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Double-crested Cormorants: Adult Response To Egg Oiling

Georgian Bay and North Channel Region of the Great Lakes Ontario

Year Two: 2004
Peaceful Parks Coalition
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The Peaceful Parks Coalition is a volunteer citizen's coalition dedicated to preserving the ecological integrity of Ontario's wild spaces.

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Introduction

There is much research on Double-crested Cormorants (DCCO), especially since their numbers plummeted in the 1960s and 1970s because of toxic contaminates in the Great Lakes. After such contaminants were prohibited and cormorants began to recover, studies began focusing on their increasing numbers and the potential impacts their thriving population might have on other natural resources such as vegetation and other colonial birds. But since Double-crested Cormorants are skillful and impressive aquatic predators, most of the current studies focus on fisheries with the aim to suppress cormorant populations to increase fish species important to the sport fishery.

While researchers continue to record the number of cormorant nests and population trends, very little research is concerned with the cormorant itself as a recovering species. For example, little research currently explores how the growing cormorant population is influenced by natural limitations such as predation, the availability and crowding of nesting sites, nutritional requirements and their influence on prey selection or how its role as predator influences the overall aquatic ecosystem.

In 2003, The Peaceful Parks Coalition (PPC) began a multi-year observational study to measure the impacts of "egg oiling" on nesting adult Double-crested Cormorants in the Georgian Bay and North Channel region of Lake Huron in Ontario. The colonies under observation are part of a larger "egg oiling" program conducted by the Ontario Ministry of Natural Resources (OMNR).

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This year's study (2004) attempted to refine our findings from the previous year (2003). Last year, colonies that were not "oiled" successfully completed the nesting cycle. But "oiled" colonies displayed both early abandonment of nesting sites and extended incubation periods.

This year we expanded our study to four colonies – two oiled and two not oiled, and attempted to measure 1) whether cormorants are incubating oiled eggs longer than birds with "un-oiled" eggs; 2) the length of time between feeding periods, measured by incubation changeovers by nesting partners and; 3) compare this to birds that have lost their eggs to predation, re-nest and hence sit on nests for consecutive incubation periods.

We were successful in gathering some of the data we needed, but the overall study could not be completed as originally designed because during our field work we witnessed wide spread nesting failure in both the experimental and control colonies. The Ontario Ministry of Natural Resources also recorded a dramatic decline in cormorant population across the region, but offers no explanation as to the cause for the sudden collapse.

The value of our study therefore shifted to witnessing and documenting cormorants under extreme stress and the resulting nesting failure. This paper describes our observations and suggests that a severe food shortage caused wide spread nest failure among Double-crested Cormorants in the Georgian Bay and North Channel region of Lake Huron.

While reading through this paper, it is important to note that w e were unaware of any food shortage prior to our visitations to the colonies. We proceeded with our study as we had initially intended. It was only after observing cormorants that it quickly became apparent that their behaviour was quite different than the previous year.

Study Area and Method

The Georgian Bay and the North Channel region of the Great Lakes is the junction of Georgian Bay, Lake Huron, and Lake Superior and home to one of the largest concentration of nesting Double-crested Cormorants on the Great Lakes.

It is also a popular tourist destination for both naturalists and anglers and supports a commercial fishery. All these activities progressively intensify through the spring and summer months – the cormorant breeding season – with leisure motor craft activity being most prevalent. Cormorant colonies in this area are numerous but much smaller than the large concentrations seen in southern waters such as Lake Ontario. They nest on granitic gneiss (metamorphosis granite) rock and limestone islands and shoals, both inshore and open waters. Some of these colonies are situated on very busy water corridors and the birds have become tolerant of speeding motorboats.

Since our study is observational only, no samples were taken. We limited disturbance as much as possible. Nesting birds were observed during daylight hours for periods of approximately 8 -12 hours at a time. The primary observation method used to observe the birds was the utilization of a small tent in which the observer spent the total duration of the visits. The tent was pre-set prior to arriving at each colony, and a motorized boat was utilized in which the operator delivered and retrieved the observer in order to minimize the level of disturbance to each colony. Each colony was observed on consecutive days.

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The colonies under observation were Rock SW of St. Mary's Island, West Rock, Southwest Hawk Island (main colony only) and Hawk Island (this colony was referred to as the sister colony in our 2003 report).

