# A REVIEW OF THE TORONTO ZOO'S HEADSTARTING PROGRAM FOR RECOVERY OF THE BLANDING'S TURTLE IN ROUGE VALLEY NATIONAL URBAN PARK

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# ABSTRACT

Conservation reintroduction programs are valuable tools in supporting endangered or extinct species in the wild. With the many ways humans are causing adverse environmental impacts, it is crucial that we put effort into reversing our adverse effects to avoid large-scale irreversible changes to ecosystems. Places like zoos and sanctuaries already have facilities and staff extensively trained in caring for animals. These locations can be the key institutions to support various wildlife conservation projects. The Blanding's turtle head-starting program at the Toronto Zoo and the turtle reintroduction into Rouge Valley National Urban Park are successful steps in restoring a population of an endangered species. The year that the individuals were released over the period 2014-2020 did impact the turtles' chances of survival, with particularly low survival in 2020, but there was equal success with male and female releases and variable but equal success with hard and soft releases.

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The views and conclusions presented in this paper do not reflect the views or positions of the Toronto Zoo.

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# INTRODUCTION

Throughout the world, countless wild animal and plant species face extinction. In many cases, there are opportunities for people to help these species recover through intervention. The focus species of this review is the Blanding's turtle (*Emydoidea blandingii*), which currently faces extinction. Each animal and plant is different and requires a unique approach to support its population. In the program being reviewed, the approach taken is called captive rearing or "head-starting." Head-starting describes a recovery approach in which individuals in the egg or juvenile stage are brought from the wild to be raised in a controlled environment. In the earliest stages of many animals' lives, they are vulnerable, and have fewer ways to protect themselves from predators and the environment. Captive rearing or head-starting programs differ from captive breeding. Captive breeding involves an already captive population in which males and females are paired and new individuals are born and raised in captivity from the beginning of their lives. In both captive breeding and head-starting programs, after individuals have reached a desired developmental state, they may be released into the wild. These programs aim to introduce new members to existing wild populations to prevent extinction.

The Toronto Zoo engages in raising and reintroducing Blanding's turtles into Rouge Valley National Urban Park, an example of head-starting for recovery of this species at risk. A literature review in this thesis will focus on notable reintroduction programs worldwide, methods used globally to ensure an individual's survival in the wild, and global efforts at monitoring, including the impacts of reintroduction on wild populations. Following this review, data that was shared by the Toronto Zoo's Species Recovery Branch's head-starting program for Blanding's turtles will be reviewed to explore factors determining the survival of released individuals into the wild monitored through radio-tracking. These factors include the sex of the individuals, the year of release, and the type of release. Finally, analysis of the literature will supplement the review of data to explore the question of whether the release of captive turtles affects the wild population in Rouge National Urban Park.

## LITERATURE REVIEW

The Blanding's turtle (*Emydoidea blandingii*) is a North American freshwater species, primarily occupying in the Great Lakes and Mississippi River regions. Blanding's turtles prefer shallow marshes, bogs, and swamps, with slow-moving water, abundant vegetation, and soft substrates (COSEWIC, 2016; primary references are found in this Recovery Plan). Their diet mainly consists of aquatic plants, insects, snails, crayfish, and small fish. Turtles reach sexual maturity at 14-25 years, and they breed from April to June. Females lay 6-13 eggs in each clutch. They incubate their nest on land, from which young hatch after 60-85 days. Blanding's turtles can live up to 80 years in the wild, making them one of the longest-lived turtles. The sexes exhibit some differences in behaviour, particularly during the breeding season, when male Blanding's turtles may actively seek out and follow female turtles. Female Blanding's turtles are responsible for finding suitable nesting sites and laying their eggs. They may travel up to 10 km to find the right location. Males do not participate in nesting. Female Blanding's turtles tend to be larger than males.

Blanding's turtles are considered a threatened species in many parts of their range — endangered in Nova Scotia and the Great Lakes/St. Lawrence region — due to a combination of factors. Turtles require a variety of wetland and upland habitats for different life stages, including nesting sites, basking areas, and winter hibernation sites (COSEWIC, 2016). Habitat loss and fragmentation due to development, agriculture, and other human activities can limit the availability of suitable habitats. In addition, turtles are often killed on roads while travelling between habitats, particularly during the breeding season. Climate change can affect Blanding's turtles in several ways, including changes in nesting site availability and quality, changes in precipitation patterns that can affect food availability, and changes in the timing of breeding and hibernation. Eggs and hatchlings are vulnerable to predation by various predators, including raccoons and skunks. Predation rates can be exceptionally high in fragmented or degraded habitats. Understanding more about the Blanding's turtle can give us a better understanding of how they live and how to support their population with conservation efforts.

