltd, Nemaska Lithium Inc., Stornoway Diamond Corporation, Dével. durable, Envir. et Lutte contre changements climatiques, Canadian Malartic Partnership, Hecla Mining Company, Ministère des Forêts, de la Faune et des Parcs, Conseil de la Première Nation Abitibiwinni

Madame,

J'ai le plaisir de vous informer que le CRSNG a approuvé l'addition du nouveau partenaire et les fonds additionnels résultant de l'appariement de leur contribution pour la subvention de professeur-chercheur industriel indiquée ci-dessus. Cette contribution du CRSNG appuie uniquement la **partie recherche** du projet pour une période d'un an à partir du **le 1er avril, 2017.**

Veuillez prendre note qu'une seule lettre d'octroi est valide au cours d'une année financière. Par conséquent, cette lettre d'octroi vient annuler et remplacer la lettre du 23 juin, 2017, et tient compte du montant total des versements effectués cette année.

Année	Montant accordé	Année financière	Montant du paiement	*Total pour l'année financière (à l'usage du CRSNG seulement)*
1*	$108,197.00	2017	$108 197.00	***$160,167.00***
1A	**$51,970.00**	**2017**	**$51,970.00**	
2	$172,845.00	2018	$172,845.00	
3	$151,066.00	2019	$151,066.00	
4	$137,234.00	2020	$137,234.00	
5	$84,368.00	2021	$84,368.00	

Canada

.../2

*Veuillez noter que la première partie du paiement pour l'année1 a déjà été versée le 23 juin, 2017.

La lettre d'octroi pour la partie salaire a été envoyée directement à Mme M. Champagne.

Vous trouverez ci-joint le document **Modalités de la subvention** révisé, reflétant les changements dans la distribution des contributions des partenaires industriels.

Le CRSNG doit autoriser par écrit au préalable toute dérogation aux activités initiales du projet de recherche, toute dérogation au budget global initial, toute réaffectation des ressources représentant plus de 20 p. 100 d'un poste budgétaire approuvé.

Vous trouverez ci-inclus des autocollants. Veuillez les apposer en évidence sur toute pièce d'équipement acquise à l'aide de cette subvention.

Je vous offre mes meilleurs vœux pour un succès continu dans cette entreprise de recherche.

Veuillez agréer, Madame Fenton, l'expression de mes sentiments les meilleurs.

Patricia Rouillard

Patricia Rouillard
Gestionnaire
Partenariats de recherche

Téléphone : (613) 992-1372
Télécopieur : 613-992-5337
Courriel: Patricia.Rouillard@nserc-crsng.gc.ca

PR/km

c.c : M. Champagne, Québec en Abitibi-Témiscamingue
J. Moulinier, Recherche, Québec en Abitibi-Témiscamingue
G. Girard, Finances, Québec en Abitibi-Témiscamingue
R. R, Ouranos Consortium
J. Noël, Agnico-Eagle Mines Ltd
S. Thibault, Nemaska Lithium Inc.
M. Boucher, Stornoway Diamond Corporation
F. Poisson, Dével. durable, Envir. et Lutte contre changements climatiques
N. D'Anjou, Canadian Malartic Partnership
L. Anctil, Hecla Mining Company
S. Légaré, Ministère des Forêts, de la Faune et des Parcs
B. Croteau, Conseil de la Première Nation Abitibiwinni
Finances, CRSNG

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2017/11/30

Dossier : IRCSA 514079 - 16
Année financière : 2017 – 2018

PROTÉGÉ

Madame M. Champagne
VICE-RECTORAT
À L'ENSEIGNEMENT, RECHERCHE ET CRÉATION
445, BOUL. DE L'UNIVERSITÉ
LOCAL B-305
ROUYN-NORANDA QC J9X 5E4

Objet : Professeurs-chercheurs industriels - régulières - salaires (IRCSA) intitulé NSERC Industrial Research Chair on Northern biodiversity in a mining context, (Titulaire agrégé/agrégée: Mme N.J. Fenton), avec Consortium Ouranos, Les mines Agnico-Eagle Ltée, Nemaska Lithium Inc., Stornoway Diamond Corporation, Dével. durable, Envir. et Lutte contre changements climatiques, Partenariat Canadian Malartic, Hecla Mining Company, Ministère des Forêts, de la Faune et des Parcs, Conseil de la Première Nation Abitibiwinni

Madame,

Cette lettre d'octroi vient annuler et remplacer la lettre du 23 juin, 2017.

Cette lettre a pour but de vous informer au changement apporté aux paiements du CRSNG en raison de l'addition d'un partenaire à la subvention de professeur-chercheur industriel indiquée ci-dessus. Cette contribution du CRSNG appuie uniquement la **partie salaire** du projet. Il n'y a pas de changement apporté à l'an 1 qui a été versé le 23 juin dernier.

Année	**Montant accordé**	**Année financière**	**Montant du paiement**	***Total pour l'année financière (à l'usage du CRSNG seulement)***
1	62 243.00 $	2017	62 243.00 $	*62 243.00 $*
2	57 365.00 $	2018	57 365.00 $	
3	54 744.00 $	2019	54 744.00 $	
4	55 326.00 $	2020	55 326.00 $	
5	56,092.00 $	2021	56,092.00 $	

Canada

La lettre d'octroi pour la partie recherche a été envoyée directement à Madame N.J. Fenton.

Vous trouverez ci-joint le document **Modalités de la subvention** révisé, reflétant les changements dans la distribution des contributions des partenaires industriels.

Veuillez agréer, Madame Champagne, l'expression de mes sentiments les meilleurs.

Patricia Rouillard

Patricia Rouillard
Gestionnaire
Partenariats de recherche

Téléphone : (613) 992-1372
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Cc : N.J. Fenton, Québec en Abitibi-Témiscamingue
J. Moulinier, Recherche, Québec en Abitibi-Témiscamingue
G. Girard, Finances, Québec en Abitibi-Témiscamingue
R. R, Consortium Ouranos
J. Noël, Les mines Agnico-Eagle Ltée
S. Thibault, Nemaska Lithium Inc.
M. Boucher, Stornoway Diamond Corporation
F. Poisson, Dével. durable, Envir. et Lutte contre changements climatiques
N. D'Anjou, Partenariat Canadian Malartic
L. Anctil, Hecla Mining Company
S. Légaré, Ministère des Forêts, de la Faune et des Parcs
B. Croteau, Conseil de la Première Nation Abitibiwinni
Finances, CRSNG

Natural Sciences and Engineering Research Council of Canada
Conseil de recherches en sciences naturelles et en génie du Canada

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RÉVISÉ
(30 novembre, 2017)
MODALITÉS ET CONDITIONS DE LA SUBVENTION

Sommaire de la subvention

Dossier :	Salaire : IRCSA 514079 - 16 Recherche: IRCPJ 514080 - 16
Titre du projet :	NSERC Industrial Research Chair on Northern biodiversity in a mining context
Partenaires universitaires :	Titulaire agrégée: N.J. Fenton, Vice-rectorat à l'enseignement et recherche, Québec en Abitibi-Témiscamingue Administrateur : M. Champagne, Vice-rectorat à l'enseignement et recherche, Québec en Abitibi-Témiscamingue
Partenaire(s) industriel(s) :	R. Siron, Consortium Ouranos J. Noël, Les mines Agnico-Eagle Ltée S. Thibault, Nemaska Lithium Inc. M. Boucher, Stornoway Diamond Corporation F. Poisson, Dével. durable, Envir. et Lutte contre changements climatiques L. Anctil, Hecla Mining Company S. Légaré, Ministère des Forêts, de la Faune et des Parcs N. D'Anjou, Canadian Malartic Partnership B. Croteau, Conseil de la Première Nation Abitibiwinni

Début du projet : 2017/04/01 ***Fin du projet :*** 2022/03/31

Dates de remise des rapports :

Vérification de la contribution de la société	2018/03/01
1er rapport d'étape	2018/10/01
Vérification de la contribution de la société	2019/03/01
Vérification de la contribution de la société	2020/03/01
2e rapport d'étape	2020/04/01
Vérification de la contribution de la société	2021/03/01
Rapport d'état	2021/04/01
Rapport final	2022/06/30

Natural Sciences and Engineering Research Council of Canada | Conseil de recherches en sciences naturelles et en génie du Canada

FORM 101
Application for a Grant
PART I

Institutional Identifier			Date 2016/06/29
System-ID (for NSERC use only) 386145362			
Family name of applicant Martel	Given name Denis	Initial(s) of all given names D	Personal identification no. (PIN) **Valid** 322304

Department Vice-rectorat à l'enseignement et recherche	Institution that will administer the grant Québec en Abitibi-Témiscamingue
Language of application [X] English [ ] French	Time (in hours per month) to be devoted to the proposed research / activity
Type of grant applied for Industrial Research Chairs - IRC	For Strategic Projects, indicate the Target Area and the Research Topic; for Strategic Networks indicate the Target Area.

Title of proposal
NSERC Industrial Research Chair on northern biodiversity in a mining context

Provide a maximum of 10 key words that describe this proposal. Use commas to separate them.
biodiversity, industrial development, nordic, boreal biome, landscape, bryophytes, lichens, metal mines, wetlands, ecological planning

Research subject code(s)		Area of application code(s)	
Primary	Secondary	Primary	Secondary
4704	4710	1000	409

CERTIFICATION/REQUIREMENTS

If this proposal involves any of the following, check the box(es) and submit the protocol to the university or college's certification committee.
Research involving : Humans [X] Human pluripotent stem cells [ ] Animals [X] Biohazards [ ]

Indicate if the proposed research takes place outdoors and if you answered YES to a), b) or c) – Appendix A (Form 101) must be completed
[X] NO [ ] YES

TOTAL AMOUNT REQUESTED FROM NSERC

Year 1	Year 2	Year 3	Year 4	Year 5
170,440	162,140	142,440	147,190	109,740

SIGNATURES (Refer to instructions "What do signatures mean?")

It is agreed that the general conditions governing grants as outlined in the NSERC *Program Guide for Professors* apply to any grant made pursuant to this application and are hereby accepted by the applicant and the applicant's employing institution.

Applicant

Head of department

Dean of faculty

President of institution (or representative)

Applicant's department, institution, tel. and fax nos., and e-mail
Vice-rectorat à l'enseignement et recherche
Québec en Abitibi-Témiscamingue
Tel.: (819) 7620971 ext. 2258
FAX: (819) 7974727
denis.martel@uqat.ca

The information collected on this form and appendices will be stored in the Personal Information Bank for the appropriate program.
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Personal identification no. (PIN)	Family name of applicant
Valid 322304	Martel

CHAIR CANDIDATES/CHAIRHOLDERS

I have read the statement "What do signatures on the application mean?" in the accompanying instructions and agree to it.

Name	Research/ activity time (hours/month)	Type of Chair	Signature
Fenton Nicole	120	Associate	

SUPPORTING ORGANIZATIONS (if organization different from page 1)

It is agreed that the general conditions governing grants as outlined in the NSERC *Program Guide for Professors,* as well as the statements "What do signatures on the application mean?" and "Summary of proposal for public release" in the accompanying instructions, apply to any grant made pursuant to this application and are hereby accepted by the organization.

Family name and given name of signing officer, title of position, and name of organization	Signature
Gingras, Martin, M Director General Ministère des Forêts Faune Parc, direction général nord-ouest Thibault, Simon, S Director Environmental and Social Responsability, Nemaska Lithium Siron, Robert, R Scientific co-ordinator Ouranos Croteau, Benoit, B Director Socioeconomic development and the environment, Abitiwinni First Nation	

Personal identification no. (PIN)	Family name of applicant
Valid 322304	Martel

Before completing this section, read the instructions for the definition of collaborators in the Eligibility Criteria section of the Program Guide for Professors.

COLLABORATORS

PIN, family name and initial(s)	Research/ activity time (hours/month)	Organization / Department
Asselin, H	20	Québec en Abitibi-Témiscamingue,
Bergeron, YG	10	Québec en Abitibi-Témiscamingue,
Demers, I	10	Québec en Abitibi-Témiscamingue,
Imbeau, L	20	Québec en Abitibi-Témiscamingue,
Guittonny-Larchevêque, M	10	Québec en Abitibi-Témiscamingue,
Plante, B	10	Québec en Abitibi-Témiscamingue,
Tremblay, F	10	Québec en Abitibi-Témiscamingue,
Mazerolle, MJ	10	Laval,
Valeria, O	10	Québec en Abitibi-Témiscamingue,

Use additional page(s) if necessary.
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Personal identification no. (PIN)	Family name of applicant
Valid 322304	Martel

SUPPORTING ORGANIZATIONS (if organization different from page 1)

Family name and given name of signing officer, title of position, and name of organization	Signature
Noel, Josée, J Project Leader Mining Reclamation Agnico Eagle Mines Limited Anctil, Lucienne, L Environment coordinator Hecla Mining, Casa Berardi Mine Poisson, Frédéric, F Analyste Ministry Sustainable Management Environment and Climate Change Larose, Michel, M Northern coordinator community relations Nordic and mining Sustainable development, Environment, Climate Change	
Boucher, Martin, M Vice-president Sustainable Development Stornoway Diamonds	

Personal identification no. (PIN)	Family name of applicant
Valid 322304	Martel

SUMMARY OF PROPOSAL FOR PUBLIC RELEASE (Use plain language.)

This plain language summary will be available to the public if your proposal is funded. Although it is not mandatory, you may choose to include your business telephone number and/or your e-mail address to facilitate contact with the public and the media about your research.

Business telephone no. (optional):

E-mail address (optional): nicole.fenton@uqat.ca

Mining is one of Canada's most important industries, generating well paid jobs, and raw materials and technological advances that are exported worldwide. In many parts of Canada, including Abitibi-Témiscamingue and Nord-du-Québec, the mining industry has stimulated exploration, settlement and urban development. Public perception of this industry has shifted over time. The focus on well paid jobs is reduced and environmental and social impacts are highlighted. As such, the mining industry has been modifying its practices to be more socially and environmentally responsible. At the same time, potential ore deposits in Canada, and around the world, are in progressively more remote regions as deposits in easier to access areas have already been developed. Consequently, many ore deposits that are currently being exploited or developed are in northern parts of Canada. In both Québec and Ontario, provincial governments have clear plans to develop mineral resources in the northern parts of their territories. Both of these plans clearly state that industrial projects must be developed sustainably and in consultation with local communities. To achieve sustainable development in the north several elements need to be considered: the rapidly changing climate, the role of First Nations, and the dominance of small plants such as mosses and lichens. Surprisingly, globally few studies have dealt with the overall impact of mines on terrestrial biodiversity and even fewer in a boreal context that includes First Nations, cryptogams and climate change. The mission of the NSERC Industrial Research Chair is to increase knowledge creation and transfer on northern biodiversity in order to develop strategies to reduce the impacts of development throughout the mine life cycle, in the context of multiple impacts including climate change. This mission will be accomplished by integrating scientific and traditional knowledge and will permit industries, governments and communities to reduce their impact on biodiversity, plan for reduced impacts in the future, and integrate aboriginal perspectives and climate change to these plans.

Other Language Version of Summary (optional).

Personal identification no. (PIN)	Family name of applicant
Valid 322304	Martel

Calculate the sum total expenditures and contributions from individual budget pages 5 and 6 transfer the amounts to this Consolidated Budget page. When using the On-line System to complete the form, this Consolidated Budget page will be automatically generated with the information you have already entered.

CONSOLIDATED BUDGET (Proposed Expenditure and Contributions from Supporting Organizations)

	Year 1	Year 2	Year 3	Year 4	Year 5
Cash expenses					
Senior/Executive Chair Salary Costs					
Associate Chair Salary Costs	112,000	112,000	112,000	112,000	112,000
Senior/Executive Chair Research Program Costs					
Associate Chair Research Program Costs	194,690	201,390	181,690	186,440	107,740
Total cash expenses	**306,690**	**313,390**	**293,690**	**298,440**	**219,740**
Cash contributions to Chair program (not including overhead)					
Industry	136,250	151,250	151,250	151,250	110,000
University					
Other	0	0	0	0	0
Total amount requested from NSERC	170,440	162,140	142,440	147,190	109,740
Total cash contributions	**306,690**	**313,390**	**293,690**	**298,440**	**219,740**
"Cash equivalent" in-kind contributions to direct costs of research					
Industry	21,600	10,800	0	0	0
University					
Other	0	0	0	0	0
Total "cash equivalent" in-kind contributions	**21,600**	**10,800**	**0**	**0**	**0**
Other in-kind contributions to direct costs of research					
Industry	36,600	28,500	21,800	21,800	21,800
University					
Other	10,295	10,295	25,295	2,995	2,995
Total other in-kind contributions	**46,895**	**38,795**	**47,095**	**24,795**	**24,795**

Personal identification no. (PIN)	Family name of applicant
Valid 322304	Martel

Before completing this section, **read the instructions** and consult the *Use of Grant Funds* section in the NSERC Program Guide for Professors concerning the eligibility of expenditures for the direct costs of research and the regulations governing the use of grant funds.

PROPOSED EXPENDITURES FOR DIRECT COSTS OF RESEARCH (include cash expenditures only)

Name of Chair candidate/Chairholder: Fenton, Nicole — Type of Chair: Associate

	Year 1	Year 2	Year 3	Year 4	Year 5
Chair Salary Costs					
Salary and benefits	**112,000**	**112,000**	**112,000**	**112,000**	**112,000**
Research Program Costs					
1) Salaries and benefits					
a) PhD students	31,000	27,000	63,000	35,000	21,000
b) Master's students	24,000	64,000	30,000	18,000	18,000
c) Undergraduate students	18,000	18,000	6,000	6,000	0
d) Postdoctoral fellows	0	0	0	50,000	0
e) Technical/professional assistants	24,990	24,990	24,990	24,990	24,990
f)	0	0	0	0	0
2) Equipment or facility					
a) Purchase or rental	0	0	0	0	0
b) Operation and maintenance costs	0	0	0	0	0
c) User fees	0	0	0	1,000	0
3) Materials and supplies	32,500	7,000	3,600	4,500	0
4) Travel					
a) Conferences	0	6,000	7,500	5,250	3,000
b) Field work	29,400	19,600	9,800	4,900	3,950
c) Project-related	0	0	0	0	0
5) Dissemination costs					
a) Publication costs	0	0	2,000	2,000	2,000
b) conference	8,200	8,200	8,200	8,200	8,200
6) Other (specify)					
a) project manager	26,600	26,600	26,600	26,600	26,600
b)	0	0	0	0	0
Total Research Program Costs	**194,690**	**201,390**	**181,690**	**186,440**	**107,740**
TOTAL CASH EXPENSES (Chair Salary Costs + Total Research Program Costs)	**306,690**	**313,390**	**293,690**	**298,440**	**219,740**
Total cash contributions to Chair program (not including overhead) from industry, if applicable.	136,250	151,250	151,250	151,250	110,000
Total cash contributions to Chair program (not including overhead) from university, if applicable.					
Total cash contributions to Chair program (not including overhead) from other sources, if applicable.	0	0	0	0	0
TOTAL AMOUNT REQUESTED FROM NSERC (transfer to page 1)	170,440	162,140	142,440	147,190	109,740

Canada

Personal identification no. (PIN)	Family name of applicant
Valid 322304	Martel

Before completing this section, read the instructions on contributions from supporting organizations and consult the *Use of Grant Funds* section in the NSERC *Program Guide for Professors* concerning the eligibility of expenditures for the direct costs of research, the regulations governing the use of grant funds, and the *Guidelines for Evaluating Cost-Sharing Ratios and In-Kind Contributions in University-Industry Collaborations* concerning the eligibility of in-kind contributions. Complete this section if you are reporting in-kind contributions for the direct costs of research. Submit a separate copy for each supporting organization.

Name of supporting organization

Nemaska Lithium

CONTRIBUTIONS FROM SUPPORTING ORGANIZATIONS

	Year 1	Year 2	Year 3	Year 4	Year 5
Cash contributions to Chair program (not including overhead). Transfer amounts to page 5.	**10,000**	**10,000**	**10,000**	**20,000**	**20,000**
"Cash equivalent" in-kind contributions to direct costs of research					
1) Donation of equipment	0	0	0	0	0
2) Donation of material	0	0	0	0	0
3) Provision of technical services	0	0	0	0	0
4) Field work lodging	21,600	10,800	0	0	0
Total "cash equivalent" in-kind contributions	**21,600**	**10,800**	**0**	**0**	**0**
Other in-kind contributions to direct costs of research					
1) Salaries of scientific and technical staff	9,600	9,600	9,600	9,600	9,600
2)	0	0	0	0	0
Total other in-kind contributions	**9,600**	**9,600**	**9,600**	**9,600**	**9,600**
Total in-kind contributions to direct costs of research	**31,200**	**20,400**	**9,600**	**9,600**	**9,600**
Contributions to university overhead	**0**	**0**	**0**	**0**	**0**

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Canada

Denis Martel

Form 101 - Application for a Grant

Proposal

proposal

Section I: Proposal for establishing a Chair

Chair rationale:

Mining is one of Canada's most important industries, generating well paid jobs, and raw materials and technological advances that are exported worldwide. For example, in October 2015, Gross Domestic Product (GDP) generated by the mining sector and associated industries represented 8% of the total GDP of Canada (Statistics Canada 2015, http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/gdps04a-eng.htm). In many parts of mid to northern Canada, including the regions Abitibi-Témiscamingue and Nord-du-Québec, the discovery of ore deposits has historically stimulated exploration, settlement and urban development, and as such the mining industry plays a key role in these communities.

Public perception of this industry has shifted over time however. Once based on the well paid jobs in relatively remote regions, perception of the mining industry now includes the environmental and social impacts that this industry generates throughout its life cycle and after mine closure. As such, the mining industry has been modifying its practices to be more socially and environmentally responsible. For example, the International Council on Mining and Metals (ICMM) has generated a series of best management practices on community involvement and biodiversity (ICMM 2006, 2013) that its members, including major Canadian companies, should follow.

Potential mine deposits in Canada, and around the world, are in progressively more remote regions as deposits in easier to access areas are developed. Consequently, many ore deposits that are currently being exploited or studied for development are in northern parts of Canada, for example the Renard and Whabouchi mines in development by Stornoway Diamonds and Nemaska Lithium respectively. In both Québec and Ontario, provincial governments have clear plans to develop mineral resources in the northern parts of their territories (Plan Nord http://plannord.gouv.qc.ca/fr/vision/; Far North Land Act http://www.ontario.ca/page/far-north-land-use-planning-initiative). Both of these plans clearly state that industrial projects must be developed sustainably and in consultation with local communities. The Québec government's new strategic vision of mining development, presented in April 2016 (https://mern.gouv.qc.ca/mines/vision/documents/vision-mines_long-fr.pdf), also promotes this vision as its three objectives are: valorizing current and developing mine sectors, preventing and mitigation environmental impacts of the industry, and promoting citizen participation and transparency.

The mining industry is high profile, high profit, and organised into global best practice bodies, and as a consequence it is dependent on a "social licence" to operate (Rainey et al. 2014). Furthermore, despite the small size of individual mines, serious environmental damage has been historically generated by the industry in Canada, which along with social justice issues, has led to the creation of several advocacy groups (e.g. Mining Watch, Coalition pour que le Québec ait meilleure mine). The industry has addressed concerns over social and environmental impacts over the life cycle of the mine by modifying its practices with the development of corporate social responsibility policies (Houdet et al. 2012). After focusing on human rights, water and air pollution, and climate change, biodiversity conservation has come to the fore (Rainey et al. 2014). Both industry and government are promoting the "mitigation hierarchy", where impacts on biodiversity (generally considered to be due to habitat loss) are avoided, mitigated, restored or compensated, in that order (Gardner et al. 2013).

In order to apply the mitigation hierarchy, appropriate strategies need to be developed that are applicable to the northern environment, i.e. an environment where there are few roads, little biogeographical information for most species groups, particularly cryptic bryophytes and lichens that dominate the landscape, and the presence of many First Nations.

Université du Québec en Abitibi-Témiscamingue (UQAT) is well placed to play a key role in the development of these strategies. It is a dynamic institution, established in 1970 following demands made

by local industries and civil society. As such it has a long history of working with the local socio-economic actors to develop applied education and research programs. The mining and forestry industry are two fundamental drivers of development in the region and are part of the past and current strategic research and development plans of UQAT. UQAT has been working with the mining industry for over 30 years via its Unité de Recherche et Services en Technologie Minérale (URSTM, Research and service unit in mining technology), Industrial NSERC-Polytechnique-UQAT Chair in Environment and Mine Waste Management (Phase I and II), and of several Canada Research Chairs, including a CRC on abandoned mine site reclamation, a CRC on integrated mine waste management, a CRC on the passive treatment of contaminated mine water, and a recent CRC on the integration of the environment into the mine life cycle. These chairs are now grouped together as the IRME (Mine and Environment Research Institute). UQAT has thus been able to actively participate in the development of knowledge and practices related to the diverse regional metal mining industry (resources such as gold, silver, copper, zinc, and more recently nickel, lithium, rare earths), and to the discipline globally. A second research pole is in applied biological sciences via the NSERC Industrial Chair in Sustainable Forest Management (1998 to present), a CRC in forest ecology, a CRC in wood quality, and a CRC in Aboriginal forestry. These chairs are now grouped together in the Forest Research Institute (IRF), which is renowned internationally for its applied and interdisciplinary research. The development of the proposed Industrial Research Chair (IRC) is a clear strategic opportunity for UQAT to develop synergies and interdisciplinary research between its two main natural science research poles (mines and forests), and to capitalise on previous developments, such as CRC and laboratories. Furthermore, the proposal integrates aboriginal peoples perspectives and priorities in applied natural sciences research, building on the success of the CRC in Aboriginal forestry. The interdisciplinary and applied nature of the research program in the north reflects the northern development and interdisciplinary research orientations of the UQAT 2015-2020 strategic plan for research and creation (UQAT 2015; http://www.uqat.ca/telechargements/plan_strategique_recherche.pdf), as well as two orientations of the 2015-2020 development plan: building and maintaining strong partnerships and more specifically reinforcing partnerships with First Nations (http://www.uqat.ca/telechargements/UQAT_plan_developppement_2015-2020.pdf).

As with previous industrial projects, both the university and the industry will benefit from the collaborative research undertaken within this IRC. The changing norms of government and the public are pushing mining companies to look beyond the engineering and economic feasibility of their projects, towards the avoidance, reduction, mitigation and compensation of the biological impacts. However the industry has little capacity in this domain and little research exists in Canada on these questions. As such this IRC fills a real knowledge gap for the industry and the research results will permit them to reduce their impact on biodiversity and consequently receive operating permits and a social licence to operate. In addition, industrial partners (Hecla Québec, Nemaska Lithium, Stornoway Diamonds, Agnico Eagle) will gain first access to innovative tools developed at their sites and will mentor HQP of all levels who could become future employees. First Nations (Abitiwinni First Nation, confirmed and Cree Nation Government – discussion underway) associated with the IRC will gain information collected on their territory in a way that respects their traditions and rights and that facilitated sustainable development of their communities. The university will develop a new research expertise in an area that builds on its two main poles in the natural sciences, promote collaboration between its research institutes, and generate new research resources in the region. Ultimately the university will continue to contribute to the sustainable development of the region, to national and international research priorities and to generate new knowledge.

Description of position:

The chair holder's position will be an associate professor tenure-track position. This position requires three qualities to make the Industrial Research Chair a success: (1) a strong applied and interdisciplinary

research capacity, which implies the ability to maintain an independent and high quality scientific research program while working productively with industry and other groups and colleagues in Québec, Canada and around the world, (2) an expertise in biodiversity of multiple species groups, and in particular bryophyte and lichen species that dominate in the north, and (3) excellent leadership skills, including communication and mentorship.

The candidate, Nicole Fenton, fulfills all of these requirements (see form 100 and letters of recommendation). Fenton has been involved in applied ecological research since 1998, working with a wide variety of groups including, forestry companies (JD Irving, Tembec, Eacom, FPRésolu), peat exploitation companies (Créneau Tourbe & Agroenvironnement, Tourbières Lambert) and mining companies (Agnico Eagle, Nemaska Lithium, Goldcorp). She has maintained a high quality independent research program while working on industrially relevant questions with 38 publications in high impact independent journals (e.g. 5 articles in *Forest Ecology and Management*, 4 in *Botany*, 3 in *Canadian Journal of Forest Research*, 2 in *Ecosystems*, 2 in *Plant and Soil*, 2 in *Biological Conservation*). Furthermore, her collaborations with many different types of actors speak to her ability to collaborate across disciplines and sectors, including researchers in the social sciences (e.g. Hugo Asselin and Colin Scott with CICADA). Nicole Fenton is a globally recognised expert in bryophyte ecology, indicated by her strong research record in this area (e.g. Discovery Grant on Bryophyte Landscape Ecology and form 100), the numerous review requests (6 in 2016 so far), and her position on the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) subcommittee for mosses and lichens. She is developing an expertise in lichen ecology, as indicated by a recent Engage grant, and has also worked with vascular plants. Finally, Fenton has excellent leadership skills, honed through years of community engagement (Boards of directors, volunteering, see form 100), project management at the university level as a research associate, and mentoring of graduate students (16 to date, 10 active). She is also an excellent communicator, as indicated by invitations to present at conferences (17 since 2011), highly cited articles (38 publications, 638 citations-Scopus), and excellent teaching evaluations.

Fenton will also benefit from an excellent group of collaborators, primarily at UQAT. From the IRF, Bergeron, Tremblay, Valeria, and Imbeau have all collaborated with Fenton in the past, and their combined expertise in applied biology permit the broad and inclusive nature of the research program. Asselin, from the department of human and social development, has collaborated with Fenton in the past and has a recognised expertise in working with aboriginal communities on natural resource issues. In addition, three professors (Demers, Guittonny-Larchevêque, Plante) from the IRME will bring their expertise of the mine industry and will ground the research program in operational realities.

Fenton will benefit from:

- a reduced teaching load (1 course per year instead of 4) in order to concentrate on research, HQP mentoring and administrative responsibilities of the Industrial Research Chair.
- administrative support for the administrative, financial and human resource services of the IRC.
- access to IRF, RIME and other UQAT laboratories and equipment.
- internal support via UQAT research funds (≈ $5,000/year);
- support for international student recruitment : Three scholarship grants of approximately $4,000 per year will be dedicated to international students of the Chair;
- professional support in the preparation of grant applications and of research contracts.

UQAT does not have bachelor programmes in either the mining or forestry areas. Consequently, both the IRF and the IRME are research institutes, all faculty focus on research and training of HQP full time, with MSc and PhD students recruited from around the world.

Research capacity:

The presence of a research assistant (Arseneault), a specialist in bryophyte and vascular plant identification, enables the maintenance of the reference collection of material required for biodiversity research, and the day-to-day student support necessary to learn cryptogam identification. Arseneault is currently part-time, but is expected to move to a full time position during the mandate of the industrial research chair. Several state of the art laboratories are available to Fenton and collaborators at UQAT. Fenton has a large bryophyte ecology laboratory for experimental studies and bryophyte identification, which also houses the reference collection. Tremblay has a fully equipped genetics laboratory. Via the IRME collaborators, the different laboratories of the URSTM will be available for the project, where chemical digestions, analyses, and column studies could be executed. In addition to these facilities directly implicated in the project, there is also the Forêt d'enseignement et de recherche du Lac Duparquet (FERLD) (http://web2.uqat.uquebec.ca/ferld). Located 60 km north of Rouyn-Noranda campus, the FERLD covers a territory of 80 km^2 and offers exceptional research opportunities both in ecology, in forestry and forest management with five buildings (community pavilion, accommodation pavilions (2), dendrochronology laboratory and field laboratory). It can accommodate several researchers (university professors, scientists attached to federal and provincial research organizations), graduate students (2nd and 3rd cycles) and research assistants (undergraduate and technicians).

Research capacity is expected to grow significantly over the mandate of the industrial chair with a new facility, the Observatory on the Middle North (l'Observatoire sur le Moyen Nord), being developed in the city of Matagami (209 km to the north-east of Rouyn-Noranda). The development of this new facility will, in conjunction with this Industrial Research Chair, result in a significant increase in research capacity and will offer significant opportunities for collaborative research, and will improve working conditions in the north, permitting more field work.

Incrementallity:

The candidate, Nicole Fenton, currently in a non-permanent research position, will head the Industrial Chair Research program and will ensure that this research domain grows over the five year term. The Fenton appointment as industrial chair holder is confirming the development of a new tenure track position for the internal candidate. With this focussed approach she will be able to foster interdisciplinary research between the two institutes of UQAT and grow applied biodiversity research in the region, Canada and internationally. Moreover research capacity will grow with an additional position. The profile of successful candidate will be complementary to that of the IRC holder, to support Fenton in her research program, to develop complementary research projects to the IRC and to the UQAT research program in the field of Forest Research Institute.

Use of released funds:

This industrial chair allows the internal candidate to obtain a permanent research position. UQAT is also committed to opening another tenure-track position at the Forest Research Institute at UQAT. This position will be linked to the themes developed in the Chair, will be complementary to the IRC holder and the new professor will be able to collaborate in the work of the proposed Chair and to the Forest Research Institute research programming.

Anticipated impact:

This Industrial Research Chair responds directly to a need expressed by the industry, government and First Nations, as evidenced by the number of mines and companies (4) who are partners, the presence of federal and provincial environment ministries, and First Nations. This chair will therefore increase the

amount of research relevant to this industry at UQAT, including the training of additional HQP in an extremely interdisciplinary environment, with the both research institutes implicated. Consequently, the development of this Industrial Research Chair contributes to the development of several research priorities identified by UQAT in their Strategic Plan for Research and Creation 2015-2020, including the interdisciplinary areas of integrated natural resource management and sustainable development of the north. Furthermore, as climate change will increasingly impact northern Québec and Canada the research projects developed here will only increase in relevance and will open doors for international collaboration.

Section II: Research proposal

Synopsis

The mining industry is among the primary industries that have built the Canadian economy. However the mining industry is changing, as the perception of civil society shifts from a purely economic focus toward a holistic view that includes local community well-being and environmental impact. Consequently most governments now require detailed environmental impact assessments, management of water and tailings, and mines are required to restore depleted sites. This has stimulated research on the impacts of mine development on water quality and issues surrounding tailings management in an engineering context. Surprisingly, few studies have dealt with the overall impacts of mines on terrestrial biodiversity, including enigmatic impacts, and even fewer in a boreal context. This is a significant knowledge gap, as the boreal is both home to vibrant First Nations who are impacted by mining development and one of the sites of most rapid climate change. The mission of this proposed NSERC Industrial Research Chair (IRC) is to *increase knowledge creation and dissemination regarding northern biodiversity in order to be able to develop strategies to reduce the impacts of development throughout the mine life cycle on northern biodiversity in the context of cumulative impacts including climate change*. The interdisciplinary research program of the IRC will address three knowledge gaps within the framework of the mitigation hierarchy from a biological context that integrates First Nation's traditional knowledge and preoccupations. These knowledge gaps can be organised hierarchically into short, medium, and long term effects on the conservation of biodiversity, and together will permit the development of strategies to reduce the impacts of the mining industry on biodiversity over multiple time scales. **In order, these objectives are: (1) in the short term**, to reduce the impact of mine footprints by developing strategies to avoid and minimize impacts on biodiversity based on an understanding of footprint dynamics over the mine life cycle, with a focus on cryptogam species; **(2) in the medium term**, to avoid risk for biodiversity by developing tools for ecological planning, based on an understanding of species distributions across the landscape, First Nation's priorities and their vulnerability to climate change; **(3) in the long term**, to reduce impacts on species of particular importance to First Nation's by developing avoidance and mitigation strategies that integrate the cumulative impacts on northern biodiversity. Together these objectives will permit industries, governments and communities to reduce their current impact on biodiversity, plan for reduced impacts in the future, and integrate aboriginal perspectives and climate change to these plans. It aims to specifically include both First Nations and companies in project development, execution and dissemination. The approach of the proposed chair is innovative as it uses a specific but broad definition of biodiversity, and integrates the engineering and business concept of mine life cycle into biodiversity conservation. The proposed IRC will consolidate UQAT's position as a leader in mine and environment research, and continues UQAT's model of research development that marries scientific excellence and regional relevance.

Background

Mining is one of Canada's most important industries. Potential ore deposits in Canada, and around the world, are in progressively more remote regions as deposits in easier to access areas are developed. In

Canada, this translates into an increased interest on the part of private companies, and the federal and provincial governments, in deposits in northern Canada. This region is prized by all Canadians and by the global population for its pristine landscape and relatively untouched flora and fauna.

While most of northern Canada and Québec has not yet been industrially developed, and therefore houses most of its native biodiversity, biodiversity is declining globally with species extinction rates many times faster than the background norm (Ceballos et al. 2015, Pimm et al. 2014). Biodiversity loss weakens ecosystem functions and services (Gascon et al. 2015, Cardinale et al. 2012, Isbell et al. 2011), and rare species that are typically spatially restricted and infrequent are generally lost first (Pimm et al. 2014). However these rare species also frequently contribute disproportionately more to ecosystem function (Mouillot et al. 2013). Consequently, biodiversity loss is considered one of the greatest issues facing the international community, especially as other anthropogenic impacts are compounded by climate change (Hooper et al. 2012).

The mining industry is high profile, high profit, and organised into global best practice bodies, and as a consequence it is dependent on a "social licence" to operate (Rainey et al. 2014). The industry has addressed concerns over social and environmental impacts over the life cycle of the mine by modifying its practices with the development of corporate social responsibility policies (Houdet et al. 2012). For example, the International Council on Mining and Metals (ICMM) has generated a series of best management practices on community involvement and biodiversity (ICMM 2006, 2013). After focusing on human rights, water and air pollution, biodiversity conservation has moved to the forefront (Rainey et al. 2014). Both industry and government are promoting the "mitigation hierarchy", where impacts on biodiversity (generally considered to be due to habitat loss) are avoided, mitigated, restored or compensated, in that order (Gardner et al. 2013). Typically, only the habitat area occupied by the mine including its installations is considered during the application of the mitigation hierarchy. However, the equation of "amount of habitat loss equals amount of impact on biodiversity" is simplistic (Virah-Sawmy et al. 2014), and repeated calls are being made to integrate "enigmatic impacts" into the equation (Raiter et al. 2014). Enigmatic impacts include small cumulative impacts (e.g. fragmentation), those beyond the active site (edge effects, landscape scale, Harper et al. 2015, Gardner et al 2013), indirect impacts facilitated by development (e.g. impacts of roads), and synergistic impacts (e.g. habitat loss and climate change; Herrmann et al. 2014, Vernier et al. 2014). Although northern Canada and Quebec are being affected by climate change, cumulative and synergistic impacts are important issues that have not yet been dealt with (Vernier et al. 2014, Brandt et al. 2013).

In order to ensure that these biological concepts can be effectively assessed for the operational reality of the mining industry, they need to be integrated into the engineering and business concepts of the mine life cycle. The entire life cycle of a mine needs to be considered, from development through restoration in order to understand the true nature of impacts overtime and to develop efficient mitigation methods. Considering all of these factors, the actual footprint of an individual mine and its impacts on biodiversity may extend beyond the physical area disturbed, but the extent, severity and evolution of this footprint throughout the mine life cycle is unknown. The range of action of companies desiring to reduce their current or predicted impact on biodiversity, and consequently improve their environmental record and social capital, is limited due to this information gap.

Northern Canada is a vast territory with limited road access. As a consequence, the species are relatively little studied compared to the more densely populated south. Despite this discrepancy, we know that boreal forests of Québec house 13 reptile and amphibian species as well as 233 bird species (Lord and Robitaille 2013). In addition, over a third of the vascular plant species present in the province, and at least half of the bryophytes and lichens (Lord and Robitaille 2013) are found in the boreal. Of particular note is the influence of bryophytes and lichens (collectively cryptogams) on ecosystem functions (e.g. primary productivity, nutrient cycles) in these northern systems (Turetsky 2012, Cornelissn et al. 2007). However the distribution of cryptogams across northern Canada including northern Québec is still being described

(e.g. Faubert et al. 2011). Consequently, it is impossible for developers or the government to plan developments to avoid areas of particular interest because of their biodiversity or rare species abundance.

In contrast to western scientific knowledge, the traditional ecological knowledge of the north, held by the First Nations of the territory, is profound (Sayles 2015, Spoor et al. 2006). The recognition and dissemination of this knowledge, while respecting First Nations rights, remains a national and international challenge (Sutherland et al. 2013). The acquisition and dissemination of different forms of knowledge on northern biodiversity would permit conservation, mitigation and compensation measures to be more efficient (Herrmann et al. 2014).

The mission of this proposed NSERC Industrial Research Chair (IRC) is to *increase knowledge creation and dissemination regarding northern biodiversity in order to be able to develop strategies to reduce the impacts of development throughout the mine life cycle on northern biodiversity in the context of cumulative impacts including climate change*. This mission will be pursued via an interdisciplinary research program integrating scientific and traditional knowledge, and technology transfer towards industries, First Nations, governments, non-governmental organisations and the general population. Ten HQPs will be involved in the research projects, ensuring future professionals will be trained in this multi-disciplinary environment.

The proposed IRC builds on past and present collaborations of the candidate and researchers at UQAT. The internationally renowned research groups of UQAT (sustainable forest management, mine and environment) have been built on developing innovative research programs of high scientific merit that also meet the needs of industry. Within this context much of the candidate's past research has been applied, focussing on describing impacts of industrial development in order to suggest ways of mitigating or compensating these impacts (Paquette et al. 2015, Bois-Charlebois 2014, Thiffault et al. 2013, Fenton et al. 2013, Arseneault et al. 2012, Lafleur et al. 2011, Fenton et al. 2010, Fenton and Bergeron 2007, Fenton and Frego 2005). In addition, a second axe of the candidate's research has focussed on describing the mechanisms driving species presence within forest stands and across the landscape (Fenton and Bergeron 2013, Fenton and Bergeron 2008, Fenton and Bergeron 2006a, Fenton and Bergeron 2006b, Barbé et al. submitted a, b). The candidate's research program is also interdisciplinary, with ongoing projects involving researchers from a variety of disciplines, many of whom are included as collaborators in this proposal: Yves Bergeron (climate change and ecosystems) Louis Imbeau (wildlife), Marc Mazerolle (amphibians), Francine Tremblay (genetics), Hugo Asselin (Aboriginal forestry and natural resources), and Osvaldo Valeria (remote sensing). With this proposal, the candidate will develop new collaborations with mine and environment researchers: Isabelle Demers (environment and mine life cycle), Marie Guittonny-Larchevêque (mine revegetation) and Benoit Plante (geochemistry, tailings management). The proposed IRC will also foster the development of new collaborations with colleagues across Canada and internationally.

Proposed research:

In the past, research at UQAT, and research in general in the domain, has dealt with impacts on water quality and issues surrounding tailings management in an engineering context. Surprisingly few studies have dealt with the overall impacts of mines on terrestrial biodiversity, including enigmatic impacts, and even fewer in a boreal context. The interdisciplinary research program of the proposed IRC will address three knowledge gaps within the framework of the mitigation hierarchy from a biological context. These knowledge gaps can be organised hierarchically into short, medium, and long term effects on the conservation of biodiversity, and together will permit the development of strategies to reduce the impacts of the mining industry on biodiversity over multiple time scales. **In order, these objectives are: (1) in the short term**, to reduce the impact of mine footprints by developing strategies to avoid and minimize impacts on biodiversity based on an understanding of footprint dynamics over the mine life cycle, with a focus on cryptogam species; **(2) in the medium term**, to avoid risk for biodiversity by developing tools

for ecological planning, based on an understanding of species distributions across the landscape, First Nation's priorities and their vulnerability to climate change; **(3) in the long term**, to reduce impacts on species of particular importance to First Nation's by developing avoidance and mitigation strategies that integrate the cumulative impacts on northern biodiversity. Together these objectives will permit industries, governments and communities to reduce their current impact on biodiversity, plan for reduced impacts in the future, and integrate aboriginal perspectives and climate change to these plans. It aims to specifically include both First Nations and companies in project development, execution and dissemination. The approach of the proposed chair is innovative as it uses a specific but broad definition of biodiversity, and integrates the engineering and business concept of mine life cycle into biodiversity conservation. These concepts are developed further below.

Defining biodiversity Conserving biodiversity is important for maintaining ecosystem function and ecosystem services (Cardinale et al. 2012, Isbell et al. 2011), as well as the inherent right of species to exist (CBD, 1992). But what is meant by biodiversity? In this chair, "biodiversity" will be treated in its largest sense, including different biological scales, different kingdoms of study (e.g. plants, fungi, animals), and different world views. Academically, the definition of the term biodiversity is not limited to the number of species, as it integrates different biological scales (CBD, 1992), i.e. (i) genes, (ii) species, and (iii) ecosystems, as their functions are affected by the species populations present. However, most studies look at species diversity as it is the easiest to study, on both the practical and theoretical levels (Duncan et al. 2015). At the species scale, the composition, richness and diversity of species are indicators of the ecological integrity of a site. However, looking at diversity from different biological scales and including ecosystem and genetic diversity generates a clearer picture of the system, its components and its strengths and vulnerabilities. Genetic diversity underlies species and ecosystem diversity because it is essential to the survival of species when environmental changes occur, including synergistic and cumulative impacts from development and climate change. Ecosystem diversity indicates the spatial pattern of biodiversity across the landscape and must be considered for effective planning and to counter impacts on biodiversity. In this chair we propose to include all of these biological scales of study. This composite picture of the system is important for planning within the mitigation hierarchy.

