Note

Effects of Nesting Bald Eagles (*Haliaeetus leucocephalus*) on Behaviour and Reproductive Rates in a Great Blue Heron (*Ardea herodias*) Colony in Ontario

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Thompson, Bill. 2017. Effects of nesting Bald Eagles (*Haliaeetus leucocephalus*) on behaviour and reproductive rates in a Great Blue Heron (*Ardea herodias*) colony in Ontario. Canadian Field-Naturalist 131(4): 369–371. https://doi.org/10.22621/cfn.v131i4.1848

Bald Eagles (*Haliaeetus leucocephalus*) and Great Blue Herons (*Ardea herodias*) are known to occasionally nest in mixed colonies, even though the former is one of the primary predators of the latter. I observed the two species in four heron colonies near Lake Simcoe, Ontario during two field seasons to assess whether rates of heron chick mortality or nest abandonment were greater in a colony that supported a nesting pair of Bald Eagles than in three nearby single-species colonies. I assessed the effects of eagle presence on heron behaviour using heron movement rates, the number of heron sentries left in colonies during the nesting period, heron nest mortality rates, and the average number of successfully fledged herons per nest. There was no statistically significant difference in movement rate among the four colonies, proportion of birds remaining as sentries, nor nest mortality rates. However, nests in the mixed colony successfully fledged significantly more heron young per nest than did nests in the single-species colonies. The mixed colony was located in a wetland and open lake system that provided extensive foraging habitat and an abundance of the preferred fish prey species of both Great Blue Herons and Bald Eagles, thus reducing predation pressure on the herons.

Key Words: Lake Simcoe; colonial nesting bird; reproduction; nest predation

Introduction

Bald Eagle (*Haliaeetus leucocephalus*) numbers have been increasing in the Great Lakes basin since the 1980s (Steenhof *et al.* 2002; Eakle *et al.* 2015), leading to its delisting as a species at risk in both the United States (Eakle *et al.* 2015) and Ontario (Armstrong 2014). While this is a conservation success, there may be impacts on other wildlife species.

Bald Eagles sometimes nest in Great Blue Heron (*Ardea herodias*) colonies and are known to prey upon Great Blue Heron adults, young, and eggs (Gostomski and Matteson 1999; Vennesland and Butler 2011). In British Columbia, where Great Blue Heron populations have been rapidly increasing, the occurrence of co-nesting eagles has also been increasing (Jones *et al.* 2013), and eagle predation may be one of the most significant factors lowering heron productivity (e.g., Norman *et al.* 1989; Vennesland 1996; Vennesland and Butler 2004). Great Blue Herons nesting in the Strait of Georgia responded more to the presence of eagles than to any other predator, and eagles were responsible for the majority of documented nesting failures, either through direct predation or because of colony abandonment (Vennesland 1996; Vennesland and Butler 2004; Van Damme and Colonel 2007). While previous studies of the interactions between these two species at heron colonies have been conducted in British Columbia, co-nesting of the two species is widespread (though uncommon) across North America (Gostomski and Matteson 1999), and perhaps increasing.

More Great Blue Herons live in the Great Lakes basin than in British Columbia (Vennesland and Butler 2011), but colony size tends to be smaller (Graham *et al*. 1996; Vennesland and Butler 2004). Herons nesting in small colonies may be more subject to predation by eagles (Caldwell 1986), which suggests that a continued increase in Bald Eagle populations in the Great Lakes basin could lead to reductions in Great Blue Heron populations, through predation or colony abandonment or both.

The objective of this study was to assess whether the presence of Bald Eagles led to higher rates of heron chick mortality or nest abandonment.

Methods

I conducted weekly surveys of four heron colonies near Lake Simcoe, Ontario (44.4°N, 79.35°W) in 2014 and 2015. The heronries included one where a pair of Bald Eagles had been nesting for at least three successive years (near Keswick) and three with no recent records of nesting eagles (near Barrie, Carden, and Lagoon City). The four colonies were 21–61 km from each other. Surveys were conducted from heron arrival in the second week of April until heronry abandonment (defined as three weeks with no nesting herons observed), or the end of the nesting season.

