The role of European Starlings in the decline of Red-headed Woodpeckers in Ontario

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Introduction

Over the past 20 years, Red-headed Woodpecker (*Melanerpes erythrocephalus*) populations have been declining dramatically across their range (COSEWIC 2007, Berl *et al.* 2015). The species continues to decline despite being widespread with a natural distribution spanning southern Canada and the eastern and central United States. In Canada specifically (the northern limit of the range), Red-headed Woodpeckers have declined 48% since 1994 (COSEWIC 2007). The most often suggested reasons for the decline are those pertaining to negative impacts on the species' breeding ecology. Lack of open habitat through the suppression of brush fires, fewer nesting snags, shifting agricultural methods (e.g., destruction of woodlots and conversion

European Starling.
Homer Caliwag


Red-headed Woodpecker. *P. Allen Woodliffe*

of old fields), loss of mast-producing trees and competition for limited nesting sites with conspecifics have all been suggested as reasons for the observed population crash (COSEWIC 2007, Berl *et al.* 2015). Usurpation of nesting holes by other cavity nesting species is another potential cause of decline, particularly when coupled with additional stress factors (Koenig 2003, Frei *et al.* 2015).

The European Starling (*Sturnus vulgaris*) is a highly competitive cavity nester that has been implicated in the usurpation of nests for at least 27 species of primary and secondary cavity-nesting birds (Koenig 2003). The starling has the added detraction of being a non-native species, having been introduced from Europe intentionally to North America in 1890 and has since become abundant throughout the continent (Cable 1993). Woodpecker species throughout North America have been affected by the starling's introduction and subsequent spread, including Northern Flickers (*Colaptes auratus*) and Red-bellied Woodpeckers (*M. carolinus*) (Ingold 1994, Wiebe 2003). Starlings have been found to compete for breeding sites with Red-headed Woodpeckers, with successful nest cavity usurpation having been directly observed (Frei *et al.* 2015). Despite the known threat that starlings pose to the Red-headed Woodpecker, scant research has been implemented to better understand the significance this competition has on the woodpecker's corresponding abundance.

An increasing number of studies have been conducted using citizen science sources such as the Breeding Bird Survey and Christmas Bird Count which allow open access to data on distribution and abundance of birds across a wide temporal scale; one of the few studies examining the effects starlings have on breeding cavity-nesters was conducted by Koenig (2003) using long-term citizen science data. Decades of data were analyzed, including examining the mean densities of cavity-nesters before and after starling invasion throughout North America. Ultimately, few cavity-nesters, either primary or secondary, were reported by Koenig (2003) to be negatively affected, if at all, by starlings. However, in this correlational study, the size of the study area (North America) and inclusion of winter submissions (a time when woodpeckers and starlings do not compete for nests) may understate the importance of site specific and breeding-centric cases of competition among cavity nesters. Few studies have focused specifically on Red-headed Woodpecker and starling competition, especially in an Ontario-wide spatial scale with a recent study by Frei *et al.* (2015) being a notable example. Additionally, to our knowledge, no studies have examined the relationship between the abundances of European Starlings and Red-headed Woodpeckers using data available through eBird, a popular citizen science initiative which allows open access to a large repository of distribution and abundance data spanning decades.

For this study, we compiled the relative abundance of Red-headed Woodpeckers and European Starlings in important breeding areas of the woodpeckers in southern Ontario during the breeding season. Abundance dynamics of Red-headed Woodpeckers were compared to those of starlings to explore the possible correlations between starling demography and Red-headed Woodpeckers. We hypothesise that Red-headed Woodpecker abundance is impacted by starling abundance in Ontario and predict that Red-headed Woodpecker-starling abundance will have a significant interaction with time (year) being a significant predictor variable.

