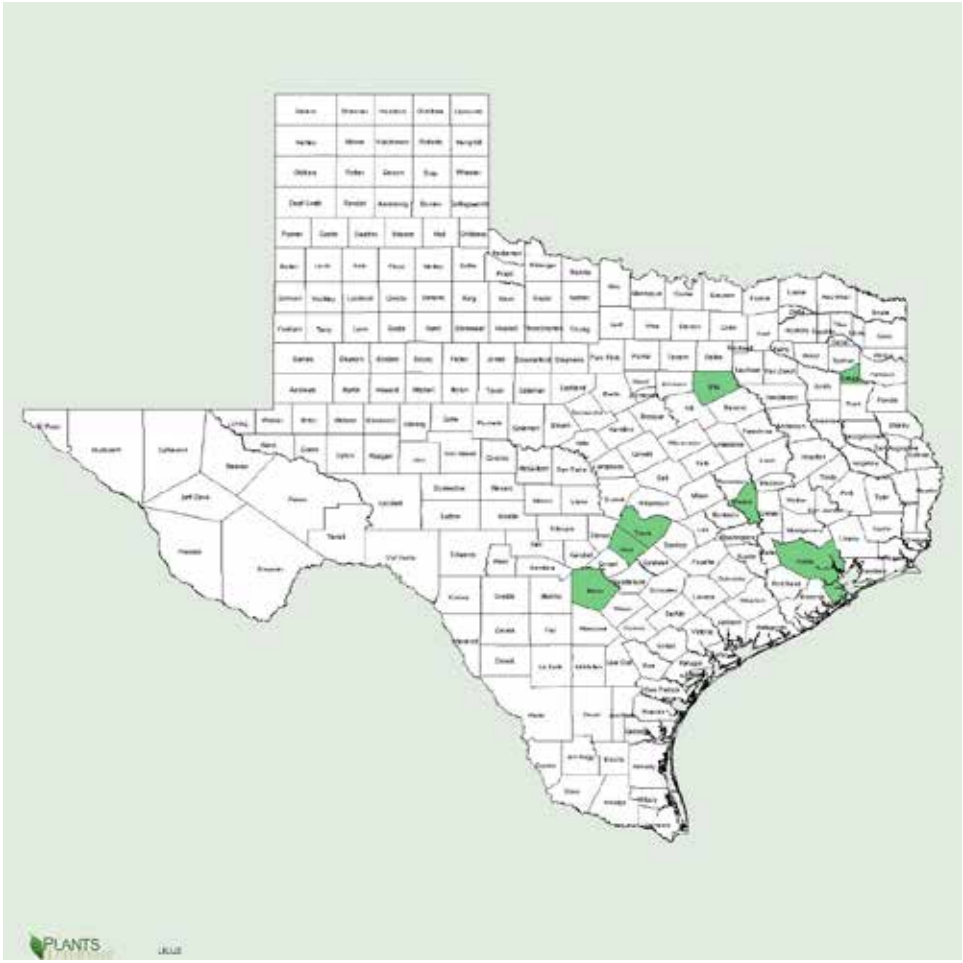
Age of residential development and recipient habitat explain the distribution and abundance of exotic woody species in central Texas woodlands

Gabriel De Jong
Dr. Norma Fowler
The University of Texas at Austin

Biological invasions: a global threat to biodiversity and ecosystem function

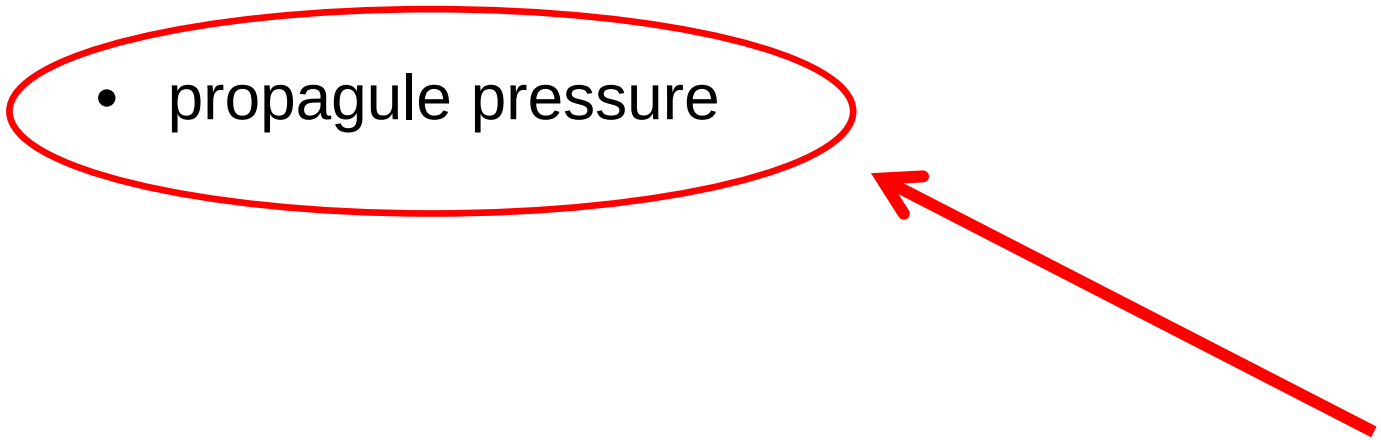
What explains the apparent idiosyncratic nature of invasions across the landscape?



Distribution of *Ligustrum lucidum* in Texas

Three general research approaches:

- invasiveness
- invasibility
- propagule pressure



Propagule pressure (PP) = the number of individuals introduced to a given location

propagule size: set of individuals in one introduction event

propagule number: frequency of introduction (reintroduction) events

Colonization pressure (CP) = the number of species introduced to a given location

Benefits to examining PP and CP in biological invasions:

1. PP is becoming more accepted as an important determinant of establishment success

2. Simple hypothesis: “The more you introduce, the more you get” (Lockwood et al. 2009)

3. Growing evidence of important role in spread of introduced species

4. Informing management

It is often difficult, or impossible, to measure PP and CP directly

- In some cases we may know PP and CP:
  - biological controls
  - historical records (ex. European Starlings, House Sparrows, etc.)

