ASSESSING THE POTENTIAL DISTRIBUTION OF ASIAN GYPSY MOTH IN CANADA- A COMPARISON OF TWO METHODOLOGICAL APPROACHES.

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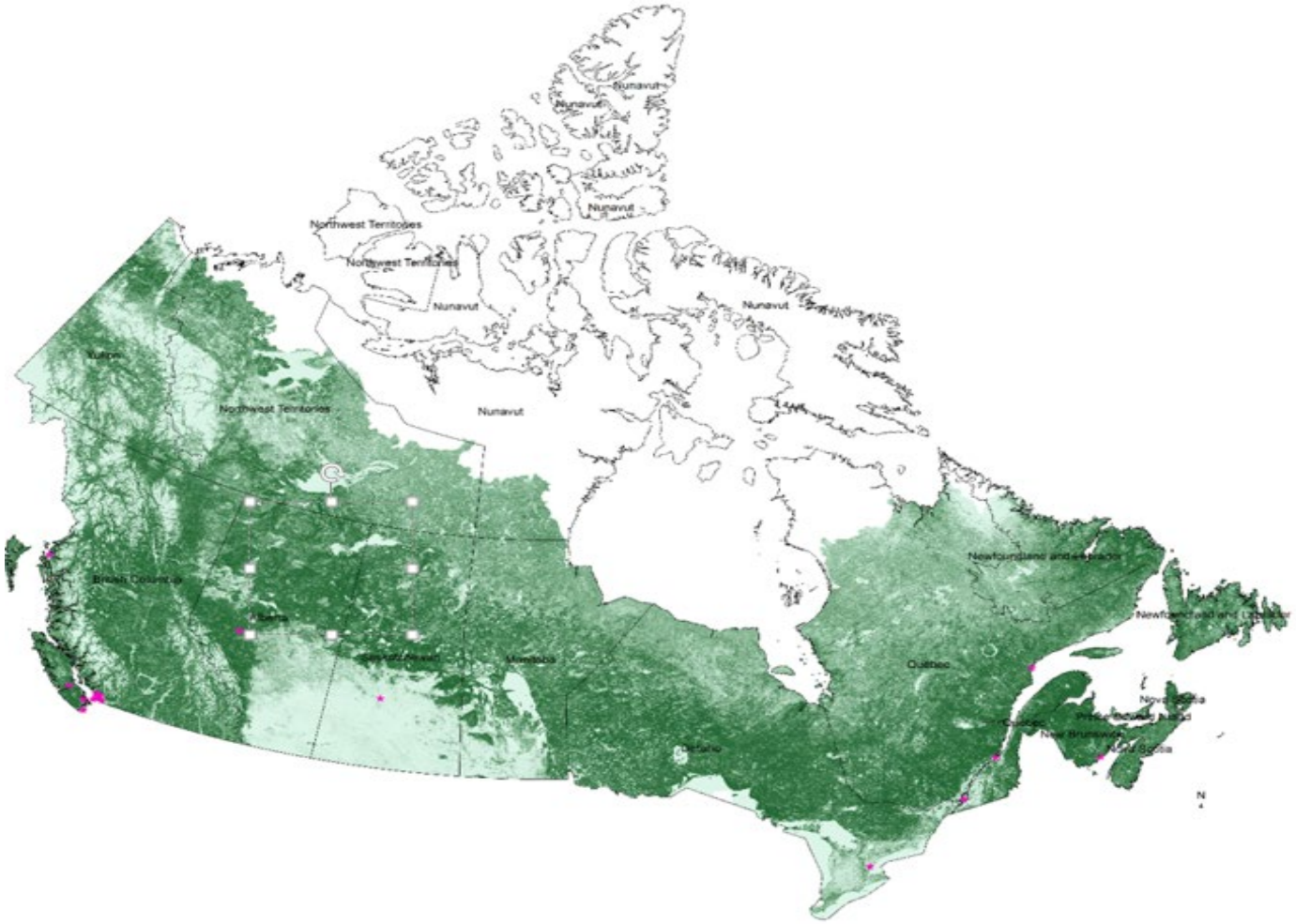
Outline

- Introduction
- Research Objectives
- Materials and Methods
- Results
- Discussion and Conclusions

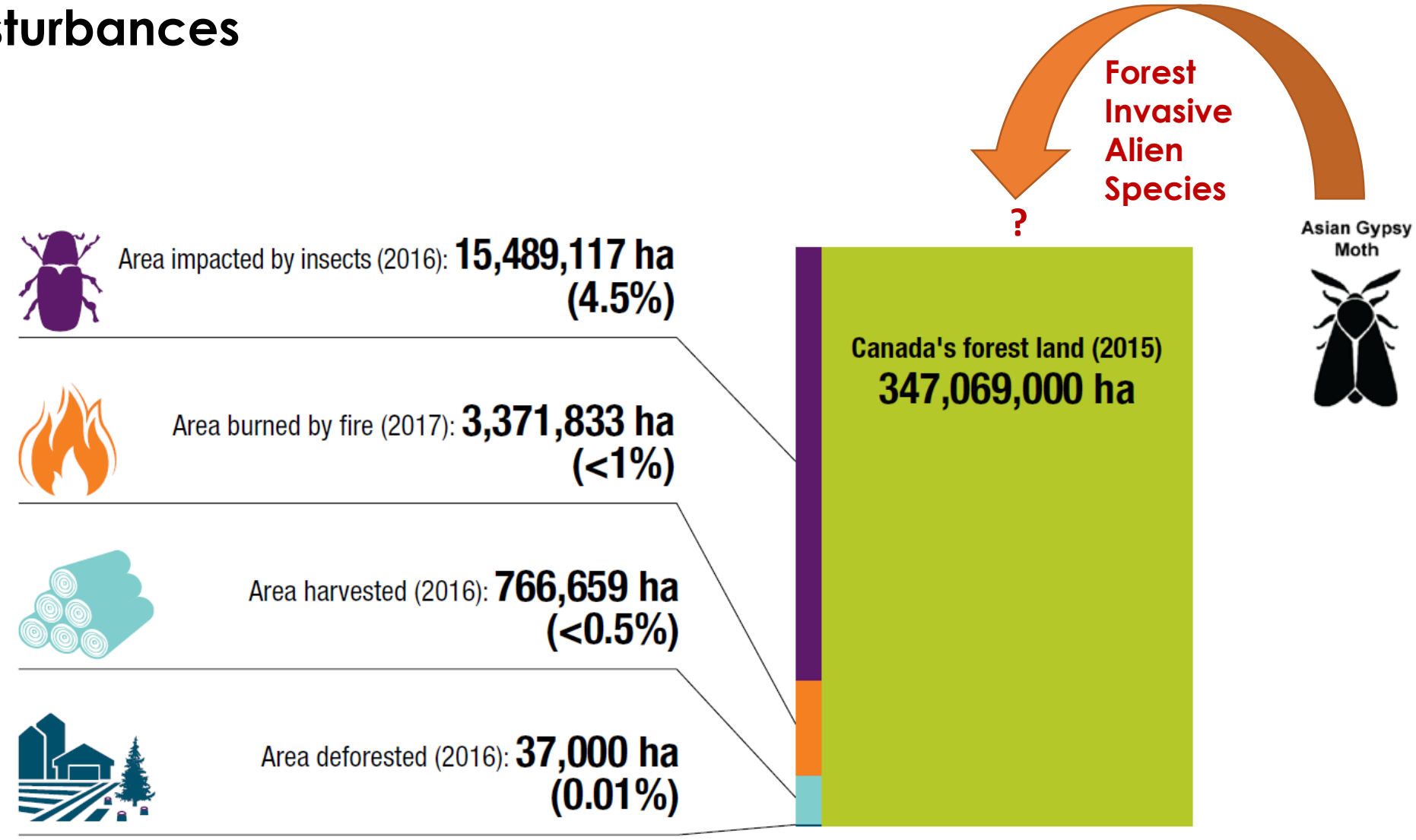
Forests are essential to Canada



- Resource
  - 347 million ha
  - 9 % of the world's forests
- Economy
  - $24.6 billion (1.6% GDP)
  - 209'940 direct jobs
  - 107'380 indirect jobs
- Ecosystem services