Methods

The study sites selected for analysis were derived from data on important breeding locations for the Red-headed Woodpecker in Ontario provided through a comprehensive report on the species' Canadian status (COSEWIC 2007). Abundance data were compiled for Red-headed Woodpeckers and European Starlings using eBird submissions within Chatham-Kent, Durham, Elgin, Essex, Frontenac, Haliburton, Hastings, Kawartha Lakes, Leeds and Greenville, Middlesex, Muskoka, Norfolk, Northumberland, Peterborough and Simcoe counties (eBird 2016a). Abundance was based on the mean number of birds reported on all submitted checklists within the region for each year's breeding season.

Abundance data were compiled from 1974-2015 to allow for submissions before the 48% decline reported up to 1994 (COSEWIC 2007) and during the major decline in Ontario ongoing since then. All data were used to compute weekly means within the known breeding season of the Red-headed Woodpecker in Ontario (16 weeks from 1 May to 31

August to account for any possible breeding) to keep the study breeding-centric and to avoid comparison of starling-woodpecker abundance during woodpecker migration out of the province (winter months). An annual breeding season abundance value was found by taking an overall average of the weekly mean sightings of Red-headed Woodpeckers and European Starlings within the study area and time specified previously. Having only been launched in 2002, much of the eBird data used in this study comes from historic pre-launch checklists. Historic data are subjected to the same vetting process as post launch data including potential questioning from regional editors (most of Ontario eBird records are at present subjected to regional editors) and automatic flagging of unusual sightings and count numbers (Burrell 2012, eBird 2016b). Historic data are largely sourced from dedicated birders and monitoring programs such as those submitted from regional partners including Bird Studies Canada, which helps maintain the eBird Canada regional portal (Bird Studies Canada 2016). To explore whether there was a relationship between Red-headed Woodpecker and European Starling abundance, we ran a general linear model (dependent variable: abundance, independent variables: year and species, interaction: year x species).

Results

A total of 72,276 checklists was submitted within the fifteen specified counties

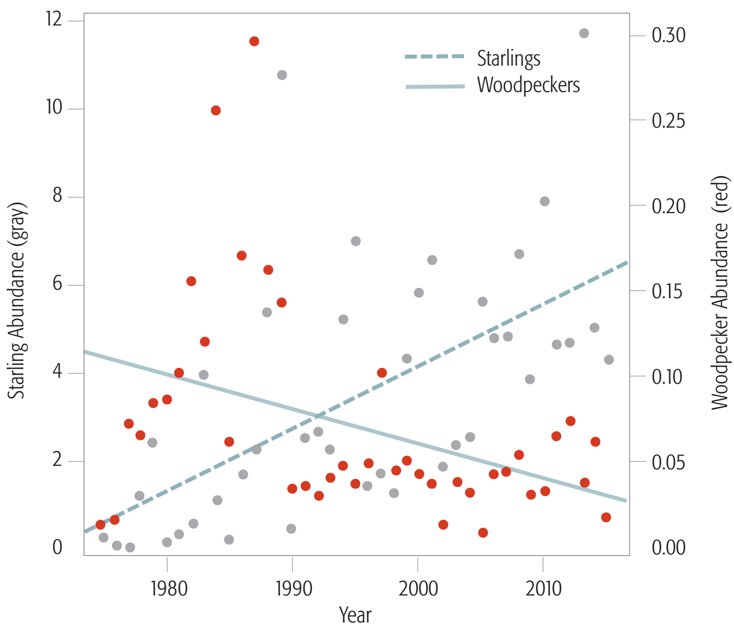

Figure 1: In southern Ontario, the relative abundance of Red-headed Woodpeckers (red) during the breeding season (May-August) declined significantly while European Starling (grey) increased in abundance from 1974 to 2015 ($F_{1,80} = 21.566$, $p < 0.0001$).

during the May-August spring-summer season from 1974 to 2015. Of the checklists submitted, 22,944 were from before the 2002 launch of eBird. Peak Red-headed Woodpecker abundance was reported during the 1986 breeding season with an average of 0.3 birds recorded per checklist. The lowest abundance for Red-headed Woodpeckers was found during 2004 with an average of 0.007 birds per checklist. European Starling abundance peaked in 2012 with an average of 11.7 birds recorded per checklist. The lowest abundance, with an average of 0.004 birds per checklist, was reported for 1976.

