Summary Report:
Monitoring, research, and management activities at the Peltier Island heronry during 2004 & 2005 field seasons

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Introduction

Historical records document that a large colonial waterbird nesting colony has been present in the Rice Creek Chain of Lakes watershed since at least 1945 (Natural Heritage & Non-game Research Program, MN-DNR 2006). In 1989, Great Blue Herons (*Ardea herodias*) occupied the Peltier Lake site (Anoka County T 31 R 44 Sec 11), which grew to become the second largest colonial waterbird colony in the Minneapolis/St. Paul metropolitan area. At its height in 1996, the Peltier site attained an estimated maximum size of 1,149 active nests with three heron species (Great Blue Heron – *Ardea herodias*; Great Egret – *Ardea alba*; Black-crowned Night Heron – *Nicticorax nicticorax*) occupying the site. Beginning in the year 2000, local residents noticed the apparent abandonment of the Peltier Island colony over a month before chicks would normally have fledged (Butler 1992). Ground survey work confirmed that the colony had experienced near to complete loss of recruitment. Over the next five nesting seasons, this pattern continued (Table 1) and coincided with a steep decline in the number of active nests within the colony (Figure 1).

Year	Colony desertion date
2000	June 14, 2000
2001	June 18, 2001
2002	June 11, 2002
2003	some chicks fledged
2004	June 15, 2004
2005	4 chicks fledged

Table 1:
Since the year 2000, the Peltier Island colony has experienced either complete abandonment or sharply reduced productivity (MN-DNR 2004).

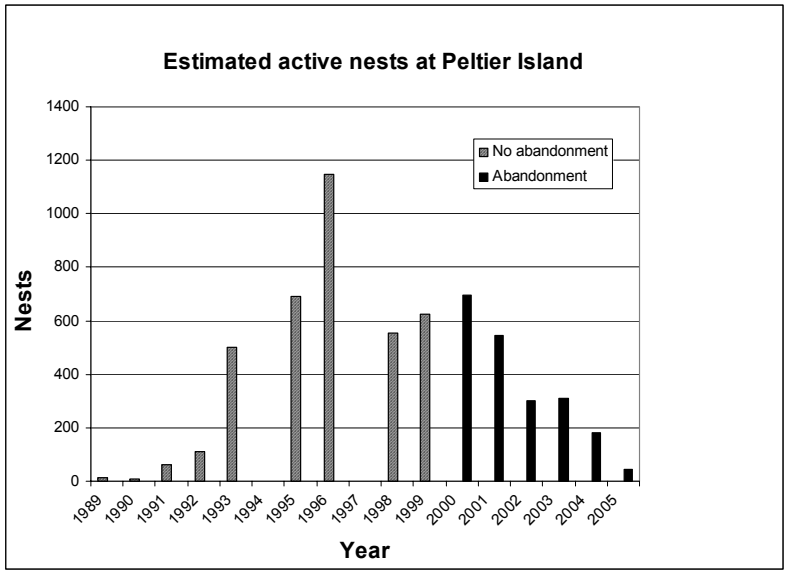

Figure 1:
Annual estimated colony size at the Peltier Island heronry (MN-DNR 2004). These data are based upon winter nest counts. The colony reached its maximum size in 1996 with a nest count of 1,149. The number of active nests in 2004 was estimated at 186 and in 2005 at 25-30.

Upon the urging of local residents, the recommendation of Peltier Island Heron Task Force and with funding from the Minnesota State Wildlife Grant administered by the United States Fish and Wildlife Service, and Anoka County, a study was initiated to determine the cause(s) of abandonment and to recommend management measures geared toward preserving the Peltier Island colony. To facilitate this study, Dr. Francie Cuthbert of the University of Minnesota Department of Fish, Wildlife, and Conservation Biology was retained as a consultant. Andrew Von Duyke, a University of Minnesota graduate student was also hired by Anoka County to monitor the Peltier Lake colony and other metro area colonies.

Brief background on Great Blue Herons

Great Blue Herons (*Ardea Herodias*) are the largest North American heron and are widely distributed. In Minnesota, Great Blue Herons return each spring about March 17th and lay eggs by about April 1st. Chicks typically hatch around May 1st. Clutch size ranges from two to five eggs. Fledging occurs after July 4th. Wild Great Blue Herons can live up to 20 years.

