Habitat suitability analysis for an invasive bee, *Anthidium manicatum*

By Kelsey K Graham, Biology Department, 5.11.16

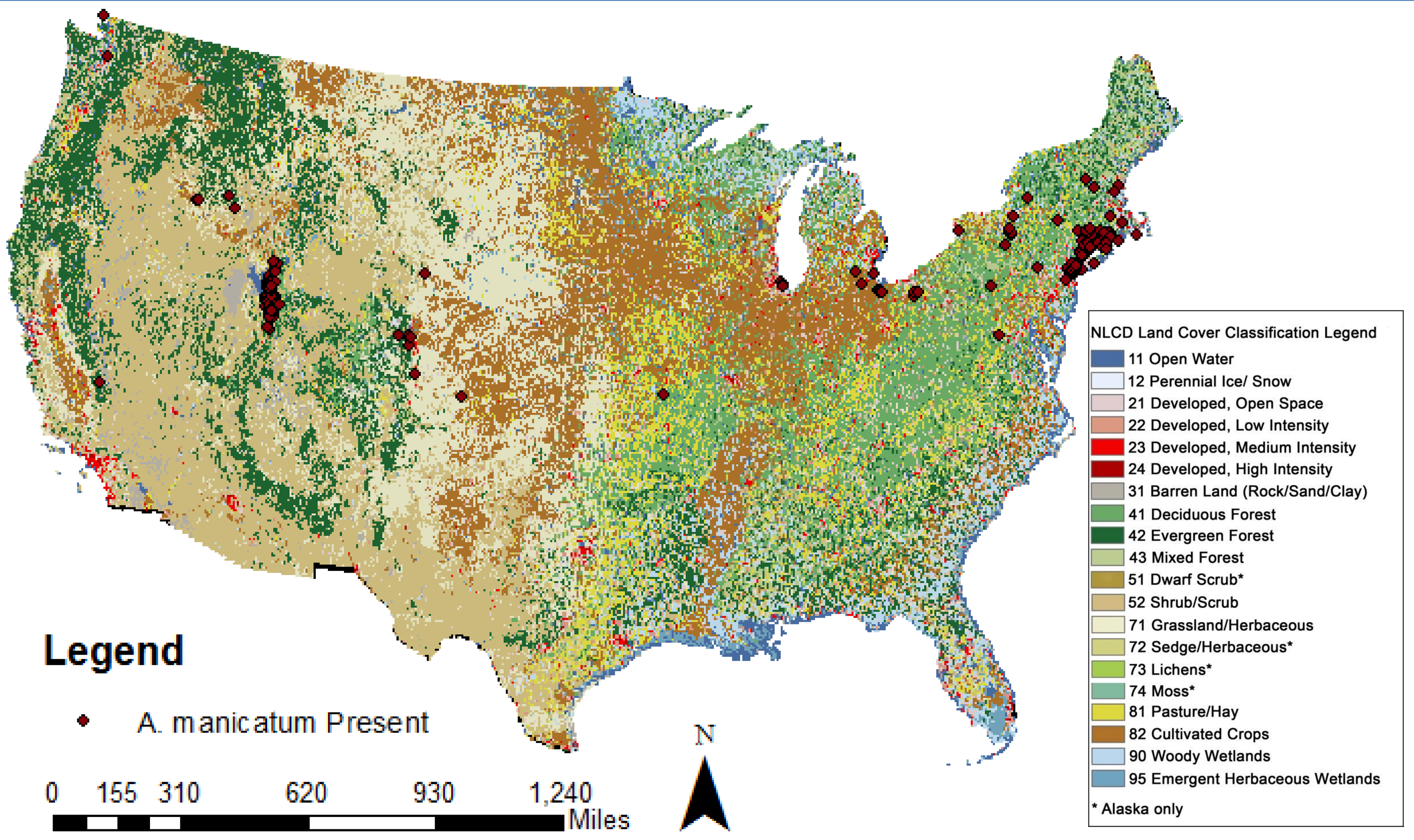

Figure 1. Current presence data for *A. manicatum*. (Data - AnthWest (Griswold et al., 2014); Background – NLCD 2011 land cover)

