Assessing the potential impact of invasive species on native biota: a case study on the invasion of ring-necked parakeets in northern Belgium

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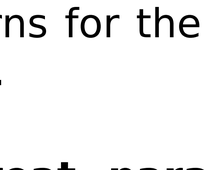
Biological invasions are a major threat to biodiversity[1], but not all introduced species are equally invasive, and management efforts should concentrate on invaders that will have the greatest ecological impacts[2]. Among birds, ring-necked parakeets *(Psittacula krameri)* are among the most successful invaders. Originating from Africa and Asia, they have established at least 65 populations in Europe[3]. Currently, there may be as many as 11.000 parakeets in Belgium. This growing population raises concerns for the loss of native avifauna, such as the nuthatches *(Sitta europaea)* who compete with parakeets for nest cavities[4,5].

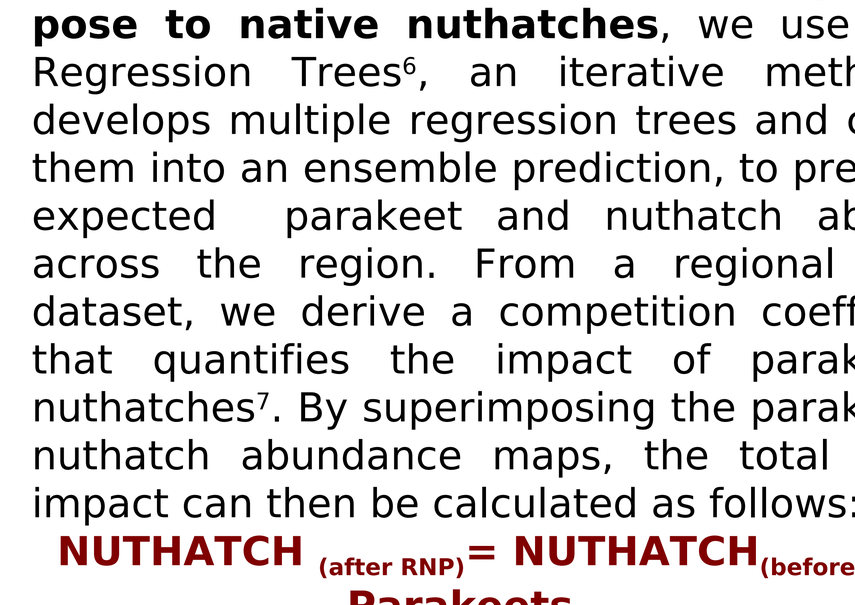
In order to **evaluate the threat parakeets pose to native nuthatches**, we use Boosted Regression Trees[6], an iterative method that develops multiple regression trees and combines them into an ensemble prediction, to predict the expected parakeet and nuthatch abundance across the region. From a regional Brussels dataset, we derive a competition coefficient α that quantifies the impact of parakeets on nuthatches[7]. By superimposing the parakeets and nuthatch abundance maps, the total parakeet impact can then be calculated as follows:

$$\mathbf{NUTHATCH}_{\text{(after RNP)}} = \mathbf{NUTHATCH}_{\text{(before RNP)}} - \alpha \cdot \mathbf{Parakeets}_{\text{(predicted)}}$$

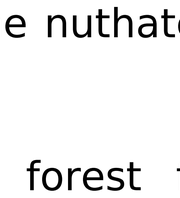
Analysis of 48 Brussels forest fragments shows that **parakeet abundance** is highest in older, fragmented forests in urban areas (Figs. 1a-c). Our model shows that sites further from the release site have not yet attained their carrying capacity (Fig 1d). Data on **nuthatch abundance** were obtained from the Flemish Breeding Bird Atlas, and as this dataset was zero-inflated (excess of forests without observations) nuthatch distribution was analyzed using a two-step model, consisting of a presence-absence and an abundance model[8]. Nuthatch presence is mainly influenced by forest size and structural forest characteristics such as forest age and canopy cover (Figs. 2a-d) whereas for nuthatch abundance, tree species composition is also important, showing that nuthatches prefer large, old deciduous forest and reach their highest abundance in oak-dominated fragments (Figs 3a-d).