In the general linear model analysis, there was a significant interaction between year and species ($F_{1,80}$= 21.566, p<0.0001). The abundance of European Starlings increased consistently throughout the study period, while the abundance of Red-headed Woodpeckers decreased (Figure 1).

Discussion

The interaction between year and species abundance was found to be significant, consistent with our hypothesis that there was a negative correlation between Red-headed Woodpecker abundance and European Starling abundance and that starlings are a likely contributing factor to the ongoing decline of Red-headed Woodpeckers. Frei *et al.* (2015) found evidence that starlings were having a significant negative impact on Red-headed Woodpecker nesting success: aggressive interactions with starlings were recorded frequently and no less than six out of the sixteen nest failures were due to starling usurpation. Additionally, failed nests were found to be more than twice as likely to have a high density of starlings present within the vicinity of the active cavity (Frei *et al.* 2015). Their study indicates the mechanisms that help explain the inverse population trends correlation we found.

A sudden crash in the average abundance of Red-headed Woodpeckers recorded on checklists after 1990 (before which it appears to be increasing alongside starling abundance) suggests the presence of additional decline factors in addition to starling nest usurpation and other forms of competition (Figure 1). A consistent decline in abundance from the start of this study period would be expected if starlings were the primary or lone factor in such a drastic population decline over a short period of time, as starlings had already been well-established in the study area by 1974. The study by Koenig (2003) examining the effects starlings have on primary and secondary cavity nesters found that only three species showed declining trends in density as starling density increased. Mean Red-headed Woodpecker density did not significantly differ after the first record and subsequent establishment of starlings on selected breeding sites examined in that study, suggesting as in our case, that additional factors were contributing to the overall decline of the species.

Both intra- and inter-specific competition for nests have been described in Red-headed Woodpeckers. Red-headed Woodpeckers are bold and highly territorial, a behavior which leads to common

Red-headed Woodpecker.
P. Allen Woodliffe

instances of conspecific conflict. Persistent and aggressive territorial behaviours between breeding Red-headed Woodpeckers were observed frequently during a study of the species in New York (Berl *et al.* 2013). Notable among the conspecific territorial events observed was an attempted theft of the nest site (which would likely have resulted in the destruction of any eggs or young contained within). The intruding bird was observed on seven occasions landing within one metre of the cavity with one of those landings resulting in it entering the nest cavity briefly before retreating (Berl *et al.* 2013). Suggested explanations for the attempted nest theft include limitation of breeding sites. Red-headed Woodpeckers typically take longer than other woodpeckers to excavate a nest cavity (up to two weeks) which may incite intraspecific nest theft for the benefit of increased fitness for the invading individual, particularly if nesting trees and surrounding breeding habitat are at low densities (Lindell 1996, Berl *et al.* 2013). In contrast, a study by Atterberry-Jones and Peer (2010) found that cooperative breeding was adopted in some mated pairs of Red-headed Woodpeckers, possibly as a response to a high density of conspecifics within ideal breeding habitat compared to more sparsely inhabited surrounding areas. The helpers in that study largely assisted the breeding pair by defending the nesting area from conspecifics, because heightened levels of territorial conflict was thought to be a significant stress on overall breeding success (Atterberry-Jones and Peer 2010). Out of 28 Red-headed Woodpecker nests followed in an Illinois study (Hudson and Bollinger 2013), only a single case of usurpation was documented; the usurper was not a starling but rather a Pileated Woodpecker (*Dryocopus pileatus)*, a native species. Another woodpecker species, the Red-bellied Woodpecker, has increased in population and expanded its breeding range in Ontario within the same general time that the Red-headed Woodpecker has declined (Kirchman and Schneider 2014). Despite this recent expansion, the Red-bellied Woodpecker is an unlikely source of interspecific competition with the Red-headed Woodpecker as both species co-exist throughout much of their range further south and have significantly different choices in breeding habitat including site location and the condition of the nesting snag (Jackson 1976).