There are many ways in which conservation scientists work to bring back endangered species. In the case of this project, the Toronto Zoo is using head-starting or captive rearing of the Blanding's turtle. In many cases of head-starting, the initiative begins when it is determined that factors affecting survival of early stages of life of the species in the wild comprise the fundamental reason for a population decline. For example, head-starting supported a wood turtle population (*Glyptemys insculpta*) in another project supported by the Toronto Zoo.

A three-year post-release study observed the survivorship of individuals raised in captivity through head-starting had around 20% higher survivability comparing those released soon after hatching (Mullin et al., 2023). Allowing more time for young reptiles to develop and grow free from predators and winter temperatures can make a difference in sustaining a population. The case of Mona Island iguanas (*Cyclura cornuta stejnegeri*), which do not need to contend with factors related to winter, were found travelling back to the facility where they were released, presumably underscoring the need young feel for escaping predators (Pérez-Buitrago et al., 2008). Captive rearing and reintroduction programs can be found worldwide and support various endangered species.

Since each conservation rearing program is unique, the methods of preparing the animals for release will differ between projects. Conservationists also use captive breeding, which is often compared to head-starting, but the two strategies differ in many ways. Releasing captive-bred animals into the wild can be challenging and complex, and several potential obstacles and pitfalls must be addressed to maximize the success of these programs (Faria et al., 2010). First, captive-bred animals may lack the necessary survival skills to thrive in the wild, such as finding food, avoiding predators, and navigating their environment. In some species, essential skills can be taught to the young by mimicking natural environments. In the case of the swift fox (*Vulpes velox*), those working to recover the species observed each captive animal's behaviour to determine its fitness for release. Factors such as boldness resulted in a high likelihood of early death (Bremner-Harrison et al., 2004). Second, when released into the wild, captive individuals may introduce new diseases into a recovering population. In the case of Mona Island iguanas, there were no observed increases in parasitism or disease on release of captive individuals, perhaps because these individuals were taken from the wild, meaning their genetic resistance to disease should be like that of those already in the wild (Pérez-Buitrago et al., 2008). Third, reintroduction sites must have suitable habitats and resources for released animals to survive, including adequate food and shelter, appropriate climate conditions, and protection from predators. In cases where a decline in a wild population is due to significant environmental changes or where humans have disturbed the habitat, the challenge for the population to recover surpasses efforts toward captive rearing.

Post-release monitoring is integral to any wildlife release program, as it helps assess individuals' success and identify any potential issues or challenges. There are several common ways that post-release monitoring is done. Radio telemetry involves attaching small radio transmitters to released individuals to track their movements and behaviour in the wild (Gutema, 2015). Radio telemetry can provide valuable information on habitat use, home range, and survival rates. Collecting tissue samples from the target population or using non-invasive techniques such as fecal collections from the area it occupies allows genetic analysis to track the ancestry of released individuals and their offspring and assess genetic diversity and population structure (Araki et al., 2007). In the simplest case, regular wild population surveys can be conducted to determine the overall population size and distribution and to track changes over time (COSEWIC, 2006). Engaging local communities in monitoring efforts can help to increase the coverage and effectiveness of monitoring efforts. Community members can be trained to identify and report sightings of released individuals toward population size and distribution data. Finally, remote sensing technologies, such as satellite imagery and photos from camera traps and overhead drones, can be used to monitor a population, as well as any habitat changes, including the impact of habitat restoration efforts (Pettorelli et al., 2014). A combination of monitoring methods is often used to evaluate the success of release programs. Unfortunately, in the many academic articles on release programs, post-release monitoring is often a key component missing from the process. Having a sound method to gather data about released individuals should be a priority for release programs, additionally to allow for an understanding of how newly released individuals impact their ecosystems.

## MATERIALS & METHODS

The Toronto Zoo provided an extensive Excel spreadsheet listing the Blanding’s turtle individuals that they reared and released into the forests and wetlands of Rouge Valley National Urban Park in Toronto, Ontario. All these turtles were hatched from eggs collected in the wild outside of Toronto. Staff from the Ontario Ministry of Natural Resources and Forestry, in coordination with staff from the Rouge Valley National Urban Park, direct the Toronto Zoo to collect turtle eggs in locations designated for development in a given season where the eggs would not otherwise survive. From late May to early June, female turtles lay their eggs, and researchers excavate nests and collect the eggs to transport to the Toronto Zoo. These eggs are then incubated and hatched at the Toronto Zoo. Some juvenile turtles are also brought to the Toronto Zoo from other facilities.

