The conservation of Black-crowned Night-herons at Tommy Thompson Park

By
Louisa Gentile

Supervised by
Gail Fraser

A Major Paper submitted to the Faculty of Environmental and Urban Change in partial fulfillment of the requirements for the degree of Master in Environmental Studies, York University, Toronto, Ontario, Canada

March 31st, 2022

ABSTRACT

Environmental planning involves making decisions about the natural environment, working landscapes, and public health to create an improved environment. This paper explores how planning can be used to create different options for a healthier environment for wildlife. Black-crowned night-herons (*Nycticorax nycticorax*; night-herons) will be used as an example, to discuss the relation between environmental planning and wildlife conservation. Night-herons are the most abundant and widespread heron in the world, and one of the largest North American colonies nest at Tommy Thompson Park, in Toronto, Canada. The aim of this paper was to analyze the night-heron population in Ontario and assess whether the trend in colony size at Tommy Thompson Park is doing better or worse than others in the eastern North America (east of Lake Michigan). An analysis of a ten-year night-heron nest success at Tommy Thompson Park, showed repeated and wide-spread nest failures, likely and primarily due to raccoon predation; and a substantial decline in nest numbers over time. Nest counts from one other area in New York also showed declines; and the species has been listed in many jurisdictions. The colony at Tommy Thompson Park was one of the largest, yet now is relatively small. I recommend that the park managers need to consider predator control to ensure the night-heron population at Tommy Thompson Park is maintained.

FOREWORD

Throughout my graduate career I have been focused on exploring how environmental planning correlates to wildlife conservation. I have taken various courses that have provided a better understanding to wildlife conservation, and the different elements. Such as habitat conservation, strategies, threats, and different conservation areas. This study has given the opportunity to take what I have learned throughout my academic career, to the exploration of environmental challenges and concerns through a closer examination of black-crowned night-herons. I have used black-crowned night-herons as an example, to examine the drivers that impact this species, analyze data from an urban site, and explore how environmental planning intersects within wildlife management in order to conserve this species. My goal at the start of the graduate program was to gain a better understanding of wildlife conservation, and my final paper allowed myself to gain the experience I need for my career.

TABLE OF CONTENTS

TABLES AND FIGURES

Chapter 1

Using the concept of environmental planning towards the conservation of a declining species

As defined by the Government of Canada, a threatened species is "a wildlife species that is likely to become endangered if nothing is done to reverse the factor's leading to its extirpation or extinction" (2014). The Species at Risk Act was implemented in 2003, as a federal government commitment to prevent wildlife species from becoming extinct and secure the necessary actions for their recovery (Government of Canada, 2002; Government of Canada, 2022). This approach ensures that scientists, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), provide fully independent recommendations, and the decisions are made by elected officials (Government of Canada, 2016). The listing process begins with COSEWIC reviewing "research information on population and habitat status, trends, and threats; uses community and Aboriginal traditional knowledge; and applies assessment criteria based on international standards" (Government of Canada, 2016) of species deemed to be in danger of disappearing from Canada. COSEWIC then assesses the species as *extinct*, *extirpated*, *endangered*, *threatened*, *special concern*, or *not at risk*. If a species is classified as at risk, the assessment and supporting evidence is sent to the Minister of Environment and the Canadian Endangered Species Conservation Council (COSEWIC, 2019). Within 90 days, the Minister of the Environment must publish a response to the assessment, including a timeline of action. The response is forwarded to the Governor in Council, whom is meant to provide a decision within nine months to approve, decline, or request additional information from COSEWIC (Government of Canada, 2016).

Once a species has been approved and added to Schedule 1 of SARA, it will benefit from all legal protection afforded, and the mandatory recovery plan. After producing a recovery plan, an Action Plan is created to guide management actions. If the Governor in Council has not

decided within nine months of receiving the assessment, the Minister shall, by order, amend the list according to COSEWIC's assessment (Government of Canada, 2016).

The goal of SARA is to protect listed species primarily by conserving their habitat; and to do so various policies must be enforced. Given that human development results in habitat loss and added pressures on declining populations, using the approaches of environmental planning is one way to promote sustainable development and minimizing habitat loss.

While rich with varying angles of environment (see Daniels, 2009, 178), here I consider environmental planning as the process of facilitating decision making to carry out development, with consideration given to the natural environment (Daniels, 2009). It is a concept rooted in the debate between the human use of natural resources and the protection of nature (Daniels, 2009). Similar to the COSEWIC assessment process, environmental planning involves the establishment of goals and objectives, collection and analysis of information, evaluation of alternative courses of action, and recommendation of a course of action to the corresponding municipality (Lein, 2003). It can be a tool used in biological conservation through the integration of policies and guidelines that enable planners to plan in conjunction with nature (McKinstry Jr., McElfish and Jacobson, 2007). Specific to threatened species, environmental planning acts as an effective management initiative, towards creating an environment embedded with natural ecosystems, rather than one dominated by cement and buildings (McKinstry Jr., McElfish and Jacobson, 2007).

Urban areas with natural ecosystems embedded within can provide physical and psychological human health benefits, and can result in improved socio-economic benefits for urban communities, such as air filtration, rainwater drainage, and sewage treatment (Yli-Pelkonen, 2008). Urban development changes terrestrial and aquatic ecosystems, including their habitat structure, species diversity and species composition (Yli-Pelkonen, 2008) and thus urban areas may not provide the habitat required for population recovery for species at risk.

Minimizing the loss of natural landscapes is a challenge environmental planners face with most city development projects (Yli-Pelkonen, 2008). The planner "must highlight the most valuable parts of the green areas that must be conserved so that they are not threatened by development and those parts that can be sacrificed for the new construction" (Yli-Pelkonen, 2008). When making these decisions, species assessments form part of the ecological information that is used in determining the conservation value of the area (Yli- Pelkonen, 2008). including the types of species found in the area, their conservation status, and ensuring environment protection.

In this paper, I will consider the relationship between environmental planning and wildlife conservation using black-crowned night-heron (*Nycticorax nycticorax*) as an example. Black-crowned night-herons (night-herons here on in) have yet to be federally listed on SARA, however, is listed as threatened in Ontario through the Endangered Species Act (Ontario, 2021).

