ONTARIO BIRDS

VOLUME 27 NUMBER 1
APRIL 2009

JOURNAL OF THE ONTARIO FIELD ORNITHOLOGISTS

ONTARIO BIRDS

VOLUME 27 NUMBER 1
APRIL 2009
PAGES 1— 56

ARTICLES

Cover Illustration: Golden-winged and Blue-winged Warblers
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ISSN 0822-3890
Publications Mail Agreement No. 40046348

Golden-winged Warbler, female.

Golden-winged Warbler, male.
Photo: Laurie Smaglick-Johnson

Population densities of Golden-winged Warbler, Blue-winged Warbler and their hybrids, in eastern Ontario

Assessment with standardized survey protocols and mapping using Geographic Information Systems (GIS)

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Introduction

Golden-winged Warblers (*Vermivora chrysoptera*) have long fascinated birders and ornithologists alike, due in part to their flashy plumage, distinctive songs, and ability to hybridize with the closely related Blue-winged Warbler (*Vermivora pinus*). The Golden-winged Warbler population near the Queen's University Biological Station (QUBS) north of Kingston, Ontario, has been the subject of extensive, ongoing study since 1997. However, researchers have never systematically surveyed tracts of land to estimate densities of Golden-winged and Blue-winged Warblers or their hybrids in the area. We present survey protocols and results from populations at QUBS; these baseline data are crucial in order to develop a long-term conservation strategy for the declining Golden-winged Warbler. Detailed population data from QUBS also has the potential to act as a case study, providing an in-depth example of how abundances might change through time in other locations. Population surveys are particularly important in light of current threats to Golden-winged Warblers that include the advancing range of Blue-winged Warbler populations and habitat loss.

Distributions, habitat and ecology of Golden-winged and Blue-winged Warblers

Golden-winged Warblers breed from extreme southeast Saskatchewan, southern Manitoba and Minnesota, east through southern Ontario and southwest Quebec, and south to Georgia

Golden-winged and Blue-winged pair. *Photo: Laurie Smaglick-Johnson*

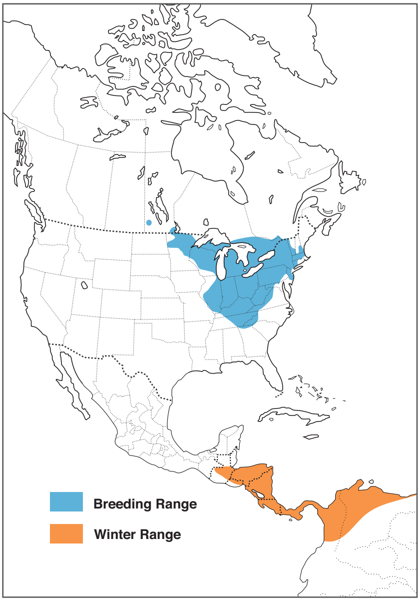


Figure 1. Summer (breeding) range, shown in blue, and winter (non-breeding) range, shown in orange, of the Golden-winged Warbler.
Source: Birds of North America

Figure 2. Summer (breeding) range, shown in blue, and winter (non-breeding) range, shown in orange, of the Blue-winged Warbler.
Source: Birds of North America

(Confer 1992, COSEWIC 2006; Figure 1). They are Neotropical migrants, wintering in a large area from southern Mexico, through Central America, to northwestern South America (Mills *in* Cadman *et al.* 1987a; Figure 1). The Blue-winged Warbler breeds from South Dakota to Oklahoma to South Carolina, and into southern Ontario (Gill *et al.* 2001; Figure 2). They winter from mid-Mexico through the coasts of Central America, and south to Panama (Mills in Cadman *et al.* 1987b; Figure 2). Both species breed in open, early successional areas where most vegetation is less than three metres in height (Mills *in* Cadman *et al.* 1987a, b, Hunter *et al.* 2001). Territories also contain deciduous trees used as singing perches, and are often positioned along a forested edge (Confer 1992). Surrounding trees are essential for foraging on moth larvae and caterpillars (Confer 1992, Demmons 2000).

Golden-winged and Blue-winged Warbler distributions have undergone a series of changes with breeding range expansions and contractions over the past century or more (Hamer *et al.* 2005). These changes correlate closely with patterns of human land use and changes to management practices (Confer *et al.* 2003). Golden-winged Warbler distribution expanded northward from the Appalachian region into Ontario in the early 1900s, Manitoba and Saskatchewan as early as the 1960s, and Quebec in the

1970s (Hamer *et al.* 2005, COSEWIC 2006). Blue-winged Warblers, historically west of the Appalachians and south of the Great Lakes, began to expand northward beginning in the 1860s, and eventually reached Minnesota, Ontario and the southern New England states (Mills *in* Cadman *et al.* 1987b, Vallender *in* Cadman *et al.* 2007b).

Conservation concerns

Golden-winged Warblers are declining across most of their range in Canada and the United States. Populations in Ontario have declined by approximately 12% per year during the past ten years (Gill 1997, Sauer *et al.* 2005), leading them to be classified as Threatened by the Committee on the Status of Endangered Wildlife in Canada and protected under the Species at Risk Act (COSEWIC 2006, 2007). In Canada, populations were growing until 10 years ago, likely because of a northeastward range expansion. Since that time, the species has started to disappear from regions in the southernmost portions of Ontario (presumably due to the arrival of the Blue-winged Warbler and subsequent hybridization; COSEWIC 2006). Moreover, it has been suggested that the species may have reached the uppermost limits of suitable habitat within Ontario (K.V. Rosenberg pers. comm.). Considered in concert, these factors are likely both contributing to why the increasing trend in the province is no longer occurring.

Loss of early successional habitat is thought to be the primary factor behind range-wide Golden-winged Warbler declines (Smith *et al.* 1993, Confer and Larkin 1998); this is caused by the anthropogenic suppression of natural forest fires (Hunter *et al.* 2001), and encouragement of forest regrowth after disturbance or abandonment. Evaluation and conservation of suitable habitat will therefore be critical for slowing declines of the Golden-winged Warbler. Another factor in the decline of Golden-winged Warblers may be nest parasitism by the Brown-headed Cowbird (*Molothrus ater*). Cowbird parasitism may be particularly important in declines in the United States; the impact in Canada is largely unknown (Confer *et al.* 2003, COSEWIC 2006).

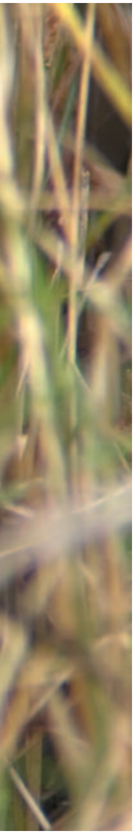
Hybridization is another cause for concern. Blue-winged and Golden-winged Warblers can mate to form two recognized types of hybrids, as well as a wide range of hybrids which are not easily classified as either type, and are, therefore, classified as introgressed. The two main hybrid types are designated by different plumages and known as "Lawrence's" and "Brewster's" (Brewster 1874, Parkes 1951), so named because they were once considered separate species (Lawrence's Warbler and Brewster's Warbler).

These hybrids are both rare in Ontario, with the Brewster's hybrid found most often around the Niagara Escarpment and Oak Ridges Moraine, along the southern edge of the Canadian Shield, and in the Long Point area (Vallender and Leckie *in* Cadman *et al.* 2007). The Lawrence's hybrid, the much rarer form, was

Golden-winged Warbler nest. *Photo: Laurie Smaglick-Johnson*

reported as a possible, probable or confirmed breeder in only five Ontario locations, during the course of surveying for the second Atlas of the Breeding Birds of Ontario (Cadman *et al.* 2007). Breeding was reported as possible in one square in the region of Waterloo, possible in two squares and probable in one square in the region of Hamilton, and confirmed at one location near Elgin, close to QUBS (Vallender and Leckie *in* Cadman *et al.* 2007).

Although a sighting of one of these rare birds can be exciting, they signal a growing problem for the persistence of Golden-winged Warblers. As the Blue-winged Warbler's range expands northward, hybridization between the species has been implicated in Golden-winged Warbler declines. 'Pure' Golden-winged Warbler genes can become extirpated from local populations, a process termed "genetic swamping" (Gill 1997), although these genes can also persist in the population within hybrids (Dabrowski *et al.* 2005). At present, there is no evidence that hybrids are at a disadvantage compared to the parental species in this system (Vallender *et al.* 2007a), so numerically



dominant Blue-winged Warblers may be able to 'swamp out' Golden-winged Warblers after a short period of contact.

However, given that gene flow is bidirectional between these species (Shapiro *et al.* 2004, Dabrowski *et al.* 2005), it should be noted that the mechanism by which Blue-winged Warblers replace Golden-winged Warblers in areas of contact remains largely unknown (Vallender *et al.* 2007b). Over the past century, the Blue-winged Warbler has replaced the Golden-winged Warbler in substantial regions of its historic breeding range, especially at lower elevations west of the Appalachian Mountains and in the area to the south of Lake Ontario and Lake Erie (Dabrowski *et al.* 2005, Hamer *et al.* 2005). Establishment of Blue-winged Warbler populations usually coincides with decreases in local Golden-winged Warbler populations, with complete replacement typically occurring within 50 years of Blue-winged Warbler arrival (Gill 1980, 1987, 1997). The only known site where this has not yet occurred is in New York State, where the two species have co-existed for over 100 years (Confer and Tupper 2000).

Though interactions with Blue-winged Warblers may play a large role in the decline of Golden-winged Warblers, the relative contribution of competition versus hybridization to the declines remains unknown (Gill 1997, Vallender *et al.* 2007b). In addition, the relative importance of Blue-winged Warblers amid other factors, such as habitat loss and parasitism, in Golden-winged Warbler declines remains poorly understood and appears to depend on the geographic location of the population (COSEWIC 2006). Habitat loss is severe in some areas yet nonexistent in other areas where the species is nevertheless declining (J.L. Confer pers. comm.); Blue-winged Warblers are absent from some declining Golden-winged Warbler populations, and the prevalence of nest parasitism varies across the range (Confer *et al.* 2003, COSEWIC 2006).

Golden-winged Warblers and Blue-winged Warblers in Ontario

Golden-winged Warbler males begin to arrive in Ontario in early May, and are followed thereafter by females, who breed between early June and mid-July (COSEWIC 2006). In southern Ontario, Golden-winged Warblers have shown recent declines and range contractions which have been paralleled by a northward expansion of the Blue-winged Warbler into many areas of southern and eastern Ontario (Mills *in* Cadman *et al.* 1987a,b, Vallender *in* Cadman *et al.* 2007 a,b). Hybridization occurs in all areas where these two species come into contact (Gill 1997).

