A Study of Behavior and Nest Distribution in the Shad Island Rookery Missisquoi National Wildlife Refuge, Swanton, Vermont



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Executive Summary

Shad Island is one of the largest Great Blue Heron rookeries on Lake Champlain. Recent concern about the effects of invading Double-crested Cormorants (*Phlacrocorax auritus*) has prompted two types of investigations in the Shad Island Rookery in 1999 and 2000. A behavioral study was conducted of nesting Great Blue Herons (*Ardea herodias*) and Double-crested Cormorants to try to determine if there are adverse effects of cormorants on nesting herons. A second investigation gathered baseline data on the rookery: all nests on Shad Island were identified as either heron or cormorant and mapped in 1999. In 2000, all nests were remapped and assessed for activity and new nests on nearby Metcalfe Island were also identified and mapped in 2000.

In 1999, results of the behavioral study showed that herons nesting near cormorants stayed on the nest significantly longer than herons nesting away from cormorants (P < 0.0001). All other behaviors that were studied, feeding rate, feeding time, number of young produced and aggressive encounters-showed no difference between the two groups. Conversely, in 2000 herons nesting near cormorants did not spend more time on the nest than herons nesting away from cormorants. Instead, on average the reverse was true. Furthermore, ANOVA analyses suggest that there is significant variation from nest to nest rather than between the groups of nests. In 2000, feeding rate and total feeding time were significantly different in the two groups (P < 0.05 and P < 0.03 respectively) with herons nesting near cormorants. Though significant, the difference is small and is probably not biologically meaningful.

Nest mapping showed a shift in nesting pattern between the two years of the study. In 1999, 581 active nest were reported on Shad Island alone, with no known nests off the island. In 2000, there were a total of 431 heron nests on Shad Island of which 339 were active, 57 inactive and 34 unknown. On nearby Metcalfe Island, new areas were colonized with 135 nests, putting the total rookery number at 566. Only nests on Shad were successful in 2000, with almost all heron nests on Metcalfe abandoned before they produced young. In both years, mean number of young produced per active nest was similar with 2.9 young per nest (n = 38 nests). In 1999, 35 cormorant nests were detected on Shad Island and 71 were detected in 2000. An additional 73 cormorants were found in the newly colonized part of the rookery, for a total of 144 cormorant nests. All 144 nests appear to have failed.

These results suggest that though cormorants are increasing dramatically they do not appear to change the behavior of Great Blue Herons when they nest nearby or alter nest productivity. Clearly there was a dramatic shift in nest distribution in 2000, but whether that is in response to Double-crested Cormorants is unknown. Also, in 2000, there was a decrease in the number of active nests, which could be an artifact of; (1) time of determination of nest activity between the years; (2) different weather conditions between years (2000 was a flood year, while 1999 was unusually dry); (3) greater disturbance of nests by fisherman in areas with high water, and possibly the interaction of any of these three.

It is possible that herons and cormorants compete early in the nesting season for limited resources such as nest sites or sticks. On average, Great Blue Herons nest earlier than cormorants but there are waves of later nesting herons who may come into competition with

cormorants. Because of the great increase in the number of nesting cormorants, lower productivity in 2000, and the movement of 25% of nests into non-historic nesting areas (all of which failed), it seems most pressing to continue to monitor the Missisquoi rookery. Additional research into early season competition may be an important avenue to investigate to better understand the impact of cormorants on nesting Great Blue Herons. Though there may be a significant effect of nesting cormorants on the rookery, hasty remedies to a burgeoning cormorant population in the rookery must also be avoided. The most well documented and well understood threat to heron rookeries is disturbance and an ill considered cormorant removal process is likely to be a much more severe threat to nesting herons than the cormorants themselves.

Section 1- Behavioral Study

In the past five years Double-crested Cormorants have started to nest in the Shad Island rookery which has historically been inhabited only by nesting Great Blue Herons. Though Great Blue Herons and Double-crested Cormorants are known to nest together in other rookeries (Thompson 1981, Drapeau et al. 1984, Paton and Kneedy 1993), cormorants are relative new comers to Lake Champlain and to the nesting populations of herons on the lake. Concern about invading cormorants seems warranted as nesting cormorants have killed off live nest trees on several islands in Lake Champlain, leaving few trees left for species that require arboreal nests. Additionally, large nesting colonies of cormorants are thought to affect other birds that nest on these islands, such as Ring-billed, Black-backed and Herring Gulls as well as Common Terns.

Shad Island, unlike many of the other Lake Champlain Islands, is not as likely to be adversely affected by cormorants due to its geomorphology. Shad Island is the product of sediment deposition where the Missisquoi river meets Lake Champlain and is regularly washed by the spring high water, potentially preventing the death of its trees (Hill 2000). Soil tests on Shad Island in 1999 show no adverse effects to the soil of a large number of nesting birds (Hill 2000).

Nevertheless, habitat destruction for the Great Blue Heron is not the only concern on Shad Island. It is also unclear whether Double-crested Cormorants disrupt or alter the nesting behavior of Great Blue Herons. Therefore, this study compared behaviors of two groups of nesting herons, one near nesting cormorants and one away from nesting cormorants.

Methods-Behavioral Study

Study Sites

Twenty-one Great Blue Heron nests were studied over a six-week study period. All nests were located on the northern side of Shad Island, which is located on Lake Champlain, in the most northwestern part of Vermont. Shad Island is located in the Missisquoi National Wildlife Refuge and has been the location of a large heronry for over 60 years (See Figs. 1&2)



Fig 1. Shad and Metcalfe Island rookery in 2000 (black dots represent nest trees) with location of study nests and study platform.

Behavioral Study

The heron study nests were broken into two groups, cormorant present nests and cormorant absent nests. Cormorant present nests had an active cormorant nest on the same tree



Fig 2. Great Blue Heron Nest Density 2000.

as the observed heron nest. Cormorant absent nests had no cormorant nests within 100 meters of the observed nests. There were 11 study nests in the cormorant present group and 10 study nests in the cormorant absent group. Nests were observed in four-hour blocks 6-10 times, from June 6th through July 11th. All observations were made from a blind located in the marsh off of the north shore of Shad Island (Fig 1).

During the four-hour blocks we quantified four different types of behavior: time spent at the nest, feeding rate of nestlings, amount of time spent feeding nestlings and aggressive encounters. A feeding was calculated as the number of times one of the heron adults returned to the nest and regurgitating food to the young. We also quantified total number of minutes spent feeding young during a four-hour block. Similarly, time spent at the nest was quantified as the amount of time per four-hour block that an adult heron occupied a nest. We considered an aggressive encounter to be any event when a nesting heron raised up its crest and tried to attack another heron or other species that approached the nest.

The fate of all young in all nests was followed until they fledged. This allowed for a comparison of mean number of young fledged between cormorant absent and cormorant present heron nests.

Statistical Analyses

An analysis of variance (ANOVA) was used to test for difference in the four quantified behaviors. From this type of analysis it is easy to discern whether there is a significant difference in the measured variable by group or within the group. In this case, it measures whether there is a significant difference in the tested variable by nests near or away from cormorants or whether

there is a significant difference by nest alone and not by grouping. A t-test was used to compare the mean number of young fledged in the two nest groups.

Results-Behavioral Study

In the 2000 field season only two of four behavioral differences varied significantly between the two groups of nesting Great Blue Herons. Additionally there was no significant difference in number of young fledged between the groups.

This year, Great Blue Herons nesting near cormorants spent on average less time (mean = 30 min) on their nest than did birds nesting away from cormorants (mean = 46 min). Results of an ANOVA show that there is not a significant difference by group in how long herons stay at the nest (P > 0.2) but rather there is significant difference by nest (P < 0.005).