Source: NRCan. State of Canada's forests. Annual Report 2015

Forest disturbances

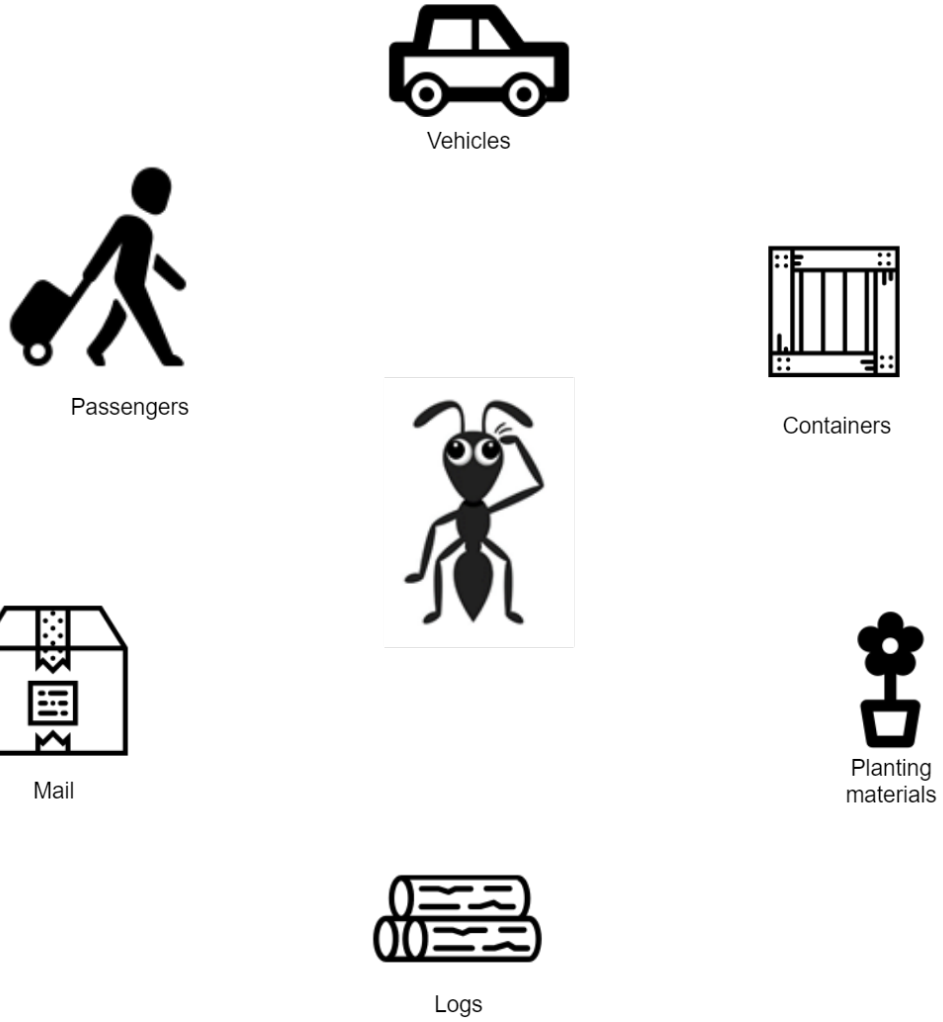


Source: NRCan. State of Canada's forests. Annual Report 2017

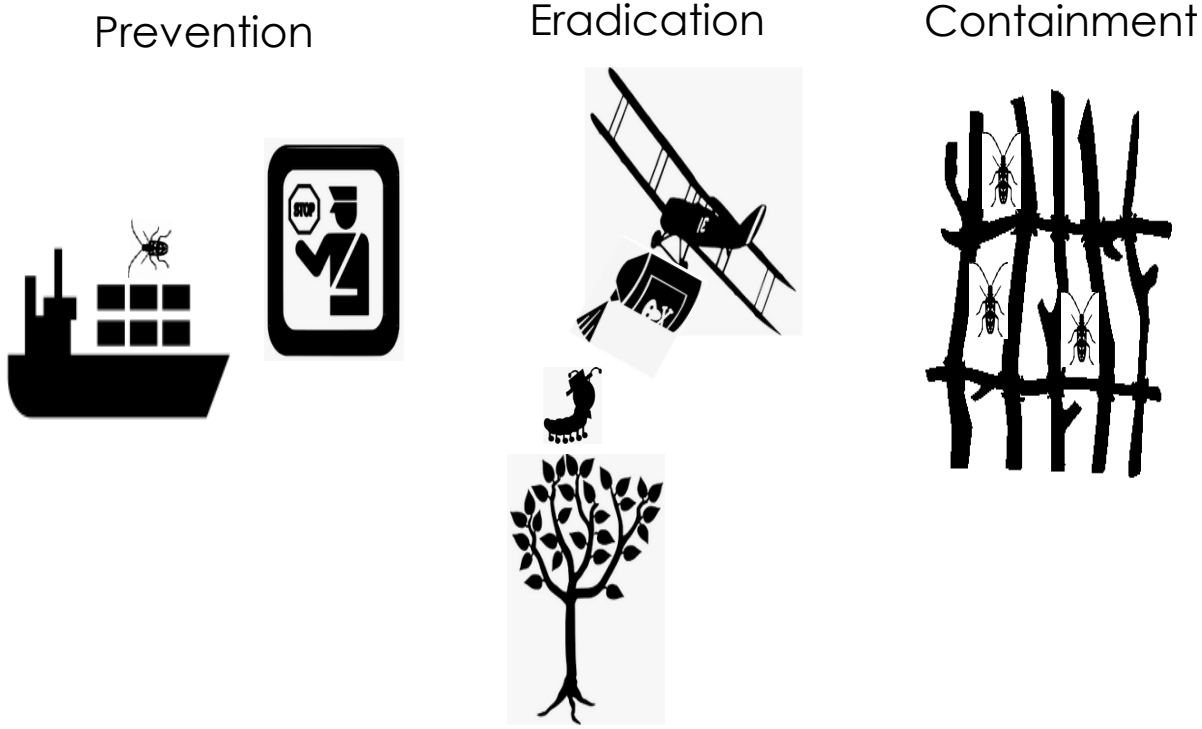
Asian Gypsy Moth (AGM): *L. dispar asiatica & L. dispar japonica*

- Listed as one of the 100 worst invasive alien species in the world.
- Broad host range (over 600 plant species).
- Flight capable females.
- Strong dispersal traits.
- Not yet permanently established outside their native range.