Rock SW of St. Mary's Island is a limestone island located in a busy motorboat channel between the town of Killarney and Little Current, Ontario. This colony is fairly large for the area, reaching over 300 nesting birds. West Rock is a small remote limestone island in open water approximately 12 kilometres south of Killarney, and both Southwest Hawk Island and Hawk Island belong to a series of granitic gneiss (metamorphosis granite) rock islands collectively known as The Hawks Islands.

Nests on Rock SW of St. Mary's Rock and West Rock were "oiled" by the Ontario Ministry of Natural Resources. The nests from The Hawks Islands were "un-oiled".

All nests were ground nests.

While last year's study observed nesting cormorants throughout the colony, this year we narrowed our observations to 10 and 12 selected nests from each colony. Since we utilized the same method of observation as the previous year (a small tent), we were limited as to the selection of nests that could be marked and easily viewed from the observer's vantage point. Nests on the outer periphery of the colony were best viewed by the observer but were also most susceptible to predation. So we chose a combination of nests from the edge of each colony - some exposed with little protection from predation, and others under shrubs and/or nestled along boulders and more likely to escape predation.

Each nest was marked using a numbered plain cotton strip, and each egg was marked with non-toxic green paint. On every visit, the observer recorded the number of eggs in each marked nest upon arrival and departure. Any new eggs resulting from re-nesting were marked with red paint. Every 30 minutes the state of each nesting adult was noted.

Results

No cormorants were found nesting on Hawk Island. Last year, there was a colony of approximately 120 nests. We suspect this colony is fairly new, and possibly resulting from cormorants avoiding "oiling" activities on other more established colonies. It was not recorded during the census of cormorant colonies conducted by the Canadian Wildlife Service between 1971 and 2000.

Much of the nest construction on the Hawk Island colony was rudimentary and few survived over winter – another indication the colony was hastily established, and/or colonized by young breeding birds. Older colonies have large, tall sturdy nests that survive the winters, and are rebuilt and maintained and used again each nesting season.

Cormorants nested on the remaining three colonies, but each colony was smaller than the previous year, except for Southwest Hawk Island. It should be noted that the total nest count for Southwest Hawk Island includes all sub-colonies, however the main colony under observation declined from 42 active nests in 2003, to 29 in 2004. A slight increase occurred in a well protected splinter group.

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West Rock – oiled
2003 - 169 active nests *
2004 – 112 active nests

Rock SW of St. Mary's Island - oiled
2003 – 382 active nests
2004 – 257 active nests

Hawk Island (sister island) – not oiled
2003 – approximately 120 active nests
2004 – no active nests

Southwest Hawk Island – not oiled
2003 – 94
2004 – 113

Other colonies
Heywood Rock - oiled
2003 – 71 active nests

**Nest counts were done only after colonies had abandoned. We counted nests by dropping a marker in all apparently occupied nests (AONs) - nests that were built up and remained moist inside. The markers were then collected and counted.*

Since 2001, the Ontario Ministry of Natural Resources has been conducting the census of nesting Double-crested Cormorants in Georgian Bay and the North Channel, and this year they recorded a 50% decline over 2001 population levels across the region. This decline was not observed in the southern portion of the Great Lakes.

It has been suggested that the cormorant population has possibly reached its carrying capacity within the natural environment, but our observations suggest a severe food shortage caused cormorants to either: abandon nests during incubation; decide not to re-nest after a clutch has been lost to predation; or forego nesting altogether.

May 30, 2004
First Visit To Colonies
We surveyed each colony and marked nests and eggs for the study. We did not stay and observe the colonies on this visit because marking nests, eggs and the presence of the observer would create too much of a disturbance.

already incubating eggs. Neither cormorants nor gulls were nesting on Hawk Island (sister colony). On this visit, our boat operator identified a red fox on the island. The presence of the fox could have delayed the nesting season. While no cormorants nested here this year, a small colony of Herring Gulls eventually completed the nesting cycle.

Six nests were marked on both Southwest Hawk Island and Rock SW of St. Mary's Island. On the second visit, the number of marked nests would increase to 10 for Southwest Hawk Island and 12 for Rock SW of St. Mary's Rock.

