



Management and Conservation Article

Seasonal Abundance and Species Richness of Birds in Common Reed Habitats in Lake Erie

SHAWN W. MEYER,^{1,2} *Biology Department, University of Western Ontario, London, ON N6A 5B7, Canada*

SHANNON S. BADZINSKI, *Long Point Waterfowl, Bird Studies Canada, 115 Front Street, Port Rowan, ON N0E 1M0, Canada*

SCOTT A. PETRIE, *Long Point Waterfowl, Bird Studies Canada, 115 Front Street, Port Rowan, ON N0E 1M0, Canada*

C. DAVISON ANKNEY, *Biology Department, University of Western Ontario, London, ON N6A 5B7, Canada*

ABSTRACT Common reed (*Phragmites australis*) forms dense stands with deep layers of residual organic matter that negatively affects plant diversity and possibly habitat use by wetland birds. We sought to determine whether seasonal relative abundance and species richness of birds varied among 3 habitat types in Great Lakes coastal wetland complexes recently invaded by common reed. We used fixed-distance point counts to determine species relative abundances and species richness in edge and interior locales within common reed, cattail (*Typha* spp.), and meadow marsh habitats of various sizes during 2 summers (2001 and 2002) and 1 autumn (2001) at Long Point, Lake Erie, Ontario, Canada. We found that total relative abundance and species richness of birds were greater in common reed habitat compared to cattail or meadow marsh habitats. However, we also found that relative abundance of marsh-nesting birds was greater in meadow marsh habitat than in cattail and common reed during summer. Lastly, we found that, irrespective of habitat type, habitat edges had higher total relative abundance and species richness of birds than did habitat interiors. Our results show that common reed provides suitable habitat for a diversity of landbirds during summer and autumn but only limited habitat for many marsh-nesting birds during summer. Based on these results, we recommend restoration of meadow marsh habitat through reduction of common reed in Great Lakes wetlands where providing habitat for breeding marsh-nesting birds is an objective. Managers also might consider reducing the size of nonnative common reed stands to increase edge effect and use by birds, possibly including wetland birds.

KEY WORDS common reed, Great Lakes, habitat, *Phragmites*, wetland, wetland birds.

Wetlands within the lower Great Lakes region historically have been subjected to numerous stressors that have impacted distribution, extent, and function of those wetlands. Over the past 200 years, >60% of wetlands have been drained or degraded throughout southern Ontario, Canada, with wetland losses >80% in some parts of this region (Snell 1987). Although rates of wetland loss have decreased in the past few decades, many of the remaining wetlands continue to be degraded by human activities, such as dredging, eutrophication, pollutants, altered hydrological regimes, and introduction of nonnative species (Roman et al. 1984, Crowder and Bristow 1988, Herdendorf 1992, Mitsch and Gosselink 2000, Timmermans et al. 2008). As of 1993, 139 exotic aquatic species have become established in the Great Lakes ecosystem (Mills et al. 1993). Nonnative species are of major concern for Great Lakes wetlands and have surpassed pollution and alteration of habitat as the primary cause of wetland degradation in the region. For example, purple loosestrife (*Lythrum salicaria*) and zebra mussels (*Dreissena polymorpha*) have altered the ecological integrity of some coastal wetlands by disrupting food webs and displacing native flora and fauna (Thompson et al. 1987, MacIsaac et al. 1992, Dermott et al. 1993). Therefore, evaluating the ecological impacts of nonnative species on native species is an important step toward recommending possible management actions that conserve or restore biodiversity within the Great Lakes ecosystem.