Image source: http://www.biosafegenomics.com



FIAS Introduction Pathways

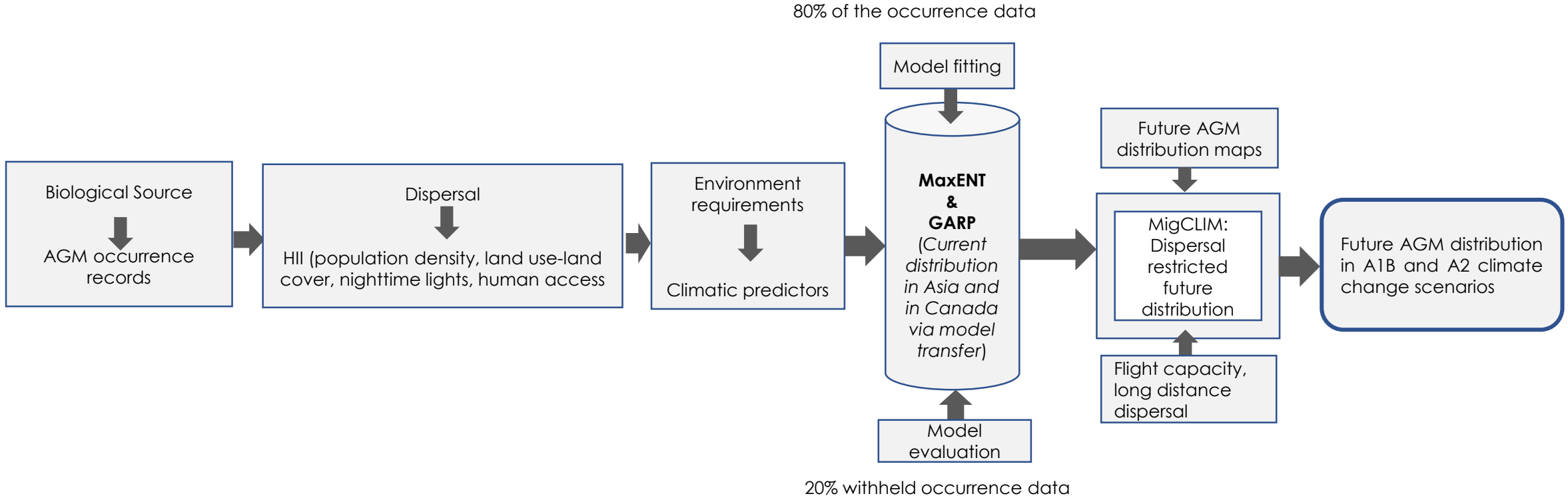


Mitigation measures

Research Objectives

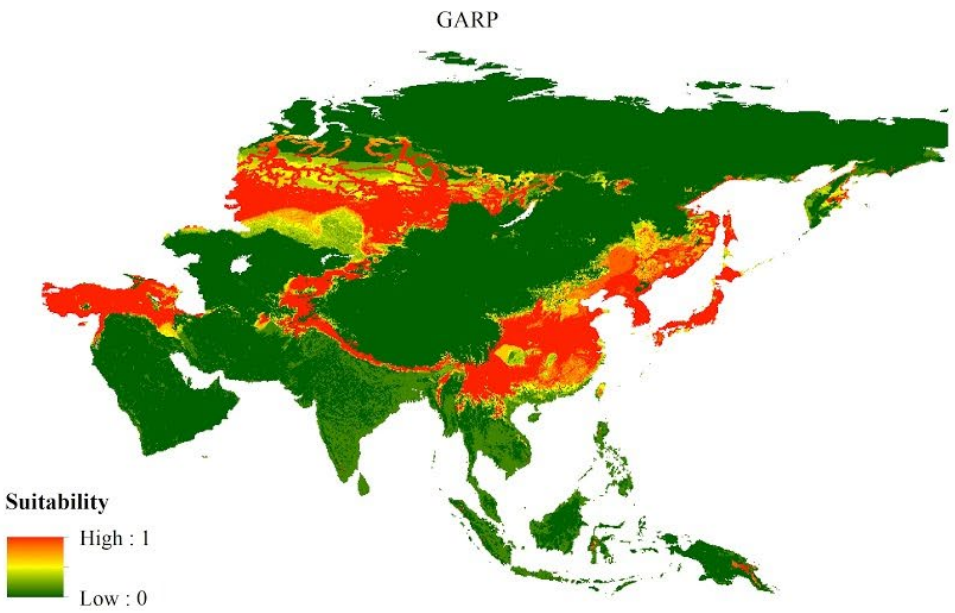
1. To map potential distribution of AGM in Asia and Canada,
2. To compare the performance of MaxEnt-based predictions with the GARP predictions, and
3. To include AGM dispersal constraints in projections of AGM distributions under climate change scenarios.

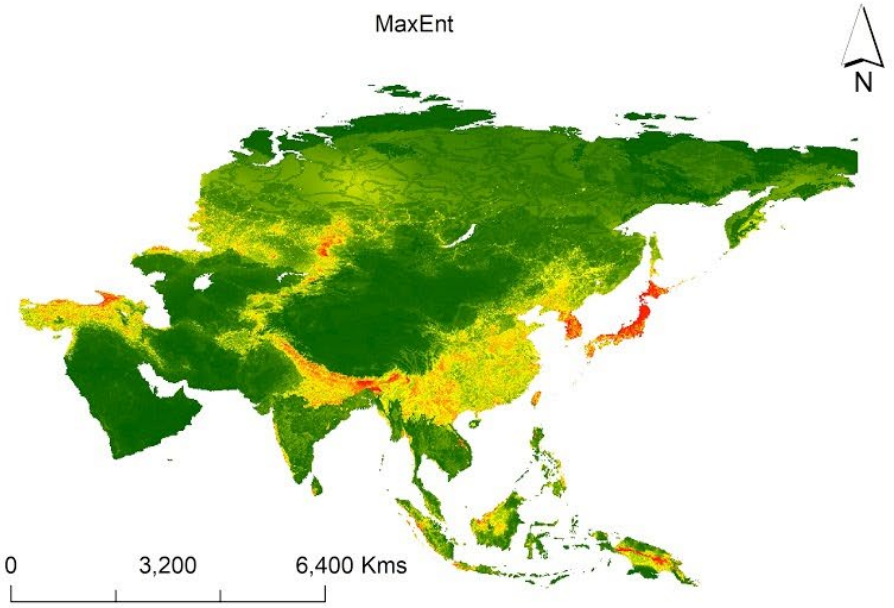
Flowchart representing the modelling flow used to model Asian gypsy moth distribution in this study