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Eggs in each nest:

Southwest Hawks Island – not oiled

Nest	1	2	3	4	5	6
Eggs	4	3	3	3	1	5

Rock SW of St. Mary's Island – oiled

Nest	1	2	3	4	5	6
Eggs	4	2	4	3	1	4

June 5, 2004

Southwest Hawk Island – unoiled

We marked an additional 4 nests for a total of 10 marked nests. The initial marked nests were too close to a large shrub, and escaped predation the previous year. Since our study is strictly observational, we could not simulate nest failure to measure the impacts of re-nesting and consecutive incubation periods. The 4 additional nests were located on the colony's outer edge, and most likely to be attacked by gulls.

We observed the colony on this visit. The tent placement was approximately 10 metres away.

Eggs In Nests Upon Arrival – 9:17am

Nest	1	2	3	4	5	6	7	8	9	10
Eggs	4 orig.	0	3 orig. 1 new	3 orig.	1 orig. 2 new	5 orig.	4	2	1	2

Unlike last year, the birds were very skittish – slow to return to the colony after the arrival of the observer and slow to resume nesting once they returned. A full 45 minutes passed before cormorants returned to this colony, and another 15 minutes passed before cormorants resumed nesting. The Herring Gulls were also slow to return to the island after the initial disturbance caused by our arrival, but the gulls always return before cormorants

In a span of 25 minutes, gulls stole 11 eggs from cormorant nests.

Cormorants eventually resumed nesting but were easily scared off their nests. Simple movements by the observer inside the observational tent was enough to scare nesting cormorants, therefore the observer refrained from taking any photographs or video. **

Within the first 2 hours, cormorants took flight on 7 occasions. Each time, they circled once overhead and returned immediately. During this time, gulls took the opportunity to steal eggs.

The observer arrived on the colony at 9:17am. The birds did not resume steady, uninterrupted nesting until approximately 12:30pm. During this visit, we did not record a switch of nesting duties between partners.

A very cold wind blew from the east.

Eggs In Nests Upon Departure – 5pm

Nest	1	2	3	4	5	6	7	8 *	9	10
Eggs	4	0	4	3	2	5	4	?	0	2

**this nest was missed*

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June 6, 2004
Rock SW of St. Mary's Island - oiled

Eggs In Nest Upon Arrival – 7:50am

Nest	1	2	3	4	5	6
Eggs	4 orig.	2 orig.	1 orig.	3 orig.	0	3 orig.

This colony presented another problem for the study in so far as the colony had very little protection from predation except for a few large boulders. Therefore, nests were clustered tightly together within a beak radius. Clustering nests together makes search "foot patrols" by scavenging gulls difficult, but also difficult to identify individual nesting birds for this study.

Six additional nests were marked on this visit. The first nests marked were along the largest boulder, the additional six nests were chosen for their visibility from the observational tent. The tent was approximately 15 metres away.

Markers had also been moved from one nest to another and/or removed altogether as cormorants stole nest materials from other nests.

***It is difficult to say whether the tent placement had an impact on nesting birds from the main colony. Last year, the tent was placed 15 metres away from the main colony and closer, 10 metres, to a smaller sub colony. In the previous year, the sub colony was always slower to return to their nests than the main colony. Nesting cormorants in the main colony appeared to be unaffected by the observational tent. This year, the opposite was true. The smaller colony appeared to ignore the observer, while the main colony, while tolerant of the presence of the observer, was much more cautious and skittish. Perhaps the placement of the tent crossed a threshold in which its presence caused a subtle but distinct ongoing disturbance. However, both colonies were reluctant to return to their nests this year after disturbance*

This colony was divided into two sub colonies of, more or less, equal size. The sub colony under observation was slightly larger and physically higher than the smaller sub colony. The smaller colony was situated in a slight depression and away from the Herring Gull colony. It fared better against gull predation.

This colony displayed similar behaviour to that of Southwest Hawk Island the previous day. The birds were skittish and took flight on several occasions, but returned immediately. Gull predation was heavy.

The day was cold, windy and at times it rained heavily. For the better part of the day, birds remained on their nests with their heads tucked away. Even the gulls were grounded. On this occasion we observed two sets of partners switching nesting duties. This occurred mid afternoon, approximately 3pm.