The Golden-winged Warbler's Ontario range spans from the northern shore of Lake Erie near London, to the eastern edge of Lake Ontario near Kingston north to Ottawa, Sudbury and Spanish, including the Bruce Peninsula. Separate from this area, there is a small group south of Kenora near Lake of the Woods (COSEWIC 2006). An estimated 18.2% of the global population of Golden-winged Warblers (estimated at 105,000-270,000 breeding pairs) reside in Ontario each breeding season, with the majority of these birds concentrated in southern Ontario (Vallender *in* Cadman *et al.* 2007a, K.V. Rosenberg, pers. comm.). Blue-winged Warblers are now distributed throughout much of southern Ontario, as far north as the east shore of Georgian Bay (Vallender *in* Cadman *et al.* 2007b). Initially recorded in Ontario in the early 1900s, Blue-winged Warblers were confirmed to be breeding by the 1950s and the species has been increasing in local abundance since then (McCracken 1994, Vallender *in* Cadman *et al.* 2007b). Blue-winged Warblers were confirmed to be breeding at QUBS in 2005 (R. Vallender unpublished data), but likely first arrived in the late 1980s, albeit in very low numbers (Weir 1989, R.J. Robertson and T. Demmons unpublished data).

Studies at Queen's University Biological Station

The Golden-winged Warbler population of approximately 200 breeding pairs near the Queen's University Biological Station (QUBS) north of Kingston (44°34N, 76°19 W, Leeds & Grenville and Frontenac Counties) has been extensively studied since 1997. These studies have provided excellent long-term breeding, demographic and genetic data, some of the best available for the species. Investigations have ranged from nesting habitat, site fidelity, feeding behaviour, reproductive performance, migratory origins, plumage and genetic relationships between Golden-winged and Blue-winged Warblers (Demmons 2000, Paquin 2006, Reed *et al.* 2007, Vallender *et al.* 2007a,b, Fraser *et al.* 2008, McKinnon and Robertson 2008, Neville *et al.* 2008). This extensive research has required males to be colour-banded for individual identification. These banding efforts provide an excellent opportunity for surveys such as ours, allowing us to use colour band sightings to confirm auditory point count observations and differentiate between males on neighbouring or overlapping territories.

The study sites at QUBS are within the hybrid zone, yet right at the northern, expanding edge of the Blue-winged Warbler distribution. The northernmost hybrids in Ontario have been found approximately one hundred kilometres north of our study sites, west of Ottawa (Vallender and Leckie *in* Cadman *et al.* 2007). This is an area of recent, yet active, hybridization (Vallender *et al.* 2007b).

Given the historical and continuing expansion of Blue-winged Warblers northward, there is a need to document changes in Blue-winged Warblers and their hybrids in terms of their relative and absolute abundance, habitat use, and breeding sites at QUBS, as well as at other sites in Ontario.

No Blue-winged Warblers or hybrids were detected on QUBS land when research began in 1997 (T. Demmons unpublished data) and were not thought to be present in the area (Weir 1989), yet one or two Brewster's hybrids were present in 1991 and an introgressed Blue-winged Warbler hybrid was found on QUBS property from 1991-1993 (Martin and Robertson 1994). With continual study, the arrival of Blue-winged Warblers and increasing numbers of hybrids at this site have been documented. The population at QUBS provides the unique chance to follow a population from its initially pure Golden-winged Warbler demographic through to the predicted complete turnover to pure Blue-winged Warbler, monitoring hybridization throughout.

Our investigation aimed to estimate population densities of Golden-winged Warblers, Blue-winged Warblers and their hybrids (Brewster's, Lawrence's and introgressed) for the first time in a systematic way on QUBS property. This provided baseline data that can be used in long-term monitoring of population densities, hybridization and habitat use of these species. We also colour banded new males to allow continued estimates of return rates for this population. By surveying three different areas containing a variety of successional land types, we can follow population shifts with habitat changes that include both loss and gain of suitable habitat. These baseline data will allow researchers to document future changes in populations around QUBS. This project holds incredible potential to inform conservation and management plans across the Golden-winged Warbler range, especially in Ontario.

Methods

Survey sites

Our three survey sites were chosen based on their previous roles in Golden-winged Warbler studies at QUBS, confirmed breeding pairs and varying degrees of succession.

The Pangman Conservation Reserve near the village of Chaffey's Lock, is one of the central QUBS properties and has been used for a variety of wildlife studies for many years, including multiple Golden-winged Warbler projects mentioned earlier. The Pangman survey area measured 152 ha, or 1.52 km^2. The area contained five large marsh areas, one lake, and a portion of a second lake, with large forested areas and localized open habitat. The terrain was generally flat and often wet, and common plant species included white ash (*Fraxinus americana*) and common prickly-ash (*Zanthoxylum americanum*) (V.J. Emery and L.E. King unpublished data).

The Massassauga Tract is a large property south of the town of Westport. Approximately one-third of Massassauga was surveyed, for a total area of 220 ha, or 2.20 km^2. This section was chosen as it was most accessible by road, included areas where Golden-winged Warblers had been detected in previous years, and contained additional open areas which could potentially provide suitable habitat. The property consists of a mix of mature forest and grassy areas, with occasional patches of scrub. The terrain is generally dry, very rocky with hills and small cliffs, and several small marshes in the southern section. Common plant species were similar to those in the Pangman area.

The Bracken Tract is a large waterfront property south of the town of Westport, and west of the town of Newboro. We surveyed the entire mainland section of the tract (204 ha, or 2.04 km^2) because previous research found many Golden-winged Warblers here, especially in the western areas. The tract consists largely of abandoned farmland with active seasonal cattle grazing in the eastern portion and large but fragmented forest sections. The terrain is generally even with some exposed portions of flat rock, one pond, and one large central wetland, in addition to several smaller marshes. Common plant species included meadowsweet (*Spiraea* spp.) and common milkweed (*Asclepias syriaca)*.

Previous surveys

We include bird counts from 2006 and 2007 in our discussion. In these years, surveys were conducted by visiting sites with apparently suitable habitat and areas that were known to be occupied by Golden-winged Warblers in previous years (Paquin 2006, H.J. Munro pers. comm.). During these years, song playback was used inconsistently and did not adhere to a standardized protocol. The method used here involved consistent playback and complete surveying, and thus should provide better detection and more observations even if the population is decreasing. For these reasons, and because the protocols in previous years did not include a way to test for the absence of birds in an area, comparisons between years are for interest only. Continued use of the formalized protocols of 2008 will allow informative comparisons with future surveys.

Measuring population densities can prove difficult as it is necessary to ensure that every individual is counted only once. Therefore, to improve accuracy we combined (i) colour banding for individual identification, (ii) comprehensive survey methods including both auditory and visual techniques and (iii) Geographic Information Systems (GIS) to help maximize coverage of plots, analyze survey results and map locations of focal males.

Visual confirmation of birds

We recorded band combinations of previously banded birds and attempted to band all males without bands using both aluminum numbered Canadian Wildlife Service (CWS) bands and coloured plastic bands. Maintaining a banded population is essential for determining return rates of birds and improving estimates of population changes. Keeping a record of banded bird locations also ensured no birds were counted twice during the survey, and confirmed species identification as Golden-winged, Blue-winged, or hybrid warblers with close inspection in the hand. Birds banded in 2008 have band combinations starting with BS, or blue and silver bands on the left leg.

Playback design

The survey playback was based on a monitoring protocol developed by the Cornell Lab of Ornithology Conservation Science Department. The playback has four elements: silence, type 1 and type 2 Golden-winged Warbler songs (Confer 1992), and a recording of Black-capped Chickadees (*Poecile atricapillus*) mobbing a singing Eastern Screech–Owl (*Megascops asio*). Type 1 songs function primarily to attract mates and for species recognition (different for the two species), and type 2 songs are used in territory defense (shared by both species) (Spector 1992). Blue-winged Warblers and hybrids also responded to type 2 song of Golden-winged Warbler (as previously observed in Murray and Gill 1976). We used all four of these elements to ensure that as many male birds as possible were detected. Females cannot be reliably surveyed as they will not consistently respond to playback or to mobbing, so only males are included in results.

For efficiency, we shortened the playback at alternating survey points from 18 minutes (long playback) to 10 minutes (short playback) (Table 1). We also tested the detection ability of playback to verify our survey methodology. Although the shorter protocol was not perfect at detecting birds, we minimized error with multiple visits to survey sites, along with visual identification of colour banded birds to confirm auditory detection. Additionally, the shorter playback is the same length or longer than previous survey playbacks that have been shown to be effective (e.g., 3 minutes of playback, 6 minutes of total observation, Kubel and Yahner 2007; 3 minutes of playback, 7 minutes of total observation, Martin *et al.* 2007).

Table 1. Playback design for detecting Golden-winged Warblers, showing the sequence of playback components for long (17 minutes) and short (10 minutes) survey protocols.

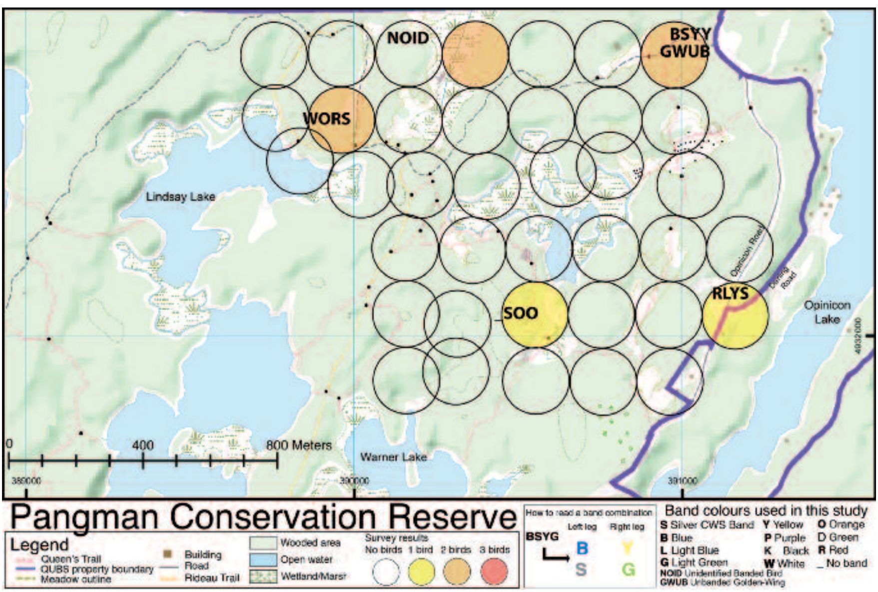
Minute	Playback type (long protocol)	Playback type (short protocol)
1	Silence	Silence
2	Silence	Silence
3	Silence	Silence
4	Type 1	Type 1
5	Type 1	Type 1
6	Type 1	Type 1
7	Type 1	Silence
8	Type 1	Type 2
9	Silence	Type 2
10	Type 2	Silence
11	Silence	
12	Mobbing	
13	Mobbing	
14	Mobbing	
15	Mobbing	
16	Mobbing	
17	Silence	

Survey point count layout

Previous work has shown that Golden-winged Warbler songs can be detected at a maximum distance of 100-150 meters from their territories (Kubel and Yahner 2007) or even as far as 200 metres in some areas (K.V. Rosenberg pers. comm.). However, based on field experimentation of hearing distances in our study area, we concluded that a 100-meter radius circle was most appropriate and placed a circle of this size around each point count to represent the area surveyed. Any birds with territories within each circle should be heard or seen from the survey point. Birds whose territories occupied more than one circle were unlikely to be counted twice because we visually confirmed colour band combinations of banded birds for most of our detections.