Predation has also been found to be a significant cause of mortality and nest failure of Red-headed Woodpeckers. Hudson and Bollinger (2013) found that five out of the seven nest failures in the sample of 28 nests were due to predation, more than any other contributing factor. In South Carolina, 19 of 80 radio-tagged Red-headed Woodpeckers were killed by predators, the only documented cause of mortality and the most significant source of nest failure (17 were killed by raptors while the remaining two were killed by snakes) (Kilgo and Vukovich 2012). Kilgo and Vukovich (2012) also found that the abundance of patches of dense tree or brush stands was significantly related to predation rates and suggested that the lack of ideal habitat was the overall most significant factor for survival. Limited high quality breeding habitat in Ontario has been suggested to lead to maladaptive breeding site selection (Frei *et al.* 2013). Some Red-headed Woodpeckers have been found to select nest sites based on availability of food resources as the defining factor as opposed to predation avoidance; yet predator avoidance is a characteristic of successful sites (Kilgo and Vukovich 2012). The selection of relatively dangerous nesting sites was viewed as a possible ecological trap for the southern Ontario population, with anthropomorphic changes to habitat suggested as the factor driving the use of less than ideal sites with fewer surrounding cover patches and more open canopies around the nest snag where food is abundant alongside predators (Frei *et al.* 2013). The bright and conspicuous colouration, bold nature and preference for breeding in open habitat likely contribute to the high predation rate. Further studies using eBird or other citizen science data but focusing on avian predator abundance and its correlation with woodpecker abundance may support the suggestion of the importance of predation as a contributing factor to the decline.

Perhaps the most compelling explanation for the species decline in abundance in Ontario is the overall loss of suitable breeding habitat. Studies that have examined the breeding habitat of Red-headed Woodpeckers have found similar requirements for ideal breeding conditions including a certain snag density, nesting tree height, diameter at breast height of the nesting snag, and proximity to open habitat (Kilgo and Vukovich 2012, Berl *et al.* 2015). Additionally, tree decay state was one of the characteristics deemed important for nest location; trees were deemed suitable for nesting when they exceeded a decay value "corresponding to trees with > 33% decadent canopies" (Berl *et al.* 2015). The high decay factor may have to do with Red-headed Woodpeckers preferring softer wood because they are relatively poor cavity excavators when compared to other woodpeckers (Berl *et al.* 2013).

This has important implications in habitat management for this species which, based on data from the Berl *et al.* (2015) study, would require sites with trees well into their natural decay within grassland tree stands. Such sites are increasingly lacking in Ontario as old fields, tallgrass prairie and woodlots are increasingly converted into intensive agricultural lands and urbanized areas (COSEWIC 2007). It has been suggested that there was a minor resurgence of the population in the 1970s - 1980s following the spread of Dutch elm disease which resulted in additional decaying trees for nesting and foraging (Woodliffe 1987). Systematic suppression of brush fires, a significant contributing factor to large snag and open habitat creation, may also be a major contributing factor to the loss of ideal breeding habitat (Davis *et al.* 2000, Brawn 2006).

Overall, our study and conclusions from related studies suggest European Starlings are a contributing factor to the decline of Red-headed Woodpeckers in Ontario. Starling abundance, alongside other stressors including predation and competition with other cavity nesters and conspecifics are likely worsened by province-wide alteration of breeding habitat, which is perhaps the most important single factor in the decline of the Red-headed Woodpecker.

Acknowledgements

This study was made possible through the efforts of all those who submitted records to eBird. Further acknowledgment goes to the creators of eBird and the folks who keep it running; it is an amazing resource for birders. Additionally, we thank those who provided useful commentary and suggestions for improvement on the original draft of this paper.

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