- We use surrogates for estimating PP and CP:
  - volume of ship ballast water
  - distance to roads
  - number of visitors to a preserve
  - nursery records

There is a need to test new potential surrogates for PP and CP

Examining the role of PP and CP in central Texas invasions

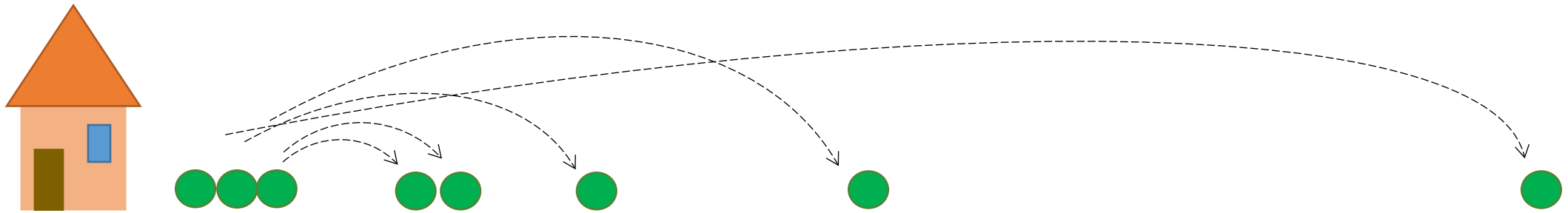
observation: most invasive woody species in central Texas are landscaping species

hypotheses: we expect that native woodland fragments that are:

1. **closer to developmen**t and

2. near **older development**

will have **more exotic woody species**
as a result of ongoing PP and CP



Methods

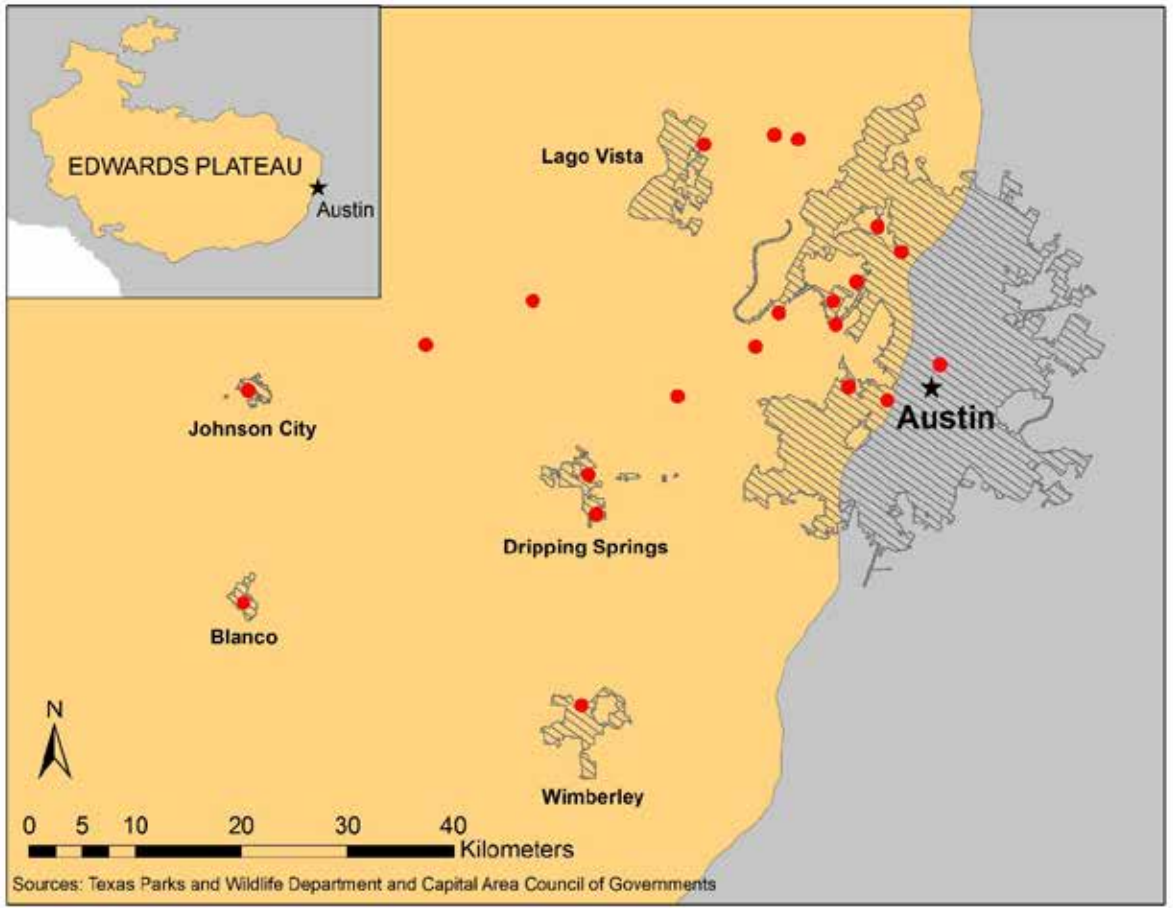
study region: eastern Edwards Plateau

sites: state parks, preserves, city parks, and private properties

Site selection

goal: a range of distances to development and a range of ages

management history was taken into account



Field-collected data

randomly located plots within three vegetation types:

riparian

mesic woodland

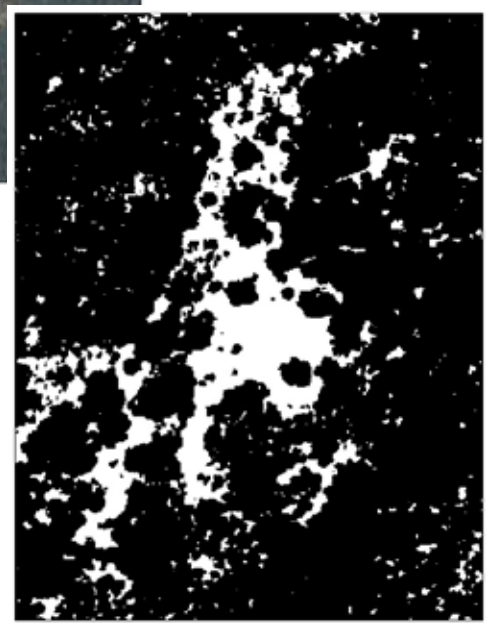
upland

recorded numbers of exotic and native species and their identities

recorded presence/absence of exotic and native species

Data from maps and aerials (ArcGIS)

canopy cover: from 2012 aerial photographs converted to binary images (TNRIS)



distances
streams, roads, development, and city-center

slope, aspect

soil types

age of development: maps (Google) and property appraisal data (county appraisal districts)

Analysis

generalized linear models and Akaike information criterion to identify the best models (SAS 9.3)

Poisson distribution (log link) to model exotic and native richness

logistic regression (binomial distribution, logit link) to model presence/absence of common exotic species