A total of 142 point counts was conducted. We focused our efforts on three tracts of QUBS land that have had known Golden-winged Warbler territories in the past two years [Pangman (38 points), Massassauga (53 points) and Bracken (51 points)]. Using GIS software (ArcGIS 9.2, ESRI, Redlands, California, USA), we set out a grid of points separated by 200 meters in all directions to prevent survey overlap. We assigned alternating long and short protocols to each of these survey points.

Figure 3. Distribution of birds shown by band combinations, and results of point counts shown by survey radii, within the Pangman Conservation Reserve, near Chaffey's Lock, ON, Queen's University Biological Station (QUBS). The purple outline represents the property boundary. All band combinations represent Golden-winged Warblers.



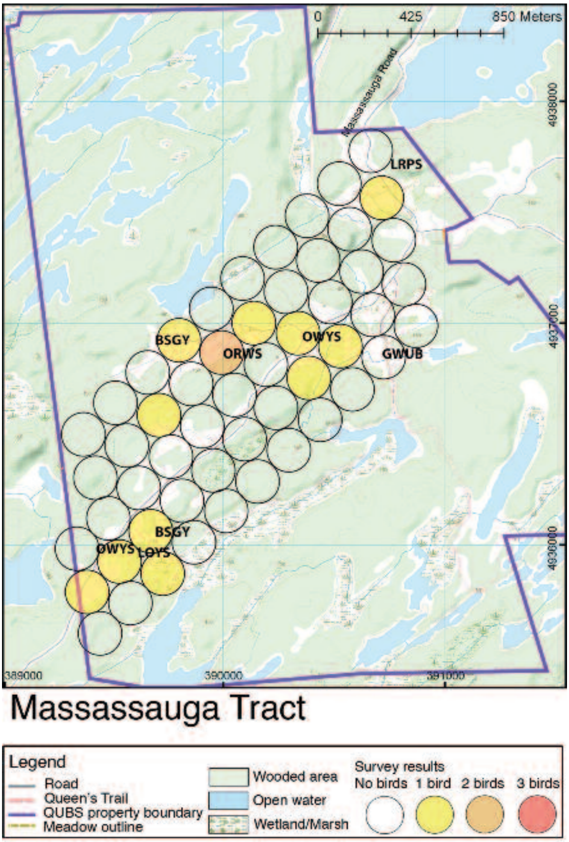


Figure 4. Distribution of birds shown by band combinations, and results of point counts shown by survey radii, within the Massassauga Tract, near Newboro, ON, Queen's University Biological Station (QUBS). Purple outline represents the property boundary. All band combinations represent Golden-winged Warblers. Note that two band combinations (BSGY and OWYS) are repeated on the map, as these males changed territories during the field season. See Figure 3 for complete legend.

Survey protocol

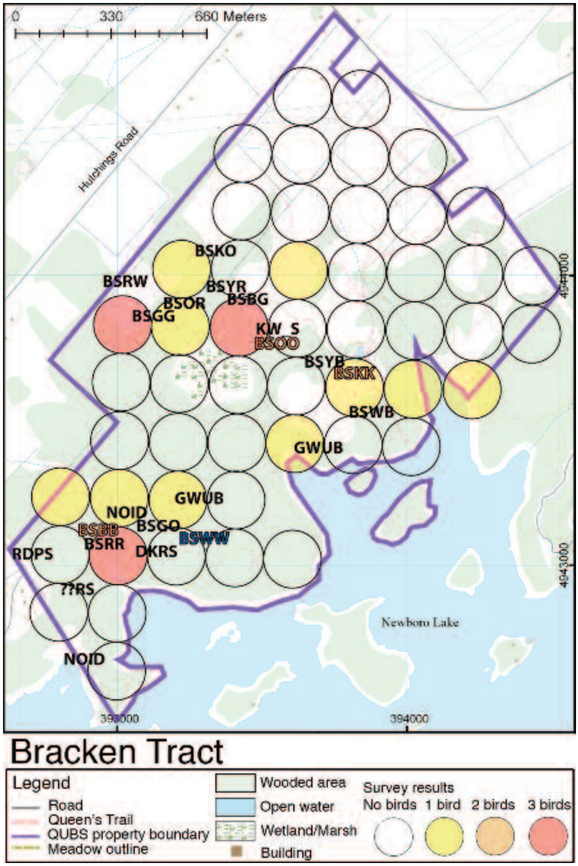
Surveys were conducted between 04:30 and 11:00h, between 10 May and 20 June 2008. Every-other survey point on every-other transect (1/4 of all points) was visited twice within the survey period, and every survey point was visited at least once between 25 May and 20 June 2008.

Using a handheld Global Positioning System (GPS) unit (GPSMAP 60Cx, Garmin International, Olathe, Kansas, USA) we hiked to each of the survey points, recorded the latitude and longitude coordinates of each field site, and followed the designated playback protocol for that point count. When a point was inaccessible (in the middle of a lake or deep swamp) the point on the shoreline which was closest to the original point was used instead. We recorded the minute of detection for all birds seen and heard during the protocol, as well as those birds seen or heard after the protocol had ended and upon subsequent visits.

Mapping survey results

We created the precise maps of Figures 3, 4, and 5 showing survey results and the locations of each male bird using GIS software (ArcGIS 9.2, ESRI, Redlands, California, USA). These maps include the following data; (1) The UTM (Universal Transverse Mercator) coordinates in Zone

Figure 5. Distribution of birds shown by band combinations, and results of point counts shown by survey radii, within the Bracken Tract, near Newboro, ON, Queen's University Biological Station (QUBS). Purple outline represents the property boundary, which for this tract delimited the survey area. Black band combinations represent Golden-winged Warblers, blue band combinations represent Blue-winged Warblers and red band combinations represent the hybrid Brewster's Warbler. See Figure 3 for complete legend.



18 along the map borders (the same coordinates used to locate sites by GPS); (2) landscape information, including forested, open, wetland and aquatic habitat; (3) circles representing the approximate area in which birds could be detected when observers were at the centre of the circle completing the protocols, coloured according to the number of birds detected; (4) the locations of birds, marked as a band combination, unbanded Golden-winged Warbler (GWUB), or Golden-winged Warblers for which band combinations were unknown (NOID). As there were discrepancies between auditory and visual identifications (eg: some birds were heard twice), all densities were calculated using the visual identifications.

Results

In the 5.76 km^2 surveyed at intervals of 200 metres, we found 30 Golden-winged Warblers, one Blue-winged Warbler, three Brewster's hybrids and zero Lawrence's hybrids, for a total of 34 birds across all areas. The mapped results of surveys conducted in Pangman, Massasauga and Bracken are presented in Figures 3, 4 and 5 respectively.

General observations

Males usually responded well to playback and mobbing, becoming visibly agitated while approaching the speaker. Playback seemed more useful earlier in the breeding season, and mobbing more effective later in the season. This may result from males aggressively defending territories in the beginning of the season, then defending their mate and perhaps offspring from a perceived predator later in the season during nesting.

Golden-winged Warblers often nest in aggregations of as many as ten pairs (Confer and Knapp 1981, Vallender *in* Cadman *et al.* 2007a), and we often found several males within the same small area. This is well illustrated in Figure 4 (the southwest corner of the survey area of Massassauga) and Figure 5 (most birds located in Bracken were in close proximity to each other). This could be a result of the birds clustering at suitable habitat patches (Vallender *in* Cadman *et al.* 2007a), as the open habitat, when present, is often large enough to support several adjacent territories. Pangman Conservation Reserve

Six male Golden-winged Warblers were found in the surveyed area (Figure 3), a density of 0.039 per ha. Of these, we banded one, three had been banded in previous years, one remained unbanded, and one was unidentified as to whether or not it was banded. The densities of Blue-winged Warblers and hybrids were zero.

Massassauga Tract

Six male Golden-winged Warblers were found in the surveyed area (Figure 4), a density of 0.027 males per ha. Of these, we banded one, four had been banded in previous years, and one remained unbanded. The densities of Blue-winged Warblers and hybrids were zero.

Bracken Tract

Eighteen male Golden-winged Warblers were discovered during surveying (Figure 5). Of these, we banded ten, four had been banded in previous years, two we were unable to band, and two were unidentified as to whether or not the bird was banded. This represents a density of 0.088 males per ha. One Blue-winged Warbler and three hybrid (Brewster's) males were found, and we banded all four of these birds.

Discussion

In total, we detected 30 Golden-winged Warblers, one Blue-winged Warbler, three Brewster's hybrids, and zero Lawrence's hybrids during our surveys in three separate areas on QUBS property (Figures 3-5). This represents a total of 34 male birds across an area comprising 5.76 km^2, representing an overall density of 0.052 male Golden-winged Warblers per ha, 0.0017 male Blue-winged Warblers per ha, and 0.0052 male hybrids per ha.

Geographic Resources

We used GIS software and GPS units in order to visualize large-scale patterns and collect precise and informative data in the field. Previously, surveyors navigated to bird territories with the aid of landmarks, descriptions, and approximate visual measurements, which may change with time. For repeatability, all point count locations were GPS marked and surveyors will be able to locate this point exactly in future years. In addition to helping recognize patterns such as the distribution of males over certain areas of cleared or forested land, the precision of GIS technologies is essential to monitoring population changes in such late successional species that may show only subtle shifts in habitat use over many years. We are confident that GIS and GPS technologies will be central to precisely measuring future shifts in Golden-Winged Warbler habitat use.

Pangman Conservation Reserve

Pangman (Figure 3) had an intermediate density of Golden-winged Warblers at 0.039 males per ha, slightly below the overall average across the three areas.

In 2006 and 2007, twelve and ten male Golden-winged Warblers, respectively, were found within this study area, even without the use of a standardized survey protocol. We had expected to find higher numbers in 2008 when surveying with a standard protocol for the first time, but were surprised to find fewer birds. If this trend continues in future years, it may suggest that the advancing succession in this area is reducing the suitability of the habitat for Golden-winged Warblers. Blue-winged Warblers and hybrids have not been reported within this area in the past two years, but it is noteworthy that a rare Lawrence's hybrid was sighted in 2006 just adjacent to this area, that has been undetected by researchers in the past two years.

Massassauga Tract

Massassauga (Figure 4) had the lowest density of Golden-winged Warblers at 0.027 males per ha, approximately one-half of the average density across the three areas. Land cover on this tract appeared either too mature (tall, closely spaced trees) or not mature enough (open, grassy fields devoid of shrubs) with fewer areas in the in-between stages that are suitable for Golden-winged Warblers than the other tracts (V.J. Emery and L.E. King unpublished data). Additionally, gradual and shrubby edges of forests are thought to be important to the nesting success of Golden-winged Warblers (Demmons 2000). We noticed that most forest edges at Massassauga were more abrupt than those found at Bracken, and hypothesize that the edge habitat in Massassauga is suboptimal, an idea we will explore with future vegetation studies.

Interestingly, two males in this area showed territory shifts within this same 2008 season (BSGY and OWYS, Figure 4). This underscores the importance of a banded population, as the shifts were immediately confirmed in the field, and we avoided counting each bird twice.