Ontario Endangered Species Act

The provincial Endangered Species Act was first introduced in 2007, "to identify species at risk based on the best available scientific information; to protect species that are at risk and their habitats, and to promote the recovery of species that ae at risk; and to promote stewardship activities to assist in the protection and recovery of species that are at risk" (Ontario, 2007, c.6, s.1). The Committee on the Status of Species at Risk in Ontario (COSSARIO), a committee of experts, considers which plants and animals should be listed at risk. They then send their species listing decisions to the Minister of the Environment, Conservation and Parks. Once received, it is then posted on the Government of Ontario's website (Ontario, 2021). When a species is classified as either *endangered*, *threatened*, or *extirpated*, a recovery strategy is created by individuals and agencies with expertise on the species, within a year for endangered species, and two years for threatened species, and sent to the Ministry of the Environment, Conservation and Parks (Ontario, 2021).

Once a recovery strategy is created a specific habitat regulation is developed under the Endangered Species Act, replacing the general habitat protection (Ontario, 2021). Within nine

months a government response statement outlining recovery actions must be published by the Ministry of the Environment, Conservation and Parks (Ontario, 2021). A review of progress towards protecting and recovering a species must be conducted by the Ontario government within five years of the government response statement being published (Ontario, 2021).

Black-crowned night-herons

Night-herons are the most abundant and widespread heron in the world that prefers nesting near an aquatic habitat, such as fresh and saltwater marshes, swamps, and lakes (Hothem et al., 2020). Night-herons can be found in the temperate and tropical regions of every continent, except Australia and Antarctica. In North America, their distribution is across central and southern regions, north to the Canadian Prairies (Hothem et al., 2010). Yet throughout much of their range in North America, the species appears to be declining, and in some states and provinces, have been identified as a species' at risk (see Chapter 2).

The night-heron population in Ontario has seen a perceptible decline over the past decade (Rush et al. 2015). Known causes of this have been habitat loss due to human disturbance, and suspected causes are pesticides or possible nesting sites competition with double-crested cormorants (*Nannopterum auritum*) (Hothem et al., 2010; see also Chapter 2). I will use Tommy Thompson Park (TTP) - an important breeding area for night-herons in Ontario - as an example of how environmental planning intercepts with the conservation of a declining species.

Tommy Thompson Park, environmental planning and night-herons

TTP, also known as the Leslie Street Spit, is a five-kilometre-long human-made peninsula in Lake Ontario (McDonald, 2012). Once used for port-related facilities in the 1950s it is now the largest area of natural habitat on the waterfront (Wilson et al., 2001). However, shaping this urban space happened over decades of urban ecological political struggles as different levels of government, and citizen groups fought over what to make of this land (Hartmann, 1999).

In 1976, a planning process was initiated to turn the Leslie Street Spit into an aquatic park. This plan envisioned beaches, fishing piers, community sailing clubs, government docks, and roads and parking lots allowing car access at every part of the Spit (Hartmann, 1999). However, while these plans were coming along, the Spit had become a natural escape for residents as early successional plants and animals colonized open spaces. A community intervention ensued by the Friends of the Spit to prevent the development of an aquatic park (Hartmann, 1999). As an intense political struggle formed, Metropolitan Toronto and Region Conservation Authority (MTRCA) announced the need to initiate a new master plan, due to the strong public opposition of the development and to the natural succession of plant and wildlife species (Hartmann, 1999).

In 1989, Toronto and Region Conservation (TRCA) completed an extensive provincial environmental assessment and planning process, which resulted in the creation of the Tommy Thompson Park Master Plan (City of Toronto Report, 2021). This plan was approved in 1994 and ensured the park's natural growth without development and the privatization of uses (City of Toronto Report, 2021). Following the principles of environmental planning, the main objectives of the plan were to: preserve significant species; protect environmentally significant areas; enhance aquatic and terrestrial habitat; and enhance public recreational opportunities (MTRCA,1989).

The Master Plan followed the idea of TTP as a natural area, defining human presence by low-intensity recreation such as walking or biking (Taylor et al., 2011). Under the TTP Master Plan, the space was classified as a natural area based "on a natural succession or ecological approach, augmented by minimal intervention ad management to achieve: the preservation of significant species such as the Common Tern (*Sterno hirundo),* Black-crowned Night-heron, and Double-crested Cormorant; [and] the protection of environmentally significant areas realizing their dynamic biological nature over time." (MTRCA 1992:2). Since then, TTP has been designated as an Environmentally Significant

Area and is recognized as a Canadian Important Bird Area, for supporting the conservation of birds and their habitat (City of Toronto Report, 2021).

Planners focus on promoting “new urbanism”, which encourages the preservation of the environment and limits the acres needed for urbanization (Taylor and Cadieux, 2013). This has been a major priority in TTP even back in the 1980s when the Master Plan was approved. The Master Plan is a vision for the wildlife community that inhabits the area, instead of human benefits. Although there are developments of walkable communities, the plan is focused on protecting the habitat of significant species.

TTP has been a nesting site to night-herons since 1979, nesting in the colonizing forests on Peninsulas A, B, and C. The habitat provides needed proximity to water for foraging, and ample vegetation for cover (Wilson and Cheskey, 2001; see also Chapter 2). The presence of this species, one of many, was used in the argument to conserve the Spit as an urban wilderness area (MTRCA 1992).

In contemporary times the TTP Master Plan can be seen as an example of the environmental planning process used as a tool in night-heron management. Since the implementation of the Master Plan, TRCA continues to conserve TTP, guided by the principles of “Conservation by Design”. This is defined “as the purposeful act of designing for a variety of natural habitats while combining natural succession principles to create functional, productive areas” (TRCA, 2020). In regard to night-herons, this approach is the reason this waterbird species continues to nest in the park. Nesting and foraging habitat remains available due to the wetland enhancements and restoration projects TRCA has implemented. The maintenance of habitat has the potential to conserve what is left of Ontario’s night-heron population.

The next chapter of this paper will focus on night-Herons, and their current status in eastern North America, particularly focusing on states adjoining Ontario. The aim of the paper will be to analyze the night-heron populations in Ontario and assess whether the TTP colony is doing better or worse than others. This will be done by comparing a dataset focused on the last ten years of night-heron nest success at TTP to qualitative data from literature review. The intent of the study is to provide recommendations to TRCA on night-heron management to ensure the species persistence at TTP.

REFERENCES

Cadieux, K.V., and L.E. Taylor. (2013). Introduction: Sprawl and the Ideology of Nature. In *Landscape and the ideology of nature in exurbia: Green sprawl* (pp. 21–37). Routledge.

