Centre d'étude de la forêt

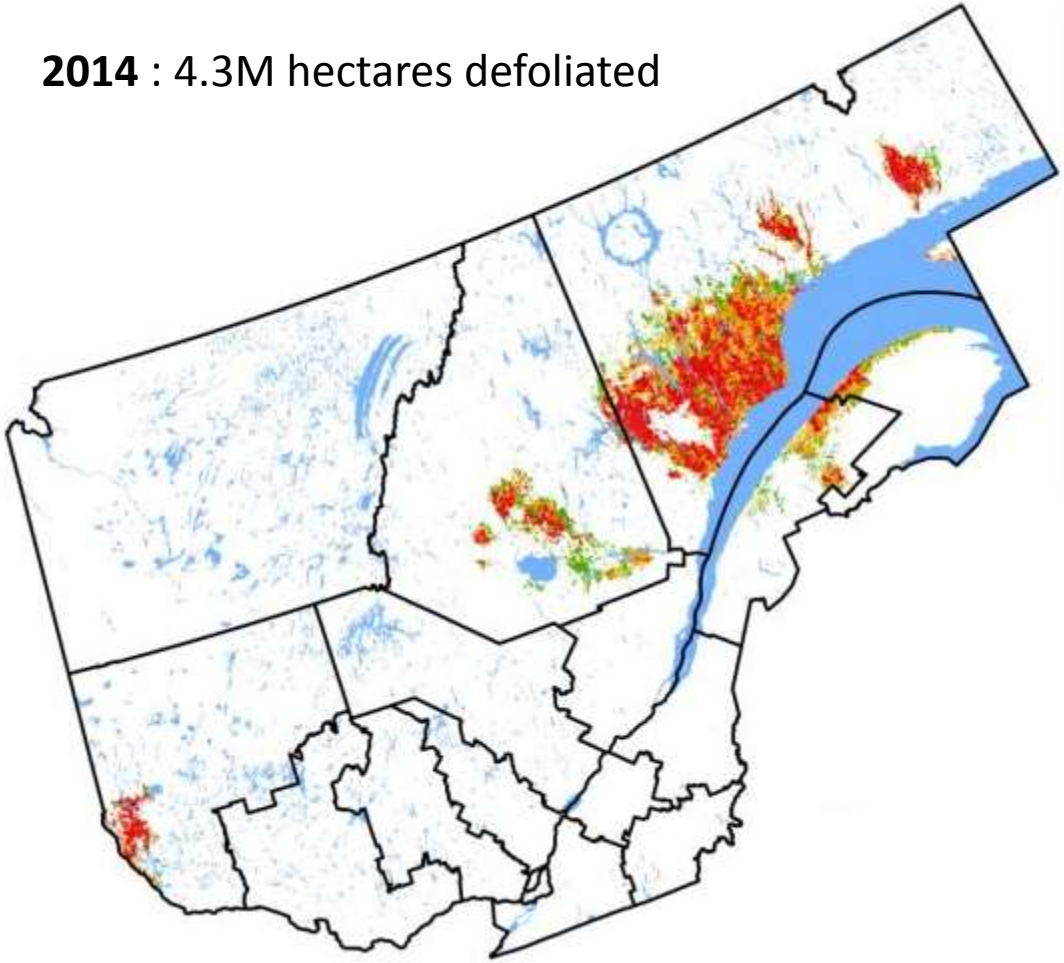
Université de Montréal

Dynamique spatiale des populations d'*Apanteles fumiferanae* et de *Glypta fumiferanae*, des parasitoïdes des larves de la tordeuse des bourgeons de l'épinette.

S. Legault et P. James
Département de sciences biologiques, Université de Montréal

SPRUCE BUDWORM (SBW) OUTBREAK IN QUEBEC

2014 : 4.3M hectares defoliated



How does spatial heterogeneity affect SBW parasitoids dynamics ?

Same effects for different species?

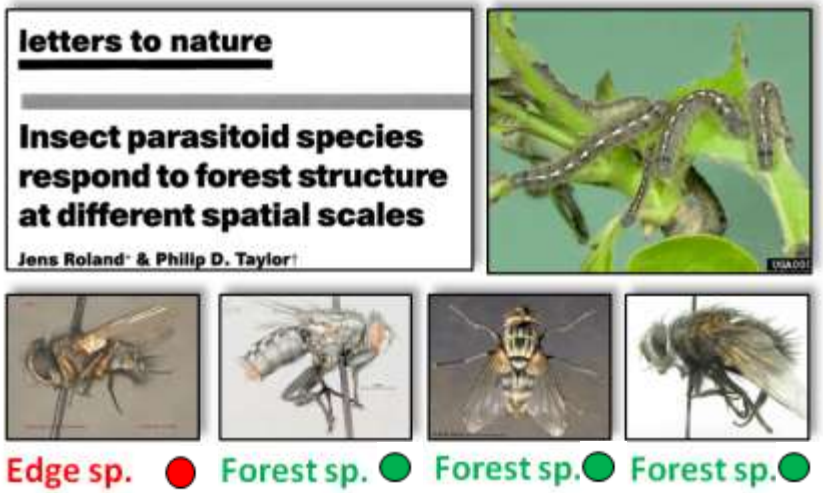
Same spatial scales?

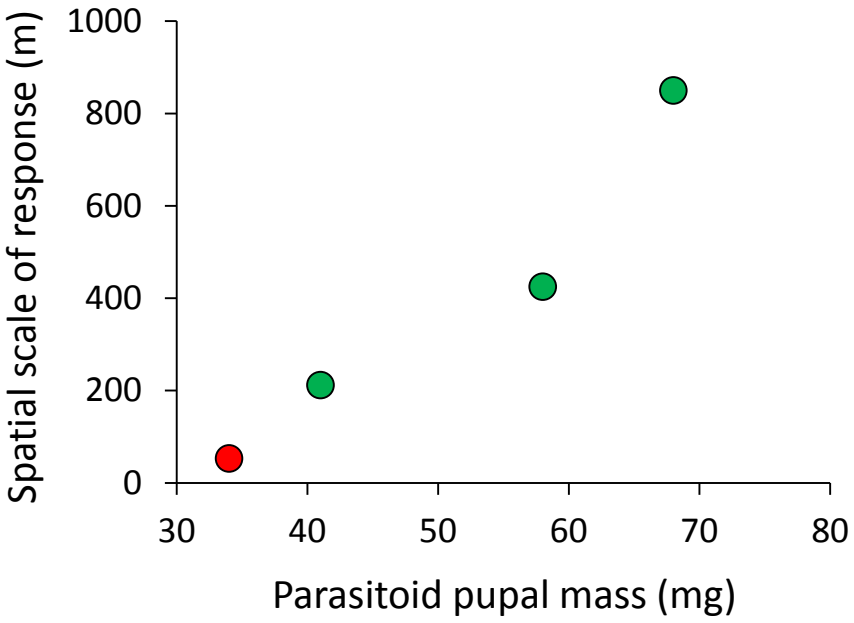
SPATIAL SCALING IN LANDSCAPE ECOLOGY

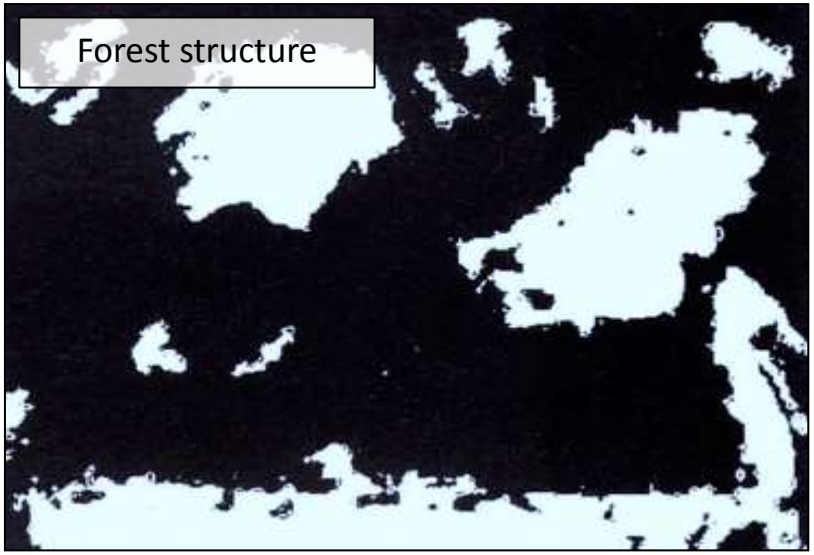
Scale is a central issue in landscape ecology

Spatial patterns results from **multi-scale processes**

Species perceive the landscape in **different ways** and at **different spatial scales**



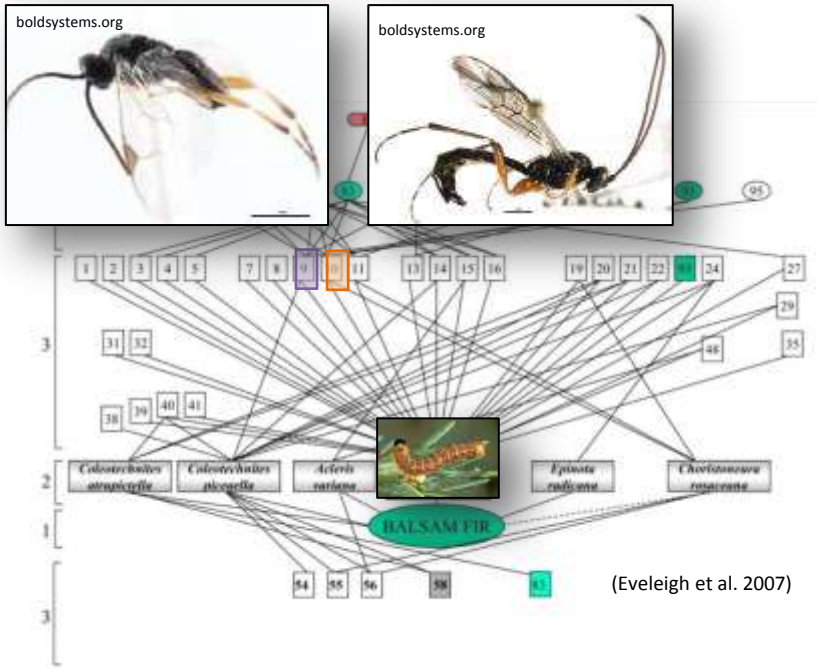




SELECTION OF PARASITOID SPECIES

Apanteles fumiferanae (Braconidae)

Glypta fumiferanae (Ichneumonidae)



(Eveleigh et al. 2007)

Both species are abundant during SBW outbreaks;

Both species attack L1-L2 instars in late summer;

Both species are univoltine and relatively specialists;

But, they have **different body size**, suggesting they could have different dispersal abilities and scale-dependent response to landscape heterogeneity.