Herons nesting with cormorants spent more time feeding young (3.5 min per 4hrs) and had a higher feeding rate (1.3 feedings per 4hrs) than did herons nesting away from cormorants (2.4 min per 4hrs and 0.9 feedings per 4hrs). The difference in feeding rate was significant with $\alpha = 0.05$ (P < 0.04) but the difference in total minutes spent feeding was not significant (P >0.05). Aggressive encounters hardly ever occurred in either group with herons nesting near cormorants displaying aggressive behavior 0.02 times per 4hrs and herons nesting away from cormorants displaying aggressive behavior 0.04 times per 4hrs. This difference was not significant with (P > 0.7). Only 6 aggressive encounters were seen in total over the course of the study, none of which were directed at cormorants.

There was no difference in number of young fledged per group. Herons nesting near cormorants (n = 8) fledged less young (mean = 2.5), than did herons (n = 9) nesting away from cormorants (mean = 3). This difference was not significant (P > 0.1).

Discussion-Behavioral Study

The purpose of this two-year study, conducted in 1999 by Michelle Hill and in 2000 by Zoe Richards, was to measure the effect of Double-crested Cormorants nests on nesting Great Blue Herons. In particular, the study hoped to gain some insight on whether nesting Great Blue Herons changed their behavior as a result of nesting so close to this quickly invading species.

In 2000, we measured and compared four behavioral variables: the amount of time Great Blue Herons spent on their nests, the amount of time spent feeding young, feeding rate, and the number of aggressive encounters. In particular we wanted to be able to duplicate the result that herons that nested near cormorants as a group spent more time at their nests. We were not able to duplicate this result in 2000. Herons did spend significantly different amounts of time on their nests, but in this year's study, that difference was not stratified by group (near or away from cormorants). Something akin to "parenting style" may account for the difference rather than a reaction to nearby cormorants. Though in 1999, herons nesting near cormorants, it is reasonable to say that the results of the two years show no consistent effect and therefore probably no overall effect. An increase in the time spent at a nest could have lead to decreased time spent searching for food and so last years results were of concern. In this case, the importance of conducting a study for more than one year is reinforced.

The idea that there is no clear effect in this study of cormorants on the behavior of nesting herons was further reinforced by our 2000 finding that herons nesting with cormorants had a higher feeding rate (i.e. parents returned to the nest with food more often) than did the cormorant absent group. This discounts the hypothesis that herons may spend more time on their nest and

thus waste valuable time that they could be garnering food for their young. Furthermore, there was no difference in the mean number of young produced by herons in 2000 suggesting that the ultimate measure of reproductive success is not altered in each grouping. We also observed 2 nest failures, one in each study group, again suggesting that in 2000 nesting cormorants were not an obvious cause of failure for herons, though sample size was very small.

It is important to look critically at the two years of the study and consider what other factors may have influenced the documented results. Most notably, the weather conditions were radically different in 1999 and 2000. Nineteen ninety-nine was a dry year with the water levels hardly breaking 96 feet. Shad Island was never inundated with water. In 2000, we had high water for an extended period of time, with levels up to 100.8 feet and Shad inundated with three to four feet of water. The water did not start to recede from the island significantly until the third week of June. Due to high water, the 5-week sample period started and ended three weeks later this year than last. High water in known to negatively impact Great Blue Herons as most of their usual shallow feeding areas tend to be under water (Custer et al. 1996). It is possible that behavior was more clearly dictated by the high water than proximity to nesting cormorants.

Of more importance, is the possible effect of asynchronous nesting on time spent at the nest by herons, in a five week snapshot study. In 1999, it appeared that most nests seem to have been initiated at the same time. In 2000, we found that we had nests with radically different initiation dates. Some nests were initiated at least 5 weeks after other nests. With only part of the nesting cycle surveyed, and a small sample size, it is easy to imagine a scenario where you have a disproportionate amount of nests initiated earlier or later in one group than another. Because we know that adult Great Blue Herons spend less time at their nest as their young grow older (Hill 2000), a greater proportion of late starting nests in either the cormorant absent or

present group would lead to the perception that one group stayed on the nest longer on average than the other. Avoiding this problem requires following nests through the whole cycle (7-9 weeks that young are in the nest) or following the same phase of the nest cycle for a shorter period of time (e.g. from hatch date to week 5 of young in the nest). The tremendous difference in nest initiation in the 2000 season highlights this problem, but the 1999 season results are also not immune from this as well. All that is needed is a one week difference in nest initiation, with the cormorant present group hatching their young about one week later, to see the clear result that was found last year. There is also reason to believe that later nesting herons are more likely to be in areas with cormorants (See Thompson 1991 and Section 2). It is likely that our snapshot study would have been sensitive enough to show a strong result, but is less likely to capture a subtle one.

The lack of direct competition between nesting cormorants and nesting herons is consistent with other published work that has looked at the effects of Double-crested Cormorants on Great Blue Herons. Great Blue Herons are known to nest with other heron species (Butler 1992) and also with Double-crested Cormorants (Thompson 1981, Paton and Kneedy 1993, Drapeau et al. 1994). Thompson (1981) and Drapeau et al. (1994) did not find direct competition between these birds rather they found that cormorants may affect herons in ways not tested by the two years of this study.

Both Drapeau et al. (1994) and Thompson (1981) suggest that cormorants tend to nest with herons because of the benefit of acquiring sticks from old nests or reusing old nests. Sticks are a much sought after commodity for cormorant nests and a heron rookery is a much more likely source of sticks than any place outside of the rookery. In the Shad Island rookery, cormorants only nested with herons and were not found nesting away from the rookery. As the

herons appear to initiate nests 3-4 weeks earlier, on average, than do cormorants, it is the cormorants that are deciding where it is most advantageous to settle. Additionally, it is likely that late nesting herons and cormorants may directly compete for nest sites and sticks. Cormorants may settle in unoccupied heron nests from the previous season discouraging herons from initiating nests there (Thompson 1981, Drapeau 1994), and could be responsible for a shift in distribution of heron nests seen in 2000 (See Discussion in Section 2 and Figs. 3&4).

Management Implications

Our work suggests that there is no direct competition between nesting herons and cormorants when the nests are in close proximity. But, if the scant literature on co-nesting of Great Blue Herons and Double-crested Cormorants is correct, future studies should look at the process of nest initiation in herons and cormorants to (1) gather better baseline data on nest initiation (i.e. do herons in this rookery actually initiate nests at different times?) and (2) to see if competition for sticks displaces nesting herons. It seems likely that this is where direct aggression and competition for a valued resource is likely to occur.



Nest Trees 2000

Forest Emergent Wetland Water



Section 2-Rookery Dynamics in the Year 2000

There is a lively debate in the literature about how to accurately count heron nests. Most agree that although aerial counting either through photography and or direct observation, is the most efficient and least disruptive way to count nesting herons of all varieties (ardeids), it may be neither accurate nor precise (Gibbs et al. 1988, Dodd and Murphy 1995, Frederick et al. 1996, Hill 2000). In particular, dark herons such as the Great Blue tend to be missed in aerial counts as they blend into the background more readily than light or white herons (Gibbs et al. 1988). Most methods of assessing the size of a rookery tend to undercount when compared with a breeding season ground count (Gibbs et al. 1998, Hill 2000).

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Tests of four different methods of nest counting in 1999 showed that the Shad Island rookery was best counted from the ground as all other methods showed a significant undercount when compared with the ground count for Great Blue Herons. In 2000, all nests (Double-crested Cormorants and Great Blue Herons) were counted from the ground and a new post season count was initiated once the leaves were off of Shad Island to see how that compared with summer results. Additionally, we mapped all nest trees with a GIS so we could compare number and distribution of heron and cormorant nests in the Shad Island rookery.