City of Toronto. (2021, May 10). *Tommy Thompson Park Update*. Retrieved February 27, 2022, from https://www.toronto.ca/legdocs/mmis/2021/ie/bgrd/backgroundfile-166869.pdf

COSEWIC. (n.d.). *Cosewic Wildlife Species Assessment: Process, categories and Guidelines*. Cosewic / Cosepac - Assessment process and criteria. Retrieved February 27, 2022, from https://www.cosewic.ca/index.php/en-ca/assessment-process/wildlife-species-assessment-process-categories-guidelines.html

Daniels, T.L. (2009). A Trail Across Time: American Environmental Planning from City Beautiful to Sustainability. Journal of the American Planning Association, 75 (2), 178- 192.

Government of Canada. (2014, October 9). *Species at Risk public registry: glossary.*Canada.ca. Retrieved February 27, 2022, from https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/glossary-terms.html#t

Government of Canada. 2016, December 29). *Species listing process: Species at Risk Act.* Canada.ca. Retrieved February 27, 2022, from https://www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding/listing-process/act.html

Government of Canada. (2022, March 22). Species at Risk Act. Retrieved February 27, 2022, from https://laws.justice.gc.ca/eng/acts/S-15.3/

Hartmann, F. M. (1999). *Nature in the city: Urban ecological politics in Toronto* (thesis).

Hothem, R.L., B.E. Brussee and W.E. Davis, Jr. (2010). Black-crowned Night-Heron (*Nycticorax nycticorax*), The Birds of North America Online (A. Poole, Ed.). Cornell Lab of Ornithology, Ithaca, New York.

Hothem, R.L., B.E. Brussee, W.E. Davis Jr., A. Martínez-Vilalta, A. Motis, and G.M. Kirwan. (2020). Black-crowned Night-Heron (*Nycticorax nycticorax*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY,USA. https://doi.org/10.2173/bow.bcnher.01

Lein, J. K. (2003). Integrated Environmental Planning. United Kingdom: Blackwell Science Ltd.

Metropolitan Toronto and Region Conservation Authority [MTRCA]. (1989). Tommy Thompson Park Master Plan and Environmental Assessment. MTRCA, Toronto, Ont.

Metropolitan Toronto and Region Conservation Authority [MTRCA]. (1992). Tommy Thompson Park Master Plan and Environmental Assessment Addendum. MTRCA, Toronto, Ont.

McDonald, K. (2012). Colonial Waterbird Populations at the Leslie Street Spit/Tommy Thompson Park. *Ontario Birds*, *30*(1), 2–12. Retrieved February 27, 2022, from https://sora.unm.edu/sites/default/files/2-12%20OB%20Vol%2030%20%231%20Apr2012.pdf.

McKinstry Jr., R. B. J. McElfish and M. Jacobson. (2007). Coordination and Planning Tools that can be Applied to Biodiversity Conservation. Widener Law Journal, 16 (3), 879-908.

Ontario. (2021). *How species at risk are listed*. ontario.ca. Retrieved February 27, 2022, from https://www.ontario.ca/page/how-species-risk-are-listed

Ontario Government. (2007). *Endangered Species Act (2007),* S.O. 2007, c.6.

Taylor, B., D. Andrews and G.S. Fraser. (2011). Double-crested Cormorants and urban wilderness: conflicts and management. Urban Ecosystems 14, 377-394.

TRCA. (2020, August 30). *Natural Area Enhancement Plan - Tommy Thompson Park*. Tommy Thompson Park | Leslie Street Spit. Retrieved February 27, 2022, from https://tommythompsonpark.ca/natural-area-enhancement-plan/

Yli-Pelkonen, V. (2008). Ecological information in the political decision making of urban land-use planning. *Journal of Environmental Planning and Management*, *51*(3), 345–362. https://doi.org/10.1080/09640560801977224

Wilson, W.G. and E.D. Cheskey. (2001). Leslie Street Spit – Tommy Thompson Park Important Bird Area Conservation Plan. Can. Nature Fed., Bird Studies Can., Fed. of Ont. Naturalists. 56 pp.

Chapter 2

Conservation of Black-crowned Night-herons at Tommy Thompson Park, Toronto, Ontario

INTRODUCTION

Colonial waterbirds are known to inhabit wetland and shoreline ecosystems and can be categorized as either a seabird (gulls, terns, cormorants, pelicans) or a wading bird (herons, egrets, ibises) (Erwin, 1995). The variety of different species share two characteristics: they gather in colonies during nesting season, and they obtain their food from the water (U.S. Fish and Wildlife Service, 2002).

Colonial waterbirds are useful indicators of the ecological health of their ecosystems, as they exhibit responses to the changes of wetland habitats, and these responses are important signs of deterioration of ecosystem quality (Rahman and Ismail, 2018). One of the greatest risks towards colonial waterbirds is the change or loss of habitat. Whether it is from human disturbance or environmental factors, the decrease of available foraging and nesting habitat limits the number of birds that can be sustained within breeding ranges (Rahman and Ismail, 2018; Parnell et al., 1988). The greatest threat towards these species is when wetlands and forests are converted to other uses (i.e., human development). Another threat to colonial waterbirds is contaminants (Parnell et al., 1988). This includes environmental contaminants such as oil pollution in marine ecosystems, as well as industrial waste products, and intermediate chemicals used in synthesis of plastic compounds (Parnell et al., 1988). Other threats posed to colonial waterbirds are lack of food supply, disease, and interspecific competition, and predation at colony sites (Parnell et al., 1988); sometimes multiple factors contribute to population declines.

In early twentieth century Canada, the severe decline in the numbers of colonial waterbirds was one of the issues that contributed to the adoption of the Migratory Birds Convention Act in 1917. Still legislated in 2022, the purpose of this Act is to “ensure the conservation of migratory bird populations by regulating potentially harmful human activities” (Government of Canada, 2017). The Migratory Birds Convention Act has guidelines to protect nesting birds, such as “stay off seabird and waterbird colonies, maintain appropriate buffer zones", with the overall goal of minimizing disturbance to nesting birds (Government of Canada, 2021). While not all species nesting in Canada have the protection of Migratory Birds Convention Act, some examples of colonial nesting waterbirds are great egret (*Ardea alba)*, California gull (*Larus californicus)*, Caspian tern *(Hydroprogne caspia)*, and black-crowned night-heron (*Nycticorax nycticorax).*

The black-crowned night-heron (night-herons from here on in) are known to be active at night and breed in colonies (Hothem et al., 2010). They have a cosmopolitan geographic distribution, present in every continent except Australia and Antarctica. Due to their aquatic diets, their nesting (simple stick nests in trees or tall bushes), is typically on islands or along coasts, streams, marshes, and swamps (Hothem et al., 2020). The species is used as an indicator of environmental quality of aquatic ecosystems due to its core habitats in either freshwater or marine systems (Hothem et al., 2020).