Eggs In Nests Upon Departure – 4:15pm

Nest	1	2	3	4	5	6	7	8	9	10	11	12
Eggs	3 or.	0	0	3 or.	0	0	3 or.	0	0	1 or.	3 or.	0

June 12, 2003
Southwest Hawk Island – unoiled
Eggs In Nest Upon Arrival – 8am

Nest	1	2	3	4	5	6	7	8	9	10
Eggs	4 orig.	0	4 chicks	0	0	1 orig.	3 orig.	0	0	2 orig.

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A strong and cold easterly wind prevailed on this day. The force of the wind collapsed the observational tent, and possibly prevented cormorants from returning to the colony. Once we flushed the birds upon our arrival, they did not resume nesting until the wind subsided. By mid-afternoon, approximately 4pm, the wind suddenly dropped and the day quickly became very hot. The birds then returned.

During the windstorm, cormorants congregated just below the nest site, along a soft sloping depression. We observed them flocking to this area but could not observe them directly once perched. The usual perching area for the main colony was an open rock ledge, just above the colony. The colony was built along its edge. On that day, this perch would have been exposed to the high wind. A popular loafing shoal on the eastward side of the island was also abandoned. The water was too rough and white capped.

During the absence of nesting cormorants, gulls raided and completely emptied all nests including the four young chicks. In rapid fire, using aerial attack, the gulls swooped down and took one chick after another within seconds.

With empty nests, the cormorants resumed nesting. Eventually, birds began preening and perching. By 7:30pm, birds begin to return en masse and perch on shore rocks.

On departure at 7:58, we observed all sub-colonies. All nests were empty except in the largest sub-colony nestled along a fissure between granite bedrock and under shrubs. This colony was protected from the wind and faired better against predation. Only the outer nests were empty. Young chicks survived.

June 13, 2004
Rock SW of Mary's Island - oiled
Eggs In Nest Upon Arrival – 7:50am

Nest	1	2	3	4	5	6	7	8	9	10	11	12
Eggs	3 or.	0	1 new	0	1 new	0	3 or.	0	0	1 or.	3 or.	0

The day was hot and sunny but a cold breeze prevailed. Many of the birds remained nestled on their nests with heads tucked. Many nests still contained eggs especially within the centre of the colony, but many of the peripheral nests were empty.

The colony was more active on this occasion, with many birds preening, and returning from foraging. Partners who had lost their clutch to predation displayed mating behaviour, and on more than one occasion non-nesting female birds attempted to occupy empty nests of other cormorants and/or oust resident nesting birds. These encounters were subtle but persistent. However, birds continued to be alarmed and took flight on several occasions, always returning immediately

On departure, at approximately 5pm, all the marked nests were empty except nest 1) which contained its 3 original eggs. The female cormorant remained on the nest throughout the observation period.

Eggs In Nest Upon Departure – 5pm

Nest	1	2	3	4	5	6	7	8	9	10	11	12
Eggs	3 or.	0	0	0	0	0	0	0	0	0	0	0

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June 21, 2004
West Rock - oiled

There was no nesting activity on our first visit on May 30, 2004. As last year, this colony was last to commence nesting. On this visit, we marked ten nests.

Eggs in Nest Upon Arrival – 7:38am

Nest	1	2	3	4	5	6	7	8	9	10
Eggs	3	2	3	4	1	3	2	1	2	2

The day was once again, overcast, cold and very windy, only reaching 14 degrees Celsius. This colony is surrounded by tall dense vegetation, so the observer attempted to observe the birds through the cover of vegetation, as opposed to the observational tent that would flap in the wind.

Last year, our tent placement was only 3 metres away from the edge of the colony. Large boulders and rocks made tent displacement difficult, yet cormorants returned to the colony. This year our observer was amongst tall vegetation and farther away, approximately 13 metres, but after the initial disturbance created by our arrival, cormorants did not return to the colony.

At approximately, 12pm the observer emerged and surveyed the colony.

Nest	1	2	3	4	5	6	7	8	9	10
Eggs	3	1	3	4	0	2	2	1	2	2

While the marked nests survived the morning "raid" by gulls, predation throughout the colony was high. It could be that the presence of the observer assisted in protecting these nests from predation. All other nests had their eggs "stolen" with only a few exceptions.