Methods-Nest Counts

In the ground count, we systematically counted all nests on the Shad Island Rookery using two observers. Because of high water, nest counting started in late June and went into August. All trees in the rookery were examined for the presence of nests by one observer standing at the base of the tree while the other observer looked into the canopy from four ordinal

directions. All trees were individually marked with bright color flagging to avoiding double counting or accidentally missing nest trees. After all nests were counted we marked all active nest trees with a blue, pre-numbered aluminum tag (last years nest trees were marked with a silver metal tag) to have a more permanent record of nest trees.

We distinguished between heron and cormorants nests in two ways. One, if we were able to see the bird on the nest it was characterized by its occupant. Two, we considered nests that were built of small sticks and nest material such as grass and other non-stick vegetation to belong to cormorants.

We also ascertained whether nests were active by looking either for the presence of adult or young birds, a significant amount of guano below the nest or remains of a recent meal below the nest (Gibbs et al. 1997). Nests that were very obscure, or counted after young had fledged were put into an unknown category. We calculated average number of fledges per nest by looking at the number of young in a sample of 38 nests. Young were counted just before fledging when they were thought to be 6-7 weeks old.

We mapped all nest trees using a GIS. An existing coverage for Shad Island created by Michele Hill (2000) was modified to reflect this years nest tress. We mapped new nest trees by pacing the distance from gps'ed transects that run across Shad Island to trees that were not mapped last year. Additionally we ran and gps'ed new transects across Metcalfe Island in three locations in order to map newly colonized areas in 2000 (fig. 5). All transects were overlaid onto a 3 class land-cover map that was created from digitizing digital orthophotos. All transects are labeled and marked with red flagging. Transects on Shad have metal stakes on either end.



Figure 5. Location of transects created in 1999 and 2000.

All information from 1999 are 2000 are stored in Arc/Info software and the nest information is spatially correlated to map information which allows us to map many element of the rookery(see Figs 1-9).

We also conducted a leaf off nest count on November 8th, 2000. We counted nests on Shad Island by having observers walk between transect lines and count all visible nests between two lines. Observers counted nests on adjacent transects so that if a nest tree was on the line, they could decide who would count it to avoid missing that tree or double counting. As the count was intended to be a one day count, we did not note the number of each tree and check to see if the information gathered this summer was the same as was gathered in the late fall. Because all information about nest number and type was written of flagging tied to the trees, if an observer happened to see an obvious discrepancy between the summer data and what could be observed in the tree, it was noted.

In our final tabulation of nest numbers we used a combination of summer and late fall counts. We considered the summer count to be the most accurate in terms of nest identification and number, because in the fall, count trees were not individually marked and birds were no longer on their nests. But, where we had noted a tree number that had clearly been undercounted we added those nests to our totals. For example, if an observer in November came across a tree whose tag indicated there were 4 heron nests in the tree and with the leaves off we could see that there were 6 herons nests, we added an extra two to our total. If an observer found a tree that was tagged to have 4 nests but only had two in November, we did not change our totals because of the possibility that a nest had fallen from summer to fall.

Results-Nest Counts

We detected a total of 431 Great Blue Heron nests on Shad Island and 135 Great Blue Heron nests on Metcalfe Island. Total number of heron nests, 566, in 2000 are similar to the 1999 total of 581 heron nests, showing a slight decrease (4%) from last year. In 2000, 71 Double-crested Cormorant nests were found on Shad Island and 73 were found on Metcalfe Island within the heron rookery (Fig. 6). In 1999, only 35 total cormorant nests were detected and they only occurred on Shad Island. This represents an 102% increase in cormorant nests on

Nest Trees with Cormorants 1999 and	I 2000 Forest Emergent Wetland Water
	 Nest Trees with Cormorants 1999 Nest Trees with Cormorants 2000
	Nest Trees will Cormorants 2000
0 0.1 0.2 0.3 0.4 0.5 KM	



/wal/work/richards/whad/newt00.aml: September, 2000

Shad Island and a 311% increase in the rookery (Table 1).

Of the 431 Great Blue Heron nest found on Shad Island in 2000, 339 were active, 57 inactive and 34 unknown. We suspect that most active nests fledged young as we ascertained nest activity late in the nesting season. On Metcalfe Island, of the 135 heron nests, only 1 was active, 127 were inactive and 7 were unknown (Fig. 7). The heron nests on Metcalfe in the Eel Creek area were initiated late in the nesting season and abandoned soon after nest initiation (all were abandoned by the third week of June)(Fig. 8).

Consistent with 1999 results, cormorants in 2000 produced almost no young. Of 71 nests on Shad Island, we found 8 to be active with all of them ultimately failing except possibly one nest. On Metcalfe Island, all 73 cormorant nests failed and the cormorants in the Eel Creek area of Metcalfe Island, like the herons, abandoned their nests by the third week of June.

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Table 1. Results of the ground nest count on Shad and Metcalfe Islands, June-November 2000.

Species	Total Nest 20	00.	Active Nests 2000	Inactive nests 2000	Unknown nest 2000
Great Blue Heron	566	is is	340	184	42
Double-crested Cormorant	144	ā	. 8	136	0

Though the number of Great Blue Heron nests between the years are similar, the distribution of those nests is markedly different. In 1999 all 581 heron nests were found on Shad Island. In 2000, 431 nests were on Shad Island and 135 had moved onto Metcalfe. Of the 135 nests on Metcalfe Island, 101 nests surrounded Eel Creek, which is not an historic nesting area for Great Blue Herons (A. Zelley pers. communication)(Fig 9). Twenty-five percent of the population did not nest on Shad Island in 2000.

Active and Inactive Heron Nest Trees 2000

Forest
Emergent Wetland
Water

- Nest Trees with 1 or More Active Nests
- Nest Trees with Only Inactive Nests





Active and Inactive Cormorant Nest Trees 2000	 Forest Emergent Wetland Water
 Nest Trees with 	n 1 or More Active Nests
- Nest Trees with	n Only Inactive Nests
A Contraction of the contraction	
0 0.1 0.2 0.3 0.4 0.5 KM	W E

Fig 8. Location of active and inactive cormorant nests.

Nest Tree Use 1999 and 2000

1	Forest	
-	1 01030	

Emergent Wetland

Water

- Nest Trees used in 1999 and 2000
- Nest Trees used only in 2000
- Nest Trees used only in 1999



0.2

0.3

0.4

0.5 KM

0.1

In 1999, all 35 cormorant nests occurred in one clump in the center of Shad Island. In 2000, cormorant nests were evenly distributed across all areas that were occupied by nesting herons.

Average nest success was the same in 2000 as it was in 1999 with an average of 2.9 young per nest being fledged. Though the average number of fledges per nest is similar to 1999, there appeared to many fewer nests that actually made it to that point which suggests that total number of young produced in 2000 was greatly reduced from 1999.

Discussion-Nest Counts

The spatial distribution and number of active nests varied greatly in 2000 as compared with information gathered in 1999. It is complicated to figure out cause and effect of various changes in a two-year study. Additionally, natural variation in weather, and heron and cormorant reproduction, lead to differences in the way the study was conducted in the two years. Nonetheless, there were some disturbing trends in 2000, such a shift in distribution of heron nests, wide nest failure and a dramatic increase in nesting cormorants. It is very plausible that the nest failures and shift in nesting areas have nothing to do with cormorants, but the reverse is also true. In this discussion, I will try to outline some of the potential causes of nest failure, and nest shifting and look at some of the potential consequences of continued rapid growth of nesting cormorants.