In North America, night-heron populations have been tracked primarily through decadal nest counts at colonies, with the objective of providing an assessment of the number of nesting pairs (Rush et al., 2015). These data assist in evaluating long-term changes in the distribution and abundance of the species, including population trends, potential threats to breeding populations and conservation assessments (Rush et al., 2015).

According to the latest analysis of the Great Lakes Colonial Waterbird Census, 1977-2009, the average night-heron colony size decreased 75% over this period in Canada (Rush et al., 2015:4). In the United States, over the same thirty-year period, the number of night-heron nests declined significantly by an estimated 57% (Rush et al., 2015:4). Rush et al. (2015) estimated a net loss of more than 2000 night-heron nests within the Great Lakes region.

Within the Great Lakes region, night-herons are considered a threatened species in many jurisdictions. Population declines are related to wetland drainage and destruction, due to human development and drought in wintering areas (Hafner and Kushlan, 2002). Night-herons are also highly susceptible to water pollution and pesticides such as organophosphates, DDE, and carbamates (Kushlan and Hancock, 2005). Avian diseases and competition with other species (i.e., double-crested cormorant, *Nannopterum auritum*) are other potential causes to the decline of the species (Kushlan and Hancock, 2005).

In this paper, drawing on the literature I focus on the current status night-herons, and summarize possible explanations for the species' conservation status in eastern North America. These data provide the context to a more detailed monitoring dataset (Fraser unpublished data) on the nest success trends and causes of nest failure; and the outcome of predator deterring experiment at Tommy Thompson Park, Toronto, Ontario. Based on the results, I suggest management activities specific to Tommy Thompson Park and discuss the larger implications of the declines of night-herons in the Great Lakes region.

STUDY AREAS

Eastern North America was regional focus of the literature review of night-heron conservation status. This area includes eastern Canadian provinces (Ontario, Quebec, New Brunswick, and Nova Scotia), and states east of the Mississippi River in the United States (Michigan, New York, New Jersey, Vermont, Pennsylvania, Wisconsin, Maine, and Ohio).

Quantitative monitoring data on nest success were collected at Tommy Thompson Park (TTP). TTP is a human built peninsula on Lake Ontario, that is now designated urban wilderness area (Taylor et al, 2011). The park consists of four peninsulas extending from the west side, referred to as Peninsulas A, B, C, and D (McDonald et al., 2018). Because it is a peninsula, the site hosts common predatory mammalian species such as raccoons (*Procyon, lotor)* and Virginia opossum (*Didelphidae virginiana)* that can access night-heron nests (Wilson and Cheskey, 2001).

Night-herons nested in eastern cottonwood trees (*Populus deltoides*) and trembling aspen (*Populus tremuloides*) in solo or mixed colonies with double-crested cormorants (see Rosenberger 2015). The nesting population of night-herons was relatively low in the late 1970s (1979 n = 6 nests) and in 1980s (1980-1985 ranging from 27 – 42 nests; and increased to 918 nests between 1987-1989; Jarvie et al. 1999). In 2002, the nesting population peaked at 1,203 nests and has declined since then (TRCA unpublished data; see also Tommy Thompson Park, 2020).

METHODS

Status of night-herons eastern North America data collection

Locations of known night-heron colonies were obtained from decadal censes and birding sources. Their current conservation status was found from published literature/gray literature, government, and wildlife agencies websites. Information gathered from secondary sources were compared to data collected at TTP, where possible.

TTP data collection

Nest monitoring

Night-heron nests were followed annually on peninsulas B or C between 2010 and 2019. Night-herons typically arrived at TTP to nest typically in the first week of May and monitoring was initiated during this time period. A nest was considered initiated and

included in the sample when an adult with nest material (even just a few sticks) were present; if the attending adult never began incubation it was counted as failed. Nests were tracked using maps of trees and checking trees weekly. Nest productivity was calculated as the proportion of nests which fledged at least one chick to all nests initiated. As the age of nest content was unknown, chick age and breeding chronology was estimated by subtracting the average length of incubation (twenty-four days; Hothem et al., 2020), out of the total number of days the nest was observed. A nest was identified as successful if chicks were observed in the nest for thirty-five days or longer. A nest was considered usurped if a cormorant or great egret was observed in a nest which had a night-heron present in the week prior. Nest failure was categorized by the status of each stage (nesting building, incubating, and chick rearing), and possible causes were identified when possible.

Raccoon deterring experiment

Between 2011 and 2017 variations of an experiment to deter raccoons from night-heron nesting trees was undertaken (Table 3). The design used a treatment (ninety-one-centimeter-long single sheet of metal predator guard wrapped around a tree at breast height) and control (tree wrapped only in foil) protocol. When a predator accessed a tree, they left paw prints in the foil, thus the predator guards also had foil wrapped around the top to see if the predator guard had been breached.

RESULTS

Status of night-herons for eastern North America

The night-heron has an extremely large range, distributed all around the world (IUCN, 2016) and the global population is estimated to number 570,000 - 3,730,000 individuals (Wetland International, 2015). While the population has been decreasing (IUCN, 2016), the last

IUCN Red List assessment of night-herons (October 2016), identified the species as of *low concern* due to the population and range being large and not approaching the thresholds for vulnerable under the population size and range size criterion (Bird Life, 2022; IUCN, 2016).

In the eastern and northern Canadian provinces (see Figure 1) in North America, data were found for Ontario, Quebec, where the species was seen as *threatened* or a *low concern* (Table 1). Under the *Species at Risk* assessment, the status of the species in Canada was classified as threatened (Government of Canada, 2015). Threats identified for the species were habitat loss, pesticides, and competition with double-crested cormorants (Hothem et al., 2010).

In comparison, all of the states classified the species as at risk (Table 1) and outlined habitat loss as the leading cause to population decline, as well as human disturbance. However, there was a lack of information for some provinces and states (Table 1).

Nest monitoring at Tommy Thompson Park (TTP)

At the time of their peak in 2002, night-herons represented one-third of the estimated Canadian breeding population (Tommy Thompson Park, 2020) however, the nesting population has declined substantially over the last twenty-year period and nest success over the past decade mirrors those declines (Tables 2, 4). Compared to New York, while TTP had higher nest counts, both sites experienced steady declines between 2018 and 2021 (Table 2). Nest failures at TTP also increased throughout the study period (Table 4).