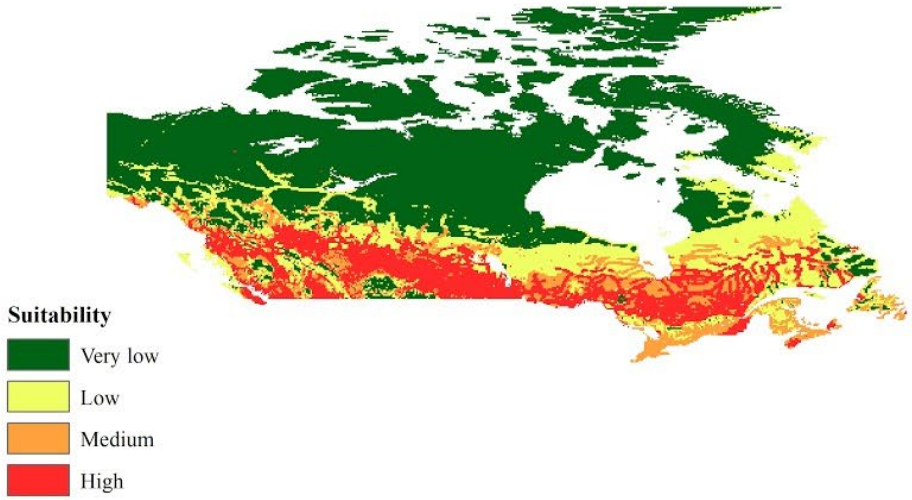


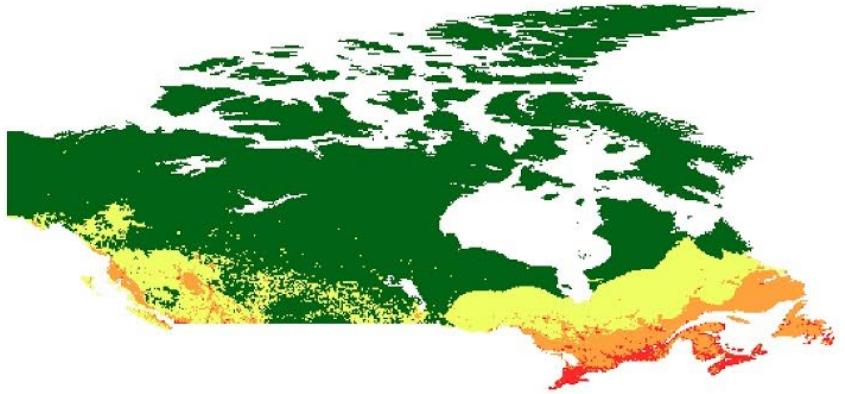
- Identification of the most-important uncorrelated environmental variables along with the optimal regularization multiplier.
- Best performing model, based on AICc values.
- Evaluation metrics: AUC, PAUC and Sensitivity