Distribution Shifts

This year, for the first time, 25% of the heron population nested off of Shad Island. One possible explanation is that cormorants have displaced some proportion of the heron colony, out

competing them for either nest sites or for nesting material. This type of competition has been documented in at least two other rookeries that contain nesting population of both Great Blue Herons and Double-crested Cormorants (Thompson 1981, Drapeau et al. 1984). Cormorants have been known make nests in old heron nests and also to directly destroy active but unattended heron nests for their sticks (Thompson 1981, Drapeau et al. 1984).

The observed patterns of displacement that we saw this year are not inconsistent with this hypothesis. Nests initiated in the Eel Creek area were late. There were no nests in this area on May 13th but by May 23rd, many heron nests were in the process of being constructed. A good proportion of herons initiate nests in early to mid April on Shad Island. It is possible that when late nesting herons returned to Shad Island they could have found that old nests were occupied by cormorants, the usual abundance of sticks available in previous seasons nests were used up, or that prime nesting locations were already occupied by cormorants. Any of these scenarios may have lead them to build nests in nearby but unoccupied areas like Eel Creek. Though not directly measured it appears that nest trees on Metcalfe are smaller and shorter than the nest trees on Shad Island, which may also suggest that newly colonized areas are not as good habitat as Shad.

It is also worth considering the role of the State of Vermont's management of cormorants as a potential cause of cormorants in the rookery. For the past three years cormorant eggs have been oiled on Young Island to prevent them from hatching. It is worth considering the possibility that egg oiling displaces adult cormorants to somewhat less desirable habitat like the Shad Island rookery, where they are more vulnerable to predation than on other Lake Champlain Islands.

Nesting Success in Herons

Overall nesting success appeared to be lower in 2000 than in 1999. There were more inactive nests on Shad Island and one very large group of heron nests on Metcalfe were completely abandoned early in the nesting cycle. It is likely that nests were abandoned because of disturbance on Metcalfe Island.

Great Blue Herons are extremely sensitive to disturbance and the effects of a variety of types of disturbance are well documented (Werschkul et al. 1975, Tremblay and Ellision 1979, Bjorklund 1975 and Drapeau et al. 1984). The fact that so many nests (cormorants included) were abandoned so quickly makes it likely that disturbance rather than predation was the cause of the failure. Though cormorants seem to tolerate disturbance more readily than do herons, they have also been know to abandon whole areas due to disturbances especially when they are building nests and laying eggs (Cairns et al. 1997). All areas in early June were inundated with water and boat travel was possible right under all of the nesting trees in the rookery. Travel on Shad Island is prohibited and signs mark the periphery. As nesting areas on Metcalfe were new this year there were no signs prohibiting boat traffic (fishermen) from making their way into these forests. Also, it seems likely that there was an airboat night fishing in the region as both herons and cormorants were laying their eggs (M. Sweeny pers comm).

Conversely, it is possible that high water alone may be the cause of the abandonment. Figure 7 shows that there is a pattern to the abandonment on Shad and Metcalfe Islands. There are few abandoned nests in the heart of the rookery and only nests on the outskirts did not succeed. High water causes stress for herons as many of their regular feeding grounds are covered with too much water to actively hunt, and it appears that the presence of high water underneath nest trees can delay nesting and also stimulate herons to abandon nests (Custer et al.

1996). Therefore, abandoned nests may have had water under them for longer or belonged to young inexperienced birds who abandoned more readily when the water levels remained high.

It is worth noting that nest activity was determined in 1999 on Shad in mid-May. If nest activity had been determined at this time in 2000, similar result would have been found as most nests were abandoned after mid-May. This does not discount Hills results as she was quite sure that most of those nests did actually fledge young.

Nest Failure in Cormorants

Cormorant nests failed almost across the board in 2000 just as they had in 1999. It is likely that cormorant nests failed for a number of reasons. As already discussed, nests on Metcalfe Island may well have been abandoned because of disturbance, but nests were also abandoned or failed right in the heart of the Shad Island where there was not likely to be any disturbance. The nests that failed on Shad failed slowly, not quickly like on Metcalfe. It may be that predation in rampant for these birds. After the high water receded from Shad, muddy exposed soil was soon completely covered with raccoon (*Procyon lotor*) tracks. One set of fisher (*Martes pennanti*) tracks was also identified. Cormorants are likely to be easy prey for the fierce raccoon as the adults may not be able to ward them off. An adult Great Blue Heron is probably better able to defend its nests from raccoons, though I suspect they are also a cause of nest failure in herons as well. Furthermore, only 2 nests were known to have produced visible nestlings and one of those nests was ultimately destroyed by raccoon predation (we found what was left of nestlings who had been devoured).

Shad Island is not like the other Lake Champlain Islands where cormorants nest. Most of the nesting islands are small and remote which makes them poor habitat for mammalian

predators. Shad on the other hand is only separated from the mainland by small river channels and is thus replete with the regular set of predators found in this area.

Management Implications

Shad Island is an ideal place for a Great Blue Heron rookery. By almost all measures it fits published accounts of areas of high productivity and persistence for a rookery (Carlson and Mclean 1996, Gibbs and Kinkel 1997, Dickson and Sullivan 1996, Watts and Bradshaw 1994). It is far away from development, close to excellent feeding grounds and it's blocked from human disturbance by a water barrier (Carlson and Mclean 1996).

This makes a threat such as invading Double-crested Cormorants a particularly tricky problem to sort out. First of all, it is not clear what the effects of cormorants are on herons. So far, in two years of study, we can show no direct impact of nesting cormorants on herons and yet there are some disturbing trends in nesting patterns that send up red flags about the health of the rookery. Furthermore, even if we deemed cormorant populations worth controlling, the problem of removing them from the rookery has the very real chance of destroying it. There are many accounts of disturbance disbanding a rookery (Bjorklund 1975, Temblay and Ellison 1979) and one in particular where disturbance of a heronry by scientists allowed cormorants to finally get the upper hand (Drapeau et al. 1984).

This years nest distribution shift may be a tip off that cormorants do affect nesting herons and that we need to look at a different part of the nesting cycle to see the effects. A behavioral study that looks at nest initiation and competition for nest space is recommended. Additionally, it is important to continue to monitor the size, success and distribution of heron nests on Shad

Island as measures of rookery health. This should help us understand whether the changes we see in the rookery are caused by normal variation or whether we are seeing a decline in the rookery. Furthermore, any attempt to manage cormorants should, for the time being, occur outside of the rookery itself because of the well-documented effects of disturbance on the rookery.

Section 3-Recommendations

1. We recommend that studies looking at the effects of nesting cormorants on nesting Great Blue Herons be continued. In particular we suggest that next year (2001), a study of nest initiation of both herons and cormorants be conducted early in the season. This should give us baseline information on nest initiation dates for herons and cormorants. Also, this should give us some insight into whether herons and cormorants compete for sticks and nest sites.

2. We recommend concluding the nesting study as laid out in 1999 and 2000, as there appears to be no direct effects of nesting cormorants on nesting herons once the nests are established. Our findings are consistent with the few other studies that have looked at the co-nesting of Double-crested Cormorants and Great Blue Herons.

3. We recommend that a detailed count of all nests continue from the ground. In 1999 these counts were done in mid-May when counting was easy, as leaf growth had just begun. In 2000, we counted nests in early summer, which is much more labor intensive as nests are very hard to spot in the dense leaf growth. This early summer count gives a more accurate picture of nest success as most nests are close to fledging; therefore we recommend that this type of count be continued next year so that nesting success can be determined. Also, we recommend that this be supplemented with a late season count to pick up any missed nests once the leaves are off. It should be noted that in future years, when detailed studies may not be required, late season leaf off counts are likely to be the most efficient, accurate and least disruptive way to gather just data on nest numbers.