Apanteles : ≈ 3mm

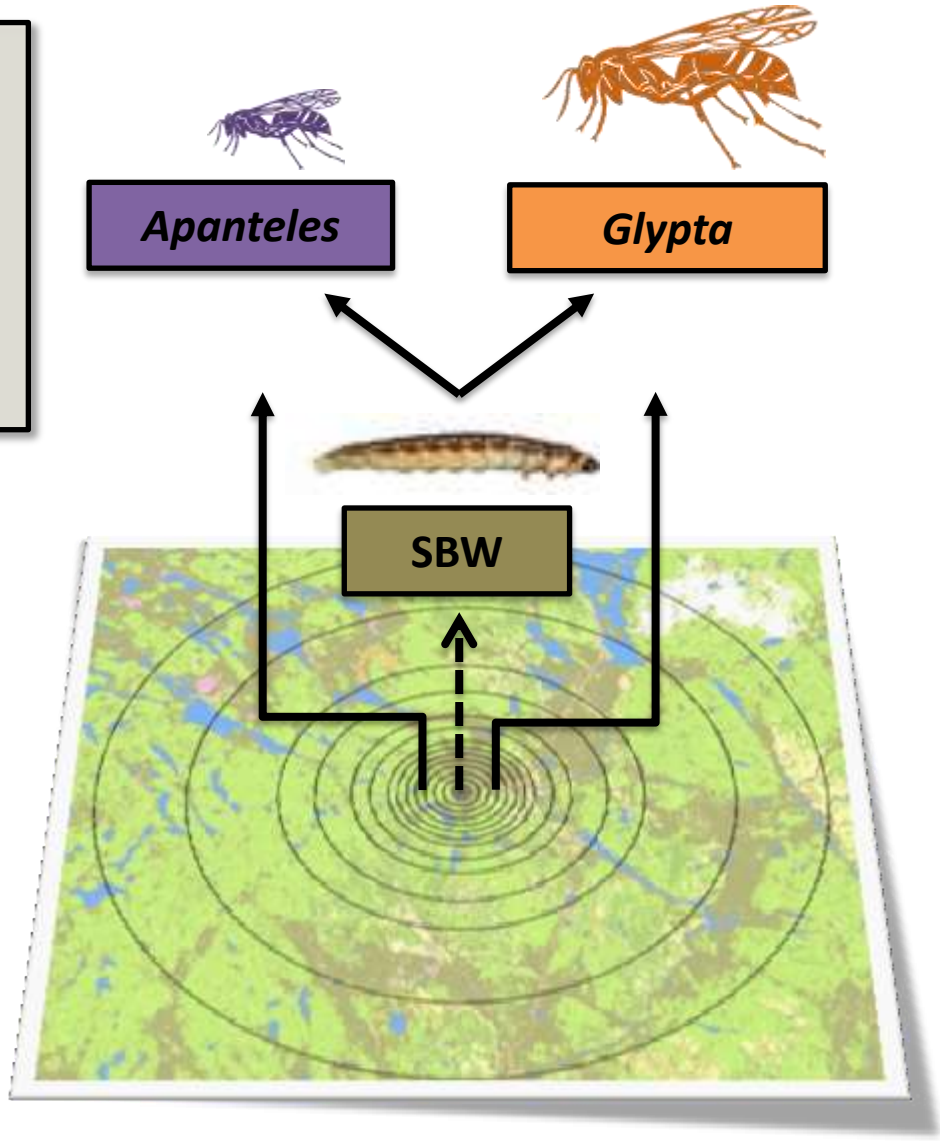
Glypta: ≈ 10 mm

SPECIFIC OBJECTIVES

How does spatial heterogeneity affect SBW parasitoids dynamics ?

Same effects for different species?

Same spatial scales?



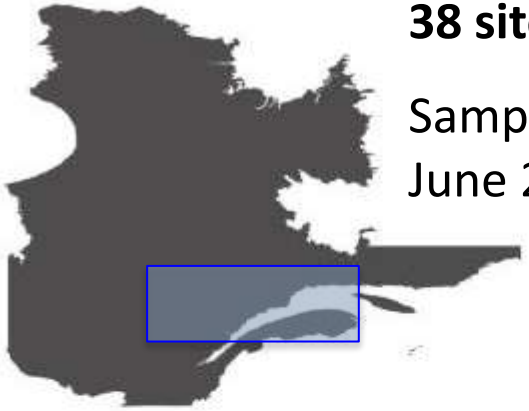
Determine the relative effects of

1) **Latitude**
2) **Local SBW larval density**
3) **Landscape heterogeneity**
4) **Outbreak age**

on SBW larval parasitism rates by ***Apanteles*** and ***Glypta***.

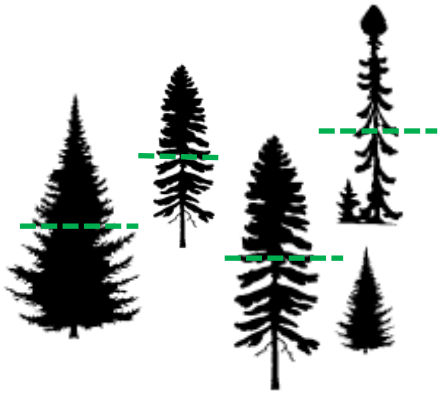
Determine their **spatial scale of response** to **3)** and **4)**

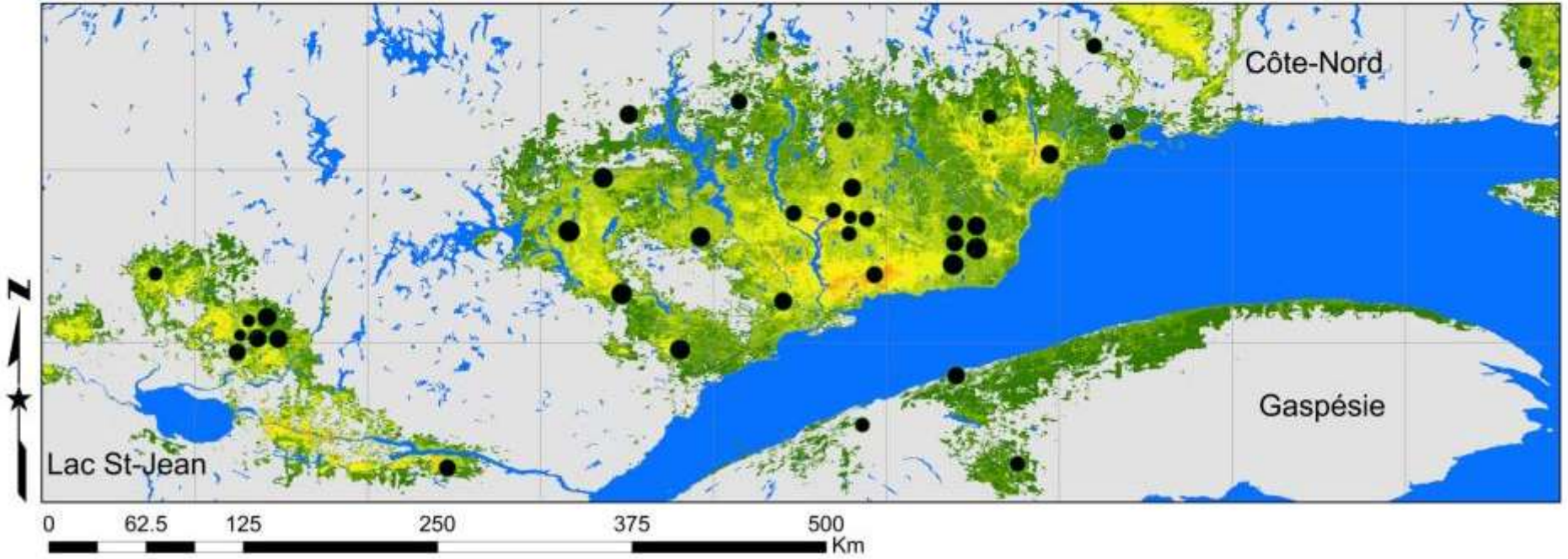
FIELD SAMPLING AND SBW LARVAE REARING



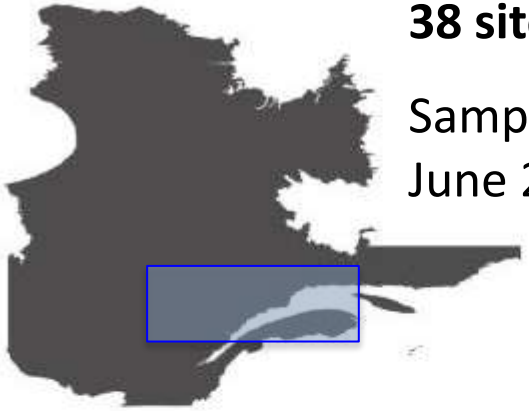
38 sites across the province of Québec

Sampling of SBW **L3-L4 instars** around June 2014 using **BioSIM**





FIELD SAMPLING AND SBW LARVAE REARING



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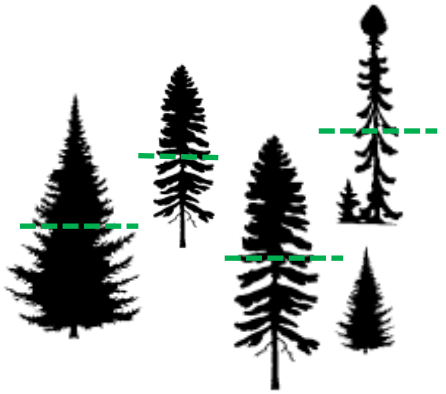


SBW density :