In 2006 and 2007, one and four male Golden-winged Warblers, respectively, were detected within the surveyed areas of the Massasauga Tract, along with two male Brewster's hybrids in 2006 and one male Blue-winged Warbler in 2007 (Paquin 2006, H.J. Munro pers. comm.). The increase in the number of Golden-winged Warblers found in 2008 likely reflects the much larger area surveyed, including discovery of several new territories, and the use of standardized protocols.

Bracken Tract

Bracken (Figure 5) had the highest density of all surveyed areas at 0.088 Golden-winged Warbler males per ha. It was also the only area in which Blue-winged Warblers and hybrids (Brewster's) were found, with one and three males sighted, respectively. The presence of a Blue-winged Warbler and hybrids may simply result from higher overall densities of birds, including Golden-winged Warblers, in this area. Bracken may represent habitat most suitable for Golden-winged Warblers, as active cattle grazing in the eastern portion has helped to maintain an early successional state over many years (QUBS 2004).

In 2006 and 2007 respectively, ten and seventeen male Golden-winged Warblers were found within the surveyed areas of the Bracken Tract, along with one male Brewster's hybrid in 2006 and one male Blue-winged Warbler in 2007 (Paquin 2006, H.J. Munro pers. comm.). The increased numbers in 2008 likely reflects surveying throughout the entire tract as opposed to only certain sections.

Golden-winged Warbler Densities

Golden-winged Warbler densities have rarely been reported in the literature, but range from 0.55 males per ha in an area comprising only seedling trees, to 0.04 males per ha for an area with saplings and medium-sized aspen (Roth and Lutz 2004). Given that Golden-winged Warbler territories can be as large as two or even five hectares (Confer 1992), the first density (0.55) represents an extremely high concentration of male birds, more than five times the highest density found in this study (0.088 males per ha at Bracken). Other densities have been reported as males per station, with the highest being 0.79, or approximately 0.20 males per ha (calculated from Martin *et al.* 2007). Since all of Bracken is not entirely suitable habitat for Golden-winged Warblers, our intermediate estimates of density seem reasonable.

However, we still do not know whether all suitable habitat on QUBS property is currently occupied by Golden-winged Warblers. Additionally, the detection of all male birds in a given area is generally not possible (Thompson 2002); detection probabilities can vary widely, including with habitat (Kubel and Yahner 2007), which differed greatly across our study areas. Previous work with Golden-winged Warblers has demonstrated that detection can be extremely difficult, even when close to an active nest (Confer *et al.* 2008). While we attempted to address this issue with repeated sampling, and a survey protocol which included both song playback and mobbing, it is nevertheless important to acknowledge that our counts likely did not include every male bird, and, therefore, our calculated densities represent our best estimates.

Early successional habitats

Golden-winged and Blue-winged Warblers specialize in using early successional land such as old farm fields (Litvaitis 2003, Vallender *in* Cadman *et al.* 2007). Species such as these which rely on open areas have declined more than those found in mature forests (Askins 1993, 2000, Rich *et al.* 2004, Cadman *et al.* 2007), often due to habitat loss, whether anthropogenic or natural (the inevitable process of succession). Anthropogenic habitat loss is likely a problem for species such as the Golden-winged Warbler, as the Atlas of the Breeding Birds of Ontario shows "rural non-farm" areas, such as abandoned farms, have been decreasing since approximately 2001 in areas south of the Canadian Shield, where the Golden-winged Warbler is concentrated (Cadman *et al.* 2007).

Compounding this problem, natural habitat loss also contributes to declines. Since the Golden-winged Warbler relies on an inherently ephemeral early stage of succession, habitat maintenance is a challenge because appropriate habitat rapidly progresses to forest if intervention is not implemented (Hamer *et al.* 2005). To maintain suitable early successional habitat, disturbances such as timber harvesting, grazing, or periodic use of fire, need to be reinstated, requiring active management (Confer 1992, Klaus and Buehler 2001, Roth and Lutz 2004). Another management approach is leaving gradual or soft edges to hayfields, which can increase the suitability of habitat for nesting sites (Demmons 2000).

At our study sites, many of the open fields of Massassauga are mowed annually for hay, leaving 'sharp' edges, while in Bracken, open areas are maintained by late-summer grazing by cattle, leaving much more 'gradual' edges, which appeart o better support Golden-winged Warblers. These types of simple modifications to agricultural practices and management could affect habitat suitability for Golden-winged Warblers.

When management plans such as these are put into place, careful monitoring will be needed to ensure that the managed habitat is fulfilling the needs of these declining shrubland species. Our results will serve as a baseline for this type of monitoring at QUBS and contribute to the Golden-winged Warbler conservation initiatives currently underway across the breeding range of the Golden-winged Warbler.

To meet this challenge of monitoring Golden-winged Warblers, the help of amateur and professional field ornithologists and birders is more important than ever. With limited resources, professional ornithologists cannot survey the amount of land required to follow population changes across the entire province. The Atlas of the Breeding Birds of Ontario was one of our greatest resources in identifying trends, and the level of detail provided in the most recent Atlas allowed us to compare changes in populations in the areas around our survey sites. The importance of this information cannot be overstated, and we hope that in the future field ornithologists and birders will continue to monitor bird species, especially those which are declining and most in need of our attention.

To help monitor Golden-winged Warblers, Blue-winged Warblers, and three other declining migratory songbirds, submit your sightings to Priority Migrant eBird coordinated through Cornell Lab of Ornithology at www.ebird. org//primig. Finally, if birding in an area where our studies have taken place, please report colour banded warblers to the North American Bird Banding Program at http://www.pwrc. usgs.gov/bbl/ or call **1-800-327-BAND (2263)**, and help play a part in the crucial long-term monitoring of these threatened species.

Acknowledgements

We thank Frank Phelan, Floyd Connor, Frances Bonier, Martin Piorkowski, Mark Conboy, and all members of Paul Martin's Lab for assistance with research at QUBS. Thanks to our external reviewer for manuscript comments. Funding provided by an NSERC grant to PRM and RJR, and the J. Allen Keast Research Fellowship to LEK and VJE.

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A Long-eared Owl x Short-eared Owl (*Asio otus x A. flammeus*) specimen from Ontario

Michel Gosselin and Kristen Keyes

Over the course of her graduate work on Short-eared Owls (*Asio flammeus*), Keyes found an unusual specimen of owl in the collections of the Canadian Museum of Nature. Upon examination, this individual proved to have features that are almost perfectly intermediate between the Short-eared Owl and the Long-eared Owl (*A. otus*).

This specimen was received in early 1991 from E.R. [Kit] Chubb, Avian Care and Research Foundation, Verona, Ontario, and was prepared as a study skin (catalogue no. CMNAV 92233) by Richard M. Poulin. According to the catalogue data and the information supplied more recently by Kit Chubb, this owl was originally found with a broken humerus, on 28 October 1990, near Tweed, Hastings County. It was given veterinary care at the Avian Care and Research Foundation, but had to be euthanized on 15 December 1990. The bird was relatively fat (4, on a scale from 0 to 5) after its two months in captivity, and was determined to be a male from post-mortem gonad examination.

Short-eared Owls and Long-eared Owls are the sole members of the genus *Asio* in temperate North America, where they have extensive overlapping ranges. The species differ to some extent in habitat choice: the Long-eared Owl is an arboreal bird that hunts over open areas at night, while the Short-eared Owl inhabits open areas, where it may hunt by day as well as by night. Nevertheless, interspecific tree-roosts have been documented for these two species (Holt and Leasure 1993, Marks *et al.* 1994). Hastings County has suitable, adjoining habitat for both species, although the natal origins of CMNAV 92233 are unknown. According to descriptions in Holt and Leasure (1993) and Marks *et al.* (1994), the mating behaviours of Short-eared Owls and Long-eared Owls have many similarities, but their calls are different. Polygamy seems to occur occasionally in both species.

Worldwide, there are seven or eight species in the genus *Asio*, some of which exhibit marked geographical variation that may eventually lead to the recognition of additional species (del Hoyo *et al.* 1999). Short-eared Owls and Long-eared Owls have been assigned to distinct subgenera by Wolters (1975-82) [*Brachyotus* and *Asio*, respectively], indicating that the two species are not each other's closest relatives on a global basis — although they are in Ontario. Likewise, Randi *et al.* (1991) state that "the genetic distance between *A. otus* and *A. flammeus* is unusually large for congeneric bird species." Similarly, Wink *et al.* (2004) do not show these two species as each other's closest relatives (they associate *A. flammeus* with *A. capensis*, and *A. otus* with *A. clamator*). However, Voous (1989) claimed that Short-eared Owls and Long-eared Owls "are probably each other's closest relatives". This is based on the karyological work of Belterman and DeBoer (1984), though the authors did not report data on any other *Asio* species.

According to Pyle (1997), Short-eared Owls are told from Long-eared Owls in the hand by their shorter ear tufts (<25mm). The ear tufts of CMNAV 92233 measure ca 41 mm (Fig. 1).

Figure 1. Left to right: Short-eared Owl (CMNAV 86182, HY male, 8 November 1986, *Hastings* County), presumed hybrid (CMNAV 92233), and Long-eared Owl (CMNAV 89915, HY male, 12 November 1987, *Renfrew* County). Apical view showing the ear tufts.

Figure 2. Left to right: Short-eared Owl (CMNAV 86182, HY male, 8 November 1986, *Hastings* County), presumed hybrid (CMNAV 92233), and Long-eared Owl (CMNAV 89915, HY male, 12 November 1987, *Renfrew* County). Frontal view showing the underside of the primaries, and the underside of the secondaries for the two specimens on the left.

Figure 3. Left to right: Short-eared Owl (CMNAV 86182, HY male, 8 November 1986, *Hastings* County), presumed hybrid (CMNAV 92233), and Long-eared Owl (CMNAV 89915, HY male, 12 November 1987, *Renfrew* County). Dorsal view.

Figure 4. Left to right: Short-eared Owl (CMNAV 86182, HY male, 8 November 1986, *Hastings* County), presumed hybrid (CMNAV 92233), and Long-eared Owl (CMNAV 89915, HY male, 12 November 1987, *Renfrew* County). Frontal view.

Figure 5. Left to right: Short-eared Owl (CMNAV 86182, HY male, 8 November 1986, *Hastings* County), presumed hybrid (CMNAV 92233), and Long-eared Owl (CMNAV 89915, HY male, 12 November 1987, *Renfrew* County). Dorsal view of the tails.

Figure 6. Left to right: Short-eared Owl (CMNAV 86182, HY male, 8 November 1986, *Hastings* County), presumed hybrid (CMNAV 92233), and Long-eared Owl (CMNAV 89915, HY male, 12 November 1987, *Renfrew* County). Frontal [underside] view of the tails.

Other diagnostic features mentioned by Pyle (1997) include the blackish primary tips and the light trailing edge on the wings of Short-eared Owls. The colouration of the primary tips of CMNAV 92233 is intermediate between the two species, as is the pattern of the secondaries (Fig. 2).

The plumage of CMNAV 92233 shows a number of additional characters that are intermediate between Short-eared Owls and Long-eared Owls. The overall buffy colouration is that of a Short-eared Owl, yet the upperparts are heavily vermiculated as in the Long-eared Owl (Fig. 3). The underparts are streaked as in the Short-eared Owl, yet many of the streaks show a minute transverse bar, reminiscent of those of the Long-eared Owl (Fig. 4). The tail bands have features of both species, but mostly of the Long-eared Owl (Fig. 5 and 6).