While biodiversity inherently includes all kingdoms of life, most "biodiversity studies" tend to only examine large charismatic groups, such as birds, mammals, amphibians, trees and vascular plants, and frequently only one group at a time (Bregman et al. 2015 birds, Isbell et al. 2015 grassland plants, Pimm et al. 2014, 2015 wildlife). These studies often do not address the other species present within the landscape, particularly cryptogam species (bryophytes, lichens). Studies including cryptogam species are difficult as the technical expertise to identify many of these groups is rare across Canada (Council of Canadian Academics 2010). In addition, sampling techniques must be carefully adapted to include multiple kingdoms that operate at different spatial scales (Sebek et al. 2015). This chair will specifically address cryptogam diversity (bryophyte, lichen) and integrate multiple kingdoms (plants, animals, fungi) in innovative nested study designs that permit interdisciplinary collaboration.

In addition biodiversity does not usually integrate the perspectives of First Nations, often putting forth the idea of "fortress biodiversity" with humans excluded from conservation processes (Gavin et al. 2015, Mulrennan et al. 2012). The inclusion of traditional ecological knowledge or biocultural heritage and their dynamic understanding of territories (Gavin et al. 2015) permits a broader understanding that enriches conservation and increases its chances of success (Shen et al. 2012, Uprety et al. 2012, Gagnon and Berthiaume 2009), in addition to recognizing traditional tenure and valorizing different world views (Sayles 2015, Mulrennan et al. 2012). This chair will work towards integrating traditional perspectives on diversity and conservation into its research program via active inclusion of First Nation's participants at all steps of the projects. The interdisciplinary integration of multiple types of biodiversity is innovative and will be developed gradually. As such, all elements will be integrated throughout the research program, but not necessarily in each project.

Mine life cycle The life cycle of a mine is an engineering and business concept that has not been exploited in biological research. Mines are generally considered as a static disturbance on the landscape as either "operating" or "closed". However, mines do go through a clearly defined cycle that will be used to structure an understanding of the temporal evolution of mine impacts, which will suggest which mitigation or avoidance measures will be most effective. The mine life cycle begins from when a deposit of interest has been found involves seven steps, some of which occur concurrently. Initially, detailed exploration (1) is undertaken to define the available resources and preliminary environmental assessment. During this period plans are developed (2) to determine whether it is possible to operate the mine in such a way that it is economically viable, sellable to financiers and environmentally and socially acceptable in order to obtain the necessary permits from the government. While there is not yet a footprint of the mine at this stage, it is during this planning process that incorporating acts to reduce impacts on biodiversity in the plan can reduce restoration costs, increase social acceptability, and facilitate permit acquisition. Once financing and permits are obtained, construction (3) of the infrastructures is undertaken, and the mine enters into operation (4). Mine closure (5) and restoration (6) may occur simultaneously during or after operations, and subsequently post-restoration monitoring (7) is ongoing.

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

In the context of the size of northern Canada or Quebec, the area occupied by any given mining project is very small, even for large projects covering several hundred hectares. Consequently, the biological consequences of the loss of the area itself should be minimal. However, what is the footprint of the enigmatic impacts (e.g. fragmentation, landscape impacts, indirect impacts; Raiter et al. 2014) around these installations, and how does this evolve within the mine life cycle? Surprisingly, this question has been little documented, even less so when the entire life cycle of the mine is considered.

A number of mechanisms may generate the mine footprint, changing through the mine life cycle. These mechanisms include edge effects, dust and other particulate pollution, and indirect effects linked to roads (which may include all the preceding). The generated footprint may vary in size with life cycle stage and the type of surrounding ecosystems (e.g. deciduous vs coniferous forest, vs wetlands). The reduction in habitat quality and quantity associated with edge has been identified as a major factor impacting biodiversity around the world (Harper et al. 2015, Orihuela et al. 2015, Dupuch and Fortin 2013). Results from post-harvest studies in the boreal forest indicate that lichens and bryophytes are particularly sensitive to these disturbances (Paquette et al. 2015, Boudreault et al. 2013, Dynesius and Hylander 2007), while vascular plants are more resilient (Harper et al. 2015, Mayor et al. 2015, Langor et al. 2014). In addition to edge effects, dust and particulate pollution are generated around open pits, dry tailings impoundments and gravel roads. These particulates have been shown to influence bryophyte and lichen morphology and growth rates, resulting in community composition changes (Cleavitt et al. 2015, Leblanc et al. 1974). Bryophytes also have been used for decades to determine heavy metal pollution loads, as they bioaccumulate many pollutants on their highly charged surfaces (Vuković et al. 2016, Harmens et al. 2010, Onianwa 2000). While many studies were initially carried out in North America to determine the spatial extent of mine pollution (Leblanc et al. 1974), almost all recent studies focus on large scale monitoring of air quality in Europe (see Fernandez et al. 2015, Harmens et al. 2010). Consequently, little is known of the distribution of particulate pollution around modern mines in boreal Canada or how bioaccumulation in bryophytes changes over the life cycle of a mine, although some work indicates that traces may remain for decades (Agnan et al. 2015). Roads are an additional mechanism generating a footprint on the landscape. In addition to fragmenting the landscape, generating edge effects and generating dust, roads are corridors for invasive species (either exotic or expansion of native species, Langor et al. 2014; Laquerre et al. 2011) and several invasive wetland species have been documented to use these linear

disturbances (Albert et al. 2015, Laquerre et al. 2011, Mortensen et al. 2009). However, the impact of roads in the boreal has been little studied, except for the emblematic woodland caribou (Herrmann et al. 2014, Beauchesne et al. 2013, Leclerc et al. 2012, Whittington et al. 2011).

In this objective the aim is to describe mine footprints including enigmatic impacts, and to propose mitigation strategies integrated into the life cycle of a mine, in four student projects: PhD 1, focussing on changes in community composition due to the combined impact of edge effects and particulate pollution; MSc1, a more detailed initial study on the bioaccumulation of heavy metals in bryophytes in collaboration with Plante; MSc2, with Guittonny-Larchevêque, a strategy to reduce impacts via restoration of tailings impoundments using bryophytes will be tested; and in MSc 3, in collaboration with Demers, we will model the economic impact of integrating these strategies for different types of mines and landscapes. Once this final project is completed, concrete solutions, and their cost-benefit analysis, will be proposed to reduce the footprint around mines.

PhD1: Determining the footprint of mines on plant diversity: integrating enigmatic impacts and the mine life cycle. (Direction: Fenton; Advisors: Bergeron and Demers) (Milestones 1,3,7,14,19,24,25,34,38,40) The overall objective of this PhD project is to determine the footprint of mines and their roads, beyond the immediate developed area, using vegetation composition (vascular plants, bryophytes, lichens) as the indicator. This project will integrate the interaction between the ecosystem types surrounding the mine/road, and the characteristics of the mine/road. It will be divided in three chapters: (1) Determining the spatial footprint of mines on vegetation over their life cycle; (2) Determining the spatial footprint of roads on vegetation; (3) Developing mitigation strategies for reducing the mining footprint on plant biodiversity over the mine life cycle. A number of mines in Abitibi and Nord-du-Québec in different stages of the mine life cycle (operation to post-restoration monitoring) will be examined in the first chapter of this project. Permission from mining companies to access the land has been obtained for four mines (two operating: Casa Berardi of Hecla Québec, LaRonde of Agnico Eagle, two closed/restored Joutel, and Lapa of Agnico Eagle) and permission will be pursued for two additional sites. Using a stratified selection process, eight parallel transects perpendicular to each mine periphery will be established through different types of ecosystems (coniferous vs deciduous forest vs wetlands) and adjacent to different types of sectors (e.g. buildings, tailings impoundments). Three control transects will be established through undisturbed areas with similar ecosystems, in the same region as each mine using random starting points. Vegetation composition (frequency of vascular plant, bryophyte and lichen species) will be determined in 25m^2 plots (5x5m) along the transects at increasing distances (i.e. 0, 20, 50, 100, 200, 500m, 1km) for a total of 462 plots. Plots will be assigned to an ecosystem type. A modified version of the Newmaster et al. (2005) habitat sampling method will be used. Samples of bryophytes, lichens and *Carex* spp. will be collected for identification in the lab, with support from research assistant Arseneault. A similar sampling design will be used in chapter 2, as twelve 1km sections of roads (two per mine) will be selected using available GIS information, to stratify for access roads of different ages and traffic intensities, and crossing different types of ecosystems (coniferous vs deciduous forest vs wetlands). In each 1km long section, 200m transects parallel to the road at different distances (i.e. 0, 20, 50, 100, 200, 500m, 1km) will be established starting from a randomly chosen point. Six plots (25m^2, for a total of 504 plots) will be randomly established along each transect and the composition of the vegetation will be determined as above. Data will be analysed similarly in chapters 1 and 2, with determination of changes in community composition, including relative abundance of specialist, generalist and invasive species as a function of distance from the mine/road, ecosystem type and characteristics of the mine/road (e.g. buildings vs. tailings impounds or high vs low traffic density) using mixed models. Finally, the results of the first two chapters and the results of MSc 1 will be integrated to propose mitigation strategies in chapter 3.

MSc 1: Spatial footprint of particulate pollutants around active and restored mines: bryophyte growth and bioaccumulation. (Direction: Fenton, Plante) (Years 2-4; Milestones 1,8,10,20) In contrast to

PhD 1, which has a broad community composition perspective including multiple taxa, this MSc project will focus on the impacts of particulate pollution on a single bryophyte species, *Pleurozium schreberi*, one of the most common species in the boreal and widely used in bioaccumulation studies (Onianwa 2000, Fernández et al. 2015). The objective is to determine how the interaction between distance from point source, ecosystem type, and mine life cycle stage influence the spatial extent of particulate pollution (arsenic, lead, copper and zinc) around a point source (mine). European studies suggest that the effects of small point sources do not extend more than 100m, with up to 1km for larger installations, although the exact distance varies with a number of factors including wind, topography and surrounding vegetation (Onianwa 2000, Fernández et al. 2015). Specifically, four mine sites from PhD 1 will be retained (active: LaRonde, Casa Berardi; closed: Joutel, Lapa), six of the established transects will be used and samples will be collected from plots at increasing distances from each point source, approximately 10m, 50m, 100m, 200m, 500m and 1km during the spring. Care will be taken to not place samples close to other point sources (roads, other mines, villages), which should be possible in the relatively sparsely developed region. Samples will not necessarily be established in openings as is recommended in regional monitoring studies (Fernández et al. 2015) but rather in the ecosystem type present in that plot, to determine the effect of the interaction between ecosystem type, distance from source, and mine life cycle stage on metal accumulation. Over 1km from each mine, a reference transect will be established with six sampling plots spaced as above to account for regional variation in particulate pollution, as no studies have yet examined the background levels in our region. Overall, 168 composite 1L samples of *P. schreberi* will be collected following the method in Fernández et al. (2015) and analysed for metal content following Zechmeister et al. (2011). Within each plot the growth rate of *P. schreberi* over 1 year will also be measured, using small plastic markers as has been previously used (Rydgren et al. 2006). These measures will allow us to determine the impact of the accumulated metals on the moss. We anticipate that individual mines will emit different relative amounts of the pollutants. Consequently, we will focus on the spatial extent of the pollutants as a whole, rather than focussing on individual metals, although those questions could be addressed in future studies.

MSc2: Using bryophytes to restore mine tailings impoundments: humid sites. (Direction: Fenton, Guittonny-Larchevêque) (Years 1-2; Milestones 4,9) In this project the ability of peatland bryophytes (particularly *Sphagnum* spp.) to grow on humid mine tailings will be determined. The use of bryophytes would represent an advantage as bryophyte dominated peatlands are a dominant part of the boreal landscape, and are thus more natural than agricultural or other species typically used. These pasture species represent the introduction of non-native species into the environment, and as such are a threat to native biodiversity that may increase as the climate warms (Languor et al. 2014). In addition, humid areas of tailings impoundments are difficult to revegetate as the combination of conditions precludes most vascular plants. *Sphagnum* spp. regeneration following peatland exploitation for horticultural peat has been widely studied (e.g. Lamers et al. 2015, Gonzalez and Rochefort 2014). In this project we propose to test some of these findings (e.g. type and thickness of mulch) on the novel basal material of mine tailings that represent a harsh growing environment (salinity, acidity, metals). Growth of *Sphagnum* spp. on mine tailings of the Joutel site will be tested in laboratory in standard columns (6 months) and field settings over 18 months (2 growing seasons), using naturally sourced *Sphagnum* spp. dominated peat. Growth will be assessed weekly in laboratory and biweekly in the field; visually during establishment (development of new shoots) and subsequently with markers on the stem, as previously used by Fenton and others (Rydgren et al. 2006).

MSc3: Economic impact of integrating mitigation strategies for reducing the impact of mine development on plant biodiversity.(Direction: Fenton, Demers)(Years 4-5; Milestones 33,42,46,49,53) This MSc project will apply the proposed mitigation strategies from PhD 1 on model virtual mines inserted into landscapes with different types of ecosystems surrounding them. As the six different mines examined in PhD1 all have different characteristics, we will model the economic impacts (positive or negative) of

integrating the mitigation strategies in different types of mine characteristics, and with landscapes with different proportions of ecosystem types (coniferous vs deciduous forest and wetlands) and distance to trunk roads. Mine characteristics include: dry stack to pulp tailings; in situ vs ex situ mineral processing; different strategies of overburden restoration (revegetation, return to the pit). Specifically, construction and operation data for mines will be obtained from the sites that participated in PhD1 and will be simulated in different landscapes of the Abitibi and Nord-du-Québec regions using ecoforestry maps and GIS software. The cost-benefit balance will be determined by the application of a reclamation cost model developed by UQAT (IRC on mine waste management B. Bussière), to which biodiversity data will be incorporated.

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

While objective 1 develops strategies for mitigating biodiversity impacts, the second objective develops tools for avoiding impacts on biodiversity during mine development. As such, the tools developed here would be used in the second step of the mine life cycle, i.e. planning. Avoiding impacts at this stage has economic, social and biodiversity benefits, as it is less costly to avoid impacts than to mitigate or compensate them. Proactive strategies permit more community participation, and fewer impacts on biodiversity take place.

Ecological planning, which identifies large areas with high geological and topographical diversity (ecoregions), aims to identify sensitive areas and exclude them from resource development (Kier et al. 2005), and results in better conservation of ecosystem services (Cimon-Morin et al. 2015). However, this coarse filter process does not provide information at the fine scale of industrial development. The size and inaccessibility of much of northern Québec, and Canada, preclude field studies of the entire territory that could refine this coarse filter. Consequently, indices that describe the territory based on characteristics that can be mapped from existing and new remotely sensed data are the only practical path for finer scaled development tools. In this objective the IRC candidate and collaborators proposes to develop an index focussing on one broad ecosystem type but including several types of values (biodiversity of plants and animals, and First Nations priorities). Imbeau, and Asselin will each head projects dealing with different aspects of diversity, while Valeria will head aspects associated with remote sensing. This multi-disciplinary team is innovative and will permit the development of concrete and useable geospatial tools as the research team has developed in the past (Henneb et al. 2014, Herrmann et al. 2014, Dhital et al. 2013, Germain and Asselin 2010).

Classifying wetlands using biodiversity and First Nations priorities. (PhD2,3; MSc4,5; PDF1). Northern Québec, particularly north-western Québec, is dominated by wetlands, as it is part of the vast Hudson Bay/James Bay Lowlands, the second largest area of wetlands in the world. These wetlands provide numerous ecosystem services, including fixing carbon, regulating the hydrological cycle and providing habitat for a variety of plant and animal species (Cimon-Morin et al. 2015). As wetlands are omnipresent on the landscape, any development project may either entirely or partially disturb a wetland. In addition to being omnipresent, these wetlands are also variable. They consist of bogs, fens, marshes, swamps and beaver ponds that contain a diversity of species (Warner and Asada 2006). Are these different types of wetlands equivalent in terms of biodiversity and ecosystem services? Should some types of wetlands or wetlands with certain characteristics be prioritised for conservation? While the carbon stocking capacity of northern wetlands has received significant attention (van Bellen et al. 2011), few studies have focussed on their other ecosystem services, including biodiversity.

Another essential element of northwestern Québec is the First Nations that have occupied the territory for thousands of years and who still manage it with ancestral systems (Sayles and Mulrennan 2010, Whiteman 2004). Historically, their perspective was not taken into account when the territory was developed, although the modern treaties changed this trend (Government of Québec, 2012). An example of this is a study on the use of wetlands by Cree using ecosystem services that is currently undertaken by

members of the research team in collaboration with the First Nation of Wemindji, and the mining company Goldcorp in relation to the mine Éléonore (MSc student Bois-Charlebois, co-supervision Asselin, Fenton).

We propose to develop an indicator to classify wetlands based on their value for biodiversity conservation and First Nations' priorities in the black spruce forest of north western Québec. This index will permit ecological planning to avoid impacts on the most important sites, and could also be used to stratify compensation when impacts are unavoidable. The integration of several types of knowledge, and the active participation of stakeholders in the project should increase the usefulness and robustness of the index (Lindenmayer et al. 2015, Fraser et al. 2006).

Common methodology. The project will take place along a south-west to north-east gradient in the traditional territories of Pikogan First Nation in the west, Nemaska First Nation in the north and Mistissini First Nation in the east. This project will be undertaken with several First Nations. Pikogan First Nation is already a research partner of the IRC (see letter of support), and discussions are underway with the Cree Nation Government. Upon approval of the IRC, detailed agreements will be pursued with the two remaining communities. A similar approach was used in the development of Asselin's CRC on aboriginal forestry. Three mining projects (and partners) are also present in each of these sectors, Casa Berardi (Hecla Québec), Whabouchi (Nemaska Lithium), and Renard (Stornoway Diamonds) respectively. Field work in the remote Whabouchi and Renard sectors will be undertaken with the logistic support of the industrial partners (housing and transport), significantly reducing costs and increasing project feasibility. A preliminary classification of wetlands based on ecoforestry maps has already been undertaken (Ménard et al. 2006) using the 3rd decennial forest inventory. This classification divided wetlands into different groups, including bogs, fens, marshes, swamps and beaver ponds. It will be updated to the 4th inventory in this project, including the maps generated from remote sensed data for the northern commercial forestry limit, and it will serve to stratify sampling and ensure that the classification can be extended across the land base. This initial stratification phase will be undertaken by the two PhD students in collaboration with the First Nation and industrial partners, and under the supervision of the academic directors. Plants (vascular, bryophytes, lichens) and animals (birds, amphibians, mammals) in different types of wetlands will be surveyed (PhD2, 3, MSc 4) to determine which types of wetlands are most important for these groups. In parallel the use and importance of different types of wetlands for First Nations will be determined in three communities in the black spruce forest (Pikogan, Nemaska, Mistissini; MSc 5). A PDF will integrate these four student projects in one index, including additional broadly available remotely sensed information (e.g. indices from Landsat 8 indices). The use of the vegetation maps, which are available for the whole land base, will permit the index to be applied to all of the black spruce boreal forest of western Québec. As much as possible field inventories will be carried out on the same sites for different groups to facilitate intergroup comparisons and integration.

PhD 2 and MSc 4: Plant and lichen diversity across wetland types. (PhD 2 Direction: Fenton; Codirection: Bergeron; Advisor: Valeria PhD 2; Years 1-4; Milestones 1,2,5,12,22,23,28,32,39) (MSc 4 Direction: Fenton; Advisor: Valeria; Years 1-3; Milestones 1,5,12,21) Wetlands house a great diversity of plant species, particularly bryophytes as the humid environment permits this poikilohydric group to flourish. Compared to the wetlands of western Canada, (e.g. Belland and Vitt 1995, Locky and Bayley 2006, Doering and Coxson 2010), our knowledge of the plant biodiversity in Québec's boreal wetlands is fragmentary. Furthermore, while it has been demonstrated that wetland conditions and functions are affected by climate dependant factors such as precipitation and fire cycle (Arlen-Pouliot and Payette 2015, Benscoter et al. 2015, Miller et al. 2015, Loisel et al. 2014, Terrier et al. 2013), the link to biodiversity and rare species presence has not yet been investigated at the landscape level. These PhD (vascular plants and bryophytes) and MSc (lichens) projects will determine the species diversity and rare species occurrences in different wetland types across the black spruce boreal forest of Québec. 45 wetlands will be selected based on the ecoforestry map classification, equally divided among ombrotrophic bogs, fens, swamps and beaver ponds, and the three sectors (Casa Berardi, Whabouchi, Renard). Each selected site

will be visited by a three person team (two students plus field assistant) and plant and lichen species will be identified in each site using the floristic habitat sampling method (Newmaster et al. 2005) with a five hour limit. This method is adapted to capture diversity in sites with multiple microhabitats, such as wetlands. Species presence and abundance following Vitt et al.'s relative abundance scale (1995) will be noted. Bryophytes, *Carex* spp. and lichens will be sampled and brought back to the lab for definitive identification. Environmental conditions will be measured to confirm the initial stratification: pH, conductivity, calcium content, peat depth and forest cover. Diversity will be determined at several spatial scales, following Whittaker: site, variation among sites, and territory. The presence of regionally and provincially rare species will also be noted. Analyses in the two projects will focus on the variation in rare species presence and diversity at different spatial scales among the wetland types and in relation to the environmental variables. In addition, PhD 2 will analyse the results of both projects in the context of climate change to determine the relative vulnerability of different wetland types and their biodiversity to climate change in collaboration with Ouranos. The vulnerability of different wetland types to climate change will be modeled using published relationships between variables determined by climate (e.g. fire, precipitation) and wetland processes, including increased pond or flark development with greater precipitation (Arlene-Pouliot and Payette 2015), reduced *Sphagnum* spp. cover under warmer conditions (Miller et al. 2015, Terrier et al. 2013), increased peat growth, and increased hollow or fen development under warmer conditions (Benscoter et al. 2015, Loisel et al. 2014). Spatialized future climate conditions will be generated by Ouranos for the studied landscape using several scenarios and general circulation models (GCMs) will be evaluated, to have a more global view. Using a combined analysis the elements of diversity most at risk due to climate change can be determined and this evaluation included in the final model.

PhD 3: Vertebrate community diversity in small wetlands. (Direction: Imbeau, Codirection: Mazerolle; Advisors: Fenton, Valeria) (Years 1-4; Milestones 1,2,5,11,17,26,36) Wetlands are generally high quality wildlife habitat, however within this group wetlands with small ponds (surface area < 8ha) are particularly important for several animal groups including waterfowl and amphibians, who preferentially select small ponds for breeding (Gibbs and Melvin 1993, Lemelin et al. 2010, Semlitsch et al. 2015). These small ponds are unique habitats as they are too small for lacustrine processes to develop, i.e. thermal stratification and wave exposed banks (Cowardin et al. 1979). Beaver ponds are one of the most abundant forms of ponds in the boreal and are the most frequently used wetland habitat type for many species. Despite the fact that wetlands are abundant in boreal Québec (12.9% of the land base; Pellerin and Poulin 2013) the importance of beaver ponds is still poorly known for this region. Active beaver ponds are particularly productive in terms of vegetation, explaining their selection by waterfowl for reproduction (Nummi 1992, McKinstry et al. 2001, Rosell et al. 2005). Once abandoned by beavers, herbaceous and shrub vegetation attracts many riverbank and forest bird species (Aznar and Desrochers 2008). For amphibians, beaver ponds are of primary importance for the reproduction of toads and frogs (Rosell et al 2005, Stevens et al. 2007). While amphibians are less sensitive to the age of the pond than birds, they do respond to variations in size, as intermediate size tend to be richer as they are less likely to dry out over summer, and are too small to be colonised by fish (Semlitsch et al. 2015). This PhD project will quantify the differences in the bird, amphibian, and mammal communities in different wetland types with ponds (bogs, fens, active and abandoned beaver ponds). Fourty-eight ponds in peatlands (24 bogs, 24 fens) and 48 beaver ponds (24 active, 24 abandoned) will be selected based on classified wetlands from the ecoforestry maps, equally distributed in the three sectors (Casa Berardi, Wabouchi, Renard - 32 ponds per sector). The state of beaver ponds will be verified in the field (active vs abandoned). In each site, digital recorders will record birds (morning) and amphibians (evening) during twenty minutes for five consecutive days, two times over the reproductive season of the different groups (June to August). Mammals will be sampled by adding one camera trap near the pond edge on each site. Species observations (sight and sound) will also be made along a transect when recorders and cameras are installed

and removed from each site to increase observations of species groups that are not captured auditively (e.g. waterfowl, riverbank birds). Playbacks will also be used during transect visits to increase observations of more discrete bird species (Gibbs and Melvin 1993). We will compare species use of ponds by the pond type, pond size, and depth using dynamic occupancy models (MacKenzie et al. 2003).

MSc 5 Aboriginal use and valorization of wetlands. (Direction: Asselin; Codirection: Fenton; Advisor: Valeria) (Years 2-3; Milestones 6,13,15,18,29,35) Wetlands are an important part of boreal ecosystems, particularly in the western boreal forest of Québec. This territory is used by Cree, Atikamekw and Anicinapek communities that obtain ecosystem services essential for their subsistence and the preservation of their way of life and culture. However, most studies on land use have focussed on forest ecosystems and the variability of ecosystem services provided by wetlands has not yet been documented (Germain 2012, Jacqmain et al. 2008). For a stratification index of wetlands to be pertinent from both a biological and social perspective, it is important to include First Nations' perspectives. The ecosystem services concept allows us to consider the interface between ecological and social systems and will be used in this project to integrate First Nation's priorities into the stratification index (Ndione 2014, MEA 2005). Different users of the territory from the three target nations who are recognised for their knowledge of the territory and wetlands will be interviewed. Interviews will take place on the land whenever possible, in order to facilitate interaction between participants and the researchers and increase the amount of information collected (Huntington 2000). Discussion groups will also be held on a regular basis to validate the interpretation of the results and to collect additional information, by presenting community members with syntheses of the results (Asselin and Basile 2012). Photographs and maps will also be used during the discussion groups to stimulate discussion and spatialize the information (Stedman et al. 2004). These discussion groups will be a key element in establishing a hierarchy of different wetland types on the basis of ecosystem services and other criteria (e.g. accessibility, relative abundance, size).

PDF Developing an integrated index for wetlands. (Codirection: Fenton, Imbeau, Asselin, Valeria) (Year 4; Milestones 30,41,44,47) Once the data indicating the relative biodiversity and aboriginal interest of different wetland types are available (i.e. the results of PhD 2, PhD 3, MSc 4, and MSc 5), a post-doctoral fellow will integrate them into a common index that will also include widely available remote sensing data, such as derived indices from Landsat (e.g. NDVI, wetness index). The integration of data from several different projects into a meaningful and useful index is challenging (Lindenmayer et al. 2015, Fraser et al. 2006). However, integrating and combining different types of information cross validates the results of all the studies (Liedloff et al. 2013, Davis and Ruddle 2010), and offers a more complex view of a difficult concept of "ecosystem value" required for priorization (Lindenmayer al. al. 2015). The PDF will evaluate several methodological approaches, including Bayesian modelling (e.g. Lliedloff et al. 2013, Kuhnert et al. 2010), a conservation planning approach (e.g. the program Marxan, Ball et al. 2009), or a simpler composite method (e.g. Asselin et al. 2015, Jacqmain et al. 2012). The different methods will be evaluated on their ability to generate a meaningful index that both faithfully transmits the different types of information, and is easily understood and used by stakeholders (i.e. industrial, government, and aboriginal partners).

Objective 3 (Long term): Vulnerability of key species for Aboriginal communities to cumulative impacts (PhD 4) (Direction: Fenton; Codirection: Tremblay, Asselin) (Years 3-5; Milestones 16,27,31,37,43,45,48,50,51,52) Aboriginal communities have clearly identified the cumulative impacts of development and climate change as one of their main concerns (Cree Trappers Association (CTA), 2011). In this objective we propose to evaluate the vulnerability of key plants species, or cultural keystone species (Uprety et al. 2012, Garibaldi and Turner 2004) using species habitat and climate requirements and genetic population structure as factors and ecosystem service production (Ndione 2014, MEA 2005) as the response variable. Plants with small effective population sizes (Ne) that are highly differentiated are expected to be less resilient to climate change and as individual populations represent significant portions

of their total genetic diversity. In collaboration with First Nations partners, an approach based on integrating traditional ecological knowledge (TEK) and plant functional traits will be used to identify two species for detailed study. Of species previously identified as having reacted to climate change, two will be chosen that have contrasting functional traits, such different pollination mechanisms. As this project will be developed in collaboration with participating communities details on selection criteria have not yet been determined. The vulnerability of the chosen species (i.e. their continued ability to provide the ecosystem services identified by community members) will be determined taking into account climate change, actual and potential habitat loss due to climate change and development and their genetic diversity or structure. In order to achieve this ambitious goal, species' habitats, including climate envelopes, will be determined by a combination of techniques (e.g. literature search, modelling and TEK) and modelled across the landscape, and into the future, including climate shifts and future developments. Population genetic structure will be determined by analysing samples collected from across the landscape, in conjunction with First Nations partners. Ecosystem service production will be measured across the landscape in different habitat types and climates. Ecosystem service production will be modeled as a function of habitat, and will be projected into the future, including the effects of climate change and development. Results will suggest groups of species, based on the functional traits, which should be considered particularly vulnerable to cumulative disturbances, including climate change.

Proposed collaborations:

The research programme of the proposed industrial chair is inherently interdisciplinary, as the IRC program integrates different aspects/perceptions of biodiversity into the development of industrial projects, with a focus on projects in the Eeyou Istchee James Bay Region. As such, several university collaborators are included in the proposal and their involvement is assured via their roles as directors, co-directors and scientific advisors of the student projects. The diverse expertise of the different university researchers involved will ensure that the broad mandate of the chair can be fulfilled. The following table summarizes the different contributions of the chair candidate and the different collaborators. In addition to these established and new collaborations, the IRC will provide a platform to include researchers across Canada in projects.

Name	Position/Institution	Speciality	Contribution to the Chair
Nicole Fenton	Professor*, IRF†-UQAT	Bryophyte and vascular plant ecology and conservation, sustainable development	Direction MSc 1, 2, 3 & 4; Codirection MSc 5; Direction PhD 1, 2 & 4; Advisor PhD 3; Direction PDF 1
Hugo Asselin	Professor, CRC(2), ‡UQAT	Aboriginal Forestry and forest ecology	Direction MSc 5; Codirection PhD 4; Co-direction PDF 1
Yves Bergeron	Professor, CRC(1), IRF†-UQAT	Disturbance and landscape ecology; applied ecology	Codirection PhD 2, Advisor PhD 1, PhD 4
Isabelle Demers	Professor CRC(2), RIME§-UQAT	Integration of the environment into mine life cycle planning	Codirection of MSc3; Advisor PhD 1
Louis Imbeau	Professor, IRF†-UQAT	Wildlife management	Direction PhD 3; Codirection PDF 1
Marie Guittonny-Larchêveque	Professor, RIME§-UQAT	Revegetation of mine sites	Codirection MSc 2, Advisor MSc 1
Marc Mazerolle	Assoc. Professor, Université Laval	Herpetology and conservation biology	Codirection PhD 3

Benoit Plante	Professor, UQAT	RIME§-	Environmental impacts of mine tailing	Codirection MSc 1
Francine Tremblay	Professor, UQAT	IRF†-	Plant genetics	Codirection PhD 4
Osvaldo Valeria	Professor, UQAT	IRF†-	Remote sensing, management tool development	Advisor PhD 2, 3, MSc 3, 5 and Codirection PDF 1

* Currently on a short term contract to develop the industrial chair.
† Forest Research Institute (Institut de recherche sur les forêts)
‡ Department of human and social development and Canada Research Chair in Aboriginal Forestry
§Research Institute on Mine and Environment (Institut de recherche en mines et en environnement)

In addition, as this chair is developed with the explicit goal of inclusiveness of different visions, a variety of First Nations, industrial and government partners will also be involved in the research program. Research on First Nation's territories or involving First Nation's members will not take place without support from the band, and a signed research agreement. Partnerships with actors from First Nations have been/are being developed. Confirmed First Nations partners include Benoit Croteau (Abitibiwinni First Nation). The Cree Nation Government has expressed their support for the project and discussions are underway. Upon approval of the IRC, detailed agreements will be pursued. Partnership implies respecting First Nations priorities, and the co-development of detailed work plans and hypotheses, field work, results interpretation and presentation, and output validation, as well as ownership of the information by the source community (Asselin and Basile 2012). Industrial partners (mining companies and Ouranos) will also participate actively in the project, through development of the proposed projects, mentoring of Mitacs interns, cash and in kind contributions to field work, data sharing, as well as results interpretation and output validation. Finally, as this project interacts with several laws and certifications, governmental partners are vital for results to be actively applied on the landscape within a reasonable delay. As such research partners from the Ministry of Sustainable Development, the Environment, and the Fight against Climate Change (regional Michel Larose, and national branch Frédéric Poisson) and the Ministry of Forest, Wildlife, and Parks (Sonia Légaré) are also involved via project development, in-kind contributions and output validation. The impact of research finalities is expected to result in reduced biodiversity loss from both a western science and First Nation's perspective, and reduced mitigation and compensation costs for industrial partners. Government partners will gain planning tools and guidelines.

Research management:

Within UQAT, the day to day management of the research program will be undertaken by the candidate chairholder, with the participation of the UQAT research collaborators for their individual projects, and administrative support (see research management budget justification). The part-time research assistant (Julie Arseneault, MSc.) will help the candidate chairholder and UQAT collaborators manage the multiple projects, by training students in field techniques, offering support during the field seasons, training students in cryptogam (bryophyte and lichen) and vascular plant identification, and maintaining the equipment and facilities necessary for this type of research. Maintaining the resources necessary to identify bryophytes and lichens requires considerable time and effort, and it would be difficult for the chair candidate to accomplish this as well as conduct an ambitious research programme. Since the completion of her MSc in 2013 (Co-Direction Fenton), Arseneault has been working as a research assistant in the candidate's lab on a part-time basis (7-9 months per year). With this and her previous experience, she has developed significant expertise in bryophyte identification, field techniques, and field crew and lab management.

The explicit inclusion of all parties (industry, First Nations, governments) in the development of the research program and in the research management is innovative. In addition to participation in specific student projects, several tools will be used to ensure efficient communication between the university researchers and partners from other disciplines. In order to ensure that partner organisation perspectives are taken into account we will form two committees: orientation and strategic. The orientation committee is composed of all industrial, governmental, First Nations partners, and university collaborators. The orientation committee will oversee the activities of the chair, including general orientations and approval of the annual research and financial reports. It will meet at least once per year, and it will coincide with student presentations to illustrate research program progress and offer important technology transfer opportunities and student training opportunities. The strategic committee will be made up of a minimum of two industrial partners, a representative of each of the Ministries of Sustainable Development, the Environment, and Climate Change and Forest, Wildlife, and Parks, a minimum of two First Nations partners, two collaborating university professors, two graduate students at the chair and the chairholder (minimum total 11). The strategic committee develops the annual research and financial reports for approval by the orientation committee, and will advise the chairholder on strategic orientations.

Training of highly qualified personnel:

The proposed IRC includes five MSc students, four PhD students, 1 PDF and eight undergraduate summer students. The graduate students will each be responsible for a research objective, while the undergraduate students will be field assistants. As such it makes a considerable contribution to the training of HQP in this field. The students will be enrolled in the Master's in Boreal Ecology (UQAT) and the Doctorate in Environmental Sciences (UQAM-UQAT-UQAR-UQTR) and will be members of the Institute for Forest Research and the Mine and Environment Research Institute of UQAT. As such they will benefit from the multi-disciplinary environment created by these dynamic research groups (seminars, conferences, presentations).

Students will benefit from specific opportunities associated with the proposed IRC. All student members of the chair will be included in the orientation committee and will present progress reports at the annual meeting. This meeting will be organised in an informal way in order to encourage interaction between First Nations, industrial and government partners and students. In addition the students will choose two representatives to sit on the strategic committee. These students will be active members of this committee and will therefore be able to enhance their skills in research management and to better understand the perspectives of different collaborators. In addition to these formalised interactions, each student project is undertaken in collaboration with at least one collaborator from industry and/ or government. As such, they will have greater contact with these partners and will stimulate discussion of detailed project objectives and methodology to reach project goals with them. As a consequence of these training opportunities graduates from the proposed chair will have a solid understanding of the mechanics of collaborative, applied research in a multi-disciplinary context.

All students (undergrad to doctoral) will benefit from a collaborative research group in which students are encouraged to help, and learn from each other's projects. Specifically PhD students are encouraged to mentor MSc students, and both have the opportunity to mentor undergraduates. All graduate students undertake significant research projects that lead to Master's and PhD theses, and published articles (1-2 for Master's students and 3-4 for PhD students). The chairholder will mentor the students at all stages of their research projects (proposal, methodology preparation, field work, identification, analyses, manuscript preparation and submission). Students will be encouraged to apply for scholarships and prizes, and to present their work. PhD students are expected to work more independently than Master's students. All students are expected to write article based theses, and students who write articles are always first author.

Summer undergraduate students will be encouraged to apply for NSERC undergraduate fellowships, and to complete their own research project, under the supervision of the graduate student and the candidate. When possible these projects will be published as well.

In addition to these disciplinary skills, students will be encouraged to develop "key professional skills" as identified by both the STLHE (Society for Teaching and Learning in Higher Education), and CAGS (Canadian association of graduate students) to promote a rapid integration into different work environments. As condensed by the CAGS these professional skills are: Communication Skills, Management Skills, Teaching and Knowledge Transfer Skills, and Ethics. Students develop these skills by participating in a wide variety of conferences, including non-academic ones and international scientific meetings, managing field work budgets and personnel (under supervision), writing articles for professional publications (e.g. Couvert Boréal, Quatre-Temps), and supervising undergraduate student projects.

Value of the research results and benefits to Canada:

The research program of the proposed chair was developed in discussion with industrial, government and First Nation partners, as is indicated by the association of partners with different research projects. As such research results will be highly valuable to the partners and will permit them to improve either their industrial planning and management or co-habitation on the territory. Specific examples include (1) the development of mitigation techniques for impacts beyond the mine site, including a cost and savings analysis. We anticipate that these results will permit industrial partners to reduce impacts on biodiversity and potentially reduce costs associated with restoration. (2) The development of a georeferenced tool to determine relative wetland value based on biodiversity and First Nation's priorities. This tool made up of multiple GIS layers will permit detailed understanding of the relative value of individual sites across the landscape. These relative values can then be used in the planning process to evaluate different development (or conservation) scenarios, and to determine the relative size of compensation required for the loss of different sites. (3) A vulnerability analysis for two culturally important species. This analysis will orient future actions in terms of adaptation and mitigation to climate change impacts, and the theoretical basis underlying the project will provide guidelines for future studies.

Mining is one of Canada's most important industries. While mining has been a key industry for decades, the public perception of this industry has shifted over time; once based on the well paid jobs in relatively remote regions, the focus has now been on the environmental and social impacts that this industry generates throughout its life cycle and after mine closure. The mining industry has been modifying its practices to be more socially and environmentally responsible. This project aims to reduce the environmental impacts of mineral exploration, extraction and processing operations, to increase social acceptability of project developments, and to increase the potential for harmonious and responsible development projects in the future.

Rapport d'avancement

présenté au
Comité stratégique de la

Chaire industrielle
CRSNG - UQAT
sur la biodiversité en
contexte minier

4 OCTOBRE 2018

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Crédits photos: Équipe de la Chaire, Pixabay

UQAT
INSTITUT DE RECHERCHE
SUR LES FORÊTS

Avancement par objectif

Mise en contexte

Ce rapport résume les avancements de la Chaire suite à la saison de terrain 2018 et a été préparé pour le comité stratégique de la Chaire industrielle CRSNG - UQAT, dans le cadre de la rencontre du 4 octobre 2018. Il reprend, en grande partie, le contenu présenté au CRSNG dans le cadre des suivis exigés.

Objectif 1

Objectif 1

Réduire l'empreinte écologique des mines sur la biodiversité pendant leur cycle de vie complet

Ph.D. 1 - Déterminer l'empreinte spatiale des mines sur la diversité végétale: intégrations des impacts énigmatiques et du cycle de vie des mines

Pour le projet de doctorat (Ph.D. 1) « *Determining the footprint of mines on plant diversity: integrating enigmatic impacts and the mine life cycle* », un étudiant, Xiangbo Yin, a été recruté et est arrivé en juin dernier. Il travaille actuellement sur sa proposition de projet. Par contre, des données ont été récoltées pendant l'été 2017 par l'associée de recherche (Arseneault) autour des mines LaRonde et Lapa. La collecte de données continuera pendant les étés 2019 et 2020. À terme, ce projet permettra de mieux comprendre et connaître l'empreinte réelle sur les communautés végétales des mines, et ce, à différents stades de leur cycle de vie.

Bilan de terrain 2017

Nbr placettes	Sites miniers	Nbr jours
58	LaRonde – Agnico Eagle	8
49	Lapa – Agnico Eagle	0

M.Sc. 1 - Empreinte spatiale des polluants particulaires autour des mines actives et restaurées - Croissance et bioaccumulation des bryophytes

Le projet de maîtrise (M.Sc. 1) intitulé « Empreinte spatiale des polluants particulaires autour des mines actives et restaurées - Croissance et bioaccumulation des bryophytes » a été transformé en projet de postdoctorat (Dre Jean). L'échantillonnage a commencé en 2017 avec 4 sites miniers (Laronde, Lapa, Akasaba, Joutel) pour un total de 197 échantillons collectés le long de 28 transects (incluant les témoins). Les premières extractions des métaux lourds, issus des

mousses séchées et broyées, ont été complétées avec succès dans le laboratoire de Dr Benoit Plante à l'IRME.

L'information obtenue par ce projet fournira de nouvelles données quant à l'étendu et la distribution des poussières. Toutes ces informations pourront ensuite être intégrées dans les évaluations environnementales des projets miniers afin de mieux prendre en compte ces impacts et ainsi, mieux les mitiger. Intégrer ces informations à la planification est le sujet du projet M.Sc. 3 (*Economic impact of integrating mitigation strategies for reducing the impact of mine development on plant biodiversity*) qui sera recruté en 2020.

Bilan de terrain 2018

Nbr de placettes	Sites miniers	Période	Nbr de jours
49 (7 transects)	Lapa - Agnico Eagle	12-15, 27 juin, 9 juillet	7
57 (8 transects)	LaRonde - Agnico Eagle	18-29 juin	8
49 (7 transects)	Joutel - Agnico Eagle	3-6 juillet, 13-15 juillet	7
42 (6 transects)	Akasaba Ouest - Agnico Eagle	10-13 juillet, 9 août	5

M.Sc. 2 - Utilisation des bryophytes pour la restauration de sites miniers humides

Le projet M.Sc. 2 intitulé « Utilisation des bryophytes pour la restauration de sites miniers humides » est très avancé. Les dernières collectes de données sur le terrain ont été effectuées à l'été 2018. Dave Tremblay, étudiant attitré à ce projet, compte déposer son mémoire au cours de l'automne 2018. Ce projet analyse l'utilité de transférer des résidus de matière organique perturbée (andains forestiers) produits par l'industrie forestière vers des sites miniers pour favoriser la végétalisation. Quelques modifications ont été apportées à ce projet depuis la demande de subvention. Les essais en laboratoire n'ont pas été effectués et ont été remplacés par des expériences in situ, avec l'installation de dispositifs sur le site minier de

Joutel au printemps 2016. Huit placettes de 2 m par 2 m ont été installées dans 2 secteurs humides du parc à résidus miniers de Joutel, 4 dans la zone neutre et 4 dans la zone acide. Un 30 cm de matière organique a été installée et a été récoltée dans un secteur de déblaiement d'hiver à 50 km du site minier. L'évolution du CO_2 dans les 8 placettes, ainsi que l'évolution dans la couverture végétale ont été suivies depuis 2016, et ce, deux fois par année. Les résultats démontrent que, dans la zone neutre, l'ajout de la matière organique permet une revégétalisation à plus de 50 % après deux ans et que cet ajout n'augmente pas les émissions de CO_2 du parc à résidus miniers. Par contre, dans la zone acide, il y a eu un développement végétal de courte durée (~18 mois), suivi d'une régression et d'une perte de matière organique. Ces données sont très intéressantes parce qu'elles suggèrent une potentielle synergie entre deux industries importantes de la Jamésie, qui pourrait avoir peu d'effet sur le bilan de carbone des opérations

Bilan de terrain 2018

Nbr de placettes	Jours de terrain
4	5

Nouveaux projets

L'ajout de Canadian Malartic comme partenaire à la Chaire industrielle (IRC) a permis d'ajouter 4 projets à l'objectif 1, soit les projets Ph.D. 5, M.Sc. 6, M.Sc. 7 et M.Sc. 8.

Ph.D. 5 - Importance régionale des parcs à résidus miniers pour la biodiversité des plantes

Ce Ph.D. n'est pas encore commencé puisque la Chaire est actuellement à la recherche d'un étudiant prometteur pour ce projet ambitieux.

M.Sc. 6 - Relations spatiales des plantes et des mycorhizes sur un parc à résidus miniers

Le projet MSc 6 cherchera à analyser comment les arbres colonisent les parcs à résidus miniers et a débuté cet été. Avec ce projet, de nouvelles collaborations ont pu être concrétisées avec d'autres professeurs. Dr Philippe Marchand, spécialisé en statistique spatiale et qui a récemment joint l'équipe de chercheurs de l'IRF-UQAT, ainsi que deux professeures de l'Université Paul Sabatier (Toulouse, France), Dres Mélanie Roy et Monique Gardes, spécialisées dans l'analyse génétique

des mycorhizes, travailleront sur ce projet. Une bourse Samuel de Champlain (FQRNT), qui concrétise la collaboration entre l'UQAT et l'Université Paul Sabatier, a été obtenue et finance le séquençage des mycorhizes, financement qui devait initialement provenir de la Chaire du Dr Yves Bergeron (Chaire en aménagement forestier durable). Des travaux sur le terrain ont été effectués en 2018 pour caractériser la distribution spatiale des espèces d'arbres dans le site minier Beattie à Duparquet. Les analyses spatiales seront effectuées par un de Master 1 (de France, mais en stage au Québec) au printemps 2019. Un étudiant à la maîtrise (M.Sc. 6), Supun Madhumadhawa, a été recruté et commencera ses travaux en janvier 2019. Il fera l'échantillonnage de mycorhizes à l'été 2019 et les analyses à Toulouse en 2020 pour comprendre le rôle des mycorhizes dans la colonisation des résidus miniers par les arbres.