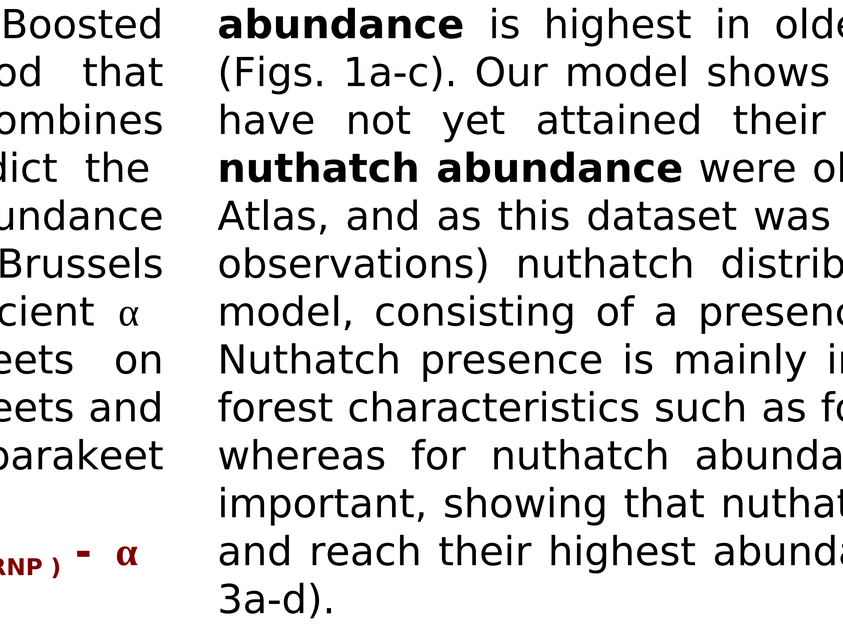
Ring-necked parakeet



Figs 1(a-d). Factors governing parakeet abundance

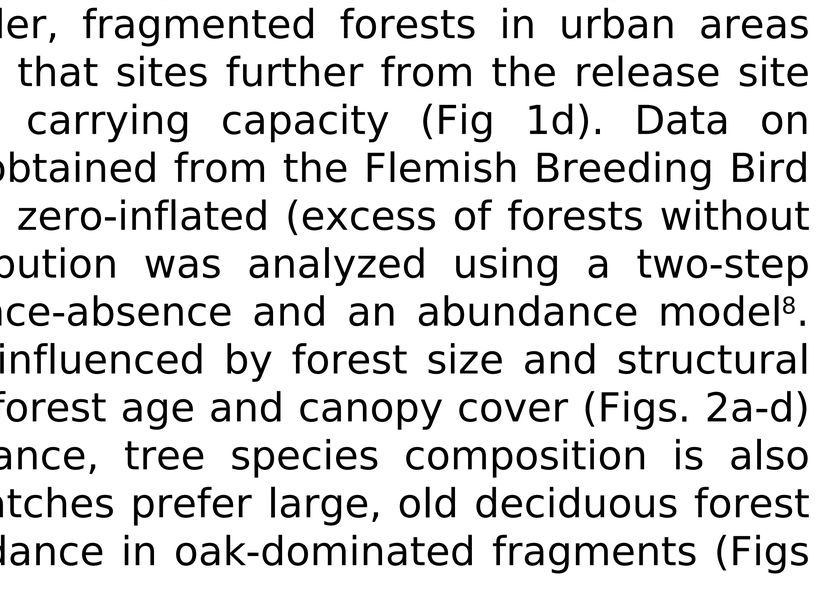


Nuthatch presence-absence



Figs 2(a-d). Factors governing nuthatch presence/absence

Nuthatch abundance



Figs 3(a-d). Factors governing nuthatch abundance

Our models predict about **22.000 (9.000-39.000) parakeet pairs** and, in the absence of competition with parakeets, about **4.600 (2.900 – 6.500) nuthatch pairs** (Fig. 4).

Analysis of a Brussels dataset (n=44) shows that, after accounting for nuthatch habitat selection, parakeet abundance negatively influences nuthatch numbers (P = 0.004) and from the slope of the regression line of parakeet abundance, we derive a competition coefficient α = 0.029 (0.0352-0.0106; pairs/ha).