The standard measurements of CMNAV 92233 fall almost halfway between the means given by Godfrey (1986) for male specimens of the two species:

Wing chord

Short-eared Owl	283.5-307.5 mm	mean 302.9 mm
CMNAV 92233	294 mm	
Long-eared Owl	269.5-295 mm	mean 286.7 mm

Tail length

Short-eared Owl	135.5-149.5 mm	mean 146 mm
CMNAV 92233	146.4 mm	
Long-eared Owl	141.5-153.5 mm	mean 148.1 mm

Weight

The weight of CMNAV 92233 also falls in between the means for males of the two species as given by Holt and Leasure (1993) and Marks *et al.* (1994):

Short-eared Owl	315 g
CMNAV 92233	300 g
Long-eared Owl	245 g

The large number of bars across the outer primaries, as in Long-eared Owls (Pyle 1997), and the dark point at the tip of the central rectrix, as in Short-eared Owls (Baker 1993), would indicate that CMNAV 92233 is a hatch-year bird.

Given the intermediate nature of most physical features of CMNAV 92233, and the fact that some of the plumage features fall outside the range of variation seen in Short-eared Owls or Long-eared Owls separately, it is fitting to consider this bird as a hybrid between the two species. Males are the homogametic sex in birds, and therefore hybrid birds are more often males (McCarthy 2006). McCarthy (2006) reports hybridization in several genera of owls (*Athene, Bubo, Ninox, Otus, Strix*), but not in *Asio*. He includes a puzzling reference to *Asio flammeus* x *A. otus* in the Tytonidae, but this is simply based on a Danish checklist where the two species are listed together under "*Asio otus/flammeus*" [which does not refer to hybrids, but to owls unidentified as to species]. McCarthy (2006), quoting from Flieg (1971), also reports that a female Barn Owl (*Tyto alba*) held in captivity with a male Striped Owl (*Asio clamator*) produced eggs with developing embryos — but the possibility that these embryos were parthenogenetic (see Olsen, 1962) was not raised. It must be noted that the American Ornithologists' Union (1998) currently assigns the Striped Owl to *Pseudoscops*, not to *Asio*.

CMNAV 92233 would fit in category B of Gilham and Gilham (1996) — when the hybrid parentage of an individual is not known from direct observation of the parents, but inferred from its appearance. It might be possible to investigate further the parentage of this specimen through DNA analyses, such as the ones used by Clark and Witt (2006) for hybrid hawks (*Buteo*).

Acknowledgments

We would like to thank Gay McDougall Gruner for the generous assistance and logistical support she provided to Keyes during a study of the Short-eared Owl collection at the Museum of Nature. Also, our thanks are extended to Kit Chubb for her relentless work for the welfare of birds, and for ensuring that data generated from her work were put to good use — including the preservation of potentially useful specimens.

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Wind Turbines and Birds
The Erie Shores Wind Farm Experience: Breeding Bird Surveys

Ross D. James

Introduction

In a recent article (James 2008) I provided information about some bird species nesting near wind turbines, where I had found nests for those species. In this article I will look more generally at bird populations in areas near wind turbines, as revealed by breeding bird surveys. In order to try to assess any potential effects of wind turbines on bird populations, it is usual to undertake a series of breeding bird point counts. While it would be ideal to count at or close to final turbine locations, both before and after turbines are installed and working, this has not always been possible. Breeding bird point counts were conducted in 2003 in the area proposed for the Erie Shores Wind Farm, 3 years before the turbines began operation. There were unanticipated delays in getting the wind farm in operation, and turbine locations were not yet established. While the point counts of 2003 provided quantitative information about the bird populations, most of the count points were not close enough to the final turbine positions in the large area initially under consideration, to be useful for comparison to counts after operations began.

During 2006 and 2007, once the 66 turbines of this wind farm were operating, point counts were conducted more focused on the turbines. Some woodlands and ravines were not readily accessible, without either trampling crops, or taking unacceptable amounts of time and effort to get near a turbine. There were also a few point counts done in 2006 that were not repeated because of significant habitat/condition changes in the subsequent year. Additional details of the wind farm can be found in James (2008).

Post-construction point counts were conducted in three habitat types where possible: 1) In woodlands greater than 10 ha, and within 400 m of a turbine. Where woodlands were sufficiently large and close, counts were conducted in pairs, one within 100 m of a turbine (1 at 156 m), and the second about 250–300 m more distant (without getting closer than 100 m to the edge of the woodland). There were 20 counts in woodlands in both years, including 6 pairs of counts. 2) In wooded ravines that were at least close to 100 m across or wider, and within 400 m of a turbine. There were 7 counts in ravines, all more than 180 m from a turbine. 3) In agricultural fields that were large enough to establish two count points on laneways or roadways near a turbine, one point within 100 m of a turbine, and the second at least 300 m farther away (as far as possible without getting within 100 m of a significant change in habitat). In addition, any roadside count conducted in 2003 within 400 m of a turbine was added. There were 23 roadside counts comparable in both years, including 5 pairs of close and more distant counts.

Point counts were of 10 minutes duration, each sampled twice, at least a week apart, in reasonably good weather, between a half hour before sunrise and 10:30 h. The maximum number of any species recorded on any particular count was used. An effort was made to eliminate duplication, particularly with pairs of counts, but also from week to week at one location. In 2006, counts were done 29-31 May and 8-10 June; in 2007, on 27-30 May and 10-13 June.

Results – Woodland Counts

On woodland counts, 56 bird species were noted over the 2 years (Table 1). The number of species increased from 46 in the first year of operation to 54 in the second. In both years the most numerous species included: Great Crested Flycatcher, Red-eyed Vireo, House Wren, American Robin, Yellow Warbler, Northern Cardinal, Rose-breasted Grosbeak, Common Grackle and Baltimore Oriole. These are predominantly more characteristic of edges, openings and shrubby areas, reflecting the fragmented nature of the woodlands, and/or the removal of trees from wooded areas.

Species which might have been considered sensitive (eg. Wood Thrush) were as numerous as ever. The species with the most notable decline was Mourning Warbler, but this change was not likely the result of the turbines. Eight of 10 recorded in 2006 were >150 m from turbines, and 2 of 3 in 2007 were <150 m. The second year was much drier than the first and this may have affected some species. Other declines were modest and may have been only the result of normal variation. Species seen only once in any year but not the other could be random

Table 1. Bird species and numbers recorded in 2006 and 2007 on 20 woodland breeding bird point counts at Erie Shores Wind Farm.

Species	in 2006	in 2007
Canada Goose *(Branta canadensis)*	1	18+?
Wood Duck *(Aix sponsa)*	1	
Wild Turkey *(Meleagris gallopavo)*	1	4
Green Heron *(Butorides virescens)*		1
Cooper's Hawk *(Accipiter cooperii)*		1
Killdeer *(Charadrius vociferus)*		1
American Woodcock *(Scolopax minor)*		1
Mourning Dove *(Zenaida macroura)*	3	6
Yellow-billed Cuckoo *(Coccyzus americanus)*	4	4
Black-billed Cuckoo *(C. erythropthalmus)*	2	1
Cuckoo sp?		1
Red-headed Woodpecker *(Melanerpes erythrocephalus)*	2	6
Downy Woodpecker *(Picoides pubescens)*	1	3
Hairy Woodpecker *(P. villosus)*	6	5
Northern Flicker *(Colaptes auratus)*	4	4
Pileated Woodpecker *(Dryocopus pileatus)*	2	1
Woodpecker sp?		1
Eastern Wood-Pewee *(Contopus virens)*	9	12
Least Flycatcher *(Empidonax minimus)*	4	1
Great Crested Flycatcher *(Myiarchus crinitus)*	19	16
Warbling Vireo *(Vireo gilvus)*	6	6
Red-eyed Vireo *(V. olivaceus)*	30	41
Blue Jay *(Cyanocitta cristata)*	11	9
American Crow *(Corvus brachyrhynchos)*	37	41
Bank Swallow *(Riparia riparia)*	4	8
Black-capped Chickadee *(Poecile atricapillus)*	3	2
White-breasted Nuthatch *(Sitta carolinensis)*	3	6
Carolina Wren *(Thyrothorus ludovicianus)*	1	1
House Wren *(Troglodytes aedon)*	16	18
Blue-gray Gnatcatcher *(Polioptila caerulea)*		2
Veery *(Catharus fuscescens)*	9	7
Swainson's Thrush *(C. ustulatus)*	1	1
Wood Thrush *(Hylocichla mustelina)*	8	13
American Robin *(Turdus migratorius)*	15	17
Gray Catbird *(Dumetella carolinensis)*	9	6
European Starling *(Sturnus vulgaris)*		3
Cedar Waxwing *(Bombycilla cedrorum)*	3	1

Species	in 2006	in 2007
Yellow Warbler (*Dendroica petechia*)	24	21
Black-throated Blue Warbler (*D. caerulescens*)	1	
Pine Warbler (*D. pinus*)		1
Black-and-white Warbler (*Mniotilta varia*)		2
American Redstart (*Setophaga ruticilla*)	8	8
Ovenbird (*Seiurus aurocapilla*)	3	2
Northern Waterthrush (*S. noveboracensis*)	1	
Mourning Warbler (*Oporornis philadelphia*)	10	3
Common Yellowthroat (*Geothlypis trichas*)	4	2
Eastern Towhee (*Pipilo erythrophthalmus*)	5	7
Chipping Sparrow (*Spizella passerina*)		2
Song Sparrow (*Melospiza melodia*)	7	12
Northern Cardinal (*Cardinalis cardinalis*)	17	29
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)	19	27
Indigo Bunting (*Passerina cyanea*)	5	5
Red-winged Blackbird (*Agelaius phoeniceus*)	6	5
Common Grackle (*Quiscalus quiscula*)	11	33
Brown-headed Cowbird (*Molothrus ater*)	9	12
Baltimore Oriole (*Icterus galbula*)	15	22
American Goldfinch (*Carduelis tristis*)	1	3

variation. Most species showed an increase, or remained the same. The number of geese in 2007 is uncertain as some were heard and not seen. The Swainson's Thrushes were no doubt late migrants, not expected to nest in the area.

Given the wide variation in point count data, it would be difficult to find any significance to an overall increase or decrease in numbers in any two years of data. However, a comparison of overall averages of species and individual numbers at least indicates the direction of changes. A comparison of average counts of species and individuals recorded on woodland point counts at Erie Shores is given in Table 2. The average counts, for both species and individuals, were higher in 2007 than the first year of operation of the turbines. Overall, there was no indication that woodland birds had been negatively impacted by the presence of the wind turbines.

Table 2. Average numbers of species and individuals recorded on 20 woodland point counts at Erie Shores Wind Farm in 2006 and 2007.

	2006	2007
Species – average/count	14.8	15.95
Individuals – average/count	18.1	23.2

Table 3. Average numbers of species and individuals on 6 pairs of close and more distant woodland point counts at Erie Shores Wind Farm in 2006 and 2007.