The colony was smaller than the previous year, and there were many empty nests. West Rock is an old colony. Many of the nests are very tall, built up over many generations, and remain intact from year to year. The empty nests were not a result of predation, but rather were not used at all this year. They were dry inside and no new nesting material was weaved amongst the old sticks.

I moved off the colony to the farthest point on the island, approximately 125-150 meters away. At this point there seemed little purpose in observing the birds as initially planned. It has become quite apparent that something was ailing the birds. They were skittish, not foraging, and predation levels high.

I observed cormorants rafting from this vantage point for the remainder of the day. Cormorants continued to fly over the colony but did not resume nesting. By late afternoon, cormorants begin to gather in large rafts, others returned to the colony but took flight almost immediately. By 6pm, the wind calmed and the birds began loafing along the shore.

Eggs in Nest Upon Departure - 7pm.

Nest	1	2	3	4	5	6	7	8	9	10
Eggs	0	0	0	0	0	0	0	0	0	0

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June 26, 2004

Rock SW of St. Mary's Rock - oiled

This day was extremely cold and windy, but sunny. Frost had fallen during the night. We initially flushed the birds at 8:18am, but had trouble landing the boat because of large waves crashing onto the rocks. During this time cormorants had returned to the colony, but only to be flushed again by the arrival of the observer.

Eggs In Nest Upon Arrival – 8:43am

Nest	1	2	3	4	5	6	7	8	9	10	11	12
Eggs	0	n.g.	3 n.e.	n.g.	1 n.e.	0	2 n.e.	0	0	0	0	n.g.

n.g.=nest gone n.e=new eggs

The wind was strong from the west. Cormorants were not able to fly directly into the wind. All birds were down with their heads tucked. There was little movement or preening. Regardless of whether eggs were present, birds nestled down into their nests. On this day we witnessed more aggressive behaviour amongst both cormorants and gulls jostling for "squatting rights" on nests. One cormorant temporarily left its nest unattended, only to be quickly occupied by a Herring Gull. The nest was empty and the gull immediately nestled down on the nest. It was ousted upon the return of the resident cormorant.

Since there was very little movement by cormorants, it appeared gulls devised a method - a "false alarm" - to remove cormorants from their nests, after which gulls, using aerial attacks, raided the nests.

On more than one occasion, gulls appeared to sound an alarm call. This in turn alerted cormorants and they simultaneously fled. However, the gulls did not, and neither incubating cormorants – nest 3 and 7.

The cormorants returned immediately after one rotation over the colony, but within this time, gulls efficiently raided nests. The action of the gulls seemed very strategic and nests raided seemed pre-planned. Windy conditions appeared to enhance the ability of gulls to detect vulnerable nests by hovering low over the colony. Once cormorants fled, gulls swiftly attacked them from the air.

The wind gained strength throughout the day, but it remained sunny. The water was very rough. By late afternoon, the wind calmed, and birds began returning to the colony. At 6:15pm, the female returned to nest 3 and relieved her partner. The male has been incubating eggs since our arrival.

However, approximately an hour later, cormorants took flight en masse, and in rapid succession, three gulls stole the remaining three eggs in the nest. The female cormorant returned to an empty nest.

Upon departure, a quick survey of the colony revealed all nests to be empty with very few exceptions. The lower sub colony fared better against predation. Eggs remained in many nests.

Eggs In Nest Upon Departure – 7:45pm

Nest	1	2	3	4	5	6	7	8	9	10	11	12
Eggs	0	n.g.	0	n.g.	0	0	0	0	0	0	0	n.g.

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June 27, 2004
Southwest Hawks Island - unoiled
We knew as we approached the colony that it was deserted. No birds were flushed upon our arrival. A survey of the colony revealed complete abandonment of all sub colonies including the largest sub colony. This colony escaped heavy predation and had young chicks in approximately 5 nests on our last visit on June 12, 2004.

There was no evidence of heavy predation - no obvious litter of broken eggshells or remnants of dead chicks. Although vandalism seemed the obvious conclusion, the Ontario Ministry of Natural Resources took a census of the colony on June 24, and recorded all eggs were broken. No other details were noted. **

We searched for cormorants before we left the area, and discovered a large flock perched on another nearby island.