Results - common species

Ligustrum lucidum

Nandina domestica

Lonicera japonica

Melia azedarach

Ligustrum sinense

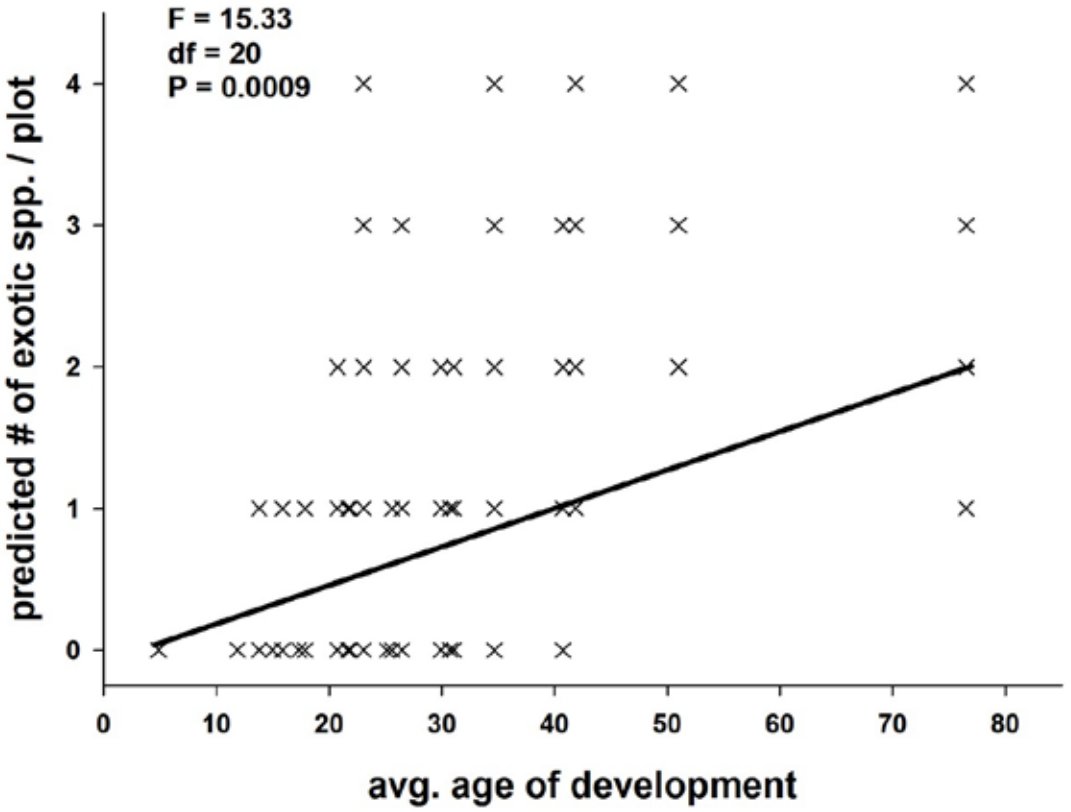
Results - uncommon species that may spread

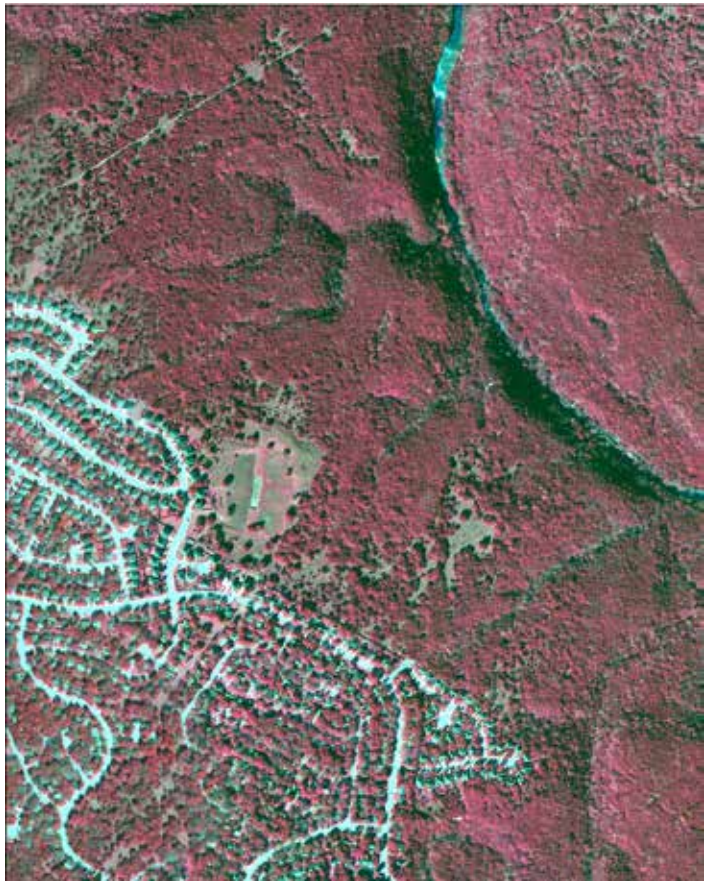
Photinia serratifolia

Triadica sebifera

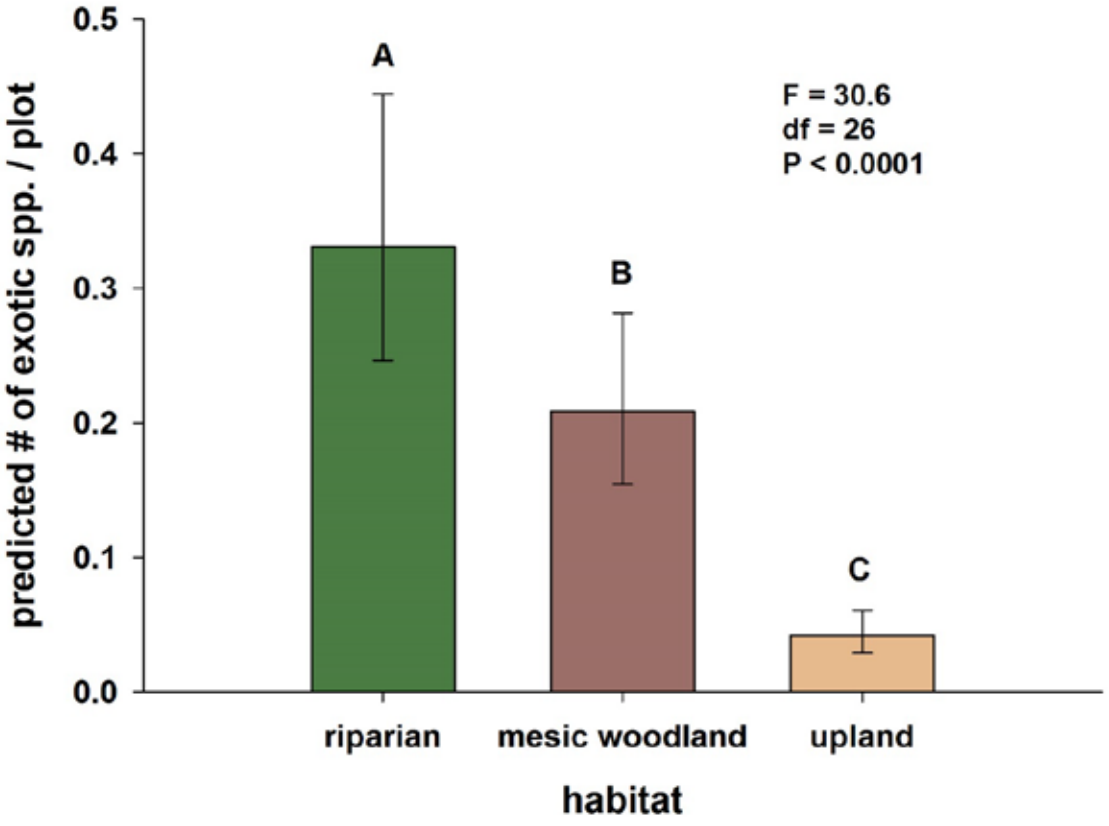
Morus alba

The best model predicting the number of **exotics** had two predictors: **age of development** and habitat