Bilan de terrain 2018

Site	Jours de terrain
Beattie, Duparquet	7

M.Sc. 7 - Importance régionale des parcs à résidus miniers pour la sauvagine en comparaison avec des étangs à castors

Le projet M.Sc. 7 a démarré cet hiver avec l'arrivée de l'étudiante Émilie Desjardins. Plusieurs observations d'ornithologues amateurs font état de la présence d'espèces rares ou peu communes de sauvagines, dont le cygne trompette, dans des étangs miniers. Ce projet cherche donc à analyser la présence de cette sauvagine dans les sites miniers. Cet été, Émilie Desjardins a pu sélectionner 15 sites miniers et 39 sites témoins (étangs à castor actifs et inactifs) pour ses suivis et a démarré les observations ainsi que la prise d'échantillons liés aux conditions d'habitats, notamment des échantillons d'eau. Jusqu'à présent, elle a pu démontrer qu'une diversité d'espèces de sauvagines utilisent les étangs miniers et que ce phénomène n'est pas limité aux quelques sites connus des ornithologues. En 2019, Émilie continuera sa collecte de données sur les oiseaux et sur les caractéristiques des étangs qui pourraient expliquer les patrons qu'elle observe.

Bilan de terrain 2018

Nbr de sites inventoriés	Jours de terrain
15 sites miniers: Preissac A, Aldermac, Stadacona, Darius (O'Brien), Terrains Aurifères, East Sullivan, Bouchard-Hébert -Nyrstar, Lac Herbin - QMX Gold, Norbec - First Quantum Minerals, Camflo - Monarques Gold, Westwood - Iamgold, Joutel - Agnico Eagle, Yvan Vézina - Iamgold, Aumaque - Eldorado Gold, Beacon - Monarques Gold	2 jours par site minier
39 sites témoins	37 jours au total

M.Sc. 8

Le dernier projet à avoir été ajouté à cet objectif (M.Sc. 8) devait étudier la transplantation d'une espèce qui est régionalement rare pour éviter la perte d'une population en raison du développement minier. Ce projet était prévu pour les années 4 et 5 de l'IRC mais il sera transformé. En effet, le partenaire industriel (Canadian Malartic) a informé Dr Nicole Fenton que l'espèce rare en question avait été mal identifiée et qu'elle ne se trouve pas sur son site. Des discussions ont donc lieu avec les partenaires pour établir un autre projet.

Objectif 2

Cet objectif cherche à comprendre la distribution de la biodiversité des milieux humides sous plusieurs angles en Eeyou Istchee Baie-James. Un deuxième aspect de ce projet est l'effet des changements climatiques sur ces milieux et cette biodiversité. Pour assurer ce volet, une demande Mitacs, en association avec le consortium Ouranos, a été obtenue pour la bourse du Ph.D. 2 en novembre 2017.

Une première étape dans ce projet est la classification des milieux humides par type de milieux (p. ex. : tourbière ombrotrophe et minérotrophe), selon la classification utilisée par le MFFP. Cette tâche devait être réalisée par un postdoctorant. Par contre, Dr Djamai, qui avait été recruté pour ce mandat, a eu un poste au gouvernement fédéral et n'a pas pu effectuer cette tâche. La firme de consultation (Forchemex) a été embauchée pour effectuer cette classification dans des rayons de 50 km autour des 3 sites miniers ciblés dans cet objectif (Casa Berardi, Whabouchi, Mine Renard), et ce, pendant l'hiver 2018. En janvier 2018, 3 étudiants ont été recrutés pour mener les projets Ph.D. 2, Ph.D. 3 et M.Sc. 4. Le terrain a débuté en 2018.

Ph.D. 2 et M.Sc. 4 Analyse et modélisation des dynamiques des communautés de lichens, bryophytes et trachéophytes des milieux humides du nord-ouest du Québec

L'étudiant Marc-Frédéric Indorf (Ph.D. 2) mène le projet qui porte sur la biodiversité végétale intitulé « Analyse et modélisation des dynamiques des cortèges de bryophytes et trachéophytes des milieux humides du nord-ouest du Québec ». L'étudiante Tana Route (M.Sc. 4), s'attarde aux lichens présents dans ces milieux avec le projet intitulé « Les lichens et les communautés de lichen des tourbières en Eeyou Istchee Baie-James : biodiversité et facteurs environnementaux déterminants ». Avec leurs aides de terrain, ils ont fait 3 mois de terrain dont un mois à chaque installation minière. Les étudiants sont maintenant dans l'identification de leurs échantillons récoltés dans 37 sites échantillonnés et préparent une courte saison de terrain (~1 semaine chaque) pour

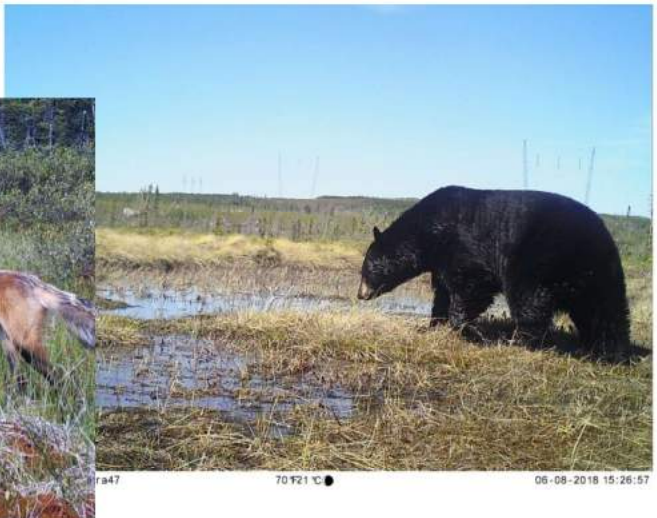
compléter leurs données en 2019. Le comité de suivi Ouranos a également été formé pour le projet de Marc-Frédéric Indorf et la première réunion s'est tenue en septembre 2018.

Bilan de terrain 2018

Nbr sites	Sites miniers	Communautés	Période	Nbr jours
13	Casa Berardi - Hecla Quebec	Pikogan - communauté algonquinne	29 mai au 24 juin, 28-30 août	25
12	Whabouchi - Nemaska Lithium	Nemiscau - communauté crie	6-27 juillet	22
12	Mine Renard - Stornoway Diamonds	Mistissini - communauté crie	2-23 août	22

Ph.D. 3 - Diversité des communautés de vertébrés des milieux humides de petite taille dans le Nord-du-Québec

L'étudiant Mariano Javier Feldman (Ph.D. 3) a démarré son projet qui porte sur la biodiversité des vertébrés pour ces milieux humides, particulièrement pour les petits étangs, très communs dans le paysage d'Eeyou Istchee Baie-James. Sa première saison de terrain de 4 mois a permis de sélectionner 48 étangs, répartis équitablement entre les différents types d'étangs (étangs de castor et étangs de tourbières) et entre les différents sites miniers, eux-mêmes situés le long d'un gradient nord-sud. Mariano procède maintenant à l'analyse des photos et des enregistrements collectés dans ces 48 étangs. Les données sont prometteuses avec plusieurs observations de vertébrés dans les différents étangs. Une deuxième année de terrain est prévue en 2019.



Bilan de terrain 2018

Nbr sites	Sites miniers	Communautés	Période	Nbr jours
16	Casa Berardi - Hecla Quebec	Pikogan - communauté algonquinne	14 au 28 mai	14
17	Whabouchi - Nemaska Lithium	Nemiscau - communauté crie	30 mai au 15 juin	16
17	Stornoway Diamonds	Mistissini - communauté crie	21 juin au 11 juillet	22
16	Casa Berardi - Hecla Quebec	Pikogan - communauté algonquinne	13 au 23 juillet	11
17	Whabouchi - Nemaska Lithium	Nemiscau - communauté crie	24 juillet au 4 août	11
17	Stornoway Diamonds	Mistissini - communauté crie	6 au 15 août	11

M.Sc. 5 - Utilisation et importance des milieux humides par les autochtones et évaluation du stress chez l'orignal à proximité d'exploitations minières en Eeyou Istchee

Le quatrième volet de l'Objectif 2 est une classification de ces mêmes milieux humides selon leur valeur auprès des communautés autochtones. Éliane Grant, étudiante à la maîtrise (M.Sc. 5) a donc été recrutée pour mener ce projet. Elle a réalisé un stage à l'été 2018 au sein de la Chaire et débute sa maîtrise cet automne. Pendant son stage, Éliane a pu participer aux rencontres avec les communautés et discuter avec des maîtres de trappe. Elle a aussi participé à un atelier à Montréal, Mapping Back qui sera pertinent pour son mémoire. Avec l'expertise d'Éliane sur les biocontaminants acquis dans un laboratoire pendant son B.Sc. à Université de Montréal, à laquelle s'ajoutent les observations des maîtres de trappe et celle d'Éliane (étant elle-même chasseuse crie), un volet sur les hormones de stress présents dans les poils des orignaux a été ajouté au projet. En effet, l'orignal est une espèce primordiale pour les communautés qui utilisent les milieux humides de la Jamésie. La *Cree Trappers Association* a été ciblée comme collaboratrice clé pour mener ce projet. Éliane est en rédaction de sa proposition de recherche et les démarches de communication pourront ensuite débuter.

Pour ces quatre projets (Ph.D. 2, M.Sc. 4, Ph.D. 3 et M.Sc. 5), les différentes communautés autochtones impliquées dans chaque secteur ont été rencontrées.

Nicole Fenton, et certains de ses étudiants, ont pu discuter avec des représentants des communautés de Pikogan, de Nemaska et de Mistissini (comité environnement, et Conseil de bande et maîtres de trappes). Le détail de ces rencontres apparaît dans le tableau à la section 3. Ces communications se poursuivent avec les membres des communautés impliquées intéressées par le projet et des visites de terrain devraient être prévues pendant l'été 2019.

Le projet de postdoctorat prévu pour l'intégration de l'ensemble des résultats de classification des milieux humides, tant sur l'aspect de la biodiversité que sur l'aspect autochtone, n'est pas encore débuté puisqu'il dépend des résultats des autres projets nommés ci-haut. Ce projet sera une occasion de mieux comprendre le lien entre la biodiversité et l'utilisation du territoire par les autochtones et les services écosystémiques. En outre, la classification obtenue servira d'outil d'aide à la décision dans l'aménagement du territoire Eeyou Istchee Baie-James.

Ces projets serviront à établir une classification des milieux humides en lien avec leur biodiversité. Ce savoir est d'autant plus important puisque le Nord-du-Québec présente une grande abondance de milieux humides pour lesquels très peu de connaissances existent. En plus du développement prévu dans les prochaines années (Plan Nord), les changements climatiques touchent aussi fortement ces milieux. Il est donc important de mieux comprendre et connaître ces milieux encore relativement peu impactés. De plus, en les classifiant, cela permettra une meilleure prise en compte des milieux les plus riches et les plus critiques en termes de biodiversité.

Objectif 3

Cet objectif se concrétisera par un projet de doctorat (Ph.D. 4 - *Vulnerability of key species for Aboriginal communities to cumulative impacts*) prévu pour les années 3 à 5 de la Chaire de recherche. Ce projet cherche à comprendre l'effet des perturbations cumulatives, incluant les changements climatiques, sur deux espèces clés pour les communautés autochtones. Il se basera sur plusieurs éléments qui seront décrits par les autres projets précédents. Ce projet, qui n'est actuellement pas encore amorcé, a été discuté avec plusieurs représentants des communautés qui ont démontré un vif intérêt. Pendant l'année qui suit, un étudiant au doctorat sera recruté pour ce projet.

Bilan cumulatif

Avec ses différents projets, la Chaire implique plusieurs personnes, particulièrement à l'été avec l'ajout des aides de terrain.

Emploi/étudiants	Nombre	Pourcentage de temps consacré au projet
Professeurs	11	sans objet
Étudiants de premier cycle	1	50
Étudiants à la maîtrise	3	100
Étudiants au doctorat	3	100
Stagiaires postdoctoraux	1	100
Attachés de recherche	1	100
Techniciens	3	50
Agente de liaison	1	33
Étudiants au niveau collégial	3	75
Personnel de soutien administratif	1	20

Transfert, communication et interactions avec les différents intervenants

Dans le tableau ci-dessous et à la page suivante, vous trouverez les principales présentations, publications et couverture médiatique des travaux associés à la Chaire.

Présentations et rencontres	Dates
Fenton, N.J., 2017. Biodiversité du moyen nord et les changements climatiques: nouveau projet qui met l'emphase sur les milieux humides. *Invited presentation annual conference Ouranos Consortium.*	Novembre 2017
Présentation au comité environnement de la Mine Renard, Mistissini	Octobre 2017
Conférence de presse de lancement de la Chaire industrielle CRSNG-UQAT sur la biodiversité en contexte minier	27 mars 2018

Présentation lors du comité d'orientation de la Chaire industrielle CRSNG-UQAT sur la biodiversité en contexte minier	27 mars 2018
Présentation au comité environnement de la Mine Whabouchi, Val-d'Or	Avril 2018
Présentation au Colloque annuel du CEF par Dave Tremblay	30 avril 2018
Présentation à la communauté de Nemaska, Nemaska	Mai 2018
Présentation au département développement socio-économique et environnement Conseil de la Première Nation Abitibiwinni, Pikogan	Mai 2018
Séminaire de recherche de l'IRF, présentation du mémoire de Dave Tremblay	22 mai 2018
Présentation au Conseil de bande de Mistissini, Mistissini	Juin 2018
Présentation aux maîtres de trappe de Mistissini, Mistissini	Juin 2018
Proposition de projet de doctorat par Marc-Frederic Indorf	6 septembre
Présentation au comité de suivi Ouranos	6 septembre
Présentation au Forum Régional sur les changements climatiques, Eastmain	Novembre 2018
Présence médiatique et autres publications	
Couverture médiatique lors du lancement de la Chaire (Communiqué émis, repris notamment par Radio-Canada, Le Citoyen)	27 mars 2018
Entrevue avec Éliane Grant sur les ondes de Radio-Canada	9 juin 2018
Page Web de la Chaire sur le site de l'UQAT (en développement)	En cours
Article dans le journal Le Citoyen, projet de Dave Tremblay	28 août 2018
Article sur la Chaire dans la revue « Le Couvert Boréal » de l'Association forestière de l'Abitibi-Témiscamingue (AFAT)	Automne 2018

Merci à tous les partenaires de la Chaire industrielle CRSNG – UQAT sur la biodiversité en contexte minier

CRSNG NSERC

Hecla QUÉBEC

MINE CANADIAN MALARTIC

stornoway

NEMASKA LITHIUM

OURANOS

AGNICO EAGLE

Québec

PIKOGAN

Grand Council of the Crees (Eeyou Istchee)
Grand Conseil des Cris (Eeyou Istchee)

Cree Nation Government
Gouvernement de la Nation Crie

Note : *Dans ce document, le genre masculin est utilisé comme générique, dans le seul but de ne pas alourdir le texte.*

Progress Report

presented to the
Strategic Committee
of the

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

OCTOBRE 4TH 2018

Nicole Fenton
Sophie Laliberté

Photo credits: Chair team, Pixabay

UQAT
INSTITUT DE RECHERCHE SUR LES FORÊTS

Advancement by objective

Context

This report summarizes the Chair's progress following the 2018 field season and was prepared for the Strategic Committee of the NSERC - UQAT Industrial Research Chair, as part of the October 4th 2018 meeting. It largely reflects the content presented to NSERC in the 18 month status report.

Objective 1

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

Ph.D. 1 - Determining the footprint of mines on plant diversity: integrating enigmatic impacts and the mine life cycle

For the Ph.D. 1 a student, Xiangbo Yin, has been recruited and arrived last June. He is currently working on his project proposal. Data were collected during the 2017 summer by my research associate (Arseneault) around the LaRonde and Lapa mines. Data collection will continue during the summers of 2019 and 2020. Ultimately, this project will help us to better understand and know the real footprint of mines on plant communities at different stages of their life cycle..

2017 field report

Nbr of plots	Mining sites	Nbr of days
58	LaRonde – Agnico Eagle	8
49	Lapa – Agnico Eagle	0

M.Sc. 1 - Spatial footprint of particulate pollutants around active and restored mines: bryophyte growth and bioaccumulation

The Master's Project (M.Sc. 1) has been transformed into a postdoctoral project (Dr. Jean). Sampling began in 2018 with 4 mining sites (Laronde, Lapa, Akasaba, Joutel) for a total of 197 samples collected along 28 transects (including controls). The first heavy metals extractions, from dried and crushed mosses, were successfully completed in Dr. Benoit Plante's laboratory at IRME.

The information obtained from this project will provide new data on the extent and distribution of particulate pollution around mine sites. This information can then be integrated into the mining projects environmental assessments to better take into account these impacts and thus better mitigate them. Integrating this information into planning is the subject of the M.Sc. 3 project "Economic Impact of Integrating Mitigation Strategies for Reducing the Impact of Mine Development on Plant Biodiversity" to be recruited in 2020.

2018 field report

Nbr of plots	Mining site	Period	Nbr of days
49 (7 transects)	Lapa - Agnico Eagle	June 12th -15th , 27th , July 9th	7
57 (8 transects)	LaRonde - Agnico Eagle	June 18th -29th	8
49 (7 transects)	Joutel - Agnico Eagle	July 3th -6th , 13th -15th	7
42 (6 transects)	Akasaba Ouest - Agnico Eagle	July 10th -13th , August 9th	5

M.Sc. 2 - Using bryophytes to restore mine tailings impoundments: humid sites

The M.Sc. 2 is very advanced. The last field data was collected in the summer of 2018. Dave Tremblay, student leader of this this project, will submit his master's thesis during the fall of 2018. This project analyzes the utility of transferring disturbed organic matter residues (windrows) produced by the forest industry to mining sites to promote revegetation.

Some modifications have been made to this project since the grant request. Laboratory tests have not been performed and have been replaced by in situ experiments, with the installation of test plots at the Joutel mine site in the spring of 2016. Eight 2m x 2m plots were installed in 2 wetland areas of the Joutel mine tailings site, 4 in the neutral zone and 4 in the acid zone. 30 cm of organic matter were installed and harvested from windrows 50km away from the mine site. The CO2 emissions in the 8 plots, as well as changes in vegetation cover were monitored since 2016, twice a year. The results

show that in the neutral zone, the addition of the organic matter allows a revegetation of more than 50% after two years and that this organic matter addition does not increase the CO2 emissions of the tailings. On the other hand, in the acid zone, there was a little plant development (~ 18 months), followed by a regression and a loss of organic material. These data are very interesting because they suggest a potential synergy between two industries in James Bay, which could have little effect on the carbon footprint of operations

2018 field report

Nbr of plots	Nbr of days
4	7

New projects

The addition of Canadian Malartic as a partner to the Industrial Research Chair (IRC) has allowed the addition of 4 projects to Objective 1, namely the Ph.D. 5, M.Sc. 6, M.Sc. 7 and M.Sc 8.

Ph.D. 5 - Regional Importance of Tailings for the plant biodiversity

This Ph.D. is not yet started since the Chair is currently looking for a promising student for this ambitious project.

M.Sc. 6 - Spatial relationships of plants and mycorrhizae on tailings

Le projet MSc 6 cherchera à analyser comment les arbres colonisent les parcs à résidus miniers et a débuté cet été. Avec ce projet, de nouvelles collaborations ont pu être concrétisées avec d'autres professeurs. Dr Philippe Marchand, spécialisé en statistique spatiale et qui a récemment joint l'équipe de chercheurs de l'IRF-UQAT, ainsi que deux professeures de l'Université Paul Sabatier (Toulouse, France), Dres Mélanie Roy et Monique Gardes, spécialisées dans l'analyse génétique des mycorhizes, travailleront sur ce projet. Une bourse Samuel de Champlain (FQRNT), qui concrétise la collaboration entre l'UQAT et l'Université Paul Sabatier, a été obtenue et finance le séquençage des mycorhizes, financement qui devait initialement provenir de la Chaire du Dr Yves Bergeron (Chaire en aménagement forestier durable). Des travaux sur le terrain ont été effectués en 2018 pour caractériser la distribution spatiale des espèces d'arbres dans le site minier Beattie à Duparquet. Les analyses spatiales seront effectuées par un de Master 1 (de France, mais en

stage au Québec) au printemps 2019. étudiant à la maîtrise (M.Sc. 6), Supun Madhumadhawa, a été recruté et commencera ses travaux en janvier 2019. Il fera l'échantillonnage de mycorhizes à l'été 2019 et les analyses à Toulouse en 2020 pour comprendre le rôle des mycorhizes dans la colonisation des résidus miniers par les arbres.

Bilan de terrain 2018

Site	Jours de terrain
Beattie, Duparquet	7

M.Sc. 7 - Regional Importance of Tailings for Waterfowl Compared to Beaver Ponds

The M.Sc. 7 project started this winter with the arrival of MSc student Émilie Desjardins. Several birdwatchers report rare or unusual waterfowl species in mining ponds, including trumpeter swans. This project therefore seeks to analyze the presence of waterfowl in mining sites. This summer, Émilie was able to select 15 mining sites and 39 control sites (active and inactive beaver ponds) for monitoring, and began observations and sampling related to habitat conditions, including samples of water. So far, she has been able to demonstrate that a variety of waterfowl species use the mining ponds and that this phenomenon is not limited to the few sites known to ornithologists. In 2019, Émilie will continue her data collection on birds and pond characteristics that could explain the patterns she is observing.

2018 field report

Nbr of inventoried sites	Nbr of days
15 mining sites: Preissac A, Aldermac, Stadacona, Darius (O'Brien), Terrains Aurifères, East Sullivan, Bouchard-Hébert -Nyrstar, Lac Herbin - QMX Gold, Norbec - First Quantum Minerals, Camflo - Monarques Gold, Westwood - Iamgold, Joutel - Agnico Eagle, Yvan Vézina - Iamgold, Aumaque - Eldorado Gold, Beacon - Monarques Gold	2 days per sites
39 control sites	37 days total

M.Sc. 8

The last project (M.Sc. 8) added to the objectif 1 was to study the transplantation of a species that is regionally rare to avoid the loss of a population due to mining development. This project was planned for years 4 and 5 of the IRC but it will be transformed. In fact, the industrial partner (Canadian Malartic) informed Dr. Nicole Fenton that the rare species in question had been misidentified and is not on its site. Discussions are taking place with the partners to establish another p

Objective 2

This objective seeks to understand the distribution of wetland biodiversity from several angles in Eeyou Istchee Baie-James. A second aspect of this project is the effect of climate change on these environments and this biodiversity. For this objective, a Mitacs application, in association with the Ouranos consortium, was obtained for the Ph.D. 2 fellowship in November 2017.

A first step in this project is the classification of wetlands (eg, ombrotrophic bog and minerotrophic bog), according to the classification used by the MFFP (*Ministère des forêts, de la faune et des parcs)*. This task was to be performed by a postdoctoral fellow. However, Dr. Djamai, who had been recruited for this task, found a position in the federal government and was unavailable to accomplish it. A consulting firm (Forchemex) was hired to perform this classification within 50 km radius around the 3 mine sites targeted for this purpose (Casa Berardi, Whabouchi, Renard Mine), during the winter of 2018. In January 2018, 3 students were recruited to lead the Ph.D. 2, Ph.D. 3 and M.Sc. projects. 4. The field started in 2018.

Ph.D. 2 et M.Sc. 4 Plant and lichen diversity across wetland types

Marc-Frédéric Indorf (PhD 2) leads the project that focuses on plant biodiversity entitled "Analysis and modeling of dynamics of bryophytes and tracheophytes in wetlands of north-western Quebec." Tana Route (MSc 4), focuses on the lichens in these environments with the project entitled "Lichens of peatlands in Eeyou Istchee Baie-James: biodiversity and environmental determinants". With their field assistant, they did 3 months of field work, one month at each mining site and surroundings. Students are now identifying their samples harvested in 37 sampled sites and are preparing a short field season (~ 1 week each) to complete their data in 2019. The Ouranos monitoring committee was also formed for Marc-Frédéric's project and the first meeting was held in September 2018.

2018 field report

Nbr of sites	Mining sites	Communities	Period	Nbr of days
13	Casa Berardi - Hecla Quebec	Pikogan - algonquin community	May 29th to June 24th, August 28th-30th	25
12	Whabouchi - Nemaska Lithium	Nemiscau – cree community	July 6th -27th	22
12	Renard - Stornoway Diamonds	Mistissini – cree communauté	August 2 th -23 th	22

Ph.D. 3 - Vertebrate community diversity in small wetlands

Mariano Javier Feldman (PhD 3) has started his project on vertebrate biodiversity for these wetlands, particularly in small ponds, which are very common in the Eeyou Istchee James Bay landscape. His first 4-month field season resulted in the selection of 48 ponds, evenly distributed among the different types of ponds (beaver ponds and peat ponds) and between the different mine sites, themselves located along a gradient North-South. Mariano is now analyzing the photos and recordings collected in these 48 ponds. The data is promising, with several observations of vertebrates in the different ponds. A second year of field work is planned in 2019.

Bilan de terrain 2018

Nbr of sites	Mining sites	Communities	Période	Nbr jours
16	Casa Berardi - Hecla Quebec	Pikogan – Algonquin community	Mai 14 th to 28 th	14
17	Whabouchi - Nemaska Lithium	Nemiscau –Cree community	Mai 30th to June 15 th	16
17	Stornoway Diamonds	Mistissini – Cree community	June 21 th to July 11 th	22
16	Casa Berardi - Hecla Quebec	Pikogan – Algonquin community	July 13 th - 23 th	11
17	Whabouchi - Nemaska Lithium	Nemiscau – Cree community	July 24 th - August 4 th	11
17	Stornoway Diamonds	Mistissini – Cree community	August 6 th to 15 th	11

M.Sc. 5 - Aboriginal use and valorization of wetlands

The fourth component of Objective 2 is a classification of these same wetlands according to their value to Aboriginal communities. Éliane Grant, Master's student (MSc 5) was recruited to lead this project. She completed an internship in the summer of 2018 in the Chair and began her master's degree this fall. During her internship, Éliane was able to participate in meetings with communities and discuss with tallymen. She also participated in a workshop in Montreal, Mapping Back, that will be relevant for her thesis. With the expertise of Éliane on biocontaminants acquired during her BSc at Université de Montréal, to which are added tallymen and Eliane's observation (being a Cree hunter herself), a section on the stress hormones found in moose hairs was added to the project. Indeed, moose is a very important species for communities that use James Bay wetlands. The Cree Trappers Association has been targeted as a key collaborator for this project. Éliane is writing her research proposal and the communication process with communities will then begin.

For these four projects (PhD 2, MSc 4, PhD 3 and MSc 5), the different indigenous communities involved in each sector were met. Nicole, and some of her students, were able to talk with representatives of the communities of Pikogan, Nemaska and Mistissini (Environment Committee, and Band Council and Trappers). The details of these meetings appear in the table in

section 3. These communications are maintained with the concerned community members interested in the project and field visits should be scheduled during the summer of 2019.

The post-doctoral project planned for the integration of all wetland classification results, both in terms of biodiversity and the Aboriginal values, is not yet started since it depends on the results 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 tool 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 particularly important since Nord-du-Québec has a great number 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 and know these environments, which are still relatively unaffected. Moreover, by classifying them, this will allow to better consider the richest and most critical sites in terms of biodiversity.

Objective 3

This objective will be led by a doctoral project (PhD 4) planned for Years 3 to 5 of the Research Chair. This project seeks to understand the effect of cumulative impacts, including climate change, on two key species for Aboriginal communities. It will be based on several elements that will be described by the other projects. This project, which is not yet started, was discussed with several community representatives who showed a keen interest. During the following year, a doctoral student will be recruited for this project.

Cumulative results

With its various projects, the Chair involves several people, especially in the summer with the addition of the field assistants.

Employees/Students	Numbers	Time percentage spent on the project
Professors	11	NA
Undergraduate students	1	50
Masters students	3	100
PhD students	3	100
Postdoctoral fellowship	1	100
Research Associate	1	100
Technicians	3	50
Liaison officer	1	33
College students	3	75
Administrative support staff	1	20

Transfer, communication and interactions with various stakeholders

In the table below, you will find the main presentations, publications and media coverage of the work associated with the Chair.

Presentations and meetings	Dates
Fenton, N.J., 2017. Biodiversity of the Middle North and Climate Change: A new project that focuses on wetlands. Invited presentation annual conference Ouranos Consortium	November 2017
Presentation to the environment committee of the Renard Mine, Mistissini	Octobre 2017
Press conference launching the NSERC-UQAT Industrial Research Chair on Biodiversity in Mining Context	March 27th 2018

Presentation to the orientation committee for the NSERC-UQAT Industrial Research Chair on Biodiversity in Mining Context	March 27th 2018
Presentation to the Whabouchi Mine Environmental Committee, Val D'Or	April 2018
Presentation at the CEF Annual Conference by Dave Tremblay	April 30th 2018
Presentation to the community of Nemaska, Nemaska	May 2018
Presentation to the Socio-Economic Development and Environment Department Abitibiwinni First Nation Council, Pikogan	May 2018
IRF Research Seminar, Presentation of Dave Tremblay's Brief	May 22th 2018
Presentation to the Mistissini Band Council, Mistissini	June 2018
Presentation to the tallymen of Mistissini, Mistissini	June 2018
PhD project proposal by Marc-Frederic Indorf	September 6th
Presentation to the Ouranos monitoring committee	Septembre 6th
Presentation at the Regional Forum on Climate Change, Eastmain	November 2018
Media presence and other publications	
Media coverage at the launch of the Chair (Communiqué issued, including Radio-Canada, Le Citoyen)	March 27th 2018
Interview with Éliane Grant on Radio-Canada	June 9th 2018
Web page of the Chair on the UQAT website (under development)	Ongoing
Article in the newspaper Le Citoyen, Dave Tremblay's project	August 28th 2018
Article on the Chair in the review "Le Couvert Boréal" of the Abitibi-Témiscamingue Forestry Association (AFAT)	Autumn 2018

THANK YOU TO ALL THE PARTNERS OF THE

CRSNG - UQAT INDUSTRIAL CHAIR ON BIODIVERSITY IN MINING CONTEXT

Grand Council of the Crees (Eeyou Istchee)
Grand Conseil des Cris (Eeyou Istchee)

Cree Nation Government
Gouvernement de la Nation Crie

OBJECTIFS DE RECHERCHE

1. Réduire l'empreinte écologique des mines sur la biodiversité pendant leur cycle de vie complet
2. Éviter le risque pour la biodiversité en développant des outils pour la planification écologique
3. Diminuer les impacts cumulatifs sur les services écosystémiques fournis par la biodiversité

COORDONNÉES

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Titulaire de la Chaire
Institut de recherche sur les forêts (IRF)
Université du Québec en Abitibi-Témiscamingue (UQAT)

445, boul. de l'Université, bureau F-219
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Courriel: nicole.fenton@uqat.ca

Site Web :
https://www.uqat.ca/recherche/chaire-industrielle-crsng-uqat-biodiversite-en-contexte-minier/

Facebook:
Institut de recherche sur les forêts
https://www.facebook.com/irfuqat

UQAT
UNIVERSITÉ DU QUÉBEC EN ABITIBI-TÉMISCAMINGUE

CHAIRE INDUSTRIELLE CRSNG - UQAT

SUR LA BIODIVERSITÉ EN CONTEXTE MINIER

MISSION

La mission de la Chaire est de **générer** et **diffuser** des connaissances sur la biodiversité nordique afin de **développer des stratégies visant à réduire l'empreinte écologique d'une mine tout au long de son cycle de vie**, et ce, dans un contexte de perturbations multiples, y compris les **changements climatiques**, et dans un souci d'inclusion à la fois des **connaissances scientifiques et traditionnelles**

Ces projets vous intéressent? Vous aimeriez être tenus informés des avancements ou y participer ?

Contactez-nous! Toutes les coordonnées se retrouvent au verso

DES PROJETS D'INTÉRÊT

Un des projets de recherche visera à documenter l'utilisation et l'importance des milieux humides en Jamésie par les autochtones à l'aide d'entrevues dans les communautés.

Une évaluation du stress chez l'orignal à proximité d'exploitations minières en Eeyou Istchee sera aussi menée en étudiant la quantité d'hormones de stress dans les poils des orignaux.

Un autre projet cherchera à analyser la vulnérabilité de deux espèces végétales clés pour les communautés autochtones en étudiant l'effet cumulatif des perturbations, incluant les changements climatiques.

Crédits photos: Nicole Fenton, Sophie Laliberté, Marc-Frédéric Indorf, Xiangbo Yin

NSERC CRSNG · OURANOS · Québec · PIKOGAN · stornoway · NEMASKA LITHIUM · Hecla QUÉBEC · MINE CANADIAN MALARTIC · AGNICO EAGLE

RESEARCH OBJECTIVES

1. To reduce the impact of mine footprints by developing strategies to avoid and minimize impacts on biodiversity over the mine life cycle
2. To avoid risk for biodiversity by developing tools for ecological planning
3. To reduce cumulative impacts on ecosystem services provided by biodiversity

CONTACT INFORMATION

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Facebook:
Institut de recherche sur les forêts
https://www.facebook.com/irfuqat

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NSERC-UQAT INDUSTRIAL CHAIR ON

NORTHERN BIODIVERSITY IN A MINING CONTEXT

MISSION

The mission is to increase knowledge creation and dissemination regarding northern biodiversity in order to be able to develop strategies to reduce the impacts of development throughout the mine life cycle on northern biodiversity in the context of cumulative impacts including climate change.

Do these projects interest you? Would like to be kept informed about our progress or to participate in a project?

Contact-us! *All of our contact information is on the back!*

SPECIFIC PROJECTS

One of the research projects aims to document the use and relative importance of wetlands in Eeyou Istchee by First Nations via interviews with members of different communities.

An evaluation of the level of stress experienced by moose near mines in Eeyou Istchee will be carried out by looking at the amount of stress hormones in moose fur.

Another project aims to determine the vulnerability of two key plant species for First Nations by determining the cumulative effects of disturbances including climate change on these plants.

Photos: Nicole Fenton, Sophie Laliberté, Marc-Frédéric Indorf, Xiangbo Yin

NSERC CRSNG OURANOS Québec PIKOGAN stornoway NEMASKA LITHIUM Hecla QUÉBEC CANADIAN MALARTIC AGNICO EAGLE

ᐊᓐ ᐋ ᐃᔑ ᓂᑐᐧᐋᔨᐦᑖᑯᐦᒡ ᒫ ᐃᔑ ᓂᑐᒋᔅᒫᔨᐦᒌᑭᓂᐧᐃᒡ

1 ᒫ ᒌ ᐊᒋᐧᐃᐱᐦᒌᑭᓂᐧᐃᒡ ᐊᓐ ᐋ ᐃᔑ ᑎᒎᐦᑭᐦᐄᒫᐱᔨᒡ ᐅᐦᒋ ᐊ ᒨᓂᐦᐄᒫᓂᐧᐃᒡ ᐊ ᐧᐃ ᐆ ᐧᐋᑎᔅᒌᑭᓂᐧᐃᒡ ᒫ ᒌ ᓂᑳᐦᐄᑲᓂᐧᐃᒡ ᑭᔮᐦ ᒨᒃ ᒫ ᒌ ᐊᒋᐧᐃᐲᐦᒌᑭᓂᐧᐃᒡ ᐊᓐ ᒫ ᐃᔑ ᐅᓈᒋᐦᒌᑭᓂᐧᐃᒡ ᐊᓂᔅᑭᒥᑯ ᐊᔅᒌᐦᒡ ᐊᓂᑎᐦ ᐅᐦᒋ ᐊᒨᓂᐦᐄᒫᓂᐧᐃᒡₓ¸

2 ᒫ ᐧᐃᓂᑳᐦᐄᑭᓂᐧᐃᒡ ᐋ ᐅᓇᒋᐦᒌᑭᓂᐧᐃᒡ ᐊᓂᔅᑭᒥᑯ ᐊᔅᒌᐦᒡ ᐊ ᐅᔑᐦᒌᑭᓂᐧᐃᒡ ᒫᐧᑳᓐ ᒫ ᐊᐱᒋᐦᒌᑭᓂᐧᐃᒡ ᒫ ᐧᐋᑎᐦᐃᑎᓈᓂᐧᐃᒡ ᐊᓂᐦᒡᐅᒋᐦᒫᓂᐧᐃᒡ ᐊᔅᒌᐦᒡₓ

3 ᐧᐃ ᓈᓂᑳᓂᑭᓂᐧᐃᒡ ᑖᓐ ᐊᓐ ᐋ ᐃᔑ ᐅᓂᒋᐦᒌᒥᑭᐦᒡ ᐊᓂᑎᐦ ᒫᐧᑳᓐ ᐊᓂᐦᒡᐅᒋᐦᒡ ᐊᔅᒌᐦᒡ ᐅᐦᒋ ᐊᓐ ᐊᑗᐦᑐᒌᑭᓂᐧᐃᒡ ᒫᐧᑳᓐ ᐊᔅᒌᐦᒡ

ᒫ ᒌ ᐊᔨᒥᐦᐄᑦ

ᓂᐧᑳᓪ ᕓᓐᐧᑖᓐ

ᓈᑳᓂᐱᔅᑎᐦᒃ, ᒋᔅᑯᑎᒫᒫᓯᐤ
ᒥᔅᑎᑯᒡ ᐊᓈᓂᑐᔅᒋᒫᔨᒫᑮᐧᐃᒡ
ᒋᔅᑯᑎᒫᑐᑭᒥᑯᒫᐅᒡ ᐋ ᐃᔅᐹᔨᐦᑖᑯᐦᒡ
ᕈᐊᓐ-ᓈᕋᓂᑖ (ᑯᐸᒃ)

ᒥᐧᑖᐦᑖᐦ : : 819 762-0971 ext 2312
ᑳᒋᓯᐱᔨᒡ : 819-797-4727

ᑯᓭᐱᐦᒋᑭᓂᐦᒡ ᒥᓯᓂᐦᐄᑭᓐ ᐋ ᐃᑎᓯᐦᐄᑭᓂᐧᐃᒡ :
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https://www.uqat.ca/recherche/chaire-industrielle-crsng-uqat-biodiversite-en-contexte-minier/

ᑯᓭᐱᐦᒋᑭᓈᔮᐲ:
https://www.facebook.com/irfuqat/

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ᓈᑳᓂᐱᔅᑎᐦᒃ ᐊᓐ ᐊᑎᒫᐱᓯᓗ ᐃᑖᐦᒫᔅᑭᒥᑯ ᐋ ᐃᔑ ᑎᒑᑭᐦᐄᒫᐱᔨᒡ ᐊᓂᔅᑭᒥᑯ ᐅᐦᒋ ᐊᓐ ᐊᒨᓂᐦᐄᒫᓂᐧᐃᒡ ᐋ ᐃᔑ

ᐊᓐ ᐧᐋᐦᑑᑖᑭᓂᐧᐃᒡ

ᐅᑎᐦ ᐆ ᐧᐋᐦᒋ ᑑᑖᑭᓂᐧᐃᒡ ᐊᑎᑎᐤ ᐋ ᐧᐃᒋᔅᒉᔨᐦᑖᑭᓂᐧᐃᒡ ᑭᔮᐦ ᒫ ᒌ ᒋᔅᒉᔨᐦᑖᑯᐦᑖᑭᓂᐧᐃᒡ ᐅᑖᐋᐦ ᐊᑎᒫᐱᓯᒧ ᐊᓂᔅᑭᒥᒄ ᐋᔅᒌᐦᒡ ᒫ ᒌ ᐆ ᐧᐋᑎᔅᑖᑭᓂᐧᐃᒡ ᒫᐧᑳᓐ ᐊᓐ ᒫ ᐧᐋᑏᐦᑑᑖᑭᓂᐧᐃᒡ ᐋ ᐧᐃ ᐊᒋᐧᐃᐲᐦᑖᑭᓂᐧᐃᒡ ᑖᓐ ᐊᓐ ᐋ ᐃᔨ ᐅᓈᒥᐦᑖᒥᑭᐦᒡ ᐅᐦᒋ ᐊᓐ ᐋ ᒨᓂᐦᐄᒫᓂᐧᐃᒡ ᐅᑖᐦ ᐊᑎᒫᐱᓯᒧ ᐄᐦᑖᒫᔅᑭᒥᒄ ᑭᔮᐦ ᒫᒃ ᑖᓐ ᐋ ᐃᔨ ᐋᔫᔅᒃ ᑖᑭᐦᐄᒫᐱᔨᒡ ᐊᓐ ᒌᔨᑯᐦᒡ.

ᒋᒧᒋᐦᐄᑯᓈ ᐅᐦᐄ ᐧᐋ ᐃᔨ ᑑᑖᑭᓂᐧᐃᒡ? ᒋᓂᑎᐧᐋᔨᐦᑖᓈ ᒫ ᒌ ᒋᔅᒉᔨᐦᑎᒥᓐ ᐊᓐ ᐊᓂᑎ ᐋᑎ ᐄᐦᑎᑯᐦᒡ ᐊᓐ ᐧᐋ ᐃᔨ ᑑᑖᑭᓂᐧᐃᒡ?

ᐸᒋ ᐊᔨᒥᐦᐄᓈᓐ! ᒥᓯᐧᐋ ᐊᓐ ᐊᓂᑎ ᒫ ᒌ ᐅᐦᒋ ᐸᒋ ᑳᒋᔅᑎᓂᔫᐦᒡ ᐊᑯᑎ ᐅᑎ ᐧᑳᔅᑖᐦ ᒫᓯᓈᑖᒡ!

ᐊᓂᐦᐄ ᐧᐋᒋᐦᒡ ᒫ ᑑᑖᑭᓂᐧᐃᒡ

ᐹᔨᒄ ᐊᓐ ᒫᑑᑖᑭᓂᐧᐃᒡ ᐋ ᒥᓯᓂᐦᐄᑭᓂᐧᐃᒡ ᐊᓐ ᐋ ᐃᔨ ᒋᔅᑎᒫᐤ ᐋᐱᒋᐦᑖᑭᓂᐧᐃᒡ ᐋ ᓂᐱᐅᔅᑭᒥᑳᒡ ᑭᔮᐦ ᒫᒃ ᐋᒦᔅᒫᑯᔅᑭᒥᑳᒡ ᐅᑖᐦ ᐄᔨᔨᐤ ᐊᔅᒌᐦᒡ ᐋ ᐊᔨᒥᐦᐋᑭᓂᐧᐃᒡ ᐄᔨᔨᐅᒡ ᑯᐧᑳᒋᐦᒫᒧᐧᐃᓐ ᓂᓈᐦᑰᐤ ᐃᐦᑖᐧᐃᓂᐦᒡ.

ᐊᓐ ᑭᔮᐦ ᒫ ᑭᓂᐧᐋᐱᐦᑖᑭᓂᐧᐃᒡ ᑕᓐ ᐋ ᐃᔨ ᑎᑕᑭᐦᐅᑯᑦ ᒨᔅ ᐊᓂᔫᔨᐤ ᐊᒧᐧᐃᓂᐦᐄᒫᓈᓂᐧᐃᒡ ᐊᐦᑎᑯᓂᔨᒡ ᐊᓂᑖᐦ ᐹᔨᐧᐃᒡ ᐄᔨᔨᐤ ᐋᔅᒌᐦᒡ ᐊᓂᔫᔨᐤ ᐊᑭᓂᐧᐋᐱᐦᑖᑭᓂᐧᐃᒡ ᐊ ᐃᔨ ᑎᑯᓂᔨᒡ ᐊᓂᑎ ᐅᐱᐧᔫᐧᐋᐦᒡ.

ᐊᓐ ᒫᒃ ᒥᓐ ᑯᑎᒡ ᒫ ᑑᑖᑭᓂᐧᐃᒡ ᐋ ᐧᐃᒋᔅᒉᔨᐦᑖᑭᓂᐧᐃᒡ ᓂᔑ ᑎᐦᑐ ᓂᐦᑖᐅᒋᐦᒋᑭᓐ ᐊᓂᔫᔨᐤ ᐃᔫᐱᒋᐦᑖᒡ ᐄᔨᔨᐅᒡ ᐋ ᐧᐃ ᒋᔅᒉᔨᐦᑖᑮᐧᐃᒡ ᑖᓐ ᐋ ᐃᔨ ᑖᑭᐦᐄᒫᐱᔨᒡ ᐊᔅᒡ ᐊᓐ ᐊᔨᐦᒡ ᐋᔨᑖᔨᐦᑖᑯᐦᒡ ᒌᔨᒄ ᑖᓐ ᐋ ᐃᔨ ᑖᑭᐦᐄᒫᐱᔨᒡ ᐊᓂᑎᐦ ᐊᓂᐦᐄ ᐊᓂᑎ ᓂᔑ ᓂᐦᑖᐅᒋᐦᒋᑭᓐ.