Common reed (*Phragmites australis*) is a large, perennial rhizomatous reed that grows in aquatic, semiaquatic, and terrestrial habitats (Kiviat 1987, Marks et al. 1994). Although common reed has been in North America for $\geq 3,000$ years, a nonnative genotype from Europe has been introduced into eastern North America sometime within the last century (Niering and Warren 1977, Saltonstall 2002). This introduction, in conjunction with many large-scale disturbances (e.g., sedimentation, salinity, and altered hydrological regimes) has favored rapid expansion of common reed (Roman et al. 1984, Kiviat 1987, Marks et al. 1994, Meyerson et al. 2000). For example, at Long Point, Ontario, nonnative common reed stands increased exponentially (50%/yr) between 1995 and 1999, primarily replacing cattail (*Typha* spp.) and meadow marsh habitats (Wilcox et al. 2003). Meadow marsh habitat consists of sedges (e.g., *Carex* spp.), grasses (e.g., *Calamagrostis* spp.), forbs (e.g., *Iris* spp.), and shrubs (e.g., *Cornus* spp. and *Alnus* spp.) that tolerate shallow, periodic inundation and provide important habitat for Great Lakes wildlife (Riffell et al. 2001). Due to aggressive growth and recent expansion of common reed in North America, some wetland functions (e.g., hydroperiod and nutrient cycling) have been negatively affected (Ward 1942, Jones and Lehman 1987, Chambers et al. 1999, Meyerson et al. 2000, Rice et al. 2000). Similarly, several studies have documented common reed negatively affecting native floral diversity by shading, crowding, and inhibiting seed germination of other plants and faunal diversity due to changes in habitat structure and penetrability of wetland interiors (Ward 1942, Jones and Lehman 1987, Benoit and Askins 1999, Meyerson et al. 2000, Rice

¹ E-mail: Shawn.Meyer@ec.gc.ca

² Present address: Environment Canada, Canadian Wildlife Service – Ontario, 335 River Road, Ottawa, ON K1A 0H3, Canada

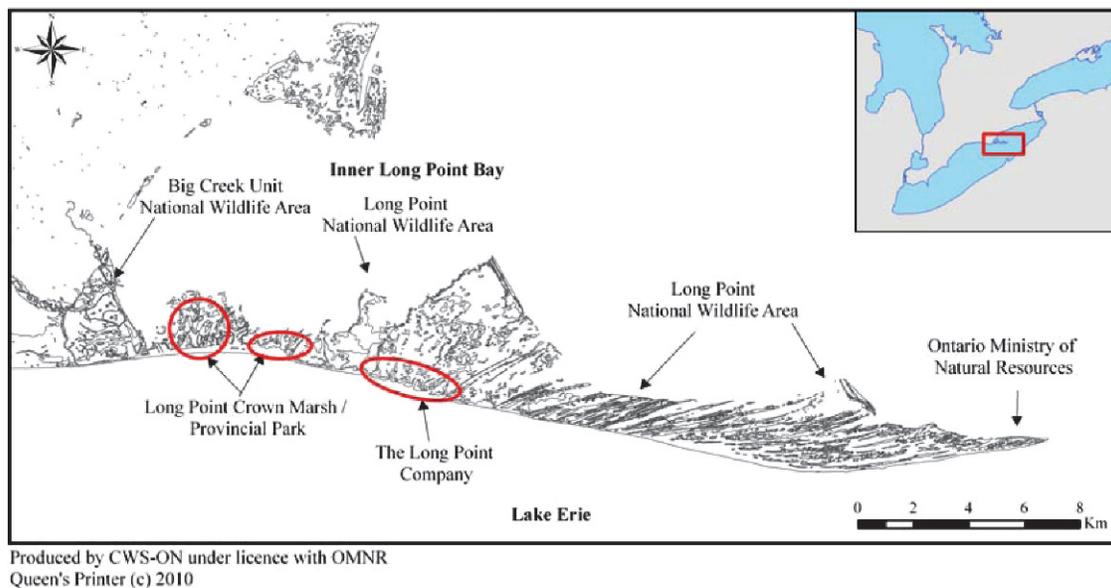


Figure 1. Location of 3 study sites at Long Point, Lake Erie, Ontario, Canada, where bird surveys were conducted in 2001 and 2002.

et al. 2000). Marsh-nesting birds are one group that may be negatively affected. For example, marsh wren (*Cistothorus palustris*) can be displaced as common reed replaces cattail, preferred nesting habitat for marsh wren (Verner 1965).