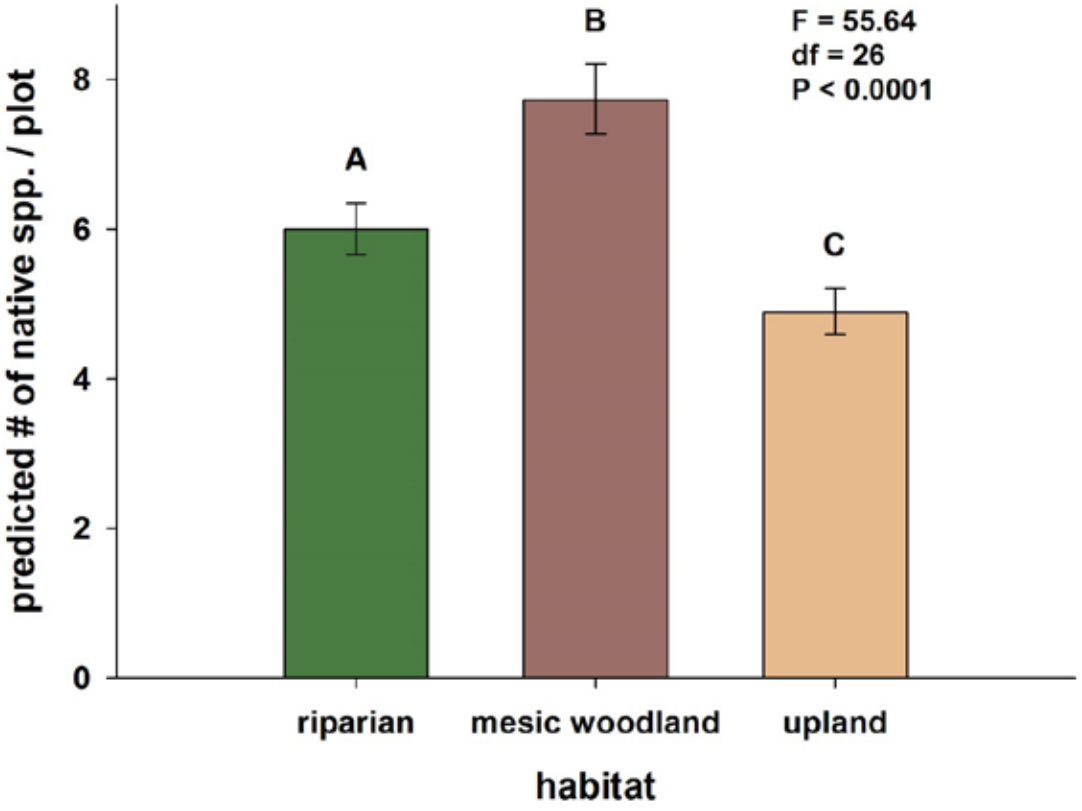




The best model predicting the number of **exotics** had two predictors: age of development and **habitat**



The best model predicting the number of **native species** had three predictors: **habitat**, slope, and soil order.



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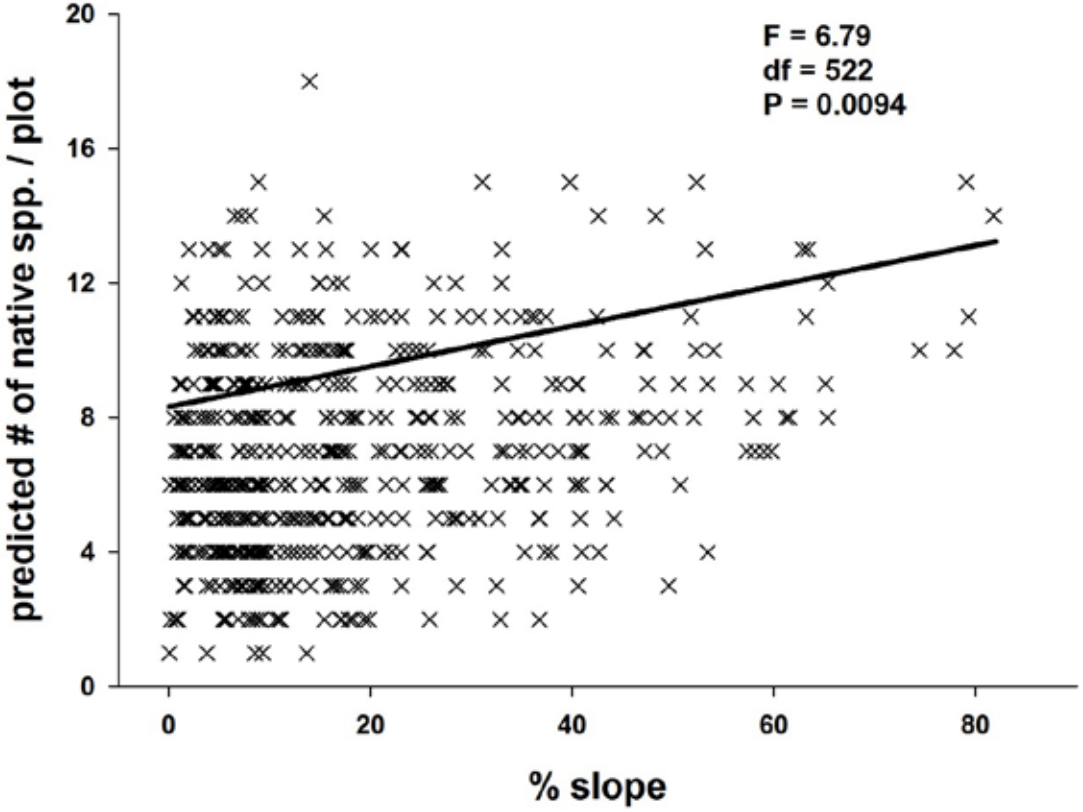