ᒥᓯᓈᐱᔅᑭᐦᐄᑭᓐ : Nicole Fenton, Sophie Laliberté, Marc-Frédéric Indorf, Xiangbo Yin

NSERC CRSNG · OURANOS · Québec · PIKOGAN · stornoway · NEMASKA LITHIUM · Hecla QUÉBEC · CANADIAN MALARTIC

Annexe 3-4

Avis d’octroi et Description de projet – CRSNG-RDC – Dynamique hydrogéologique holocène et bilan de carbone associé dans les tourbières oligotrophes du Centre-Nord du Québec (UQAM)

Natural Sciences and Engineering Research Council of Canada
350 Albert Street
Ottawa, Canada
K1A 1H5

Conseil de recherches en sciences naturelles et en génie du Canada
350, rue Albert
Ottawa, Canada
K1A 1H5

Le 28 novembre 2017

Dossier : RDCPJ 513542 - 17

05 DEC. 2017

Madame M. Garneau
Département de géographie
Université du Québec à Montréal
CP 8888 SUCC CENTRE-VILLE
MONTREAL QC H3C 3P8

Madame Garneau,

Objet : Subventions de recherche et développement coopérative - projet (RDCPJ) intitulée « Holocene ecohydrological dynamics and related carbon balance in the oligotrophic peatlands of north-central Québec, Canada », en collaboration avec Nemaska Lithium Inc., Stornoway Diamond Corporation

J'ai le plaisir de vous informer que le CRSNG a approuvé en principe l'octroi d'une subvention à l'Université du Québec à Montréal pour la demande susmentionnée.

L'octroi de la subvention est conditionnel à l'approbation par le CRSNG de l'entente de recherche définitive entre l'université et les partenaires industriels. L'entente signée doit être conforme à la Politique sur la propriété intellectuelle du CRSNG et doit être parvenue au CRSNG au plus tard **le 28 mai, 2018**, date après laquelle l'offre de financement sera retirée.

Lorsque la condition est remplie, la **date de début** du projet qui sera appuyé par le CRSNG ne peut pas précéder **le 27 novembre, 2018**. Si la condition est remplie après le 1 mars 2018, le premier paiement de la subvention sera reporté à l'année fiscale suivante et la date de début ne pourra être antérieure au 1er avril 2018. La date de début sert à établir les calendriers de paiements et de présentation des rapports. **L'entente sur la propriété intellectuelle demandée doit couvrir au moins la durée complète du projet appuyé par le CRSNG.**

À titre d'information, vous trouverez ci-joint les commentaires reçus suite à l'évaluation de votre demande et les *Lignes directrice du CRSNG à l'usage des examinateurs externes*. Nous avons supprimé des documents l'identité des auteurs et toute référence à des tierces personnes conformément aux principes de la *Loi sur la protection des renseignements personnels*.

Si vous souhaitez recevoir une copie de ces documents dans l'autre langue officielle, veuillez en informer le CRSNG.

Un sommaire des contributions en espèces du CRSNG et des partenaires industriels figure ci-dessous.

	Montants demandés	Contributions de l'industrie		Montants recommandés
		en espèces	en nature	
Année 1	$40,628	$26,086	$30,300	$40,628
Année 2	$52,114	$26,086	$38,800	$52,114
Année 3	$63,414	$26,086	$23,600	$63,774
Total	$156,156	$78,258	$92,700	$156,516

Des rapports d'activité seront demandés à des intervalles déterminés. Les conditions relatives à cet octroi vous seront transmises en même temps que le paiement du premier versement.

N'hésitez pas à communiquer avec moi si je puis vous aider de quelque façon que ce soit.

Veuillez agréer, Madame Garneau, mes sincères salutations.

Erika Bilodeau
Administrice principale de programme
Partenariats de recherche

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EB/km

P.j.

c.c. M. Larocque, Sciences de la terre et de l'atmosphère, l'Université du Québec à Montréal
M. Lavoie, Géographie, Laval, l'Université du Québec à Montréal
P. Martineu, Recherche, l'Université du Québec à Montréal
S. Thibault, Nemaska Lithium Inc.
M. Boucher, Stornoway Diamond Corporation

0 5 DEC. 2017
RECHERCHE ET CRÉATION

For NSERC office use only

Form 101 - Application for a Grant

Send to NSERC with your attachments, if applicable

Reference Number: 386129814

Applicant: Michelle Garneau **NSERC PIN:** 109930

Québec à Montréal

Program: Collaborative Research and Development Grant

Application Title: Holocene ecohydrological dynamics and related carbon balance in the oligotrophic peatlands of north-central Québec, Canada

---

Michelle Garneau

Form 101 - Application for a Grant

Electronic Attachments:

- Budget Justification - Budget justification
- Contributions from Supporting Organizations - Attachment - Contribution from industrial partners
- Relationship To Other Research Support - Research support
- Proposal - Proposal
- References - References
- Other Documents - Letter of support_ULeeds

Michelle Garneau

F100/Personal Data Form

Electronic Attachments:

- Contributions - Contributions_F100

Marie Larocque

F100/Personal Data Form

Electronic Attachments:

- Contributions - Contributions

Martin Lavoie

F100/Renseignements personnels

Electronic Attachments:

- Contributions - Martin Lavoie_Contributions

Michelle Garneau

Formulaire 183A - Renseignements requis des organismes participant aux PPR (présenté par le candidat)

Electronic Attachments:

- Lettre(s) d'appui - Lettre support Stornoway
- Profil de l'entreprise - Profil entreprise
- Lettre(s) d'appui - Nemaska
- Profil de l'entreprise - Profil entreprise

Natural Sciences and Engineering Research Council of Canada | Conseil de recherches en sciences naturelles et en génie du Canada

Institutional Identifier	
System-ID (for NSERC use only)	386129814

FORM 101
Application for a Grant
PART I

Date: 2017/05/31

Family name of applicant	Given name	Initial(s) of all given names	Personal identification no. (PIN)
Garneau	Michelle	M	**Valid** 109930

Department	Institution that will administer the grant
GEOTOP-UQAM-McGILL (Centre recherche géochimie et géodynamique)	Québec à Montréal

Language of application	Time (in hours per month) to be devoted to the proposed research / activity
[X] English [ ] French	20

Type of grant applied for	For Strategic Projects, indicate the Target Area and the Research Topic; for Strategic Networks indicate the Target Area.
Collaborative Research and Development Grant	

Title of proposal
Holocene ecohydrological dynamics and related carbon balance in the oligotrophic peatlands of north-central Québec, Canada

Provide a maximum of 10 key words that describe this proposal. Use commas to separate them.
Peatlands, Climate change, Peat accumulation, Ecohydrology, Hydrological desequilibrium, Carbon dynamics, Poor fens, Natural disturbance, Anthropogenic pressure, Modelling

Research subject code(s) Primary	Secondary	Area of application code(s) Primary	Secondary
4150	4700	1002	1000

CERTIFICATION/REQUIREMENTS

If this proposal involves any of the following, check the box(es) and submit the protocol to the university or college's certification committee.
Research involving : Humans [ ] Human pluripotent stem cells [ ] Animals [ ] Biohazards [ ]

Indicate if the proposed research takes place outdoors and if you answered YES to a), b) or c) – Appendix A (Form 101) must be completed
[X] NO [ ] YES

TOTAL AMOUNT REQUESTED FROM NSERC

Year 1	Year 2	Year 3	Year 4	Year 5
40,628	54,114	62,414	0	0

SIGNATURES (Refer to instructions "What do signatures mean?")

It is agreed that the general conditions governing grants as outlined in the NSERC *Program Guide for Professors* apply to any grant made pursuant to this application and are hereby accepted by the applicant and the applicant's employing institution.

Applicant

Head of department

Applicant's department, institution, tel. and fax nos., and e-mail

Géographie
Québec à Montréal
Tel.: (514) 9873000 ext. 1933
FAX: (514) 9873635
garneau.michelle@uqam.ca

Dean of faculty

President of institution (or representative)

The information collected on this form and appendices will be stored in the Personal Information Bank for the appropriate program.
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Valid 109930	Garneau

CO-APPLICANTS

I have read the statement "What do signatures on the application mean?" in the accompanying instructions and agree to it.

PIN, family name and initial(s)	Research/ activity time (hours/month)	Organization	Signature
132329, Larocque, M	15	Québec à Montréal	
156195, Lavoie, M	10	Laval	

Use additional page(s) if necessary.

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Before completing this section, read the instructions for the definition of collaborators in the Eligibility Criteria section of the Program Guide for Professors.

COLLABORATORS

PIN, family name and initial(s)	Research/ activity time (hours/month)	Organization / Department
Baird, AJ	15	University of Leeds,
Morris, PJ	15	University of Leeds,
287071, Rosa, ER	15	Québec en Abitibi-Témiscamingue,

Personal identification no. (PIN)	Family name of applicant
Valid 109930	Garneau

CO-APPLICANTS' ORGANIZATIONS AND/OR SUPPORTING ORGANIZATIONS (if organization different from page 1)

It is agreed that the general conditions governing grants as outlined in the NSERC *Program Guide for Professors,* as well as the statements "What do signatures on the application mean?" and "Summary of proposal for public release" in the accompanying instructions, apply to any grant made pursuant to this application and are hereby accepted by the organization.

Family name and given name of signing officer, title of position, and name of organization	Signature
Roche, Stéphane, SR Vice Doyen à la recherche, FFGG Laval Boucher, Martin, MB Vice president-sustainable development Stornoway Diamonds Corporation Thibault, Simon, ST Director - Social and Environment Nemaska Lithium	

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SUMMARY OF PROPOSAL FOR PUBLIC RELEASE (Use plain language.)

This plain language summary will be available to the public if your proposal is funded. Although it is not mandatory, you may choose to include your business telephone number and/or your e-mail address to facilitate contact with the public and the media about your research.

Business telephone no. (optional): 1 (514) 9873000 Ext. 1933

E-mail address (optional): garneau.michelle@uqam.ca

In the central-north Quebec region, peatlands are vulnerable to recent climate change but also to industrial development activities. Peatlands in this region are mainly represented by systems that developed in topographic depressions of the Precambrian Shield. They are characterized with surface patterning similar to that observed in western Labrador, central Sweden and northern Finland. In eastern Canada, those ecosystems have shown recent ecohydrologic disequilibrium expressed by a general water table rise. In this region of Quebec where mining activities are in development, peatlands had never been studied in detail before a successful NSERC Engage project and a Mitacs Acceleration project were initiated during summer 2016 in collaboration with the industrial partner Stornoway Diamonds Corporation (Mine Renard). Preliminary results show that the peatlands do present a similar pattern of ecohydrological disequilibrium to those documented in the northeast section of the La Grande River watershed and confirm the importance of investigating their vulnerability to natural and anthropogenic pressures in terms of hydrology but also in terms of future greenhouse gas (mainly carbon dioxyde and methane) balance. The proposed project aims at quantifying the hydroclimatic changes that may have influenced the ecohydrologic disequilibrium phenomenon in these northern ecosystems. To do so, quantitative paleoclimate reconstruction using pollen, plant macrofossils and water table reconstructions will be developed to support modeling peatlands water dynamics (including groundwater exchanges) in order to identify the most sensitive parameters that influenced the phenomenon in northeastern Canada over the past millenia. Both Stornoway Diamonds Corporation and Nemaska Lithium industrial partners support this initiative as wetlands compensation measure required from the Quebec government. One of the expected results transferred to the industry will be the development of an index of biological integrity for vulnerable peatland systems in the context of the ongoing development on the northern territory.

Other Language Version of Summary (optional).

Personal identification no. (PIN)	Family name of applicant
Valid 109930	Garneau

ACTIVITY SCHEDULE
(Refer to instructions to see if this section applies to your application. Use additional page(s) if necessary.)

Milestone	Description of activities	Anticipated starting date	Anticipated completion date
Start-up meeting	Meeting between the PI, CO-PI and collaborators via videoconference. Sites have already been selected from a Mitacs and Engage NSERC Partnership projects in collaboration with the Stornoway industrial partner in 2016.	2017-07-03	
Site characterization for groundwater	The geologic and geomorphic context will be characterized by the research professional (Sylvain Gagné) before site instrumentation. An elevation model will also be realized.	2017-07-10	2017-07-13
Purchase of equipment	Purchase of equipment (see section 2 in the Budget justification) following the first visit in the field and for the quantification of groundwater exchanges	2017-07-17	
Field instrumentation for groundwater budget and modelling	Piezometers with automated water table sensors will be installed in the two selected peatlands	2017-08-07	2017-08-14
Visit in the field from the PI and CO-PI	The PI- and CO-PI will visit the two sites that have been chosen in 2016. They will also visit the whole territory affected by the mining activities as well as the mining infratructures.	2017-08-09	2017-08-12
Choice for MSc 2 candidate and related schedule	MSc 2 related with Part 2 of the project : Reconstructing postglacial regional vegetation, July temperature and annual precipitation	2017-09-05	2019-09-03
Field campaign to dismantle the hydro equipment	The equipment will be uninstalled for the winter season duration	2017-10-10	2017-10-13

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ACTIVITY SCHEDULE
(Refer to instructions to see if this section applies to your application. Use additional page(s) if necessary.)

Milestone	Description of activities	Anticipated starting date	Anticipated completion date
Choice for MSc 3 candidate and related schedule	MSc 3 related with Part 3 of the project : Present-day peatland water budget and quantification of groundwater interactions	2018-01-08	2020-01-06
Second field campaign for the hydrological measurements	Installation of wells and automated equipment on the two sites	2018-06-04	2018-06-11
Field visit of collaborators and postdoctoral fellow	Field visit for the collaborators from United Kingdom and the post doc candidate (to be recruited). Meeting with all members and students. Presentation of preliminary results. Discussion on data integration and modelling. Planning of publication of result	2018-07-23	2018-07-27
Completion of MSc 1 project	Completion of the MSc 1 related with Part 1 of the project. This MSc was started with a Mitacs acceleration funding in 2016. A scientific paper will be co-authored by MSc 1, supervisor and co-supervisors and submitted for publication.	2018-08-20	
Field campaign	Desintallation of hydrologic field equipement	2018-10-08	2018-10-11
Beginning of post-doctoral internship	Post doctoral internship that includes data integration from the 3 MSc projects and ecohydrological modelling	2018-12-03	2020-08-31
Field campaign	Installation of equipment in the field	2019-06-03	2019-06-10

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ACTIVITY SCHEDULE
(Refer to instructions to see if this section applies to your application. Use additional page(s) if necessary.)

Milestone	Description of activities	Anticipated starting date	Anticipated completion date
Team meeting	A 3rd team meeting is planned before project completion to discuss the interpretation of final results and some potential related issues	2019-07-15	
Completion of MSc 2 project	Reconstructing postglacial regional vegetation, July temperature and annual precipitation using pollen analysis. A scientific paper will be co-authored by MSc 2 and supervisor, co-supervisors and submitted for publication	2019-08-20	
Field campaign	Final desintallation of hydrologic field equipement	2019-10-07	2019-10-10
Completion of MSc 3 project and hydrological modelling	Reconstructing postglacial regional vegetation, July temperature and annual precipitation. A scientific paper will be co-authored with MSc 3, supervisor, co-supervisors and post doctoral candidate and submitted for publication	2019-12-20	
Completion of DigiBog modelling	Modelling completion. it is expected that 2 or 3 co-authored scientific publications will be published from this internship.	2020-08-31	

Personal identification no. (PIN)	Family name of applicant
Valid 109930	Garneau

See instructions for further details.

PROPOSED EXPENDITURES

	Year 1		Year 2		Year 3	
	Cash	In-kind	Cash	In-kind	Cash	In-kind
1) Salaries and benefits						
a) Students	30,000		30,000		15,000	
b) Postdoctoral fellows	0		22,000		45,000	
c) Technical/professional assistants	10,000	16,800	15,000	16,800	15,000	16,800
d) Research assistant	5,000					
2) Equipment or facility						
a) Purchase or rental	9,714	0		0	0	0
b) Operation and maintenance costs	0				0	
c) User fees	0	0	0	0	0	0
d)	0		0		0	
3) Materials and supplies						
a) 14C radiocarbon dates	6,000	0	6,000	0	0	0
b) 210 Pb chronologies	1,200		1,200		0	
c) C/N analysis	3,000	0		0	0	0
4) Travel						
a) Conferences	0		0		8,000	
b) Field work	1,800	13,500	2,000	22,000	1,500	6,800
c) Project-related travel			4,000		4,000	
d)	0		0		0	
5) Dissemination						
a) Publication costs	0		0		0	
b)	0		0		0	
6) Technology transfer activities						
a)	0		0		0	
b)	0		0		0	
c)	0		0		0	
TOTAL PROPOSED EXPENDITURES	66,714		80,200		88,500	
Total support from industry	26,086		26,086		26,086	
Total support from university						
Total support from other sources						
AMOUNT REQUESTED FROM NSERC	40,628		54,114		62,414	

Canada

Personal identification no. (PIN)	Family name of applicant
Valid 109930	Garneau

See instructions for further details.

PROPOSED EXPENDITURES

	Year 4 Cash	Year 4 In-kind	Year 5 Cash	Year 5 In-kind	
1) Salaries and benefits					
a) Students	0		0		
b) Postdoctoral fellows	0		0		
c) Technical/professional assistants	0	0	0	0	
d) Research assistant	0		0		
2) Equipment or facility					
a) Purchase or rental	0	0	0	0	
b) Operation and maintenance costs	0		0		
c) User fees	0	0	0	0	
d)	0		0		
3) Materials and supplies					
a) 14C radiocarbon dates	0	0	0	0	
b) 210 Pb chronologies	0		0		
c) C/N analysis	0	0	0	0	
4) Travel					
a) Conferences	0		0		
b) Field work	0	0	0	0	
c) Project-related travel	0		0		
d)	0		0		
5) Dissemination					
a) Publication costs	0		0		
b)	0		0		
6) Technology transfer activities					
a)	0		0		
b)	0		0		
c)	0		0		
TOTAL PROPOSED EXPENDITURES	0		0		
Total support from industry	0		0		
Total support from university					
Total support from other sources					
AMOUNT REQUESTED FROM NSERC	0		0		

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Michelle Garneau

Form 101 - Application for a Grant

Budget Justification

Budget justification

Budget justification

The total expenses of the project are distributed between the MSc students and postdoctoral fellow salaries, professional support, scientific equipment and other direct costs associated with the research like the field campaign costs and laboratory analyses. An amount has also been planned for team meetings which include the participation of the two collaborators from Leeds University (United Kingdom) during year 2 as well as the participation to national and international conferences for the students. In total, 50% of the total requested amount is allocated to salaries and 75% of this amount attributed to HQP (MSc students and postdoctoral fellow).

1. Salaries

	YEAR 1	YEAR 2	YEAR 3
a) <u>Students</u>:			
Masters (3):			
Year 1 : MSc1 (Mylène Robitaille) and MSc 2 (to be determined)	30 000 $	30 000 $	15 000 $
Year 2 : MSc2 and MSc3 (to be determined):			
Year 3 : MSc3			
For each candidate : 15 000 $ / year x 2 years			
b) <u>Postdoctoral fellow</u> (1):			
Ecohydrological modelling (M-A Bourgault is the foreseen candidate)	----	22 000 $	45 000 $
c) <u>Professional support :</u>			
UQAM : 10 ka/yr for Sylvain Gagné	10 000 $	10 000 $	10 000 $
ULaval : 5ka/yr for Myosotis B.Desroches		5 000 $	5 000 $
d) Research assistant :	5 000 $		
5 ka/yr for undergraduate research assistant (to be determined)			
TOTAL :	**45 000 $**	**67 000 $**	**75 000 $**

a) <u>Students</u> :

Three (3) MSc grants will be allocated within Parts 1, 2 and 3 of the proposal. The project within Part 1 (*Holocene paleohydrological and paleoecological reconstruction of the peatlands in the Centre-nord Quebec*) has seen its first year funded by a Mitacs internship with the Stornoway partner which allowed a preliminary characterization of the studied region and cores sampling. The funding for the MSc project of Part 1 will be completed at the end of year 1 under the supervision of Pr. Garneau (candidate Mylène

Robitaille, dept. geography, UQAM). The project related to the objectives of Part 2 (*Reconstructing postglacial regional vegetation, July temperature and annual precipitation*) will be realized at Laval University under the supervision of Pr. Lavoie (candidate to be determined, dept. of geography) while the project of Part 3 (*Present-day peatland water budget and quantification of groundwater interactions*) will be achieved under the supervision of Pr. Larocque (UQAM) (candidate to be determined ; dept. sciences de la terre et de l'atmosphère). Each MSc candidate will spend 100 % of his time on the CRD project and will receive an amount of 15 000 $ / year to realize his respective research project.

b) Postdoctoral fellow:
A postdoctoral candidate will be hired during the second part of the project in order to synthesized the different proxy data and integrate them as model inputs of the DigiBog model. The results from the groundwater exchanges obtained from Part 3 will also be tested as new component in an updated version of the model. The candidate Marc-André Bourgault is foreseen as the ideal candidate to accomplish the work. He will will spend some time working in Leeds (UK) with the authors of the model (Baird *et al*, 2012 ; Morris *et al*, 2015) who are collaborators to the project.

c) Professional support :
During the course of the project, an experienced research professional already working with Dr Larocque, Sylvain Gagné, will be an invaluable asset in the field and with the groundwater modeling work. His technical and analytical skills will bring him to install the equipment and coordinate the acquisition of groundwater data. Sylvain Gagné will also assume some project coordination and administration. The dedicated amount for his salary will garantee an equivalent of two days/month and corresponds to less than 10% of the amount of the proposal. Myosotis B. Desroches is the research professional from the terrestrial paleoecology, palynology and anthracology laboratory, Centre d'études nordiques, Laval University. The amount dedicated to her salary will support the time she will spend for the training of MSc 2 for analyses and quantitative treatment of data. The attributed amount correponds to two days/month of salary.

d) Research assistant :
An amount of 5 000 $ / year is also requested for the salary of an ungraduate student from UQAM that will help with laboratory and other technical tasks during Year 1 of the project and for MSc 1: 10.2 hours/week during 15 weeks (respectively automn and winter terms @$16.28/hour).

2. Equipment

	YEAR 1	YEAR 2	YEAR 3
Purchases :			
1.3001 Levellogger Junior Edge, M5/F15) (Total 16 = 8 / peatland) .	6 640 $		
2.Piezometre A.I., 615N, 12", (NO BARB) (Total 16 = 8 / peatland)	1 488 $		
3.Optical lector for piezometer (Total 2)	320 $		
TOTAL: 8 448$ + taxes (see quote attached)	9 713.09 $		

Purchases :
Piezometres and dataloggers need to be bought in order to instrument the two peatlands and get some continuous measurements of the water table fluctuations and the fluxes for the adjacent mineral aquifer for a two entire season period. See below the quote for the costs associated to the purchase of the equipment. This amount will be spent during the first year of the project.

3. Material and supplies

	YEAR 1	YEAR 2	YEAR 3
a)Radiocarbon dating – Accelerator Mass Spectometry (AMS)			
André E. Lalonde laboratory, U. Ottawa			
40 samples @ 300$/sample	6 000 $	6 000 $	-----
b) **^{210}Pb chronologies** - UQAM	1 200 $	1 200 $	----
c) **Laboratory analyses :**			
Carbon analyses - C:N *GEOTOP- UQAM*	3 000 $	-----	-----
TOTAL:	**10 200 $**	**7 200 $**	**-----**

a) **Radiocarbon chronologies :**
Paleoecological studies need detailed radiocarbon chronologies in order to develop precised age-depth models and constrain the reconstructions obtained from the different proxy data analyses. Radiocarbon chronologies for MSc 1 and MSc 2 projects will be realized by

Accelerator Mass Spectometry (AMS) at the André Lalonde laboratory (University of Ottawa). Geotop has a research agreement with this radiocarbon laboratory so the cost per sample is low compared to other lab : 300 $ CAN. Four pieces of wood from drowned trees and 36 peat samples from the different cores will be dated : 40 samples @ 300 $: 12 000 $

b) ^{210}Pb chronologies :
In order to date the recent (< 150 years) peat accumulation rates from the collected cores, ^{210}Pb analyses from the two central profiles of the sampled peatlands will be realized at Radiogenic Isotopic Laboratory from Geotop. Internal rate for students is 50 $/sample. Twelve samples / profile for two profiles will totalize 1 200 $.

c) Laboratory analyses :
Analyses of C:N ratios will be realized at the Stable Isotope Laboratory from Geotop (UQAM) to provide quantified data on peat decomposition. Internal rates for students is 10 $ / sample. A total of 240 samples will be processed at 4 cm intervals on the central and lateral cores : 240 @ 10 $ = 2 400 $.

4. Travel costs

	YEAR 1	YEAR 2	YEAR 3
a)Car rental (field work) A total of 45 days of field work is planned over the 3 years. Each field campaign will require a vehicule location to travel to and between the two peatland sites. For security reasons, it is not possible to drive from Montreal to the mining site. So all team members will fly to the site.Car will be transported by Stornoway and be available once on the site.	1800 $	2000 $	1500 $
b) Conferences : In total, 4 (national or international conferences (1 for each project objective) will be attended by the 3 MSc students and the postdoc candidate during the 3rd year of the project : 2000 $ / conference / objective : 8 000 $	----	-----	8 000 $
c) Project related travel : A travel is planned for the collaborators fom UK : 2000$ /collaborator. During the summer 2018, a meeting will take place on the site of the industrial partner to visit the studied peatlands, meet with the industrial partners and the different team members.	-----	4 000 $	------

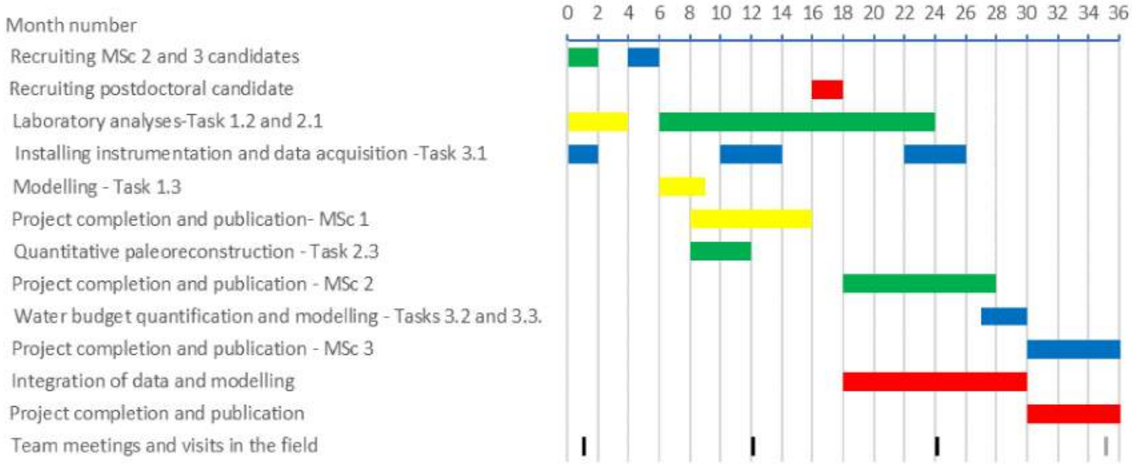
Budget is also planned for the postdotoral fellow to work at Leeds university with the Pr. Baird and Pr. Morris authors of the DigiBog model and collaborators ----- ------- 4 000 $

5. Dissemination (publication costs)
A choice has been made to publish results of the research in open-access journals as supported by the Open Access policies of NSERC.
Results of MSc 1 and MSc 2 will be submitted to the journal : *The Holocene*
Results of MSc 3 and postdoc will be submitted to the following journal :
Ecohydrology, Hydrological Processes, Journal of Hydrology
These journals have no publication costs

TOTAL BUDGET	YEAR 1	YEAR2	YEAR 3	TOTAL
Total project cost	66 714	80 200	88 500	**235 414 $**
Support partners – cash to direct cost of research*	26 086	26 086	26 086	**78 258 $**
Support partners – in kind	30 300	38 800	23 600	**92 700 $**
Total support – industrial partners	56 386	64 886	49 686	**170 958 $**
Total amount requested from NSERC	**40 628**	**54 114**	**62 414**	**157 156 $**
*Contribution from partners to indirect costs of research	3 914	3 914	3 914	11 742 $

PLANNED ACTIVITY SCHEDULE

Gantt chart of the planned activity schedule for the project (responsibility for activities are classified by colors: yellow = MSc 1, green = MSc2, blue = MSc 3 and red = post doctoral. Black = team work meetings involving co-PIs Garneau, Lavoie, Larocque and collaborators Baird, Morris and Rosa.



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2005 RUE JEANNE MANCE
ATTR: SYLVAIN GAGNE
MONTREAL , QC , H3C 3P8

Date : 2017/05/03 Page: 1 / 1

Tél. / *Tel.*: (514) 987-3000

Téléc. / *Fax*:

Attention :

Courriel / *Email* :

F.A.B. / *F.O.B.*: GENEQ

Préparé par / *Prepared by*: CAMILLE PARADIS-GAUDET

Validité / *Validity*	Taxe(s) et douane(s) en sus, si applicable / *Tax(es) and duty(ies) extra, if applicable*	Conditions / *Terms*
2017/04/10		**NET 30 JOURS/30 DAYS**

Art. / *Item*	No de catalogue / *Catalog Nb.*	Description	Qtée / *Qty*	Prix unitaire / *Unit price*	Esc. / *Disc*	Prix Total / *Total Price*
1	SO110241-0	3001 LEVELOGGER 3001 JUNIOR EDGE, M5/F15	16	415.00		6,640.00
2	SO102842-0	PIEZOMETRE A.I., 615N, 12", (NO BARB)	16	93.00		1,488.00
3	SO110149-0	3001 LECTEUR OPTIQUE POUR LEVELOGGER (USB)	2	160.00		320.00

N° T.P.S / *G.S.T.*	SOUS-TOTAL / *SUBTOTAL*	8,448.00
101978872RT0001	T.P.S. / *G.S.T*	422.40
N° T.V.P. / *P.S.T.*	T.V.P. / *P.S.T.*	842.69
1000824549TQ0001	TOTAL	9,713.09

CAMILLE PARADIS-GAUDET

Personal identification no. (PIN)	Family name of applicant
Valid 109930	Garneau

Before completing this section, read the instructions for contributions from supporting organizations and consult the *Use of Grant Funds* section in the NSERC *Program Guide for Professors* concerning the eligibility of expenditures for the direct costs of research and the regulations governing the use of grant funds, and *Guidelines for Evaluating Cost-Sharing Ratios and In-Kind Contributions in University-Industry Collaborations* regarding the eligibility of in-kind contributions.

Name of supporting organization

Nemaska Lithium

CONTRIBUTIONS FROM SUPPORTING ORGANIZATIONS

	Year 1	Year 2	Year 3	Year 4	Year 5
Cash contributions to direct costs of research (Transfer amounts to page five (5); except those for the Ship Time program.)	13,043	13,043	13,043	0	0
In-kind contributions to direct costs of research					
1) Salaries for scientific and technical staff	9,600	9,600	9,600	0	0
2) Donation of equipment, software	0	0	0	0	0
3) Donation of material	0	0	0	0	0
4) Field work logistics	0	0	0	0	0
5) Provision of services	0	0	0	0	0
6)	0	0	0	0	0
Total of in-kind contributions to direct costs of research	9,600	9,600	9,600	0	0
In-kind contributions to indirect costs of research (not leveraged)					
1) Use of organization's facilities	0	0	0	0	0
2) Salaries of managerial and administrative staff	0	0	0	0	0
3)	0	0	0	0	0
Total of all in-kind contributions	9,600	9,600	9,600	0	0
Contribution to postsecondary institution overhead	1,957	1,957	1,957	0	0

Canada

Michelle Garneau

Form 101 - Application for a Grant

Contributions from Supporting Organizations - Attachment

Contribution from industrial partners

NEMASKA LITHIUM

1) Cash contribution to direct costs of research

The **cash contribution** from Nemaska Lithiumis $ 15 000 / year for 3 years = $ 45 000*

The cash contribution from partner to **indirect** costs of research represents 15% overhead. So : $ 1957 / year for 3 years = $ 5871

TOTAL NET CASH CONTRIBUTION TO DIRECT COSTS OF RESEARCH : 39 129 $

2) The in-kind contribution to direct costs of research

The in-kind contribution from Nemaska Lithium to direct costs of research is related to salary and expanses of the scientific staff involved in the project

Salaries for scientific staff :

A total of 9 600 $ /year has been calculated for the contribution of the biologist Simon Thibault, who acts as Director in Environment and Social responsability in the Nemaska Lithium company. Simon Thibault will be working with us in the development of indices of biological integrity for vulnerable peatland systems in the context of the ongoing evelopement of the northern territory. This amount represents an equivalent of 85 hours / year @ 100$/h and includes his salary (Total : 8500 $) AND other expanses as visits on the site, meetings in Montreal as he is based in Quebec city, documents etc.) (Total : 1100 $)

TOTAL for salaries – scientific staff **:** **28 800 $**

In summary :

TOTAL - net cash contribution to direct costs of research (Stornoway Diamond Corporation AND Nemaska Lithium) **78 258 $**

TOTAL – in-kind contribution to direct costs of research (Stornoway Diamond Corporation AND Nemaska Lithium) **92 700 $**

TOTAL CONTRIBUTION FROM INDUSTRY 170 958 $

Michelle Garneau

Form 101 - Application for a Grant

Proposal

Proposal

1. SYNOPSIS

Peatlands are widespread ecosystems of the boreal and subarctic landscape and, as large carbon sinks, they play a globally-important role in carbon cycling and feedbacks to climate change. In the central-north Quebec region (52°30'-53°85'N), peatlands are vulnerable to recent climate change but also to industrial development activities. The biogeographic limit of the peatlands in this region corresponds to the ecotone between the open boreal forest and the forest-tundra. Peatlands in central-north Quebec are mainly represented by patterned fens that developed in topographic depressions of the Precambrian Shield. They are characterized by mildly minerotrophic conditions with current surface patterning similar to that observed in western Labrador, central Sweden and the *aapa* mires of northern Finland. In eastern Canada, those patterned fens have shown recent ecohydrologic disequilibrium expressed by a general water table rise with degradation of drier features such as strings and expansion and coalescence of pools defined as "*aqualysis*". In this region of Quebec where mining activities are in development, peatlands had never been studied in detail before a successful NSERC Engage project and a Mitacs Acceleration project were initiated during summer 2016 in collaboration with the industrial partner Stornoway Diamond Corporation (Mine Renard). Preliminary results show that the peatlands do present a similar pattern of ecohydrological disequilibrium to those documented in the northeast section of the La Grande River watershed (54°00'N-54°05'N) and confirm the importance of investigating their ecohydrological vulnerability to natural and anthropogenic pressures in terms of hydrology but also in terms of future greenhouse gas (mainly carbon dioxyde and methane) balance. We propose here a multidisciplinary project that aims at quantifying the hydroclimatic changes that may have influenced the ecohydrologic disequilibrium phenomenon in northern patterned fens. To do so, Holocene quantitative paleoclimate reconstruction using pollen, plant macrofossils and water table reconstructions will be developed to support modeling peatlands water dynamics (including groundwater exchanges) in order to identify the most sensitive parameters that influenced the large-scale *aqualysis* phenomenon in northeastern Canada over the past millenia. These results will contribute to developing an index of biological integrity for vulnerable peatland systems in the context of the ongoing development on the northern territory.

2. BACKGROUND

Peatlands cover about 12% of Canadian land area and are particularly abundant in the Hudson Bay and James Bay regions (Tarnocai *et al*., 2005). In Quebec, peatlands cover between 9 and 12% of the land surface (Payette and Rochefort, 2001). In a recent synthesis, Garneau *et al.* (2014) highlighted the links between regional climatic conditions and boreal and subarctic peatland dynamics in terms of surface vegetation and patterning, plant productivity (C stocks) and natural disturbances along latitudinal and continental-oceanic climatic gradients in Quebec. The ombrotrophic peatlands which dominate the boreal regions are gradually replaced by oligotrophic fens in subarctic latitudes with the abundance of pools gradually increasing towards the north. The factors influencing the development of these patterned ecosystems have been documented by several authors (Glaser and Janssens, 1986; Foster and Wright, 1990; Korhola, 1994; van Bellen *et al*., 2013; Arlen-Pouliot and Payette, 2015; White and Payette, 2016) with various hypotheses tested on the contrasting roles played by autogenic (differential decomposition, peat hydraulic conductivity) and allogenic factors (topography, climate).

Pool formation and expansion over peatland surfaces contribute to major changes to ecological functions (Charman, 2001) including increases in greenhouse gases emissions (GHG) such as CO_2 (Cliche-Trudeau *et al*., 2012; Pelletier *et al*., 2015) and CH_4 (Cliche-Trudeau *et al*., 2013). GHG fluxes from pools may be more important at the scale of whole peatlands than fluxes from the terrestrial areas so a better understanding of the factors controlling pool formation may help to evaluate the role of these microforms in the global C budget. The proposed project aims to understand the autogenic and allogenic factors that have influenced Holocene pool development and expansion in the oligotrophic fens of central-north Quebec. To do so, the hydroclimatic changes will be reconstructed using quantitative pollen and water table reconstructions, vegetation succession and geochemical changes. The simulation

of current peatland hydrodynamics will complement this approach by comparing the vulnerability of the systems with the major recent and present-day forcings. The integration of contemporaneous processes as analogues will help to tackle the paleoecohydrological modelling inputs. To the end, we aim that our integrative approach allow the identification of the most sensitive processes that influenced the large-scale aqualysis phenomenon that occured in the past millenia (< 3000 yrs) in eastern Canada with impacts on biodiversity and GHG balance. For our industrial partners, these results will help the development of index for biological integrity (in terms of vegetation and soil microorganisms) in peatlands that will be applied in further research and development projects on the northern territory.

3. DETAILED PROPOSAL

3.1 Scientific issues and research problem

Peatlands in the central-north Quebec (latitude 52°30'-53°85'N) were poorly documented until a preliminary project supported by a MSc Mitacs internship allowed documentation of the geomophological and ecological contexts in which they developed on the Stornoway Diamond Corporation territory (mine Renard, 52°49'N - 72°11'W). Relativey small and shallow peatlands accumulated in topographic depressions filled with glacial till. Following a regional characterization with aerial photos and ground-thruting validation during a field campaing in July 2016, results confirmed their mildly minerotrophic conditions, with current surface patterning similar to that from the northeast section of the La Grande River watershed. After four days of peatland surveys, two sites located in two different watersheds were selected based on their regional representativeness (respectively 3.11 ha and maximum depth 215 cm and 3.95 ha and maximum depth 345 cm). Manual coring was first carried out at 5 m gridded intervals in each selected peatland in order to reconstruct the basin topography before peat coring (Fig. 1). Two marginal and one central peat cores were collected in each of the two peatlands, giving a total of 6 peat cores. Surface vegetation surveys were carried out using 1 m^2 quadrats adjacent to the coring sites and testate amoebae surface samples (20 cm^3) collected for the calibration of the Quebec quantitative transfer function water table depth (Lamarre *et al.*, 2013). The preliminary results obtained from this Mitacs internship established a solid background to define the aims and objectives of the present proposal.

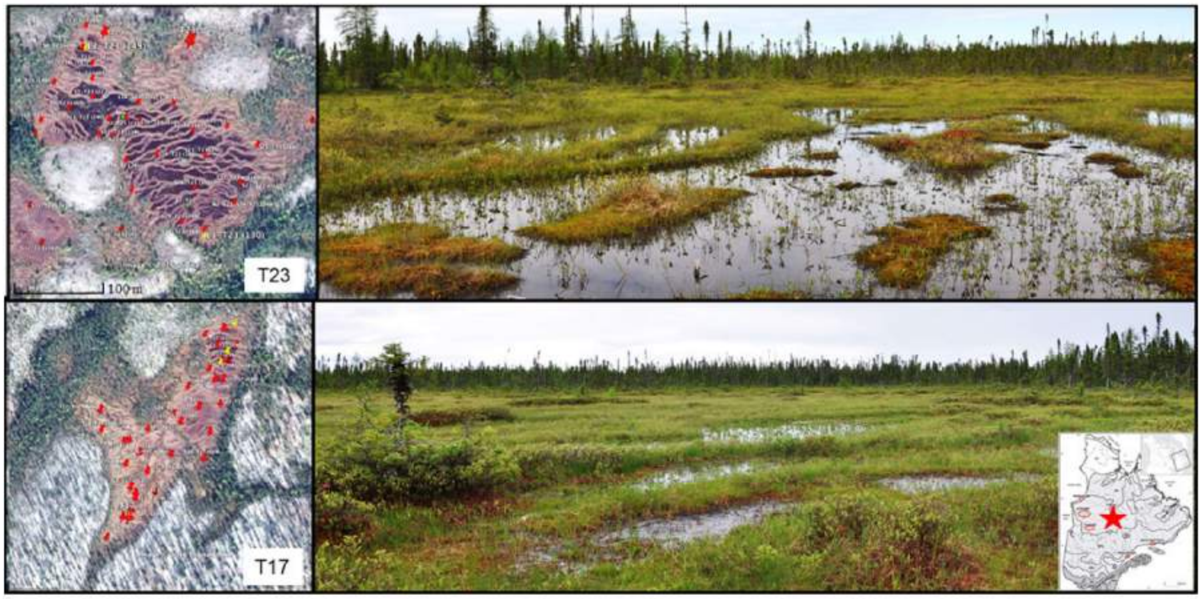

Figure 1: The two studied peatlands (T23, 52°38'50" N 72°11'33" W, and T17, 52°43'28" N 72°12'48" W): on the left, aerial view with location of the different coring points (red) and surrounding mineral context covered by open boreal forest cover. On the right, view from the surface of the peatlands.

Peatlands in the region of the mine Renard are characterized by high dominance of aquatic microforms such as pools and wet hollows and show indications of recent water table rise expressed by tree mortality, physical degradation of strings, and pool expansion. Evolution of peatlands towards more aquatic ecosystems may have major consequences for their carbon sequestration and ecological functions. The transformation of terrestrial vegetated microforms into wet hollows and pools enhance peat decomposition and bring significant potential increases in emissions of GHG such as CO_2 and CH_4 (Waddington *et al.*, 1998; Pelletier *et al.*, 2007; McEnroe *et al.*, 2009; Cliche-Trudeau *et al.*, 2014). It is important to understand the mechanisms involved in the long-term development of these pools to better predict their evolution in the context of ongoing climate change.

Prior to this proposal, an NSERC Engage project was undertaken in 2016 with the Stornoway Corporation industrial partner using preliminary simulations with the DigiBog model (Baird *et al.*, 2012). DigiBog is a peatland development model that accounts for the interactions between the processes that govern litter production and peat decay, and the processes that drive peat hydrology (including peat hydraulic properties) and peatland water table behavior. Results from the simulations have been compared with ecohydrological reconstructions from the Laforge region (van Bellen *et al,* 2013) and suggest that the ecosystem shift from a treed, ombrotrophic *Picea-Sphagnum* bog to a poor minerotrophic state with abundant flarks and pools, could not have occurred under cooler and wetter climatic conditions alone. It has then been hypothesized that a major reduction in litter production, triggered by a reduction of growing season length, and enhanced input of minerotrophic groundwater flow, contributing to enhanced decay, was essential for the persisting shift observed in the stratigraphy (van Bellen *et al*, submitted). Several hypotheses have been suggested to explain this change such as colder climate conditions and shorter growing seasons, higher precipitation rates or increased cloudiness (van Bellen *et al*, 2013; Garneau *et al*, in review; van Bellen *et al*, submitted) and these support the main research questions that are addressed in the present proposal: 1) What are the conditions that influenced peat accumulation through time in this northern ecotonal region? 2) What are the ecohydrological forcings that induced the shift from bog to fen in these systems? 3) Has groundwater had an impact on the hydrological disequilibrium registered in the peatlands?

3.2 Objectives

The overall goal of this project is to identify the most important processes that influenced the ecohydrological disequilibrium in the boreal and subarctic poor fens with the transformation of terrestrial vegetated microforms into wet hollows and pools that modified their ecosystem functions. To achieve this goal, four specific objectives are defined:

1. Reconstruct the paleohydrological and paleoecological conditions that influenced peat accumulation and carbon dynamics throughout the Holocene;
2. Reconstruct the Holocene regional vegetation and related climate variations in terms of temperature and precipitation;
3. Document the present-day hydrological dynamics and groundwater exchanges within the peatland watersheds;
4. Simulate the effect of different forcings on the peatlands ecohydrological functioning over the last 5.5 k years obtained by the results of specific objectives 1 and 2.

3.3 Research methodology

In order to provide useful results for the understanding of the hydrological disequilibrium and to document the ecological value of these ecosystems in terms of their biodiversity and carbon sequestration function, a combination of field methods (ecological and hydrogeological) and models will be used. The proposed methodology is developed in four parts, each aiming at one specific objective. Part I will focus on reconstructing the ecohydrological conditions that influenced the initiation and development of peat accumulation following ice margin retreat. It will use field-base data collected during summer 2016 and additional water table quantitative reconstruction. Part II will focus on

reconstructing postglacial regional vegetation history, July and January temperatures and annual precipitation from the same peat cores collected during summer 2016. Part III will document the present-day hydrological dynamics of the two selected peatlands within their respective watersheds. Finally, Part IV will integrate results from Parts I, II and III to simulate the interactions between Holocene climate variations, length of growing season, peat productivity, peat hydraulic properties and water table behaviour in order to identify the most influential parameters that caused the ecohydrological disequilibrium in the peatlands. The four parts of the project are described below.

Part I : Reconstructing the ecohydrological conditions that influenced peat initiation and peatland development following ice margin retreat

Responsible: M. Garneau; *collab.*: M. Lavoie, M. Larocque, P. Morris and A. Baird; *HQP*: MSc1

Context and objective: There are no existing data on the paleoecohydrological conditions that influenced the long-term peatland development in central-north Quebec. The objective of Part I is to provide the context that supported the development of peatlands in this poorly documented region and to identify the most influential factors in the ecohydrological functioning of the peatlands.