Most failed nests had an unknown cause (Table 4), but where it was possible to determine nest failure indicates that raccoon predation, especially in 2016 and 2017 (Tables 3,4) and likely in 2018-2019 was significant. Other known causes were nest takeover by double-crested cormorants, and great egrets. While the nest stage of nests failed varied, in most years the majority failed during incubation (Table 3).

Raccoon deterring experiment

Raccoons appear to be able to access trees with predator guards as nest failure was comparable to trees wrapped only with foil. A paired t-test for nest productivity for five years (2011, 2014, 2015, 2016, 2017) showed no difference between foiled and predator guard (91 cm) trees ($t = -0.7$, $p = 0.5$).

DISCUSSION

In this study, I found that the status of night-heron populations in eastern North America was either un-known or at-risk (Table 1). At two study sites with some monitoring (Table 2), the nesting populations declined and the nest success at TTP followed this trend.

Night-herons in Eastern North America

Rush et al. (2015) described declines in colony size for both Canadian (71%) and US populations (57%) over a thirty-year period. The population decline seemed to correspond with an increase in the number of colonies (i.e., increase in number of colonies resulted in a decrease in colony size). TTP had a large colony for many years (Rush et al., 2015), but has now declined substantively (Table 2).

Night-herons may be considered a peripheral species in Canada because they are at the northern part of this species range (Figure 1). Peripheral species are predicted to be lower in abundance in contrast to populations at the centre of the range which should be abundant (Fraser, 1999; Lomolino et al., 2016). Peripheral species inhabit small proportions of local patches towards the edge of their range, the area of occupancy declines, and the average population densities within occupied patches also decline (Lawton, 1993). Night-herons have a large geographic range, however within their local abundances in eastern North America, their populations are diminishing. While some argue that peripheral species are less of a conservation concern (Fraser, 1999; Lomolino et al., 2016), because night-herons are declining across some of their range, including core areas, there should be efforts to bolster their populations in both Canada and the U.S.

Nesting monitoring

TTP provided one of the only sites where nest success data were being collected. Other studies show night-heron nest success as quite variable. Erwin and Custer (1982) report nest success between 65-79% for the Atlantic coast and argue that when a colony is visited only periodically, nest success data may be underestimated due to some nests being initiated and lost before or between visits (Erwin and Custer, 1982:49). To deal with this problem they recommend using the Mayfield method which estimates "daily mortality rates based on the number of nests lost per nest-days" and permits rigorous statistical testing among groups (Erwin and Custer, 1982:54). For example, Erwin and Custer (1982:50) estimate of night-heron nest success 2-13% higher without the Mayfield method. Given the nest count trends and repeated annual nest failure, future work should consider population modeling estimates, though it's unlikely nest success is inflated in recent years where failure was 100%.

Habitat structure may also influence nest success. A study at Poyrazlar Lake, in northwest Turkey, Uzum (2009) examined the influence of nest characteristics (height and distance from shore) on breeding success and found that birds that built their nests lower and furthest from the shore were more successful in breeding, while those that nested close to the shore experienced greater failure rates due to increased exposure to human disturbance and adverse climatic factors. At TTP, there are over 10,000 visitors annually (TRCA personal communication). While it is unknown how visitors impact nesting night-herons, it's more likely that predation caused night-herons to shift spatially (see Rosenberger 2015).

Causes of nest failure at TTP

While causes of nest failure were varied, or unknown, raccoons appeared to be a leading cause of night-heron nest failure. Raccoons have adapted well to both urban environments, leading to increases in population densities in the city. For example, during 1994 and 2007, in Southern Ontario there was an average of 3.4 and 13.6 raccoons/km compared to <1.5

raccoons/km in northern Ontario (Rosatte et al., 2010). An abundance of food resources and denning sites, and high reproductive potential are leading factors towards the high population rate in Ontario (Rosatte et al., 2010). Raccoons are an example of an "abundant native vertebrate that impacts the conservation of endangered species" (Smith and Engeman, 2002). In Florida, they are known to cause substantial destruction of sea turtle nests throughout southeastern United States, and nesting birds such as terns and skimmers on shore (Smith and Engeman, 2002).

Raccoons are known predators of night-heron nests. Jungsoo and Tae-Hoe (2007) suggest that raccoons are more likely to predate night-heron nests when at the chick rearing stage in Korea, though in this study, overall, nests were more likely to fail during the incubation stage.

TTP is an urban wilderness, not a city park. Coyotes, which can eat young raccoons are present at the site. Therefore, raccoons may not be as abundant as the urbanized areas around the site and they are subject to the seasonal peaks and declines of prey availability. While raccoons are omnivores and typically generalists, it is possible, that some individuals have specialized on night-herons and have taught their young this behaviour which may explain the decline in night- heron nest success over the study period. More work is needed on raccoon behaviour and density at TTP.

Double-crested cormorants have increased substantially in the North American Great Lakes (Wyman and Cuthbert, 2015). Their abundance, body size and nest densities have caused researchers to hypothesize about the potential negative effects on co-nesting waterbirds, through nest-site competition (Wyman and Cuthbert, 2015). Wyman and Cuthbert (2015) provide observations at the Pigeon Lake waterbird colony and suggest that "species identity and habitat structure are related to the agnostic interactions among nesting individuals", and that some co-nesting species may be more affected than others. Heron interactions at Pigeon Lake were limited, so cormorant presence increased the number of interactions involving herons (Wyman and Cuthbert, 2015). Cuthbert et al. (2002) suggest that night-heron colony

declines or abandonment is not impacted by cormorants, but note the need for more data. Rosenberger (2015) found no change in cormorant nest usurpation of night-heron nests despite the increase of cormorants at TTP, suggesting that cormorants are not the primary cause of night-heron nest failures.

Jarvie et al. (1997) provides an eight-year monitoring program documenting the cormorant colony expansion at TTP. Their GIS mapping study showed that the nesting areas of the cormorants expanding, and the night-herons receding, leading the assumption of a cause-and-effect relationship between the two species (Jarvie et al., 1997). However, observing a cormorant takeover was uncommon. Based on data collected within the last decade, competition does not seem to be an extensive cause to nest failure, as it was dominantly seen only in 2014 (see Rosenberger, 2015).

Management

Aside from the predator control experiment at TTP, few management actions have been directed at night-heron populations. Night-herons will change nest site selection, therefore management strategies can only be derived for the specific site, instead of on a continental scale. In this study, I've focused on a specific region, however, additional data on causes of nest failure at different sites need to be done to have a better understanding of the trends for this species.

