Analysis of Changes in Breeding Bird Community Richness in Lower Great Lakes Basin Areas of Concern and Surrounding Federal Ecoregions

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by

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EXECUTIVE SUMMARY

Degradation of wildlife populations and/or the loss of fish and wildlife habitat are Beneficial Use Impairments that have been identified in most Great Lakes Areas of Concern (AOCs). However, the relative extent to which these impairments have been influenced by restoration and protection efforts in the AOCs is an important gap in information.

One line of evidence that can be used to assess these Beneficial Use Impairments is the status of breeding birds. Using data from two Ontario Breeding Bird Atlases and the breeding-bird community as a surrogate for “wildlife” and “wildlife habitat”, we assessed the extent to which avifaunal metrics within AOC landscapes have changed (improved or become further degraded) over a 20-year timeframe, relative to changes in the surrounding Federal Ecoregions. The AOCs were compared to the surrounding Federal Ecoregions because the ecoregions provide comparable vegetation, geologic, climatic and landuse attributes that could be used as a contextual control for larger-scale processes affecting breeding bird populations.

In general, changes in the richness of bird community guilds in the lower Great Lakes Basin AOCs tended to track changes in the surrounding Federal Ecoregions. Land-associated bird guilds (particularly forest birds) and grassland bird guilds showed the most consistent changes in species richness across the lower Great Lakes Basin, with a general increase in forest bird richness and decline in grassland bird richness over the 20 years between atlases. Results for water-associated bird guilds were mixed, but tended to show some declining trends in species richness in the Detroit River and St. Clair River AOCs. In contrast to other AOCs, the richness of bird guilds in the Severn Sound AOC met or exceeded that of the broader landscape for all species guilds.

Results suggest that reforestation, natural regeneration of previously cleared areas and shifts away from agricultural pastureland are benefiting forest-associated bird species, while grassland birds are declining, likely as a result of a net loss in available grassland habitat. In the face of ongoing development and population growth, continued restoration efforts will be necessary to maintain bird community guilds at their present (or improved) state. This is especially true for grassland birds, aerial foragers, and aquatic-associated birds, which declined across many of the AOCs and Federal Ecoregions. The St. Lawrence River (Cornwall), Detroit River and St. Clair River AOCs, in particular, would likely benefit from a greater amount of forest, wetland and grassland restoration, in order to meet or exceed species richness in the surrounding landscape. Restoring large, interconnected patches of each habitat type will likely be necessary to sustain area-sensitive forest, grassland and marsh bird species richness.

Although this study examined the change in richness of bird guilds over the past 20 years, the cause(s) of those changes was not examined. Studies that examine why bird communities are changing should be undertaken as decision-support for the allocation of future remediation dollars. For example, the change in bird community richness in response to landscape-level changes in habitat composition should be analyzed to determine whether bird communities are changing in response to a change in the amount of suitable habitat available or to the increased fragmentation of suitable habitat as development continues in southern Ontario. Research that examines whether aquatic bird declines are the result of too little restoration or of poor habitat and water quality in restored areas, including factors beyond the scope of Remedial Action Plans (e.g., water level fluctuations, climate change, invasive species), would be beneficial to organizations involved in the remediation of wetland habitat.
Results reported here also relied upon statistical tests to determine if results were mathematically significant at $p < 0.05$. However, low variation around the mean may result in statistically significant results that are not necessarily biologically significant (e.g., significant change in shorebird richness by less than one species in the Niagara River (Ontario) AOC and Federal Ecoregion #135; Table 8). Alternatively, small sample size and high variation around the mean may result in statistical non-significance, despite biologically significant differences (e.g., non-significant decline in landbird richness by approximately 10 species in the St. Clair River AOC; Table 10). Thus, the magnitude of change and the error associated with the change in species richness should be examined when interpreting the results presented. Additional localized research should be conducted in AOCs that experienced large but statistically non-significant changes in bird community richness to determine if the changes observed are real.
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INTRODUCTION

Areas of Concern (AOCs) are sites that have been environmentally degraded and fail to meet the general and specific objectives of the Canada-United States Great Lakes Water Quality Agreement (amended by Protocol, 1987), such that the area’s ability to support beneficial uses related to aquatic life is compromised. The Canadian and United States governments together identified 43 AOCs in the Great Lakes Basin. Remedial Action Plans (RAPs) were then developed for each AOC to identify specific problems and Beneficial Use Impairments (BUIs) in the AOCs, guide restoration and protection efforts, and measure the progress of those efforts. Measuring the progress of remediation efforts is necessary to determine if the specific goals of each RAP are being met, and whether an AOC can be removed from the list of AOCs (i.e., ‘delisted’).

Degradation of wildlife populations and/or loss of wildlife habitat are BUIs that were identified in most AOCs. However, the relative extent to which these BUIs have improved with restoration and protection efforts in the AOCs is an important gap in information, but is necessary to provide a defensible mechanism to delist AOCs. One line of evidence to examine any improvements in the AOCs is to use breeding-bird communities as an indicator of “wildlife” and “wildlife habitat.”