Few studies have assessed use of nonnative common reed by breeding birds in North America (but see Benoit and Askins 1999). Given that many marsh-nesting birds are declining in the Great Lakes Region (Crewe et al. 2006), our objective was to determine whether relative abundance and species richness of wetlands birds differed among nonnative common reed, cattail, and meadow marsh habitats, which are the primary habitats that common reed is replacing at Long Point, Ontario (Wilcox et al. 2003). We also wanted to determine the possible effect of common reed patch size on relative abundance and species richness of birds.

STUDY AREA

We conducted our study in common reed, cattail, and meadow marsh habitats at 3 sites within the greater Long Point marsh complex: Long Point Crown Marsh, Long Point Provincial Park Marsh, and Long Point Company Marsh (Fig. 1). We selected these 3 marshes because each contained patches of common reed, cattail, and meadow marsh habitat of various sizes. Vegetation communities were similar across sites. These sites were classified as Great Lakes coastal marshes because they had wetland-dependent biotic communities influenced by annual, seasonal, and daily water level fluctuations of Lake Erie (Albert et al. 2005).

Each study site was characterized by a general south–north gradient of vegetation communities typically progressing from the upland to meadow marsh to emergent marsh to shallow open-water habitats of Inner Long Point Bay. Meadow marsh communities typically were characterized by intermittent to seasonal inundation and dominated by grasses, sedges, and shrubs. Emergent marsh communities were seasonally to semipermanently flooded and typically

dominated by cattail. Common reed existed across a wide range of wetland elevations but tended to occur more often within meadow marsh plant communities. All common reed at our study sites was identified as a highly invasive, nonnative genotype (Wilcox et al. 2003). Lake Erie water levels were higher in 2002 than in 2001, which resulted in deeper inundation across all elevations in 2002, especially during summer months (Fisheries and Oceans Canada 2008).

METHODS

Study Design and Data Collection

We used fixed-distance point counts to determine relative abundances and species richness of birds at edge and interior locations for each habitat type (i.e., common reed, cattail, and meadow marsh). From late April to early May 2001, we systematically established permanent survey stations (hereafter, stations) at each site. We established the first station 50 m from the upland in meadow marsh vegetation. We then took a compass bearing parallel to the marsh edge, traveled 250 m, and established the next station. We continued establishing stations every 250 m until the marsh ended, then took a perpendicular bearing, traveled 250 m down-slope, and established the next station on a second transect that paralleled the first transect. We repeated this process until the entire study site was systematically covered with stations. We used a 250-m buffer between stations to minimize the probability of multiple counts of individual birds during consecutive visits to the same study site (Bird Studies Canada 2003). We marked the center of each station with a 2.6-m wooden post with flagging tape and recorded each location with a Global Positioning System to allow us to accurately relocate stations.

We completed habitat assessments of each station during late July each year after we finished breeding bird surveys and after most vegetation had matured. Habitat assessments

provided data we used to assign a habitat classification (i.e., common reed, cattail, or meadow marsh) to stations each year. A detailed description of vegetation sampling procedures is provided in Meyer (2003). Briefly, we mapped vegetation at each station using a line-transect method, where each station was at the center of a 100 × 100-m square (Brower and Zar 1977). We categorized habitat type (i.e., common reed, cattail, or meadow marsh) every meter for 50 m in the 4 cardinal directions from the center of the station. We indexed dominance of each habitat type at each station as the sum of the total length (m) of each type divided by total transect length (Benoit and Askins 1999). We assigned habitat classification to the type with >79% dominance. If dominance was <79% for all habitat types, we selected the dominant type as the habitat that had >1.5 times the coverage of the second ranked habitat type, which always occurred.