Records in the spreadsheets included the year each turtle hatched, codes related to identifying notches implemented on its shell, predicted sex, release year, release location, type of release, whether radio transmitters were attached to the shell before release, and whether the individual was still alive after two years. Since the sex of Blanding's turtles is determined by temperature, researchers caring for the animals were able to predict sex at birth based on incubating conditions. For turtles brought to the Toronto Zoo from other facilities, sex was unknown. For all individuals that died after release, a date of death was also included. Types of release included hard, soft, and direct. Hard releases involved releasing the turtle into the wild after being raised in captivity for two years. Soft releases included turtles raised in captivity for up to two years, staying during the latter part of this period in a buffer zone near the release site to become accustomed to their new surroundings, then fully released into the wild. Direct releases involved newly hatched turtles delivered to the wild soon after hatching.

Tallies of the number of survivors and mortalities were compiled by sex and release year. Release location was not independent of the year of release, so release location was not included in the analysis. The approach to analysis was to use three-way contingency tables and produce log-linear models (based on log-odds ratios derived from the tables), comparing to the random case with chi-square tests of homogeneity. Odds ratios not significantly different from one (log-odds ratios equal to zero, e.g., no difference in the odds of mortality by sex), were assumed when the partial chi-square statistic for any factor, e.g., sex, showed that it did not contribute to differences in survival. Significant factors were those where the chi-square statistic's probability, $p$, of occurring by chance alone was less than 0.01.

## RESULTS

Between 2014-2020, Toronto Zoo staff released 368 Blanding's turtles into Rouge Valley National Urban Park. Among those with identified sex (94%), 140 were males, and 205 were females, a sex ratio of 41:59 (males to females; Table 1). Released females were found dead slightly more often than males, even when correcting for their greater representation in the sample (Table 2). However, the odds of mortality were the same for the two sexes (chi-square = 1.2, $p = 0.27$; Table 3).

Table 1. Number of Blanding's turtles released into Rouge National Urban Park, by sex and by year of release.

| Release year | Males | Females | Sex unknown |
|---|---|---|---|
| 2014 | | | 4 |
| 2015 | 5 | 1 | 19 |
| 2016 | 34 | 39 | |
| 2017 | 26 | 22 | |
| 2018 | 42 | 65 | |
| 2019 | 14 | 23 | |
| 2020 | 19 | 55 | |
| Total | 140 | 205 | 23 |

Table 2. Blanding's turtles tracked and found dead among those listed in Table 1 (above).

| Release year | Males | Females | Sex unknown |
|---|---|---|---|
| 2014 | | | 6 |
| 2015 | | | 1 |
| 2016 | 2 | 5 | |
| 2017 | 1 | 7 | |
| 2018 | 1 | 4 | |
| 2019 | 5 | 6 | |
| 2020 | 13 | 17 | |
| Total | 22 | 49 | 7 |

Table 3. Odds ratios and confidence intervals comparing the odds of Blanding's turtles being found dead versus presumed living after two years, based on their sex.

| | Males | Females |
|---|---|---|
| Living | 157 | 231 |
| Dead | 26 | 48 |
| Odds ratio (95% CI) | | 1.2 (0.6, 1.8) |

Incidence of mortality did not differ according to when the turtles were released, except in one year (Table 4). The mortality of turtles released in 2020 was 3.5 times higher than in the previous period, 2016-2019 (chi-square = 35.1, $p$ <0.001). While only the year of release was present in the data, most of the individuals that died did so within the same year of release with the average length of life being 0.53 years. There was no significant correlation between release type (hard, direct, and soft) and mortality (Table 5).

Table 4. Odds ratios and confidence intervals comparing the number of Blanding's turtles being found dead in the period 2016 to 2019 compared to the number in 2020.

| Years | Living | Dead |
|---|---|---|
| 2016 | 73 | 7 |
| 2017 | 48 | 8 |
| 2018 | 107 | 5 |
| 2019 | 37 | 11 |
| 2020 | 74 | 30 |
| Odds ratio (95% CI) | 3.5 (2.7, 4.3) | |

Table 5. Percentage of individuals released by different release types between 2014 and 2020.

| | Hard | Soft | Direct |
|---|---|---|---|
| 2014 | 0 | 100 | 0 |
| 2015 | 0 | 81 | 19 |
| 2016 | 13 | 30 | 56 |
| 2017 | 13 | 75 | 13 |
| 2018 | 11 | 33 | 57 |
| 2019 | 26 | 74 | 0 |
| 2020 | 46 | 1 | 53 |
| 2021 | 100 | 0 | 0 |
| 2022 | 54 | 0 | 46 |

## DISCUSSION

In 2020, a significant predation event happened, and many of the turtles released that year were found dead. After observing different methods of release, 2020 shows a near fifty-fifty split between hard and direct release, as in other years, when different forms of release have no significant correlation with mortality. With the given data, it is almost impossible to know the exact reasoning behind the increase of mortality in 2020. While there is no definitive explanation, I propose below a possible theory through my own speculation.