Based on the data analyzed in this paper, the major threats towards night-herons across jurisdictions is habitat loss (Table 1). In many states, night-heron habitat has been loss due to human disturbance. A suggestion to prevent further loss would be to protect the habitat by implementing environmental laws to protect wetlands from development, pollution, and any other forms of human development. With respect to contaminants as a risk additional, laws pertaining to the use of pesticides and/or polluting waters associated with their habitat should also be taken into consideration. For example, feathers of the New York Harbor Estuary night-heron population were examined in 2004 revealing significant concentrations of lead, chromium and mercury were found (Padula et al., 2010). Padula et al. (2010) called for further investigation

to determine if metal contaminants are playing a role in this population's decline.

Regarding competition with other waterbird species, additional research is needed to be done to better understand the relationship between the species and decide if it is a major threat (Cuthbert et al., 2002). There is limited evidence that show's any direct negative effect towards night-herons by other species and cormorants in particular. Additional observations at colony nesting sites needs to be done daily during breeding season. Management activities focused on maintaining and restoring habitat would benefit night-herons at a state, provincial, and federal level.

TTP hosted a significant proportion of the eastern North America night-heron population (Rush et al., 2015). Raccoons are likely the primary threat to the continued presence of night herons at TTP. Since the attempted deterrence of raccoon predation failed, other management actions may be necessary. For example, Florida introduced a "one time only" live-trap and relocate program to reduce the abundance of raccoons in Hugh Taylor Birch State Park (Smith and Engeman, 2002). This resulted in a major population decrease for the area. However, this option must follow standard wildlife management protocols.

REFERENCES

Audubon (2021, October 20). Black-crowned night-heron. Retrieved February 27, 2022, from https://www.audubon.org/field- guide/bird/black-crowned-night-heron

BirdLife International. (2022). European Red List of Birds. Office for Official Publications of the European Communities, Luxembourg.

Cuthbert, F. J., Wires, L. R., and McKearnan, J. E. (2002). Potential impacts of nesting double-crested cormorants on great blue herons and black-crowned night-herons in the U.S. great lakes region. Journal of Great Lakes Research, 28(2), 145–154. https://doi.org/10.1016/s0380-1330(02)70572-8

Erwin, R. M., and Custer, T. W. (1982). Estimating reproductive success in Colonial Waterbirds: An evaluation. Colonial Waterbirds, 5, 49–50. https://doi.org/10.2307/1521032

Erwin, M. (1995). Colonial Waterbirds. In A Report to the Nation on the Distribution Abundance, and Health of U.S Plants, Animals, and Ecosystems (pp. 53–57). Essay, National Museum of Natural History, Smithsonian Institute.

Espace pour la vie Montreal. (2022). *Black-crowned Night-herons*. Retrieved February 27, 2022, from https://m.espacepourlavie.ca/en/biodome-fauna/black-crowned-night-heron

Fraser, D. F. (1999). Species at the edge: the case for listing of "Peripheral" species. In At risk: Proceedings of a conference on the biology and management of species and habitats at risk, Kamloops, British Columbia, 15-19 February 1999. Edited by L. Darling. British Columbia Ministry of Environment, Lands and Parks, Victoria, B.C. pp. 49-53.

Government of Canada, ECCC. (2017, September 6). Migratory Birds Convention Act, 1994. ARCHIVED - Environment and Climate Change Canada - Enforcement. Retrieved February 27, 2022, from https://ec.gc.ca/alef- ewe/default.asp?lang=en&n=3DF2F089-1

Government of Canada (2021, March 29). Birds protected in Canada. Retrieved February 27, 2022, from https://www.canada.ca/en/environment-climate-change/services/migratory-birds-legal-protection/list.html#toc0

Government of Canada (2002). *Species at Risk Act* (S.C. 2002, c. 29). Retrieved from https://laws.justice.gc.ca/eng/acts/S-15.3/

Hafner, H., and Kushlan, J. A. (2002). Action plan for conservation of the Herons of the world. Heron Specialist Group, Gland, Cambridge and Arles.

Hothem, R. L., Brussee, B. E., and Davis, Jr, D. E. 2010. Black-crowned Night-Heron (*Nycticorax nycticorax*), The Birds of North America Online (A. Poole, Ed.). Cornell Lab of Ornithology, Ithaca, New York.

Hothem, R., Brussee, L, Davis Jr, B. E., Martínez-Vilalta, W. E., Motis, A. and Kirwan, G. M. (2020). Black-crowned Night- Heron (*Nycticorax nycticorax*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.bcnher.01

IUCN (2016, October 1). The IUCN Red List of Threatened Species. IUCN Red List of Threatened Species. Retrieved February 27, 2022, from https://www.iucnredlist.org/species/22697211/155515762#habitat-ecology

Jarvie, S., Blokpoel, H., and Chipperfield, T. (1999). A Geographic Information System To Monitor Nest Distributions of Double- Crested Cormorants and Black-Crowned Night-Herons at Shared Colony Sites Near Toronto, Canada (1997). Symposium on Double-Crested Cormorants: Population Status and Management Issues in the Midwest. 13.

Jungsoo, K., and Tae-Hoe, K. (2007). Clutch size, reproductive success, and growth rate of black-crowned night-herons. Waterbirds, 30(1), 129–132. https://doi.org/10.1675/1524-4695(2007)030[0129:csrsag]2.0.co;2

Kushlan, J. A. and Hancock, J. A. (2005). The Herons. Oxford University Press Inc., New York.

Lawton, J. H. (1994). Population abundances, geographic ranges and conservation: Witherby Lecture, Bird Study, 43:1, 3-19, DOI: 10.1080/00063659609460991

Lawton J. H. (1993) Range, population abundance and conservation. Trends Ecology and Evolutio. Nov;8(11):409-13. doi: 10.1016/0169- 5347(93)90043-O. PMID: 21236213.

Lomolino, M. V., Riddle, B. R., and Whittaker, R. J. (2016). Biogeography: Biological Diversity across Space and Time. Sinauer Associates.

Maine wildlife action plan revision report, Maine Wildlife Action Plan. (2015). Retrieved February 27, 2022, from https://www.maine.gov/ifw/wildlife/reports/pdfs/SGCN_Reports/Threats/Invasive%20Non-native-Alien%20Species- Diseases.pdf

Michigan Natural Features Inventory. *Nycticorax nycticorax* (Black-crowned night-heron) - Michigan Natural Features Inventory. (n.d.). Retrieved March 28, 2022, from https://mnfi.anr.msu.edu/species/description/10885/Nycticorax-nycticorax#:~:text=The%20Black%2Dcrowned%20night%2Dheron,white%20to%20pale%20gray%20underparts.