We also were interested in whether birds tended to use the edge versus the interior of each habitat type. We classified stations within 50 m of a habitat edge as an edge location, whereas stations >50 m from habitat edges were interior locations. We defined habitat edge as the area between monotypic stands where vegetation was mixed. During summer 2001, there were 16 (edge = 6, interior = 10) stations in common reed, 16 stations in cattail (edge = 6, interior = 10), and 18 stations (edge = 9, interior = 9) in meadow marsh habitats. In summer 2002, there were 18 stations (edge = 7, interior = 11) in common reed, 13 stations (edge = 3, interior = 10) in cattail, and 24 stations (edge = 13, interior = 11) in meadow marsh habitats.

Due to possible effects of common reed patch size on bird use (Benoit and Askins 1999), we estimated the area of each common reed patch using aerial photographs taken of our study sites on 5 June 2002. To do this, we delineated each common reed patch on the photographs, overlaid an acetate containing equidistantly spaced points, and counted the number of points falling within each habitat stand. We then used known distance measurements of landmarks in the field to establish a scale for each photograph, which subsequently allowed us to estimate the area (ha) of each common reed patch.

Before conducting point counts, we went to all habitat types within our study sites and determined the survey area that observers could accurately detect birds using call broadcasts of several common marsh birds from a tape recorder. We determined that observers could reliably detect marsh birds out to 25 m in all habitats (Meyer 2003). Thus, we conducted all point counts within a 25-m-radius plot around each station to standardize species detectability in all habitat types.

We conducted point counts at each station during 1 May–31 July 2001 (summer) and 30 September–15 November 2001 (autumn). We surveyed each station 6 times during each of the 2 summers to increase species detectability in all habitat types and we surveyed each station 2 times during autumn. Consecutive station visits within seasons were ≥10 days apart. We only conducted surveys under the following conditions: 1) between sunrise and 1030 hours

(Riffell et al. 2001), 2) when sustained wind speed was ≤17 km/hour (3 on the Beaufort Wind Scale), 3) no precipitation present, and 4) visibility conditions allowed for an unobstructed view of the entire 25-m-radius plot (Bird Studies Canada 2003). Surveys were conducted by the same 2 observers (SM and MS) at the same patches of all 3 habitat types during both years. Observers always stood on a 1.5-m stepladder to increase species detectability among habitat types.

During summer surveys, point counts at each station were 10 minutes long. For the first 5 minutes, we broadcasted calls from a tape player to elicit vocal responses from secretive marsh birds, whereas the final 5 minutes were for silent-listening and observation of additional species or individuals (Bird Studies Canada 2003). Call broadcasting is commonly used during breeding-season surveys to increase detection probability of secretive marsh birds (Gibbs and Melvin 1993, Conway and Nadeau 2005, Rehm and Baldassarre 2007). The species (in order) on our broadcast tape included Virginia rail (*Rallus limicola*), sora (*Porzana carolina*), least bittern (*Ixobrychus exilis*), a combination of calls of both common moorhen (*Gallinula chloropus*) and American coot (*Fulica americana*), and pied-billed grebe (*Podilymbus podiceps*). Survey duration for autumn was 10 minutes of silent-listening and visual observation to detect birds. We did not use call broadcast during autumn because most marsh-nesting birds rarely respond outside of the breeding season (Bogner and Baldassarre 2002, Lowther et al. 2009).

In all survey seasons, we counted numbers of individuals of all bird species detected within the 25-m-radius plot plus aerial insectivores flying ≤100 m above stations during each survey visit. We only included aerial insectivores when individuals were methodically and actively foraging over the habitat patch; we did not record flyovers. We used landmarks of known distance or a range finder to determine whether birds were within or outside of the station boundaries, but we did not record specific distances to birds. We only included data on birds detected within station boundaries in our analyses.

