The Potential Costs of Invasive Pests: *Nasutitermes Corniger* in Florida

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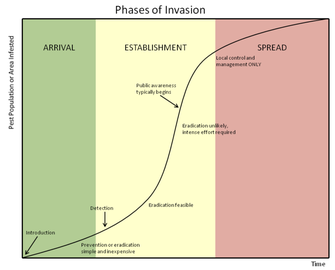
Background

• Increased trade and human mobility result in accidental and deliberate transport of organisms from their native range to locations where they were not previously present.

• An estimated 50,000 nonnative species are established in the US. A small portion of these have become pests or nuisances. Damage and control costs for these invasive species in the US exceed $120 billion annually (Pimentel et al, 2005). However, many nonnative species are beneficial and provide a large majority of the nation's food supply.

• Eradication of invasive species is feasible but costly if the organism's population is relatively low. However, efficient decision making requires reliable assessment of the potential damages and control costs.



• Many invasive species arrive through sea and air traffic, and are likely to be released in urban and suburban landscapes close to seaports and airports. Therefore, eradication campaigns against terrestrial invaders are likely to be carried out in urban and suburban environments.

Objectives

• Develop a dynamic and spatially explicit model that couples the establishment and spread of an invasive pest population to the behavior of property owners in urban and suburban areas.

• Use the model to develop estimates of the potential costs of invasive pests to inform policy decisions on the appropriation of resources for eradication or control campaigns.

Application: Conehead Termites in Florida

• A combination of *environmental* (tropical and subtropical climate, high precipitation) and *socio-economic* (tourism and trade hub, rapidly growing and urbanizing population) factors make Florida particularly vulnerable to biological invasions.

• *N. Corniger* (a.k.a., conehead or tree termite), an arboreal termite native to South America and the Caribbean basin, arrived in Dania Beach, Florida in 2001.

•Currently, resource constrained state agencies are trying to eradicate this pest. But, what would happen if there was no eradication campaign?

Methods

There are 3 main components in our approach:

1) An individual-based **model of termite colony expansion** (Tonini et al, 2013) to obtain a count of structures that lie within the area of infestation.

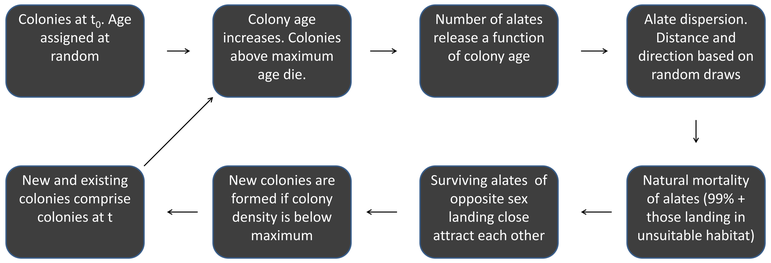
2) A **survey of pest control operators** that asked about the fees charged for different types of termite treatments to obtain a distribution of the costs of treating structures affected by termites.

3) A simple **programming model to simulate structure owners' optimal behavior** when structures are threatened by termites.

Termite Colony Expansion Model

• A GIS shapefile that differentiates suitable and unsuitable habitat (e.g., roads, waterways, airport runways) serves as the spatial base for an R script that simulates the expansion of individual colonies.

• Initial colonies were obtained from field surveys by Florida Department of Agriculture and Consumer Services staff.



Pest Control Operator Survey

• 149 responses to a web-based survey targeting registered pest control operators offering termite treatment services in Florida (~10 % response rate).

• Asked about treatment fees for a 3br/2ba single family home ~ 2,400 ft^2.