Their diet consists primarily of fish, but they will opportunistically take other prey including small birds, rodents, amphibians, and invertebrates. Visual hunters, Great Blue Herons typically forage by slowly walking or wading in order to stalk their prey. They may also stand motionless and wait for prey to happen by. Similar to other heron species, Great Blue Herons occasionally plunge dive for fish in deep water (Kelly et al. 2003, Hawkins 2003). For the most part, Great Blue Herons are diurnal hunters, but on occasion will forage nocturnally (Butler 1992).

A variety of potential causes behind the abandonment at the Peltier site were summarized in a letter to the Heron Task Force by Dr. Scott Lanyon of the University of Minnesota and also a local resident (Table 2). Given that Great Blue Herons are shy and easily disturbed, several possible causes centered on various types of disturbance. Due to their sensitivity to various types of disturbance, preferred heron nesting habitat is located in remote and inaccessible locations including islands, wetlands, or riparian zones. Within this habitat, their favored nesting locations are located within the uppermost canopy of mature hardwood forests (Figure 2). Given their inaccessible nest locations and sensitivity to human disturbance, monitoring heron colonies is not only logistically difficult, but also risky for the

health of the colony. Colony abandonment is possible particularly if disturbance within the colony occurs at critical periods of their life-cycle. Later on in their nesting, Great Blue Herons become more reluctant to leave their nests. However, upon disturbance, attending adults will leave the nest long enough to render eggs/chicks vulnerable to exposure or predation.

Figure 2:
A climber installs cameras in the crown of a Black Ash on Peltier Island. Camera height was estimated to be 75 feet. Cameras installed at Pig's Eye Lake were 100 feet high.

Methodology

Video surveillance technology was utilized to monitor heron nesting activity. This hardware is most often utilized by the security services industry but has also been incorporated into wildlife research in recent years (McQuillen & Brewer 2000; Nack & Ribic 2005; Stake & Cimprich 2003; Sabine et al. 2005). The primary advantage to this approach is the ability to collect continuous data while minimizing the risk of human disturbance. In addition to the main study site at Peltier Island (45° 11' N / 93° 3' W), the colony at Pig's Eye Lake (44° 54' N / 93° 1' W) was also monitored for use as a control. It was anticipated that comparisons between the study colony and the control colony would offer valuable insights into potential cause(s) for colony desertion (Table 2).

	Hypothesis
1	Disease
2	Eagle presence (predation)
3	Food quantity/quality
4	Health of nest trees
5	Human disturbance (other than noise)
6	Inadequate quantity and/or quality of nesting material
7	Noise disturbance: I-35W construction
8	Noise disturbance: motor boats close to the island
9	Weather

Table 2:
Proposed alternative hypotheses on the possible cause(s) of colony abandonment at Peltier Island (Heron Task Force 2002).

Table 3 shows the locations and quantities of cameras deployed in each field season. Cameras were installed between May 4, 2004 and May 12, 2004. Batteries were replaced every two days and the total time per replacement was about 10 minutes. Cameras were clustered within trees in order to capture regional disturbance events. Figure 3 shows the typical setup for video cameras during this study.

Year	Colony Location	Total # cameras used	Cameras per tree
2004	Peltier Island	8	4 cameras per tree
	Pig's Eye Lake	4	4 cameras per tree
2005	Peltier Island	14	1 camera per tree

Table 3: Locations and quantities of cameras deployed in each field season.

Figure 3:
Typical video surveillance camera setup used to monitor Great Blue Heron nesting activity at the Peltier Island and Pig's Eye Lake colonies. Note: multiple cameras in a single tree were used to capture regional disturbance events.

Figure 4:
Video evidence from 2004 suggested that mammalian predation played an important role in the status of the Peltier Island colony. In January, 2005, metal flashing (36" wide) was wrapped around all trees with nests or which could provide easy access to the canopy by predators (Hjertaas 1982).

In response to 2004 video data, metal flashing was wrapped around the trunks of all trees containing nests or any tree determined to provide easy access by mammalian predators to the forest canopy near the active parts of the colony. The width of the flashing was 36" and it was held to the tree with 2.5" screws (Figure 4). Flashing was either painted gray or factory painted brown. Throughout the season, along with nesting activity, the status of the flashing was monitored.