I made observations from a vantage point (80–300 m) that maximized nest visibility with no evidence of disturbance to the colony. To reduce disturbance at Keswick, I surveyed only the 20 nests within 50 m of the

A contribution towards the cost of this publication has been provided by the Thomas Manning Memorial Fund of the Ottawa Field-Naturalists' Club.

eagle nest. At the outset of each observation period I recorded the number of heron adults and nestlings in the colony and the number of active nests. Over 60 min I recorded heron and eagle movements, including the time at which each individual entered or exited the colony or moved to a different tree in the colony. Any interactions between herons and potential predators (including eagles) were noted, as was any evidence of food being brought to a nest by either species.

I defined movement rate as the number of times a heron entered, exited, or moved within a colony during the observation period divided by the number of adult herons present. I further defined the number of sentries left in the colony as the minimum percentage of nests that included an adult standing at or near a nest during each observation period. I defined mortality rate as the number of nestlings in the colony dying between observation periods, divided by the number of days between observations (Mayfield 1975). Success was identified when fledglings were observed flying.

I tested each variable for normality (Shapiro and Wilk 1965), and log-transformed those (productivity, mortality rate, and movement rate) that were significantly non-normal ($P < 0.05$). The effects of sharing a colony with eagles on each of these response variables were tested using analysis of variance (ANOVA). When significant differences were found among the four colonies, orthogonal contrasts were used to determine if the mixed colony was significantly different than the single-species colonies. All the analyses were done using R (R Core Team 2015).

Results

The Keswick colony had at least 64 nesting heron pairs and one nesting pair of eagles in a tree adjacent to some of the heron nests. Lagoon City had eight heron pairs, Barrie three, and Carden three. The Carden colony was abandoned by 15 June 2014 (prior to any evidence of hatching) and was not active in 2015. The four colonies were occupied by herons by the second week in April, whereas eagles began nesting at Keswick in February. At Keswick, one or both eagles were observed on their nest or on a perch in the colony during at least part of every observation period (except once per year). In five observation periods, one or both eagles flew over heron nests, either to act as sentries for their own nest or to travel between the nest and the lake. Herons never responded to the eagles by relocating among nests to protect nestlings, and in only one case did a sentry heron make an alarm call due to the proximity of an eagle. At Lagoon City, however, I observed a subadult (second-year) eagle hunting heron nestlings on 31 May. As the eagle circled the uppermost nest three times with talons extended, two adult herons in the nest made alarm calls with their beaks extended and lunged at the eagle. After the eagle abandoned the hunt, one of the herons flew to a different nest. No other evidence of attempted predation by other species was observed in any of the colonies.

No statistically significant difference in movement rate was found among the four colonies ($F_{3,27} = 0.915$, $P = 0.45$). However, Keswick herons often traded places: when a heron returned to the colony after foraging, a second heron from a nearby nest would leave the colony within one or two minutes, suggesting that the herons ensured that sentries remained at the colony to protect it from eagle predation. I did not observe this behaviour at the three other colonies. However, there was no significant difference in the minimum proportion of nests with adults present among colonies ($F_{2,19} = 0.801$, $P = 0.46$).

Predation and other disturbance may have easily occurred while I was not observing. There was, however, no significant difference in mortality rates among the three colonies that were not abandoned ($F_{2,19} = 2.194$, $P = 0.14$). Nor was there a significant difference in the proportion of nests abandoned in colonies shared with Bald Eagles, and single-species colonies ($F_{1,5} = 0.342$, $P = 0.58$). However, the Keswick colony fledged significantly more young per nest than the single-species colonies ($F_{2,19} = 17.76$, $P < 0.0001$).