Data Analysis

For analysis of our summer data, we grouped data into either marsh-nesting birds or other species (see Appendix). We separated these analyses because of the potential effect of common reed on breeding marsh-nesting birds (Benoit and Askins 1999). For autumn, we combined bird responses across species. We performed our analyses on 4 response variables: 1) total bird abundance, 2) total species richness, 3) total marsh-nesting bird abundance, and 4) total marsh-nesting bird species richness. For each of the bird groups, we used the mean number of individuals detected per station within a survey season as an index of relative abundance. We used the maximum number of species detected per station across all visits within a season as an index of species richness. We treated sample stations as independent samples within all analyses, which was reasonable due to the limited

Table 1. Means and 95% confidence intervals for total abundance (TA) and species richness (SR) for all bird species (AS) and marsh-nesting bird species (MN) detected during summer and autumn surveys conducted at edge and interior point count stations within common reed, cattail, and meadow marsh habitats associated with Lake Erie at Long Point, Ontario, Canada, 2001 and 2002.

Season	Group	Response	Habitat type						Station location			
			Common reed		Cattail		Meadow marsh		Edge		Interior	
			\bar{x}	95% CI	\bar{x}	95% CI	\bar{x}	95% CI	\bar{x}	95% CI	\bar{x}	95% CI
Summer	AS	TA	6.3	5.4–7.3	4.9	4.1–6.0	4.8	4.1–5.6	5.8	5.0–6.7	4.8	4.2–5.5
Summer	AS	SR	7.7	7.0–8.5	6.5	5.8–7.3	6.4	5.8–7.0	7.5	6.9–8.1	6.2	5.8–6.7
Summer	MN	TA	1.3	1.0–1.6	1.2	0.9–1.5	1.6	1.4–1.9	1.5	1.3–1.8	1.2	1.0–1.3
Autumn	AS	TA	4.1	2.7–6.2	1.3	0.6–2.6	1.3	0.6–2.6				
Autumn	AS	SR							1.8	1.2–2.5	1.1	0.8–1.7

detection probability of many secretive marsh birds (Gibbs and Melvin 1993).

Visual inspection of plots suggested that summer and autumn data might be best modeled using a Poisson probability distribution. During the model-fitting process described below, we evaluated plots of normalized residuals from models and verified that, indeed, error approximated a Poisson distribution. We used generalized linear models with a Poisson probability distribution and a log (ln) link function to evaluate potential sources of variation in total bird abundance, total bird species richness, marsh-nesting bird abundance (summer only), and marsh-nesting bird species richness (summer only; PROC GLM [SAS Institute 2002]). We partitioned analyses by summer and autumn because of possible differences in seasonal habitat requirements of birds, vegetation community characteristics, and bird community composition. For each response variable, we specified initial models that each included main effects and interactions that were interpretable and biologically meaningful. For summer analyses, we specified the following initial full model for each of the 4 response variables: $Y = \text{Intercept} + \text{YEAR} (2001, 2002) + \text{HABITAT} (\text{common reed, cattail, meadow marsh}) + \text{ST_LOCALE} (\text{edge, interior}) + \text{YEAR} \times \text{HABITAT} + \text{HABITAT} \times \text{ST_LOCALE}$. We removed YEAR and YEAR \times HABITAT effects from autumn models because data were only available for one year.

Our primary interest was in detecting changes in relative abundance and species richness of birds across common reed stand sizes; thus, we only developed area models for this habitat type. For summer analyses, we tested effects in the following initial full model: $Y = \text{YEAR} + \text{AREA} + \text{YEAR} \times \text{AREA}$, whereas for autumn analyses we only tested for AREA effects. If the interaction term was significant, we generated predicted values from that model, interpreted the slopes for each year, and depicted those relationships in an interaction plot. We ln-transformed area estimates to reduce the possible influence that large area estimates could have had on parameter estimation.