And finally, again in response to 2004 video data, local raccoons (*Procyon lotor*) were live captured and fitted with radio collars (Figure 5). A total of six raccoons were collared in the first week of March, 2005. Radio telemetry locations were taken 2-5 times per week throughout the heron nesting season and into the fall up until the time at which they denned up for the winter.

Figure 5:
A total of 6 raccoons were radio-collared. Five of these were females and all animals were captured on Peltier Island. Locations of all animals were monitored throughout 2005.

Summary of results

2004 Nesting Season

The Pig's Eye Lake colony, largest in the Minneapolis/St. Paul metropolitan area, thrived throughout the 2004 nesting season. However, Peltier Island's population of about 150 nests rapidly declined between May 25, 2004 and June 15, 2004 when it was ultimately agreed upon by the study team that complete colony failure had occurred Note: early signs of abandonment were documented at two separate times:

1. May 25, 2004: Aerial observers noticed many empty nests on the periphery of the colony in regions formerly occupied during the nesting season.
2. May 26, 2004: Attempted to install cameras in a second tree at Peltier Island. The originally scouted tree, which had been previously determined to be active and appropriate for camera installation, was empty. Further scouting showed that most trees in the vicinity, while not completely abandoned, had fewer active nests than observed earlier.

Table 2 summarizes the difference in nest and chick survival between the Peltier Island and Pig's Eye Lake colonies.

Colony	# Nests Monitored	# Chicks Monitored	# Chicks Surviving to Fledge
Peltier Island	8	13	0
Pig's Eye Lake	5	8	8

Table 2: Comparison of Great Blue Heron chick survivorship between the Peltier Island and Pig's Eye Lake colonies.

Video-surveillance 2004 – Pig's Eye Lake colony:

A total of five nests were monitored at Pig's Eye Lake in 2004. One nest never produced young despite the best efforts of the adults and was abandoned by May 27, 2004. However, four other nests, each containing two chicks managed to fledge all eight chicks.

Video data are still being quantified and analyzed, though it should be noted that at this point in time, no evidence has been found to suggest raccoon or any other form of predation or attempts thereof occurred in the nests under video surveillance. Furthermore, the presence of common heron predators such as raccoons, crows, and potentially eagles was well established through regular ground and aerial surveys.

Video-surveillance 2004 – Peltier Island colony:

A total of eight nests were monitored at Peltier Island. Of these nests, one had a camera malfunction. A second nest failed to produce young despite parental effort. Of the remaining six nests under video surveillance, all failed to produce young. No episodes of egg stealing were observed on video. However, in all of the remaining nests, raccoons (*Procyon lotor*) were observed entering, attacking, killing, and eating heron chicks. These

raccoons did not hesitate to attack six week old chicks which were as large, if not larger, than the raccoon itself.

Video data suggested that adults, when present, were very reluctant to defend chicks from raccoons. For example, an adult lingered nearby on screen while a raccoon fed on the carcass of a chick for several minutes. Eventually, the adult heron attacked and drove away the raccoon. Raccoon raids occurred at various times throughout the day and night. Nests were raided multiple times, either the same day or on consecutive days. Verification that multiple raccoons actively hunted within the colony occurred when two cameras simultaneously recorded raccoon raids in the same tree (Figure 6).

Figure 6:
Channels 1 and 3 show two raccoons simultaneously raiding two separate Great Blue Heron nests in the same tree. Note that the time is 9:24 PM on June 9, 2004.

Ground surveys 2004 – Peltier Island colony:

Other forms of mortality were also documented. Figure 7 shows a four week old chick that fell, was knocked, or blown from its nest. Mortality from unknown causes (Figure 8) was also evident. Sibling aggression is thought be the cause of death of a nine week old chick at Pig's Eye Lake (Figure 9). Also, predation was not solely attributed to raccoons. On May 26, 2004 while installing a second set of cameras at Peltier Island, a young Great Horned Owl (*Bubo virginianus*) was flushed from a nest. Examination of the nest contents

(Figure 10) confirmed that a family of Great Horned Owls had been preying upon the young herons. Another owlet was spotted on June 8, 2004; again in the presence of depredated Great Blue Herons (Figure 11).