July 16, 2004
West Rock – oiled
West Rock was also deserted, and no eggs were found in nests. However, the Ontario Ministry of Natural Resources reported oiling 74 nests on July 9, 2004. Therefore, this colony attempted to re-nest after our visit of June 21, 2004, but appears to have lost all its eggs once again to predation. Cormorants were seen in the vicinity.

It appeared that cormorants utilized the marked nests after our last visit because the markers were covered in guano and not easily identifiable.

Discussion

The disturbance created by our visits to these colonies is not enough to explain the rate of nest failure observed. This study obviously contributed to eggs lost to gull predation, but nesting cormorants were also hesitant to defend their nests, and many did not attempt re-nesting after a brood was lost to predation. The adults seemed weak.

The strong winds and cold weather most likely created difficult foraging conditions for Double-crested Cormorants by creating rough surface waters and strong head winds. Rough surface waters could also have prevented gulls from fishing. However, these conditions appeared to enhance the ability of gulls to detect vulnerable cormorant nests by hovering over colonies. Windy conditions increased manoeuvrability by gulls, and they used aerial attacks to strike cormorant nests. The strikes were rapid and efficient.

Wind and poor weather conditions also decreased the activity of cormorants. In times of calm weather, eggs and chicks are exposed to predators briefly, usually during times of preening or incubation changeover. On these occasions, gulls will attack on foot. But during periods of strong winds, cormorants did not move off their nests, therefore gulls appeared to devise a method – a false alarm – to scare cormorants off their nests.

***Commercial fishers and recreational anglers perceive cormorants as competitors for fishery resources and have been known to vandalize cormorant colonies.*

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The success of gull predation as witnessed this year is probably a result of both difficult foraging conditions created by rough waters, and a shortage of food supply. Cormorant colonies then became an important alternative food source for gulls. These same environmental conditions would have weakened adult nesting cormorants because cormorants feed exclusively on fish. They have no alternative food source. Windy conditions alone are not enough to explain the successful attacks by gulls on cormorant nests because while aerial attacks by gulls increased, foot patrols are the overall more successful foraging technique (Gilchrist, Gaston, Smith, 1998).

Food supply is believed to be the ultimate factor defining reproductive performance. The crudest level for the role of food in reproductive performance concerns the bird's decision whether to breed or not. There must be enough food supply for the young. Successful breeding is often dependent on reserves the female has accumulated over winter. So while birds may begin nesting, a food shortage occurring later in the season would deplete energy reserves and cause nest desertion by nesting parents. Food supply could also determine the size and laying date of the clutch.

Initial clutch size, from our sample group, on colonies Southwest Hawk Island and Rock SW of St. Mary's Island averaged 3 eggs per nests. The optimal clutch size is 4 eggs per nest (Hatch and Weseloh, 1999). West Rock, which begins nesting later than other colonies in the area, had a smaller clutch size, averaging 2.4 eggs per nest.

The colonies were also smaller overall. The Ontario Ministry of Natural Resources reported a 50% decline over 2001 population levels across the region. The Ministry concludes that their two year "oiling" program was not likely the cause of the decline. The smaller nesting colonies could reflect a decision by experienced breeding birds to refrain from breeding this year in an extraordinary response to extreme environmental conditions (Aebischer and Wanless, 1992) .

Once cormorants lost eggs to predation, many chose not to re-nest. Female energy reserves accumulated over winter were possibly depleted by this time, and the cost of energy needed to collect food for a second brood was too high. The size of food items, the distance of food sources, weather conditions, predation levels combined with food abundance will influence a bird's decision to nest.

The smaller nesting colonies, smaller clutch sizes and the lack of re-nesting by adults that lost their eggs to predation, combined with the heavy predation levels by gulls, lead us to conclude that a severe food shortage occurred in the Georgian Bay and North Channel region of Lake Huron throughout the nesting season.

The Double-crested Cormorant diet consists mostly of alewife in Lake Huron. Alewife is an exotic fish species and the most abundant prey fish throughout the Great Lakes. Few alternative food sources exist. This year The Ontario Ministry of Natural Resources report a collapse in the alewife population in Lake Huron.

The abundance of alewife in the lake is mainly influenced by both the success of the hatch of young each spring and their survival over their first winter. Since alewives are on the northern edge of their range they are susceptible to cold weather during both these critical periods.