Model Predictions & Performance

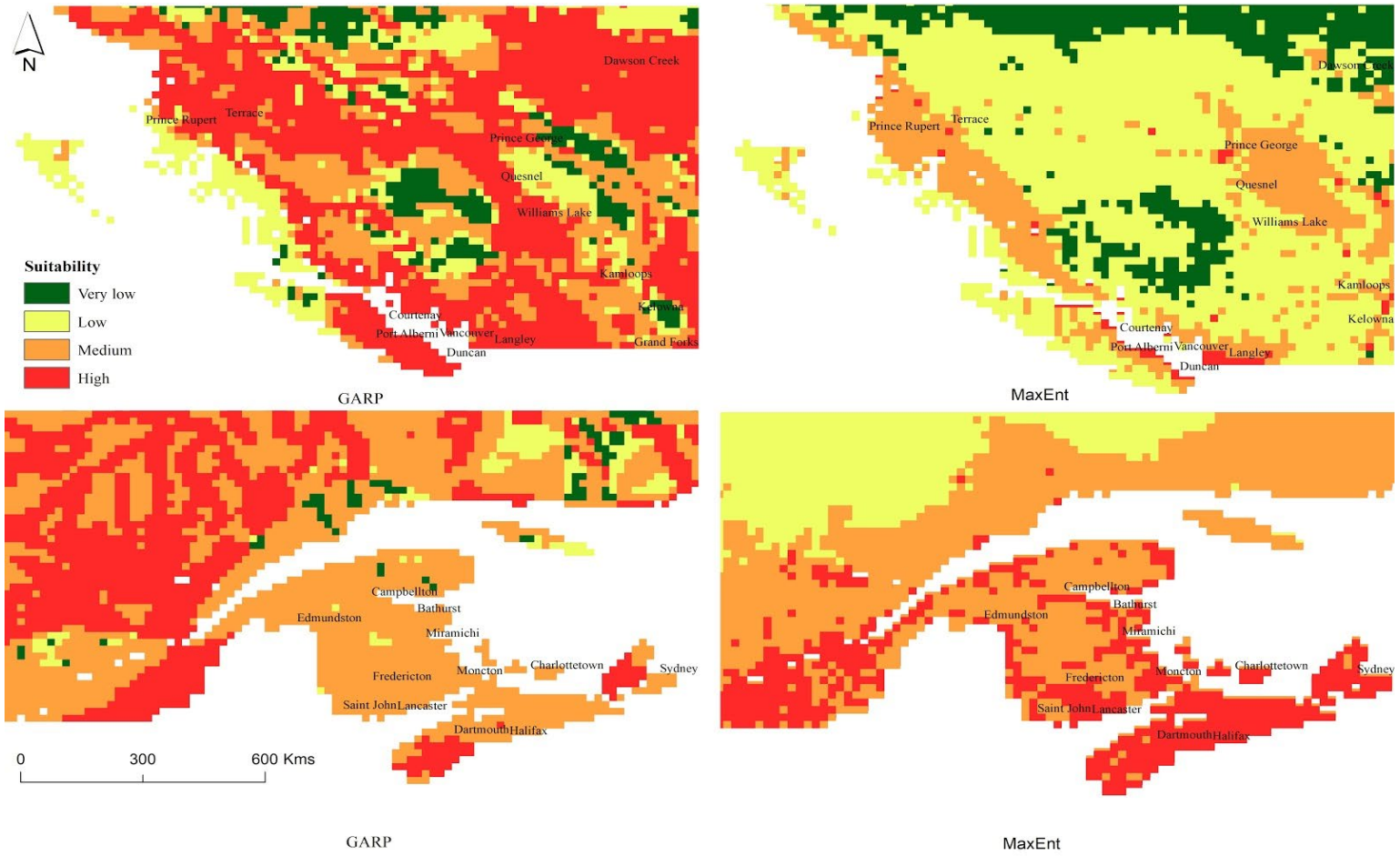








Model Predictions & Performance

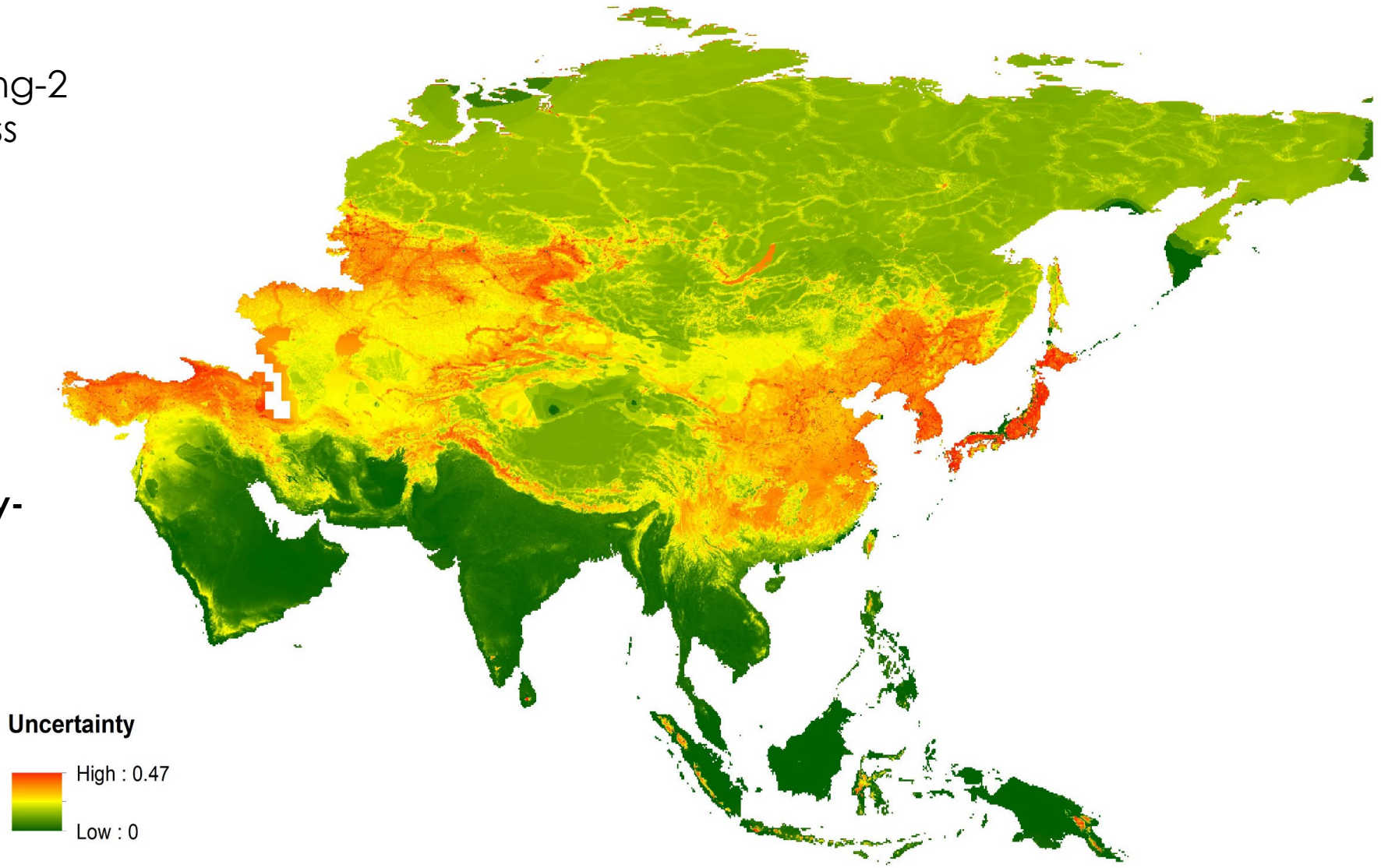


- Both of the approaches had good predictive capability.
- MaxEnt had higher AUC, pAUC and sensitivity score of 0.82, 1.40 and 1 compared to GARP 0.70, 1.26 and 0.9 respectively, indicating better discrimination of suitable versus unsuitable areas for AGM.

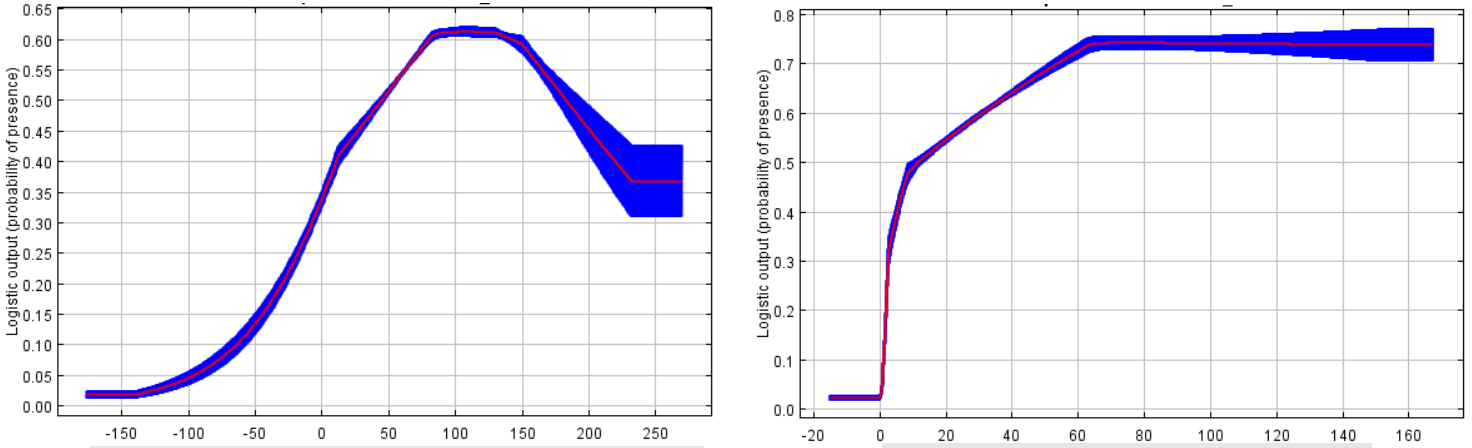
Uncertainty analysis:

Using hyper-envelope modeling-2
Interface- Monte Carlo Process

- **Cross-Validation**-10 Runs
- **Occurrence Uncertainty**- 1 km, (Noise Dist.-Normal)
- **Covariate/Predictor Uncertainty-** Noise Dist.-Normal

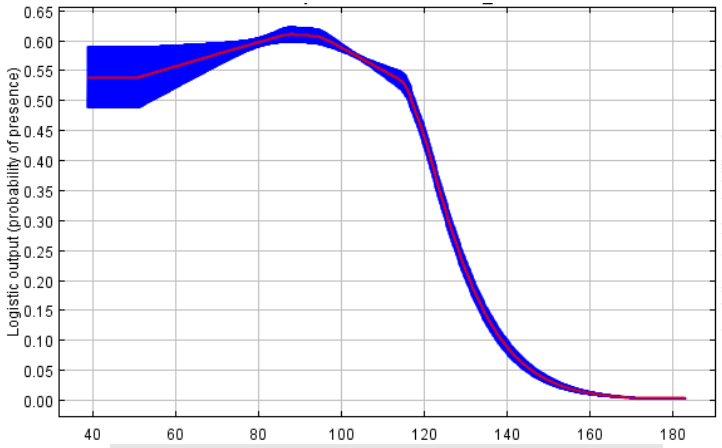


Variable Contribution and Response

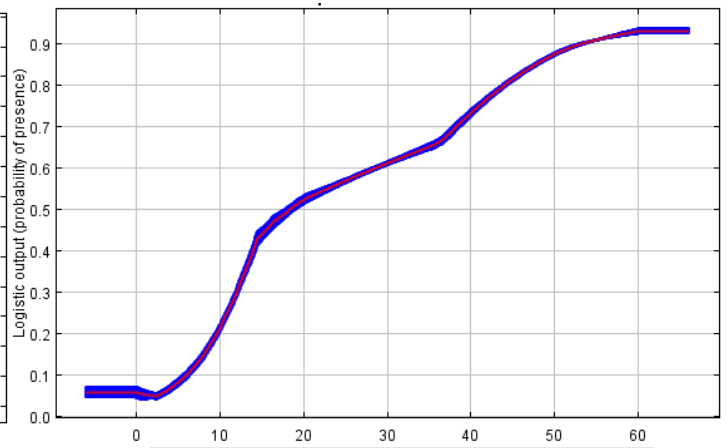


Bio1 (Annual mean temperature)