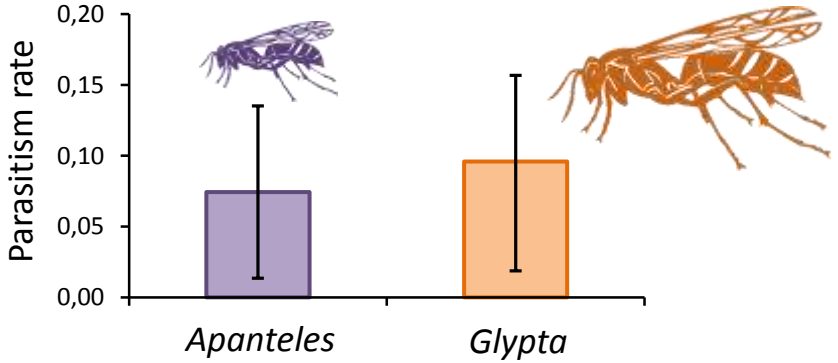
10 branches of 45 cm / site

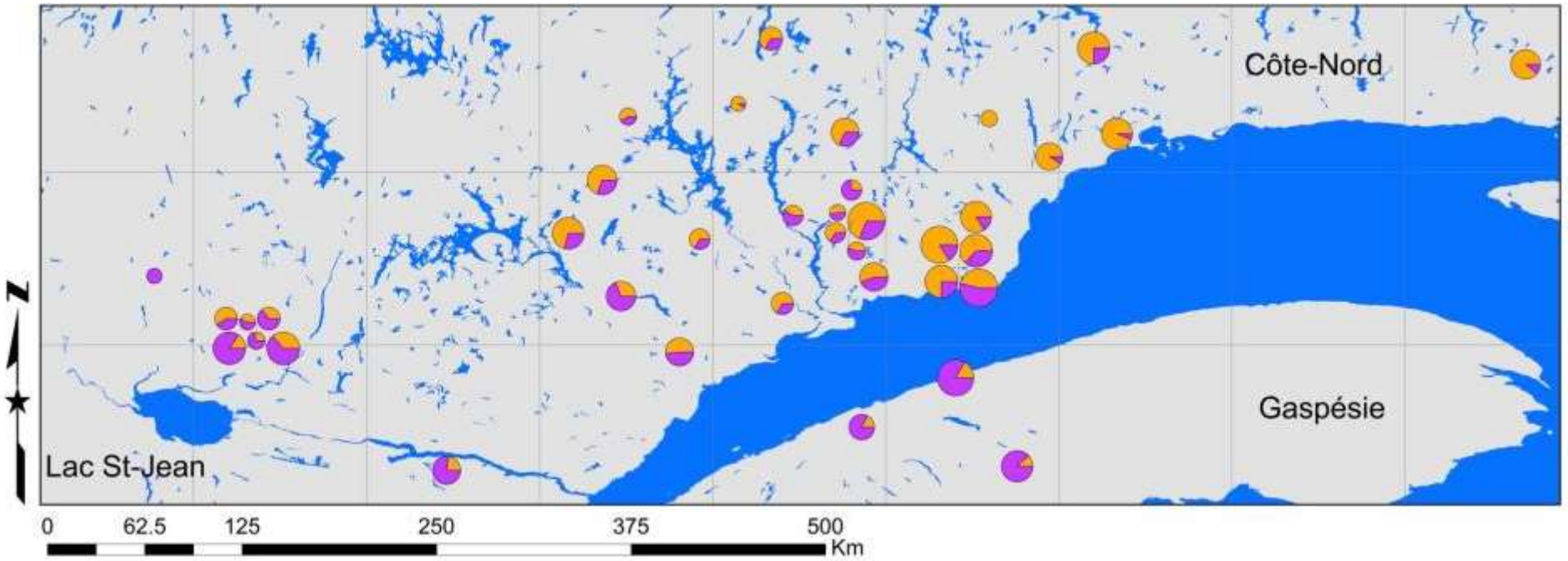
$$\frac{\text{Nb of SBW larvae}}{\text{Nb of green buds} * 100}$$

Mean = 31 ± 18 larvae / 100 buds

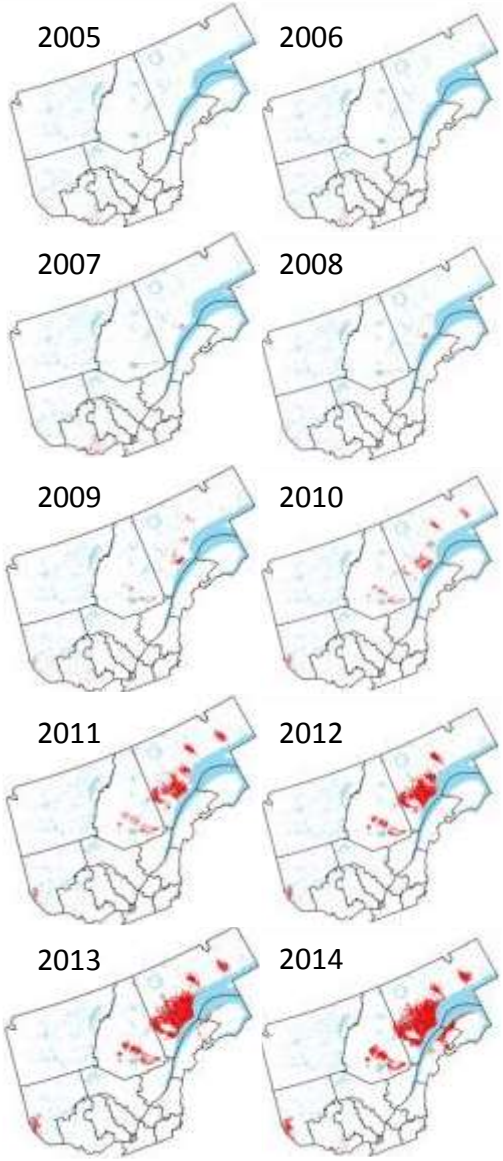
FIELD SAMPLING AND SBW LARVAE REARING

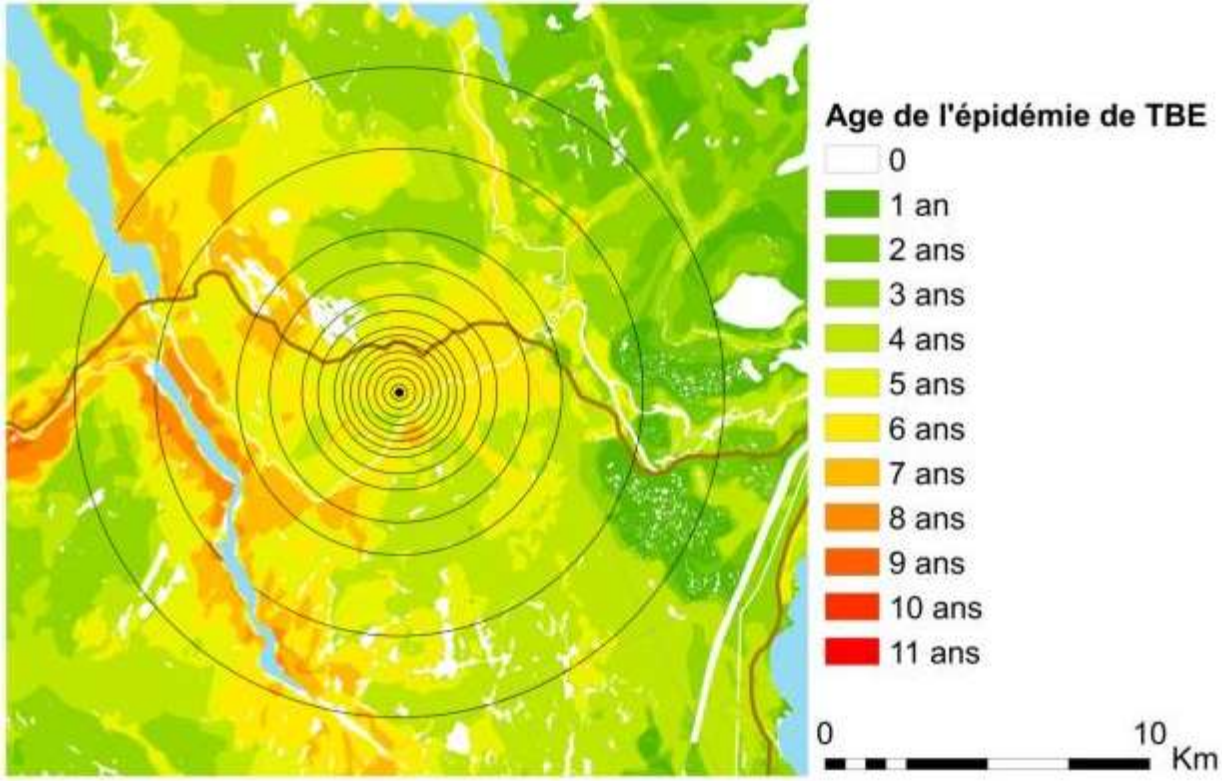
FIELD SAMPLING AND SBW LARVAE REARING





ESTIMATION OF SBW OUTBREAK AGE





Forêts, Faune et Parcs
Québec

QUANTIFICATION OF LANDSCAPE HETEROGENEITY

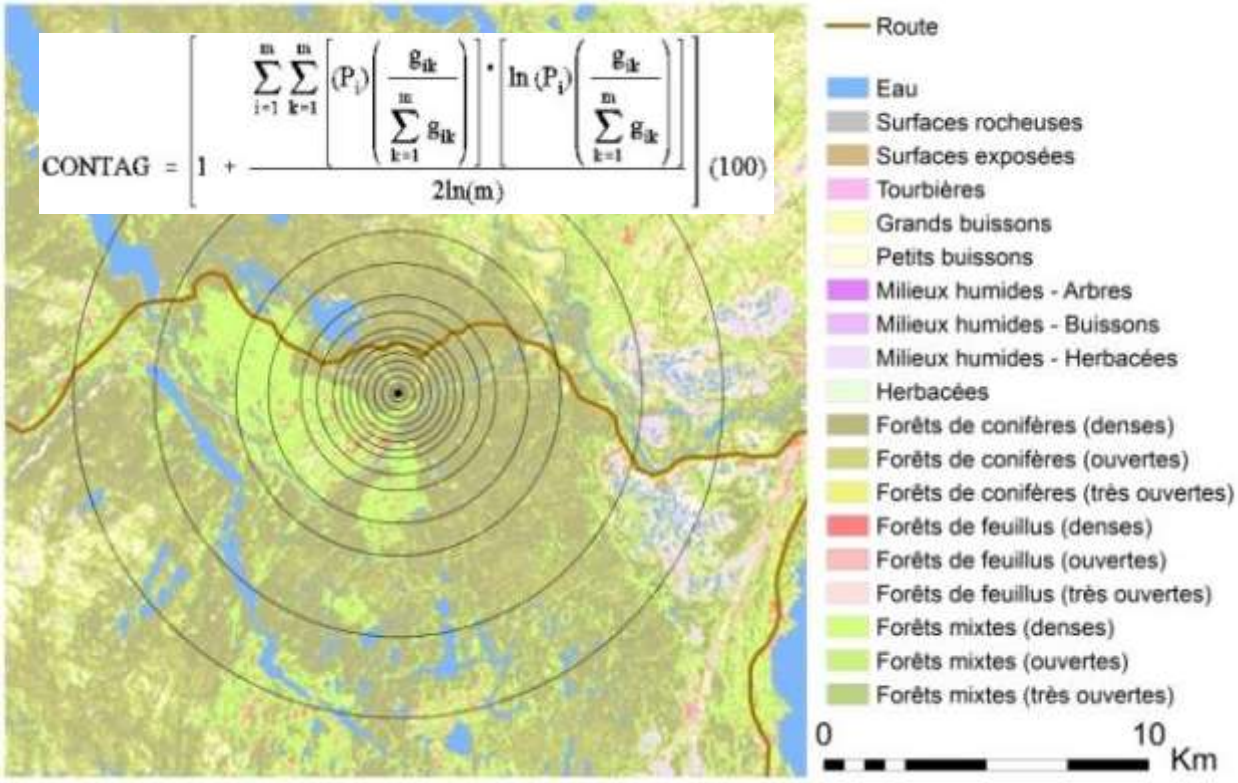
Contagion Index

High values of contagion result from landscapes with a few large contigus patches.

Effective **summary of overall heterogeneity** on categorical maps.