We evaluated all models for overdispersion (i.e., deviance $[D]/df$) and a dispersion parameter scale factor (i.e., sq root of D/df) adjusted variance and standard errors (PROC GLM; SAS Institute 2002). We used Type 3 analyses to generate likelihood (or quasi-likelihood) ratio statistics and P -values based on the limiting chi-square distributions for

each effect in the model. We used backward elimination, retaining effects when $P \leq 0.10$, on initial models to derive final models. We used parameter estimates and class means derived from final, reduced models to infer patterns within our data. Unless otherwise stated, we report parameter estimates (β) in ln units (\pm SE) and back-transformed means, along with lower and upper 95% confidence limits for more meaningful interpretation.

RESULTS

We detected 13 marsh-nesting bird species and 38 total bird species within the 3 Long Point marshes. During summer 2001, we detected 18, 18, and 23 bird species in common reed, cattail, and meadow marsh habitats (Appendix). In 2002, we detected 27, 18, and 28 bird species in those habitats, respectively. During autumn 2001, we detected 12, 8, and 10 avian species in common reed, cattail, and meadow marsh habitats, respectively.

Summer

The final model for total relative abundance of birds counted during summer included ST_LOCALE ($\chi^2_{1,101} = 3.00, P = 0.083$) + HABITAT ($\chi^2_{2,101} = 6.64, P = 0.036$) effects. We detected 1.28 times more birds in common reed compared to cattail and meadow marsh habitats, which had similar numbers of birds (Table 1). Stations near habitat edges had 20% more birds than did stations located within stand interiors. The size of common reed patches did not affect total relative abundance of birds in either summer study period ($P > 0.10$ for YEAR + AREA + YEAR \times AREA effects).

The final model for total species richness during summer included YEAR ($\chi^2_{1,100} = 3.87, P = 0.049$) + ST_LOCALE ($\chi^2_{1,100} = 10.54, P = 0.001$) + HABITAT ($\chi^2_{2,100} = 10.15, P = 0.006$) effects. We detected 18% more species of birds in common reed compared to cattail and meadow marsh habitats, which had similar numbers of species (Table 1). Approximately 20% more species also were recorded near edges compared to stand interiors. In 2002, we detected 1.108 more species relative to 2001 (2001: $\bar{x} = 6.5, 95\% \text{ CI} = 6.0\text{--}7.0$; 2002: $\bar{x} = 7.2, 95\% \text{ CI} = 6.7\text{--}7.8$).

Analyses of area effects showed that the relationship between species richness and size of common reed patches depended on year (YEAR: $\chi^2_{1,30} = 3.92, P = 0.048$; AREA: $\chi^2_{1,30} = 0.03$; YEAR \times AREA: $\chi^2_{1,30} = 2.86, P = 0.091$). Inspection of the interaction between year and area showed