With the completion of fieldwork for the second Ontario Breeding Bird Atlas in 2005, two large databases now exist on the distribution of breeding birds across two different time periods – 1981-85 and 20 years later in 2001-05. As with the first atlas, data for the second atlas were collected by about 2000 skilled volunteers, who collectively contributed over 145,000 person hours of fieldwork and submitted over 560,000 individual records. Data from these two atlases provide a means to assess changes in breeding bird communities at a variety of regional scales.

Using data from the two atlases, we assessed the extent to which relevant bird community metrics within eight Great Lakes Basin AOC landscapes changed over a 20-year time frame, relative to the surrounding Federal Ecoregions, which reflect similar vegetation, geologic and land-use features to the AOCs. Bird community metrics were chosen to reflect environmental sensitivity and habitat quality, and included richness of: area-sensitive species across primary habitat types (wetland, upland grassland, forest species); piscivorous species; aerial insectivores; and colonial waterbirds. In this report, we highlight patterns of difference or similarity between AOCs and their counterpart non-AOC landscapes (as represented by Federal Ecoregions under the Ecological Framework of Canada; Environment Canada 2005) in the change in richness of bird community metrics between atlases, and offer possible explanations for the observed differences.
Results

Total Species Richness

**AOC vs. Federal Ecoregion.** Mean change in total species richness between atlases did not differ significantly between the Bay of Quinte AOC and Federal Ecoregion #134 (Figure 7).

**Atlas 1 vs. Atlas 2.** Total species richness increased significantly ($p < 0.05$) in both the Bay of Quinte AOC and Federal Ecoregion #134 (Table 4).

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**Figure 7.** Mean change in total species richness and richness of general taxon guilds between the first and second Ontario Breeding Bird Atlas in the Bay of Quinte AOC (shaded) and Federal Ecoregion #134 (white). Marginally significant differences in the change in richness between AOC and Federal Ecoregion ($p < 0.1$) are represented by +. Guilds highlighted in blue are associated with aquatic habitats.
Table 4. Mean richness of avifaunal guilds in the Bay of Quinte AOC (n = 64 squares) and Federal Ecoregion #134 (n = 422 squares) during the first and second Ontario Breeding Bird Atlas. The direction of significant changes (*: p < 0.05; **: p < 0.01; ***: p < 0.001; ****: p < 0.0001) in richness between atlases in the AOC or Federal Ecoregion is shown by +/-.

General Taxon Guilds

AOC vs. Federal Ecoregion. In the 20 years between atlases, mean change in richness of the general taxon guilds did not differ significantly between the Bay of Quinte AOC and Federal Ecoregion #134 (Figure 7). The increase in landbird species richness between atlases was marginally (p < 0.1) greater in the AOC than in the Federal Ecoregion (Figure 7).

Atlas 1 vs. Atlas 2. Between atlases, species richness of landbirds increased significantly in both the Bay of Quinte AOC (p < 0.01) and Federal Ecoregion #134 (p < 0.01; Table 4). Richness of shorebird species declined significantly in both the AOC (p < 0.05) and Federal Ecoregion (p < 0.0001). Waterbird and waterfowl species richness did not change significantly between atlases in either the Bay of Quinte AOC or Federal Ecoregion #134.
Habitat Guilds

AOC vs. Federal Ecoregion. Between the first and second atlas, mean change in species richness of habitat guilds did not differ significantly between the Bay of Quinte AOC and Federal Ecoregion #134 (Figure 8). Mean increase in species richness of forest birds, area-sensitive forest birds and scrub birds was marginally greater ($p < 0.1$) in the AOC than the Federal Ecoregion, while a decline in species richness of area-sensitive grassland birds was marginally greater ($p < 0.1$) in the Federal Ecoregion than the AOC.

Atlas 1 vs. Atlas 2. Species richness of forest, area-sensitive forest and scrub birds increased significantly between atlases in both the Bay of Quinte AOC ($p < 0.001, p < 0.0001, p < 0.0001$, respectively) and Federal Ecoregion #134 ($p < 0.001, p < 0.0001, p < 0.0001$, respectively; Table 4). Alternatively, richness of grassland species declined significantly between atlases in both the AOC ($p < 0.05$) and Federal Ecoregion ($p < 0.0001$), and richness of area-sensitive grassland birds declined significantly in the Federal Ecoregion ($p < 0.0001$), but non-significantly in the AOC (Table 4). Again, such declines are consistent with rangewide declines in grassland birds (McCracken 2005).

Figure 8. Mean change in species richness of habitat guilds between the first and second Ontario Breeding Bird Atlas in the Bay of Quinte AOC (shaded) and Federal Ecoregion #134 (white). Marginally significant differences in change in richness between AOC and Federal Ecoregion ($p < 0.1$) are represented by $\dagger$. Guilds highlighted in blue are associated with aquatic habitats; AS = area-sensitive species.
Foraging Guilds

**AOC vs. Federal Ecoregion.** Mean increase in species richness of omnivores and piscivores was significantly \((p < 0.05)\) greater in the Bay of Quinte AOC compared to Federal Ecoregion #134 between the first and second atlas. Although species richness of ground foragers changed by less than one species on average, in both the AOC and Federal Ecoregion, a mean increase in ground forager richness in the AOC was marginally greater \((p < 0.05)\) than the decline detected in the Federal Ecoregion (Figure 9). Mean change in species richness of all other foraging guilds did not differ significantly between the AOC and the Federal Ecoregion.