Hypotheses: 1) peatlands initiated through paludification with the intrusion of moister air masses from *ca* 5500 cal BP following the disappearance of the Laurentide Ice Sheet from Hudson Bay, 2) with the onset of the Neoglacial around *ca* 3500-3000 cal BP, cooler climatic conditions induced shorter growing seasons and higher amount in precipitations that reduced fire occurrence in the regional upland forests and influenced, with increased surface runoff, a shift from *Sphagnum* to herbaceous vegetation in the peatlands.

Task 1.1 Data acquisition in the field

Methods: As presented in Section 3.1, two peatlands have been sampled during the MSc Mitacs internship in 2016 (Fig. 1). Surface vegetation surveys were undertaken and 24 testate amoebae surface samples collected along with measurements of water table depth and peat water pH. In order to reconstruct the size and morphology of the basins in which the peatlands developed, manual coring was carried out at 5 m gridded intervals in each peatland. In total, six peat cores were collected (2 lateral and one central (deepest section) from each peatland)

Milestone results: Plant vegetation survey provide a description of vascular and non-vascular species composition in the two peatlands. Testate amobae surface sampling, water table measurements and pH within the three terrestrial microforms (hummock, hollow and lawn) will be used for an index of microbiological diversity and development the water table transfer function from Task 1.3.

Task 1.2 Laboratory analyses

Methods : Several analyses will be conducted on the peat samples collected in 2016. Dry bulk density (g cm^{-3}) and loss-on-ignition (LOI; 100%) will be measured on contiguous 1-cm interval (1cm^3) sections from the mineral contact to the present-day peat surface following the protocol of Dean (1974). Results expressed in g/cm^3 will provide data on the peat stratigraphy, organic matter and related carbon content as in Turunen *et al.* (2002). Cores will be analyzed for their plant macrofossils, charcoal content (>100 um) and testate amoebae composition on 3 cm^3 samples at 1-cm contiguous intervals following the protocols of Mauquoy *et al*. (2010) and Hendon and Charman (1997) respectively. Further detailed quantification of peat decomposition will be determined by C/N ratios on 1 cm^3 sample at 4-cm intervals in the central (deepest) cores from the two peatlands.

Milestone results: Task 1.2 will provide the data needed for the reconstruction of the ecohydrological conditions that supported the initiation and development of the peatlands. Peat bulk density, carbon content and macro charcoal concentration will be expressed within the macrofossil diagrams. Testate amoebae will allow the reconstruction of the water table variations. Those reconstructions will be compared with the quantitative pollen data reconstruction in terms of temperature and annual precipitation (Task 2.3).

Task 1.3 Modelling of carbon accumulation and paleoecohydrological variations

Methods: Carbon accumulation will be calculated with values obtained from LOI and constrained with ten radiocarbon ^{14}C and ^{210}Pb dating on each core. Age-depth models will be produced using Bacon software (v2.2), a piece-wise linear Bayesian model (Blaauw and Christen, 2011). Carbon (C) mass will be calculated as the product of bulk density and C content, while temporal variations in C accumulation rates (CAR; g m^{-2} yr^{-1}) will be calculated by dividing the C mass in every 1 cm slice by its deposition time (yr cm^{-1}), based on the age-depth curves. Water table quantitative reconstructions will integrate the 24 surface samples into the Lamarre *et al.* (2013) transfer function developed for the boreal and subarctic peatlands in Quebec.

Milestone results: Data issued from Task 1.3 will provide reconstructions of peat accumulation rates along with the vegetation assemblages and the water table variations throughout the entire Holocene period covered by this study. Radiocarbon dating will allow checking of the synchrony in ecohydrological changes and confirm whether the disequilibrium has been caused by a single forcing or not. ^{210}Pb dating will help to constrain the most recent changes in the peatlands and reveal if peat accumulation has been higher during the last decades as found in other studies (Lamarre *et al.*,2012, Garneau *et al.*, 2014 and Sanderson, 2016) even when taking into account the uncomplete decomposition comprised in the acrotelm layers. Finally, the paleoecohydrological reconstruction (MSc1, supervised by Garneau et al.) will provide key information for setting up and testing the new version of the DigiBog model (Morris *et al.*, 2015) in Part IV.

Part II: Reconstructing postglacial regional vegetation, July temperature and annual precipitation

Responsible: M. Lavoie; *collab.*: M. Garneau, M. Larocque, A.J. Baird, P.J. Morris; *HQP*: MSc2

Context and objective: As in Part 1, there are no existing palynological data from the central-north Quebec region. The objective of Part II is to provide data on the postglacial regional vegetation history since ice margin retreat and reconstruct quantitative July and January temperatures and annual precipitation using the pollen-based modern analogue technique (Overpeck et al., 1985, Fréchette *et al.*, 2008). Reconstructed data will be compared with those from Part I in order to confirm or not the changes in temperatures and precipitation from the Neoglacial (ca 3500-3000 cal BP) onwards when it has been hypothesized that the forcings were the strongest (van Bellen *et al*, 2013).

Hypotheses: 1) Increased summer insolation during the mid-Holocene along with intrusion of moister air masses associated with the disappearance of the Laurentide Ice Sheet in Hudson Bay influenced the development of a closed boreal forest 2) with the onset of the Neoglacial around *ca* 3500-3000 cal BP, cooler climatic conditions induced shorter growing seasons and increase in precipitation that promoted changes in the fire regime and the forest cover fragmentation.

Task 2.1 Data acquisition in the field

Methods: As previously mentionned, pollen analyses will be carried out on the same two central (deepest) peat cores retrieved in 2016 (Fig. 1). The cores have been collected with a Box corer (105 ×8 × 8 cm) (Jeglum *et al*, 1991) for the upper 1 m and a 7.5 cm diameter Russian corer (Jowsey, 1966) was used for subsequent depths down to the mineral contact. Two overlapping cores were extracted in parallel to avoid gaps in the records.

Milestone results: The acquisition of data from the 2016 field campaign will be provided to MSc2 supervised by Lavoie et al. Pollen data will be used to reconstruct regional postglacial vegetation history as well as quantitative paloeclimatic reconstruction and support the interpretation of the ecohydrological reconstruction (Part I) and DigiBog modelling developed in Part IV.

Task 2.2 Laboratory analyses

Methods: One cm^3 will be subsampled at 2-cm interval. Preparation for pollen analysis will follow Faegri and Iversen (1989). A known volume of an exotic marker (*Lycopodium clavatum*; Stockmarr, 1971) will be added to each subsample before preparation to calculate pollen concentration (grains cm^{-3}) and pollen accumulation rates (grains cm^2 yr^{-1}) supported by the chronologies obtained in Task 1.3.

Pollen analysis will follow Richard (1970) McAndrews *et al*. (1973) and the modern pollen collection of the Centre d'études nordiques (Laval University). At least 500 pollen grains of terrestrial vascular plants (excluding those of Cyperaceae and Ericaceae) will be counted for every pollen spectrum (pollen sum). Charcoal particles >150um will be counted within contiguous peat samples (1 cm interval) and transformed into charcoal accumulation rates (CHAR; nb cm^{-2} yr^{-1}). The charcoal peaks will be detected and used to reconstruct local fire events (<1-3 km from the peatlands) over the Holocene (Higuera *et al*, 2007).

Milestone results: The pollen analysis from the central cores of the two studied peatlands will provide regional upland vegetation reconstruction from the time when the region was free of ice (*ca* 5500 cal yrs BP; Dyke, 2004) to the present-day. Supported by detailed chronologies from Task 1.3, pollen assemblages will record changes from open boreal forest to closed boreal forest.

Task 2.3 Quantitative paleoclimatic reconstructions.

Methods: Quantitative reconstructions of July temperature (°C), January temperature (°C) and annual precipitation (mm) will be obtained through the modern analogue technique (MAT) (Overpeck *et al*., 1985; Williams and Shuman, 2008; Fréchette *et al*., 2008; Fréchette *et al*. in press) using an updated version (v.1.72) of the modern pollen database for North America and Greenland (Whitmore *et al*., 2005). Paleoclimate reconstructions will be performed with the bioindic package (Guiot and Gally, 2014).

Milestone results: Pollen assemblages will be used to infer past climate variability. Pollen quantitative palaeoclimate reconstructions will also be compared with reconstructed data from Tasks 1.2 and 1.3. The quantitative reconstruction will reflect more accurately the shifts in climate variables (July temperature (°C), January temperature (°C) and annual precipitation (mm)) on regional vegetation composition and peatland surface wetness through time and will be used as input to the DigiBog model (Part IV) in order to explore the interactions between climate, peat accumulation and vegetation dynamics.

Part III: Present-day peatland water budget and quantification of groundwater interactions

Responsible: M. Larocque; *Collab*. M. Garneau, A.J. Baird, P.J. Morris and E.Rosa; *HQP*: MSc3

Context and objective: Recent studies (Bourgault *et al.* 2014; Levison *et al*., 2014) have quantified interactions between a superficial aquifer and a peatland. It is not clear yet under which geological, topographical and climatic conditions groundwater inflow to a peatland can occur. The objective of Part III is to test the hypothesis that groundwater inflow is a significant input to the two studied peatlands in order to provide insight of their hydrological resilience to climate variations.

Hypotheses : 1) the two selected peatlands receive groundwater from the surrounding superficial aquifer located in the permeable till deposits which contributes to their hydrological balance and nutrient regime, and 2) an increase of runoff and/or infiltration due to increased precipitation, lower evapotranspiration, or impermeabilisation of the hillslope surface (e.g. through fires) can increase water inputs which influence peatland hydrology and nutrient balance.

Task 3.1 Data acquisition in the field

Methods : The topographic surveys obtained in Task 1.3 will allow the geomorphologic reconstruction of the two basins in which peatlands developed. A 3-D conceptual model of the geometry of the peatlands and their watersheds will be developed in ArcGIS (licence available) using high-precision Google Earth Pro data. From these reconstructions, each peatland will be divided in four quadrants, each equipped with two piezometer (Total 16) (A.I.,615N, 12"; see *Budget justification*). Water level loggers (Total 16) (3001 Junior Edge, M5/F15; see *Budget justification*) will be installed in all the wells to monitor hourly water levels. Surface outflows from the peatland will be monitored through a handmaid triangular weir instrumented with a level logger and located at the main peatland outlet (see *Budget justification*). Slug tests will be performed on the wells to estimate hydraulic conductivity of the mineral and organic deposits. Hydraulic conductivities will also be estimated from peat coress retrieved adjacent to the dipwells.

Milestone results: Task 3.1 will provide the necessary data necessary to define precisely the 3D hydrostratigraphy of the aquifer-peatland system. This data will allow to identify and quantify the current interactions between the peatland and the aquifer.

Task 3.2 Quantify the peatland water budget

Methods: A piezometric map will be drawn for the peatland watersheds and for the peatlands themselves providing indications of groundwater flow at the two sites. Precipitation data will be measured at the weather station on the airfield near to the mine. Evapotranspiration will be calculated using data from this weather station with simple methods based on air temperature (e.g. Oudin *et al.* 2005) and with other complex methods (e.g. Priestley and Taylor, 1972). Groundwater inflow and outflow will be calculated using the Darcy equation and the hydraulic conductivity of the organic deposits (Rosenberry and LaBauch, 2008). Flow out of the peatland at the outlet will be calculated with data from the weir. Storage variations within the mineral deposits and within the peatland will be calculated using the water table variations. *Milestones results*: Task 3.2 will provide an estimation of the relative importance of the water budget components for two hydrological years (2017-2018 and 2018-2019), with their associated errors. This information will provide indications on the importance of lateral groundwater inflow to the peatland.

Task 3.3 Simulate the current and past hydrologic cycle for the two peatland watersheds

Methods: In this task we will develop a water budget model for the peatland. To determine what level of complexity will be necessary to obtain realistic flows and water levels, two different approaches will be attempted. A simple water budget model will be developed in Matlab (licence available) to represent the measured flows from the water budget components during the study period. A numerical model will also be built with Modflow, similarly to the application of Levison *et al.* (2014), to estimate subsurface flow within the watershed, including flow through the peatland. The two models will be compared for their capacity to reproduce the relative importance of fluxes at the two sites. The models will be used to investigate the short-term hydrological effects of changes in meteorological conditions.

Milestones results: Task 3.3 will provide quantitative tools to test whether the water budget conditions measured during the study period reflect a thorough understanding of the peatland hydrological functions. This quantitative understanding of short-term flow conditions will provide insight to for the understanding of long-term climate impacts.

Part IV: DigiBog simulations for ecohydrological reconstructions in peatlands.

Responsible: M. Larocque; *Collab*. A.J.Baird, P.J.Morris, M. Garneau and M. Lavoie; *HQP*: Postdoctoral fellow

Context and objective: We will use a 2-D or 3-D realisation of the most recent version of the DigiBog model (Morris *et al.*, 2015) to simulate the Holocene development of the study sites, and in particular their reponse to climate change from the Neoglacial onwards. Our previous work has shown that peatlands can exhibit complex responses to changes in precipitation and temperature (Morris *et al.*, 2015), and we will use the model to study climate change impacts at the sites but also the role of linkages with the wider catchment (e.g., surface and groundwater exchanges).

Hypotheses: 1) peatlands show a degree of homeostasis (internal stability) in response to external forcing, but 2) also show tipping point behaviour (regime shifts) when external forcing exceeds certain thresholds. 3) The DigiBog model can reveal the likely combination of forcing conditions required for aqualysis.

Task 4.1 Integration of the different proxy data from Part I and II

Methods : The different proxy data : testate amoebae, plant macrofossils, pollen, peat accumulation and humification reconstructed in Part I and Part II of the project will be used to test DigiBog, which produces virtual peatlands and 'virtual cores' of peat that can be compared to actual cores.

Milestone results: With the most recent version of the DigiBog model (version 3 in progress), in which seasonal variations of precipitation and evapotranspiration can be represented, we will identify the likely

mechanisms responsible for aqualysis and the degree to which changes in peatland surface wetness are driven by processes internal to the peatland and by external forcing.

Task 4.2 Experimental design

Methods: The DigiBog simulations will be set to start from *ca* 5500 cal years BP when peat began accumulating in the region (Dyke, 2004). The model will be driven using climate reconstruction(s) representative of temperature and precipitation from the two study sites. The reconstructions will be generated in a manner similar to that previously employed by Morris *et al*. (2015) using a combination of GCM hindcasts (e.g.Valdes *et al*., 2017) and gridded multiproxy reconstructions (e.g., Viau & Gajewski, 2009), downscaled for our sites based on local instrumental data.

Milestone results: The simulated time series of peat accumulation, peat humification, vegetation changes and water table depths variations will be compared with the palaeoecological data collected in Part I and Part II. Different parameterisations of the model will be used to see which provides the most plausible representation of the sites and the factors that influenced their development.

Task 4.3: Peatlands ecohydrological modelling

Methods: DigiBog simulates a vitrual peatland that can be 'cored' a bit like a real peatland. For a range of scenarios (model runs), in which we explore different ways in which the studied peatlands interact with their wider catchment, we will compare these virtual cores with the real core data. Such comparisons will help us establish how well DigiBog simulates the developmental history of the peatland and which scenario provides the best explanation of the aqualysis phenomenon.

Milestone results: The model outputs will allow us to identify the most important factors that influenced the ecohydrological development of the study sites. As well as accounting for climate changes, our model runs will represent peatland – mineral aquifer transfers of water as discussed in Part III.

3.4 Work plan

The schedule of activities is summarized here and detailed in the *Activity Schedule* section of *Form 101*. The proposed project has a three-year duration with a planned starting date in August 2017. The extensive 2016 field campaign (section 3.1) allowed us to document the regional geomorphological and ecological contexts of the study sites, to ensure they were appropriate for our work, and to collect surface samples and peat cores, so providing key information that will underpin the proposed study. Our past experience in leading field and modelling studies suggest that a 3-years project is appropriate for the planned work. During year 1, piezometers will be installed on the two sites as described in Part III. Dismantled in October 2017, the equipment will be re-installed from May 2018 and 2019 for the whole duration of the growing seasons. Paleo data produced in year 1will provide support for the Digibog simulations in years 2 and 3. Development of further simulations that will include groundwater exchanges will be processed in year 3. Visits in the sites during seasons 2017 and 2018 are planned for the different team members. A synthesized work calendar (Gantt diagram) has been added at the end of the *Budget Justification* file.

3.5 Role of students

MSc 1 (Mylène Robitaille, UQAM) will undertake the paleohydrological and paleoecological reconstructions; see tasks 1.1, 1.2 and 1.3 in Part I. She will be supervised by Garneau and co-supervised by Lavoie. **MSc 2** (to be determined; starting date September 2017, ULaval) (supervised by Lavoie and co-supervised by Garneau) will reconstruct the Holocene regional vegetation and related climate variations in terms of temperature and precipitation; see tasks 2.1, 2.2 and 2.3 in Part II. MSc 3 (to be determined; starting date January 2018, UQAM) (supervised by Larocque and co-supervised by Garneau and Rosa) will study the water budget of the two peatlands, see tasks 3.1, 3.2 and 3.3 in Part III. Finally, the DigiBog modelling (Part IV) will be realized over 1.5 year (2018-2019) by a postdoctoral candidate under the supervision of Larocque (UQAM) with close collaboration of professors P.J. Morris and A.J. Baird from the University of Leeds (United Kingdom) who will make available the DigiBog code. The candidate Marc-André Bourgault is the ideal candidate for the position considering his expertise in peatland hydrogeology and modelling work. Bourgault will work closely with professors Baird and

Morris and he will spend some time of his mandate at the University of Leeds for closed collaboration and training. Finally, Sylvain Gagné, an experienced research professional in hydrogeology, will help with the field logistics, equipment and some work coordination. At least one scientific paper related to each objective of the project will be published and co-authored by the different collaborators in 2020.

4. TEAM EXPERTISE AND RESEARCH MANAGEMENT

Pr. Garneau will be the project leader. She is a paleoecologist and professor in biogeography at Université du Québec à Montréal and regular member of the Geotop research center. Throughout her career Pr. Garneau has led several successful partenarial projects linking paleoecology and paleoclimatology in relation to carbon dynamics in peatlands. She has contributed to significant scientific progress on the present-day and Holocene carbon dynamics of peatlands from the Canadian boreal biome (see Form 100). She will be directly involved in Part I and Part II of the project and indirectly involved in the two other Parts (III and IV). As the project leader, Pr. Garneau will ensure scientific leadership, coordination between the members and manage the budget. She will also ensure the cohesion within the different objectives and highlight the multidisciplinary approach by organizing regular meetings and scientific activities. She will be in communication with the industrial partners and assure knowledge transfer especially relative to the index of biological integrity that will be developed and used in other projects affected by the northern development. She will be responsible to ensure visibility by supporting the graduate students and professors in participating in conferences and seminars and publishing results in high-profile scientific journals with an emphasis on co-authored papers.

Pr. Lavoie is from the Department of Geography and Centre for Northern Studies at Laval University (Québec). He is a paleoecologist working on the long-term forest dynamics (vegetation history, ecological perturbations) and peatlands, mainly in boreal and temperate regions, using pollen, plant-macrofossil and macroscopic charcoal analysis. He will lead Part II of the proposal which aims at reconstructing postglacial vegetation and climate history and will co-supervise the MSc project described in Part I.

Pr. Larocque is a hydrogeologist from the Département des sciences de la Terre et de l'atmosphère at Université du Québec à Montréal and regular member of the Geotop research center. She has an extensive experience on wetland hydroecology and on groundwater-surface water interactions. She uses field scale studies and fully-coupled flow modeling to understand the impacts of climate change on water resources and ecosystems. She will lead the part of the project described in Part III of the proposal with the collaboration of **E. Rosa** (UQAT) and coordinate along with Pr. Garneau the modelling section (Part IV) in collaboration with Pr. P.J. Morris and A.J.Baird.

The collaborator E. Rosa is a regular member of Geotop. He is a hydrogeologist specialized on wetlands. He will contribute to Part III of the proposal by co-supevising MSc3. The two other collaborators **Dr. P.J. Morris** and **Pr. A.J. Baird** from the University of Leeds (United Kingdom) will contribute to the DigiBog modeling (Part IV) along with the postdoctoral candidate and with the collaboration of Pr.Larocque and Pr. Garneau. Dr. P.J. Morris is a young and succesful scientist with experience in peatland development modeling and ecohydrology; he developed the DigiBog model suite jointly with Pr. Baird as well as a number of other peatland development models. Pr. Andy Baird holds the Chair of Wetland Science at the University of Leeds. He has expertise in wetland ecohydrology, wetland carbon (C) cycling, and the modelling of wetland processes. He helped build the DigiBog peatland development model suite with Morris (see above).Their involvement in the project represents an excellent and original added value in the field of ecohydrology in peatlands from Canada and their contribution will generate fruitful international collaboration. Finally, the involvement of a research professional **Sylvain Gagné** (hydrogeologist, UQAM) will contribute to the field logistics and equipment required in Part III of the project. He will also be involved in some work coordination.

5. HIGH QUALIFIED PERSONAL

This multidisciplinary project will involve the contribution of three MSc students and one postdoctoral fellow. The involvement of the collaborators Baird and Morris will benefit to the graduate students as it

is the first time that such scientific inputs are developed between Canada and UK. In 2018, a workshop and field campaign is planned at the Mine Renard site and will include the different team members and the industrial partners. The three MSc students will present their results and receive useful feedback on their work that will help ensure project success. They will work with our industrial partners, to the development of an index for biological integrity in peatlands that we aim to be applied in further research and development projects on the northern territory along with the government and the industries. The postdoctoral fellow will contribute to synthesize the data provided by the MSc and integrate them into a model that will allow to indentify the most sensitive parameters that influence peatland ecohydrological and carbon balance. It is planned that he will spend some months in Leeds to work in close collaboration with Baird and Morris. In addition to those HQP candidates, 1 or 2 undergraduate students will be involved in the project as summer or laboratory assistant with NSERC-USRA funding along with Garneau or Larocque NSERC-DG supplement. A close collaboration is ongoing with the two industrial partners through Benjamin Jacob (Stornoway) and Simon Thibault (Nemaska Lithium) mainly and is planned to continue in the context of the northern development and protection of wetlands as recommended by the Ministère du Dévelopement Durable, de l'Environnement et de la Lutte aux Changements Climatiques (MDDELCC). This collaboration that implies fundamental and applied research will benefit the students throughout the whole project duration. Recommendations for conservancy management to the MDDELCC are planned at the end of the project.

6. VALUE OF THE RESULTS AND INDUSTRIAL RELEVANCE

It has been estimated that the Renard Diamond Project from Stornoway company will result in a loss of 17,1 ha of wetlands of high ecological value. In virtue of the « *Loi concernant des mesures de compensation pour la réalisation de projets affectant un milieu humide ou hydrique* » of the Quebec government, proposed compensation measures should be aimed at the restoration, creation and protection of wetlands, or acquisition of knowledge of these ecosystems. In this context, several actions have been proposed to the government. One of these corresponds to the present project and aims to support acquisition of knowledge on the ecology, carbon dynamics and hydrology on peatlands in order to develop an index of ecological integrity for vulnerable peatland systems in the context of ongoing development of the northern territory. This contribution will benefit to both of our contributing industrial partners.

7. BENEFIT FOR CANADA

In Canada, boreal peatlands occupy 12% of the land surface. These ecosystems are thought to play a significant role in the carbon cycle both in terms of CO_2 and CH_4 exchanges. In central-north Quebec, peatlands have registered ecohydrological disequilibrium over the past millenia with the transformation of terrestrial vegetated microforms into wet hollows and pools during the past centuries. These changes may increase emissions of greenhouse gases such as CO_2 and CH_4 so it is important to improve understanding of the mechanisms involved in the long-term development of the peatlands to predict more accurately their evolution in the context of ongoing climate change. Peatlands can play an important role in climate change adaptation and mitigation and enhance the provision of ecosystem services by storing carbon and decreasing greenhouse gas emissions into the atmosphere. Approximately 150 Gt C is stored in Canadian peatlands, representing > 50% of total soil carbon stocks. A better understanding of the processes involved in C sequestration in high latitude ecosystems and the consequences of their transformation from sinks to sources induced by natural and anthropogenic changes has become fundamental. Peatlands in central-north Quebec are vulnerable to recent climate changes but also by the mining activities of industrial projects. It is then important to document the ecohydrological dynamics of these systems representative of a circumboreal belt comprised between the ombrotrophic and minerotrophic peatlands distribution and that are very senstive to climate variations hence, future GHG balance.

Michelle Garneau

Formulaire 183A - Renseignements requis des organismes participant aux PPR (présenté par le candidat)

Lettre(s) d'appui

Nemaska

Conseil de recherches en sciences naturelles et en génie du Canada | Natural Sciences and Engineering Research Council of Canada

FORMULAIRE 183A

Renseignements requis des organismes participant aux programmes de partenariats de recherche

Lisez les instructions avant de remplir le formulaire.

RENSEIGNEMENTS GÉNÉRAUX SUR L'ORGANISME

Nom de l'organisme Nemaska Lithium	Nom et titre de la personne-ressource de l'organisme Simon S Thibault, Directeur Resp. environn. et sociale
Adresse postale 450 rue de la Gare 1er étage Québec, QC CANADA G1K3X2	Adresse postale de la personne-ressource (seulement si elle est différente) CANADA

Numéro de téléphone 1 (418) 7048038	Numéro de télécopieur 1 (418) 6140627	Numéro de téléphone 1 (418) 7048038 ext 228	Numéro de télécopieur 1 (418) 6140627
Adresse de courriel		Adresse de courriel Simon.thibault@nemaskalithium.com	

Votre organisme est-il [X] du secteur privé? [ ] un ministère ou un organisme gouvernemental? [ ] la propriété de l'État?

Code de produits et services industriels
3000 PRODUITS MINÉRAUX NON MÉTALLIQUES
1400 EXPLOITATION DES MINES ET DES CARRI
9999 TOUTE AUTRE INDUSTRIE

Votre organisme est-il [X] à but lucratif? [ ] à but non lucratif?

Site Web: www.nemaskalithium.com

Propriété canadienne (en pourcentage) (s'il y a lieu): 100 %	Date de constitution en société au Canada (s'il y a lieu): 2007 / 05	Nombre total d'employés au Canada: 55
Type de produits vendus ou de services offerts Concentré de spodumène, hydroxyde et carbonate de lithium		Ventes annuelles totales de l'année préc. (s'il y a lieu) Bénéfice net (perte nette) de l'année préc. (s'il y a lieu)

Votre organisme est-il [X] la société mère? [ ] une filiale? (précisez)

ACTIVITÉS DE RECHERCHE ET DÉVELOPPEMENT

Votre organisme comprend-il une section de R et D? Oui [ ] Non [X]

Dans la négative, mène-t-on de la R et D dans ses locaux? Oui [ ] Non [X]

Nombre d'employés en R et D au Canada Scientifiques et techniciens :

Employés en R et D titulaires d'un doctorat :

Dépenses annuelles de R et D
année précédente :
courante :
subséquente :

RENSEIGNEMENTS SUR LE CANDIDAT

Nom de famille Garneau	Prénoms Michelle	Initiale(s) de tous les prénoms M
Titre de la proposition Holocene ecohydrological dynamics and related carbon balance in the oligotrophic peatlands of north-central Quebec		N° d'identification personnel (NIP) 109930 N° de la demande (réservé au CRSNG)

CONTRIBUTION DE L'ORGANISME

Contributions affectées aux coûts directs de la recherche	1re année	2e année	3e année	4e année	5e année
a) Contributions en espèces	13,043 $	13,043 $	13,043 $		
b) Contributions en nature	9,600 $	9,600 $	9,600 $		

Votre organisme a-t-il reçu un appui du secteur public pour de la R et D directement liée au projet proposé? Oui [ ] Non [X]

Le candidat et un ou des membres du groupe sont-ils indépendants de votre organisme? Oui [X] Non [ ]

Nom, titre et numéro de téléphone du représentant autorisé de l'organisme
Simon Thibault,
Directeur Resp. environn. et sociale
1 (418) 7048038 ext 228

Signature

Date
24/05/2017

Nemaska Lithium
450, rue de la Gare-du-Palais, 1er étage
Québec (Quebec) Canada G1K 3X2
T 418 704-6038 #228 F 418 614-0627
simon.thibault@nemaskalithium.com

Quebec City, March 20, 2017

Michelle Garneau, Ph.D.
Université du Québec à Montréal
Département de géographie
Case Postale 8888, succursale centre-ville
Montréal (Québec) H3C 3P8

Object: Letter of Intent – RDC Grant Application for "Holocene ecohydrological dynamics and related carbon balance in the oligotrophic peatlands of North-Central Quebec, Canada"

Dear Pr. Garneau,

Nemaska Lithium is a Canadian lithium company listed on the TSX Venture under the stock symbol NMX. Nemaska Lithium intends to become a lithium hydroxide and carbonate supplier to the emerging lithium battery market that is largely driven by electric vehicles, large scale lithium battery storage and 3C devices (ex. cellphones, tablets, and portable computers). The Company is located in Quebec City while the mine project (Whabouchi) is located about 30 km east of the Cree Community of Nemaska, in the Eeyou Istchee James Bay region, Quebec.

Spodumene concentrate produced at the aforementioned future lithium mine (Whabouchi Project) and potentially from other global sources will be shipped to the Company's lithium hydroxide/carbonate processing plant to be located in Shawinigan, Quebec. This plant will transform spodumene concentrate into high purity lithium hydroxide and carbonate. The Whabouchi Project has an initial mine life of 26 years as per the 43-101 compliant feasibility study published in June 2014 and updated in April 2016.

The Whabouchi Mine Project being located in the boreal region, more specifically in the James Bay Lowlands ecological region, the protection and respect of both social and biophysical aspects of the environment in which it will take place are of high importance for Nemaska Lithium. As such, the Canadian Environmental Assessment Agency, the Canadian Minister of Environment, the Cree-Quebec Review Committee (COMEX) as well as Quebec's Minister of Sustainable Development, Environment and the Fight against Climate Change (MDDELCC) all recognized Nemaska Lithium's efforts to identify and mitigate the potential impacts associated to its project by issuing all required authorizations for the Whabouchi Mine Project to move forward.

Among the conditions included in the aforementioned authorizations is the obligation for Nemaska Lithium to elaborate and implement a Wetland Compensation Plan based on the concept of ecological value. Thus, Nemaska Lithium has to compensate all wetland losses caused by its mine project in compliance with the requirements of the *Act Respecting Compensation Measures for the Carrying out of Projects Affecting Wetlands or Bodies of Water* (CQLR c. M-11.4) and, to do so, it must first have established the ecological value of the impacted wetlands. However, in Quebec, there are no adequate criteria to define the ecological

value of wetlands, especially peatlands, located in the boreal region as all criteria used by the MDDELCC were determined for the St-Lawrence Valley region in Southern Quebec.

What Nemaska Lithium has therefore proposed to the MDDELCC is the elaboration and completion of a scientific research program which would aim specifically at determining social and biophysical criteria to determine the ecological value of boreal peatlands in the Eeyou Istchee James Bay region. Such research program would act as Nemaska Lithium's Wetland Compensation Plan.

The project you are proposing is, in our opinion, a comprehensive and perfectly-suited answer to the problem Nemaska Lithium, as well as any other mining company developing projects in Northern Quebec, is experiencing. Such scientific works definitely aim at filling significant gaps in our knowledge of boreal peatlands and improving how project development can be done in the North in a sustainable way. It represents a direct solution to a problem all industrial project proponents are or will be experiencing as project development moves forward, especially in the context of Quebec's Plan Nord.

As the Director of Environmental and Social Responsibility for Nemaska Lithium, I accept with enthusiasm your invitation to participate in this collaborative project, one that relates to improving our scientific knowledge of boreal peatlands of the Eeyou Istchee James Bay region. I will lend my expertise mostly in regards to my knowledge of the study area and therefore help maximize the potential benefits of the project, for both the mining industry and the region.

As part of this Collaborative Research and Development (CRD) project, Nemaska Lithium intends to be an industrial partner through both cash and in-kind (technical expertise and support, logistics, etc.) contributions. Those are outlined in the attached F183a form.

If you have any questions, please feel free to contact the undersigned.

Sincerely yours,

Simon Thibault, M.Sc., biologist
Director of Environmental and Social Responsibility

PROFILE OF THE COMPANY

Nemaska Lithium

Nemaska Lithium intends to become a lithium hydroxide supplier and lithium carbonate supplier to the emerging lithium battery market that is largely driven by electric vehicles. The Company is located in the mining friendly jurisdiction of Quebec, Canada. Nemaska Lithium has received a notice of allowance of a main patent application on its proprietary process to produce lithium hydroxide and lithium carbonate. The Company is pursuing patent protection on this process in multiple global jurisdictions.

In tandem, the Company is developing one of the richest spodumene hard rock lithium deposits in the world, both in volume and grade. Spodumene concentrate produced at Nemaska's future lithium mine (Whabouchi) and from other global sources will be shipped to the Company's lithium hydroxide/carbonate processing plant to be located in Shawinigan, Quebec. This plant will transform spodumene concentrate into high purity lithium hydroxide and lithium carbonate for the growing lithium battery market which is driven by the increasing demand for electric vehicles and large scale lithium battery storage. The Nemaska Whabouchi spodumene deposit, located in the Eeyou Istchee / James Bay Region of Quebec, Canada, near the Cree community of Nemaska, should have an initial lithium mine life of 26 years.

Annexe 3-6

Comptes-rendus des rencontres du Comité Environnement et présentations faites aux représentants cris

NEMASKA LITHIUM // WHABOUCHI MINE PROJECT

WHABOUCHI ENVIRONMENT COMMITTEE

DATE: January 25, 2017

Were present:			
Aurora M. Hernandez	Cree Nation Government (CNG)	Environmental Analyst - Mining	AH
Lucas Del Vecchio	Cree Nation Government (CNG)	Environmental Analyst - Mining	LDV
Walter Jolly	Cree Nation of Nemaska (CNN)	Councillor	WJ
Stella M. Wapachee	Cree Nation of Nemaska (CNN)	Councillor	SW
Matthew Tanoush	Cree Nation of Nemaska (CNN)	Director of Land and Environment	MT
James Wapachee Sr.	Cree Nation of Nemaska (CNN)	R20 Tallyman	JW
Nancy Wapachee	Cree Nation of Nemaska (CNN)	R20 Tallyman's wife	JW
Pierre Mercier	Nemaska Lithium (NMX)	ESR Coordinator	PM
Simon Thibault	Nemaska Lithium (NMX)	Director ESR	ST
Were absent:			
Wayne Rabbitskin	Nemaska Lithium (NMX)	Community Liaison Agent	WR
Gregory Jolly	Cree Nation of Nemaska (CNN)	Deputy Chief	GJ

ITEMS	ACTIONS
Go around the table to present the participants. Agenda presented and adopted. Google Drive folder presented to all.	
Presentation by ST (see PowerPoint). Update on project advancement (mine construction, bulk sample and mini-DMS, potential mine expansion, etc.).	PowerPoint presentation uploaded on Google Drive
Mine Site visit for the Env. Committee on Feb. 20, 21 or 22.	Organized by ST and PM
Communication Strategy - Trimestrial Newsletter (paper copy) distributed in the community (door-to-door) as a stand-alone pamphlet-like document and posted on Facebook (Nemaska Announcements page). See example produced by Hydro-Quebec. Importance of having a nice front page, with pictures and maps. - Newsletter to include contacts for community members to express concerns, ask questions, complaints, etc. Suggestion to have WR, PM, GJ and/or MT as contacts. The Newsletter could be a 4-page hand-out which would include 3 pages of "news" and 1 page of "what is the Env. Committe", who's part of it, its role, contacts and complaints registry. - Annual Report for technical information on Env. Committee's tasks, to be prepared using NMX's annual Env. report that is required as per permits but requires significant vulgarization. - Bi-annual open information session in the community (fall and spring) that is advertised on Facebook and local radio. - DVDs with video in Cree (subtitled in English) to generally present the Chinuchi Agreement, WIC, Env. Committee, funding, training, business, employment (see Summary prepared by CNG and CNN) + contacts for comments/questions. Could also be a DVD with two videos on it, one in English and one in Cree. - JW to provide a documentary video that could be added to the aforementioned DVD for distribution to community members. - Participants of the Env. Committee also have the responsibility to disseminate information to their respective "Focus Groups" (ex. land users, women, Band Council). - Nemaska Lithium should do an annual presentation at Nemaska's AGA. Could also be done at various General Band Meetings over the year. - ST to be the representative of the Env. Committee at the WIC (i.e. the channel of communication). Will present the results of the Env. Committee meetings to the WIC, as well as the recommendations, concerns, etc.	Next meeting : Define responsibilities of Committee members regards to Communication Strategy. ST has to represent the Env. Committee at next WIC meeting (Feb. 2nd, 2017).
Permitting - Send a list of all permits (table)	List of Permits uploaded on Google Drive by ST
NMX Organizational Chart (Whabouchi mine site) - contact persons for Env. and Social aspects, as well as mine construction and operations.	To be added on Google Drive by ST
Domestic Waste Water Management - Big issue with domestic waste water from mine site that is still being dumped sporadically (during Christmas time) to Nemaska treatment facility. - ST and JW to talk to Meeyobin-Iywaashtin-Savard about the restriction of dumping wastewater in Nemaska's lagoon. - MT to talk to Public Works Dept. and George Wapachee about the restriction of dumping wastewater in Nemaska's lagoon. - MT suggests that the Hydro-Quebec site should be used for domestic waste water management, not Nemaska and not Chibougamau. NMX should sign an agreement with Hydro-Quebec. ST mentions that this was tried, but that it was unsuccessful.	ST and JW to discuss with MIS, while MT has to discuss with all Directors of CNN
Environmental and Social Surveillance Program - Description of the program and Eco-Permit Procedure	Documents added on Google Drive by ST
Environmental and Social Monitoring Plan (ESMP) - Training of Cree individuals, especially Nemaska, for environmental monitoring (ex. BHEAR). Coordination of training by PM. - Discussion with Wabajuu (Englobe) as well as with James Wapachee (Desfor) for such training to be done by these companies, under the supervision of PM. - AH mentions that she can provide support to have this training program not limited to Nemaska Crees, but also expand to all Crees (ex. perform an environmental diagnosis of Mountain Lake with CNG and using this to train Crees). - Environmental and Social Monitoring Plan will be provided in English soon; a dedicated session of the Env. Committee should take place to explain the plan in details. - JW and NW mentionned the possibility for water to outflow from Mountain Lake to the small lake located near Bible Camp and which is used as a water drinking source. Monitoring station should be added there for water quality (drinking water criteria).	Training on environmental monitoring to be coordinated by PM English version of ESMP to be uploaded on Google Drive by ST
Mine Rehabilitation and Closure Plan (MRCP) - Opportunities for somekind of training on mine rehabilitation and closure (ex. Troilus, Mine Principale) or Whabouchi mine site when progressive revegetation works will start. - NMX has initiated a research program with Sherbrooke University (Pr. Sébastien Roy) to improve revegetation methods and adapt them to boreal conditions. - Site visit at Troilus Mine Site for summer 2017 for the Env. Committee.	French version of MRCP sent to MERN uploaded on Google Drive by ST. Site visit at Troilus in summer 2017 to be organized by ST.
Emergency Measures Plan (EMP) - Will be provided in English soon. - Needs coordination with Band Council, Public Safety Dept., HQ, etc. - In case of emergency evacuation at Camp, could the Nemaska Sports Complex be used to temporarily host the workers ?	English version of EMP to be uploaded on Google Drive by ST
Location of the mine final effluent in Mountain Lake - Have prepared a cross-section view of the depth profile of the pipeline going to scenario A (mouth of Nemiscau River) using existing bathymetric data, focusing on the "Bible Camp" sector. - Perform ASAP detailed bathymetric survey along the pipeline path to scenario A. - See how technically feasible (and "DFO-permittable") it is to have the subaquatic pipeline installed under the bottom of the lake ("underground"), all along the way or only in the "Bible Camp" sector. - Meeting to take place at Bible Camp with R20 Family on this issue; presentation to be made by NMX with support from CNG. Invitation letters to be prepared by ST and sent to SW for distribution. Dinner or snacks to be provided by Peggy Wapachee (coordinated by WR). Meeting on same day as mine site visit (Feb. 20, 21 or 22).	ST to gather data on pipeline location ST to send invitation letters for R20 Familiy to SW for distribution
Borrow Pits - Maps included in the Application for an Exemption submitted to the COMEX was shown. Sites ok.	WR to provide information letter also to Reggie Wapachee
Fish Habitat Compensation Plan (FHCP) - Fish Habitat Compensation Plan will be provided in English soon, along with clear figures depicting the proposed works and associated monitoring.	English version of FHCP to be uploaded on Google Drive by ST
Wetland Compensation Plan - Research Project with UQAT and UQAM. - Collaboration with several industrial partners including NMX, Stornoway, Hecla Mining, Agnico-Eagle, MDDELCC, MFFP, Abitibiwini First Nation, and potentially CNG.	Information uploaded on Google Drive by ST
Solid Waste Management - Recyclage Ungava is in charge for the construction phase; all is shipped to Chibougamau (dry wastes, hazardous wastes) and so there is zero waste being managed in Nemaska. - For the operation phase, discussion should take place with Mr. Paradis and MT for waste management (other than hazardous wastes) and especially domestic wastes generated at the Camp. An agreement should take place between NMX and CNN for partial waste management during operation phase.	Discussion to take place between ST, MT and PM.

NEMASKA LITHIUM // WHABOUCHI MINE PROJECT			
WHABOUCHI ENVIRONMENT COMMITTEE			
DATE: September 13, 2017			
Were present:			
Lucas Del Vecchio	Cree Nation Government (CNG)	Environmental Analyst - Mining	LDV
Aurora M. Hernandez	Cree Nation Government (CNG)	Environmental Analyst - Mining	AH
Walter Jolly *(partly)*	Cree Nation of Nemaska (CNN)	Councillor	WJ
Stella M. Wapachee *(partly)*	Cree Nation of Nemaska (CNN)	Councillor	SW
Matthew Tanoush	Cree Nation of Nemaska (CNN)	Director of Land and Environment	MT
James Wapachee Sr. *(partly)*	Cree Nation of Nemaska (CNN)	R20 Tallyman	JW
Nancy Wapachee *(partly)*	Cree Nation of Nemaska (CNN)	R20 Tallyman's wife	NW
Wayne Rabbitskin	Nemaska Lithium (NMX)	Community Liaison Agent	WR
Pierre Mercier	Nemaska Lithium (NMX)	ESR Coordinator	PM
Simon Thibault	Nemaska Lithium (NMX)	Director ESR	ST

ITEMS	**ACTIONS**
Agenda presented (available on Google Drive and by e-mail)	
Review of minutes of the previous meeting - The other members of the Committee were not able to participate in the site tour since it was the 40th anniversary of the Nemaska settlement. They where all involved in activities for the celebration, but PM provided MT, JW, NW and WJ with his contacts so they can contact him whenever they want to have a visit of the mine site. - MT mentions that, to his knowledge, NEC is not dumping its wastwater in the community's lagoon anymore. However, he also mentions Ruben Jolly is in charge of this and he knows best about it. - The community newsletter initially to be issued in April 2017 was so only at the AGA at end of August. MT provides everyone with a copy. - The first NMX trimestrial letter is to be issued for the open session scheduled on October 10. More details below in the "Communication Strategy" section. - NW to provide WR with video footage on the R20 family for use in a documentary on the Whabouchi Project, the Chinuchi Agreement and the R20 family. - Next Environment Committee meeting will take place in November and will be fully dedicated to Environmental and Social Monitoring. - A session on the Fish Habitat Compensation Plan will be scheduled once its approval by the Canadian Department of Fisheries and Oceans will have further progress.	NW ST
Update on Project Development - End of operations at the end of August for the DMS modular mill. Production of spodumene concentrate was a full success with high-quality products being produced. - Meeting took place on May 17 with the R20 and R19 families on the **location of the final mine effluent** in the Nemiscau River instead of Mountain Lake. The relocation was approved by the families and thus applications for modifications to certificates of authorization and permits have since been issued to provincial and federal authorities. - **Permitting** is ongoing with multiple certificates of authorization still to be obtained, including among others for the location of the aforementioned mine final effluent pipeline and for the operation of the mine. NMX was recently informed that the approval of its Mine Closure and Rehabiltation Plan will soon be completed and thus the mining lease be issued. AH recommends that once approved, the Environment Committee should have a session dedicated to this Plan. Permits for borrow pits are also soon to be obtained, the location of those having been provided to JW this spring. - Close monitoring of conditions included in the federal and provincial authorizations is done by the CEAA and COMEX. All communications between these entities and NMX are also provided to CNG. Non-conformitites to be added to the update on project development for next meetings. - Construction of the experimental cells by the UQAT-IRME for additional geochemical, geotechnical and hydrological studies on the projected co-disposal pile will start in the week of October 9. The site is located at about km 278 of Route du Nord. - Site visits took place with Environment and Climate Change Canada (July 11), Canadian Environmental Assessment Agency (August 15) and the MDDELCC (September 12). No non-compliance were observed as to our knowledge.	
Training Programs - Trucking Class 3 started in May 2017 and Trucking Class 1 scheduled to start in Fall 2017, same for Bus Driving. All are offered by Cree School Board. - Heavy Equipment Operations started in July 2017 at mine site, and is offered by the CFP-James-Bay. -An additional training program dedicated to Nemaska Crees will start in October 2017 for environmental monitoring (Beahr Eco-Canada Program; http://www.eco.ca/beahr/program-options) and is offered by NMX and Wabajuu Environment. - Serious concerns express by ST and WR on how Cree School Board is progressing with the Drilling and Blasting program. Support from Chief and Council is needed. WR and ST explain how relevant was the support offered by Steven Wanamaker when is was acting as an advisor for the Cree Nation of Nemaska and recommends he is replaced to continue that way. WR mentions that several community members were looking forward to that program and have missed other opportunities to be part of it. This negatively impacts their perception on the NMX's project. - Considering the delays for the Cree School board to organize the Ore Processing program, NMX decided to postpone it to 2019 when the commercial plant will be in operation. This decision had to be made since the DMS modular mill was shutdown at end of August. Students will therefore be trained as part of the mine operation phase, directly in the mine concentrator.	
Project Schedule NMX is now completing project financing and plans to increase level of construction activities at mine site at the end of October, when financing is to be completed. All efforts are now deployed in Shawinigan to process spodumene concentrate and produce high-quality lithium compounds from it to qualify final products with future clients. There is still a low probability that financing is not completed in a timely manner, i.e. before winter conditions, something which would have a significant impact on construction schedule, but NMX is now putting all efforts on completing financing by end of October so that construction can go ahead as projected and construction activities increase from November and moving forward.	