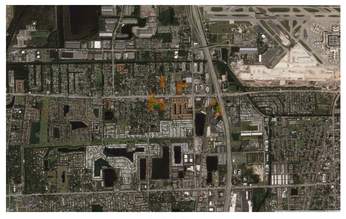
Optimal Response to Termite Threat

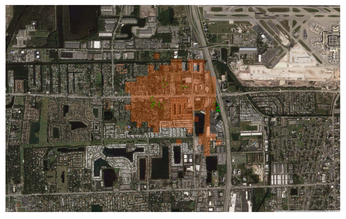
• Structure owners can be expected to choose a pest management strategy that minimizes the expected costs from termite infestations:

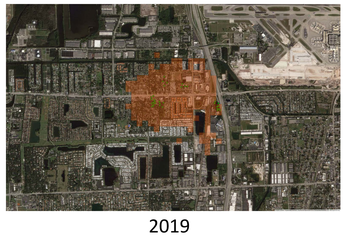
$$\min_{\delta} \; E(C) = \pi[\delta b + (1-\delta)\theta + \omega] + (1-\pi)[\delta b]$$

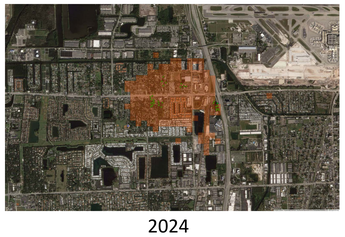
where:
• b is the annual cost of a pest control bond that ensures the property is surveyed for pests on a regular basis
• $\delta = 1$ if the owner purchases a pest control bond, $\delta = 0$ otherwise
• π is the probability that a structure in the invasion area becomes infested by termites in a given year
• θ is the expected cost of structural damage inflicted by termites
• ω is the expected cost of treating the structure to remove termites

Expected Termite Colony Expansion


2015

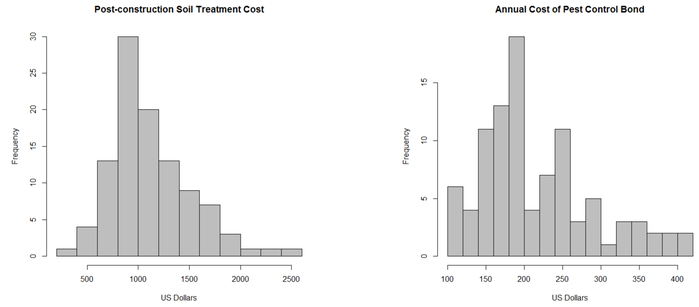

2016


2019


2024

Green dots represent the original colonies
Orange shade represents areas invaded by termites in at least 50% of model runs

Costs of Termite Treatment Options in Florida



Expected Treatment and Control Costs

Structures Affected	2014	2015	2019	2024
Mobile Homes	0	98	98	98
Single Homes	51	778	787	800
Med. Commercial	2	74	74	74
Lg. Commercial	2	20	22	24
Area (acres)	34.59	402.78	528.81	560.93
Treatment Cost	$56,550	$956,000	$972,000	$991,400
95% CI	(26,485 – 104,009)	(447,757 – 1,758,323)	(455,268 – 1,787,819)	(464,360 – 1,823,523)

Discussion

• Given the low expected costs of termite damage under moderate infestations and the high costs of termite protection bonds, the cost minimizing strategy for structure owners is to **not** purchase these bonds, even under very high probabilities of infestation.

• Treatment costs can be expected to be relatively low during the first year of the invasion. However, annual treatment costs would grow to nearly $1 million after the second year of the invasion.

• Under a 5% discount rate, the Net Present Value of treatment and control costs to be borne by structure owners is $6.6 million.

• The invasion area grows rapidly during the first two years but then slows as termite density increases over a limited area and alates swarm to areas that are already invaded.

• A public investment in eradication of $6.6 million or less is warranted to prevent the establishment and spread of this costly pest.

•The Department of Agriculture and Consumer Services expects the eradication campaign to cost nearly $250,000 per year. Eradication requires finding and eliminating colonies, rather than simply protecting structures.

•Future research will focus on optimal eradication strategies.

References

• Pimentel D, Zuniga R, Morrison D. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics* 52, 273-288.

• Tonini F, Hochmair HH, Scheffrahn RH, Deangelis DL. 2013. Simulating the spread of an invasive termite in an urban environment using a stochastic individual-based model. Environmental Entomology (42) 3, 412-423.