	2006	2007
At 6 counts close to turbines:		
Species – average/count	14.7	15.5
Individuals – average/count	18.3	20.8
At 6 more distant from turbines:		
Species – average/count	13.8	14.0
Individuals – average/count	18.1	18.3

A comparison of the 6 pairs of close and more distant counts in woodlands is given in Table 3. There was an increase in the averages of both numbers of species and numbers of individuals, whether closer or more distant from the turbines.

Wooded Ravine Counts

In the 7 wooded ravine counts, 43 species were noted over the 2 years (Table 4), with 32 species in the first year, and an increase to 39 species in the second year. In both years, the most numerous species were: Red-eyed Vireo, American Crow, American Robin, Yellow Warbler, Song Sparrow, Northern Cardinal, Red-winged Blackbird and Common Grackle. Again, most are species more characteristic of edges and shrubby areas rather than of deep woods. Most changes from year to year were relatively modest and seem likely to be random rather than influenced by turbines. The most notable change was for Blue Jay, but not surprising for a species that can be very quiet during the nesting season.

As with woodlands, a comparison of the average numbers of species and individuals per count, indicates increases in all averages during the second year of operations (Table 5). Again, a negative impact is not indicated.

Table 4. Bird species and numbers recorded in 2006 and 2007 on 7 wooded ravine point counts at Erie Shores Wind Farm.

Species	in 2006	in 2007
Canada Goose		4
Mallard *(Anas platyrhynchos)*	1	1
Wild Turkey	1	2
Turkey Vulture *(Cathartes aura)*		1
Red-tailed Hawk *(Buteo jamaicensis)*		1
Rock Pigeon *(Columba livia)*	1	1
Mourning Dove	1	6
Yellow-billed Cuckoo	3	1
Belted Kingfisher *(Megaceryle alcyon)*		1
Downy Woodpecker	2	3
Northern Flicker		1
Pileated Woodpecker		1
Woodpecker sp?		1
Great Crested Flycatcher	2	6
Eastern Kingbird *(Tyrannus tyrannus)*	1	
Yellow-throated Vireo *(Vireo flavifrons)*		1
Warbling Vireo		1
Red-eyed Vireo	12	11
Blue Jay	8	3

Species	in 2006	in 2007
American Crow	9	17
Bank Swallow	1	6
Black-capped Chickadee	2	1
House Wren	3	3
Veery		1
American Robin	5	7
Gray Catbird	5	5
Cedar Waxwing	2	
Yellow Warbler	5	6
American Redstart	1	2
Mourning Warbler	1	
Common Yellowthroat	4	2
Scarlet Tanager *(Piranga olivacea)*		1
Eastern Towhee	1	
Chipping Sparrow	1	2
Song Sparrow	9	9
Northern Cardinal	7	9
Rose-breasted Grosbeak	1	3
Indigo Bunting	3	5
Red-winged Blackbird	12	10
Common Grackle	5	12
Brown-headed Cowbird	7	5
Baltimore Oriole	4	5
American Goldfinch	2	1

Table 5. Average numbers of species and individuals recorded on 7 wooded ravine point counts at Erie Shores Wind Farm in 2006 and 2007.

	2006	2007
Species – average/count	13.6	16.9
Individuals – average/count	17.6	22.7

Roadside Counts

Over 2 years there were 62 species recorded on the 23 roadside point counts, 55 species each year (Table 6). The most numerous species both years were: gulls (mainly, if not entirely, Ring-billed Gull *Larus delawarensis*), Mourning Dove, Bank Swallow, Horned Lark, American Robin, European Starling, Red-winged Blackbird, Common Grackle and Brown-headed Cowbird. There is nothing particularly notable about any of the differences in species present one year but not the other. Most such birds were either rare locally (e.g. Orchard Oriole or House Sparrow) or not roadside birds at all (e.g. Veery or Ovenbird). The Bald Eagle nest was not active in 2007 by the summer (see James 2008), and the single Cliff Swallow colony near a count was not active in 2007.

The largest changes were in a few flocking species that might be expected to show considerable variation from year to year. The flocking species were also the least accurately counted. Some gulls may have been out of sight behind vegetation or variable topography. Rapidly milling Bank Swallows were estimated once or twice during the count period as accurately as possible, but with birds coming and going down over the shore bluffs, the actual number in view over the count area may have been higher than seen at any shorter interval. Numbers in rapidly moving flocks of starlings or blackbirds could only be estimated.

Table 6. Bird species and numbers recorded in 2006 and 2007 on 23 roadside point counts at Erie Shores Wind Farm.

Species	in 2006	in 2007
Canada Goose	4	84
Mallard	2	19
Ring-necked Pheasant *(Phasianus colchicus)*		1
Wild Turkey	2	1
Great Blue Heron *(Ardea herodias)*	1	1
Turkey Vulture	1	20
Bald Eagle *(Haliaeetus leucocephalus)*	2	
Red-tailed Hawk	1	1
American Kestrel *(Falco sparverius)*	1	1
Killdeer	20	26
Spotted Sandpiper *(Actitis macularius)*	3	
Gull sp?	155	108
Rock Pigeon	9	5
Mourning Dove	25	38
Black-billed Cuckoo	1	1
Red-headed Woodpecker	1	2
Downy Woodpecker		2
Northern Flicker	5	4
Pileated Woodpecker		1
Eastern Wood-Pewee	1	1
Great Crested Flycatcher	2	3
Eastern Kingbird	4	9
Warbling Vireo	9	11
Red-eyed Vireo	10	8
Blue Jay	1	6
American Crow	47	39
Horned Lark *(Eremophila alpestris)*	28	34
Purple Martin *(Progne subis)*	4	2
Tree Swallow *(Tachycineta bicolor)*	1	2
Bank Swallow	200	234
Cliff Swallow *(Petrochelidon pyrrhonota)*	4	
Barn Swallow *(Hirundo rustica)*	14	30
White-breasted Nuthatch		1
House Wren	8	5
Eastern Bluebird *(Sialia sialis)*		1
Veery	1	
Wood Thrush		1
American Robin	47	56
Gray Catbird	1	1
Brown Thrasher *(Toxostoma rufum)*	4	6
European Starling	98	140
Cedar Waxwing	4	2
Yellow Warbler	15	15
Ovenbird	1	
Common Yellowthroat	1	
Field Sparrow *(Spizella pusilla)*	1	1
Chipping Sparrow	11	20
Vesper Sparrow *(Pooecetes gramineus)*	10	10
Savannah Sparrow *(Passerculus sandwichensis)*	4	9
Song Sparrow	31	30
Northern Cardinal	12	15
Rose-breasted Grosbeak	3	1

Species	in 2006	in 2007
Indigo Bunting	4	3
Bobolink *(Dolichonyx oryzivorus)*	5	3
Red-winged Blackbird	67	101
Eastern Meadowlark *(Sturnella magna)*	4	1
Common Grackle	104	131
Brown-headed Cowbird	23	56
Orchard Oriole *(Icterus spurius)*	1	
Baltimore Oriole	12	17
American Goldfinch	10	11
House Sparrow *(Passer domesticus)*		1

A comparison of the average counts of individuals or species (Table 7) indicates an increase in both in the second year of operation. While some of the increase could be attributed to flocking species, there were also higher numbers of some common species such as Mourning Dove, Horned Lark and Barn Swallow. There may have been some influence of more birds moving into newly created habitat, areas where there were few if any present the first year. These would include Killdeer along the laneways, or Savannah Sparrow and Vesper Sparrow into the few available grassy areas. Many of the species were not in the fields per se, but around buildings or in wooded areas, often at some considerable distance from the count point or a turbine. This would suggest that overall numbers of birds in the area were generally higher in the second year. Some differences may have been the result of random changes in weather or in timing of the counts.

Table 7. Average numbers of species and individuals recorded on 23 roadside point counts at Erie Shores Wind Farm in 2006 and 2007.

	2006	2007
Species – average/count	16.4	17.6
Individuals – average/count	45.2	57.9

A comparison of the 5 pairs of roadside counts at close and more distant points within the same fields is given in Table 8. The only decrease the second year is a marginal drop in the average number of species at the closest points. But the numbers of individuals at these same points increased considerably. It would be difficult to argue that the turbines had any negative impact at the closer count points.

Table 8. Average numbers of species and individuals on 5 pairs of close and more distant roadside point counts at Erie Shores Wind Farm in 2006 and 2007.

	2006	2007
At 5 counts closer to turbines		
Species – average/count	16.4	16.2
Individuals – average/count	36.2	48.6
At 5 counts more distant from turbines		
Species – average/count	16.6	16.8
Individuals – average/count	43.4	50.2

Discussion and Conclusions

The turbines at Erie Shores Wind Farm are widely spaced (300 m to several kilometres between them), and the rotors are well above the vegetation (more than 41 m above ground at the lowest), some are out in farm crops 100 m or more from the nearest trees or shrubs. Nesting birds in the area were not deterred from using available habitat, even under the extent of the blades (James 2008). It should not be surprising then, that over the two years following the commencement of turbine operation, there was no decline in census numbers. It was common to observe birds foraging in vegetation and on the ground close to turbines, and in no hurry to move away. Available habitat, often only small patches among more extensive farm fields, was used, and birds were often seen in farm crops close to turbine towers. While the increases during the second year of operations may represent only random fluctuations in populations, they clearly indicate that breeding birds were not avoiding the wind turbines.

Studies at other wind farms have generally experienced similar results. European studies have generally considered mortality to be insignificant, but that displacement is potentially a more serious problem, and have focused more on this aspect of turbines. At 2 large turbines in Sweden, surveys over 3 years before and after operations began, found no indication of any effect on species diversity or abundance (Karlsson 1983). At 6 small wind farms along or near the coast in the Netherlands, the disturbance effect on breeding habitat of birds was negligible (Winkelman 1985). Two years of studies at 11 sites in Germany, indicated no effect on breeding birds (Vauk 1990). Studies over 8 years at an 18 turbine wind park (Oosterbierum) in the Netherlands, indicated no effect on breeding populations of Eurasian Oystercatcher (*Haematopus ostralegus*), Northern Lapwing (*Vanellus vanellus*), Black-tailed Godwit (*Limosa limosa*) and Common Redshank (*Tringa totanus*) (Winkelman 1992). There were no significant changes in upland breeding bird populations before or after construction of a wind farm (Bryn Titli) in Wales, either within the wind farm, or between the wind farm and an adjacent control site (Phillips 1994). There was no evidence of any disturbance effect on breeding waders at high density in close proximity to a large wind farm in coastal habitat in Gotland, Sweden. Densities of breeding waders were similar in the same habitat nearby without turbines (Percival 1998).

A study of nesting birds at Tarifa, Spain, found higher densities in the wind farm than in two other similar adjacent sites. The mean productivity of nests (number of fledglings per nest) was similar for all areas (Janss 2000). Seven years of breeding bird surveys before, during and after construction at Windy Standard wind farm in Britain, indicated no demonstrable effects on bird species (cited in Langston and Pullan 2002). A study of 10 upland wind farms in Britain, comparing breeding bird distributions at wind farms with reference to control sites and random points, indicated no significantly lower densities in wind farms, and no apparent avoidance of larger vs. smaller turbines (cited in Langston and Pullan 2002).