Background *A. manicatum*, the European wool-carder bee, has shown rapid range expansion since it first arrived in North America in the early 1960s (Fig. 1)[1]. This species is also highly aggressive towards native pollinators, with interactions often leading to severe injury or death to the other pollinator[3]. Given the concerns surrounding *A. manicatum* behavior, estimating current range and predicting its future spread is of high priority. Here I've created a habitat suitability model for *A. manicatum* in the northeastern USA (ME, NH, VT, MA, RI, CT, NY). Given *A. manicatum's* strong association with exotic flowering species[7], I tested the **hypothesis that *A. manicatum* presence will correlate with developed land in its invasive range**. This is predicted because exotic plants show strong associations with developed habitat[4-6.] Additionally, I will **compare predictions from suitability models trained with presence-only data versus presence-absence data**.

Methods *Presence-only model* - I gathered 85 known presence points for my area of interest (north east) from databases such as Discover Life[8], and published records. I then predicted habitat suitability using the program MaxEnt[9]. MaxEnt uses a maximum entropy approach to predicting species presence and assumes unbiased sampling. The environmental layers included in my model were land cover type and percent impervious surface (NLCD 2011). I reclassified percent impervious surface into 10 categories (1 = low, 10 = high) for easier interpretation of results. Regression analyses were used to test suitability of land cover classes and impervious surface level. I chose a conservative habitat preference threshold of 0.3[11]. *Presence-absence model* - I used a weighted random sampling scheme to collect presence-absence data for *A. manicatum* in 2013 and 2014 within my study region. Of 140 sampling sites, *A. manicatum* was found at 5 locations. Given the low number of confirmed *A. manicatum* presence data points from my two year sampling effort, I've combined my five presence points with 26 published presence records in New England[10]. This gave me a total of 31 presence and 135 absence records. I used regression analyses (performed in R v3.1.3) to test which environmental factors (land cover and percent impervious surface - NLCD 2011) predict *A. manicatum* presence.

Results *Presence-only model* – The MaxEnt model had an AUC score of 0.874, showing good predictability given the presence data provided. For percent impervious surface, *A. manicatum* were predicted to prefer levels 5-10, as well as level 3 (all above 0.65 preference score). For land cover type, *A. manicatum* are predicted to prefer developed land (open space and low->high), barren land, and shrub/scrub (all above 0.30 preference score). Predicted habitat suitability across the north east was visualized using ArcGIS v10.2.2 (Fig. 2). *Presence-absence model* – I used generalized linear models (family = binomial) to determine the influence of percent impervious surface and land cover type on presence of *A. manicatum*. Neither percent impervious surface or land cover type significantly predicted presence of *A. manicatum* ($p=0.39$ and $p=0.90$, respectively). Predicted habitat suitability (MaxEnt model) also did not significantly predict presence ($p=0.53$) (Fig. 3).