Discussion

Productivity rates in Great Blue Herons typically range from 0.5 to 2.7 fledglings per nest attempt (Vennesland and Butler 2011). In my study area, it ranged from 1 to 2.5 per nest, with the highest rate occurring at Keswick. A rate of 1.91 has been estimated to be required to maintain a stable population (Henny and Bethers 1971). In the current study, only Keswick had a rate this high. It was also the largest of the four colonies studied, and other authors have also found that large colonies tend to support greater productivity (Forbes *et al.* 1985; Vennesland and Butler 2004). Large colonies may be more productive due to a higher ratio of older birds (Forbes *et al.* 1985), or because they tend to be located near larger or more productive foraging habitat (Gibbs and Kinkel 1997). Great Blue Herons typically forage in water between 15 and 25 cm deep (Willard 1977) and they tend to prefer prey between 2.5 and 7.6 cm long during the breeding season (Willard 1977). The Keswick colony is located in a wetland and open lake system that provides over 5.5 km^2 of such habitat, and supports a fish community with abundant small fishes (e.g., Emerald Shiner [*Notropis atherinoides*], Spottail Shiner [*N. hudsonius*], and Trout-perch [*Percopsis omiscomaycus*]; Evans *et al.* 1996; Trumpickas *et al.* 2012).

There is a potential reproductive trade-off between access to abundant food resources and increased disturbance or predation in co-located Great Blue Heron colonies and Bald Eagle nests. In other locations, Bald Eagles can be predators of Great Blue Herons (Norman *et al.* 1989; Gostomski and Matteson 1999; Vennesland and Butler 2011). In the Keswick colony, however,

there were no occurrences of depredation by eagles, and limited evidence for behavioural response to the presence of a nesting pair of eagles during 23 hours of observation.

The preferred food source for Bald Eagles varies among habitats (Vennesland and Butler 2011), but in the Great Lakes basin it includes species such as Brown Bullhead (*Ameiurus nebulosus*) and White Sucker (*Catostomus commersonii*; Todd *et al.* 1982; Kozie and Anderson 1991), both of which are abundant in Lake Simcoe (Evans *et al.* 1996). Over the course of the 80 hours of observation in this study, three occurrences of Bald Eagles bringing food to nestlings were observed; in all three cases, the food item was a fish. Thus, in this study area, Lake Simcoe may provide enough of an alternate food source for eagles, reducing predation pressure on nesting herons—a species that will actively defend itself and its young.

Acknowledgements

Thanks to Dwayne Lepitzki, Jon McCracken, and two anonymous reviewers, whose comments immeasurably improved the quality of this report.

Literature Cited

Armstrong, E. R. 2014. Management plan for the Bald Eagle (*Haliaeetus leucocephalus*) in Ontario. Ontario Management Plan Series. Prepared for the Ontario Ministry of Natural Resources and Forestry, Peterborough, Ontario, Canada.

Caldwell, G. S. 1986. Predation as a selective force on foraging herons: effects of plumage color and flocking. The Auk 103: 494–505.

Eakle, W. L., L. Bond, M. R. Fuller, R. A. Fischer, and **K. Steenhof.** 2015. Wintering Bald Eagle count trends in the conterminous United States, 1986–2010. Journal of Raptor Research 49: 259–268. https://doi.org/10.3356/JRR-14-86.1

Evans, D. O., K. H. Nicholls, Y. C. Allen, and **M. J. McMurtry.** 1996. Historical land use, phosphorus loading, and loss of fish habitat in Lake Simcoe, Canada. Canadian Journal of Fisheries and Aquatic Sciences 53: 194–218. https://doi.org/10.1139/f96-012

Forbes, L. S., K. Simpson, J. P. Kelsall, and **D. R. Flook.** 1985. Reproductive success of Great Blue Herons in British Columbia. Canadian Journal of Zoology 63: 1110–1113. https://doi.org/10.1139/z85-167

Gibbs, J. P., and **L. K. Kinkel.** 1997. Determinants of the size and location of Great Blue Heron colonies. Colonial Waterbirds 20: 1–7. https://doi.org/10.2307/1521757

Gostomski, T. J., and **S. W. Matteson.** 1999. Bald Eagles nest in heron rookery in the Apostle Islands. The Passenger Pigeon 61: 155–159.