Negatively correlated with indices of diversity and edge density.

$$CONTAG = \left[1 + \frac{\sum_{i=1}^{m}\sum_{k=1}^{m}\left[(P_i)\left(\frac{g_{ik}}{\sum_{k=1}^{m} g_{ik}}\right)\right]\cdot\left[\ln(P_i)\left(\frac{g_{ik}}{\sum_{k=1}^{m} g_{ik}}\right)\right]}{2\ln(m)}\right](100)$$

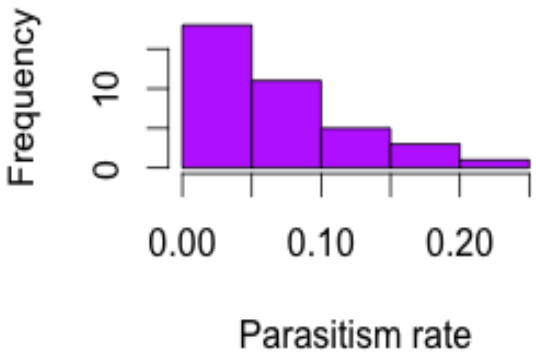


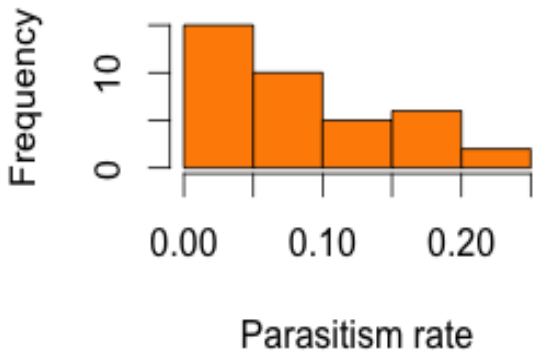
BETA REGRESSION MODELS

Response variables:

Parasitism rate by *Apanteles*

Parasitism rate by *Glypta*

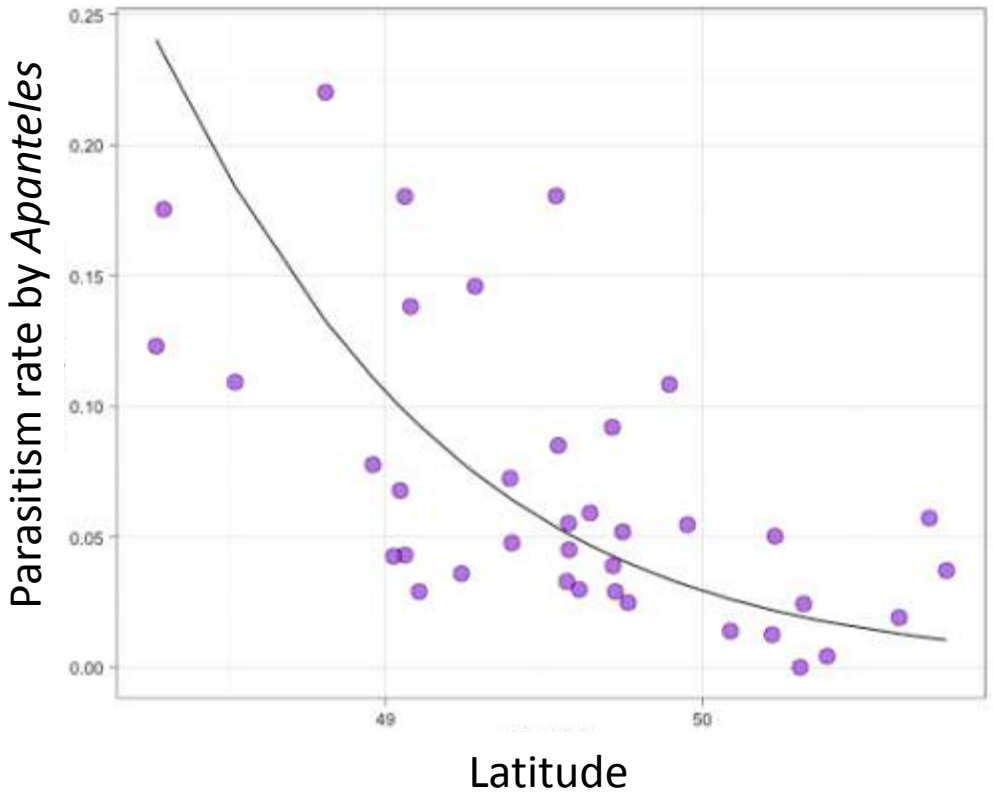


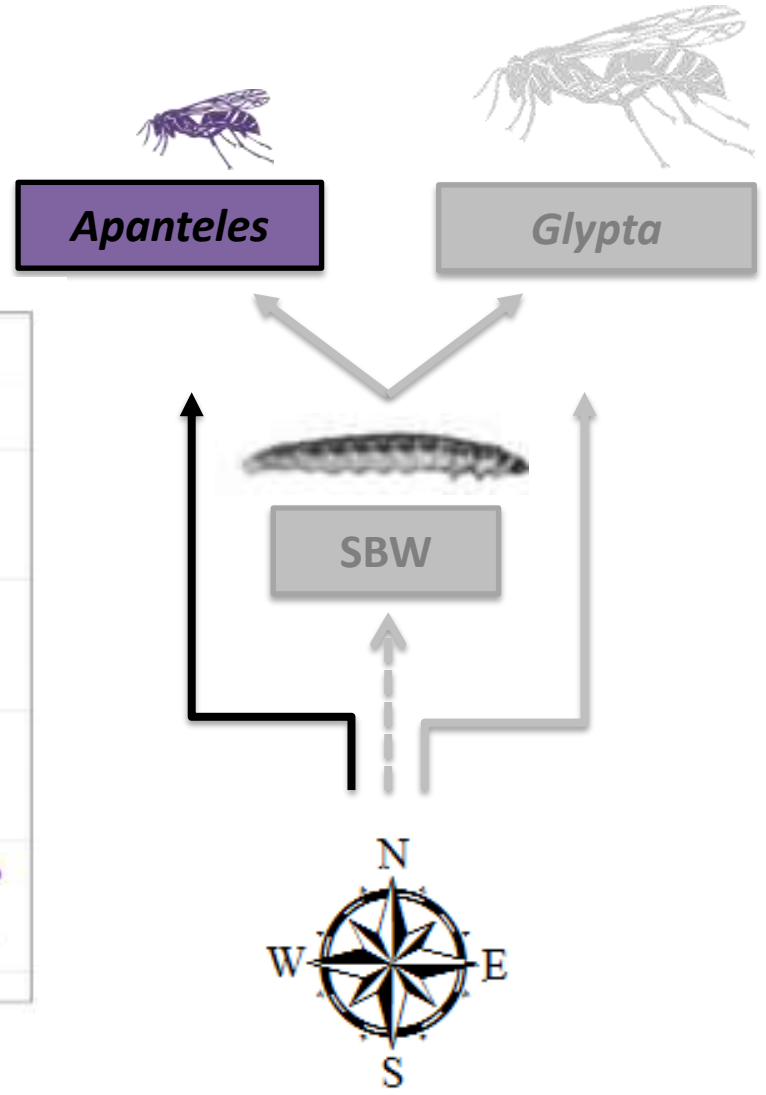


	Model	Hypothesis
1	~ Latitude	Latitudinal gradient in biological interactions
2	~ SBW density	Density-dependant responses
3	~ Contagion	Heterogeneity increase natural ennemies
4	~ Outbreak Ag	Temporal shift in community composition
…	…	…
14	~ Latitude + SBW density + Contagion + Oubreak age	Combined effects of different factors explain parasitism rates