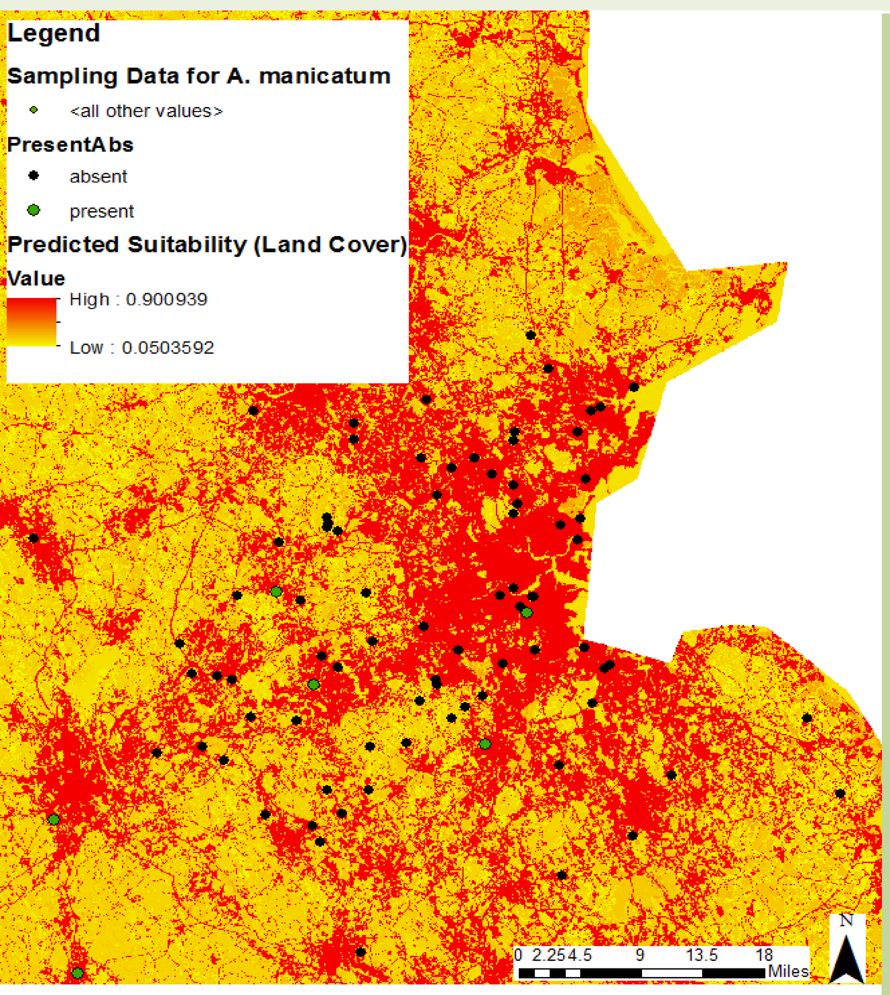

Figure 3. Predicted habitat suitability for the Greater Boston region (MaxEnt model – land cover type). Presence/Absence points from 2013-2014 sampling.

Conclusions Results from the presence-only model support the hypothesis that *A. manicatum* prefer developed habitat. However, the sampling data and presence-absence model suggest that *A. manicatum* are less prevalent than previously predicted[2], and that land cover type and impervious surface cannot significantly predict *A. manicatum* presence. The difference in model predictions could be due to insufficient presence data for this species, which may have caused overfitting of the data in the presence-only model, and/or increased the effect of any sampling bias. Additionally, this species may be more cryptic than previously estimated, and modifications to sampling effort may be needed to provide a more accurate estimate of current range and habitat preferences.