Graham, K., B. Collier, M. Bradstreet, and **B. Collins.** 1996. Great Blue Heron (*Ardea herodias*) populations in Ontario: data from and insights on the use of volunteers. Colonial Waterbirds 19: 39–44. https://doi.org/10.2307/1521805

Henny, C. J., and **M. R. Bethers.** 1971. Population ecology of the Great Blue Heron with special reference to western Oregon. Canadian Field-Naturalist 85: 205–209. Accessed 10 April 2018. https://www.biodiversitylibrary.org/item/89145#page/229/mode/1up.

Jones, I. M., R. W. Butler, and **R. C. Ydenberg.** 2013. Recent switch by the Great Blue Heron, *Ardea herodias fannini*, in the Pacific northwest to associative nesting with Bald Eagles (*Haliaeetus leucocephalus*) to gain predator protection. Canadian Journal of Zoology 91: 489–495. https://doi.org/10.1139/cjz-2012-0323

Kozie, K. D., and **R. K. Anderson.** 1991. Productivity, diet, and environmental contaminants in bald eagles nesting near the Wisconsin shoreline of Lake Superior. Archives of Environmental Contamination and Toxicology 20: 41–48. https://doi.org/10.1007/BF01065326

Mayfield, H. 1975. Suggestions for calculating nest success. Wilson Bulletin 87: 456–466.

Norman, D. M., A. M. Breault, and **I. E. Moul.** 1989. Bald Eagle incursions and predation at Great Blue Heron colonies. Colonial Waterbirds 12: 215–217. https://doi.org/10.2307/1521343

R Core Team. 2015. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Accessed 31 July 2016. http://www.R-project.org.

Shapiro, S. S., and **M. B. Wilk.** 1965. An analysis of variance test for normality (complete samples). Biometrika 52: 591–611. https://doi.org/10.2307/2333709

Steenhof, K., L. Bond, K. K. Bates, and **L. L. Leppert.** 2002. Trends in midwinter counts of Bald Eagles in the contiguous United States, 1986–2000. Bird Populations 6: 21–32.

Todd, C. S., L. S. Young, R. B. Owen, and **F. J. Gramlich.** 1982. Food habits of Bald Eagles in Maine. Journal of Wildlife Management 46: 636–645. https://doi.org/10.2307/3808554

Trumpickas, J., A. Smith, M. M. Robillard, and **J. K. L. La Rose.** 2012. Temporal shifts in the biodiversity of nearshore small fishes in Lake Simcoe. Journal of Great Lakes Research 38: 643–652. https://doi.org/10.1016/j.jglr.2012.09.006

Van Damme, L. M., and **C. Colonel.** 2007. Bald Eagle predation and other disturbance factors at Double-crested Cormorant and Great Blue Heron nesting colonies in the Creston Valley, British Columbia. Wildlife Afield 4: 213–232.

Vennesland, R. G. 1996. The effects of disturbance from humans and predators on the breeding decisions and productivity of the Great Blue Heron in south-coastal British Columbia. M.Sc. thesis, Simon Fraser University, Burnaby, British Columbia, Canada.

Vennesland, R. G., and **R. W. Butler.** 2004. Factors influencing Great Blue Heron nesting productivity on the Pacific Coast of Canada from 1998 to 1999. Waterbirds 27: 289–296. https://doi.org/10.1675/1524-4695(2004)027[0289:FIGBHN]2.0.CO;2

Vennesland, R. G., and **R. W. Butler.** 2011. Great Blue Heron (*Ardea herodias*). *In* The Birds of North America. *Edited by* P. G. Rodewald. Cornell Lab of Ornithology, Ithaca, New York, USA. Accessed 31 July 2016. http://bna.birds.cornell.edu/bna/species/025.

Willard, D. E. 1977. The feeding ecology and behavior of five species of herons in southeastern New Jersey. Condor 79: 462–470. https://doi.org/10.2307/1367726

Received 24 August 2016
Accepted 4 January 2018