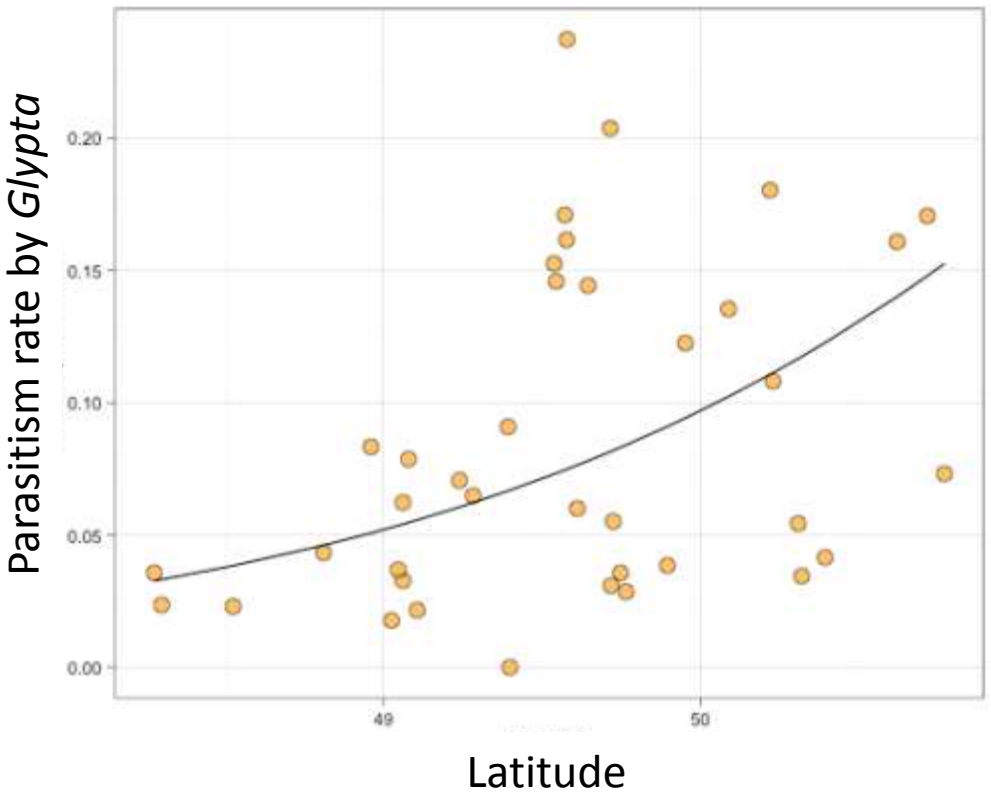
Model selection using AICc weights

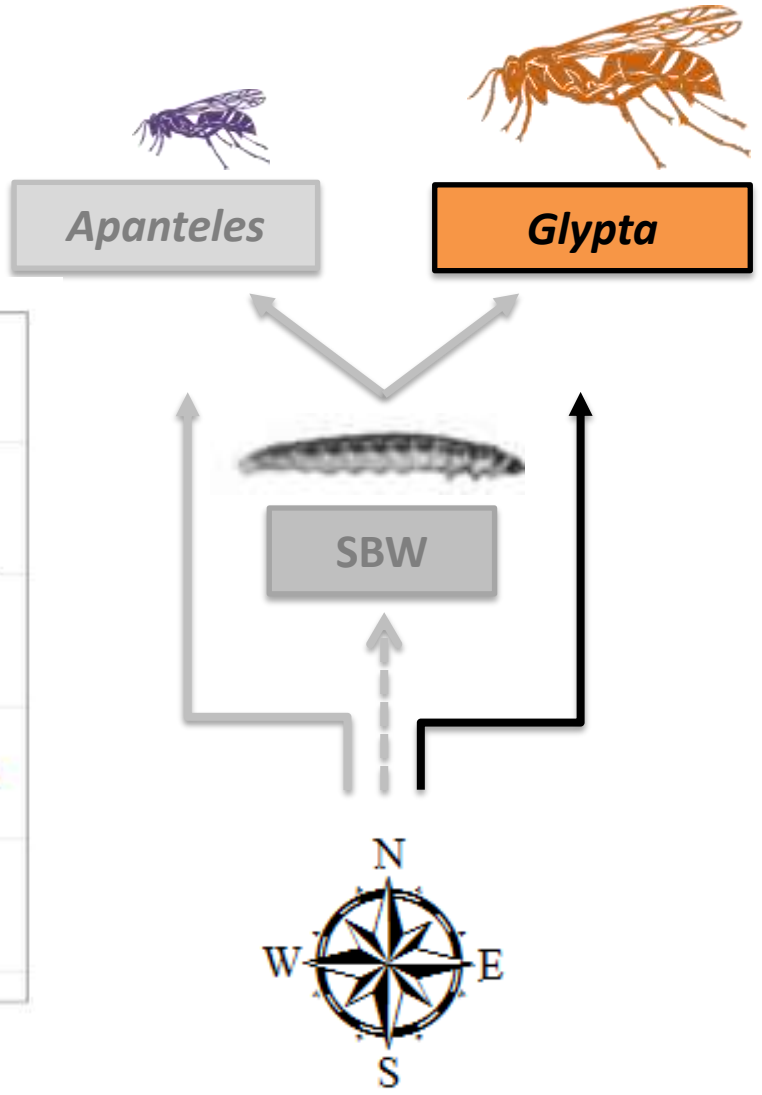
BETA REGRESSION MODELS : LATITUDE



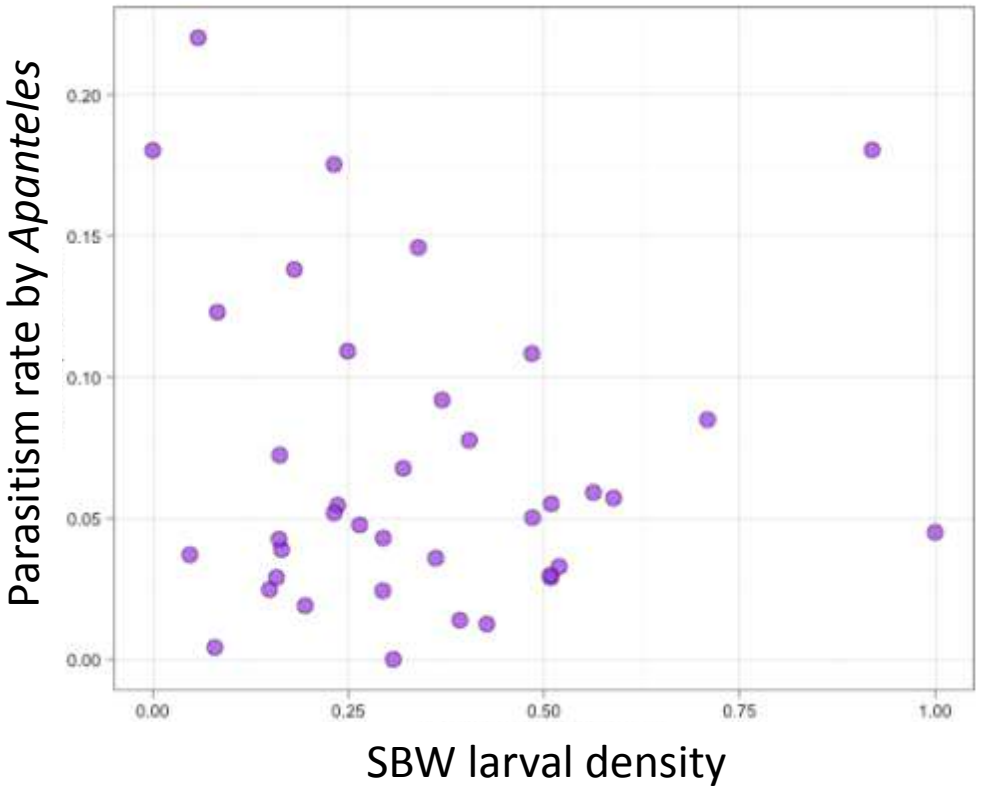


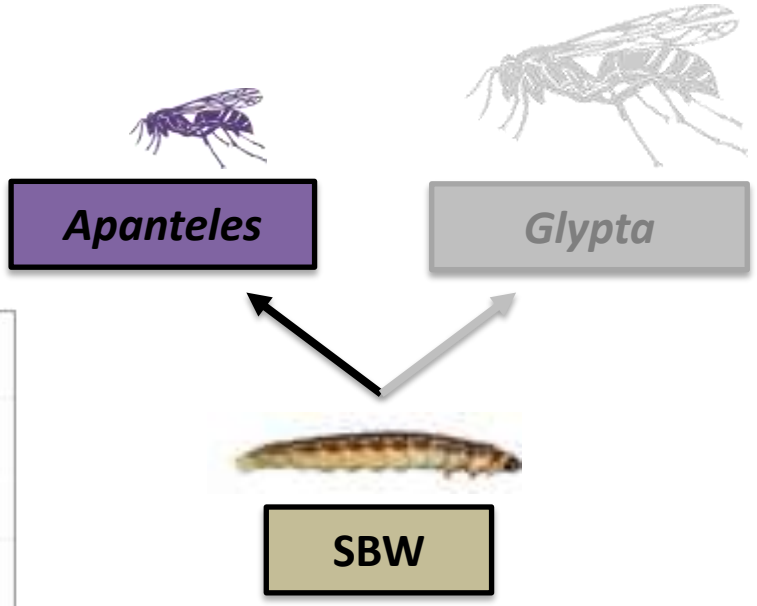
BETA REGRESSION MODELS : LATITUDE



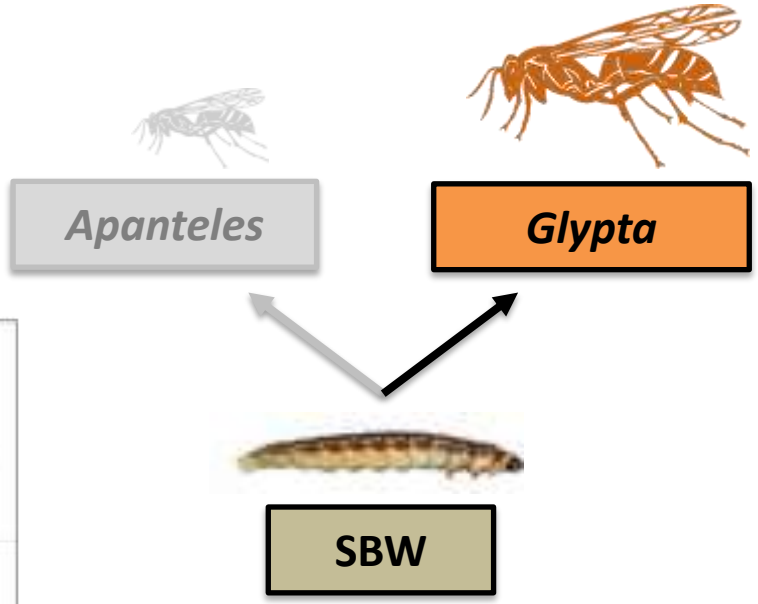


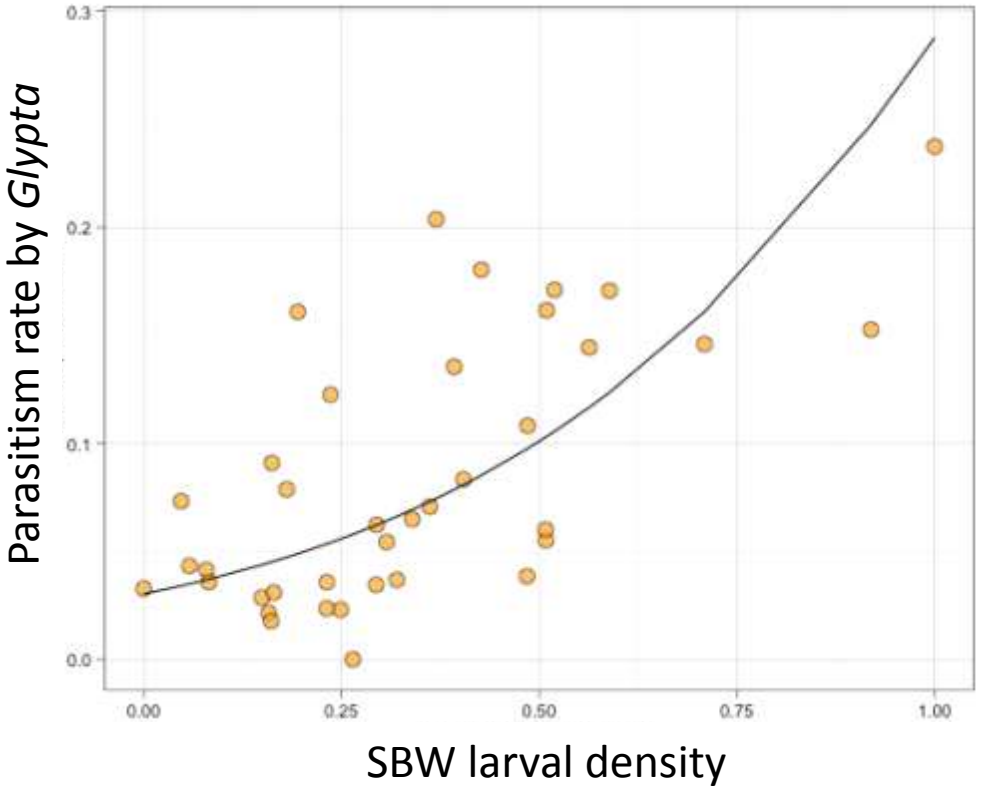
BETA REGRESSION MODELS : SBW LARVAL DENSITY



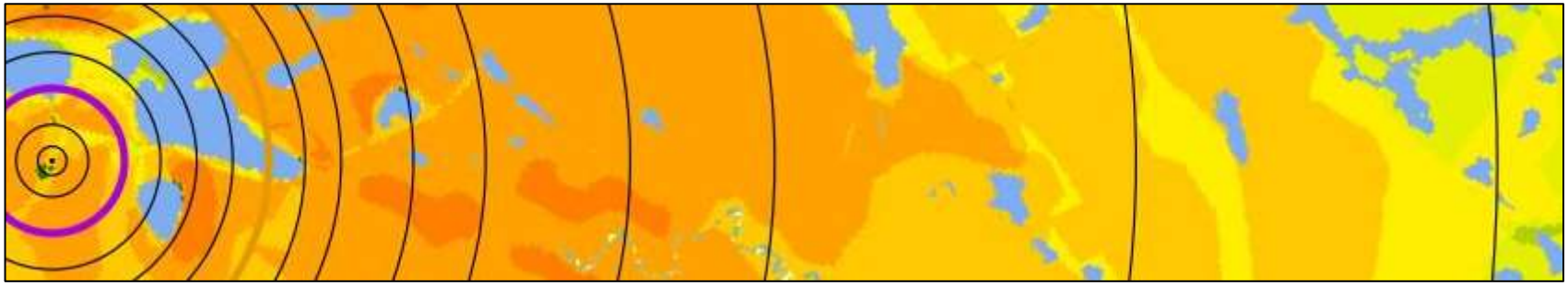


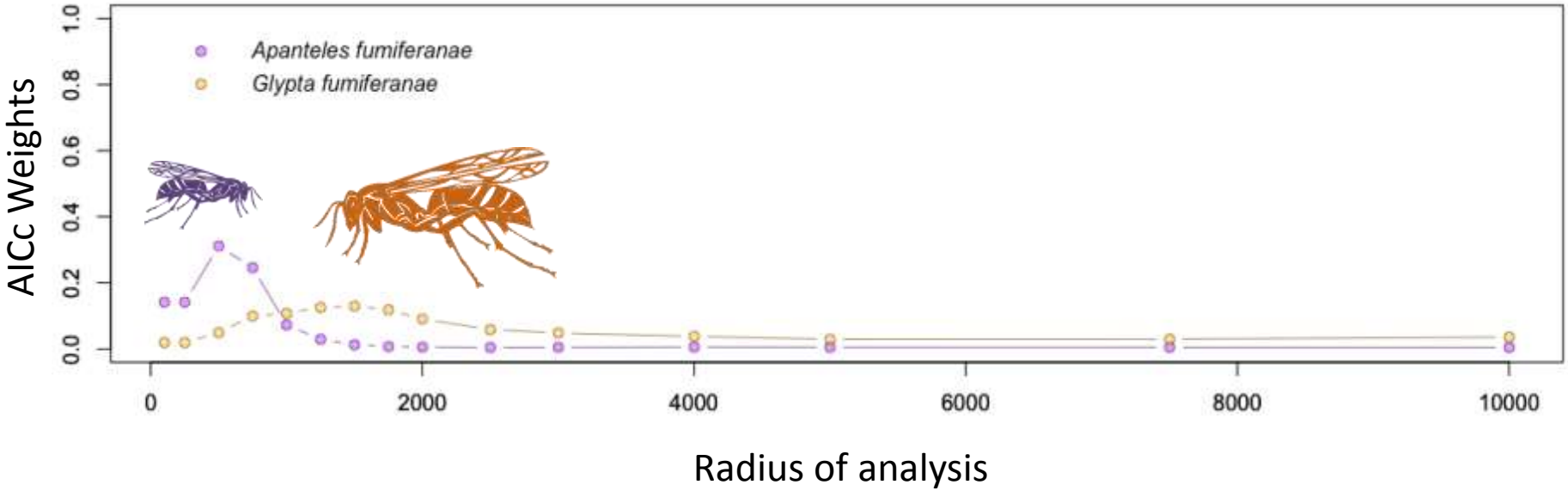
BETA REGRESSION MODELS : SBW LARVAL DENSITY