NEMASKA LITHIUM // WHABOUCHI MINE PROJECT			
WHABOUCHI ENVIRONMENT COMMITTEE			
DATE: September 13, 2017			
Were present:			
Lucas Del Vecchio	Cree Nation Government (CNG)	Environmental Analyst - Mining	LDV
Aurora M. Hernandez	Cree Nation Government (CNG)	Environmental Analyst - Mining	AH
Walter Jolly *(partly)*	Cree Nation of Nemaska (CNN)	Councillor	WJ
Stella M. Wapachee *(partly)*	Cree Nation of Nemaska (CNN)	Councillor	SW
Matthew Tanoush	Cree Nation of Nemaska (CNN)	Director of Land and Environment	MT
James Wapachee Sr. *(partly)*	Cree Nation of Nemaska (CNN)	R20 Tallyman	JW
Nancy Wapachee *(partly)*	Cree Nation of Nemaska (CNN)	R20 Tallyman's wife	NW
Wayne Rabbitskin	Nemaska Lithium (NMX)	Community Liaison Agent	WR
Pierre Mercier	Nemaska Lithium (NMX)	ESR Coordinator	PM
Simon Thibault	Nemaska Lithium (NMX)	Director ESR	ST

ITEMS	ACTIONS
Meeyobin Company - JW and NW express their concerns and issues on how are things going with regards to the business partnership they have established so far, as well as with NMX contract management policies. - AH and LDV informs that they will contact colleagues at the Department of Commerce and Industry of CNG to gather information on how CNG could help by providing business support to Meeyobin. SW proposes to do the same with Chief and Council of Nemaska. - ST mentions that once Cree entities will have help Meeyobin improve the agreements it has signed so far, it will be in a much better position to fulfill Meeyobin expectations with regards to revenue-sharing from the contracts it has obtained with its partners. ST mentions that a meeting is scheduled in Nemaska on September 27 with Iywaashtin, Meeyobin, NDC and NMC on procurement policies and business development as per the Chinuchi Agreement.	AH-LDV ST
Communication Strategy - CNG members expressed their desire in collaborating with the communication strategy. WR is responsible to follow this and contact each party, if need be. - As aforementioned, the Community Newsletter was published at the August 2017 Nemaska AGA, including information on Whabouchi Project: general update on project development, what are WIC and Env. Committees (roles, members), schedule, training programs. - Trimestrial Newsletter (paper copy, 4 pages, 8x11) will be distributed at the information session to be organized by WR in Nemaska on October 10. It will also be posted on Facebook (Nemaska Announcements page). Will include updated version of the material included in the aforementioned Community Newsletter. Newsletter to include contacts for community members to express concerns, ask questions, complaints, etc. WR and MT as contacts. The Newsletter will be a 4-page hand-out which would include 3 pages of "news" and 1 page of "what is the Env. Committe", who's part of it, its role, contacts and complaints registry. A draft will be prepared by ST for approval by the Committee. - ST has to represent the Env. Committee at next WIC meeting (October 10, 2017).	ST-WR ST
Fish Habitat Compensation Plan (FHCP) - A map locating the sites included in the most recent version of the FHCP was presented by ST. New sites were added to replacethose which were not complying with guidelines. - A future Committee meeting should be dedicated to this topic. ST mentions that this will be possible once approval by Department of Fisheries and Oceans Canada is sufficiently advanced.	ST
Wetland Compensation Plan (WCP) - COMEX has required an official WCP to be submitted by NMX, including all information provided by NMX since 2014 on that topic. An e-mail from MT acknowledging the absence of sites of interest for compensation on Nemaska territory will be attached to the WCP. - AH requires that Cree participation in the research project be effective to ensure benefits for Crees. ST recommends that CNG be a partner of the project the same way the Abitbiwinni First Nation is in order to have full access to progress report and be part of the stearing committee. ST guarantees full support from NMX to ensure benefits to Crees, ex. NMX will be the first to use the outcomes of that research project in the Nemaska area. LDV and AH will look at ways to formalize the CNG participation.	ST AH
Emergency Measures Plan (EMP) - Comments from AH on the EMP to be sent by e-mail to ST.	AH
Site Visit to Troilus Mine - ST to meet with Dany Jacob of Inmet Troilus Mine about a potential visit in summer 2018. AH recommends that Mistissini tallyman should be joining the visit as well as Hubert Petawabano (Mistissini's Coordinator of Land Management and Environment) to facilitate transfer of knowledge. - AH mentions that a future Committee meeting should be dedicated to the Mine Closure and Rehabilitation Plan since it will soon have been approved by the MERN. NMX should prepare for that session information on climate change (ex. Ouranos reports) to better assess the situation that will potentially prevail at mine closure. AH and LDV are available for supporting/collaborating with this meeting/information exchange.	ST ST-AH
Varia - AH mentions that the next IAIA conference will again host an event such as the Ashukan Conference which took place in Waskaganish last spring, but this time in South Africa. AH also mentions that it would be interesting to have NMX and JW co-presenting on the steps that lead to the relocation of the mine final effluent from Mountain Lake to Nemiscau River. This has to be rediscussed at next meeting following more details to be obtained by AH on the event. - AH will provide ST with suggestions on training and capacity-building for Committee members (ex. social impacts, business, etc.). - MT mentions a need at the community level to have more information on climate change. ST offers support on that issue. Further discussion to take place on that issue as to how NMX can help. - There was a request from the Nokiiwin Council to visit the site next year. AH will forward the request to ST so that arrangements could be made directly with the Ontario First Nation Council and CNG will provide support for organizing subsequently. - MT describes observations recently made along the shore of Champion Lake of the presence of invasive species. ST offers support on that issue. Further discussion to take place on that issue as to how NMX can help.	AH AH MT-ST AH MT-ST
Next Meeting : Site visit of Shawinigan facilities on November 23, 2017, followed by a meeting in NMX head office in Quebec City on November 24.	ST

NEMASKA LITHIUM // WHABOUCHI MINE PROJECT			
WHABOUCHI ENVIRONMENT COMMITTEE			
DATE: November 24, 2017			
Were present:			
Lucas Del Vecchio	Cree Nation Government (CNG)	Environmental Analyst - Mining	LDV
Aurora M. Hernandez *(partly)*	Cree Nation Government (CNG)	Environmental Analyst - Mining	AH
Walter Jolly	Cree Nation of Nemaska (CNN)	Councillor	WJ
Matthew Tanoush	Cree Nation of Nemaska (CNN)	Director of Land and Environment	MT
Wayne Rabbitskin	Nemaska Lithium (NMX)	Community Liaison Agent	WR
Pierre Mercier	Nemaska Lithium (NMX)	ESR Coordinator	PM
Simon Thibault	Nemaska Lithium (NMX)	Director ESR	ST
Were absent:			
Stella M. Wapachee	Cree Nation of Nemaska (CNN)	Councillor	SW
James Wapachee Sr.	Cree Nation of Nemaska (CNN)	R20 Tallyman	JW
Nancy Wapachee	Cree Nation of Nemaska (CNN)	R20 Tallyman's wife	NW

ITEMS	**ACTIONS**
Agenda presented	
Review of minutes of the previous meetings (Jan. 25, Apr. 12 and Sept. 13)	
Domestic Waste Management - MT and WJ mention that dumping of domestic wastes from CCDC camp has start back at the Nemaska Lagoon. ST precises that this is no mean related to Nemaska Lithium, but that it entirely comes from NEC (CCDC-NDC) camp. ST mentions that Ruben Jolly once mentioned to him that there would be an agreement between the Band Office and NEC to do so, but that he was not sure about it. WJ and MT mention that they are not aware of such agreement, but will investigate.	WJ MT
Communication Strategy - The Community Newsletter was published at the August 2017 Nemaska AGA, including information on Whabouchi Project: general update on project development, what are WIC and Env. Committees (roles, members), schedule, training programs, etc. - Trimestrial Newsletter (paper copy, 4 pages, 8x11) was distributed at the information session in Nemaska on October 10. It was also posted on Facebook (Nemaska Announcements page). Includes updated version of the material included in the aforementioned Community Newsletter,as well as contacts for community members to express concerns, ask questions, complaints, etc. WR and ST as contacts. The Newsletter is a 4-page hand-out. - WR will follow-up with NW about video footage for a documentary video on the R20 family and Whabouchi Project. WR mentions that Jeremy Diamond from Nemaska submitted a proposal to prepare that video, but the proposal is expensive. A discussion takes place between all to identify other potential bidders: Jonah Cooper could be one (he made the Nemaska 40th Anniversary video), and AH also mentions that CNG has some contacts and will refer them to ST. - AH proposes that the Committee elaborates an official communication strategy as part of a next meeting and that this responsibility should entirely be dedicated to this Committee, and WIC should be acting as "supervisor". The objective of the strategy would be to outline what are the important "when and what". The strategy could be included in the Socio-Economic Development Plan.	AH WR ST
Socio-Economic Development Plan - ST briefly discusses the approach NMX wants to implement in order to focus socio-economic development on the objectives of the community and not those of the mining company. ST provides information and documents on NetPositive, a non-profit collaborative research organization which works with a diverse group of stakeholders to collectively change the approach to extractive development and increase the likelihood that communities will see sustained positive outcomes from extractive sector projects. Based on multiple perspectives and global evidence about what works and what doesn't, their group bring diverse stakeholders together and position them to act on priority social issues, determined by the stakeholders themselves. - Discussion on this to take place in a future meeting once committee members have read the documents.	All
Project Schedule - PM presents the new NMX corporate video which provides with a review of what was accomplished in 2017. - NMX has underwent over the past months several due diligences by bankers and investors so that financing is progressing well. *(CONFIDENTIAL INFORMATION) A revised NI43-101 compliant feasibility study will be issued in Q1-2018, 45 days following the issuance of a press release (public disclosure) in December 2018 (CONFIDENTIAL INFORMATION)* . Financing phase is projected to be completed after the public disclosure of the updated FS. - Camp is a critical issue for both construction and operation phases. Actually, it is now the most critical issue faced by NMX. For the construction phase, there will be a need for about 400 people at peak activities while the existing capacity at NEC Camp is at max 160 people. Discussion are supposedly taking place between NDC and Hydro-Québec with regards to the acquisition of Nemiscau Camp by NDC to rent it to NMX; however, none of the WIC members (including President of NDC) knows how is this discussion progressing. There is also an even more critical issue with the operation phase, since there will be a need to built a new camp and it will have to be on NEC site. If not, a new site would have to be determined on R20 trapline and modifications to permits and authorizations will be needed, something which may impact the project schedule. - Depending on financing of the mine project, start-up of initial mining activities (pit surface stripping and site preparation for the ore and co-disposal stockpiles) is now projected to start at least 6 months before the projected commissioning of the concentrator which is scheduled for fall 2018. In such case, modification to the General Certificate of Authorization (CA) will be required for the temporary ore stockpile because its capacity will increase from what is already approved. As well, a CA from the regional office of the MDDELCC will be required to enable start of the aforementioned mining activities in April or May 2018. Discussion with MDDELCC and COMEX will be initiated next week to that regard and applications for these CAs would be issued by NMX in January 2018. - The critical issue is that camp facilities will be needed rapidly for both the construction and operation phases, and this requires full support from NDC and Chief and Council to move forward in a timely manner, incuding negociations with Hydro-Quebec. MT recommends that NMX gets that issue moving fast by relaying to Chief and Council. ST asks for attending the next Council meeting to explain the urgency of the situation.	ST MT WJ

NEMASKA LITHIUM // WHABOUCHI MINE PROJECT			
WHABOUCHI ENVIRONMENT COMMITTEE			
DATE: November 24, 2017			
Were present:			
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Aurora M. Hernandez *(partly)*	Cree Nation Government (CNG)	Environmental Analyst - Mining	AH
Walter Jolly	Cree Nation of Nemaska (CNN)	Councillor	WJ
Matthew Tanoush	Cree Nation of Nemaska (CNN)	Director of Land and Environment	MT
Wayne Rabbitskin	Nemaska Lithium (NMX)	Community Liaison Agent	WR
Pierre Mercier	Nemaska Lithium (NMX)	ESR Coordinator	PM
Simon Thibault	Nemaska Lithium (NMX)	Director ESR	ST
Were absent:			
Stella M. Wapachee	Cree Nation of Nemaska (CNN)	Councillor	SW
James Wapachee Sr.	Cree Nation of Nemaska (CNN)	R20 Tallyman	JW
Nancy Wapachee	Cree Nation of Nemaska (CNN)	R20 Tallyman's wife	NW

ITEMS	ACTIONS
Procurement and Cree Businesses - Revenu Quebec is offering support on tax/fiscal aspects of business development, not only in Nemaska, but also for the whole Cree Nation. ST will refer them to Chief Thomas Jolly, Teddy Wapachee and Andy Baribeau. - ST mentions that Teddy Wapachee followed-up with James Wapachee Sr. with regards to the multiple agreements and joint ventures that he has signed so far, creating conflicts when some of his partners offer similar services and therefore are competing for the same contracts. JW asked for legal and business development support from the Band Office and/or NDC. CNG could potentially also be offering support and Andy Baribeau offers that JW and NW meet with him. AH confirms this and precises that JW/NW will have to reach out to CNG to get their support. ST mentions that there should be a meeting between JW/NW and NDC, ideally with the CNG also. - On NMX website, there is a registry for businesses to sign in for procurement purposes. This was disclosed in various Cree and non-Cree communities and as part of a meeting that took place in Montreal in October with NDC, Nemaska business owners and representatives of Band Council. A list of contracts is continuously updated and is available on NMX website.	All
Training Programs - A meeting took place in Quebec City on October 21st with, among others, Andy Baribeau, Wayne Rabbitskin, Teddy Wapachee and Chantal Francoeur. - WR mentions that the Mining Essentials training program is projected to start in early 2018. It is a 12-week training program paid by Aboriginal and Northern Affairs Canada, along with in-kind contribution from NMX and support from CHRD. Secondary 3 is a prerequisite. Program will take place in Nemaska old band office (now Vocational Training Center owned by Cree School Board). Program includes Health&Safety certification. - WR mentions that other training programs for the mine project are projected (ex. drilling and blasting, ore processing, truck driving, etc.), and that they will take place in Nemaska and/or Chibougamau depending on th program and the required facilities. These programs will be coordinated by James Bay School Board and Cree School Board, with financial support from CHRD. Last week was the ceremony graduation for the Heavy Equipment Operation training program in Nemaska (11 graduates, all from Nemaska). There is also the trucking class 3 program that was completed in fall 2017. - ECO-Canada environmental monitoring training program will start in spring 2018 because the required certification from ECO-Canada was only obtained in November, too late to start in 2017. - ST will ask Chantal Francoeur to have a list of the projected training programs along with a schedule (what and when).	ST WR
Permitting and Non-Compliance - ST refers to the annual report for 2016 that was filed to the CEAA and is available on NMX website. - ST explains the Written Warning that was issued by the CEAA on September 26, and the reply from NMX dated October 31. The letter sent by NMX to CEAA was provided to LDV and AH. - LDV mentions that CEAA should be sending future notice to CNG and Nemaska and not only to NMX. ST mentions that he discussed this with CEAA and told them that they were already doing. LDV will follow-up with CEAA.	ST LDV
Environmental and Social Monitoring Plan - LDV mentions that he and AH reviewed the plan and have some comments. Those will be sent to ST and to the COMEX. **Emergency Measures Plan (EMP)** - ST sent a couple of months ago a preliminary version of the EMP to the MDDELCC-COMEX to initiate their review and verify its compliance with the conditions included in the Certificate of Authorization they issued in September 2015. To that effect, on September 19, 2017, the COMEX sent to NMX questions on the EMP. NMX is working on this right now and involving the Nemaska Band Office (Public Safety Dept.) in the process. LDV mentions that the Cree Health Board shared some comments with the CNG and he will forward those to ST. **Wetland Compensation Plan** - NMX will have to send to the MDDELCC-COMEX the Wetland Compensation Plan prior to February 2018 for them to review it and verify its compliance with the conditions included in the Certificate of Authorization they issued in September 2015. On September 19, 2017, the COMEX sent to NMX questions on the Wetland Compensation Plan. NMX is working on this right now. - Update from LDV on the participation from CNG to the research program: CNG sent a letter to Pr. Fenton (UQAT) to confirm their participation. Next step is to organize a meeting with the research team, CNG and NMX to set the basis of a good collaboration. **Fish Habitat Compensation Plan** - NMX will have to send to the MDDELCC-COMEX the Fish Habitat Compensation Plan once it will have been approved by Fisheries and Oceans Canada for them to review it and verify its compliance with the conditions included in the Certificate of Authorization they issued in September 2015. On September 19, 2017, the COMEX sent to NMX questions on the Fish Habitat Compensation Plan. - LDV mentions that CNG recently hired a biologist who provided comments on the Fish Habitat Compensation Plan. LDV will sent those to ST.	LDV AH ST
Varia - Funding for next IAIA conference (Ashukan Conference) in South Africa. Funding has to be approved by the WIC and also ST has to make sure the funds are available. A discussion on this is deffered to the next meeting. - Follow-up on the request from the Nokiiwin Council to visit the site next year: LDV will ask AH about it. - LDV recommends that NMX cc's LDV and AH on all official communication to COMEX (ex. application for a modification of the CA for the relocation of the effluent). ST will do so.	LDV ST
Extraordinary Meetings in 2018 AH and ST mention that we should plan in 2018 for multiple "special" meetings, each entirely dedicated to the following items: - Mine Closure and Rehabilitation Plan and Site Visit to Troilus Mine - Environmental and Social Monitoring Plan - Fish Habitat Compensation Plan (once approved) - Wetland Compensation Plan (potentially at UQAT) - Emergency Measures Plan (once approved) A schedule to that effect will be proposed by ST.	ST
Visit of the Shawinigan Plant Site (2:30pm-3:30pm)	
Next Meeting : In Nemaska, January 17, 2018. Could potentially be a "special" meeting dedicated to the Environmental and Social Monitoring Program.	All

NEMASKA LITHIUM // WHABOUCHI MINE PROJECT

WHABOUCHI ENVIRONMENT COMMITTEE

DATE: February 6 and 7, 2018

Were present:

Lucas Del Vecchio	Cree Nation Government (CNG)	Environmental Analyst - Mining	LDV
Aurora M. Hernandez *(on the phone on Feb. 7)*	Cree Nation Government (CNG)	Environmental Analyst - Mining	AH
Walter Jolly	Cree Nation of Nemaska (CNN)	Councillor	WJ
Matthew Tanoush	Cree Nation of Nemaska (CNN)	Director of Land and Environment	MT
Stella M. Wapachee	Cree Nation of Nemaska (CNN)	Councillor	SW
James Wapachee Sr.	Cree Nation of Nemaska (CNN)	R20 Tallyman	JW
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Wayne Rabbitskin	Nemaska Lithium (NMX)	Community Liaison Agent	WR
Pierre Mercier	Nemaska Lithium (NMX)	ESR Coordinator	PM
Simon Thibault	Nemaska Lithium (NMX)	Director ESR	ST

ITEMS	ACTIONS
Special meetings dedicated to General Project Update from NMX (Feb. 6) and Environmental Monitoring Program (Feb. 7)	
General Project Update from NMX	
On January 9, 2018, NMX issued a press release to that a revised Feasibility Study will be issued within 45 days as per the NI43-101 Regulation. The project now includes 33 years of life-of-mine (instead of 26), covering 24 years of open pit mining followed by 9 years of underground mining. The 2018 Feasibility Study encompasses a combined open pit and underground mine operation, concentration facilities, tailings and water management at mine site as well as a hydrometallurgical processing facility in Shawinigan. Detailed information can be found here: http://www.nemaskalithium.com/en/investors/press-releases/2018/2383c40c-3570-49e0-86f5-9df5112a253c/ As part of that report, additional waste rock and tailings co-disposal capacity was identified since life-of-mine has increased and thus mining activites as well. However, it should be noted that those are very preliminary and most likely will not be the final areas dedicated to co-disposal. Additional engineering is required and will not be completed within short term. NMX will of course include the CNN and CNG in the design of these additional facilities. Following a question by MT, ST confirmed that waste rocks can be used as construction material and that there is indeed potential for collaboration between CNN and NMX to that regard.	
ST mentions a call he add earlier on Feb. 6 AM with the Department of Fisheries and Oceans Canada (DFO) and the Department of Forests, Wildlife and Parks of Quebec (MFFP). ST summarizes the process NMX went through since 2014 in order to evaluate potential serious damages to fish (habitat loss) and elaborate compensation measures as per the Canadian Fishieries Act. Up to this day, the DFO has accepted less than half of the compensation measures NMX has proposed, some of which were actually proposed by the tallymen of CNN which were consulted to elaborate them (including JW and WJ), and others from CNG based on data extracted from Weh-Sees Indohun database. The remaining 9 compensation measures retained by DFO are still deemed insufficient and so the DFO asked NMX to provide with more... while acknowledging that there are no other potential compensation measures to be elaborated in the territory of CNN. DFO is thus asking NMX to elaborate compensation measures outside the CNN territory, i.e. anywhere in the province of Quebec. ST mentioned to the DFO that this would most likely not be acceptable by the CNN and CNG, but DFO argued that they will consult with them in the following weeks, most likely through letters sent to both. Also, ST notes that the Whabouchi project was designed to have no direct impact on the fish habitat, all potential impacts being indirect (i.e. change in drainage, dewatering of open pit). To that regard, he also mentions that there is big difference in how the DFO/MFFP and NMX do evaluate the level of serious damage on fish, with DFO considering a major impact on Lake 2, while NMX based its evaluation on hydrogeological modelling and evaluate only minimal impact on Lake 2. ST finally mentions that this is a problematic situation as DFO is now asking NMX to compensate outside CNN territory because they agree that there's no other options (i.e. talked to tallymen, Hydro-Quebec, etc., and nothing was found). NMX proposed to compensate by acquiring data through research projects, such as what Alan Penn from CNG proposed (i.e. ecological diagnostic of mountain lake, in collaboration with MFFP), and MFFP also proposed a research project on brook trout spawning areas, but there is nothing to do, DFO still wants NMX to have additional compensation measures. DFO said compensation doesn't have to be in Nemaska territory, but can be elsewhere in province of Quebec. Simon has asked DFO to consult CNN and CNG.	ST, LDV, MT
MT provides update on the Category-II land modification and shows on a map that the actual lands located north of the Whabouchi Project will be moved to an area extending from the village to Old Nemaska. There is no known timeline for this, but MT confirms that applications have been filed and are being processed by the Government of Quebec.	MT
ST mentions that there are still maps showing sensitive information on the CEAA website dedicated to the Whabouchi Project and has provided LDV with the web address.	LDV
Environmental Monitoring Program (attached PowerPoint presentation for reference)	
Monitoring of domestic wastewater treatment units System for administrative office is already installed (septic tanks and field at more than 300 m from lake), but there will be another system installed near concentrator. First system near garage and concentrator is a Bionest system : filter and decant solids (primary treatment), second treatment is a biological system, about 25m by 25m roughly at the concentrator/garage site. Physical Integrity and Stability of Structures Will be included in the Whabouchi Mine Operation Manual which is in preparation by SNc-Lavalin and will be so in full compliance with applicable regulations and standards, including the Toward Sustainable Mining (TSM) program.	
ST mentions that Environmental Monitoring is very strict and regulated. Parameters and specifications that need to be monitored weekly, monthly, annually, are all determined by provincial and federal authorities. On the other hand, environmental surveillance is more about cleaning up and reporting on environmental incidents such as spills. Monitoring looks at environmental management with a long-term vision of possible impacts. JW asked about how are managed spill that occur at end of the day, during the night. ST explained that the law is really tight on this, that they have to stop spill, clean and inform government quickly. In terms of staff, NMX is looking at hiring two people to complete PM's team at mine site. Anderson Jolly will be finished his training in April and could be a candidate. NMx is setting up an ECOCanada training program with Wabajuu environment for other candidates. Ernie Rabbittskin will also be a trainer for a training and NMX is Looking at having Ernie as the intermediate position, with a junior technician below him. About 10 people in training program, starting right after Goose Break. Training: Will they include boat and safety operator, as well as CPR? ST mentions theyr are looking at this for additional week.	ST
Sediment, Benthos & Fish monitoring: Monitoring of impact of final effluent: Sediment, Benthos and Fish, in compliance with EEM Program (Canada) and also conditions in General CofA issued by COMEX-MDDELCC. Sediment: metals can accumulate in sediments and so this is a good way to make sure there is no long-term impact, especially in rivers where flow is quite significant. Having an impact on sediment will impact benthos which will impact fish ("food chain"). Monitoring will be done upstream (reference area), and downstream (exposure, or impacted area). Not fully detailed yet, and so still need to be submitted to federal. ST mentions that monitoring of heavy metals in fish flesh will focus on walleye, pike and whitefish. ST explains sampling of Benthos method, then JW explained it in Cree for MT and WJ. MT: Observation by some members, since community has been on Champion lake, they have been seeing big grass near Champion Lake. It hasn't been like that since many years ago. Some concerns coming from the members, one of the teachers mentioned, especially about impacts on lake conditions (water level, oxygenation, etc.). ST offers support to identify the species with MT. WJ mentions that first few years he didn't observe any difference from Hydro Quebec work. But after around 4 years he has seen fish that have signs of disease and impact. ST points out at the duration of the monitoring program, which is for the full life-of-mine, including post-closure. Also monitoring of the integrity of walleye spawning grounds in Mountain Lake, and monitoring of fish population in Mountain lake, at the mouth of Creek D. Monitoring of Fish habitat compensation measures will include monitoring of success of compensation sites (mostly about monitoring the presence of fish at all life stages, ex. looking with camera).	ST, MT

NEMASKA LITHIUM // WHABOUCHI MINE PROJECT

WHABOUCHI ENVIRONMENT COMMITTEE

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Lucas Del Vecchio	Cree Nation Government (CNG)	Environmental Analyst - Mining	LDV
Aurora M. Hernandez *(on the phone on Feb. 7)*	Cree Nation Government (CNG)	Environmental Analyst - Mining	AH
Walter Jolly	Cree Nation of Nemaska (CNN)	Councillor	WJ
Matthew Tanoush	Cree Nation of Nemaska (CNN)	Director of Land and Environment	MT
Stella M. Wapachee	Cree Nation of Nemaska (CNN)	Councillor	SW
James Wapachee Sr.	Cree Nation of Nemaska (CNN)	R20 Tallyman	JW
Nancy Wapachee	Cree Nation of Nemaska (CNN)	R20 Tallyman's wife	NW
Wayne Rabbitskin	Nemaska Lithium (NMX)	Community Liaison Agent	WR
Pierre Mercier	Nemaska Lithium (NMX)	ESR Coordinator	PM
Simon Thibault	Nemaska Lithium (NMX)	Director ESR	ST

ITEMS	ACTIONS
Agronomic monitoring of revegetation: List of how many shrubs need to be replanted, and how much area needs to be hydroseeded. Planting will be monitored for 5 years once completed, including progressive revegetation during mine operations. Monitoring of hydrological, ecological and habitat function in Spodumene Bog ("muskeg"): monitoring section of wetland closest to the open pit. Making berm to block water from peatland that will flow towards the open pit. Assessing Hydrology (studying flow at the outlet of the peatland, before mine, after pit operation). Monitoring surface covered by pools and small ponds. Typically, rainfall is increasing in the region with climate change, so most likely pools would tend to increase. Monitoring water table in the peatland (piezometers, measuring the level of water in the peatland). Every 2 years, wildlife surveys in the wetland. Bats (chiropterans): this is being taken care of by the government and FaunENord. NMX and MFFP will contribute financially, but work will be done by FaunENord. Key part of monitoring is filming and recording them with echo-sounder and cnoise recorder. MT: Can Nemaska be included in monitoring? In year 2000, there was a problem with the bats in the community. MT asked how to get rid of the bats, since as they are listed as endangered, you can't kill them. At one time, on the Otter Trail, one house unit had so many bats in the attic that they had to remove the roof and replace it once bats were gone. MT went to numerous classrooms for presentations and bat safety. ST outlines that the CNN will get all the information from the monitoring of bats for free with the Annual Report, so no need to be financially involved in the monitoring. Wildlife Sightings (opportunistic observations program): this will not only be for mine site, but also for roads. Sensitive information will not be disclosed publicly.	
Physical Monitoring MT: What is procedure for placing waste rocks? ST: Explains the procedure, that cutting of trees will be done in phases. Some for site preparation will be next year, then some more for first phases of operation, and then eventually more and more. All run-off will be collected. JW would like to know some of the things before hand, something which ST confirms will be done. WR adds that every two weeks, WR and PM meet together, and so he will now invite JW to join if he is available to get general updates ahead of time. JW also asked about some current works going on near BC-1, which ST explains to be field tests for co-disposal of tailings and waste rock, as well as single waste rock and tailings (research project with UQAT). ST explains that these are for testing how water percolates and runs off in the future co-disposal pile, as well as to confirm geochemical lab results. Noise and Vibrations For the communication of the blasting schedule, SW recommends that radio, Facebook (Nemaska announcements), and a bulletin board in the community be used. ST mentions that the first two are already considered, and that the bulletin board will need to be discussed with CNN. JW mentions that as part of the construction activities, he has so far not heard noise coming from the mine site at his camp. Groundwater Monitoring PM showed the groundwater well location maps. 24 additional wells will be needed on site. Hydrology and Climate Monitoring Map locating all stations. Surface Water Monitoring Some mistakes in the station numbers, but overall no major questions regarding this.	
Ambient Air and emissions ST explains the location of the sampling stations, i.e. at Bible Camp and Reggie's camp which is the closest site from mine. Also, another station closer to site and reference site east of mine, near Route du Nord. MT: What about dust supressants? ST & PM explain it will likely be water in summer, and in winter it will a product approved the MTMDET (Calcium chlorite or microbial spray). PM explains different type of sampling for air quality monitoring. Air dust dynamic sampling: power is needed for the dynamic testing. This is extremely complicated, requires electricity for 24 hours at a time, every 3 days, while all stations are located in areas where power is not available. Consequently, battery packs combined to solar panels will be needed. However, since solar panels can't be sufficient for some period of time during the year, a genset will also be needed. This leads to a discussion about the potential intrusiveness related to the dynamic testing in remote areas (not connected to the grid). Commitee members agree that logic must prevail, and additional impacts from installation of permanent measuring equipment will be more impactful than worth, especially with regards to the noise levels generated by the dynamic testing equipment (similar to an industrial vaccuum cleaner) and the genset (which is also associated to a risk of environmental spills/leaks). On the other hand, ST mentions that static testing will also be done, as it is done at all other mine sites in Eeyou Istchee. Static testing is fairly standard, with only dust jars being implemented. The conclusion of the discussion was that NMX will discuss this issue/concern about additional impacts generated with the remote monitoring of air quality by dynamic testing with the COMEX-MDDELCC as part of a meeting scheduled for Feb. 19, focusing on a potential reduction of the intensity of dynamic sampling (ideally down to monthly, or trimestrially), combined with the monthly static testing already projected. From there, a future discussion with CNN, CNG and the CEAA would be required.	
Social Monitoring Little drinking water lake north of Mountain Lake which will be monitored, but under use of land and resources, not surface water quality monitoring. ST mentions that there is a need for quantifying some aspects, but some will be easier than others (ex. economic spin-offs, jobs, success of training, trucks on Route du Nord, etc.). On the other hand, the use of land and resources as well as community well-being will need a lot more thinking from the Committee and so NMx is suggesting to get support from Catherine Lussier to that effect. A future meeting is needed on this topic. With the dismantling of the Weh Sees Indohoun progam, MT suspects influx of fisherman and hunters and potential impacts.	All
Need for Additional Extraordinary Meetings in 2018 - Mine Closure and Rehabilitation Plan and Site Visit to Troilus Mine - Social Monitoring Plan - Fish Habitat Compensation Plan (once approved) - Wetland Compensation Plan (potentially at UQAT) - Emergency Measures Plan (once approved) A schedule to that effect will be proposed by ST.	ST
Next Meeting : Not determined.	All

A study plan for wetlands in the James Bay Lowlands of Québec

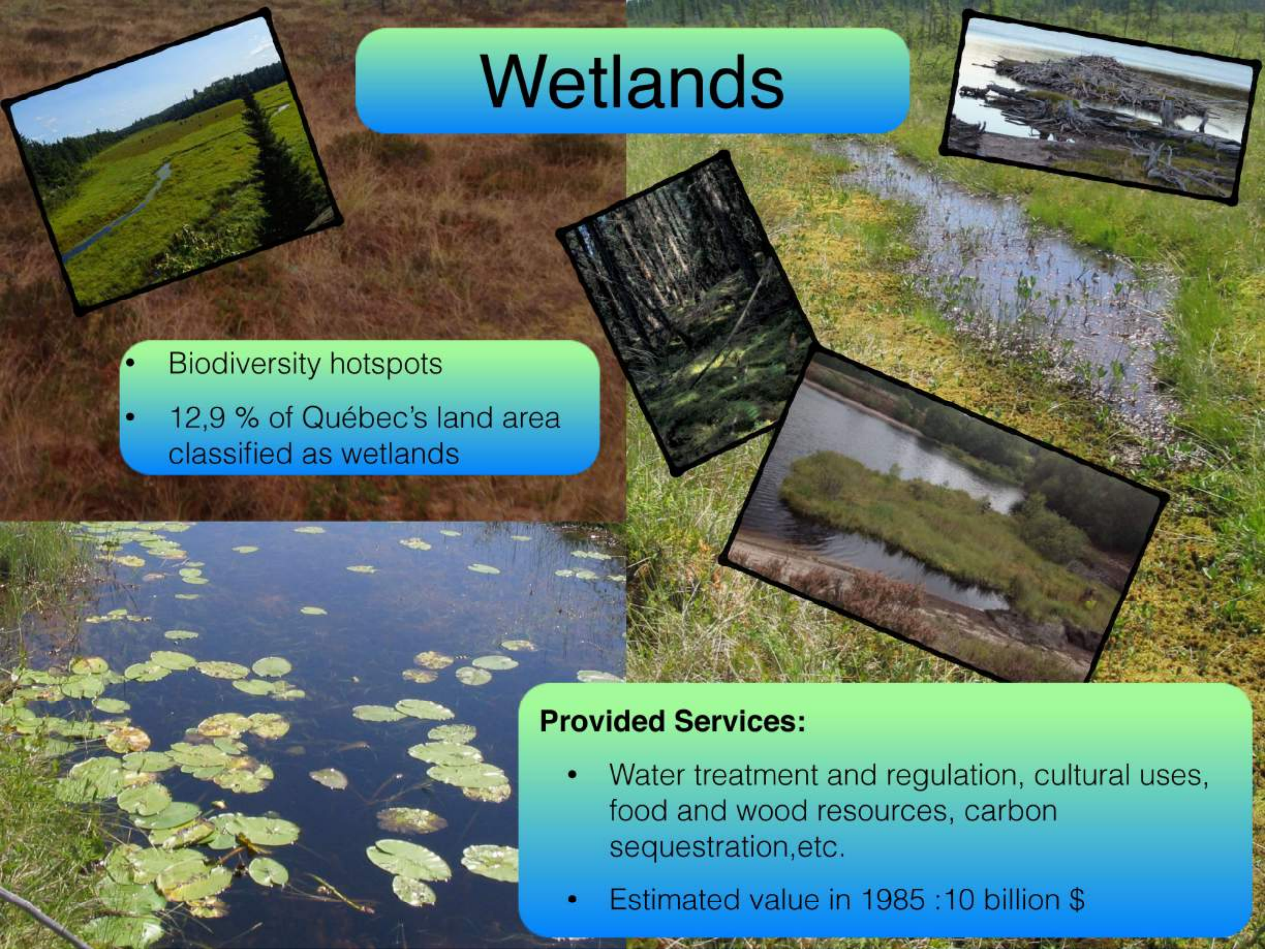
Research Chair CRSNG-UQAT "Biodiversity in a mining context" Objective No. 2:

Avoiding impacts through ecological planification

Students of UQAT :
Mariano Javier FELDMAN,
Marc-Frédéric INDORF,
Tana ROUTE

Under the direction of
Mme. Nicole FENTON

UQAT
UNIVERSITÉ DU QUÉBEC EN ABITIBI-TÉMISCAMINGUE


Wetlands
• Biodiversity hotspots
• 12,9 % of Québec's land area classified as wetlands
Provided Services:
• Water treatment and regulation, cultural uses, food and wood resources, carbon sequestration,etc.
• Estimated value in 1985 :10 billion $

Study interests

- Ecological knowledge is fragmentary
- First study of this size for the region
- A need to better understand these habitats so as to inform management decisions and potential developmental projects
- Create a base-line study of today's situation and assess possible future impacts

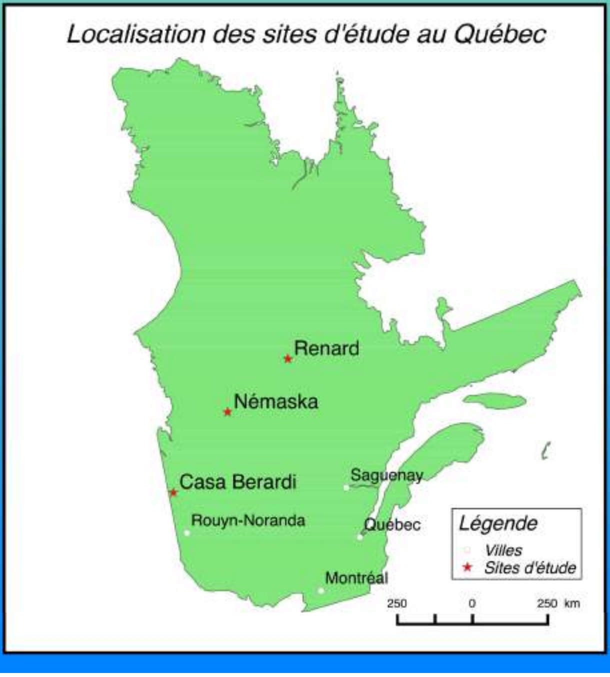
General objectives

Are there wetlands that are more sensitive than others?

Do some wetlands have a high ecological and/or economical value, implying certain management mesures?

Regarding current changes, what are the possible future scenarios and stakes?

The responses to these questions will help develop an ecological classification system for the region.



Fauna

Why are small ponds important for vertebrates?

- **Small ponds** (<8 ha) are important for several groups of animals.
- The vast majority (almost 85%) of wetland areas in Quebec are **peatlands**, but **beaver ponds** are most frequently used for many species

Should some types with certain characteristics be prioritised for conservation?

Fauna

Overall objective

Assess the value of the different small ponds for vertebrates (birds, amphibians, and mammals).

General objectives

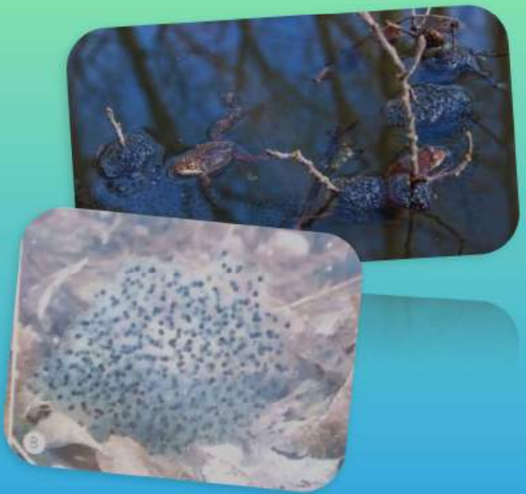
- Quantify the differences in bird, amphibian, and mammalian communities in different small wetlands types
- Compare species use of ponds by pond type and habitat variables
- Determine the presence of species that are in danger or threatened to implement future conservation and management plans

Fauna

Methodology

Amphibians: Acoustic monitoring

Egg-mass counts



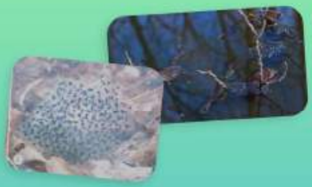
Fauna

Methodology

Amphibians:

Acoustic monitoring

Egg-mass counts



Birds:

Acoustic monitoring

Visual counts

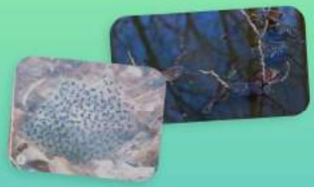
Fauna

Methodology

Amphibians:

Acoustic monitoring

Egg-mass counts



Birds:

Acoustic monitoring

Visual counts

Mammals:

Camera traps

Mammal bait

Flora

Reasons for studying plants

- directly connected to their environment
  - habitat engineers
    - primary production (food source)
      - indicators of ecosystems fonctions

Plants can serve as **bio-indicators** of their surrounding environment (toxic pollutants, climat change, ecological functionings)

Flora

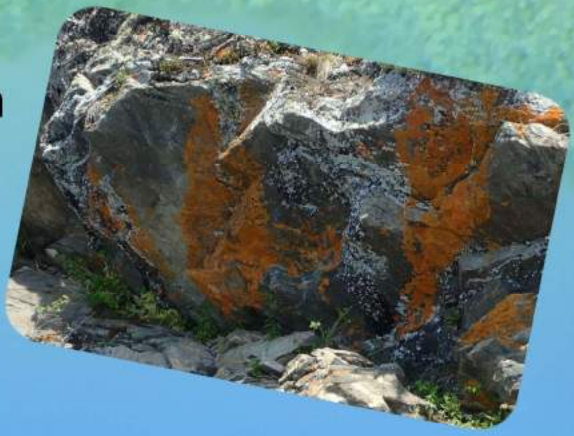
Lichens

A symbiotic association:

fungi + algae/cyanobacteria = "larger organism"

fungi -> protection

algae/cyanobacteria -> food production



Contributions to the environment:

- Atmospheric nitrogen fixing
- 90 % of the winter diet of caribou

Flora

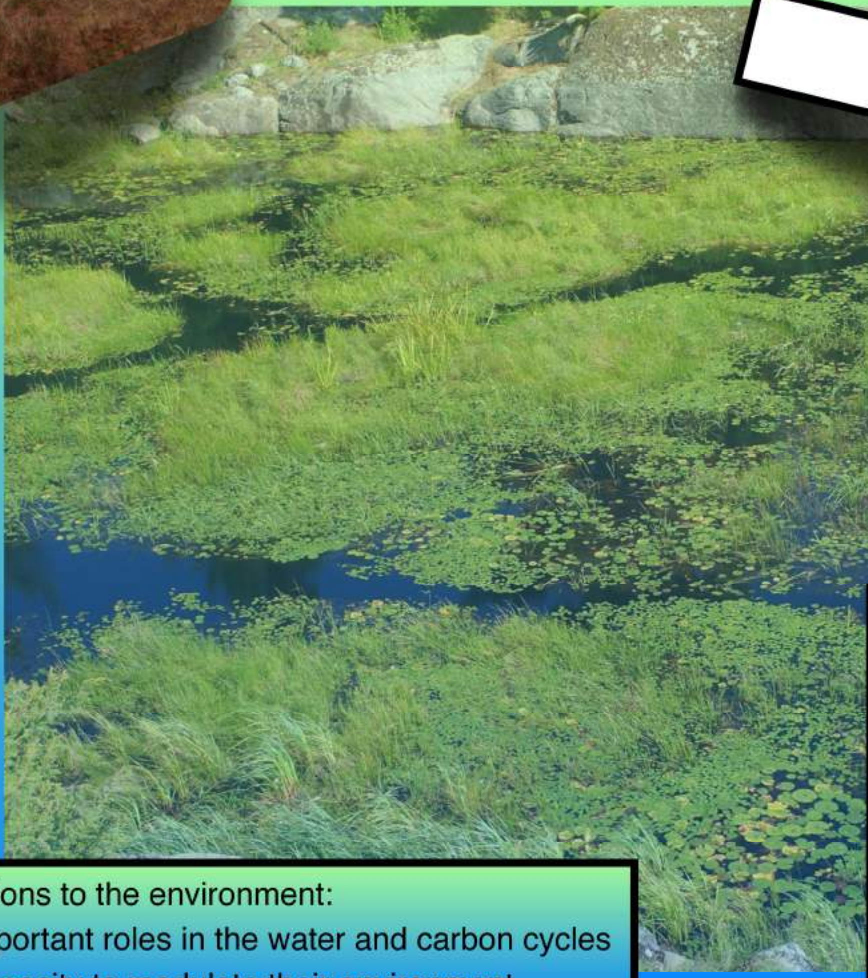
Transitional zone between
the atmosphere and the ground

Bryophytes
(mosses, peat-mosses, liverworts)

Contributions to the environment:

- Important roles in the water and carbon cycles
- Capacity to modulate their environment

Flora



Vascular plants

Contributions to the environment:

- Important roles in the water and carbon cycles
- Capacity to modulate their environment

Flora

Methodology

1. Site selection
2. Inventories and field measurements
3. Verification of the stratification of the region
4. Analysis of ecosystem fonctions
5. Identification of important future stakes

Future implications

The obtained results will help in:

- **developing an up-to-date wetland ecological classification system for the region.**

And also:

- Creating a base-line biodiversity study for the region.
- Identifying wetland types that are at risk regarding future changes.
- Informing future management decisions and territorial developmental projects.