In Belgium, a breeding peninsula for terns and plovers was constructed in 2000, in the outer port, at Zeebrugge. Despite there being 25 small- to medium-sized turbines standing in the vicinity of the peninsula, the site was very successful in attracting terns, with numbers increasing to 2791 pairs by 2007. Some terns were nesting as close as 30 m from the turbines, many at 100 m away or beyond (Stienen *et al.* 2008).

Where some declines have been indicated for one or more species, the loss usually has been attributed to human disturbance, rather than the turbines themselves. At a large facility in Washington and Oregon (Stateline), U.S.A., grassland birds combined had very similar overall use estimates pre- and post-construction (very slight increase). Any impact to individual species was largely attributed to direct habitat loss, and temporary disturbance by people and vehicles using laneways between turbines (Erickson *et al.* 2004). At a small installation of 3 turbines in the Orkney Islands, Scotland, comparing a plot that included the turbines and a control plot 2 km away over 8 years following construction, indicated no significant change in annual use by ducks, Red Grouse (*Lagopus lagopus*), waders, skuas/gulls and small passerines. The only noted decline was 3 of 5 pairs of Red-throated Loon (*Gavia stellata*), apparently the result of human disturbance (the loons were present in the morning when workers arrived) (Meek *et al.* 1993). At a large wind farm in Minnesota (Buffalo Ridge) in grasslands, bird densities were lower closer to the turbines (within 40 m, and between 80 and 180 m, than farther away). However, human distrubance was indicated to have been the probable cause of the lower densities. The turbines were also much shorter than at Erie Shores (37 m towers and 33 m diameter rotors), and noise, movement or closer spacing may also have contributed to the decline in breeding birds close to turbines (Leddy *et al.* 1999).

A decline in the number of breeding waders within 300 m of a single large turbine in Denmark (Tjaereborg) was reported by Pederson and Poulsen (1991). The cause is unclear, and since this is contradictory to other studies of waders already cited (Winkelman 1992, Percival 1998, Meek *et al.* 1993) it suggests perhaps human disturbance may have been the main factor.

In a very different habitat, high elevation forest in the Green Mountains of Vermont (Searsburg), breeding bird studies indicated that overall, within a 50 m radius of the turbines, the number of species increased slightly after construction. Here, however, the forest-dwelling species, such as Swainson's Thrush and Red-eyed Vireo, declined, and species of edges and openings, such as American Robin and Blue Jay, increased (Kerlinger 2000). Such changes might be expected where habitat is altered substantially (local forest removal). But such effects should be minimal in grassland and farmland where surrounding habitat remains the same (or is restored to the same), apart from constructed laneways.

Where habitat changes are minimal, bird populations are likely to be relatively unaffected. The disturbance caused by vehicles and people on laneways and at turbines may be temporary. Once turbines are in operation and necessary adjustments made, visits for routine maintenance are few. Any species that may have been displaced by people may well move back into available habitat once disturbance declines. Birds can quickly habituate to a structure that operates much the same every day. Farming activities on the land are typically much more of a disturbance in an agricultural setting than routine maintenance activities, or the turbines themselves. For most small birds any potential danger remains well above normal activities. For any that venture high enough to be near turbine blades, they would be well aware of the presence of the turbine and able to see and avoid the blades. The small amount of noise from the turbines is insufficient to deter birds from living in close proximity.

Acknowledgements

I am particularly grateful to the various landowners on whose properties frequent visits were made, and thank them for their patience through a couple years of activity. The people at AIM PowerGen Corporation and the Erie Shores Wind Farm involved me and supported my studies; special thanks to Ansar Gafur, David Price, Dennis Haggerty, and Herman Kolke.

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First nesting of American White Pelican on Lake Superior, Ontario, Canada

Status of the American White Pelican in the Great Lakes Region

Cynthia Pekarik, Clive Hodder, D.V. Chip Weseloh, Carolyn Matkovich, Laird Shutt, Tom Erdman and Sumner Matteson

American White Pelican egg compared to a Ring-billed Gull egg. *Photo: C. Hodder.*

Introduction

The American White Pelican (*Pelecanus erythrorhynchos*) is one of two species of pelicans nesting in North America. Its breeding distribution ranges from the Pacific Ocean to northern Lake Michigan (Ratcliff 2005). In Ontario, the breeding distribution has been confined to the western region of the province (Peck 2007). The oldest colony is located in Lake of the Woods, where breeding was first documented in 1938 (Baillie 1939). The second location where breeding was documented is in Lake Nipigon, where nests were first discovered in 1991 (Bryan 1991).

In this paper we report on the discovery of a new nesting site of American White Pelican in Ontario, discovered in 2007. The nests were found on Granite Island (Black Bay), Lake Superior, on 24 June 2007. This represents the first known nesting of American White Pelican in the Canadian Great Lakes.

In addition, we report on sightings of adults in western Lake Superior from 1999-2008 and discuss the status of the species in the Great Lakes region.

Methods

Granite Island was accessed by boat on two occasions in 2007; once on 23 May and once on 24 June. During each visit, researchers disembarked and counted the nests of colonial waterbirds, and noted the nesting of other species opportunistically. Each colonial waterbird nest was counted individually, nests were marked with a small spot of fluorescent paint as they were tallied, to ensure that they would not be double-counted.

On 23 May, the nests of Ring-billed Gull (*Larus delawarensis*), Herring Gull (*Larus argentatus)* and Double-crested Cormorant (*Phalacrocorax auritus*) were counted; on June 24, nests of American White Pelican and Double-crested Cormorant were counted.

In 2000, six comprehensive shoreline surveys were conducted in Nipigon Bay between 31 May and 19 July. The entire shoreline was surveyed by boat and the presence and number of any waterbirds was recorded.

During 2000-2008, the presence of adult American White Pelicans was recorded by Canadian Wildlife Service field crews operating on Lake Superior while boating and/or engaged in other work. These sightings should be considered opportunistic since they were not part of coordinated surveys in any given area.

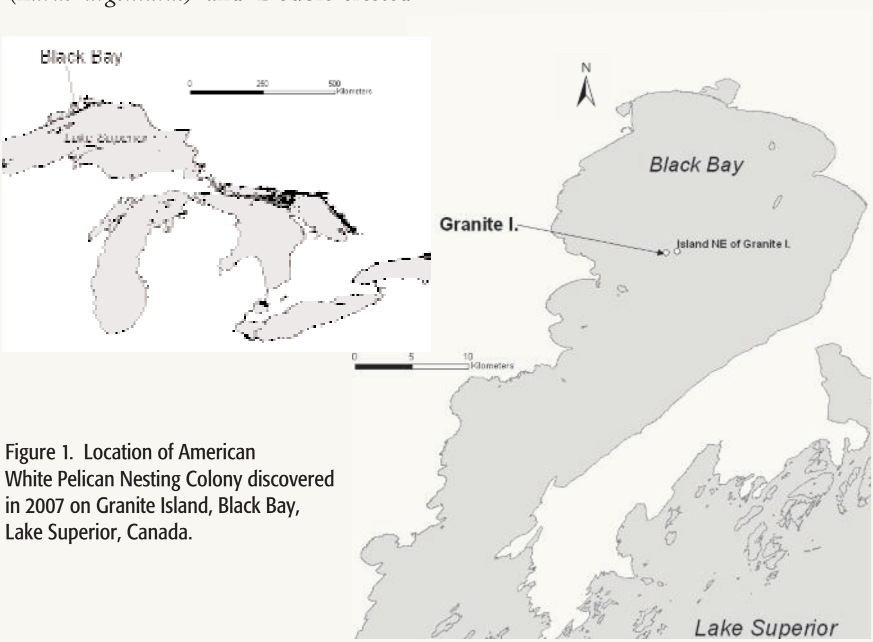

Figure 1. Location of American White Pelican Nesting Colony discovered in 2007 on Granite Island, Black Bay, Lake Superior, Canada.

Results

On 23 May 2007, the following colonial waterbird nests were counted at Granite Island: Ring-billed Gull nests: 2156,
Herring Gull nests: 138,
Double-crested Cormorant nests: 264.
No American White Pelicans were observed on the island.

The events of 24 June are recounted here: Upon approaching Granite Island one American White Pelican was observed sitting along a ridge on the north-east side of the island. As we continued to approach, the number of pelicans we could see increased. Upon our final approach, we observed approximately 37 adult pelicans that flushed from Granite Island and settled on an adjacent small low-lying island approximately 500m NE of Granite Island. Once on Granite Island, we discovered a total of 20 pelican nests. The nests were configured in two groups that were approximately 75 m apart. One group of 17 nests was located on the east side of the island along a high ridge. The nest contents included six nests with no eggs, six nests with one egg and five nests containing two eggs. A smaller group of three nests was located to the west and at a lower elevation than the larger group. Within this group, all three nests were empty, however, three eggs were observed nearby. The eggs appeared to have been predated by gulls.

In addition to the pelicans, the following colonial waterbird nests were counted:
Double-crested Cormorant nests: 286,
Caspian Tern (*Hydroprogne caspia*)
nests: 2.

A Bald Eagle (*Haliaeetus leucocephalus*) nest was observed at the south end of the island. The nest was not checked for contents. However, it was assumed to be occupied, as one adult was observed departing from the nest.

Upon leaving Granite Island, we visited the small low-lying island where the adult pelicans had settled during the time we were on Granite Island; no pelicannests were observed at that site. The adult pelicans departed from this island and returned to Granite Island where we observed them returning to the top mound, where the larger group of 17 nests was located. We did not observe pelicans

Figure 2. Nipigon Bay (Lake Superior, Canada) showing locations of sightings of adult American White Pelicans, 1999-2008 (See Table 1 for details on the sightings).

Table 1. Sightings of adult American White Pelican observed by Canadian Wildlife Service field crews, 1999-2008 (see Figure 2 for locations in Nipigon Bay).

Location – # (Figure 2)	**Location – name**	**Dates**	**Numbers of American White Pelican**
1	Nipigon Bay (Mouth of Nipigon River)	18 July, 2000 19 July, 2000	18 85
2	Nipigon Bay (West Shore)	1 July, 2000	4
3	Nipigon Bay (West of Condon Island)	26 June, 1999 26 June, 2007	24 4
4	Nipigon Bay (East of Cook Point)	31 May, 2000 1 July, 2000 2 July, 2000 18 July, 2000	1 39 9 1
	Black Bay Island (North-east of Granite Island	26 June, 2005	31
	The Welcome Islands (South-east of Thunder Bay)	22 June, 2007	14

returning to the smaller group of three nests. The location of Granite Island and the small island to the north-east are shown in Figure 1.

Adult American White Pelicans were observed in Nipigon Bay once in 1999, on seven occasions in 2000, once in 2005 and once in 2007 (Table 1, Figure 2). The maximum number of birds seen was 85, observed at the mouth of the Nipigon River, on 19 July 2000 (Table 1). Prior to 2007, pelicans were observed only once in Black Bay, when 31 individuals were sighted on the island adjacent to Granite Island on 26 June 2005 (Table 1).