4. We strongly urge that at this time no measure to control cormorants within the rookery be undertaken. The potential risks appear to vastly outweigh the benefits and until more is understood about the effects of these Double-crested Cormorants on Great Blue Herons in this rookery, control is not warranted. The potential outcome of invading cormorants on the rookery could be loss of the rookery but this outcome has not been documented on this widely studied species. The potential outcome of disturbance (caused by cormorant removal) on the rookery could be loss of the rookery and this outcome is well documented for the Great Blue Heron.

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Appendix 1. Raw nest data 2000.

Tree#200	Tree#99	flagging#20	heron	corm	# active	>50%heron active	>50%corm active
1	12	120	1	0	0	0	0
2	11	119	1	0	0	0	0
3	10	118	2	0	0	0	0
4	8	117	1	0	0	0	0
5	7	116	1	0	0	0	0
6	6	154	1	0	0	0	0
7	5	153	1	0	0	0	0
8	29	152	1	0	1	1	0
9	9	151	2	0	0	0	0
10	28	150	2	0	1	1	0
11	41	F	1	0	0	0	0
12	40	148	2	0	1	1	0
13	46	G	2	0	0	0	0
14	42	149	1	0	0	0	0
15	26	D	4	0	0	0	0
16	15	3	1	0	0	0	0
1/	14	124	1	0	0	0	0
18	NI	123	1	0	0	0	0
19	21	122	1	0	0	0	0
20	18	121	1	0	0	0	0
21		125		0	1	1	0
22	N I	2		0	0	0	0
23	20			0	0	0	0
24	21	L 147		0	0	0	0
20	39	147	1	0	0	0	0
20	44	4	1	0	0	0	0
21	43	<u>.</u>	1	0	0	0	0
20	38	146	1	0	0	0	0
30	31	140	2	1	0	0	0
31	33	140	1	0	0	0	0
32	34	139	1	0	0	<u> </u>	0
33	35	138	1	1	1	1	0
34	54	137	2	0	1	1	0
35	45	B	1	0	0	0	0
36	59	133	1	0	0	0	0
37	61	1	1	0	0	0	0
38	62	132	1	0	0	0	0
39	266	134	1	0	1	1	0
40	63	131	2	0	1	1	0
41	56	136	1	0	. 1	1	0
42	57	135	0	1	0	0	0
43	64	129	1	0	1	1	0
44	65	128	4	0	1	1	0
45	66	140	1	2	1	1	0
46	53	142	1	0	0	. 0	0
47	. 49	143	0	1	0	0	0
48	51	141	1	0	1	1	0

10	70	420	4	0	4	4	
49	70	130	1	0	1	1	0
50	86	126	1	1	0	0	0
51	80	127	4	0	0	0	0
52	82	6	1	1	1	1	0
53	265	5	2	0	1	1	0
54	85	7	3	0	0	0	0
55	NT	1	0	0	0	0	0
56	89	K	1	0	0	1	0
57	95	J	2	0	1	1	0
58	92	9	1	0	0	0	0
59	99	13	0	1	0	0	0
60	91	11	1	0	0	0	0
61	90	10	1	0	0	0	0
62	105	L	1	0	1	1	0
63	NT	M	2	0	1	1	0
64	NT	N	1	0	1	1	0
65	102	15	1	0	0	0	0
66	101	12	1	0	0	0	0
67	116	Ρ	1	0	1	1	0
68	115	Q	0	1	0	0	0
69	112	0	1	0	1	1	0
70	NT	14	1	0	1	1	0
71	114	17	1	0	1	1	0
72	NT	S	1	0	1	1	0
73	118	Т	1	0	1	1	0
74	117	R	2	0	1	1	0
75	119	U	1	0	1	1	0
76	123	нн	2	0	1	1	0
77	124	V	2	0	1	1	0
78	129	W	8	0	1	1	0
70	130	GG	2	0	1	1	0
80	100	FF	3	0	1	- 1	0
81	128	10	6	1	1	1	0
01	120	19	2		1	1	0
02	120	10		0	1		0
03	127	16	5	0	1		0
84	132	10	5	0	1	1	0
85	134	7	0	1	0	0	0
86	135	2	1	0	0	0	0
87	5	X	6	1	1	1	0
88	138	DD	6	0	1	1	1
89		FF	1	0	1	1	0
90	140	KK	6	0	1	1	0
91	155	30	1	0	1	1	0
92	141	JJ	5	1	1	1	0
93	142	II	1	0	1	1	0
94	154	29	2	1	1	1	1
95	153	28	3	0	1	1	0
96	146	31	2	0	1	1	0
97	147	32	16	0	1	1	0

98	182	35	0	1	0	C	0
99	148	33	3	0	1	1	0
100	149	0	4	0	1	1	0
101	268	0	3	0	1	1	0
102	151	0	6	0	1	1	0
103	152	27	3	0	1	1	0
104	264	26	5	1	1	1	1
105	261	25	2	0	1	1	0
106	262	24	4	0	1	1	0
107	156	LL	1	0	1	1	0
108	263	23	5	0	1	1	0
109	200	22	1	1	0	0	0
110	137	CC	3	0	1	1	0
111	157	BB	0	1	0	0	0
112	136	AA	1	0	0	0	0
113	158	20	5	0	1	0	0
114	159	21	2	0	1	1	0
115	171	39	2	0	1	1	0
116	172	40	7	2	1	1	0
117	176	41	1	0	1	1	0
118	175	36	7	1	1	1	0
119	1/3	43	3	0	1	1	0
120	1/4	42	2	0	1	1	0
121	1//	34	2	0	1	1	0
122	183	59	2	0	1	1	0
123	185	60	5	0	1	1	0
124	107	00	3			1	0
120	125	44	3				0
120	190	47	4		1		0
127	191	40	3		1	1	0
120	163	38	2	0	1	1	0
120	162	37	1	0	1	1	0
130	166	48	1	0	0	0	0
132	165	51	1	1	1	1	0
133	167	52	2	0	0	0	0
134	198	50	4	0	0	0	0
135	197	56	2	0	1	1	0
136	193	53	4	0	1	1	0
137	218	98	7	0	1	1	0
138	188	57	6	0	1	1	0
139	186	99	6	1	1	1	0
140	MNT	100	2	0	1	1	0
141	221	61	1	0	1	1	0
142	222	62	7	0	1	1	0
143	232	101	3	0	1	1	0
144	224	63	1	0	1	. 1	0
145	225	64	1	0	1	1	0
146	227	66	1	1	1	1	0

147	229	67	1	1	1	1	0
148	230	65	1	0	1	1	0
149	231	102	6	0	1	1	0
151	233	0	5	0	1	1	0
152	216	105	1	0	1	1	0
153	215	106	8	2	1	1	0
154	235	104	2	0	1	1	0
155	217	103	3	0	1	1	0
156	219	97	1	0	1	1	0
157	194	96	2	0	1	1	0
158	210	95	5	0	1	1	. 0
159	208	92	1	0	1	1	0
160	195	54	4	0	1	1	0
161	196	55	3	0	1	1	0
162	199	49	2	0	1	1	0
163	MNT	93	1	0	1	1	0
164	209	94	4	0	1	1	0
165	260	111	1	0	1	1	0
166	211	109	4	2	1	1	0
167	212	108	3	2	1	1	0
168	214	107	1	4	1	1	0
169	213	110	4	0	1	1	0
170	MNT	112	0	1	0	0	0
171	240	115	0	1	0	0	0
172	238	113	2	0	1	1	0
173	237	114	2	0	1	1	0
174	244	82	5	0	1	1	0
175	243	81	1	0	1	1	0
176	242	79	4	0	1	1	0
177	247	78	4	0	1	1	0
178	246	80	3	0	1	1	0
179	255	68	3	0	1	1	0
180	256	69	1	1	1	1	1
181	259	70	1	2	1	1	1
182	257	86	3	0	1	1	0
183	253	87	2	0	1	1	0
184	254	88	2	0	1	1	0
185	248	77	2	1	1	1	0
186	MNT	91	1	0	1	1	0
187	mnt	0	0	1	0	0	0
188	MNT	83	0	1	0	0	0
189	250	89	1	1	0	0	0
190	249	90	4	5	1	1	0
191	MNT	76	0	2	0	0	1
192	251	75	1	4	1	1	0
193	MNT	74	0	4	0	0	0
194	MNT	84	0	2	0	. 0	0
195	MNT	73	0	2	0	0	0
196	252	72	2	1	1	1	1