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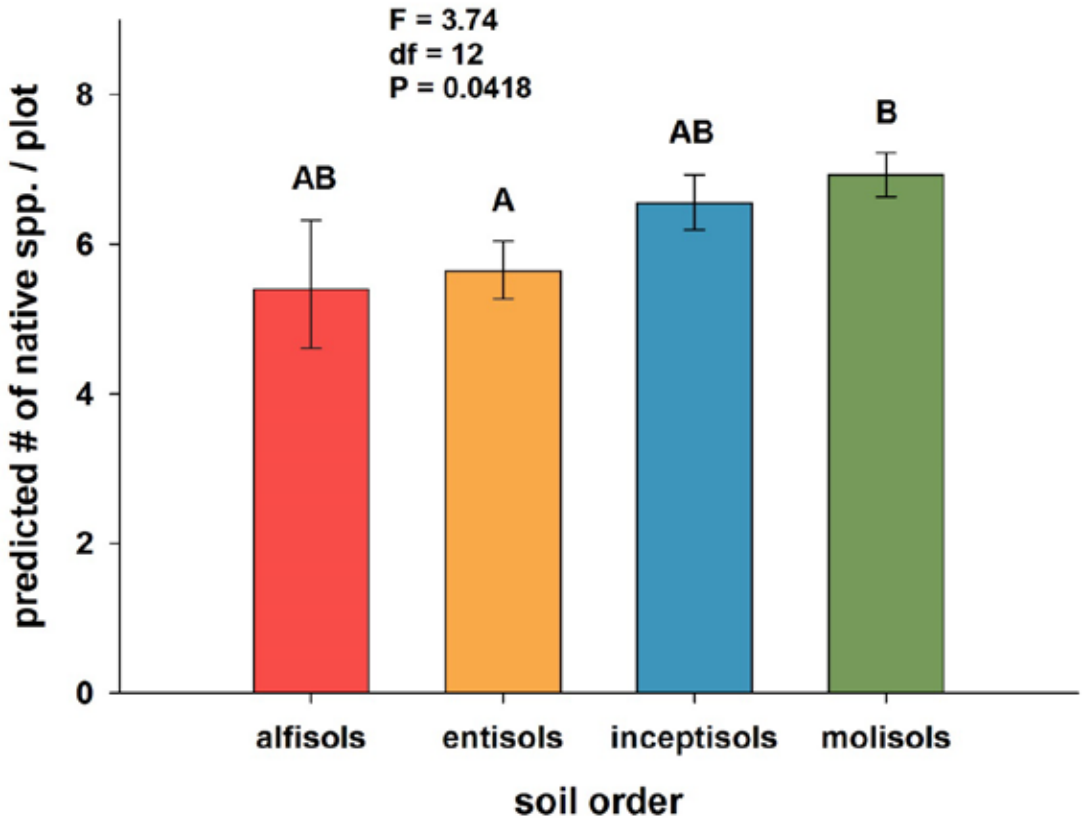
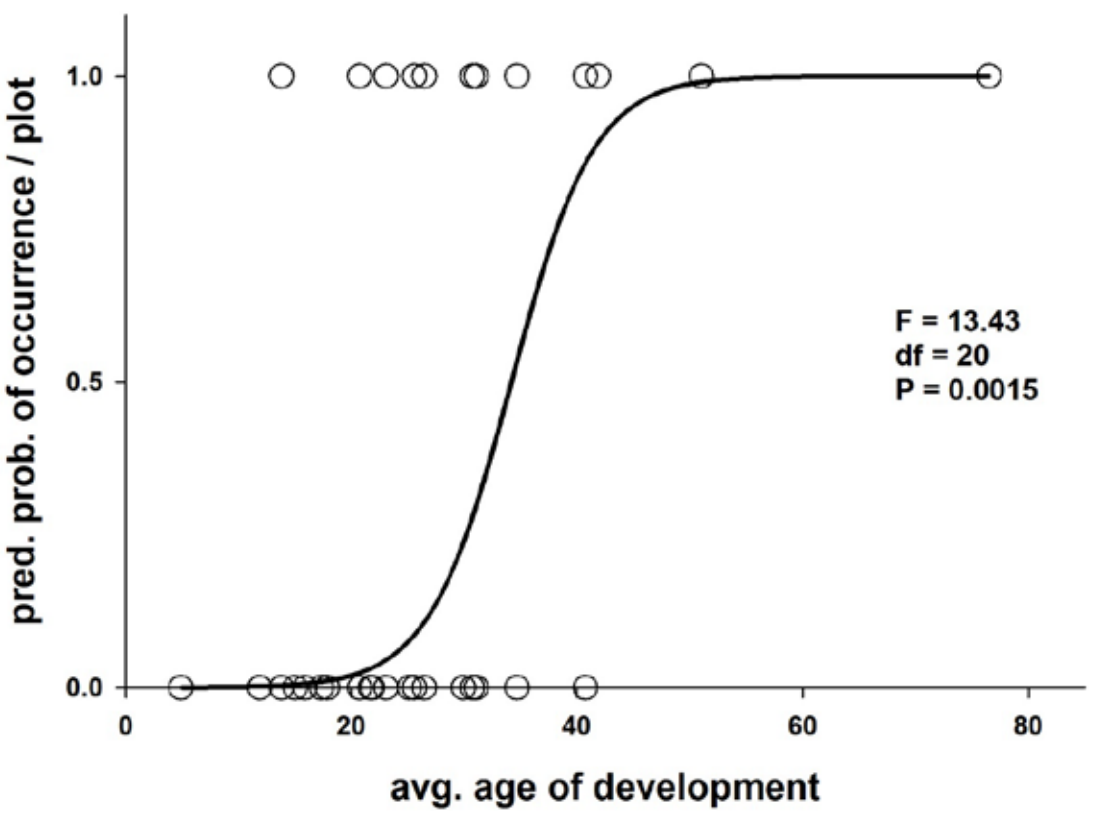


The best model predicting occurrence of ***L. lucidum*** had two predictors: **age of development** and habitat