BETA REGRESSION MODELS : OUTBREAK AGE





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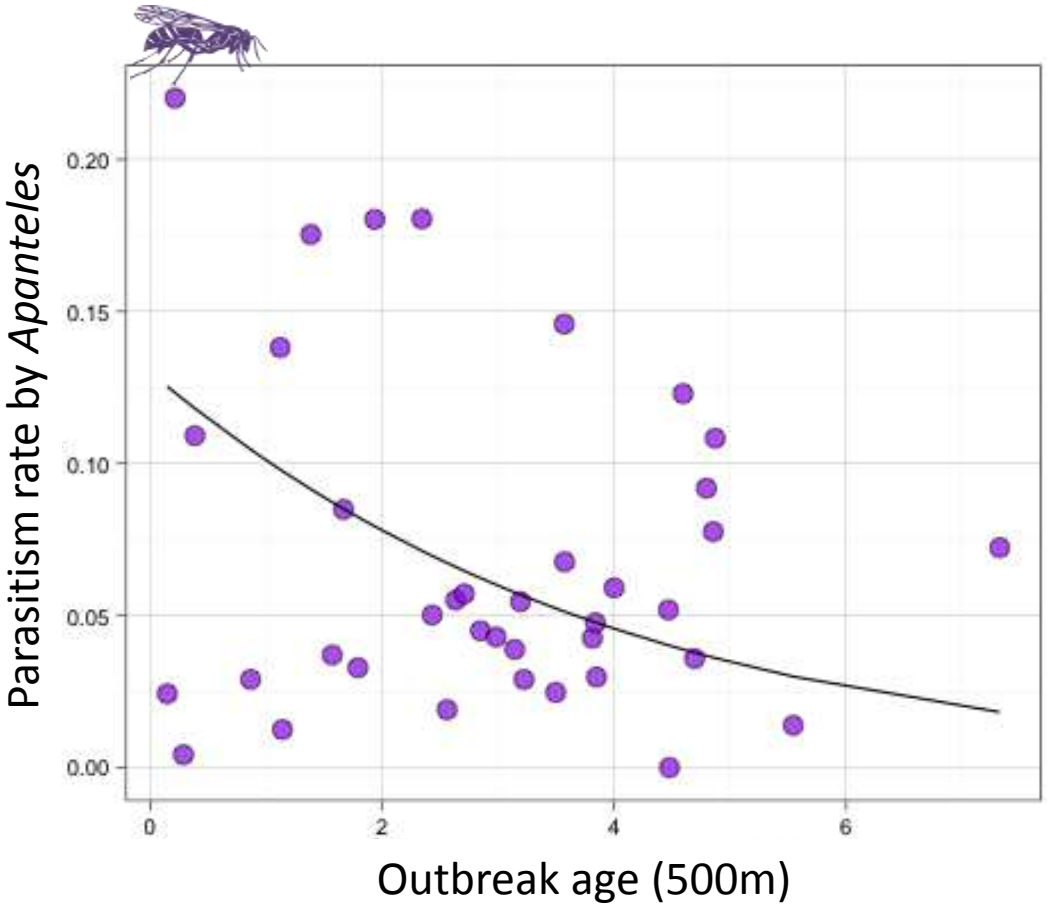

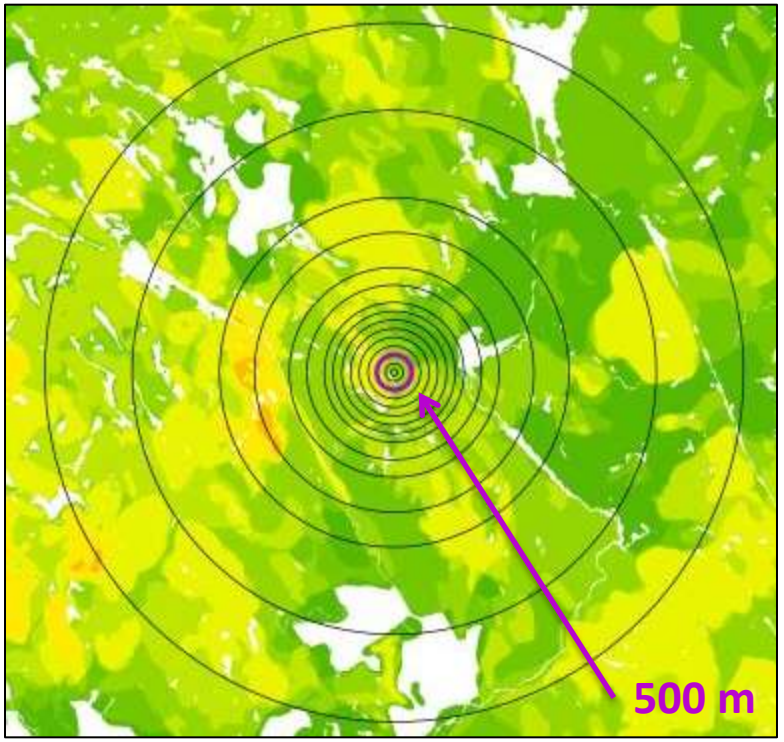

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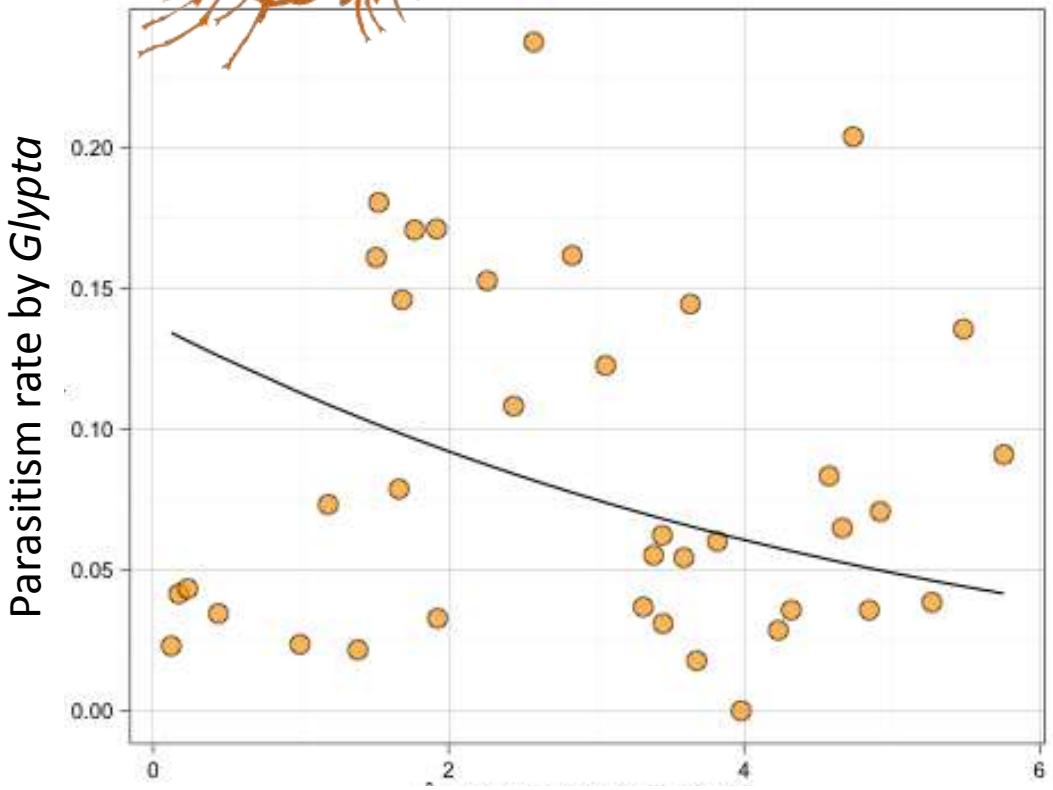
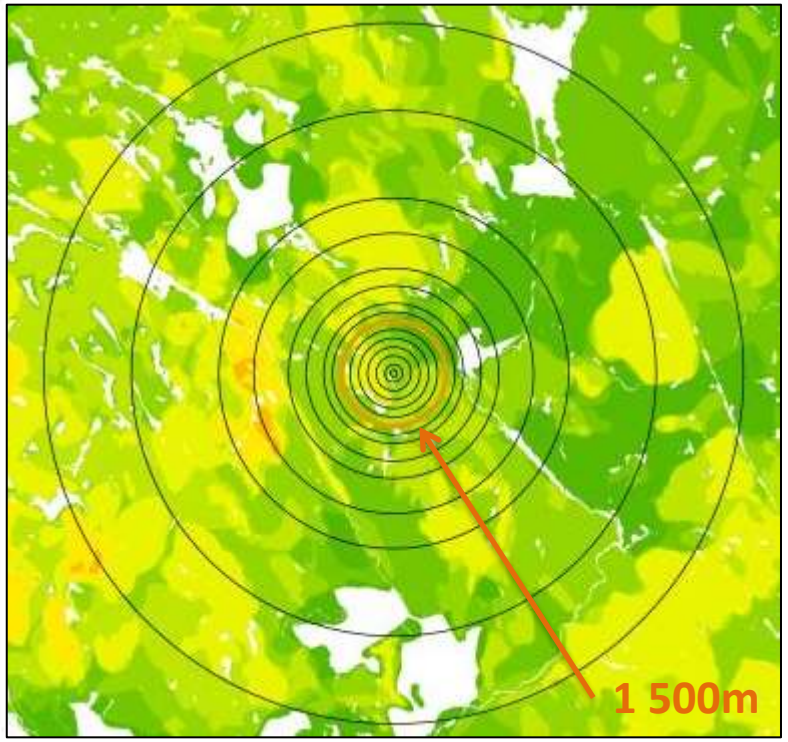
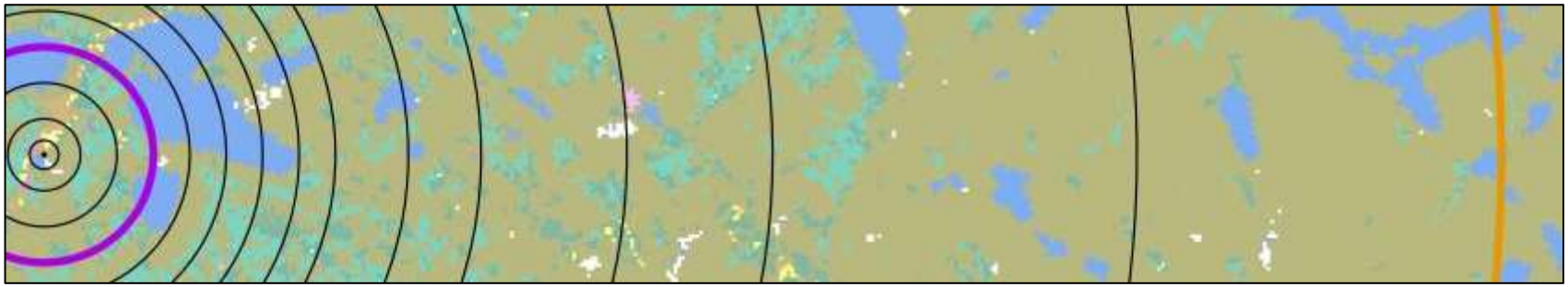
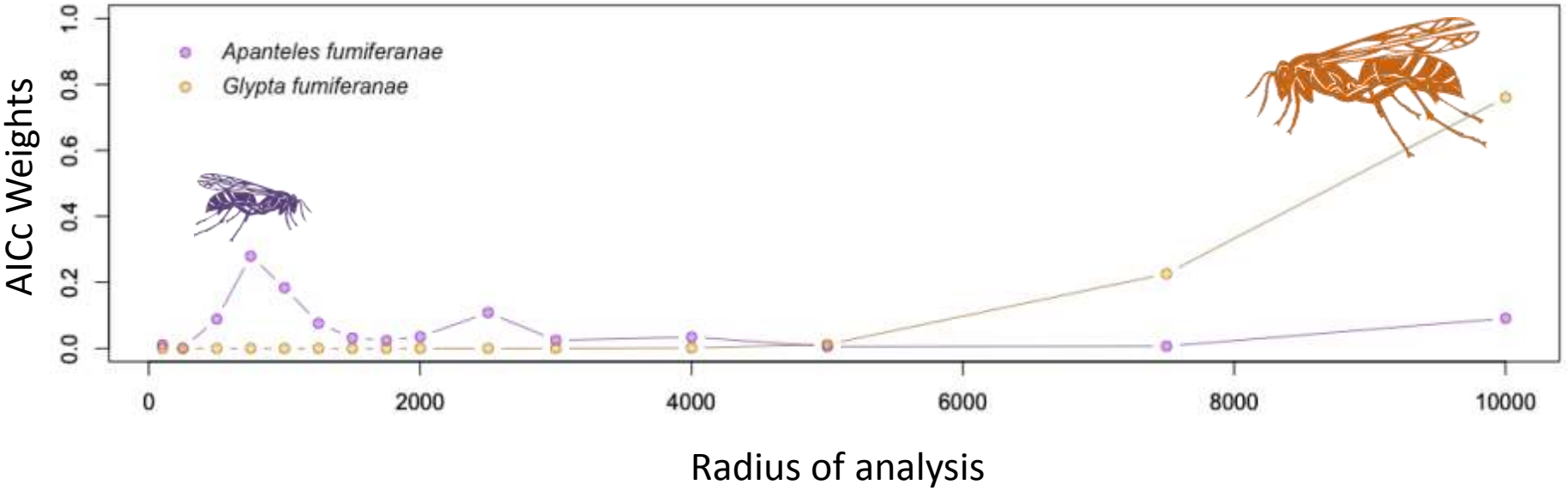