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The Ministry went on to explain:

"The 2002 year class of alewife was average in abundance but the winter of 2002/2003, which saw almost complete ice cover on Lake Huron and a late spring, resulted in the alewife population suffering high levels of winter mortality. Assessment netting conducted early in 2003 confirmed that the Lake Huron alewife population suffered substantial losses of both young and older fish during the winter of 2002/2003.

The 2003 year class of alewife was extremely abundant, the highest on record. However, the negative aspect of such an abundant year class is that often these fish compete with each other for available food and therefore their growth is lower than normal. This appears to have been the case and growth rates were low for young alewife in the summer of 2003. Netting conducted during May of 2004 has confirmed that survival of last year's young alewives was very poor over the winter of 2003/2004. The current situation is a precedent as it is characterized by two very poor year classes of alewife, back to back." (Reid, OMNR 2004).

The abundance in alewife correlates with cormorant nest numbers on Lake Huron. The nesting population of Double-crested Cormorants peaked in 2001 at 12,000 nests. It then declined in 2002, increased slightly in 2003 and collapsed by 50% from 2001 levels in 2004.

The decline in alewife is most likely the main factor contributing to the collapse in the number of nesting cormorants. It most likely influenced non-breeding by experienced adults because the sharp drop in nest numbers cannot be explained by poor weather conditions alone or a food shortage occurring later in the season. However, a food storage throughout the season, wind and poor weather conditions, and high predation levels probably caused birds that decided to nest to abandon the nesting season.

If the smaller nesting colonies reflect a decision by experienced breeding birds to refrain from breeding this year, then the reduced size of the colonies may not be an accurate indicator of overall population levels. Population levels are primarily measured by nest counts. The number of nesting birds might rebound next year if environmental conditions are favourable, but the lack of productivity this year will most likely impact populations levels over the next few years.

Our study as originally designed could not go forward this year because of the broad collapse of nesting cormorant colonies. The only information that could contribute to the original study is the duration of feeding periods. After observing nesting Double-crested Cormorants for two years, we believe that feeding periods, measured by nesting changeovers by partners, expands several hours, possibly up to eight hours, not including overnight periods.

Changeovers for Double-crested Cormorants have been measured between 1-3 hours (Hatch and Weseloh, 1999), but in the Georgian Bay and North Channel area, foraging areas expand up to 20km according to the Ontario Ministry of Natural Resources. While cormorants may return within 1-3 hours, such a large foraging radius suggests a longer time away from the nest. We witnessed partners returning to nests with twigs or water for their partners but these visits did not always result in nesting changeovers. We witnessed the majority of nesting changeovers in mid to late afternoon. These would be the first changeovers witnessed after observing the colonies for several hours within each observational day.

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Suggestions For Future Study

Study of the Double-crested Cormorant must go beyond simple bird biology and/or their impacts on sport fish. These birds have been absent from the local ecology for several decades, and only in the last fifteen years have cormorants resumed their colonial waterbird status within the Great Lakes system. They are once again a vital part of the overall ecology and it is important to understand how their presence links into the health of the Great Lakes aquatic, avian and terrestrial system.

For example, Herring Gulls, as predators of cormorant eggs, benefit from the presence of nesting cormorants. They also control the cormorant population through predation. Cormorant colonies, on the other hand, control the gull population by limiting available gull nesting areas. It is important to understand the interrelationship of predator to prey. Such a study would require observing the predator, in this case, the Herring Gulls.

We also suggest studying the condition of arriving Double-crested Cormorants from their wintering grounds. Increased harassment from U.S. jurisdictions could impact the health of migrating cormorants, especially if they are being harassed all along their migration route. Migratory birds need places to rest and feed while on their journey. Continual harassment along the "flyby" routes could ultimately weaken the birds and prevent them from accumulating energy reserves vital for successful nesting.

The Peaceful Parks Coalition has begun looking at migration routes for cormorants nesting on Lake Huron and tracking policy pertaining to the management of Double-crested Cormorants in "flyby" U.S. states, hoping to determine whether ongoing harassment of migrating cormorants could possibly contribute to their ill health.

We also encourage further research on nutritional requirements and how fish-eating birds reflect the overall health of the aquatic system.

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