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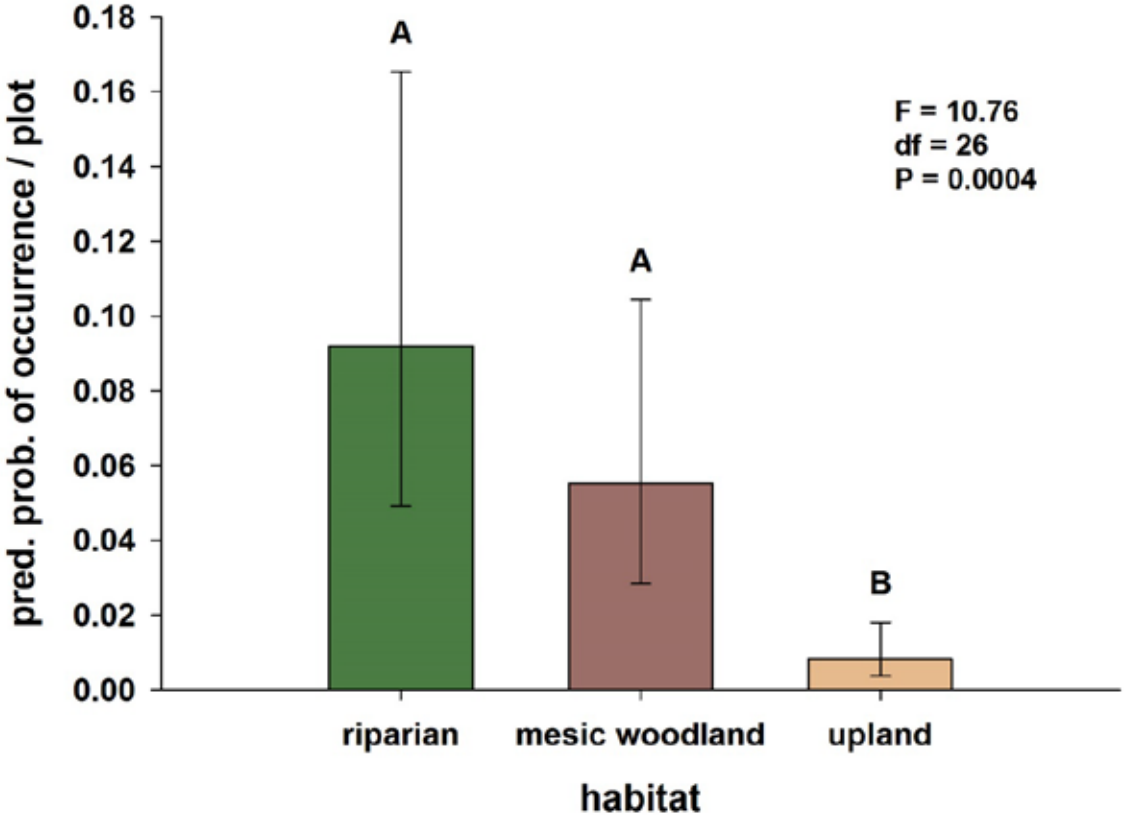
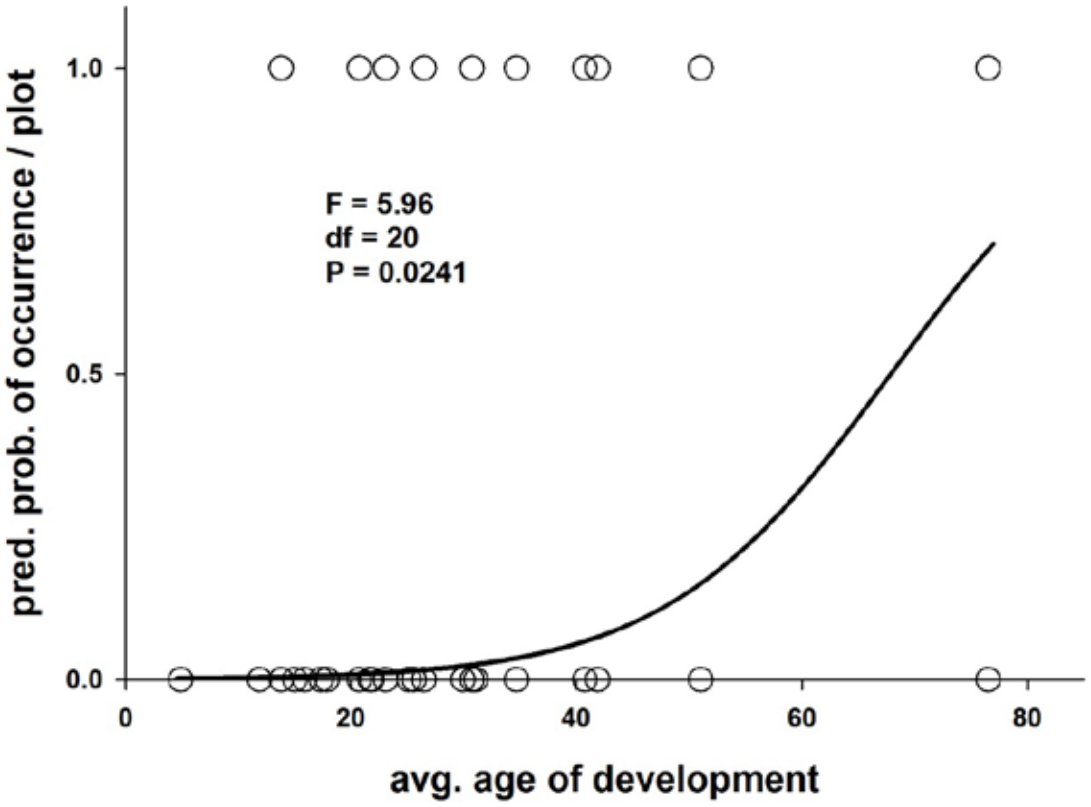


The best model predicting presence of ***N. domestica*** had three predictors: **age of development**, aspect and habitat



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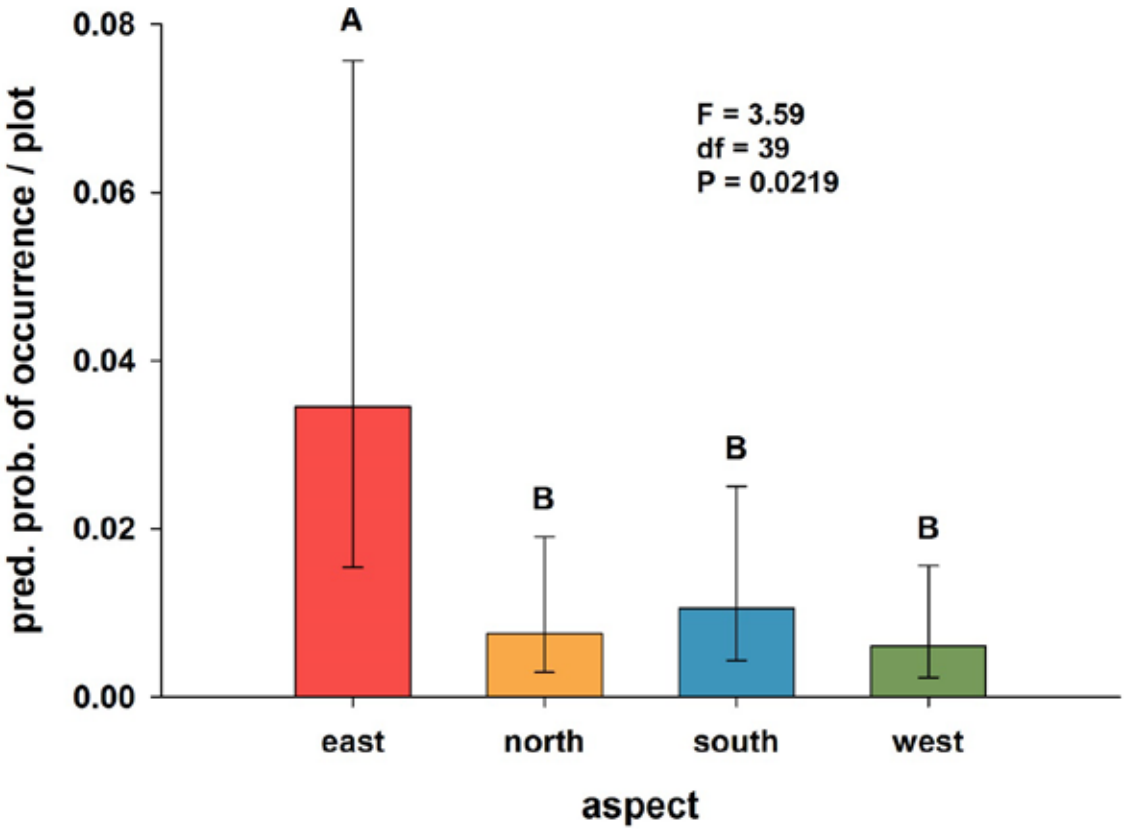