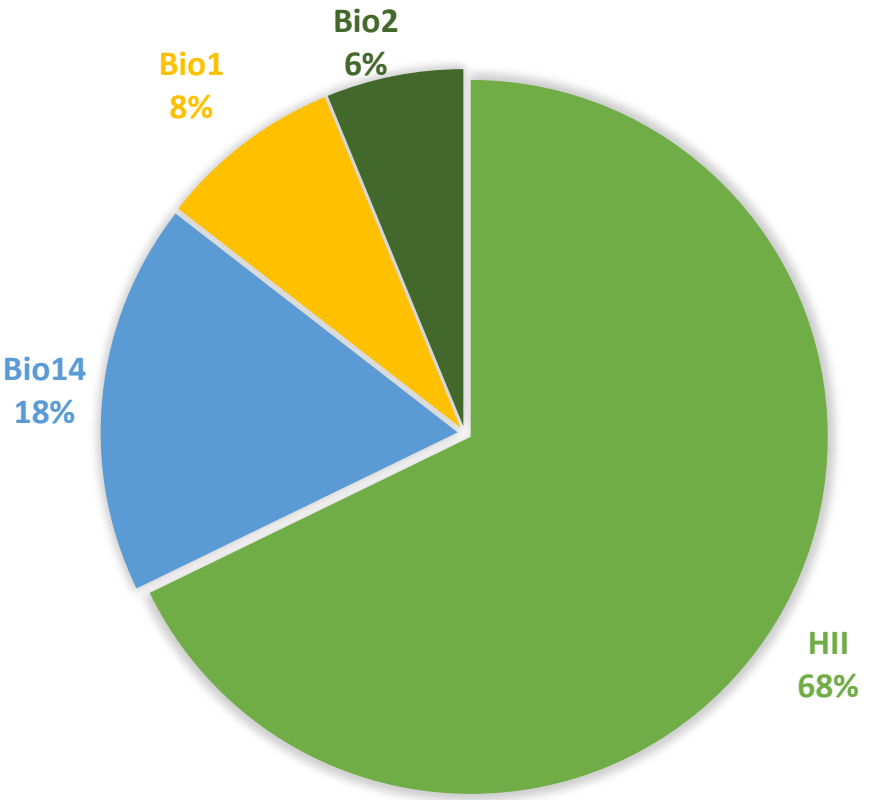
Bio14 Precipitation of Driest Month



Bio2 (Mean diurnal temperature range)

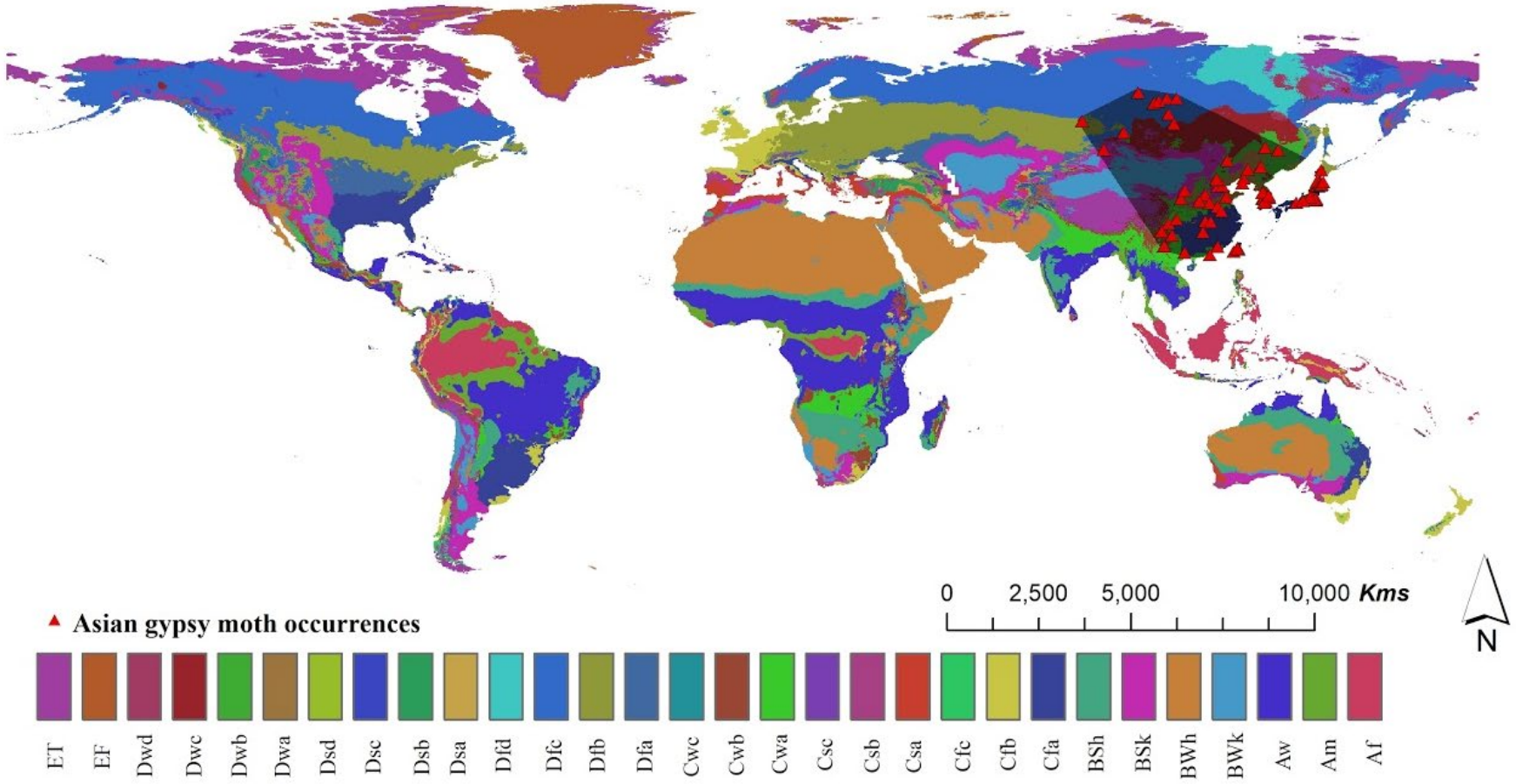


HII (Human influence index)



