

# Note

## Evidence for a Negative Effect of Double-crested Cormorants (*Phalacrocorax auritus*) on Invasive European Fire Ants (*Myrmica rubra*)

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Nesting of Double-crested Cormorants (*Phalacrocorax auritus*) in western Lake Ontario is associated with reduced abundance and nest density of European Fire Ants (*Myrmica rubra*). The impact on fire ants may be substrate related. It is of potential importance because of the negative effect of fire ants on ground-nesting water birds.

Key Words: Double-crested Cormorant; *Phalacrocorax auritus*; European Fire Ant; *Myrmica rubra*; invasive species; ant nest density; non-native; guano; soil

The invasive European Fire Ant (*Myrmica rubra*) is established in many regions of North America (Wet-terer and Radchenko 2011). Locally, its abundance and distribution are influenced by soil moisture and temperature: it prefers moist soils shaded by vegetation (Groden *et al.* 2005). North American populations may be unusually abundant, and nest densities may be high (Groden *et al.* 2005; Naumann and Higgins 2015). Infestations can have long-term consequences for ground-nesting birds, such as Herring Gulls (*Larus argentatus*; DeFisher and Bonter 2013).

Double-crested Cormorant (*Phalacrocorax auritus*) is a water bird, native to North America (Dorr *et al.* 2014), whose numbers have increased greatly in parts of the Great Lakes region over the past few decades. At high densities, tree-nesting cormorants alter soil chemistry, reducing plant ground cover and species richness (Weseloh *et al.* 2002) as well as arthropod diversity (Craig *et al.* 2012); however, these changes can also provide habitat for ground-nesting birds (e.g., Foster and Fraser 2013). When trees fall, cormorants move to adjacent forest, eventually killing the next set of trees, or they nest on the ground (McGrath and Murphy 2012). In this study, we examined how cormorant-induced forest alterations affected fire ant abundance, distribution, and nest density in a protected area.

Created in the 1970s as the Leslie Street Spit, Tommy Thompson Park (TTP) is a human-made headland extending 5 km into Lake Ontario. In 1990, cormorants started nesting there and have caused deforestation on three of the four peninsulas (Taylor *et al.* 2011). In 2015, peninsula C (43°37'37.80"N, 79°20'15.10"W) had 2561 cormorant nests in trees (22% of the 11 908 cormorant nests at TTP; Toronto and Region Conservation Authority, unpublished data; see also Taylor *et al.* 2011). It is unknown when fire ants first colonized TTP.

In August 2010 and 2015, we examined ant abundance and nest density at 12 stations located 50 m apart along a 550-m transect through the cormorant colony

on peninsula C. At each station, five pitfall traps were placed flush with the ground, half filled with salted distilled water containing a drop of unscented detergent, and left out for 48 h. Four species of ants, identified using Fisher and Cover (2007), were collected, dried, and weighed. Because of their great abundance at some stations, the number of European Fire Ants per station was estimated from the average weight of a randomly selected subsample of dried and counted ants across stations: 200 ants in 2010, 150 in 2015. We also measured ant nest density (Groden *et al.* 2005) and estimated percentage plant ground cover (Elzinga *et al.* 1998) in a 1-m<sup>2</sup> quadrat 10 m east of each station.

The transect crossed three habitats: field (open with few or no trees mostly covered in grass and forbs), healthy forest (trees alive, strong under-canopy foliage), and dying forest (trees dead or in poor condition and little understorey). Two general linear models and *post hoc* Tukey tests (Minitab 17.1.0) were used to evaluate changes in 1) ant abundance and 2) plant ground cover (both log-transformed; Zar 2010) for year and habitat type. Ant nest density was not included in the models because no nests were observed in field and dying forests (see below). Differences in ant nest density between the two study years in healthy forests were evaluated using a Mann–Whitney *U* test (Zar 2010).

Between 2010 and 2015, four stations changed habitat categories: one from healthy to dying forest (station E) and three from dying forest to field (stations A–C). At stations A–C, ground cover increased in 2015 (primarily Stinging Nettle [*Urtica dioica* L.]). Ground cover varied by habitat type, but not by year. Dying forest had significantly less ground cover compared with field and healthy forest, and there was no significant difference between the latter two categories (Table 1). Means ± standard deviation (SD) were: dying forest 3.3% ± 2.6%, field 88.9% ± 8.9%, healthy forest 88.9% ± 22.5%.

TABLE 1. Habitat characterization, ground cover, and abundance of European Fire Ants (*Myrmica rubra*) at sampling stations under Double-crested Cormorant (*Phalacrocorax auritus*) nests in Tommy Thompson Park, Toronto, Ontario, 2010 and 2015.

Station	Habitat characterization*		Ground cover†, %		Total ant abundance in five traps‡	
	2010	2015	2010	2015	2010	2015
A	DF	Field	5	80	0.0	16.0
B	DF	Field	5	80	0.0	16.0
C	DF	Field	0	90	0.0	0.0
D	DF	DF	5	5	0.0	0.0
E	HF	DF	100	0	2524.8	8.0
F	HF	HF	100	95	4915.7	13 476.0
G	HF	HF	90	90	8797.7	7812.0
H	HF	HF	30	95	8036.9	17 359.5
I	HF	HF	100	100	4927.1	3061.5
J	Field	Field	80	80	234.0	3711.0
K	Field	Field	95	95	0.0	0.0
L	Field	Field	100	100	0.0	0.0

\*DF = dead and dying forest, HF = healthy forest. Cormorants nested at stations A, B, C, and D in 2010 and at stations D and E in 2015.

†Ground cover varied by habitat type, but not by year (habitat:  $F_{2,23} = 62.2$ ,  $P < 0.0001$ ; year:  $F_{1,23} = 0.07$ ,  $P = 0.78$ ). Field and healthy forest did not differ in % ground cover, but both habitats differed from dying forest (Tukey pairwise comparison,  $P < 0.05$ ).

‡Fire ant abundance differed by habitat type, but not by year (habitat:  $F_{2,23} = 38.2$ ,  $P < 0.0001$ ; year:  $F_{1,23} = 0.6$ ,  $P = 0.42$ ). Healthy forest differed in ant abundance compared with dying forest and field (Tukey pairwise comparison,  $P < 0.05$ ).

Fire ant abundance differed by habitat type, but not by year; ant abundance was higher in healthy forest compared with field and dying forest (Table 1). Based on the 1-m<sup>2</sup> quadrat samples, no fire ant nests were observed in field or dying forest, and there was no difference in ant nest density in healthy forest between study years (mean  $\pm$  SD): 2010 ( $n = 6$ )  $1.2 \pm 1.8$  nests/m<sup>2</sup>, 2015 ( $n = 5$ )  $0.2 \pm 0.4$  nests/m<sup>2</sup> (Mann–Whitney  $U = 39.0$ ,  $P > 0.2$ ). At station E, which changed to dying forest, a substantial decline in fire ant abundance and ant nest density occurred (from three nests to zero; Table 1).

The presence of nesting cormorants appears to have a negative effect on fire ant abundance. The relatively low numbers of fire ants in forest declining because of cormorant nesting and the clear decrease in fire ant abundance and ant nest density at one station where cormorant nesting led to forest decline suggest that soil changes associated with cormorants may reduce suitability for fire ant habitation. This is of interest because other ground-nesting water birds occupying deforested areas may benefit from reducing or eliminating fire ants (see DeFisher and Bonter 2013). Future deliberations on cormorant management (e.g., Wires 2014 describes and critiques North American cormorant management) should consider the potentially positive impact of nesting cormorants on reducing fire ant infestations where the two species co-occur.

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