BETA REGRESSION MODELS : CONTAGION





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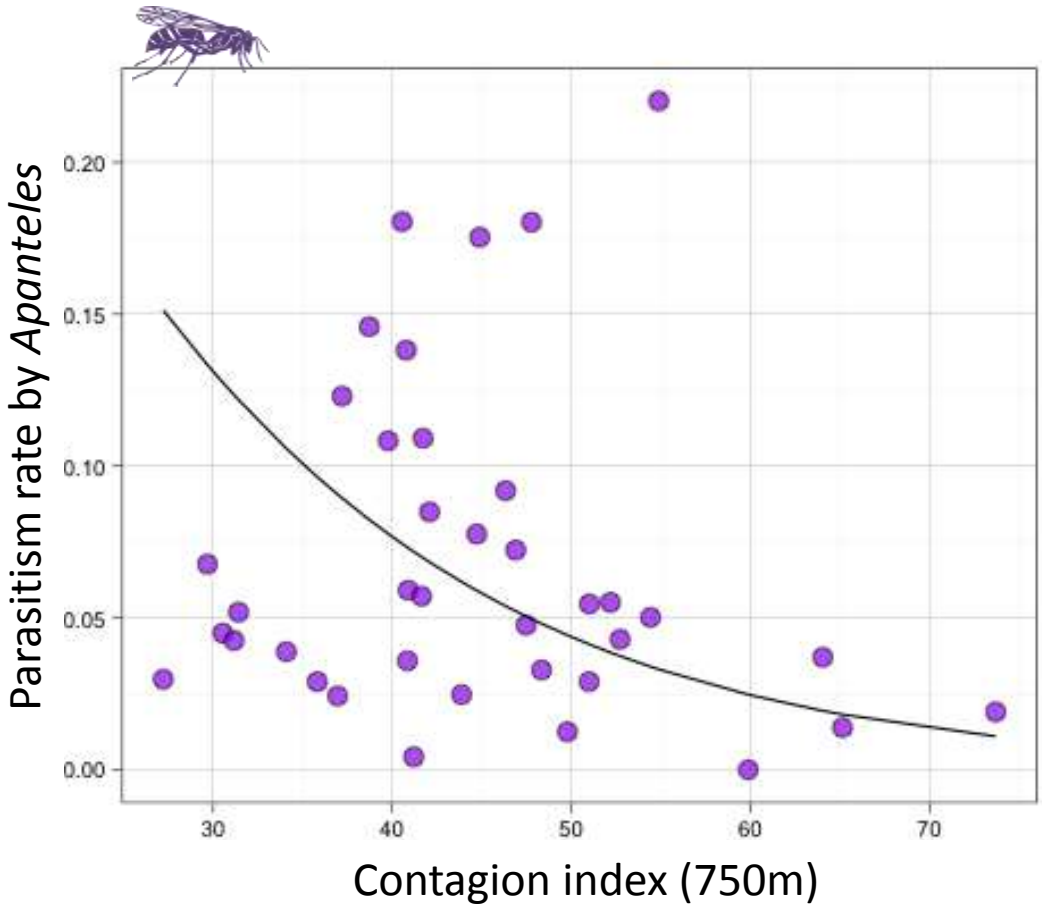

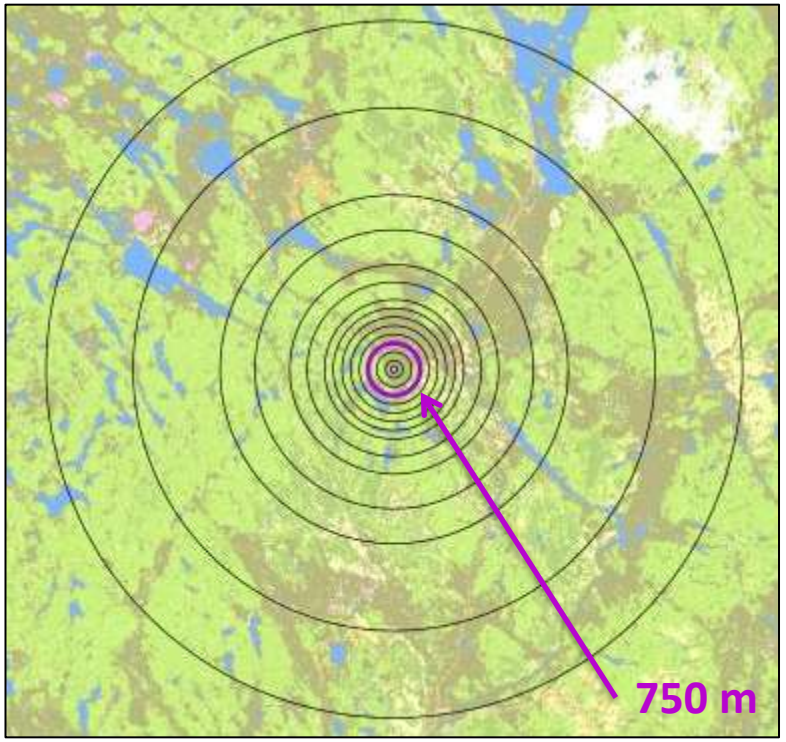

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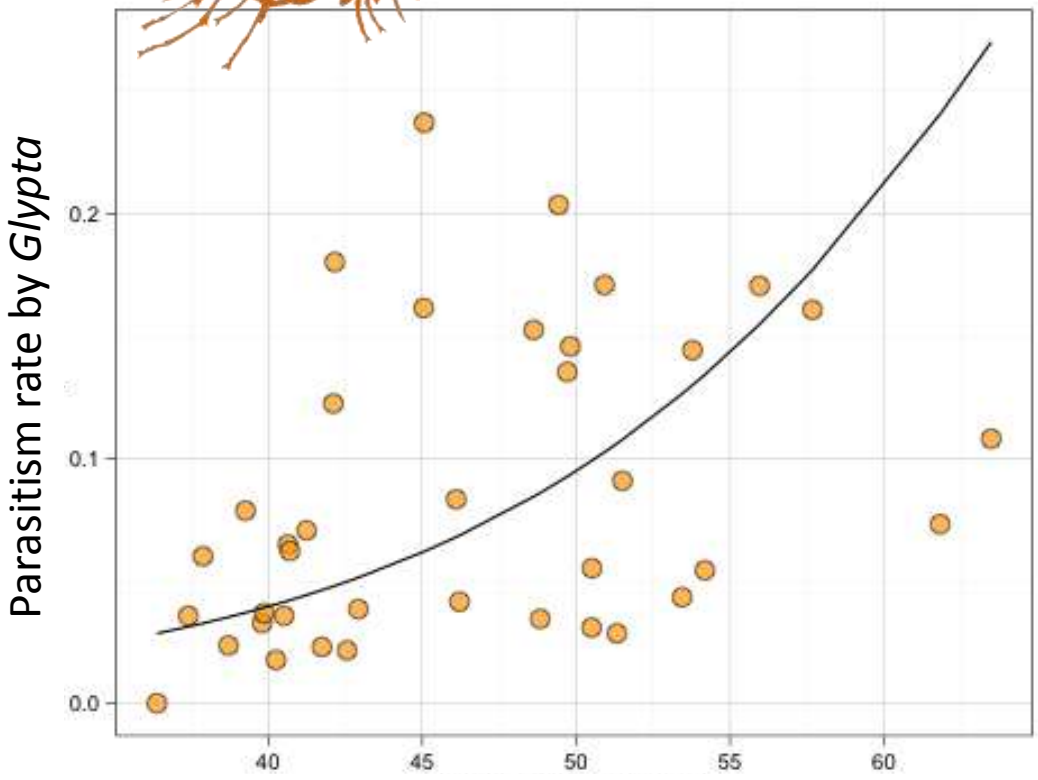
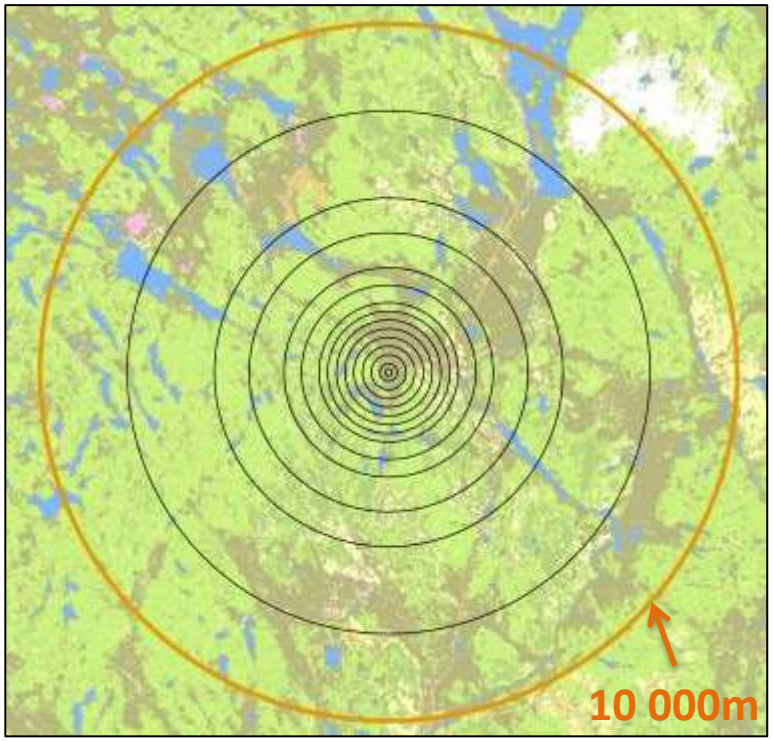