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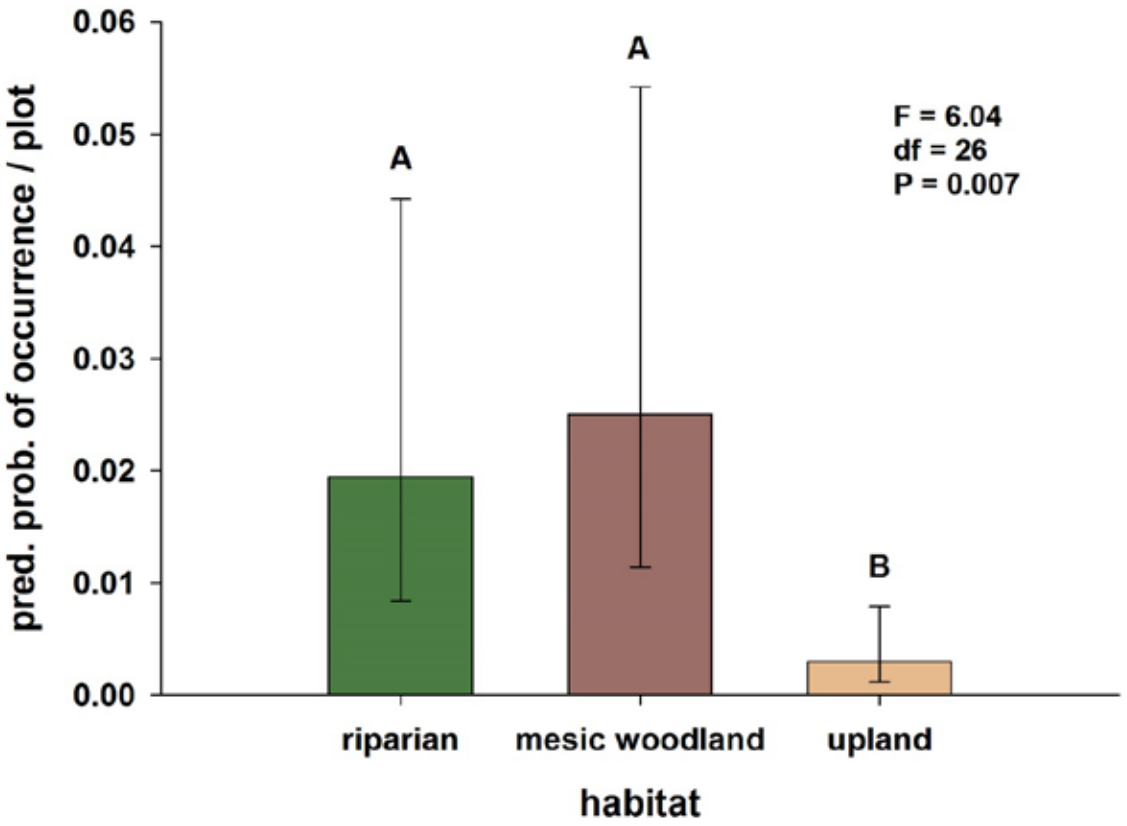
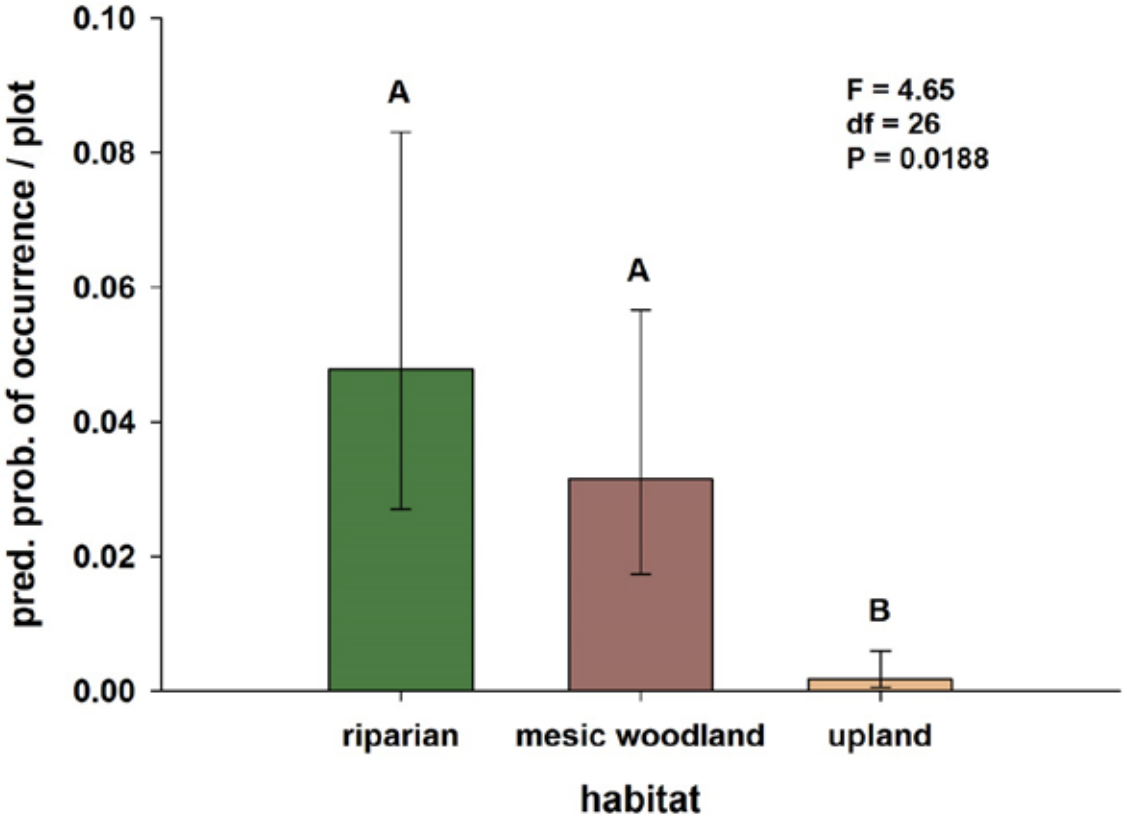