McDonald, K., Toninger, R., Chreston, A., Feldmann, I. R. and Fraser, G. S. (2018). Living with double-crested cormorants (*Phalacrocorax auritus*): A spatial approach for non-lethal management in Toronto, Canada. Waterbirds, 41(2), 208–220. https://doi.org/10.1675/063.041.0215

New Jersey Endangered and Threatened Species Field Guide. (2003). Black-crowned Night-heron. Retrieved February 27, 2022, from http://www.conservewildlifenj.org/species/fieldguide/view/Nycticorax%20nycticorax/

Nycticorax nycticorax (Linnaeus) Black-crowned night-heron. (n.d.). Retrieved February 27, 2022, from https://mnfi.anr.msu.edu/abstracts/zoology/Nycticorax_nycticorax.pdf

Ohio Department of Natural Resources. (n.d.). Black-crowned Night-herons. Retrieved March 27, 2022, from https://ohiodnr.gov/discover-and-learn/animals/birds/black-crowned-night-heron#:~:text=The%20black%2Dcrowned%20night%20heron%2C%20a%20state%2Dthreatened%20species,Point%20Island%20in%20Sandusky%20Bay.

Padula, V., Burger, J., Newman, S. H. et al. (2010). Metals in Feathers of Black-Crowned Night-Heron (*Nycticorax nycticorax*) Chicks from the New York Harbor Estuary. Archives of Environmental Contamination and Toxicology 59**,** 157–165. https://doi.org/10.1007/s00244-0 09-9427-3

Parnell, J. F., Ainley, D. G., Blokpoel, H., Cain, B., Custer, T. W., Dusi, J. L., Kress, S., Kushlan, J. A., Southern, W. E., Stenzel, L. E., and Thompson, B. C. (1988). Colonial waterbird management in North America. Colonial Waterbirds, 11(2), 129–345. https://doi.org/10.2307/1520996

Pennsylvania Game Commission. (2005). Black-crowned night heron. Retrieved February 27, 2022, from https://www.pgc.pa.gov/Wildlife/EndangeredandThreatened/Pages/Black-crownedNightHeron.aspx

Rahman, F., and Ismail, A. (2018). Waterbirds: An Important Bio-Indicator of Ecosystem. Pertanika Journal of Scholarly Research Reviews, 4(1), 81–90.

Rosatte, R., Sobey, K., Donovan, D., Allan, M., Bruce, L., Buchanan, T., and Davies, C. (2006). Raccoon density and movements after population reduction to control rabies. Journal of Wildlife Management, 71(7), 2373–2378. https://doi.org/10.2193/2006-549

Rosatte, R., Ryckman, M., Ing, K., Proceviat, S., Allan, M., Bruce, L., Donovan, D., and Davies, J.C. (2010). Density, movements, and survival of raccoons in Ontario, Canada: implications for disease spread and management. Journal of Mammalogy, 91 (1), 17, 122–135. https://doi.org/10.1644/08-MAMM-A-201R2.1

Rosenberger, L. (2015). Analysis of Double-crested Cormorant nest spatial patterns in single and multi-species colonies and their effect on cormorant behavior and on Black-crowned Night-Heron spatial patterns. M.Sc. Thesis, York University, Toronto, Ontario.

Rush, S. A., Pekarik, C., Weseloh, D. V., Cuthbert, F., Moore, D., and Wires, L. (2015). Changes in heron and egret populations on the Laurentian Great Lakes and connecting channels, 1977-2009. Avian Conservation and Ecology, 10(1). https://doi.org/10.5751/ace-00742-100107

Smith, Hmq T. and Engeman, R. M. (2002). An extraordinary raccoon, *Procyon lotor,* density at an urban park. Canadian Field-Naturalist 116(4), 636-639.

Taylor, B., Andrews, D., and Fraser, G.S. (2011). Double-crested cormorants and urban wilderness: conflicts and management. Urban Ecosystems 14, 377-394

Tommy Thompson Park. (2020, September 22). The birds of Tommy Thompson Park, on the Leslie Street Spit in Toronto. Tommy Thompson Park |Leslie Street Spit. Retrieved March 27, 2022, from https://tommythompsonpark.ca/park-species/birds/

U.S. Fishes and Wildlife. (2002). Colonial-Nesting Waterbirds: A Glorious and Gregarious Group" (2002). U.S. Fish and Wildlife Publications. 420. https://digitalcommons.unl.edu/usfwspubs/420

Uzun, A. (2009). Do the height and location of black-crowned night heron (*Nycticorax nycticorax*) nests affect egg production and breeding success? Waterbirds, 32(2), 357–359. https://doi.org/10.1675/063.032.0217

Vermont Department of Fish and Wildlife, Wildlife Action Plan (2015). Species Conservation Report. Retrieved February 27, 2022, from https://vtfishandwildlife.com/sites/fishandwildlife/files/documents/Learn%20More/General%20Education/Conservation%20 Education/JCO-Details.pdf

Wetlands International (2015). Waterbird Population Estimates. Retrieved February 27, 2022, at wpe.wetlands.org.

Wisconsin Department of Natural Resources. (n.d.). *Black-crowned Night-Heron (Nycticorax nycticorax)*. Retrieved February 27, 2022, from https://dnr.wi.gov/topic/EndangeredResources/Animals.asp?mode=detail&SpecCode=ABNGA11010

Wyman, K. E., and Cuthbert, F. J. (2015). Species identity and nest location predict agnostic interactions at a breeding colony of double-crested cormorants (*Phalacrocorax auratus)* and great blue herons (*Ardea Herodias).* Waterbirds, 38(2), 201-207. http://doi.otg/10.1675/063.038.0210

Table 1: Black-crowned night-herons current status in Canadian provinces and United States

Province	**Current Status[a]**	**What were the threats identified?**	**Original publication source**
Ontario	Threatened	Pesticides Habitat loss due to climate change, and human intrusion Cormorants	Status of Birds in Canada (Government of Canada, 2015)
Quebec	Apparently Secure/ Least Concern	Pesticides Habitat loss due to climate change, and human intrusion Cormorant	(Espace pour la vie Montreal, 2022).
New Brunswick	Data unavailable	Data unavailable	Data unavailable
Nova Scotia	Data unavailable	Data unavailable	Data unavailable
State(s)			
Michigan	Special Concern	Habitat loss	Michigan State University (Michigan Natural Features Inventor, n.d).
New York	Vulnerable/ Threatened	Data unavailable	(Audubon, 2021).
Vermont	Endangered	Cormorants Habitat loss	Bird SGCN Conservation Reports (Vermont Department of Fish and Wildlife, Wildlife Action Plan, 2015).
Pennsylvania	Endangered	Human intrusion Habitat loss	(Pennsylvania Game Commission, 2005).