197	258	71	0	3	0	0	0
198	MNT	85	0	1	0	0	1
199	0	1	1	0	0	0	0
201	0	2	1	0	1	1	0
202	0	3	0	1	0	0	0
203	0	4	3	0	0	0	0
204	0	5	1	0	0	0	0
205	0	6	1	0	0	0	0
206	0	7	0	2	0	0	0
207	0	8	2	0	0	0	0
208	0	9	1	0	0	0	0
209	0	10	2	0	0	0	0
210	0	11	1	2	0	0	0
211	0	12	1	0	0	0	0
212	0	13	2	0	0	0	0
213	0	14	1	0	0	0	0
214	0	15	2	2	0	0	0
215	0	16	0	1	0	0	0
216	0	17	0	1	0	0	0
217	0	18	0	1	0	0	0
218	0	19	1	0	0	0	0
219	0	20	1	0	0	0	0
220	0	21	1	0	0	0	0
221	0	22	1	0	0	0	0
222	0	1	1	0	0	0	0
223	0	2	0	1	0	0	0
224	0	3	2	1	0	0	0
225	0	4	2	1	0	0	0
226	0	5	2	2	0	0	0
227	0	6	2	0	0	0	0
228	0	7	1	0	0	0	0
229	0	8	0	1	0	0	0
230	0	9	2	1	0	0	0
231	0	10	1	0	0	0	0
232	0	11	1	1	0	0	0
233	0	12	7	11	0	0	0
234	0	13	1	0	0	0	0
235	0	14	4	0	0	0	0
236	0	15	1	0	0	0	0
237	0	16	1	0	0	0	0
238	0	17	2	3	0	0	0
239	0	18	0	1	0	0	0
240	0	19	1	0	0	0	0
241	0	20	1	1	0	0	0
242	0	21	1	0	0	0	0
243	0	22	1	0	0	0	0
244	0	23	2	3	0	. 0	0
245	0	24	2	0	0	0	0
246	0	25	1	1	0	0	0

247	0	26	1	0	0	0	0
248	0	27	1	1	0	0	0
249	0	28	1	0	0	0	0
250	0	29	0	2	0	0	0
251	0	30	2	0	0	0	0
252	0	31	1	0	0	0	0
253	0	32	1	0	0	0	0
254	0	33	1	0	0	0	0
255	0	34	1	0	0	0	0
256	0	35	3	1	0	0	0
257	0	36	1	1	0	0	0
258	0	37	0	1	0	0	0
259	0	38	1	0	0	0	0
260	0	39	1	0	0	0	0
261	0	40	1	0	0	0	0
262	0	41	1	0	0	0	0
263	0	42	1	0	0	0	0
264	0	43	1	0	0	0	0
265	0	44	2	0	0	0	0
266	0	43	1	0	0	0	0
267	0	40	1	0	0	0	0
268	0	47	1	0	0	0	0
269	0	48	1	0	0	0	0
270	0	49	2	0	0	0	0
2/1	0	50	0		0	0	0
272	0	51	0	2	0	0	0
273	0	52	4	3	0	0	0
274	0	53	4	1	0	0	0
275	0	55	0	1	0	0	0
270	0	56	2	2	0	0	0
277	0	57	2	1	0	0	0
270	0	58	3	2	0	0	0
280	0	59	1	1	0	0	0
281	0	60	1	1	0	0	0
282	0	61	1	3	0	0	0
283	0	62	4	2	0	0	0
284	0	63	2	1	0	0	0
285	0	64	1	0	0	0	0
286	0	65	2	0	0	0	0
287	0	66	1	0	0	0	0
288	0	67	2	0	0	0	0
289	0	68	2	1	0	0	0
290	0	69	1	0	0	0	0
291	0	70	0	1	0	0	0
292	0	71	1	0	0	0	0
293	0	72	1	0	0	. 0	0
294	0	73	1	0	0	0	0
295	0	74	1	0	0	0	0

Appendix 1. Raw nest data 2000.

296	. 0	75	1	0	0	0	0
297	81	0	0	1	0	0	0
298	75	0	2	0	0	0	0
0	0	lower metc	7	0	0	0	0

Appendix 2. Raw behavior data 2000.

site/nest	Date	Corm	feed#	feedmin	totalmin	aggressive	#young	abandonded	fledged	incubate
1a	6092000	1	0	0	240	0	0	0	0	1
1a	6142000	1	0	0	240	0	0	0	0	1
1a	6222000	1	0	0	240	0	0	0	0	1
1a	7042000	1	0	0	240	0	0	0	0	1
1a	7072000	1	0	0	0	0	0	1	0	0
1a	7112000	1	0	0	0	0	0	1	0	0
1b	6092000	1	2	6	80	2	3	0	0	0
1b	6142000	1	2	3	12	0	3	0	0	0
1b	6222000	1	2	6	7	0	3	0	0	0
1b	7042000	1	2	4	6	0	2	0	0	0
1b	7072000	1	0	0	4	0	2	0	0	0
1b	7112000	1	0	0	0	0	0	0	1	0
1c	6092000	1	1	1	4	0	2	0	0	0
1c	6142000	1	1	1	1	0	2	0	0	0
10	6222000	1	0	0	0	0	2	0	0	0
10	7042000	1	0	0	0	0	0	0	1	0
10	7072000	1	0	0	0	0	0	0	1	0
10	7112000	1	0	0	0	0	0	0	1	0
22	6062000	0	0	0	240	0	0	0	0	1
22	6082000	0	0	0	240	1	0	0	0	1
22	6132000	0	0	0	240	0	0	0	0	0
20	6142000	0	1	6	240	0	0	0	0	0
20	6162000	0	0	0	240	0	0	0	0	0
20	6222000	0	0	0	240	0	3	0	0	0
20	7042000	0	2	8	159	0	5	0	0	0
20	7072000	0	2	7	21	0	4	0	0	0
20	7112000	0	1	3	4	0	4	0	0	0
20	6062000	0	1	2	128	1	3	0	0	0
20	6082000	0	0		120	0	3	0	0	0
20	6132000	0	1	3	3	0	3	0	0	0
20	6142000	0	1	2	8	0	3	0	0	0
20	6162000	0	1	2		0	3	0	0	0
20	6222000	0	2	3	6	0	3	0	0	0
20	7042000	0		1	2	0	3	0	0	0
20	7042000	0	0	0		0	0	0	1	0
20	7112000	0	0	0	0	0	0	0	1	0
20	6062000	0	0	0	240	1*	0	0	0	1
20	6082000	0	0	0	240	0	0	0	0	1
20	6122000	0	0	0	240	0	0	0	0	1
20	6132000	0	0	0	240	0	0		0	0
20	6142000	0	0	0	0	0	0	1	0	0
20	6162000	0	0	0	0	0	0	1	0	0
20	6222000	0	0	0	0	0	0	1	0	0
20	7042000	0	0	0	0	0	0	1	0	0
20	7072000	0	0	0	0	0	0	1	0	0
20	/112000	0	0	0	0	0	0	1	0	0
20	6142000	0	1	3	5	0	0	. 0	0	0
20	6162000	0	0	0	0	0	3	0	0	0
2d	6222000	0	2	6	22	0	3	0	0	0
2d	7042000	0	1	5	22	0	0	0	0	0
2d	7072000	0	0	0	0	0	0	0	1	0

Appendix 2. Raw behavior data 2000.