To assess total parakeet impact, we constructed a histogram of all possible scenarios of parakeet and nuthatch abundance and competition strength (Fig. 5). These results suggest that **parakeets are not a major threat to nuthatches**, as most scenarios predict a rather small parakeet impact. A moderate scenario, i.e. the average values for both parakeet and nuthatch abundance and for the competition coefficient indicates a loss of 11% of the nuthatches (i.e. 528 out of the current 4616 breeding pairs).

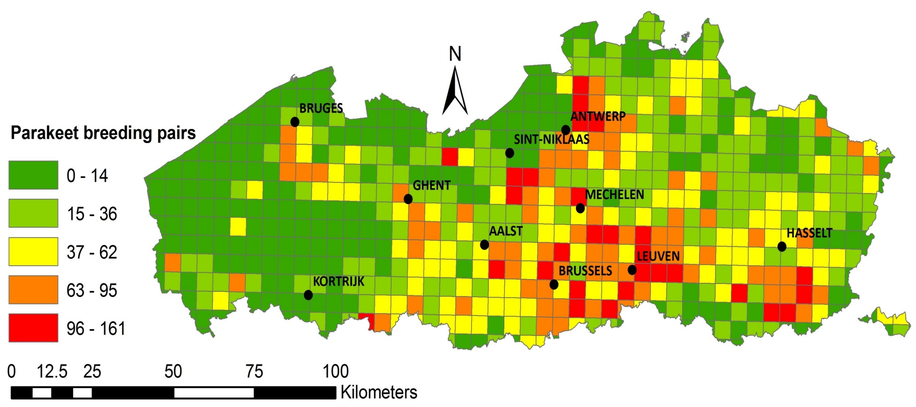


Fig. 4 Region-wide predicted parakeet abundances. Number of breeding pairs per 5x5 km UTM grid were obtained by summing the predicted parakeet abundances for each forest fragment within each grid cell.

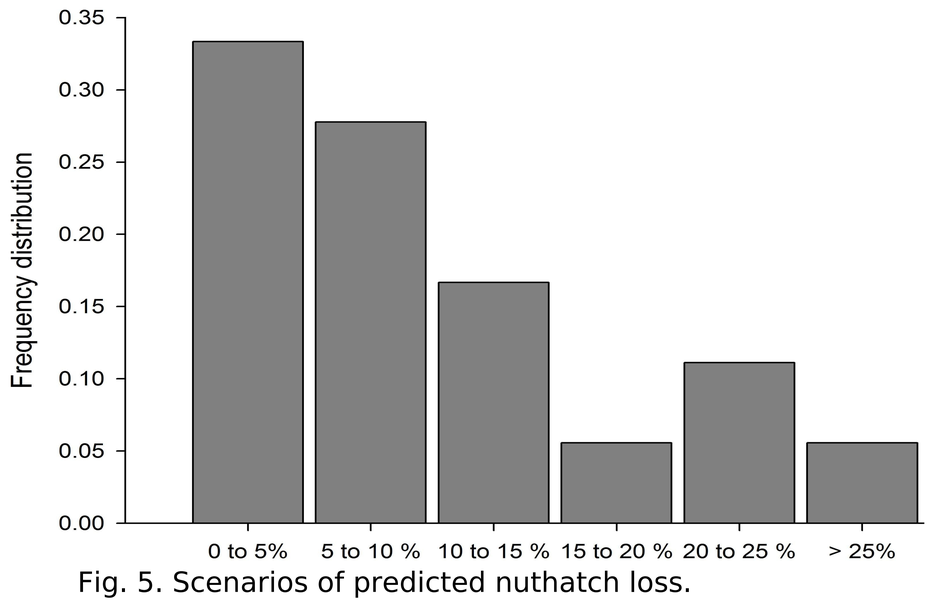


Fig. 5. Scenarios of predicted nuthatch loss.

Literature cited:1-Sala *et al.* 2000 Science,287:1770-1774;2-Parker *et al.* 1999 Biol. Invas.,1:3-19;3-Lever 2005-Naturalized birds of the world, T & AD Poyser;4-Strubbe & Matthysen 2007, Ecography,30:578-588;5-Strubbe & Matthysen 2009 Biol. Cons., *in press*;6-Elith *et al.* 2008 J. Appl. Ecol. 77:802-813;7-Shenbrot & Krasnov 2002 Oikos, 99:47-58; 8-Potts & Elith 2006 Ecol. Model. 199:153-163