Discussion

The colony found on Granite Island represents the first known nesting of this species on the Canadian Great Lakes. American White Pelicans have been nesting in Wisconsin waters of Lake Michigan since 1995 when 6 nests were reported on Cat Island (T. Erdman, pers. comm.); the growth of that colony occurred rapidly as there were 107 nests reported there in 1997 (Cuthbert *et al.* 2001). In 1999, another colony with 16 nests was discovered at Little Gull Island in Michigan waters of Lake Michigan. The total number of nests on Lake Michigan (and the Great Lakes) in 1999 was 168 (152 nests at Cat Island and 16 at Little Gull Island). In 2007, American White Pelicans were nesting at four sites on Lake Michigan: 397 nests on Cat Island, 421 nests on Lone Tree Island (T. Erdman, pers. comm.), 40 nests on Hat Island and 17 nests were estimated at Little Gull Island (based on the presence of 35 adults) (L. Wires, pers. comm).

In addition, there was nesting recorded in 2007 in Wisconsin, at inland lakes south-west of Lake Michigan. There were six sites with a total of 501 nests at Horicon National Wildlife Refuge, three sites with a total of 386 nests on Lake Butte des Morts, one site with 25 nests on Lake Winnebago, and one site with 17 nests on Lake Puckaway (S. Matteson, pers. comm.). The year 2007 marked the tenth consecutive year that American White Pelican had nested at Horicon National Wildlife Refuge and the third year they had nested on Lake Butte des Morts; 2007 was the first year they had nested on Lake Winnebago and Lake Puckaway (S. Matteson, pers. comm.).

The breeding range of the American White Pelican in Canada appears to be progressing eastward. Supporting nesting records include: nesting at Lake of the Woods (first documented in 1938), followed by nesting in Lake Nipigon (beginning in 1991), Lake Michigan (beginning in 1995), an island in the Akimiski Strait, Nunavut, where approximately 40 adults and two eggs were observed in 2006 (K. Abraham, pers. comm., Peck 2007), the establishment of colonies at inland lakes south-west of Lake Michigan since the late 1990s (S. Matteson, pers. comm.) and the nesting reported here for Lake Superior in 2007.

American White Pelican breeds mainly on isolated islands in freshwater lakes, and they tend to forage in shallow waters, which may be up to 100 km from nesting sites (Knopf and Evans 2004). The areas where we observed American White Pelicans were shallow areas; the birds were either nesting at other locations and foraging in Lake Superior, or they may have represented birds that were scouting for new nesting sites. The discovery of the nesting colony at Granite Island was unexpected as pelicans had not been observed in Black Bay as often as they had been in Nipigon Bay. However, the birds seen in Nipigon Bay may have been birds nesting on Lake Nipigon that had flown to Nipigon Bay to forage.

The North American population of American White Pelican appears to be stable or increasing (King and Anderson 2005, Ratcliff 2005). King and Anderson (2005) compared the number of nests between two time periods (1979-81) and (1998-2001) at twenty colonies and found that the number of nests had more than doubled. In Ontario, the number of nests at Lake of the Woods increased consistently from 1938 (4 pairs) to a high of 7885 pairs in 1990; recent data indicate a stable population (7432 pairs in 2004) (Ratcliff 2005). Similarly, the colonies on Lake Nipigon increased from 3 nests at one site in 1991 to approximately 638 nests at five sites in 2004 (Ratcliff 2005).

A large proportion of the continental population of American White Pelican is found in Canada. It is estimated that approximately 50% of the North American population nests in Saskatchewan and Manitoba. The colonies in Lake of the Woods contain approximately 10% of the Canadian population and approximately 8.8 % of the global population (Ratcliff 2005, IBA 2007).

C. Pekarik in the American White Pelican colony, Granite Island, with the Ring-billed Gull colony in the background. *Photo: C. Hodder.*

American White Pelican is listed as Endangered in Ontario (Ratcliff 2005). The primary method of protection for this species is afforded under the provincial Endangered Species Act (1996). Although the Ontario population appears to be increasing, it is still at risk due to fact that breeding populations are concentrated in a few areas. This makes the population susceptible to disturbances, such as human disturbance, disease outbreaks and storm events (Murphy 2005).

In Ontario, nesting colonies are located on Crown Land and some have been designated as Important Bird Areas (IBAs). In Lake of the Woods, The Three Sisters Islands have been designated as IBAs due to the large proportion of the continental population of American White Pelican found there. In addition, American White Pelican is recognized as part of the avifauna at the Sand Spit Archipelego (IBA 2007). On Lake Nipigon, the islands used by American White Pelican are owned by the Crown and are part of the Lake Nipigon Conservation Reserve; boating, fishing, camping or viewing is not permitted within 500 metres of pelican nests from 15 April to 15 August (OMNR 2004).

Conclusion

The population of the American White Pelican in and around the Great Lakes appears to be expanding, however, coordinated continental surveys are required in order to be certain of population changes. Geographically, the species appears to be expanding its range eastward, at a relatively slow pace. Continued monitoring and recording of new nesting colonies will determine if this trend continues. The Ontario population represents a significant portion of the continental population, and although nesting colonies are protected, they are vulnerable to catastrophic events due to the aggregation of many birds at those sites during the nesting season.

Acknowledgements

The authors appreciate the local knowledge and information provided by Brian Ratcliff. Chris Risely, Ken Abraham (OMNR). Linda Wires (University of Minnesota) and Glenn Barrett (CWS) provided unpublished information. Jamie Reed and Tania Havelka provided field assistance for the shoreline surveys of Nipigon Bay.

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Aberrantly-coloured eggs of Double-crested Cormorant (*Phalacrocorax auritus*) from Lake Huron

Michael Patrikeev, Scott Parker and Jeff Truscott

Figure 1. A nest of Double-crested Cormorant with seven eggs from White Rock Island, Fathom Five National Marine Park, Lake Huron. May 2008. *Photo: Michael Patrikeev*

Double-crested Cormorants (*Phalacrocorax auritus*) are a familiar sight throughout the Great Lakes, and can be seen flying overhead, or loafing and roosting in trees, or on rocks, and man-made structures along shores of lakes and other water bodies. Many thousands of these dark piscivorous birds nest on islands in lakes Ontario, Erie, Huron and Superior, where they form dense colonies, often alongside gulls and terns.

Figure 2. A nest of Double-crested Cormorant with four eggs from Lake Superior. May 1995. *Photo: Michael Patrikeev.*

Cormorant nests are built from materials available near colonies, usually finger-sized sticks, aquatic plants and other bulky materials, both natural and man-made (Hatch and Weseloh 1999, M. Patrikeev pers. obs.). One to seven eggs are laid, but most commonly 3 or 4 (Peck and James 1983, Stenzel *et al.* 1995). Eggs are pale blue and unmarked, but the pigmented layer is often obscured by an outer calcite cover that is initially white (Van Scheik 1985 in Hatch and Weseloh 1999) as can be seen in Figures 1 and 2. As incubation progresses, the eggs acquire a yellowish or brown stain from guano and dirt (Hatch and Weseloh 1999).

On 22 May 2008, several sets of cormorant eggs with a "mottled" or "speckled" appearance were found on Snake Island (45° 20' 16" N, 81° 37' 14" W) in Lake Huron, during a Parks Canada Herring Gull (*Larus argentatus)* survey. Snake Island is a relatively small (ca. 100 m x 500 m) rocky island with few shrubs and trees, lying ca. 8 km off the tip of the Bruce Peninsula, and just outside the boundaries of the Fathom Five National Marine Park. On 22 May, 30-35 ground-nests of Double-crested Cormorant were located in the southeastern part of the island. Most nests contained only 2 to 3 eggs indicating that laying was still underway.

Several nests contained eggs that appeared patterned (Figures 3 and 4) unlike typical eggs of Double-crested Cormorant. Although the background

Figure 3. "Mottled" eggs of Double-crested Cormorant. The visible pattern is mostly confined to the outer calcite layer. Snake Island, Lake Huron. May 2008. *Photo: Michael Patrikeev*

Figure 4. A clutch of heavily mottled eggs from Snake Island, Lake Huron. May 2008. *Photo: Michael Patrikeev*

colouration (slightly bluish) was typical for freshly-laid eggs of this species, the eggs from Snake Island were mottled or speckled with tan and brown, and varied from very lightly- to heavily-mottled. Some eggs were mottled so heavily that their background colour had changed to tan. Close examination revealed that it was the outer calcite cover that was patterned. The clutches were photographed but not collected. The prevalence of such "mottled" eggs in the colony could not be determined because many cormorant eggs were depredated or stolen by Herring Gulls. The cormorants had left the colony soon after we made landing, and did not return until some time after we had left. The Herring Gulls, on the other hand, lingered near the cormorant colony, and pecked and stole many eggs from unattended nests (Figure 5).

The senior author has seen thousands of cormorant clutches in colonies around the Great Lakes, but has never observed similarly patterned eggs. Several colonial waterbird experts who regularly visit cormorant colonies in the Great Lakes, also have never observed such clutches (C. Weseloh, CWS; S. Elliott retired OMNR, pers. comm.). Egg collections at Royal Ontario Museum (Toronto, Ontario), and Western Foundation for Vertebrate Zoology (Camarillo, California) do not contain any patterned eggs of the Double-crested Cormorant (M. Peck, R. James, R. Corado, pers. comm.).

It was suggested that some foreign substance on the plumage of the incubating bird (e.g., oil) may have been responsible for the "mottled" appearance of the eggs from Snake Island (L. Kiff in litt. to J. C. Eitniear). The Pelecaniformes (including cormorants) probably do not have shell pigment glands, and thus production of "coloured" eggs is highly unlikely. It was also pointed out that in the past, the chalky external cover of Double-crested Cormorant eggs was disproportionately affected by DDE, and the bright blue colour of the actual eggshell was exposed in the most contaminated eggs (L. Kiff, pers. comm.).

Figure 5. Depredated clutch of Double-crested Cormorant. Snake Island, Lake Huron. May 2008.
Photo: Michael Patrikeev

Figure 6. Double-crested Cormorants in the colony at Pigeon Island, Lake Ontario. April 1994.
Photo: Michael Patrikeev

This is a plausible theory, however, pollution by oil or similar substances would likely have manifested itself in a similar manner in various cormorant colonies across the Great Lakes. However, we have found no reports of similarly coloured eggs from our region or elsewhere. Nor were there any reports of oil spills in that area.

We plan to revisit Snake Island in 2009, and arrange for a permit to collect several sets of "mottled" cormorant eggs (assuming that eggs with "mottled" appearance can be located next year). We will further look into natural or unnatural causes that might have been responsible for mottled appearance of Double-crested Cormorant eggs from Snake Island.

Acknowledgements

We would like to express our appreciation to the following individuals for assistance in and comments on the preparation of this manuscript: René Corado (Western Foundation for Vertebrate Zoology), Tammy Dobbie (Point Pelee National Park), Jack Eitniear (Center for the Studies of Tropical Birds), John Haselmayer (Parks Canada), Ross James (Ontario Field Ornithologists), Lloyd Kiff (Peregrine Fund), Mark Peck (Royal Ontario Museum), Steve Travis (Point Pelee National Park) and Chip Weseloh (Canadian Wildlife Service).

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