Thank you for your attention!

NSERC Industrial Research Chair on northern biodiversity in a mining context:

Research proposal

UQAT
INSTITUT DE RECHERCHE
SUR LES FORÊTS

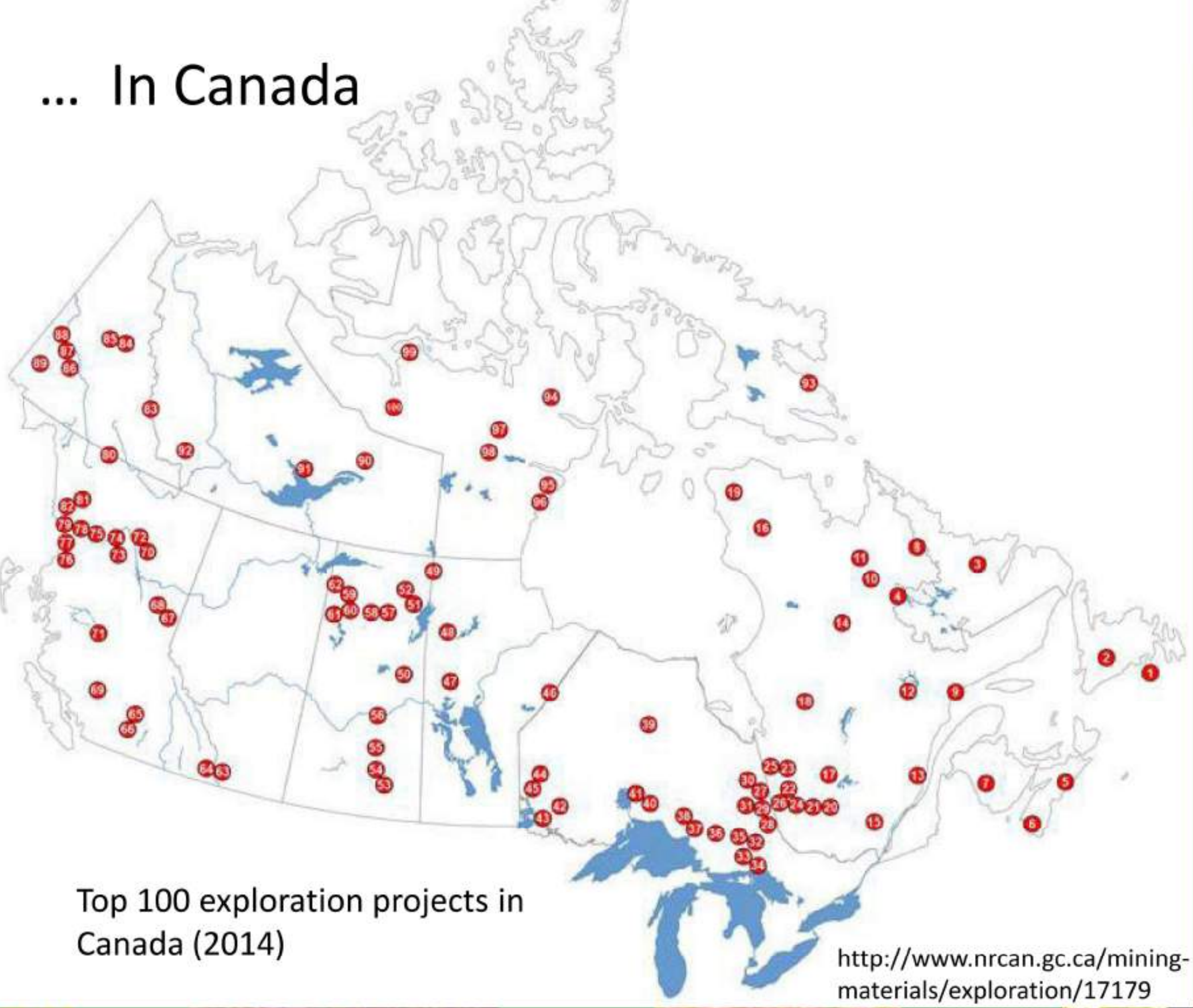
Presentation overview

- WHY is this chair necessary?
- WHAT are we going to do?
- HOW are we going to go about the research agenda?
- WHY are the results relevant and important?

WHY is this chair necessary?

1. Mining and other developments are moving North

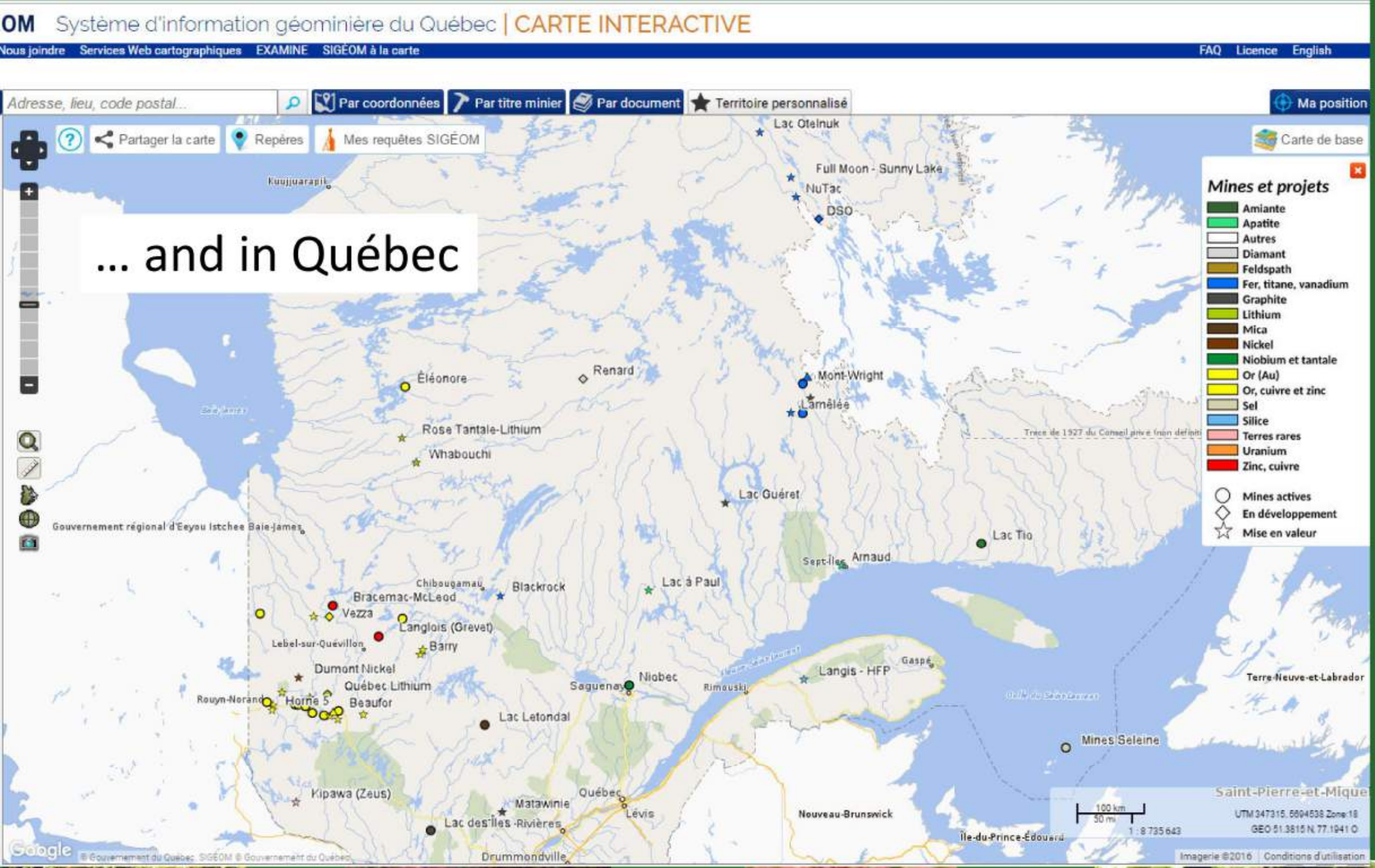
… In Canada



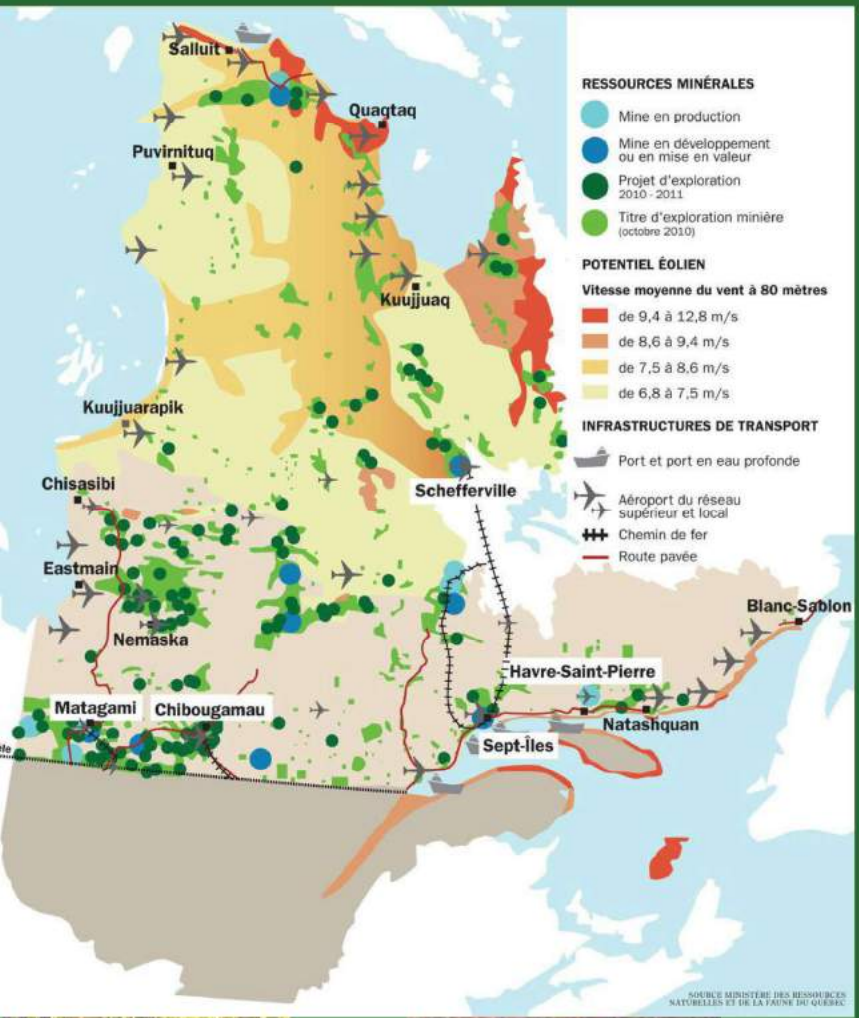
Top 100 exploration projects in Canada (2014)

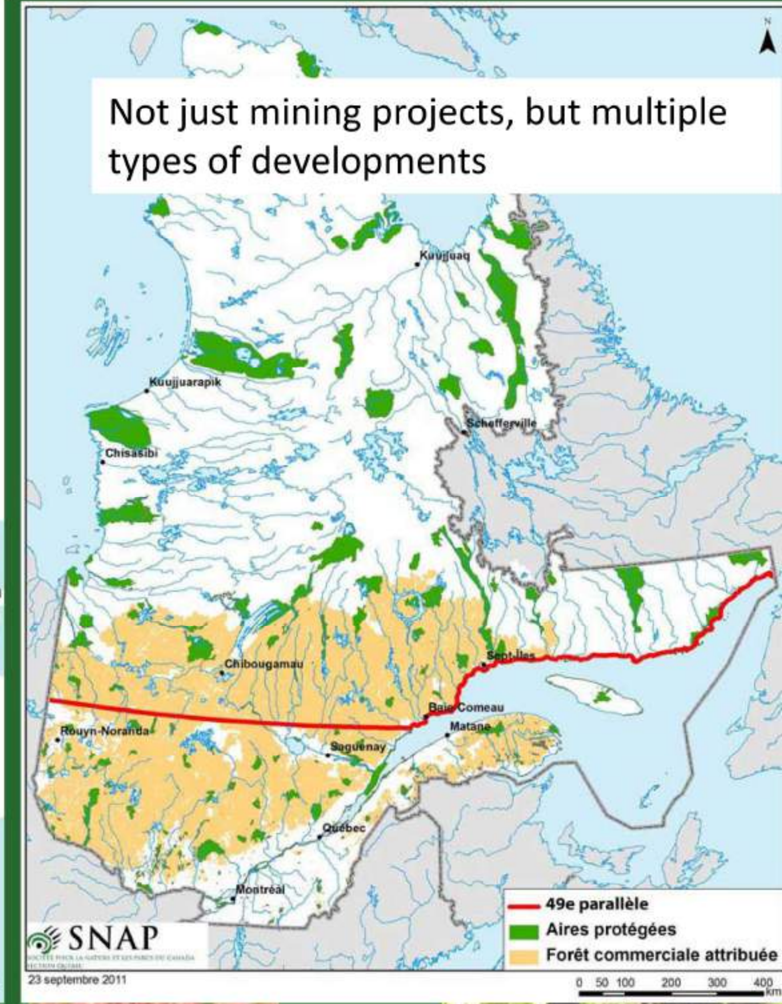
http://www.nrcan.gc.ca/mining-materials/exploration/17179

… and in Québec



Not just mining projects, but multiple types of developments





2. Wetlands are important habitats

2. Wetlands are important habitats

- Unique ecosystem services
  - Water filtering
  - Carbon fixation
  - Habitat
- Loss due to development
  - Agricultural
  - Municipal
  - Industrial

The special case of wetlands

- Required by law to compensate their loss

chapter M-11.4

ACT RESPECTING COMPENSATION MEASURES FOR THE CARRYING OUT OF PROJECTS AFFECTING WETLANDS OR BODIES OF WATER

1. For the purposes of this Act,

(1) "wetland" means a pond, marsh, swamp or bog; and

(2) "body of water" means a lake or a constant or intermittent watercourse.

2012, c. 14, s. 1.

2. In the case of an application for authorization under section 22 or 32 of the Environment Quality Act (chapter Q-2) for a project affecting a wetland or a body of water, the Minister of Sustainable Development, Environment and Parks may require from an applicant compensation measures designed, in particular, to restore, create, protect or ecologically enhance a wetland, a body of water or a piece of land near a wetland or a body of water.

No compensation measure gives rise to an indemnity. A compensation measure must be the subject of a written undertaking by the applicant, and it is deemed to form part of the conditions of the authorization or certificate of authorization.

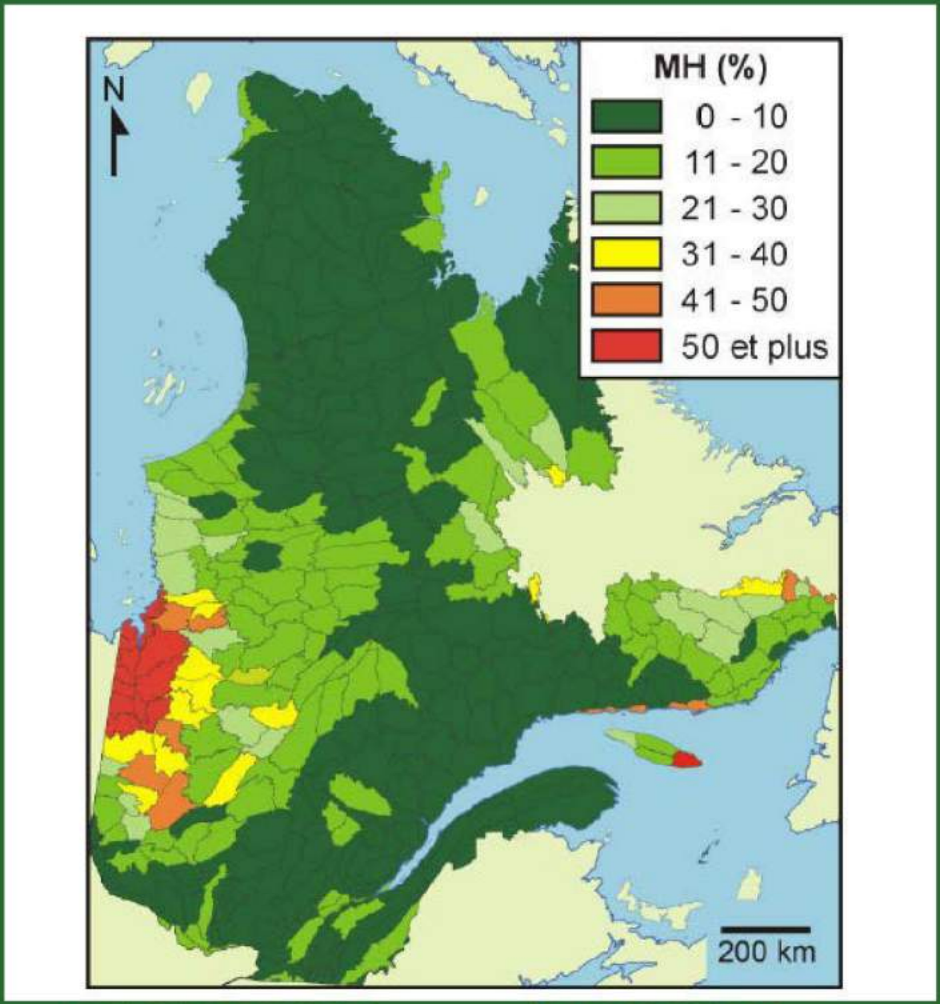
2012, c. 14, s. 2.

3. A compensation measure that was planned with a view to the issue, before 12 March 2012, of an authorization or a certificate of authorization under Chapter I of the Environment Quality Act (chapter Q-2) for a project affecting a wetland or a body of water is valid and does not give rise to an indemnity.

2012, c. 14, s. 3.

4. Sections 1 and 2 have effect from 24 April 2012.

2012, c. 14, s. 4.



Source: Pellerin and Poulin 2013

3. Cryptogams are the most important plant group

- Bryophytes
- Lichens

New Phytologist

Review

Tansley review

The resilience and functional role of moss in boreal and arctic ecosystems

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The mossy north: an inverse latitudinal diversity gradient in European bryophytes

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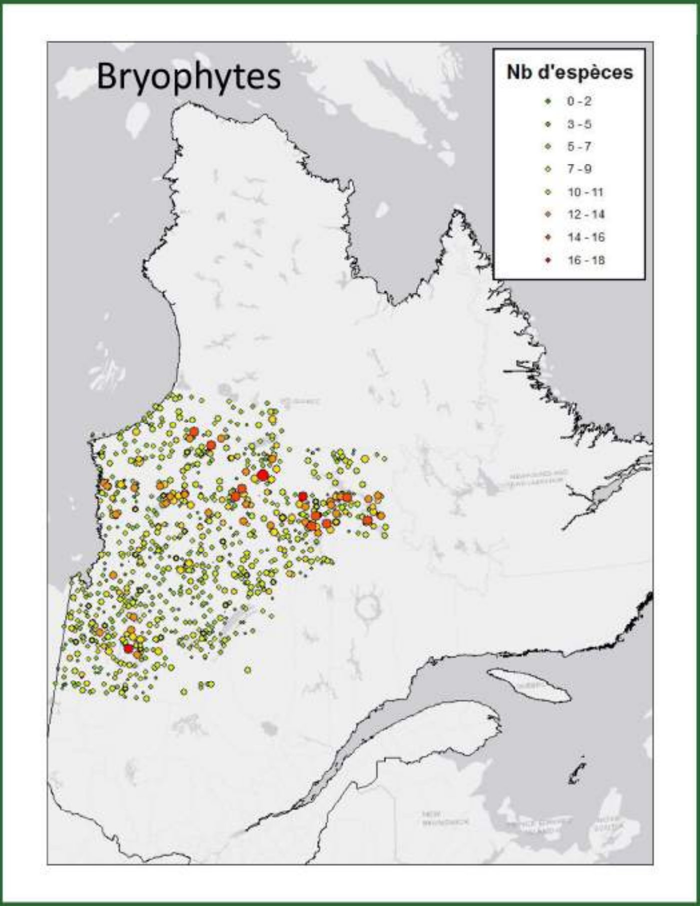
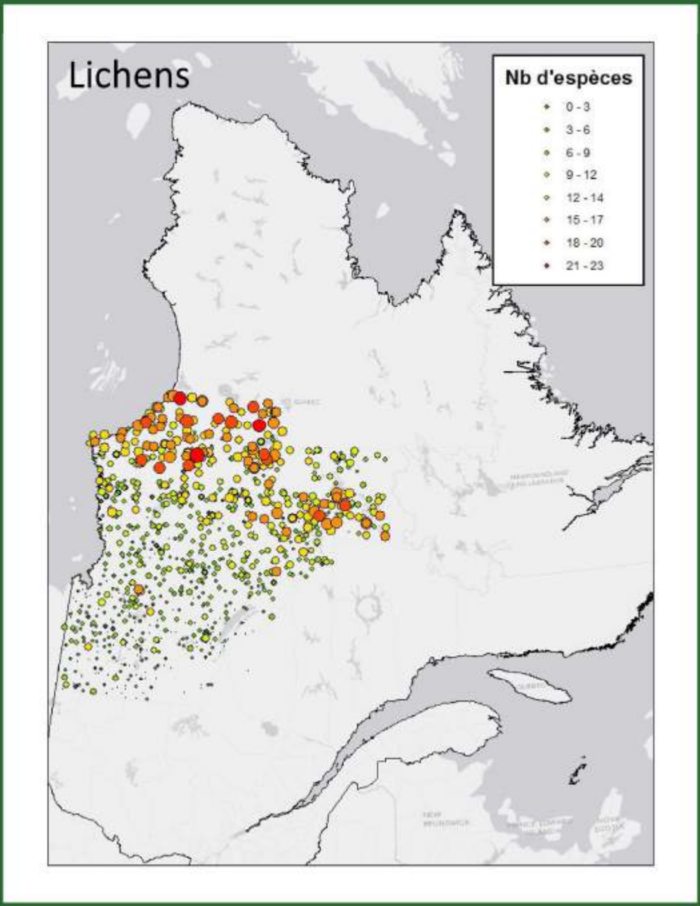
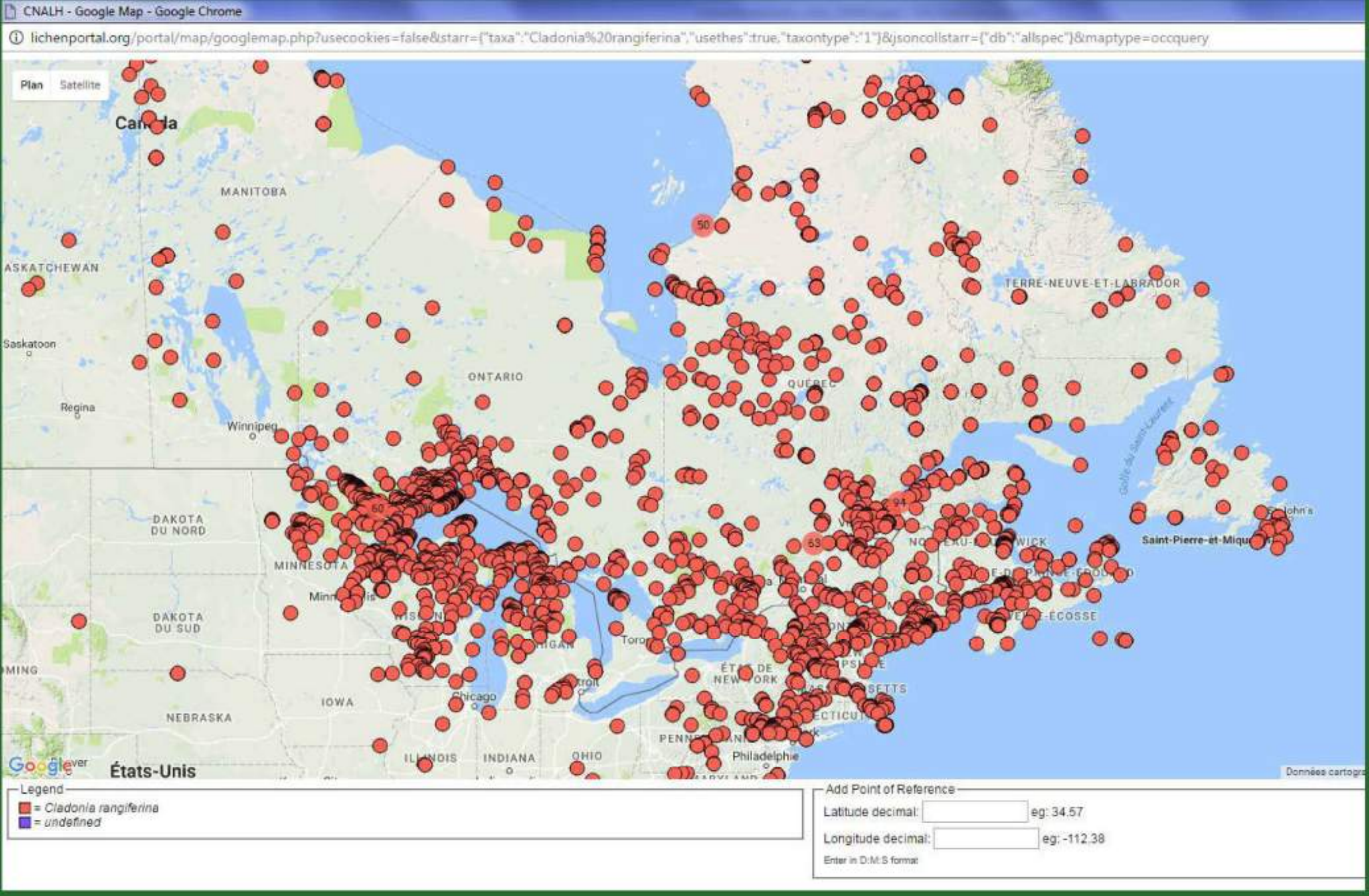
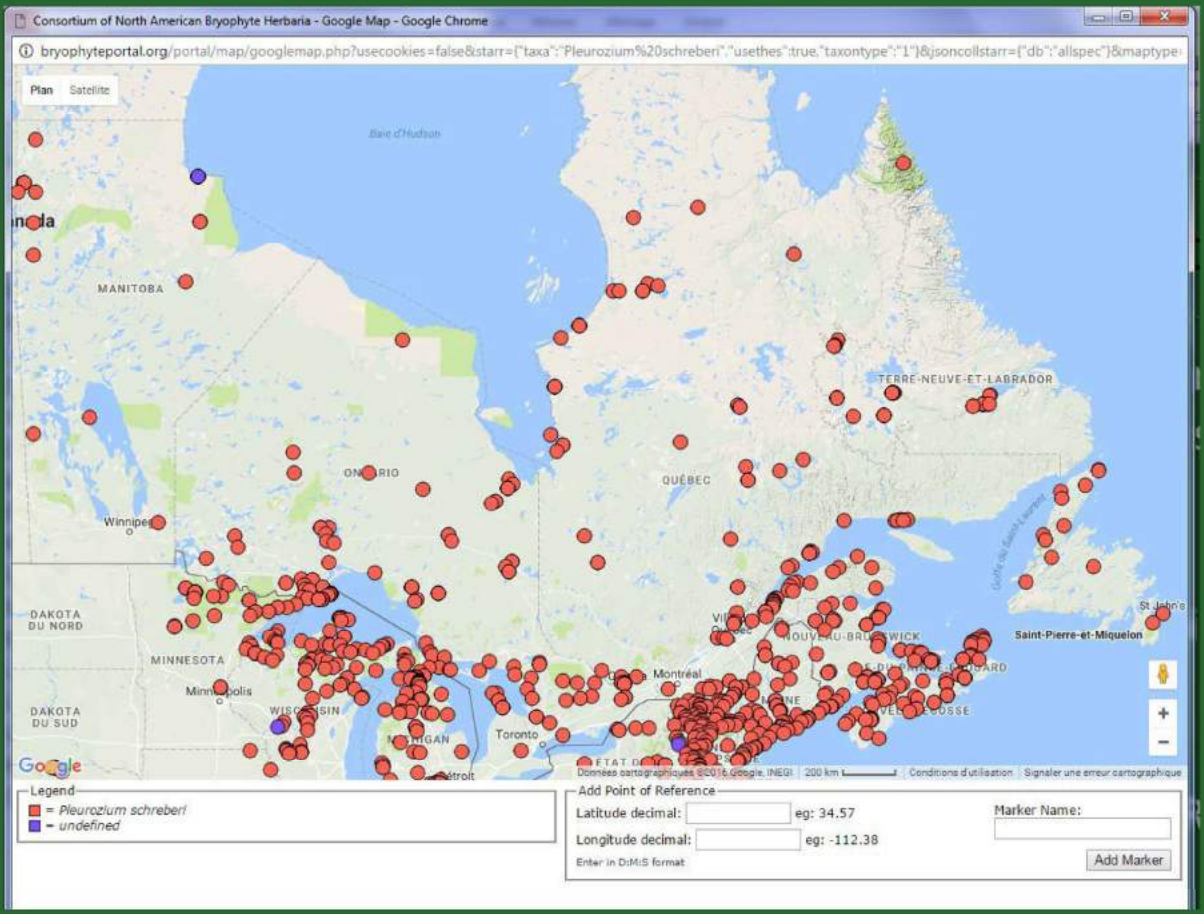

Bryophytes
Nb d'espèces
0 - 2
3 - 5
5 - 7
7 - 9
10 - 11
12 - 14
14 - 16
16 - 18

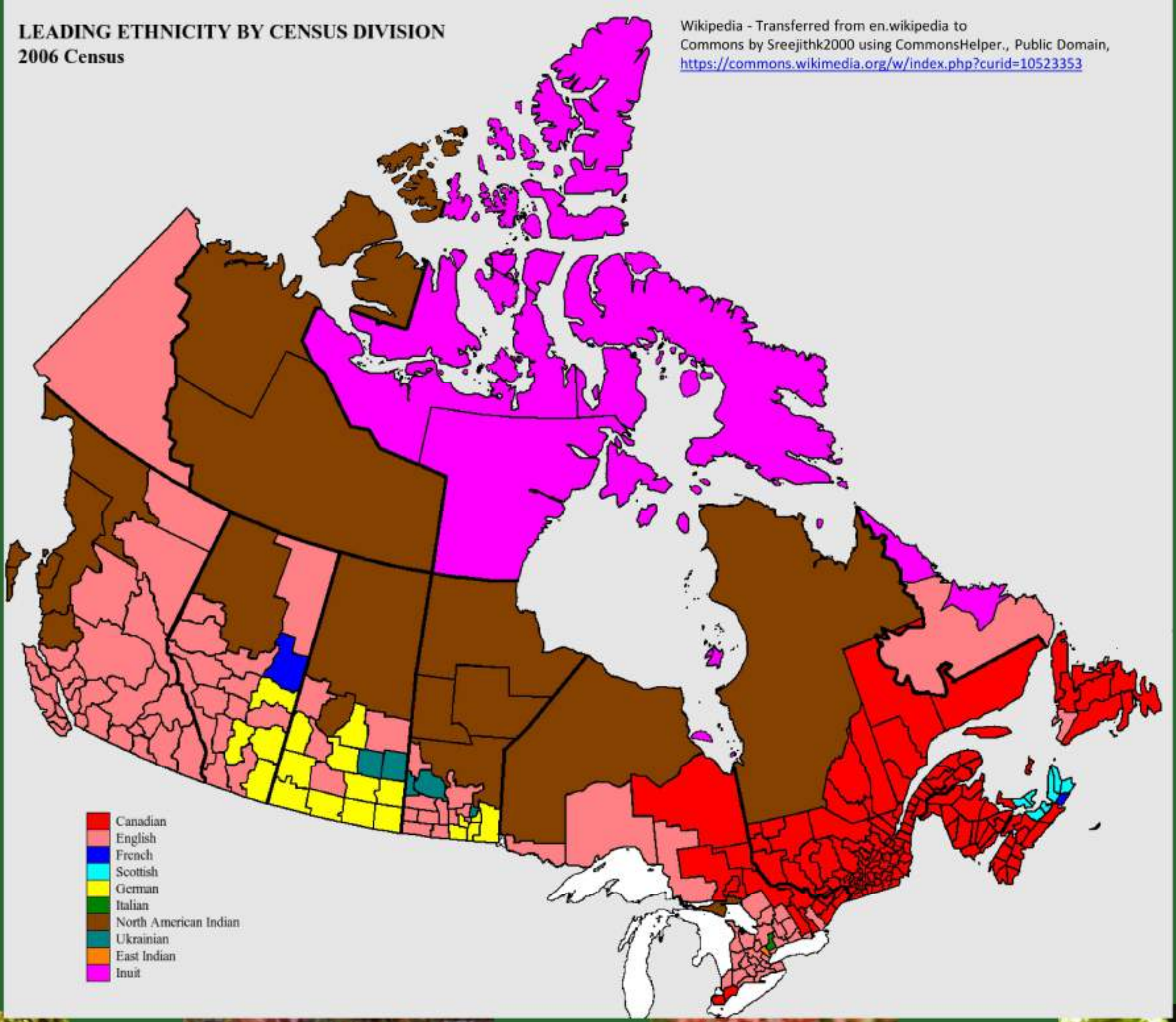

Lichens
Nb d'espèces
0 - 3
3 - 6
6 - 9
9 - 12
12 - 14
15 - 17
18 - 20
21 - 23

4. But we don't know much about bryophytes and lichens in the north


CNALH - Google Map - Google Chrome
lichenportal.org/portal/map/googlemap.php?usecookies=false&starr={"taxa":"Cladonia%20rangiferina","usethes":true,"taxontype":"1"}&jsoncollstarr={"db":"allspec"}&maptype=occquery
Plan
Satellite
MANITOBA
ONTARIO
QUEBEC
TERRE-NEUVE-ET-LABRADOR
Saskatoon
Regina
Winnipeg
DAKOTA DU NORD
DAKOTA DU SUD
MINNESOTA
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
Chicago
Philadelphie
États-Unis
Saint-Pierre-et-Miquelon
Legend
= Cladonia rangiferina
= undefined
Add Point of Reference
Latitude decimal:
eg: 34.57
Longitude decimal:
eg: -112.38
Enter in D:M:S format


Consortium of North American Bryophyte Herbaria - Google Map - Google Chrome
bryophyteportal.org/portal/map/googlemap.php?usecookies=false&starr={"taxa":"Pleurozium%20schreberi","usethes":true,"taxontype":"1"}&jsoncollstarr={"db":"allspec"}&maptype=
Plan
Satellite
Baie d'Hudson
MANITOBA
ONTARIO
QUÉBEC
TERRE-NEUVE-ET-LABRADOR
Winnipeg
DAKOTA DU NORD
MINNESOTA
DAKOTA DU SUD
Minneapolis
Montréal
Toronto
St John's
Saint-Pierre-et-Miquelon
Legend
= Pleurozium schreberi
= undefined
Add Point of Reference
Latitude decimal:
eg: 34.57
Longitude decimal:
eg: -112.38
Enter in D:M:S format
Marker Name:
Add Marker

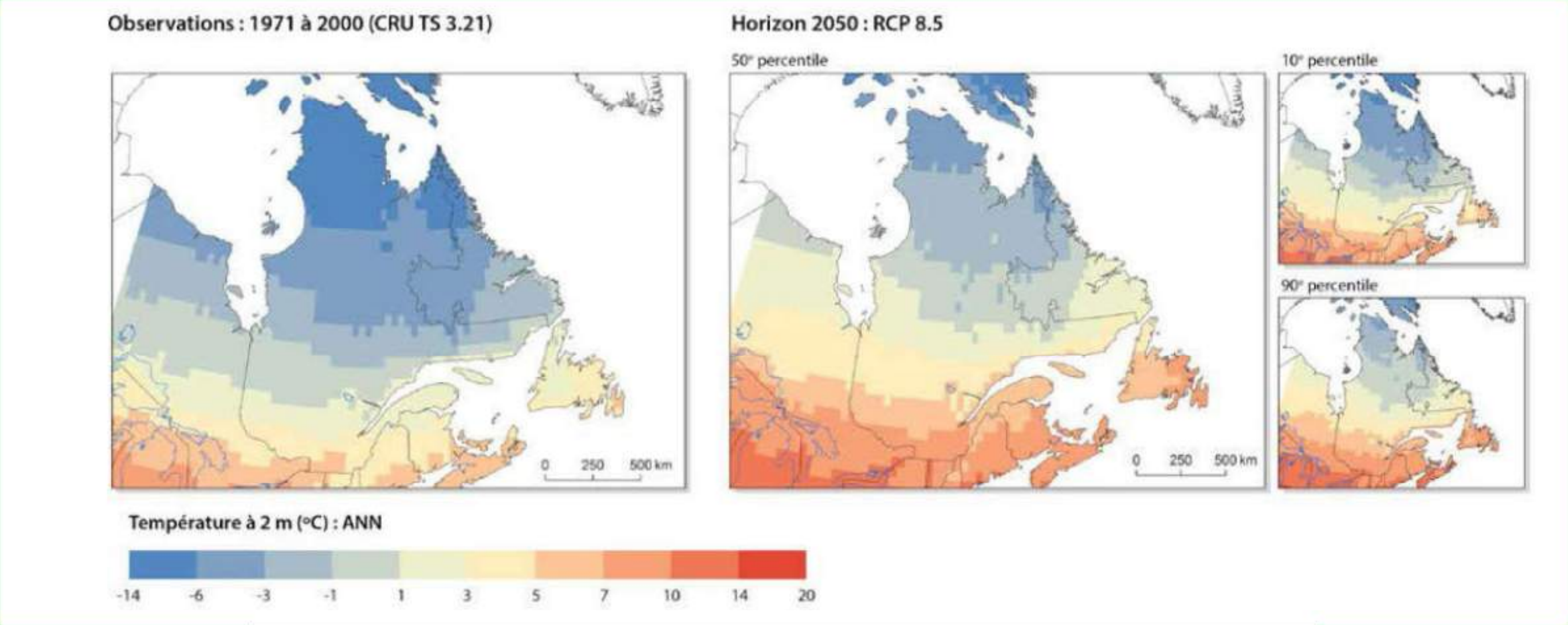
5. Aboriginal communities dominate the North


LEADING ETHNICITY BY CENSUS DIVISION
2006 Census
Wikipedia - Transferred from en.wikipedia to
Commons by Sreejithk2000 using CommonsHelper., Public Domain,
https://commons.wikimedia.org/w/index.php?curid=10523353
Canadian
English
French
Scottish
German
Italian
North American Indian
Ukrainian
East Indian
Inuit

Les The Nations 2016
Les The Nations
FAMILLE LINGUISTIQUE
LINGUISTIC FAMILY
ALGONQUIENNE
ALGONQUIAN
Abénakis | Abenakis
Algonquins
Atikamekw
Cris | Crees
Innus
Malécites | Maliseet
Micmacs
Naskapis
IROQUOIENNE
IROQUOIAN
Hurons-Wendat
Mohawks
ESKIMO-ALÉOUTE
ESKIMO-ALEUT
Inuits | Inuit
aadnc-aandc.gc.ca/nations
Affaires autochtones et du Nord Canada
Indigenous and Northern Affairs Canada
Canada

Whapmagoostui
Kuujjuarapik
Kawawachikamach
Lac-John
Matimekosh
Schefferville
Chisasibi
Radisson
Wemindji
Baie James
James Bay
Eastmain
Fermont
Waskaganish
Nemiscau
Mistissini
Waswanipi
Oujé-Bougoumou
Chapais
Chibougamau
Uashat
Maliotenam
Sept-Îles
Port-Cartier
Timiskaming
Pikogan
Amos
Rouyn-Noranda
Obedjiwan
Betsiamites
Baie-Comeau
Lac-Simon
Val-d'Or
Winneway
Mashteuiatsh
Alma
Roberval
Saguenay
Essipit
Les Escoumins
Forestville
Rimouski
Gaspé
Gesgapegiag
Wemotaci
Coucoucache
Kitcisakik
Ville-Marie
Hunter's Point
Rapid Lake
Eagle Village-Kipawa
Manawan
La Tuque
Tadoussac
Cacouna
Whitworth
Rivière-du-Loup
Listuguj
Pointe-à-la-Croix
Maria
Wendake
Kitigan Zibi
Mont-Laurier
Québec
Routes | Roads

6. Climate change is affecting the North faster than the South



Citation suggérée : Ouranos (2015). Vers l'adaptation. Synthèse des connaissances sur les changements climatiques au Québec. Édition 2015. Montréal, Québec : Ouranos. 415 p.

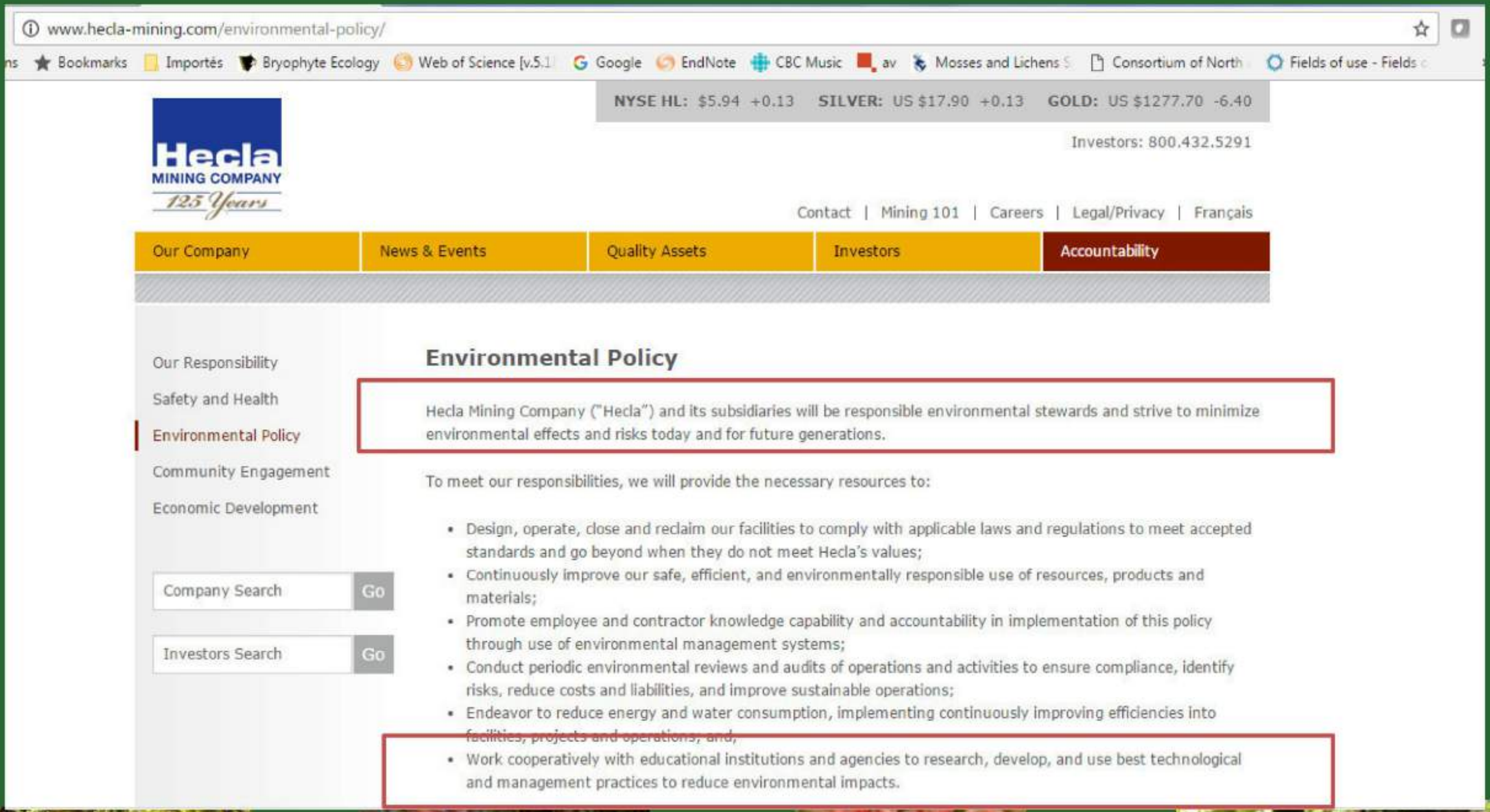
WHY is this chair necessary?

1. Mining and other developments are moving North

A changing mining industry

- Social acceptance now includes the concept of biodiversity conservation and local community implication
- Internal and external forces
  - Internal
    - Canadian mining association
    - International Council of Metal Mining
  - External
    - Cree and Algonquin Band Councils
    - Governments of Québec and Canada
    - International and national groups

A changing mining industry


www.hecla-mining.com/environmental-policy/

Bookmarks | Importés | Bryophyte Ecology | Web of Science [v.5.1 | Google | EndNote | CBC Music | av | Mosses and Lichens | Consortium of North | Fields of use - Fields

NYSE HL: $5.94 +0.13 SILVER: US $17.90 +0.13 GOLD: US $1277.70 -6.40

Investors: 800.432.5291

Hecla MINING COMPANY 125 Years

Contact | Mining 101 | Careers | Legal/Privacy | Français

Our Company | News & Events | Quality Assets | Investors | Accountability

Our Responsibility
Safety and Health
Environmental Policy
Community Engagement
Economic Development

Company Search Go

Investors Search Go

Environmental Policy

Hecla Mining Company ("Hecla") and its subsidiaries will be responsible environmental stewards and strive to minimize environmental effects and risks today and for future generations.