**Atlas 1 vs. Atlas 2.** Between atlases, species richness of bird and omnivore foragers increased significantly (AOC: \(p < 0.0001\), \(p < 0.0001\); Federal Ecoregion: \(p < 0.0001\), \(p < 0.0001\)) and richness of aerial foragers declined significantly (AOC: \(p < 0.01\); Federal Ecoregion: \(p < 0.0001\)) in both the Bay of Quinte AOC and Federal Ecoregion #134 (Table 4). Piscivore species richness increased significantly \((p < 0.01)\) in the Bay of Quinte AOC, but did not change significantly in the surrounding Federal Ecoregion #134.

**Figure 9.** Mean change in species richness of foraging guilds between the first and second Ontario Breeding Bird Atlas in the Bay of Quinte AOC (shaded) and Federal Ecoregion #134 (white). Significant differences in the change in richness between AOC and Federal Ecoregion \((p < 0.05)\) are represented by *; marginally significant differences \((p < 0.1)\) by *. Guilds highlighted in blue are associated with aquatic habitats.
Discussion

In the 20 years between atlases, mean change in species richness of the majority of avifaunal guilds examined tended to follow the same general trends in the Bay of Quinte AOC as in Federal Ecoregion #134. Species richness of omnivores and piscivores, however, increased by a significantly greater amount in the AOC than the Federal Ecoregion.

Between atlases, species richness of land associated guilds (landbirds, forest birds, area-sensitive forest birds, scrub birds, bird foragers, omnivore foragers) and total species richness increased significantly in both the Bay of Quinte AOC and Federal Ecoregion #134. In particular, area-sensitive forest warblers, including Pine Warbler, Black-throated Green Warbler and Magnolia Warbler, increased by 38%, 38% and 36%, respectively in the Bay of Quinte AOC. Common Raven, Yellow-rumped Warbler and Eastern Bluebird also experienced large (>40%) increases in the AOC (Appendix C).

A large portion of the agricultural landscape east of Toronto has either been abandoned and is regenerating to forest cover or has been converted to conservation tillage in recent decades (Environment Canada 2007; Reid 2001), including the conversion of approximately 27,000 hectares of farmland from conventional to conservation tillage in the Bay of Quinte AOC (Environment Canada 2007). An examination of the correlation between the change in richness of landbird species and historical landuse data, and in particular the net change in the amount and size of forest and scrub habitat patches in the Bay of Quinte AOC and the rest of Federal Ecoregion #134 would help determine if the observed changes are due to an overall increase in scrub and forest cover.

Species richness of grassland birds and aerial foragers, which often depend on early successional grassland habitats for nesting and/or foraging, declined significantly between atlases in both the Bay of Quinte AOC and Federal Ecoregion #134. Most notably, grassland birds such as Horned Lark, Upland Sandpiper, Spotted Sandpiper and Henslow’s Sparrow declined by 19%, 17%, 13% and 13%, respectively. Aerial foragers that experienced the greatest declines were Common Nighthawk (-25%), Whip-poor-will (-23%) and Bank Swallow (-20%; Appendix C). Research that examines the change in grassland and aerial forager richness in relation to landscape-level changes in the amount and size of habitat patches would help determine if the observed declines in species richness are the result of habitat loss and/or fragmentation. Alternatively, Whip-poor-will, which is a forest-nesting aerial forager, experienced a decline in the proportion of atlas squares occupied, despite an overall increase in forested habitat along the north shore of Lake Ontario (Reid 2001). Thus, other factors such as prey availability and surrounding land use may be limiting the productivity of this, and possibly other, aerial foraging species. Again, it is important to note that most grassland birds and aerial foragers are experiencing rangewide declines.

Piscivores, on the other hand, increased significantly in the Bay of Quinte AOC and at a significantly greater rate than in the surrounding Federal Ecoregion. Water quality has improved greatly in the Bay of Quinte AOC, which may be due to a 90% reduction in phosphorous inputs, improved water clarity, and less severe algal blooms (Environment Canada 2007). All of these improvements, combined with the rehabilitation or protection of greater than 800 hectares of wetland (Environment Canada 2007), appear to have had a positive impact on the fish community in the Bay of Quinte AOC, thereby benefiting piscivorous bird species such as Osprey and Hooded Merganser, which increased by 36% and 34%, respectively (Appendix C). Alternatively, non-significant declines in species richness of other aquatic bird guilds, including
waterbirds, waterfowl, marsh birds and area-sensitive marsh birds, across the broader landscape in both the Bay of Quinte AOC and Federal Ecoregion #134, suggest that wetland-dependent bird species would benefit from further wetland rehabilitation. An examination of the change in the amount and distribution of inland and coastal wetlands across the broader landscape over the past 20 years would help determine if habitat available to wetland-associated bird species has declined.