Figure 7:
This four week old chick fell, was blown, or knocked from its nest. Unlike owls, heron chicks that fall to the ground are not cared for by the parents, ultimately dying of starvation or depredation.

Figure 8:
This photo, taken through a spotting scope shows a dead five week old chick. The inaccessibility of nests in a colony makes it very difficult to speculate on causes of death when the carcass remains in the nest.

Figure 9:
This nine week old chick had injuries consistent with those inflicted by another heron. Like many bird species, sibling aggression in Great Blue Herons is a well documented cause of mortality (Mock 1985, Jakubas 2004).

Figure 10:
Among the contents of a Great Horned Owl nest were the remains of at least two Great Blue Heron chicks.

Figure 11:
This young Great Horned Owl, observed through a spotting scope, had remains of Great Blue Heron chicks scattered at its feet and beneath its perch.

2005 Nesting Season

During the 2005 field season, Peltier Island was the only colony monitored. Efforts were made to increase the sample size by shifting cameras from the Pig's Eye Lake site to the Peltier Island site and by modifying the pattern of camera placement such that one camera was place in an active tree. Predator deterrents (metal flashing) had been installed on trees within the colony in response to observed raccoon predation in 2004 and as such, an additional goal for video surveillance was to assess the performance of the metal flashing as a deterrent to mammalian predators in a tree nesting heron colony. Unfortunately, in the 2005 nesting season, the number of active nests sharply declined by approximately 80% below the 2004 level which resulted in an estimated 30 active nests. The greatly reduced colony size placed major limitations on appropriate camera placement forcing many compromises. Furthermore, a plan to experimentally manipulate the predator deterrents was abandoned in the interest of protecting as many nests as possible.

The Peltier Island colony did experience substantial chick loss during the 2005 season. Predation by raccoons, American Crows (*Corvus brachyrhynchos*), and Great Horned Owls is thought to have occurred. Two thunderstorms may have accounted for the loss of two chicks. Sibling aggression was confirmed to have accounted for the loss of a large, nearly fledged chick. And finally, mortality due to uncertain causes was also documented. Despite the large number of failed nests, a total of four chicks, from three nests situated in two trees are known to have fledged. These chicks were observed flying to and from their nests and foraging along the shoreline of Peltier Lake during the month of July (Figure 12). This marks the first documented recruitment from the Peltier Island colony since the year 1999.

Figure 12:
A juvenile Great Blue Heron forages in the north eastern section of Peltier Lake. This is one of four chicks believed to have fledged from the Peltier Island colony during the 2005 nesting season.

Video-surveillance 2005 – Peltier Island colony:

As already mentioned, the substantially smaller colony size placed restrictions on where and how cameras were to be installed. Furthermore, the process of installing cameras into individual trees, rather than clustered in a single tree, necessitated a longer period of disturbance. Video evidence suggests that of the 14 nests monitored, four may have suffered negatively as a result of human disturbance; most likely from exposure of the eggs while the parents were off the nest.

The primary compromise to video surveillance, due to the small colony size, was the need for longer than optimal video shot distances. Ideally, a camera would be situated within 10-15 feet of a nest. Given the configuration of the landscape, the orientation of occupied nests, and the structure of the surrounding trees, shots exceeding 30 feet or more became necessary. The long video shots mandated that focal length lenses be used. Under the conditions within the Peltier colony, these conditions were suboptimal for the following reasons: Big lenses require more light than smaller lenses which resulted in decreased camera light sensitivity. The large focal length of the lens caused the motions of a tree to become greatly amplified. And, more foliage obstructed the view of the camera. Despite these compromises, some camera evidence suggested that raccoon predation had occurred; though no direct evidence was collected. Note: a large volume of video data remains to be reviewed.

Tree flashing survey 2005 – Peltier Island colony:

Overall, the performance of the flashing as implemented was disappointing. Attempted climbs by raccoons were documented by scratches in the painted flashing. Table 3 summarizes the results of a survey of 128 flashed trees.