To meet our responsibilities, we will provide the necessary resources to:

- Design, operate, close and reclaim our facilities to comply with applicable laws and regulations to meet accepted standards and go beyond when they do not meet Hecla's values;
- Continuously improve our safe, efficient, and environmentally responsible use of resources, products and materials;
- Promote employee and contractor knowledge capability and accountability in implementation of this policy through use of environmental management systems;
- Conduct periodic environmental reviews and audits of operations and activities to ensure compliance, identify risks, reduce costs and liabilities, and improve sustainable operations;
- Endeavor to reduce energy and water consumption, implementing continuously improving efficiencies into facilities, projects and operations; and,
- Work cooperatively with educational institutions and agencies to research, develop, and use best technological and management practices to reduce environmental impacts.

Biodiversity and sustainable development in the north

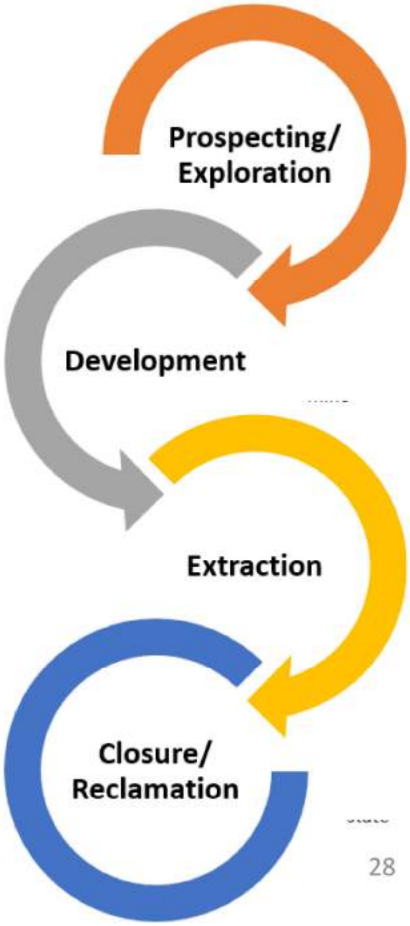
- Mitigation hierarchy?
  - Avoid
  - Mitigate
  - Restore
  - Compensate

WHICH EFFECTS?

- Inclusion of enigmatic effects?
  - Cumulative
  - Off site
  - Indirect
  - Synergistic

Biodiversity and sustainable development in the north

WHEN EFFECTS?



Knowledge Gaps

1. What are the impacts of mines on biodiversity?
    1. Does the footprint of an individual mine extend beyond the physical area disturbed?
    2. How does the extent, severity of this footprint evolve throughout the mine life cycle?
2. How is diversity distributed across the landscape in habitats?
3. What is the impact of cumulative disturbances?

CONSEQUENTLY range of action of companies desiring to reduce their current or predicted impact on biodiversity is limited

WHAT are we going to do?

Mission of the Chair

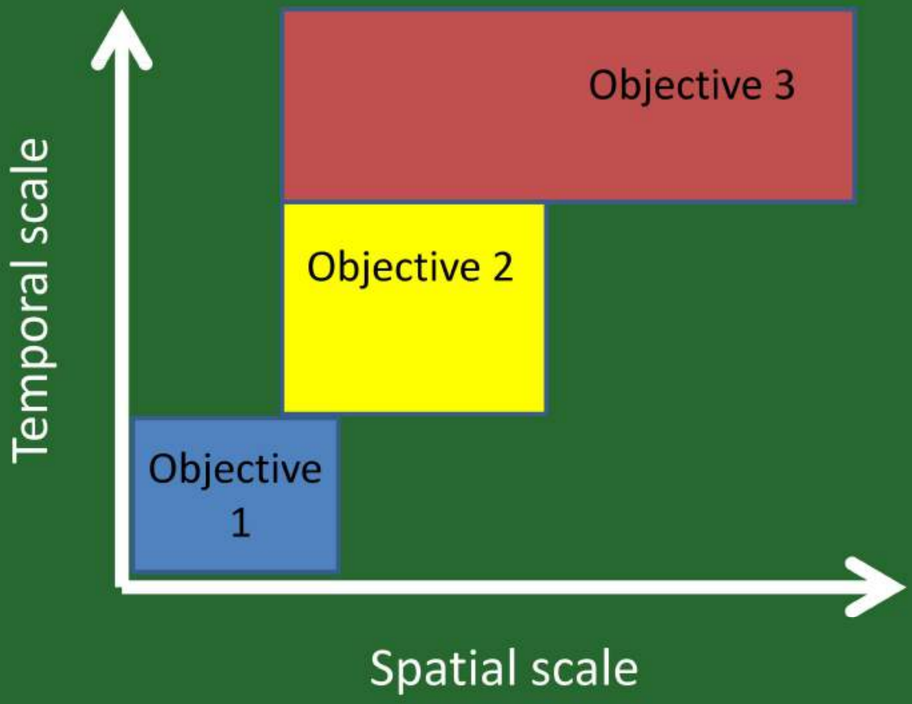
Generate and disseminate knowledge regarding northern biodiversity in order to develop strategies that reduce impacts

- *throughout the mine life cycle*
- *context of cumulative impacts including climate change*

Key innovative concepts

- Defining biodiversity
  - Biological: Multiple taxa groups - inclusion of cryptogams
    - Multiple scales
  - Traditional ecological knowledge
  - Integrating knowledge types
- Enigmatic effects
- Mine life cycle
- Short and long term
  - Fine filter: species and diversity
  - Coarse filter: habitats and ecoservices

Research objectives

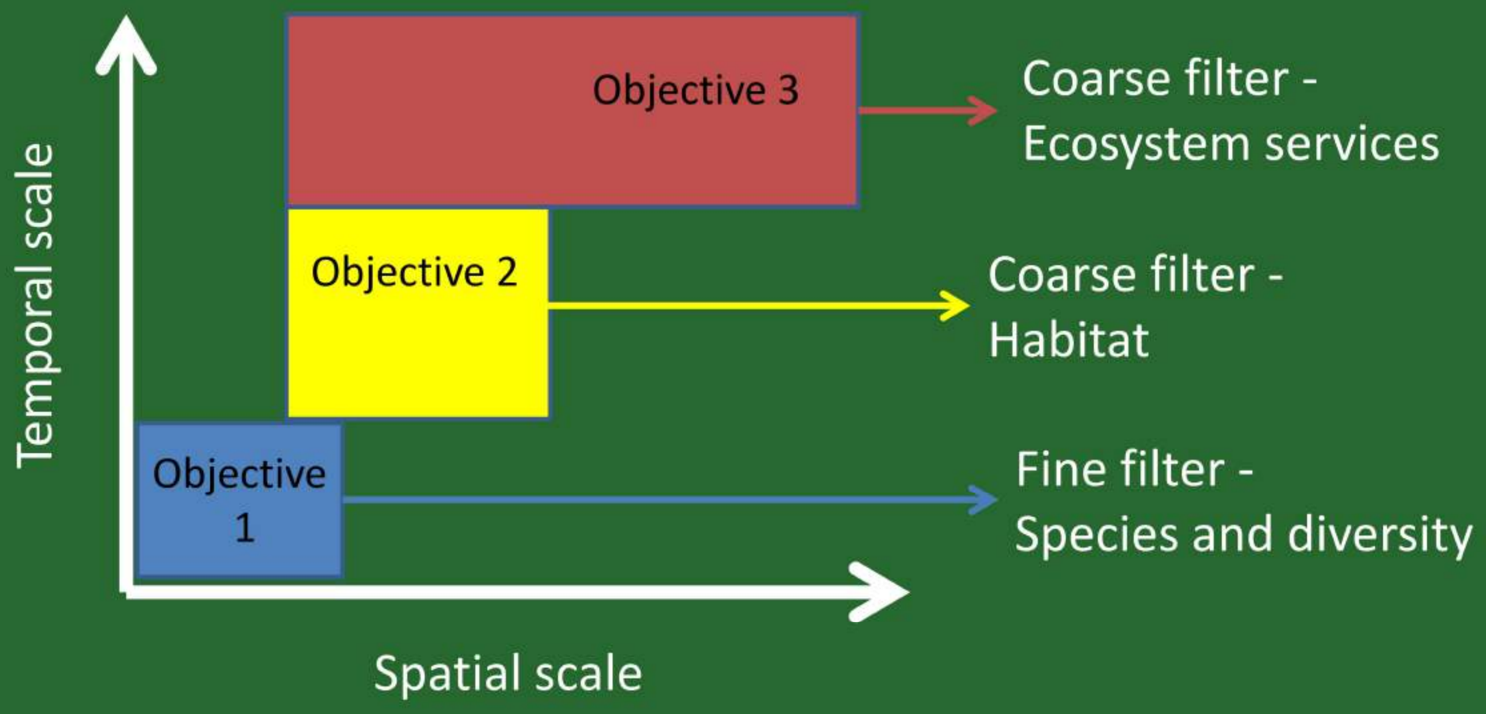


3. to reduce cumulative impacts on ecosystem services

2. to avoid risk by developing tools for ecological planning

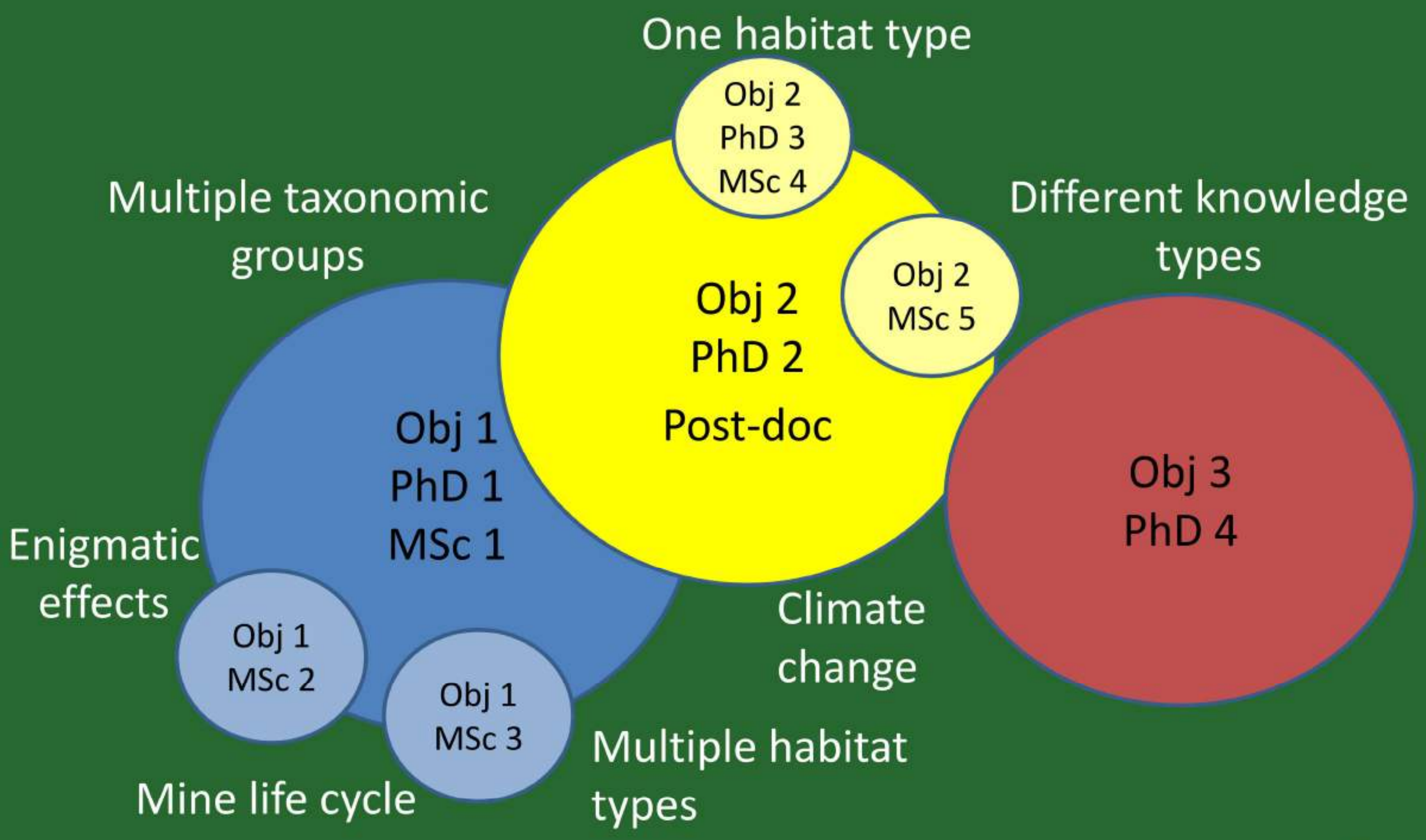
1. to reduce the impact of mine footprints over the mine life cycle

Research objectives

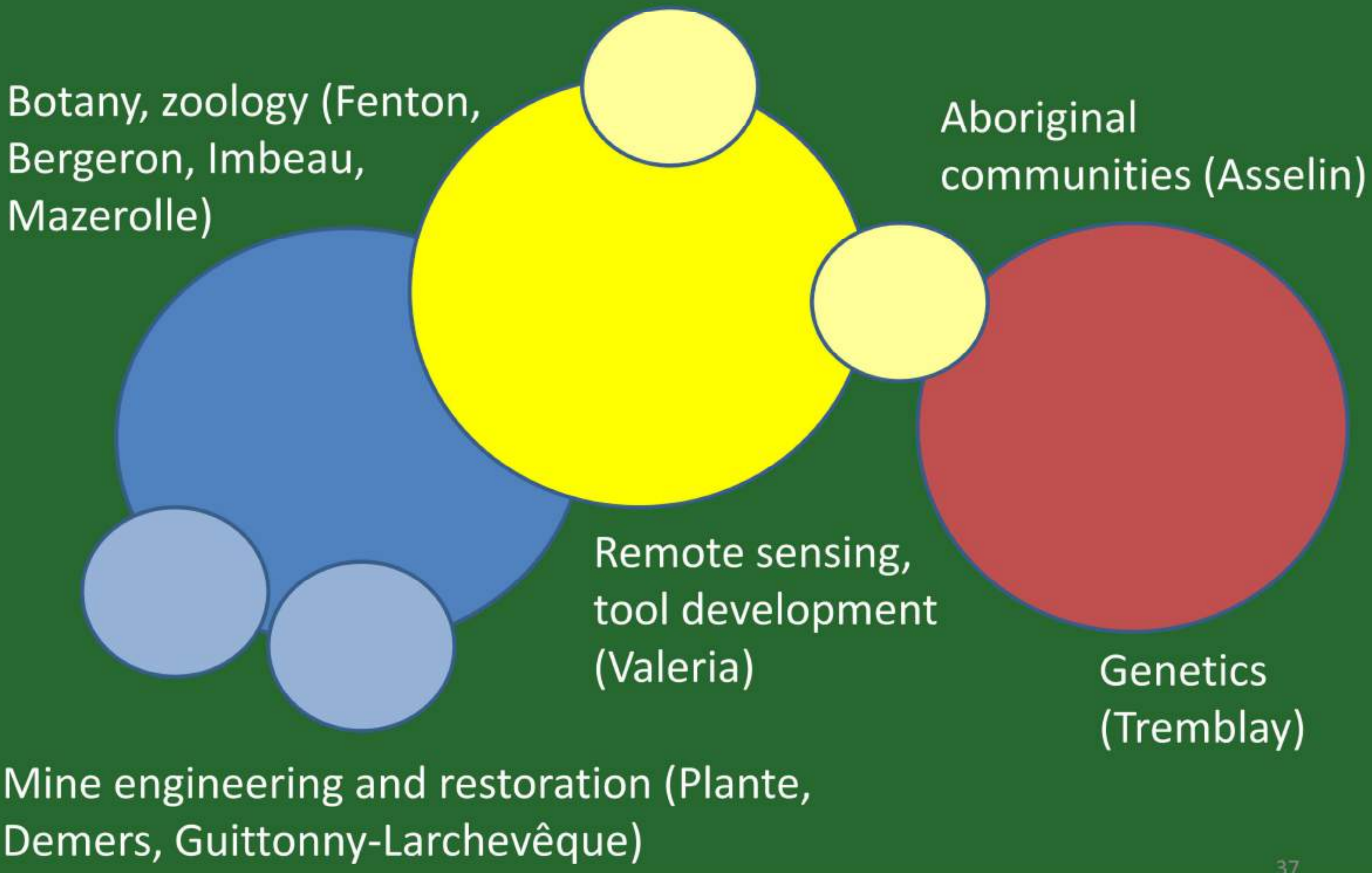


HOW are we going to meet the research objectives?

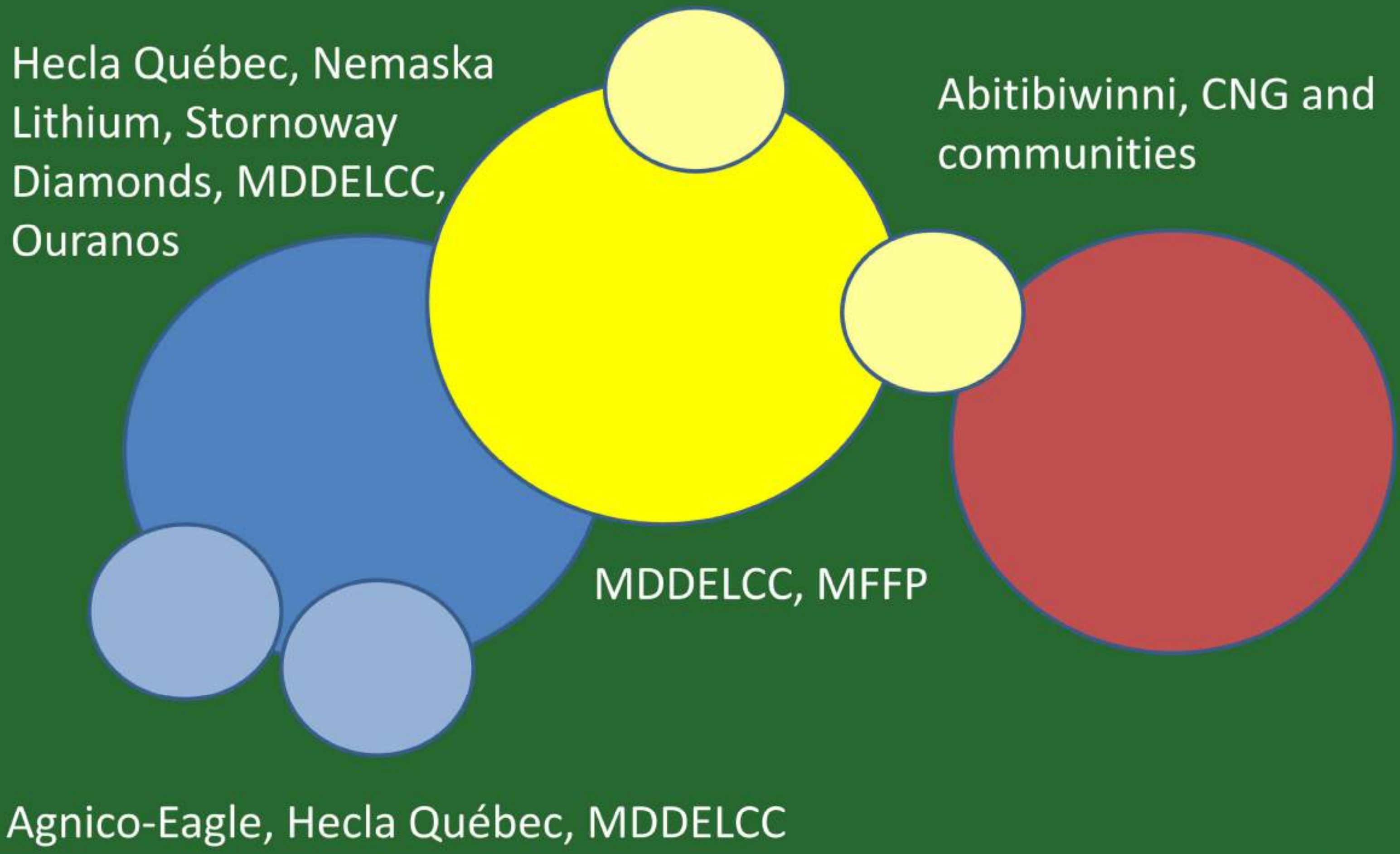
Conceptual map of projects



Interdisciplinary academic team



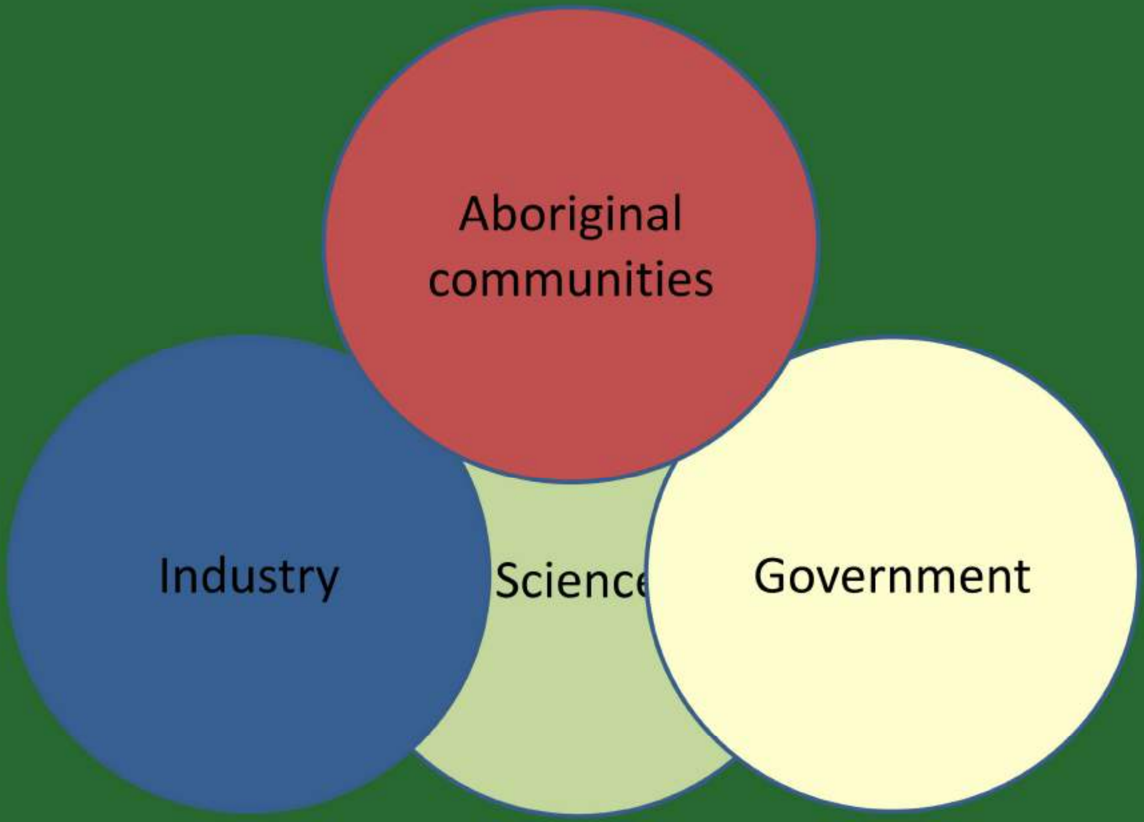
Working with partners



WHY are these results are relevant and important

- Including end-users in project planning
  - Suggesting solutions, not just identifying problems

How can research results be used?



How can research results be used?

Science: Fundamental knowledge

- Species response to disturbances
- Species distribution patterns

How can research results be used?

Industry: How can we limit our current impact?

Mitigation strategies
- Relative suceptability of different ecosystem types
- Adapting road use/ location

Cost-Benefit analysis of strategies

How can research results be used?

Industry:
How can we avoid future impacts?

- Choose locations of least interest for moveable infrastructure: **coarse filter**
- Incorporate mitigation strategies into plans
- Understand aboriginal priorities on the landscape

How can research results be used?

Government: How can we ensure env. protection?

- Avoid impacts: **coarse filter**
- Include First Nation priorities
- Incorporate mitigation strategies into plans

How can research results be used?

First Nations: How are developments impacting our territory?

- Ensure sites are chosen that minimize impacts: **coarse filter**
- Include TEK in permit process
- Measure of compound impacts on landscape

How can research results be used?

How to determine compensation ?

→ Compensation is proportional to loss

→ Include First Nation priorities

Conclusion

- Proposed IRC
  - Develops a unique expertise in a research area of high relevance for industry
  - Create new positions to increase research capacity
  - Generates synergy between the two main research groups in natural sciences at UQAT
  - Provides a stimulating inter-disciplinary environment for student training in applied science

Natural Resources Canada Canadian Forest Service
Ressources naturelles Canada Service canadien des forêts
Forest Regions of Canada
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND and LABRADOR
PRINCE EDWARD ISLAND
NEW BRUNSWICK
NOVA SCOTIA
Hudson Bay
Pacific Ocean
Atlantic Ocean
FOREST REGIONS
PRINCIPAL TREE SPECIES
BOREAL – PREDOMINANTLY FOREST: White spruce, black spruce, balsam fir, jack pine, white birch, trembling aspen
BOREAL – FOREST AND BARREN: White spruce, black spruce, tamarack
BOREAL – FOREST AND GRASS: Trembling aspen, willow
SUBALPINE: Engelmann spruce, alpine fir, lodgepole pine
MONTANE: Douglas-fir, lodgepole pine, ponderosa pine, trembling aspen
COAST: Western red cedar, western hemlock, Sitka spruce, Douglas-fir
COLUMBIAN: Western red cedar, western hemlock, Douglas-fir
DECIDUOUS: Beech, maple, black walnut, hickory, oak
GREAT LAKES – ST. LAWRENCE: Red pine, eastern white pine, eastern hemlock, yellow birch, maple, oak
ACADIAN: Red spruce, balsam fir, maple, yellow birch
GRASSLANDS: Trembling aspen, willow, bur oak
TUNDRA
0 125 250 km

The tiny moss, whose silken verdure clothes
The time-worn rock, and whose bright capsules rise
Like fairy urns on stalks of golden sheen,
Demands our admiration and our praise,
As much as cedar, kissing the blue sky.
Anon. Untitled circa 1860

NEMASKA LITHIUM

LITHIUM HYDROXIDE

POWERING THE FUTURE

Wetland Compensation Program

April 18, 2016
Cree Nation Government

Simon Thibault
Director Environmental and Social Responsibility

Project Timeline from Now On

- *General certificate of authorization (COMEX-MDDELCC) and federal (CEAA) approval obtained in July and early September 2015*
- *Project financing phase*
- *Training programs to start 2016*
- ***Construction start-up in late 2016 (expected to last 19 months)***
- ***Operation start-up in late 2017 (projected mine life of 26 years)***

Provincial CA

- ***Issued on September 8, 2015, by the MDDELCC following the recommendations of the COMEX***

- *Contains **37 conditions** covering **key aspects** of the Whabouchi Mine Project*

la Convention
de la Baie James
et du Nord québécois
Comité d'examen des répercussions
sur l'environnement et le milieu social

- *Condition #12:*

  One year after the project's authorization, the proponent must submit a wetland loss compensation plan to the Administrator for approval.

- *An Act respecting Compensation Measures for the Carrying out of Projects Affecting Wetlands or Bodies of Water*

  2. […] for a project affecting a wetland or a body of water, the Minister […] may require from an applicant compensation measures designed, in particular, to restore, create, protect or ecologically enhance a wetland, a body of water or a piece of land near a wetland or a body of water.

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Wetland Compensation Program

- ***Stornoway Diamonds' Renard Project***
  - *Condition 2.1 of the CA*
  - *Wetland losses are of 17.1 ha, all of high ecological value (mostly bogs)*

stornoway
DIAMOND CORPORATION

- ***Nemaska Lithium's Whabouchi Project***
  - *Wetland losses are of 7.38 ha, with 7.14 ha of medium ecological value and 0.24 of high ecological value*

- *First Meeting in Chapais on October 7, 2014 to present the proposed compensation program to MDDELCC, MFFP, CNG, Mistissini and Nemaska LEAs, Ducks Unlimited, etc.*

Wetland Compensation Program

- ***Acquisition of scientific knowledge*** *on the regional wetland situation*
  - ***Ecological functions at the regional level*** *(flood regulation, water quality, etc.)*
  - *Aqualysis*
    « Recent research has shown that the water surface area (i.e. ponds, waterholes) characterizing these peatlands has significantly increased over the last century in response to climate change. [...] However, the hydrological stocks and fluxes of these northern boreal peatlands have not been thoroughly quantified so far. - Rousseau et al., 2009
  - *Ducks Unlimited Canada noted in 2009 that northern boreal peatlands are «* ***immensely unknown*** *»*
  - *The Eastmain River watershed contains about 80,000 ha of wetlands, i.e. about 2% of all wetlands in the entire Northern-Quebec region*

Wetland Compensation Program

- ***Criteria used for determining their ecological value were elaborated for Southern Quebec (St.Lawrence River Valley)***
  - *High importance given to specific diversity, regional representativeness and level of disturbance*
- ***Relative impossibility of the « zero net loss » principle***
  - *Restoration of peatlands on the very long term (thousands of years)*
  - *Moreno-Mateos et al. (2012): meta-analysis of 621 restored and artificially created wetland sites concluded that biological and biogeochemical functions remained on average 26% and 23% lower than in reference sites*
  - *Protection / conservation / ecological enhancement = net loss of wetlands*

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Wetland Compensation Program

- *The problem is that* ***we do not have enough information to establish criteria to define the ecological value of boreal wetlands****, especially peatlands*

- *Biophysical criteria*
  - *Biology (specific and functional diversity)*
  - *Biogeochemistry (greenhouse gas)*
  - *Hydrology (flood control, etc.)*
  - *Etc.*

- *Social criteria*
  - *Traditional use (hunting, berry gathering, medicinal plants, etc.)*
  - *Landscape*
  - *Etc.*

Wetland Compensation Program

- *Applied research is work undertaken for the advancement of scientific knowledge with a specific practical application in view*
- ***Implementation of a research program that would enable gathering scientific and traditional data on boreal wetlands, especially peatlands***
  - *Biophysical and social data*
- ***Financial participation (funding and logistics)*** *of mining companies in the proposed Program would serve as its Wetland Compensation Plan*

CNRC·NRC Canada

Fonds de recherche sur la nature et les technologies Québec

CRSNG NSERC

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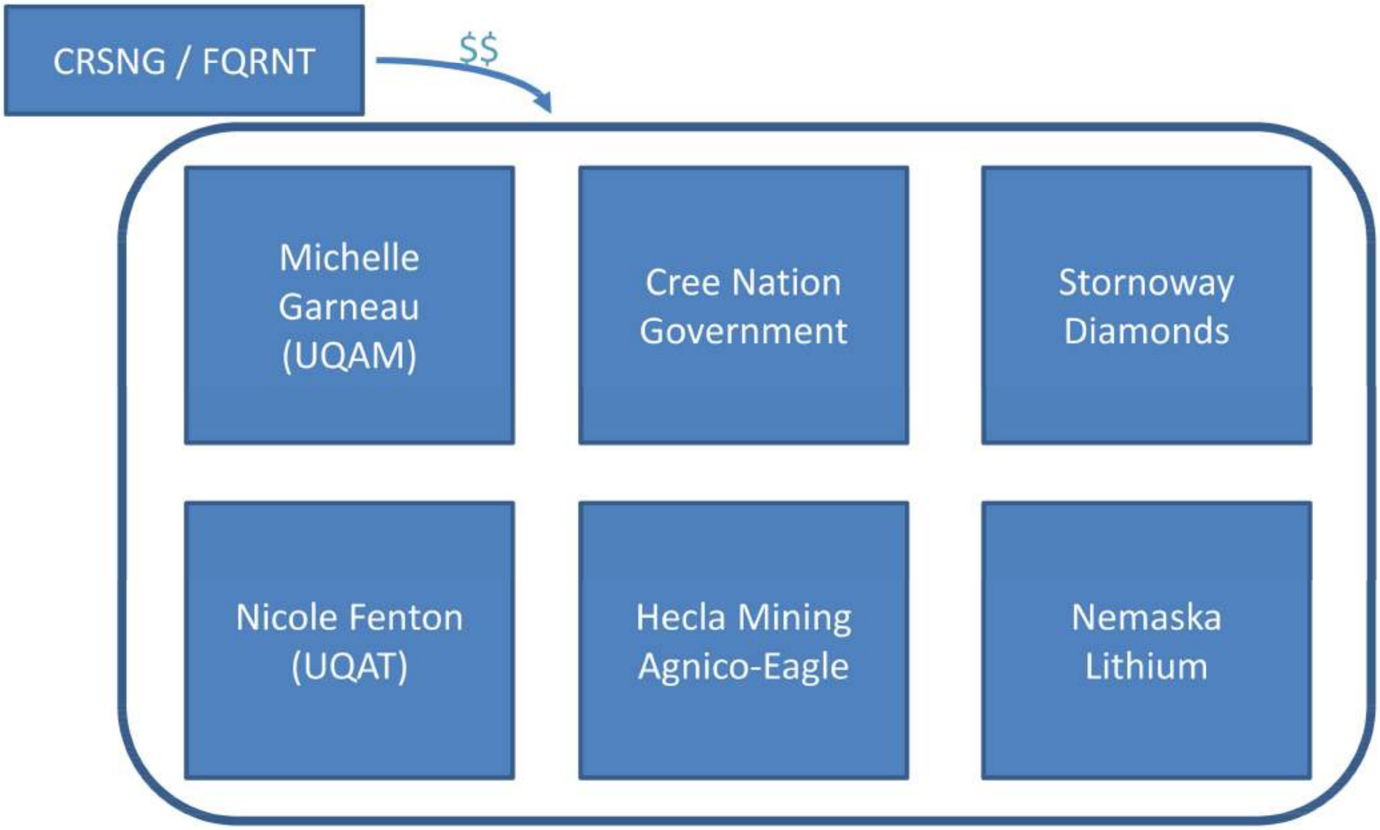
Wetland Compensation Program



Wetland Compensation Program

CRSNG / FQRNT

$$

Michelle Garneau (UQAM)

Nicole Fenton (UQAT)

Elaborate, plan and complete the research works

Administration (application for funding, management, etc.)

Graduate students (M.Sc., Ph.D.)

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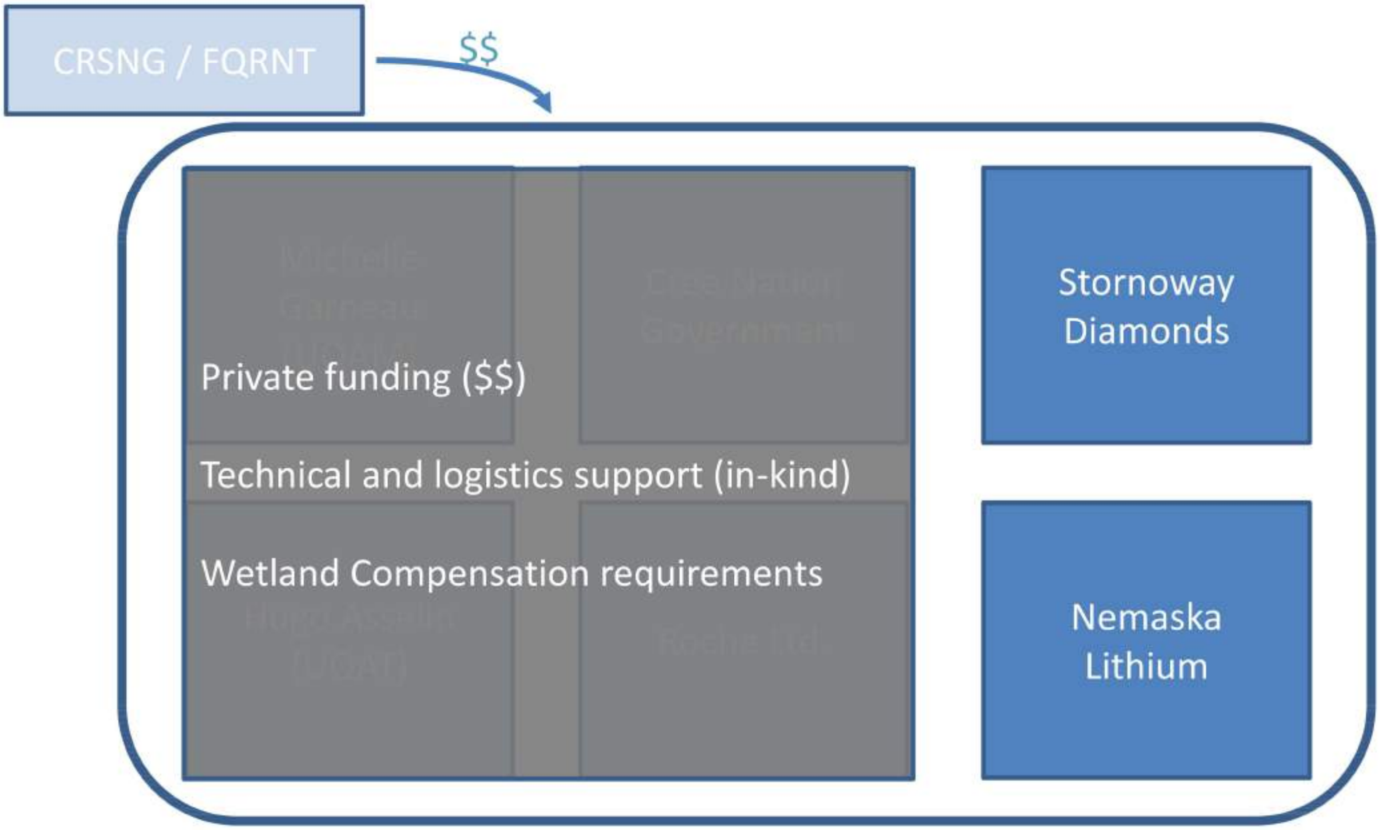
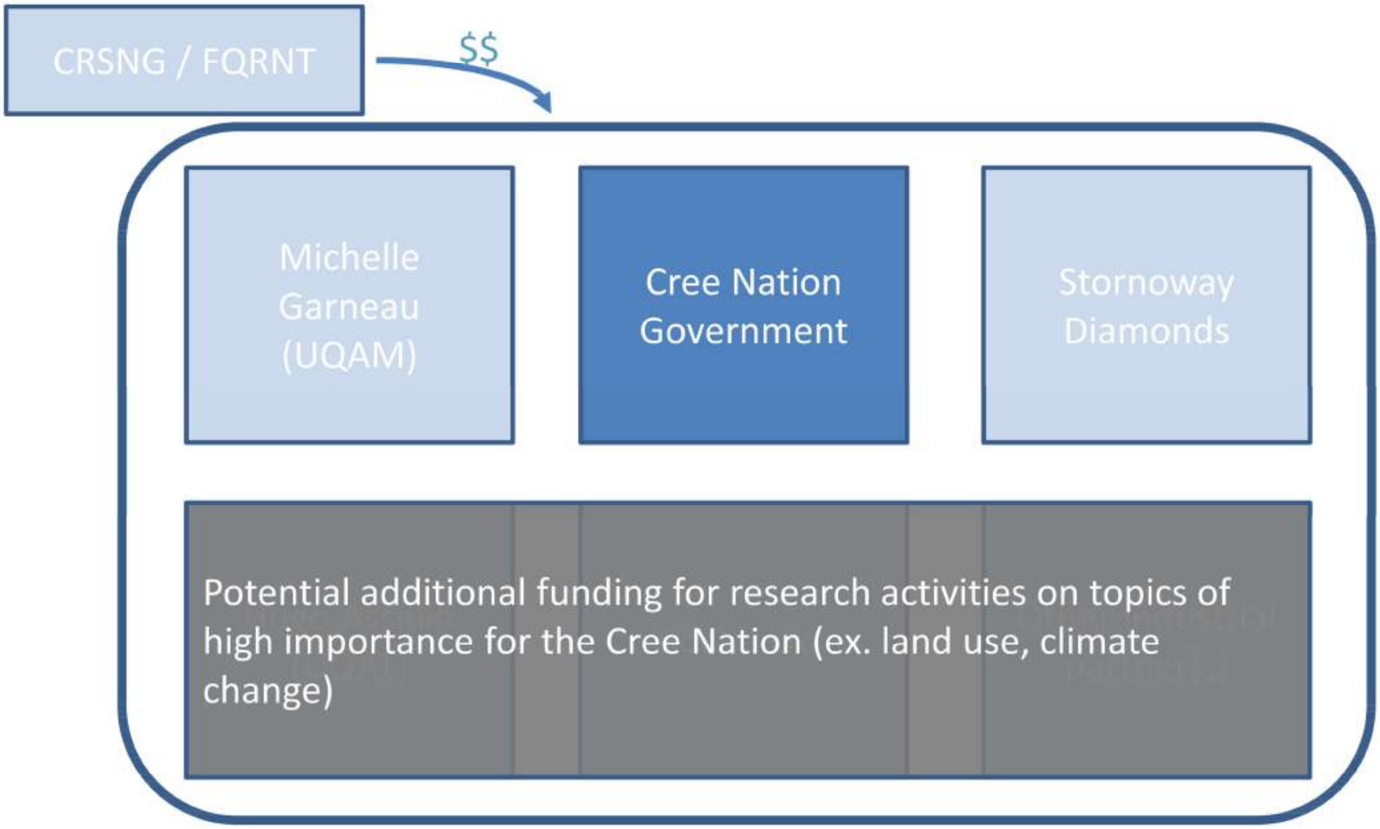
Wetland Compensation Program



Wetland Compensation Program



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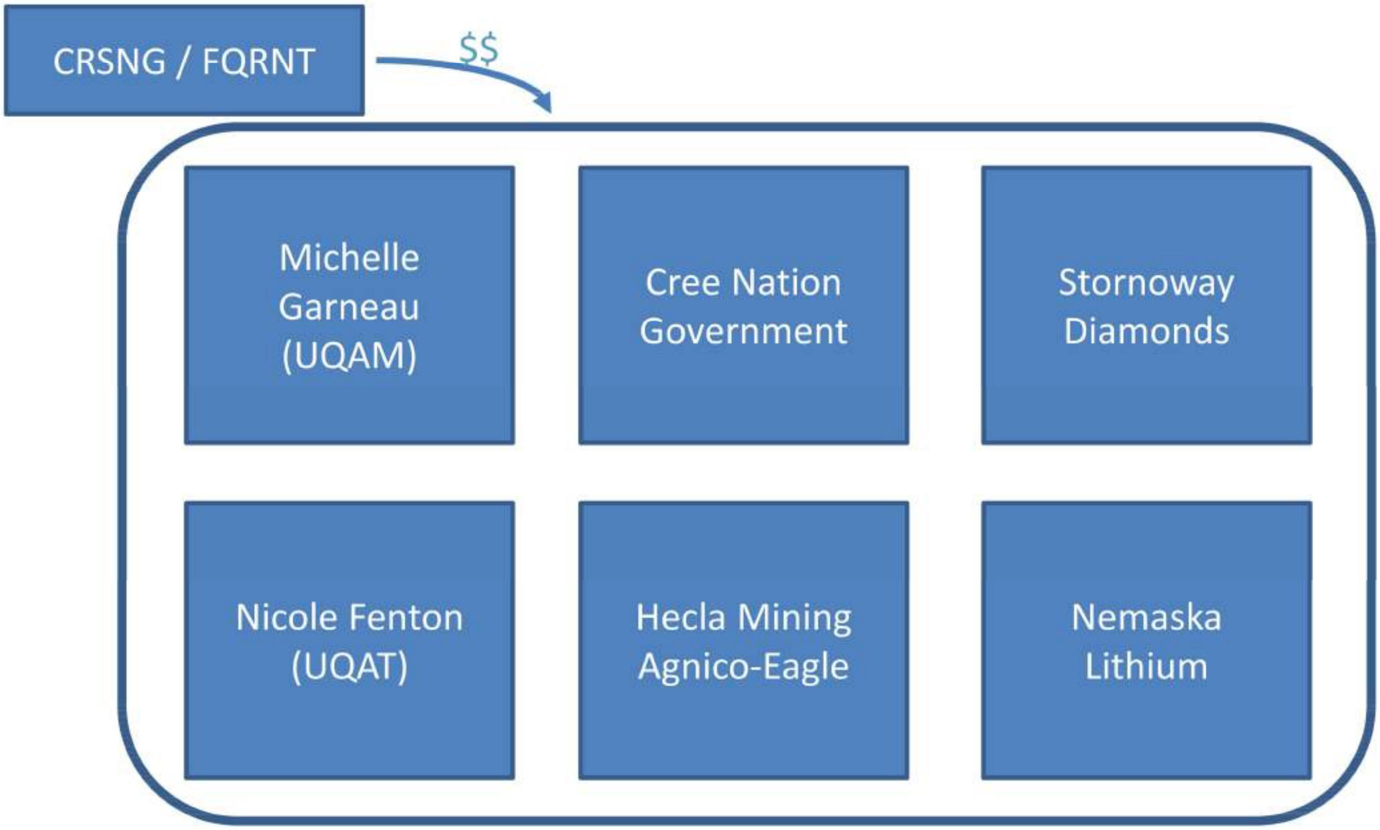
Wetland Compensation Program



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Québec

Thank you
Meegwetch

www.nemaskalithium.com