2d	7112000	0	0	0	0	0	0	0	1	0
2e	6142000	0	3	6	7	0	3	. 0	0	0
2e	6162000	0	0	0	0	0	3	0	0	0
2e	6222000	0	0	0	0	0	3	0	0	0
2e	7042000	0	0	0	0	0	1	0	1	0
2e	7072000	0	0	0	0	0	0	0	1	0
2e	7112000	0	0	0	0	0	0	0	1	0
2f	6142000	0	0	0	240	0	0	0	0	1
2f	6162000	0	0	0	240	0	0	0	0	1
2f	6222000	0	0	0	240	0	0	0	0	1
2f	7042000	0	2	2	35	0	4	0	0	0
2f	7072000	0	1	3	6	0	3	0	0	0
2f	7112000	0	0	0	0	0	0	0	0	0
2g	6142000	0	1	2	2	0	3	0	0	0
2g	6162000	0	1	2	2	0	3	0	0	0
2g	6222000	0	3	6	6	0	3	0	0	0
2g	7042000	0	2	2	4	0	3	0	0	0
2g	7072000	0	0	0	0	0	0	0	1	0
2g	7112000	0	0	0	0	0	0	0	1	0
2h	6142000	0	0	0	240	0	0	0	0	1
2h	6162000	0	0	0	240	1	0	0	0	1
2h	6222000	0	0	0	206	0	3	0	0	0
2h	7042000	0	1	2	2	0	3	0	0	0
2h	7072000	0	1	2	5	0	3	0	0	0
2h	7112000	0	1	1	4	0	3	0	0	0
2i	6142000	0	0	0	240	0	0	0	0	1
2i	6162000	0	0	0	240	0	0	0	0	1
2i	6222000	0	1	2	231	0	4	0	0	0
2i	7042000	0	1	4	6	0	4	0	0	0
2i	7072000	0	2	8	8	0	4	0	0	0
2i	7112000	0	0	0	0	0	3	0	0	0
2j	6142000	0	1	2	2	0	3	0	0	0
2j	6162000	0	1	1	1	0	2	0	0	0
2j	6222000	0	0	0	0	0	2	0	0	0
2j	7042000	0	0	0	0	0	2	0	0	0
2j	7072000	0	0	0	0	0	0	0	1	0
2j	7112000	0	0	0	0	0	0	0	1	0
3a	6062000	1	1	2	111	0	2	0	0	0
3a	6092000	1	1	2	112	0	2	0	0	0
3a	6132000	1	2	5	10	0	2	0	0	0
3a	6142000	1	0	0	0	0	2	0	0	0
3a	6142000	1	1	1	1	0	2	0	0	0
3a	6162000	1	1	1	1	0	2	0	0	0
3a	6222000	1	1	3	3	0	2	0	0	0
3a	7042000	1	1	2	2	0	2	0	0	0
3a	7072000	1	0	0	0	0	0	0	1	0
3a	7112000	1	0	0	0	0	0	. 0	1	0
3b	6092000	1	0	0	240	0	0	0	0	1
3b	6132000	1	0	0	240	0	0	0	0	1
3b	6142000	1	0	0	240	0	0	0	0	1
3b	6142000	1	0	0	240	0	0	0	0	1

Appendix 2. Raw behavior data 2000.

3b	6162000	1	0	0	240	0	0	0	0	1
3b	6222000	1	0	0	240	0	0	0	0	1
3b	7042000	1	0	0	0	0	0	1	0	0
3b	7072000	1	0	0	0	0	0	1	0	0
3b	7112000	1	0	0	0	0	0	1	0	0
30	6062000	1	0	0	87	0	4	0	0	0
30	6092000	1	2	10	10	0	4	0	0	0
30	6132000	1	1	5	5	0	4	0	0	0
30	6142000	1	1	4	4	0	4	0	0	0
30	6142000	1	1	3	3	0	4	0	0	0
30	6162000	1	1	3	3	0	3	0	0	0
30	6222000	1	2	5	5	0	3	0	0	0
30	7042000	1	2	0	0	0	0	0	1	0
30	7042000	1	0	0	0	0	0	0	1	0
30	7072000	- 1	0	0	0	0	0	0		0
30	6062000	1	1	10	240	0	0	0	1	0
30	6062000	1		10	240	0	3	0	0	0
30	6092000	1	1	8	82	0	2	0	0	0
30	6132000	1	3	9	50	0	2	0	0	0
30	6142000	1	1	3	3	0	2	0	0	0
30	6142000	1	1	3	225	0	2	0	0	0
30	6162000	1	2	6	9	0	2	0	0	0
3d	6222000	1	2	4	6	0	2	0	0	0
3d	7042000	1	2	2	24	0	2	0	0	0
3d	7072000	1	1	2	2	0	2	0	0	0
3d	7112000	1	0	0	0	0	2	0	0	0
3e	6142000	1	2	5	6	0	3	0	0	0
3e	6162000	1	2	5	9	0	3	0	0	0
3e	6222000	1	3	3	3	0	3	0	0	0
3e	7042000	1	0	0	0	0	0	0	1	0
3e	7072000	1	0	0	0	0	0	0	1	0
3e	7112000	1	0	0	0	0	0	0	1	0
3f	6142000	1	1	3	3	0	4	0	0	0
3f	6162000	1	0	0	1	0	4	0	0	0
3f	6222000	1	3	4	6	0	4	0	0	0
3f	7042000	1	0	0	0	0	0	0	1	0
3f	7072000	1	0	0	0	0	0	0	1	0
3f	7112000	1	0	0	0	0	0	0	1	0
3g	6142000	1	2	10	53	0	3	0	0	0
3g	6162000	1	2	5	5	0	3	0	0	0
3g	6222000	1	3	4	4	0	3	0	0	0
3g	7042000	1	0	0	0	0	0	0	1	0
3g	7072000	1	0	0	0	0	0	0	1	0
3g	7112000	1	0	0	0	0	0	0	1	0
3h	6142000	1	1	3	195	0	2	0	0	0
3h	6162000	1	1	4	49	0	2	0	0	0
3h	6222000	1	1	2	2	0	2	0	0	0
3h	7042000	1	3	6	6	0	2	0	0	0
3h	7072000	1	0	0	3	0	2	0	0	0
3h	7112000	1	1	1	1	0	2	0	0	0