Total # flashed trees surveyed	# surveyed trees with raccoon scratches	% of total with raccoon scratches	# of trees breeched by raccoons	% of scratched trees breeched by raccoons	% of total # of flashed trees breeched by raccoons
128	45	35%	28	62%	22%

Table 3:
This summary of a survey of flashed trees at Peltier Island heronry shows that raccoons were able to cross the flashing a majority of the time. Not shown is the nest activity of the trees with breeched flashing or near those with breeched flashing. Percentages have been rounded.

The metal flashing was shown to be effective but only under a narrow range of optimal conditions. Factors such as: avian predators, understory growth, tree configuration, and blowdowns all impacted the efficacy of this methodology. As shown in Figures 13 and 14, metal flashing does not deter avian predators. Analysis of the scratch patterns (Figure 15) revealed that the rapidly growing understory may also have aided raccoons and opossum in breaching the flashing (Coulter 1995). Tree shape/configuration is also important to flashing efficacy. For example, the active part of the colony is dominated by American Basswood (*Tilia americana*) which is prone to grow in clusters. These clusters, if close enough, can also facilitate breaching of the flashing. And finally, several large trees and many smaller limbs were blown down over the course of the 2005 season. The damage inflicted upon the flashing potentially opened up routes to the canopy, thus increasing the likelihood of predation. Installation and maintenance also required a large amount of labor.

Figure 13:
The hole in this Great Blue Heron eggshell was pecked open by an avian predator; most likely an American Crow (*Corvus brachyrhynchos*).

Figure 14:
This video screen shot shows an adult Great Horned Owl (Bubo virginianus) perched upon an abandoned Great Blue Heron nest. Prior video evidence suggested that this nest had been raided by a raccoon. The owl's use of this platform was recorded numerous times. The pattern of disappearance of nearby heron chicks may be indicative of owl predation.

Figure 15:
Multiple adjacent stems on this American Basswood (*Tilia Americana*) may have facilitated climbing by a raccoon. The large arrows show a pattern of scratches in the painted flashing that reveal the path taken past this guard.

Raccoon radio-telemetry 2005 – Peltier Island colony:

Radio telemetry of local raccoons proved to be very informative. These animals were captured and collared in early March of 2005. Radio tracking proceeded immediately with 2-5 locations taken per week. Overall 14 different den locations were located on the island. About one week after being collared, all marked animals left the island and spent the early spring on the eastern shore of Peltier Lake. This section of lakeshore is predominantly urban residential neighborhood. In the first week of April, 2005, just before ice-out and close to parturition, all collared females returned to Peltier Island. Scat samples taken from the island at this time contained large amounts of bird seed, thought to be from suburban bird feeders along the mainland. The females stayed on Peltier Island until after July 4th and then began crossing back and forth to and from the mainland. This pattern eventually stopped when the females again spent the majority of their time on the eastern lakeshore. In late fall, several of the females returned to den on the island.

It should be noted that an ongoing mark/recapture program for raccoons was being undertaken on Peltier Island throughout the 2005 season as well. A total of 11 raccoons were captured and three dead raccoons found. Preliminary analysis suggests a relatively low density of raccoons residing on the island which is consistent with the low availability of food (other than heron chicks). However, seasonal movements and the propensity of females to cohabitate with their female offspring (Zeveloff 2002) lend much uncertainty to this

estimate. Given the large number of den trees located on the island, and the variety of local food resources in the region, the low population estimate is likely to be underestimated.

Discussion

Video surveillance during the 2004 field season proved to be quite productive. A comparison of video suggests that up until abandonment, both the Pig's Eye Lake and Peltier Island colonies were healthy and productive. However, the rapid destruction of all monitored nests by raccoons at Peltier contrasted with the lack of observed predation at Pig's Eye. This suggests that raccoon predation rate may be an important difference between the two colonies.

Despite substantial chick losses at Peltier in 2005, cameras proved to be less effective and failed to directly show raccoon predation. Evidence on the ground and indirect video evidence suggest that raccoons did manage to kill at least a few chicks; which in a colony of 30 nests is still a sizeable percentage. Chick remains found on the ground were clearly eaten by raccoons but may have been scavenged once a chick fell from the nest.