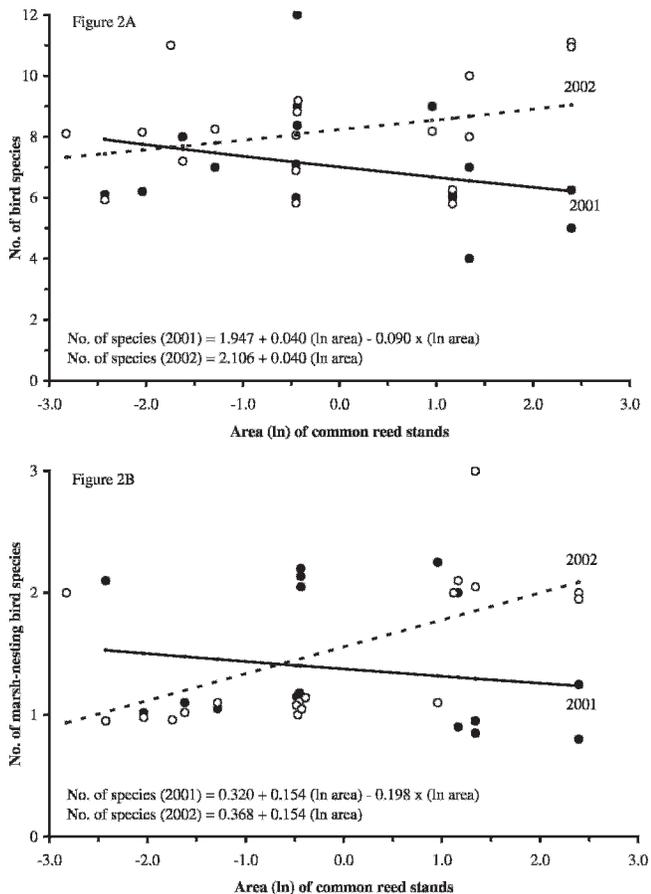


Figure 2. Relationship between number of bird species and area of common reed stands at Long Point, Lake Erie, Ontario, Canada, during summer 2001 and 2002.

that number of species decreased with increasing stand size in summer 2001, whereas number of species increased with increasing stand size in summer 2002 (Fig. 2A).

The final model for total relative abundance of marsh-nesting birds during summer included ST_LOCALE ($\chi^2_{1,101} = 5.97$, $P = 0.015$) + HABITAT ($\chi^2_{2,101} = 6.13$, $P = 0.047$) main effects. We detected approximately 25% more marsh-nesting birds in meadow marsh than in cattail and common reed, whereas, relative abundances were similar in the latter 2 habitat types (Table 1). Similarly, we recorded 1.25 times more marsh-nesting birds at stations near habitat edges than at stations located within stand interiors. There was no relationship between relative abundance of marsh-nesting birds and common reed stand sizes in either year ($P > 0.10$ for YEAR \times AREA + AREA + YEAR effects).

Species richness of marsh-nesting birds did not differ among habitat types or between years, and there was no edge effect ($\beta_{\text{intercept}} = 1.3$, 95% CI = 1.2–1.5, $P > 0.10$, all effects and interactions). Marsh-nesting bird species richness varied across common reed stand sizes but this effect differed depending on year (YEAR \times AREA: $\chi^2_{1,30} = 7.43$, $P = 0.006$). Inspection of the interaction between year and area showed that the number of species decreased slightly with increasing stand size in 2001, whereas numbers of species increased with stand size in 2002 (Fig. 2B).

Autumn

The final model for total relative abundance of birds during autumn included only the HABITAT main effect ($\chi^2_{2,47} = 12.61$, $P = 0.002$). We detected 3.15 times more birds in common reed than in cattail and meadow marsh (Table 1). Analyses showed there was no correlation between relative abundance of birds and stand sizes of common reed ($P > 0.10$ for AREA).

The final model for total species richness during autumn included the ST_LOCALE main effect ($\chi^2_{1,48} = 2.84$, $P = 0.092$). Estimates showed 60% more species were detected at stations near habitat edges as compared to those at interior locations within habitat patches (Table 1). We did not detect a difference in bird abundance in common reed stand size during autumn ($P > 0.10$ for AREA).

DISCUSSION

We found that common reed provided habitat for many birds, including some wetland birds. In fact, common reed was used by more individuals and species of landbirds during breeding and more individuals and species of all birds during autumn migration compared to cattail and meadow marsh habitats. Furthermore, we showed that, compared to small stands, large common reed stands were used by more species of birds, including marsh-nesting birds, depending on habitat availability due to stand flooding. Stand edges, in all habitat types, also were used by more individuals and species of birds than stand interiors. For marsh birds, however, fewer individuals, but not species, used common reed and cattail for breeding habitat compared to meadow marsh, which is a concern in Great Lakes coastal wetlands because many marsh-nesting bird populations are currently declining, some are listed as species at risk (e.g., least bittern), and meadow marsh habitat is being replaced by common reed (Wilcox et al. 2003, Crewe et al. 2006, Committee on the Status of Endangered Wildlife in Canada 2009). As a result, wetland managers will need to investigate management techniques to conserve meadow marsh habitat, particularly in areas where common reed is replacing this habitat type. In addition, managers should try and increase edge effect within wetlands by reducing stand size to maximize the diversity of birds, including wetland birds.