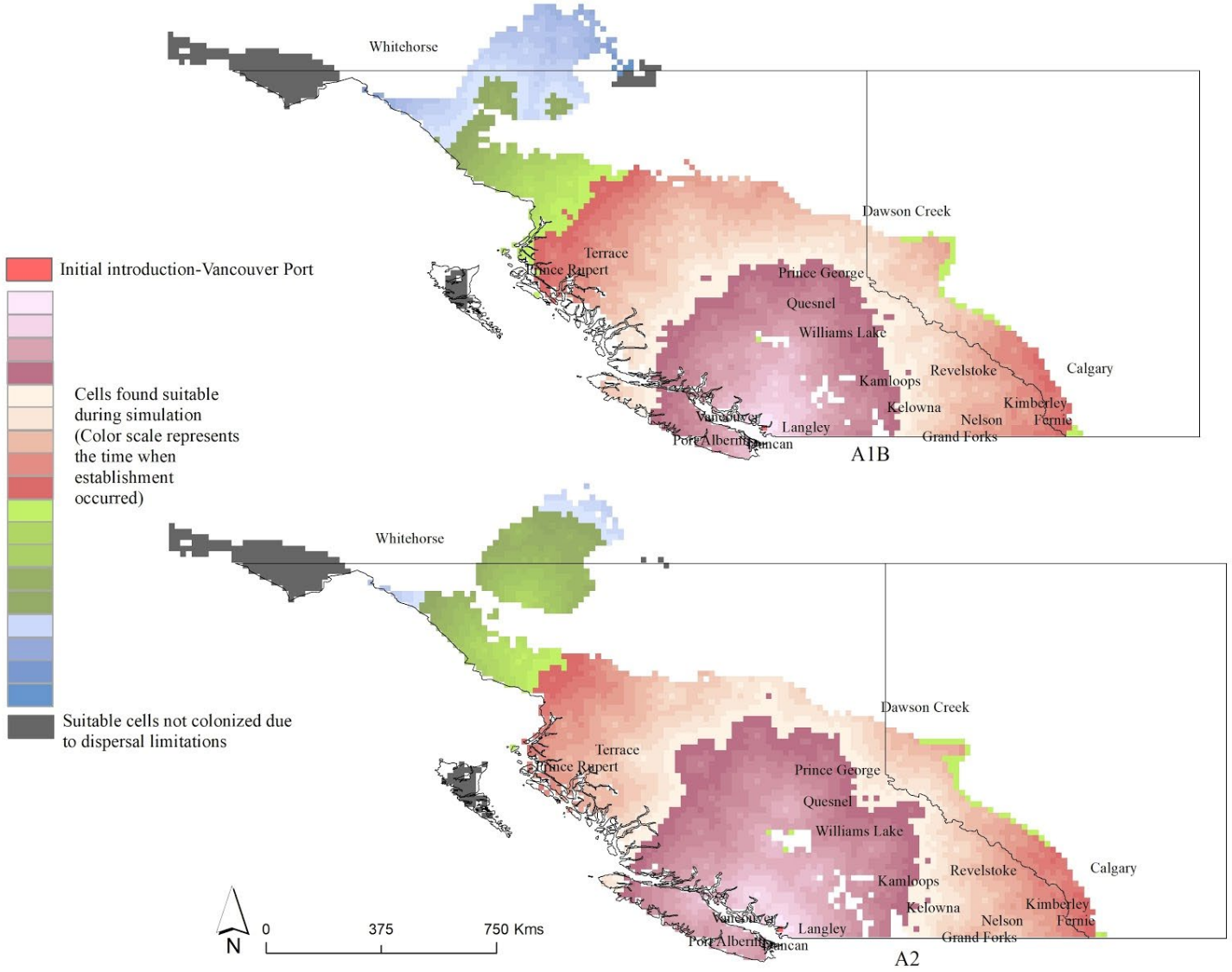
Potential habitat- Annual precipitation between 800 and 3,800 mm and driest month precipitation from 14-160 mm. The annual temperature in these areas range from 5 to 25 ° C and has a HII index value above 25 covering a large range of climatic zones.

Climatic regions at AGM locations



- Most positives located within the Koppen-Geiger climatic zones- DFb (average temperatures below 22 °C) and DFc, which represents subarctic climate where 1-3 months have average temperature above 10 ° C.

Dispersal Mapping: MigClim



Dispersal restricted future distribution of AGM under A1B and A2 climate change scenarios.

- GARP and MaxEnt performed well for AGM's native range with relatively high AUC, pAUC and sensitivity scores. However MaxEnt performed better than GARP in determining potential distributions of AGM.
- Maps produced from this study will help in providing information about the potential suitable distribution ranges of AGM for formulating effective mitigation strategies and aid in designing pest surveys and domestic quarantines.
- Additional simulations are further required under multiple scenarios of dispersal at various points of entry.

- **Ongoing Work-** Updating AGM potential distribution maps with new climate change scenarios & integration to a model based decision support system.

  (IPRRG-2020)

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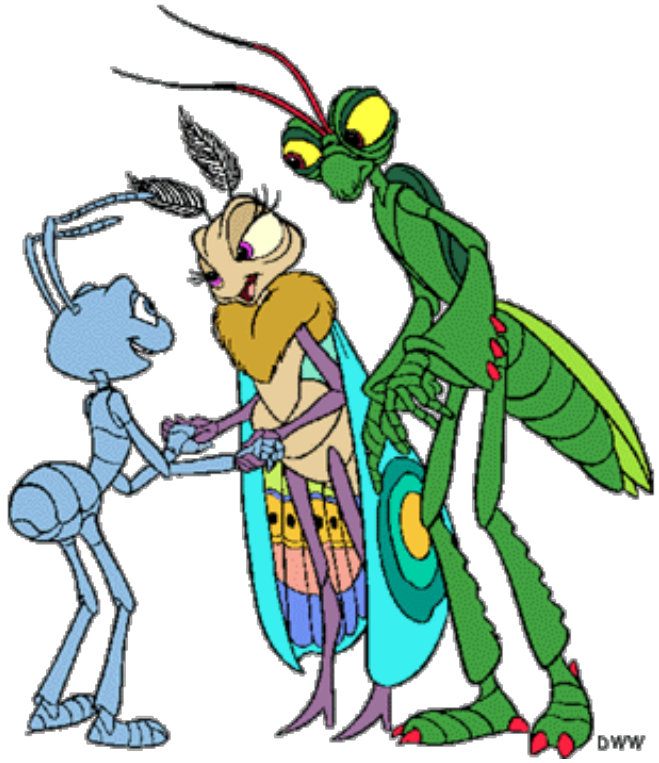


Thank you!