The rise in predators attacking turtles may have been indirectly due to the COVID-19 lockdown. The Toronto Zoo releases turtles in Rouge Valley National Urban Park, within Canada’s largest city, Toronto. COVID-19 lockdowns in 2020 allowed for unique conditions. In cases where wildlife activity was tracked during lockdowns, like the Lewisville ISD Outdoor Learning Area, changes in the detection rates of various species occurred (Eishen, 2022). Predators and scavengers, such as raccoons, striped skunks, and coyotes, all predators of Blanding’s turtles, were detected less often on paths where humans would normally be populating. Rouge Valley National Urban Park sees many visitors throughout the year, and predators and scavengers relying on food like garbage, for which the source is handy when people frequent the park’s trails, may have left the normally human-populated areas to hunt for food elsewhere. This change in behaviour could be an explanation for the increased mortality rates experienced by Blanding’s turtles in 2020.

Another factor that could be linked to the increased predation rates is changes in habitat through weather patterns or human interaction. Blanding turtles live much of their lives in aquatic environments and rely heavily on wetlands and water levels. In the modern era, we observe an increase in extremely high temperatures, which can lead to droughts and hinder wetland wildlife (Barton, 2023). As the effects of climate change become more prevalent, these increases in temperatures will only increase and may lead to even higher mortality for species such as Blanding’s turtles. Many more unknown factors could contribute to changes in mortality. Sex and type of release did not significantly impact the survivability of individual turtles. Information like this can allow Toronto Zoo staff to learn what factors they can focus on or pay less attention to during raising and releasing turtles, as different influences will be more impactful than others.

The Toronto Zoo’s head-starting program can be an effective conservation strategy for Blanding’s turtles. Blanding’s turtle hatchlings are highly vulnerable to predators, including raccoons, birds, and fish. Head-starting them in captivity can protect them from these predators until they are more robust. In addition to predation, Blanding’s turtles face various threats in the wild, including habitat loss, road mortality, and illegal collection. Head-starting turtles can protect them from these threats during the most vulnerable stages of their life cycle. In captivity, Blanding’s turtles can be provided with optimal conditions for growth and development, including consistent food availability, appropriate water quality and temperature, and protection from disease and parasites. Data for the sex ratio of the population, easier determined in captivity, can help to manage a released and a wild population better. By increasing hatchling survival and growth rates, the program can help improve the overall population growth rate for Blanding’s turtles in Rouge Valley National Urban Park.

Raising turtles in captivity can be expensive. However, other means to mitigate the effects of predators on a wild population, such as building nest boxes and culling predators, are also costly and labour-intensive, and predator culling can have a negative public perception. The dilemma of predators on recovery programs for species-at-risk is challenging. A release program that supports more turtles making nests could increase predator populations, with more eggs and hatchlings being easier prey, especially where predator populations are supplemented by scavenging garbage in an urban park. Captive breeding programs supplemented by nest boxes and other conservation efforts like habitat protection and restoration could be the best chance of recovery for Blanding’s turtles.

While reviewing the Toronto Zoo's Blanding's Turtle head-starting program, I wanted to focus on two topics I turned into questions. The first was, "Can head-starting programs allow for a noticeable increase in a given species population?" After analyzing the data and looking at specific factors related to survival, such as sex and year of release, I conclude that the Toronto Zoo's conservation effort assisted the Blanding's turtles by increasing their population. Considering that many other conservation projects also spend a lot of money on their projects, and this program shows a noticeable increase in turtle population, it indicates that head-starting programs can be a viable solution to some endangered species. The second question I asked was, "Should programs like these be tools used more often in wildlife conservation?" While the example of the Toronto Zoo's Blanding's turtle head-starting program has successfully increased the population, many factors should be considered when starting a recovery project. These programs need an existing and stable source population, proper facilities to raise young and provide them adequate care, and a useable habitat for release. If all of these conditions are met for any species, and there are sufficient funds for the program, head-starting should be considered a valuable solution to restore an endangered species.

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