BETA REGRESSION MODELS : COMBINATION OF FACTORS

Apanteles fumiferanae

Explanatory variables	AICc	AICcW	Delta_AICc
SBW_DEN + **LATITUDE** + OUTB_AGE_500m	**-184,2653**	**0,2170**	**0,0000**
LATITUDE + OUTB_AGE_500m	-183,9248	0,1830	0,3405
SBW_DEN + **LATITUDE** + OUTB_AGE_500m + CONTAGION_750m	-183,7917	0,1712	0,4736
LATITUDE + CONTAGION_750m	-183,7643	0,1689	0,5010
SBW_DEN + **LATITUDE** + CONTAGION_750m	-182,5891	0,0939	1,6762
SBW_DEN + **LATITUDE**	-182,5541	0,0922	1,7112
LATITUDE	-182,0954	0,0733	2,1699
OUTB_AGE_500m + CONTAGION_750m	-169,7417	0,0002	14,5236
CONTAGION_750m	-169,6994	0,0001	14,5659
SBW_DEN + CONTAGION_750m	-167,1944	0,0000	17,0709
SBW_DEN + OUTB_AGE_500m + CONTAGION_750m	-167,1612	0,0000	17,1041
OUTB_AGE_500m	-158,1543	0,0000	26,1110
SBW_DEN + OUTB_AGE_500m	-156,8964	0,0000	27,3689
SBW_DEN	-150,3040	0,0000	33,9613

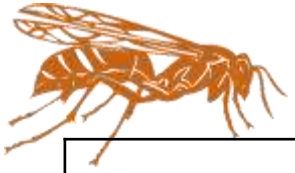
BETA REGRESSION MODELS : COMBINATION OF FACTORS

Apanteles fumiferanae

Explanatory variables	AICc	AICcW	Delta_AICc
SBW_DEN + **LATITUDE** + OUTB_AGE_500m	**-184,2653**	**0,2170**	**0,0000**

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-1,08	0,32	-3,39	< 0,001 ***
SBW density	1,14	0,56	2,04	0,041 *
Latitude	-3,31	0,55	-6,00	< 0,001 ***
Outbreak age (500 m)	-1,30	0,56	-2,32	0,021 *

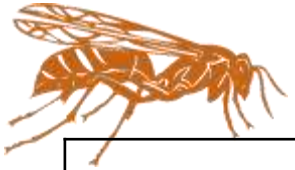
BETA REGRESSION MODELS : COMBINATION OF FACTORS



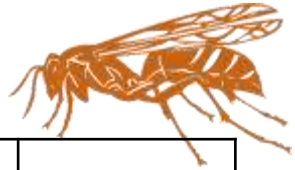
Glypta fumiferanae

Explanatory variables	AICc	AICcW	Delta_AICc
SBW_DEN + **CONTAGION_10000m**	**-165,3383**	**0,4749**	**0,0000**
SBW_DEN + LATITUDE + **CONTAGION_10000m**	-164,1413	0,2610	1,1970
SBW_DEN + OUB_AGE_1500m + **CONTAGION_10000m**	-163,2317	0,1656	2,1066
SBW_DEN + LATITUDE + OUB_AGE_1500m + **CONTAGION_10000m**	-161,6106	0,0736	3,7277
CONTAGION_10000m	-158,2708	0,0139	7,0675
LATITUDE + CONTAGION_10000m	-156,8271	0,0067	8,5112
OUB_AGE_1500m + CONTAGION_10000m	-155,8678	0,0042	9,4705
SBW_DEN + LATITUDE + OUB_AGE_1500m	-146,4480	0,0000	18,8903
SBW_DEN + OUTB_AGE_1500m	-146,0850	0,0000	19,2533
SBW_DEN + LATITUDE	-143,6603	0,0000	21,6780
LATITUDE	-142,2450	0,0000	23,0933
LATITUDE + OUTB_AGE_1500m	-138,1553	0,0000	27,1830
SBW_DEN	-137,1217	0,0000	28,2166
OUTB_AGE_1500m	-137,0726	0,0000	28,2657

BETA REGRESSION MODELS : COMBINATION OF FACTORS



Glypta fumiferanae



Explanatory variables	AICc	AICcW	Delta_AICc
SBW_DEN + CONTAGION_10000m	-165,3383	0,4749	0,0000

	Estimate	Std, Error	z value	Pr(>|z|)
(Intercept)	-4,31	0,38	-11,35	< 0,001 ***
SBW density	2,06	0,54	3,81	< 0,001 ***
Contagion (10000m)	2,48	0,52	4,82	< 0,001 ***

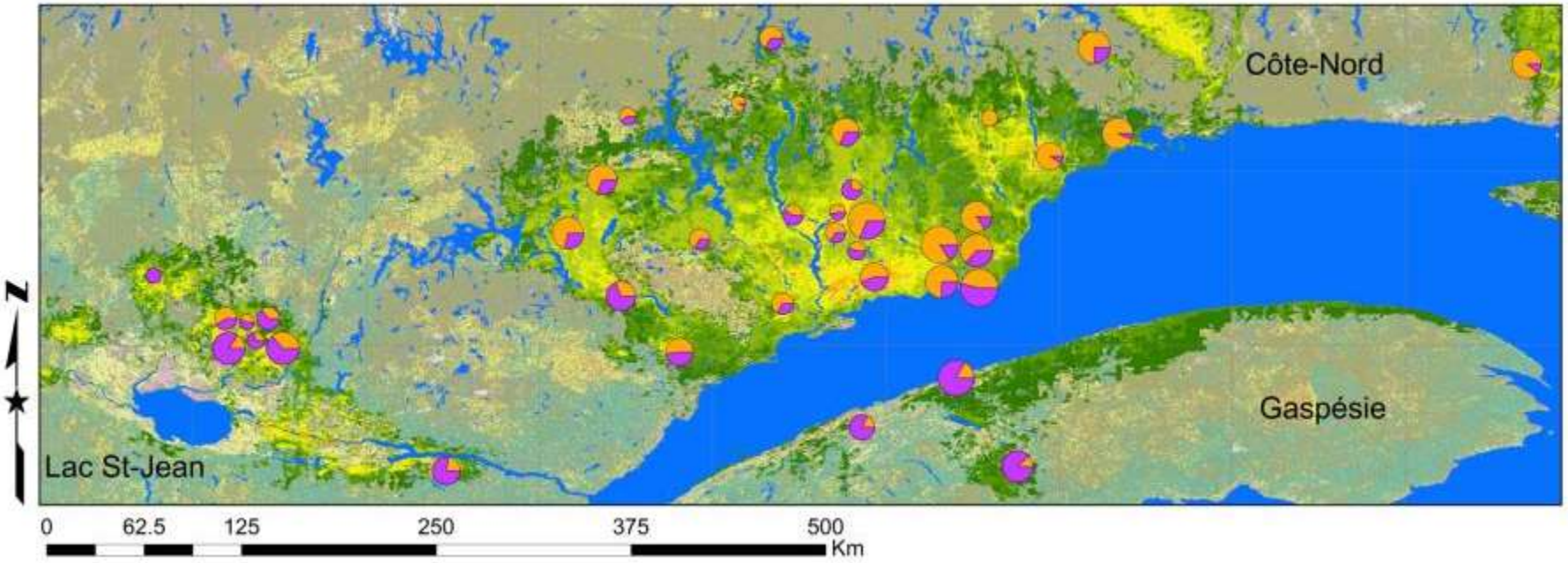
SPATIAL DYNAMICS

of Apanteles

- Southern species
- Weak density dependence response to SBW larval density
- Deacrease with outbreak age

of Glypta

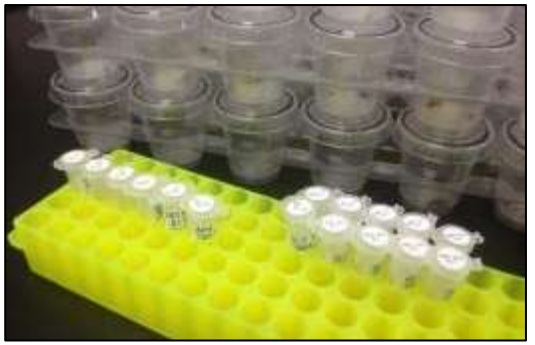
- Northern species
- Strong density dependence response
- Deacrease with landscape heterogeneity



CONCLUSION AND PERSPECTIVES

Different parasitoids species respond to landscape structure in **different ways**, and **at different spatial scales**, suggesting different **dispersal ranges**.

Ongoing **landscape genetic** project using **SNPs** to estimate **genetic structure and gene flow** of *A. fumiferanae* and *G. fumiferanae* populations in the Côte-Nord region.



ABSENCE OF GENETIC STRUCTURE FOR *GLYPTA* ?

384 individuals
1400 SNPs

T027
T017
T023A
T022X

Preliminary PCA

PCA Axis 2 (1.92 %)

PCA Axis 1 (5.01 %)

Dynamique spatiale des populations d'*Apanteles fumiferanae* et de *Glypta fumiferanae*, des parasitoïdes des larves de la tordeuse des bourgeons de l'épinette.

S. Legault et P. James
Université de Montréal , département de sciences biologiques

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Université de Montréal

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