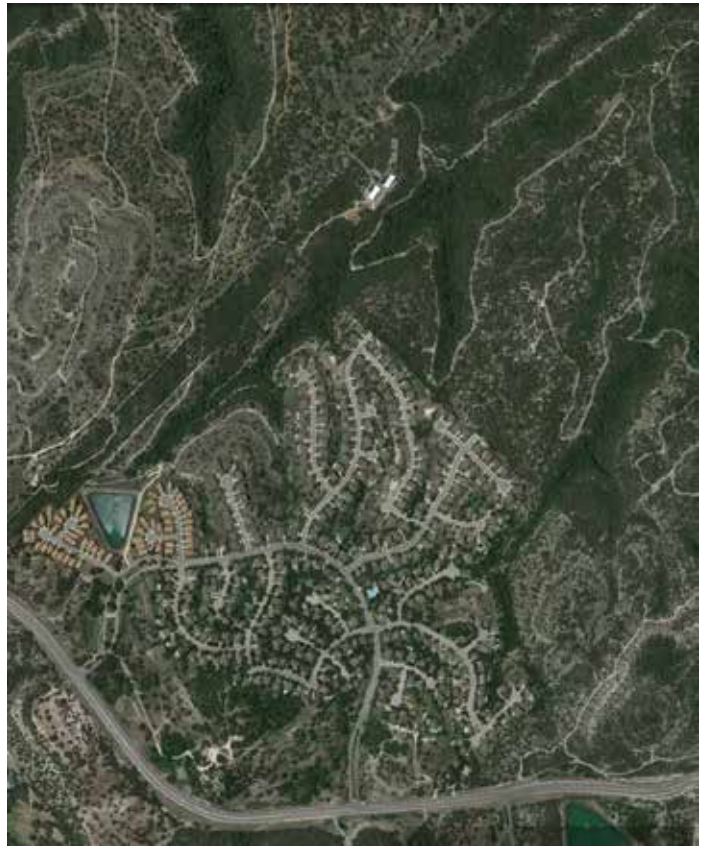
The best model predicting presence of ***M. azedarach*** had one predictor: **habitat**



As hypothesized, the number of exotic species in woodland fragments increased with the increasing age of surrounding residential development

- Distance to development was not in our final model, but this information was captured by age of development

- Habitat designations captured relevant variation in the environment that affected the distributions and abundances of exotic species



Aridity will likely limit the spread of woody exotics in central Texas

- Riparian areas were the most heavily invaded, followed by mesic woodlands, and uplands
- We expect woody exotics to be confined to riparian areas at the westernmost extents of their future ranges in central Texas
- Though drier areas appear resistant to invasion, future horticultural trends could change this

The best explanation for patterns of natives richness differed from the best explanation for exotics

- The most important predictors of native richness were ecological variables

- Habitat designations explained most of the variation in native species richness

Age of development was a useful surrogate for PP and CP and was an important predictor of exotic species' abundances and distributions

- Age of development may be a useful predictor in other regions with similar patterns of development

- Looking at invasibility without PP and CP would have ignored a significant driver of woody plant invasions

If new introductions ceased today...

- We would still have an '**invasion debt**' to deal with

  Current distributions and abundances of invasive species are the result of activities many decades past

  We can expect abundances of exotic species to increase in the future near recently developed areas

- Future efforts to restore native plant communities will be compromised if no effort is directed at stopping new or recurrent introductions of exotics

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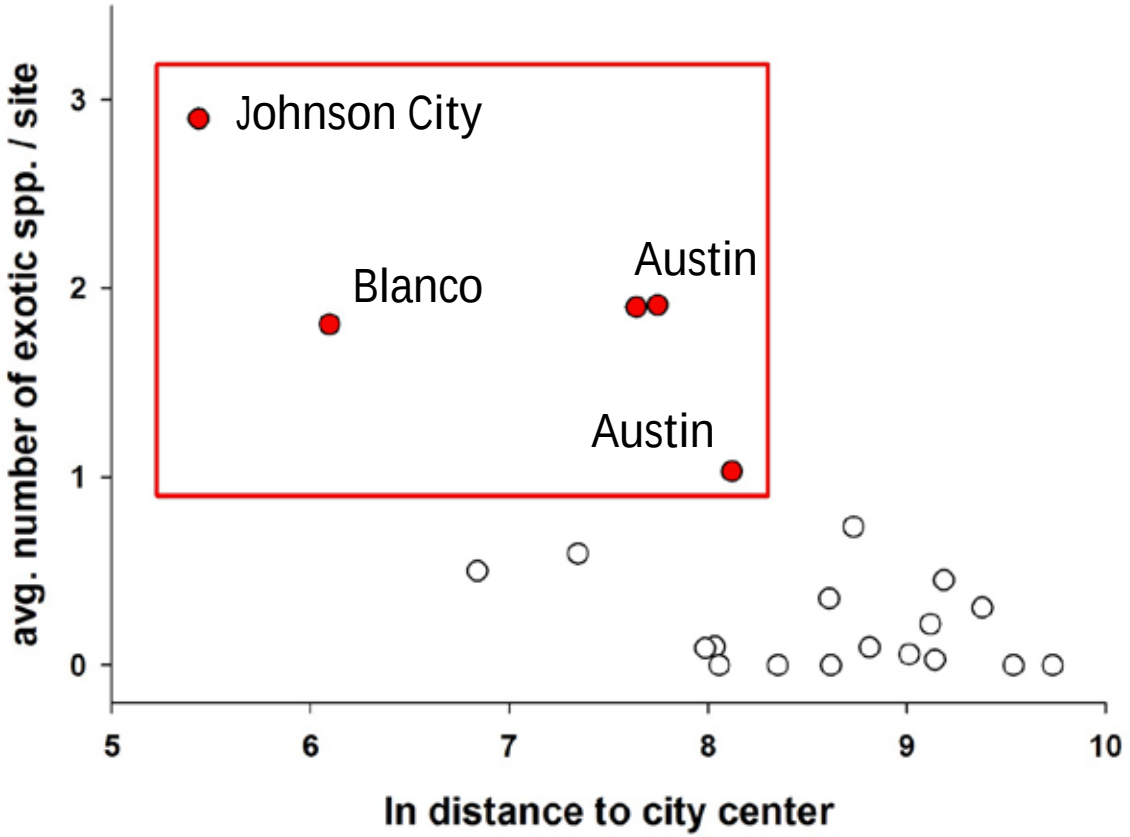
The Nature Conservancy
Travis Audubon
National Park Service
Many private landowners
City of Dripping Springs
City of Wimberley

There may be older historical processes at work, which may better explain current abundances and distributions of exotics

- Sites with the highest numbers of exotics were **closer** to **very old** cities



- May be indicative of greater human impact and the cumulative effects this and PP/CP over a longer time period (100+ yrs.)