Wisconsin	Special Concern	Habitat loss	(Wisconsin Department of Natural Resources,n.d)
Maine	Endangered	Human intrusions Lack of knowledge (breeding colony locations)	(Maine 2015 Wildlife Action Plan, 2015).
Ohio	Threatened	Habitat loss Cormorants	(Ohio Department of Natural Resources, n.d).
New Jersey	Threatened	Habitat loss Contaminants	(New Jersey Endangered and Threatened Wildlife Field Guide, 2003).

[a]Endangered- A taxon is endangered when it is to be facing a very high risk of extinction.
Vulnerable- A taxon is vulnerable when it is considered to be facing a high risk of extinction in the wild.
Least Concern- A taxon is least concern when it does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened.
Threatened- A taxon is likely to become endangered if steps are not taken to address factors threatening it.
Information obtained from Species at Risk Act. S.C. 2002, c. 29.

Table 2. Black-crowned night-heron nest count data.

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
EB Lake Ontario, NYC	105	151	44	56	79	106	36	0	0	1	3	10
Tommy Thompson Park	n/a	423	410	297	397	194	335	358	300	293	143	82

[a]New York State Department of Environment Conservation.
[b]Toronto and Region Conservation Authority

Table 3: Raccoon treatment-control experiment at Tommy Thompson Park.

	2011		**2012**	**2013**		**2014**		**2015**		**2016**	
	Foil[a]	Guard[b]	guard	no foil/ guard	guard	foil	guard	foil	guard	foil	guard
No. of nests followed (No. of trees)	61 (10)	77 (18)	61 (12)	55 (11)	25 (9)	22	50	13 (10)	19 (13)	34 (11)	14 (7)
# of nest failures	46 (75%)	27 (35%)	24 (39%)	45 (82%)	17 (64%)	17 (77%)	36 (72%)	3 (23%)	11 (58%)	30 (88%)	5 (36%)
No. failed during nest building	6 (9.8%)	7 (9%)	1 (2%)	14 (25%)	4 (16%)	8 (36%)	9 (18%)	0 (0%)	0 (0%)	2 (6%)	0 (0%)
No. failed during incubation	25 (41%)	10 (13%)	12 (20%)	29 (53%)	9 (36%)	4 (18%)	14 (28%)	1 (8%)	3 (16%)	24 (70%)	4 (29%)
No. failed with chicks	15 (25%)	10 (13%)	11 (18%)	2 (4%)	4 (16%)	5 (23%)	13 (26%)	2 (15%)	8 (42%)	4 (12%)	1 (7%)

[a]Foil – control

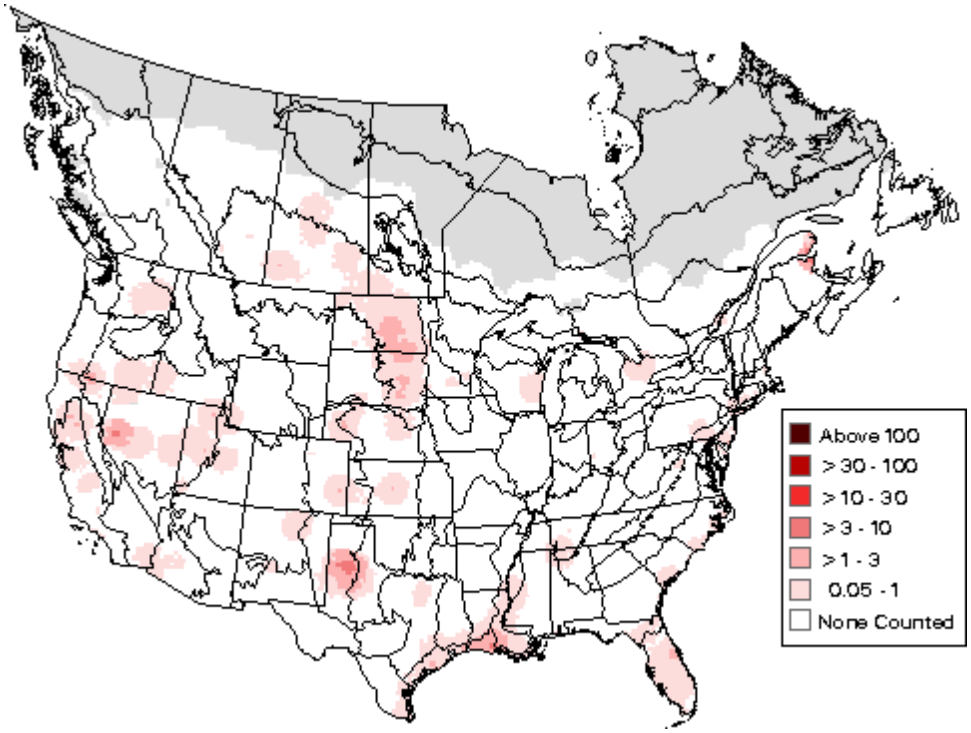
[b]Guard – was a 91 cm sheet of metal wrapped around tree trunks to prevent raccoons accessing the nests – treatment.

Table 4: Black-crowned night-heron annual nest success at Tommy Thompson Park 2010-2019.

Year	**Sample Size**	**# of Successful Nests (%)**	**Avg # of chicks fledged per nest ± SD**	**# of failed nests**	**Cause of Nest Failure**			
					Raccoons	Cormorants[a]	Egrets[b]	Unknown
2010	216	36%	0.69	138	16%	7%	4%	73%
2011	138	47%	0.96	73	41%	5%	7%	47%
2012	61	61%	1.19	24	0%	4%	0%	96%
2013	80	21%	0.35	59	5%	5%	5%	85%
2014	72	26%	0.82	53	8%	19%	0%	73%
2015	32	56%	0.78	14	0%	0%	0%	100%
2016	48	27%	0.4	35	63%	0%	0%	37%
2017	16	0	0	16	44%	6%	0%	50%
2018	27	0	0	27	0%	0%	0%	100%
2019	27	0	0	27	0%	0%	0%	100%

[a]Double-crested cormorant nest usurpations.
[b]Great egret nest usurpations.

Figure 1. Night-heron distribution map in North America[a].



[a]Breeding bird surveys. https://www.mbr-pwrc.usgs.gov/bbs/ra2015/ra2015_red_v3.shtml