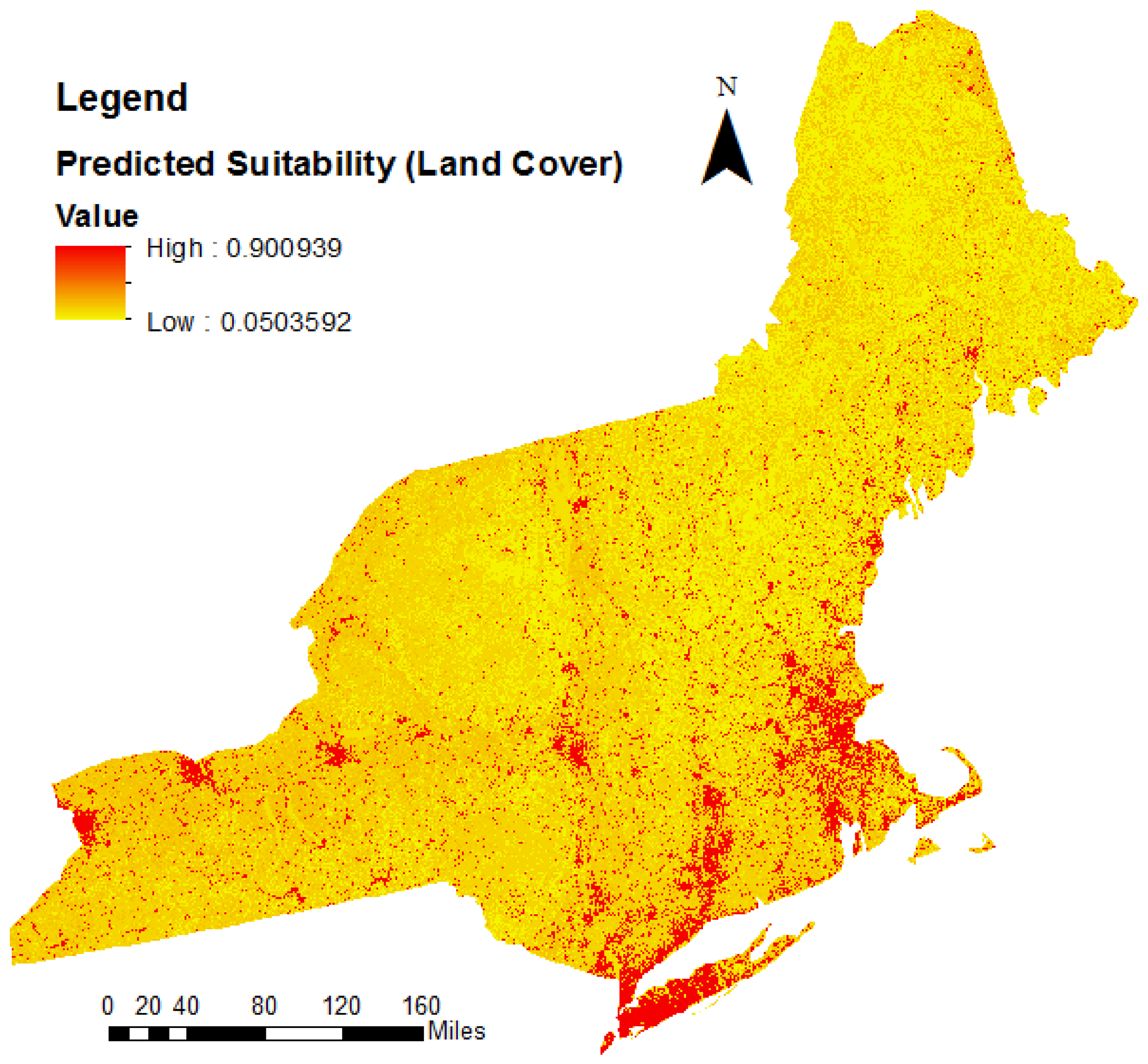

Figure 2. Predicted habitat suitability for *A. manicatum*. The program MaxEnt was used, with land cover type (NLCD 2011) included as the environmental variable.

Data: **NLCD 2011 land cover type:** Homer, C. G., J. A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N. D. Herold, J. D. Wickham, and K. Megown. *Photogrammetric Engineering and Remote Sensing* 81:345–354 (2015). **NLCD 2011 percent impervious surface:** Xian, G., C. Homer, J. Dewitz, J. Fry, N. Hossain, and J. Wickham. *Photogrammetric Engineering and Remote Sensing* 77:758–762 (2011). ***A. manicatum* presence data:** Ascher, J. S., and J. Pickering. *Discoverlife.org* (2011); Griswold, T., V. H. Gonzalez, and H. Ikerd. *ZooKeys* 408:31–49 (2014); Maier, C. T. *Proc. of the Ent. Soc. of Washington* 111:775–784 (2009).

References: **1**. Jaycox, E. R. *J. Kansas Entomol. Soc.* 40, 124–126 (1967) **2.** Strange, J. P., Koch, J. B., Gonzalez, V. H., Nemelka, L. & Griswold, T. *Biol. Invasions* 13, 2115–2133 (2011) **3.** Wirtz, P., Szabados, M., Pethig, H. & Plant, J. *Ethology* 78, 159–167 (1988) **4.** Morales, C. L. & Aizen, M. A. *Biol. Invasions* 4, 87–100 (2002) **5.** Burke, M. J. W. & Grime, J. P. *Ecology* 77, 776–790 (1996) **6.** Hobbs, R. J. & Atkins, L. *Austral Ecol.* 13, 171–179 (1988) **7.** Payette, A. *Fabreries* 26, 87-97 (2001) **8.** Ascher, J. S. & Pickering, J. *Discoverlife.org* (2011) **9.** Phillips, S. B., Aneja, V. P., Kang, D. & Arya, S. P. *Int. J. Glob. Environ. Issues* 6, 231–252 (2006) **10.** Maier, C. T. *Proc. Entomol. Soc. Washingt.* 111, 775–784 (2009) **11.** Azzurro, E., Soto, S., Garofalo, G. & Maynou, *Biol. Invasions* 15, 977–990 (2013).

Acknowledgments: I would like to thank Dr. Meghan G Maclean (School for Field Studies) for her help with sampling and data analysis. I would like to thank Babson College for some financial assistance for sampling (MGM). I would also like to thank Dr. Sumeeta Srinivasan for her help with data analysis and discussion of results.

Tufts UNIVERSITY