					Species			
					Cor=2			
Observation	Nest Number	Watch Time	Date	Week	GBH=1	Cor Present	# Nestlings	# Times Fed
	2-1	13:00	5/26/99	1	1	0	4	2
3	2-2	13:00	5/26/99	1	1	0	4	2
	2-3	13:00	5/26/99	1	1	0	4	0
	2-4	13:00	5/26/99	1	1	0	4	1
	2-5	13:00	5/26/99	1	1	0	4	2
	4-1	17:00	5/27/99	1	1	0		2
	4-2	17:00	5/27/99	1	1	0		0
	4-3	17:00	5/27/99	1	1	0		3
5	4-4	17:00	5/27/99	1	1	0		2
	4-5	17:00	5/27/99	1	1	0		0
	4-6	17:00	5/27/99	1	1	0		1
	2-1	5:00	5/28/99	1	1	0	4	2
	2-2	5:00	5/28/99	1	1	0	4	2
	2-3	5:00	5/28/99	1	1	0	4	2
	2-4	5:00	5/28/99	1	1	0		3
6	2-5	5:00	5/28/99	1	1	0		0
	2-6	5:00	5/28/99	1	1	0	3	2
	2-7	5:00	5/28/99	1	1	0		1
1	1-1	17:00	5/25/99	1	1	1		2
	1-2	17:00	5/25/99	1	1	1		1
	1-3	17:00	5/25/99	1	1	1		3
	1-5	17:00	5/25/99	1	1	1		2
	1-6	17:00	5/25/99	1	1	1		1
2	3-1	9:00	5/25/99	1	1	1		1
	3-2	9:00	5/25/99	1	1	1		1
	1-1	13:00	5/27/99	1	1	1		1
	1-2	13:00	5/27/99	1	1	1		1
4	1-3	13:00	5/27/99	1	1	1		1
	1-5	13:00	5/27/99	1	1	1		1
	1-6	13:00	5/27/99	1	1	1		1
	2-1	17:00	6/3/99	2	1	0		3
· · · · · · · · · · · · · · · · · · ·	2-2	17:00	6/3/99	2	1	0		2
18	2-3	17:00	6/3/99	2	1	0		2
	2-4	17:00	6/3/99	2	1	0		2
	2-5	17:00	6/3/99	2	1	0		1
	2-6	17:00	6/3/99	2	1	0		2
	3-1	17:00	6/1/99	2	1	1		1
	3-2	17:00	6/1/99	2	1	1		0
	1-1	5:00	6/2/99	2	1	1		1
	1-2	5:00	6/2/99	2	1	1		2
	1-3	5:00	6/2/99	2	1	1		1
12	1-5	5:00	6/2/99	2	1	1		0
	1-6	5:00	6/2/99	2	1	1		3
	3-1	9:00	6/2/99	2	1	1		1
	3-2	9:00	6/2/99	2	1	1		1
	4-1	9:00	6/10/99	3	1	0		1

	4-2	9:00	6/10/99	3	1	0		0
	4-3	9:00	6/10/99	3	1	0		1
	4-4	9:00	6/10/99	3	1	0		2
9	4-5	9:00	6/10/99	3	1	0		1
	4-6	9:00	6/10/99	3	1	0		1
	5-1	5:00	6/8/99	3	1	0		2
	5-2	5:00	6/8/99	3	1	0		1
	5-3	5:00	6/8/99	3	1	0		1
	5-4	5:00	6/8/99	3	1	0		3
	5-5	5:00	6/8/99	3	1	0		3
21	2-1	13:00	6/9/99	3	1	0		1
	2-2	13:00	6/9/99	3	1	0		3
	2-3	13:00	6/9/99	3	1	0		0
	2-4	13:00	6/9/99	3	1	0		0
	2-5	13:00	6/9/99	3	1	0		0
	2-6	13:00	6/9/99	3	1	0		1
22	4-1	5:00	6/9/99	3	1	0		2
	4-2	5:00	6/9/99	3	1	0		2
	4-3	5:00	6/9/99	3	1	0		1
	4-4	5:00	6/9/99	3	1	0		2
	4-5	5:00	6/9/99	3	1	0		1
	4-6	5:00	6/9/99	3	1	0		1
	3-1	5:00	6/10/99	3	1	1		3
	3-2	5:00	6/10/99	3	1	1		2
	1-1	17:00	6/8/99	3	1	1	4	2
19	1-2	17:00	6/8/99	3	1	1	3	2
	1-3	17:00	6/8/99	3	1	1		2
	1-5	17:00	6/8/99	3	1	1		1
	1-6	17:00	6/8/99	3	1	1		1
20	1-7	17:00	6/8/99	3	1	1		1
	2-1	17:00	6/15/99	4	1	0		1
	2-2	17:00	6/15/99	4	1	0	4	1
	2-3	17:00	6/15/99	4	1	0	4	2
	2-4	17:00	6/15/99	4	1	0		2
	2-5	17:00	6/15/99	4	1	0	4	1
10	2-6	17:00	6/15/99	4	1	0		1
	1-1	5:00	6/16/99	4	1	1		2
	1-2	5:00	6/16/99	4	1	1		2
	1-3	5:00	6/16/99	4	1	1		1
	1-5	5:00	6/16/99	4	1	1		1
11	1-6	5:00	6/16/99	4	1	1		2
	1-7	5:00	6/16/99	4	1	1		3
	4-1	17:00	6/22/99	5	1	0		2
	4-2	17:00	6/22/99	5	1	0		1
	4-3	17:00	6/22/99	5	1	0		1
	4-4	17:00	6/22/99	5	1	0		0
	4-5	17:00	6/22/99	5	1	0	-	0
14	4-6	17:00	6/22/99	5	1	0		1
	2-1	17:00	6/24/99	5	1	0	4	0

Appendix 3. Raw Behavior data 1999.

			the second se					
	2-2	17:00	6/24/99	5	1	0	4	1
	2-3	17:00	6/24/99	5	1	0	4	1
	2-4	17:00	6/24/99	5	1	0	1	1
16	5 2-5	17:00	6/24/99	5	1	0	4	1
	2-6	17:00	6/24/99	5	1	0	5	1
	3-1	5:00	6/23/99	5	1	1	4	2
	3-2	5:00	6/23/99	5	1	1	3	3
	1-1	5:00	6/25/99	5	1	1		0
	1-2	5:00	6/25/99	5	1	1		1
	1-3	5:00	6/25/99	5	1	1		1
	1-5	5:00	6/25/99	5	1	1		1
	1-6	5:00	6/25/99	5	1	1		1
23	3 3-1	17:00	7/14/99	9	1	1		0
	3-2	17:00	7/14/99	9	1	1		0
	1-1	5:00	7/15/99	9	1	1		0
24	1-2	5:00	7/15/99	9	1	1		0
	1-3	5:00	7/15/99	9	1	1		0
	1-5	5:00	7/15/99	9	1	1		0
	1-6	5:00	7/15/99	9	1	1		0
	1-4	17:00	5/25/99	1	2	1		0
	3-3	9:00	5/25/99	1	2	1		0
	3-4	9:00	5/25/99	1	2	1		0
	3-5	9:00	5/25/99	1	2	1		0
	1-4	13:00	5/27/99	1	2	1		0
	3-3	17:00	6/1/99	2	2	1		0
7	3-4	17:00	6/1/99	2	2	1		0
	3-5	17:00	6/1/99	2	2	1		0
	1-4	5:00	6/2/99	2	2	1		0
	3-3	9:00	6/2/99	2	2	1		0
	3-4	9:00	6/2/99	2	2	1		0
13	3-5	9:00	6/2/99	2	2	1		0
	3-3	5:00	6/10/99	3	2	1		0
	3-4	5:00	6/10/99	3	2	1		0
8	3-5	5:00	6/10/99	3	2	1		0
	1-4	17:00	6/8/99	3	2	1		0
	1-4	5:00	6/16/99	4	2	1		0
	3-3	5:00	6/23/99	5	2	1		0
	3-4	5:00	6/23/99	5	2	1		2
15	3-5	5:00	6/23/99	5	2	1		0
17	1-4	5:00	6/25/99	5	2	1		2
	3-3	17:00	7/14/99	9	2	1		0
	3-4	17:00	7/14/99	9	2	1		0
	3-5	17:00	7/14/99	9	2	1		0
	1-4	5:00	7/15/99	9	2	1		0