Video evidence from the 2004 nesting season suggested that once raccoons identified a vulnerable tree, they would methodically return until all nests in the tree had been raided resulting in the loss of all chicks. Usually, these raids would occur in rapid succession. During the 2005 season, this pattern of loss was seen in some trees but not in others. Though the relative lack of raccoon activity shown on video suggested that the flashing may have been marginally effective, high rates of nest failure still occurred in trees flashed with sheet metal. Aside from the relatively poor quality of video shots available over the 2005 season, it is also plausible that other causes of chick mortality played a more important role than raccoon predation.

As an example, avian predators may have had a proportionately greater impact during the 2005 season. Great Horned Owls, a known predator of Great Blue Herons (Gretch 1987), were present and active at the Peltier Island colony in 2005. American Crows (*Corvus brachyrhynchos*), also well documented predators of eggs in particular, were common in the Peltier area. Furthermore, eggs pecked in a manner consistent with crow depredation were also found within the Peltier Island heron colony. The relative importance of owls and crows upon heron mortality is not currently known though any source of chick mortality increases

in importance as the colony size decreases. Also noteworthy is the presence of Bald Eagles (*Haliaeetus leucocephalus*) in the area. Though in Minnesota there are no documented cases of eagles preying upon herons, there is ample literature on this phenomenon occurring in the Pacific Northwest. Obviously, metal flashed tree trunks would not impact the activities of these predators.

Other factors include human disturbance and stochastic events, the importance of which is inversely proportional to colony size. Video evidence suggested that human presence and disturbance during the camera installation process may have led to nest abandonment in at least four monitored nests. Given the inordinately large "footprint" of humans within a heron colony, the possibility that other unmonitored nests may have abandoned cannot be ruled out.

Further Action

Protection of important trees on Peltier Island with metal flashing likely contributed to the small amount of recruitment during the 2005 season. Given the lessons learned during and after the 2005 nesting season, adjustments and modifications were made to improve the performance of the flashing in anticipation of the herons' return. These modifications included: raising the flashing in areas where tree trunks were within 12" of each other; raising flashing above the level of the understory; adding more flashing to angled trunks; and selective thinning of suckers and other understory plants that may compromise the integrity of the flashing. Also, further addition of flashing to selected trees not previously flashed should decrease available routes into the forest canopy.

Raccoons have been shown to be remarkably adaptive and motivated when foraging. Historically, raccoon removal campaigns have been largely ineffective. Studies have shown that raccoon populations and predation rates are highly resistant to human management actions (Rosatte 2000; Ratnaswamy et al. 1997). And, given their broadly overlapping territories, removal would by necessity have to be an ongoing effort. Exacerbating this is the urbanization of the local landscape. Raccoons typically thrive in human dominated landscapes where they can achieve substantially higher population densities than in rural landscapes (Zeveloff 2002). As such, trapping and removal with the goal of decreasing the local raccoon population is not recommended. However, nest raiding behavior in raccoons

does not appear to be limiting to other metro area heronries. This suggests that at Peltier Island, raccoon predation is quite important. Furthermore, this behavior may be culturally transmitted from generation to generation among a relatively few individuals. With this in mind, a small scale focused nuisance trapping campaign is currently being conducted. If, over a period of a few seasons, this cultural behavior is trapped out or at least minimized, the Peltier Island colony may have time to recover. It should be noted that the trapping and removal of nuisance raccoons in the Peltier Island region has been initiated and funded through the management staff of Anoka County Parks and is not part of the study funded by the State Wildlife Grant.

Adaptive management has been employed at the Peltier Island heron colony over the years, and as this colony experienced greater and greater decline, more direct forms of management were employed. The fate of Peltier notwithstanding, important lessons can be taken from circumstances surrounding the history of this heronry. However, the benefits of this experience are proportional to the quality of documentation during and after employment of management actions. In light of this, further monitoring of local and regional waterbird colonies is considered to be important and is recommended. With broad regional urbanization come such macro scale disruptions as landscape alteration, loss of nesting habitat, loss of foraging habitat, water quality reduction, and shifting densities of predators. Insights into wildife behavior in dynamic settings such as the Minneapolis/St. Paul metropolitan area are directly applicable to large scale environmental management and planning and can help ensure healthy ecosystems for all.

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