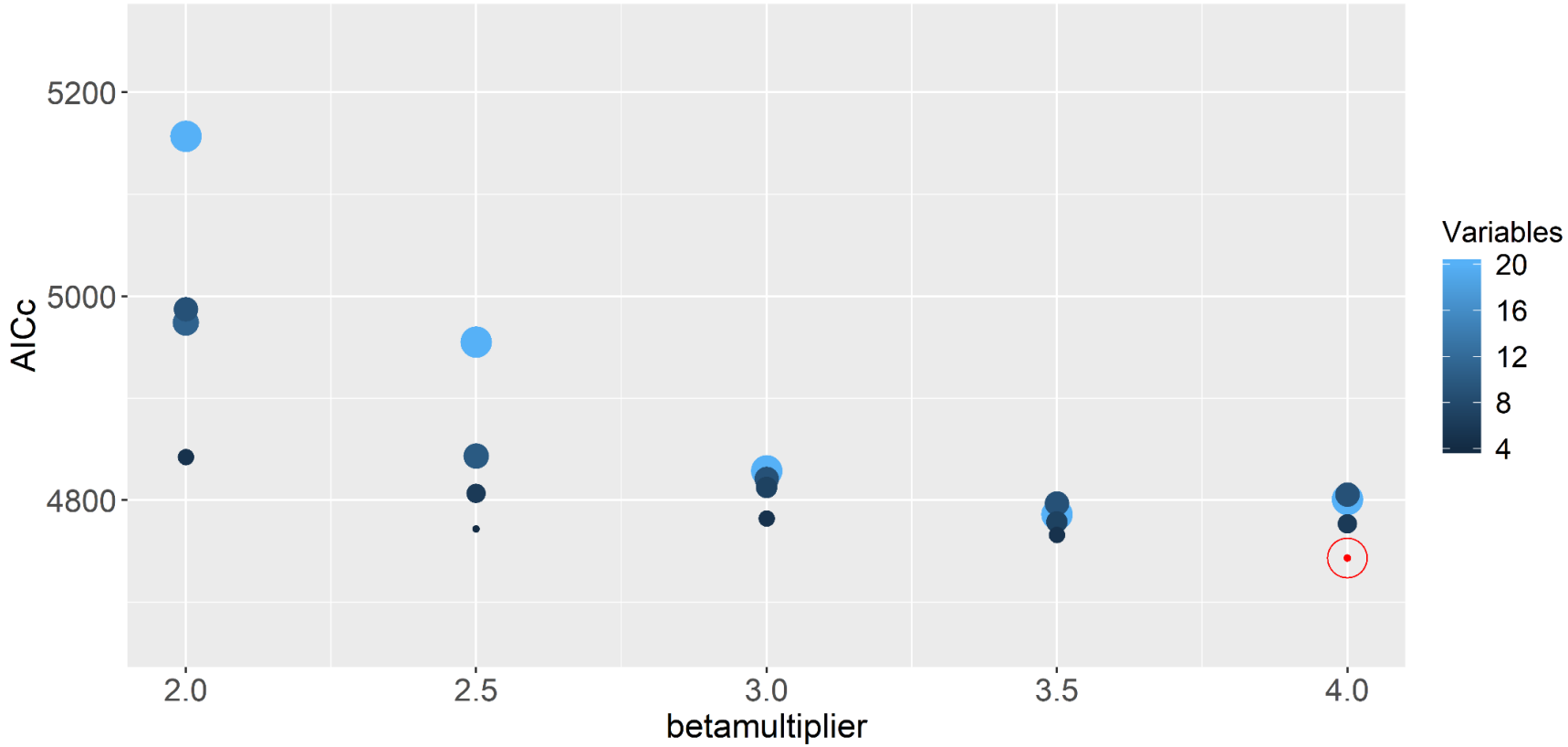
Extra Slides

- **Abstract**

- Gypsy moth (Lymantria dispar L.) is one of the world's most hazardous invasive alien species. It is currently spreading across North America, damaging forest ecosystems, posing a significant economic threat. Two subspecies L. d. asiatica and L. d. japonica (collectively referred to as Asian gypsy moth, AGM) are of special concern as they have several traits making them more potent invaders than their European counterpart (e.g. flight capability of females). Multiple detections of egg masses on vessels arriving from Asia have occurred in Canada and have led to the development of active phytosanitary measures.We assessed the potential distribution of AGM in Canada using two presence-only species distribution models (MaxEnt and GARP [Genetic Algorithm for Rule-set Prediction]). We mapped AGM potential future distribution under two climate change scenarios (A1B and A2) while implementing dispersal constraints using the cellular automation model MigClim.MaxEnt had higher AUC, pAUC and sensitivity scores (0.82/ 1.40/ 1.00) when compared to GARP (0.70/ 1.26/ 0.9), indicating better discrimination of suitable versus unsuitable areas for AGM. These model results can be used to identify areas at risk for this pest, to inform strategic and tactical pest management decisions.

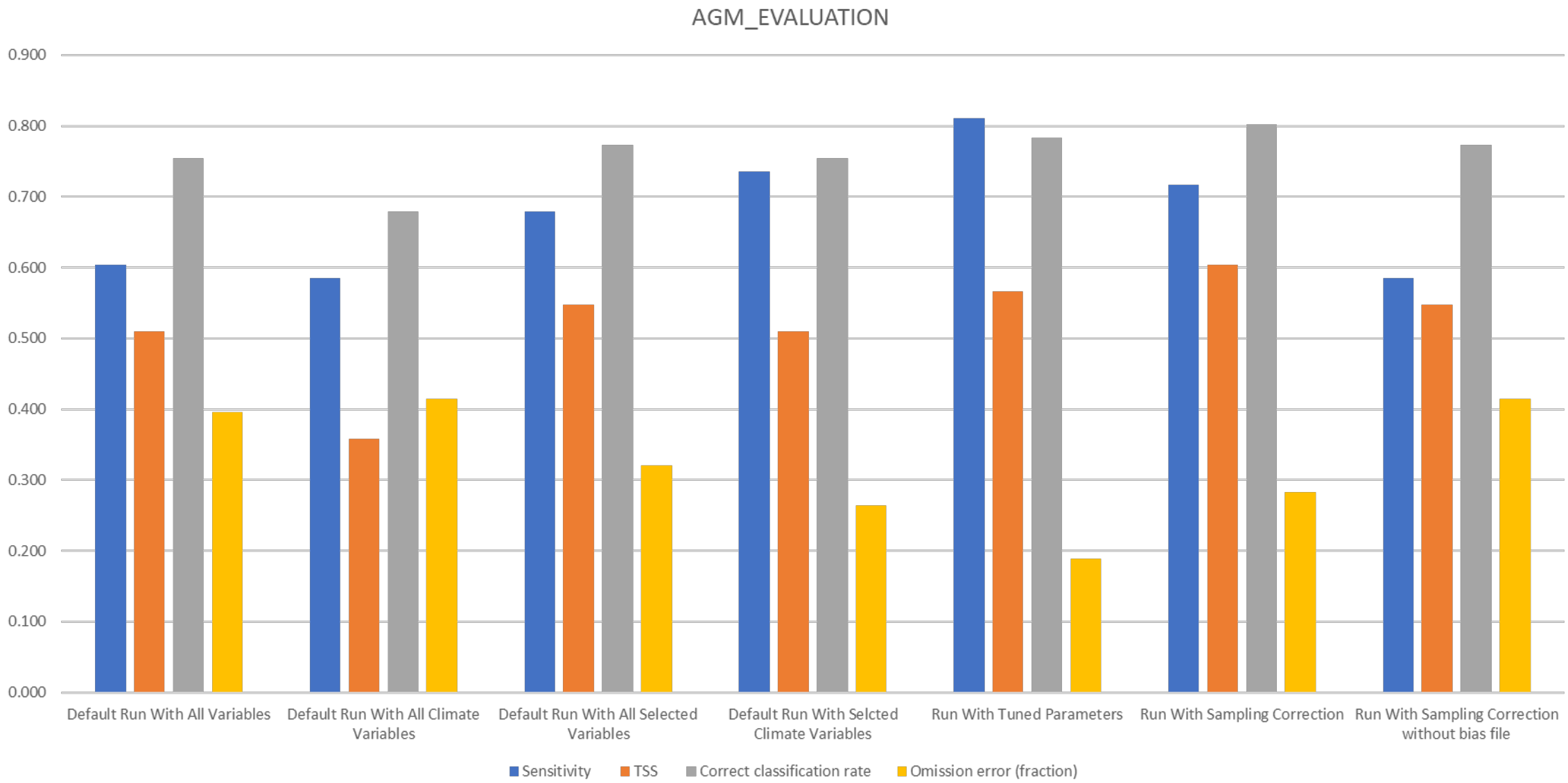
Variable and Model Selection (MaxENT)

- ✓ Bio1 (Annual mean temperature)
- ✓ Bio2 (Mean diurnal temperature range)
- ✓ Bio14 Precipitation of Driest Month
- ✓ HII (Human influence index)



Selected Model:

Model	betamultiplier	variables	samples	parameters	loglikelihood	AIC	AICc	BIC	AUC.Test	AUC.Train	AUC.Diff
23	4	4	175	19	-2350.15453	4738.309059	4743.212	4798.44	0.8394	0.8485	0.0091


AGM_EVALUATION
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
Default Run With All Variables
Default Run With All Climate Variables
Default Run With All Selected Variables
Default Run With Selcted Climate Variables
Run With Tuned Parameters
Run With Sampling Correction
Run With Sampling Correction without bias file
Sensitivity
TSS
Correct classification rate
Omission error (fraction)