Habitat Use

We found that total relative abundance and species richness of birds was higher in common reed stands than in cattail and meadow marsh habitats during summer and autumn. Most birds we documented during summer were breeding, which suggests that common reed stands provide suitable nesting habitat for some species. Specifically, we found common yellowthroat (*Geothlypis trichas*), swamp sparrow (*Melospiza georgiana*), eastern kingbird (*Tyrannus tyrannus*), willow flycatcher (*Empidonax traillii*), and yellow warbler (*Dendroica petechia*) more often in common reed during summer both years. These warblers and flycatchers nest in shrubby vegetation (often dense) situated near open areas and sometimes near water, whereas swamp sparrows tend to

use a variety of wetland habitats as long as standing water is present (Stewart 1953, Peck and James 1987, Greenberg 1988). Common reed forms thin, round stems and grows to tall heights, which resists being knocked down from wind and rain because of its high silica content (Jones and Lehman 1987, Kiviat 1987, Rice et al. 2000). As such, these physical attributes of common reed may more closely emulate adjacent shrub or forest vegetation communities, thereby providing suitable structure and complexity to support nests of many warblers and sparrows. For example, swamp sparrows build low-elevation nests (average nest ht 20–30 cm) usually above water (Peck and James 1987). As such, swamp sparrows typically build nests at the base of cattails or shrubs; common reed, however, also provides structural support and may be favored over cattail and meadow marsh habitats when water levels are high and nests become vulnerable to flooding. Moreover, warblers and sparrows line their nests with material from the surrounding environment, which allows these birds to nest in common reed, where nesting material is limited to leaves and seed heads (Peck and James 1987). Finally, the location of common reed stands next to meadow marsh and cattail, which have been shown to have a high abundance of some aerial insects, also provides ideal perching habitat for many flycatchers and swallows and may explain the higher abundance and species richness of edge stations compared to interior stations in this habitat type (Turner and McCarthy 1998).

Although common reed generally had higher total relative abundance and contained more species of birds, relative abundance and species richness of marsh-nesting birds during summer was greatest in meadow marsh habitat. In particular, we found several species of waterfowl, shorebirds, and rails more often in meadow marshes. Many of these marsh-nesting birds create a well-concealed nest bowl either under a canopy of vegetation (e.g., mallard [*Anas platyrhynchos*]; Caldwell and Cornwell 1975) or bend vegetation over the nest to create a canopy (e.g., least bittern, Virginia rail; Kaufmann 1989, Meyer and Friis 2008). Other marsh-nesting birds (e.g., marsh wren) weave a cavity from vegetation (Verner 1965). With the exception of its leaves and seed heads, common reed provides little material for nest building due to its high silica content and rigidity (Kiviat 1987). Thus, common reed is particularly limiting for ground-dwelling birds, such as waterfowl, rails, and shorebirds, which use material at or near the nest site to construct their nest (Caldwell and Cornwell 1975, Kaufmann 1989). A lack of building material and inability to conceal their nest could explain why many of these species did not nest in common reed. For other ground-dwelling birds, such as bitterns and herons, openings within stands of vegetation are required for access to these habitats for nesting and foraging (Manci and Rusch 1988, Gibbs et al. 1991). Meadow marshes typically contain a mixture of sedges and grasses interspersed with hummocks, mudflats, and pools of water (ephemeral and permanent), thereby providing access for many of these birds. Conversely, common reed forms tall, dense stands that some marsh-

nesting birds cannot access (Ward 1942, Benoit and Askins 1999). The higher abundance of food resources within meadow marsh compared to common reed and cattail also could explain the use of this habitat by many marsh-nesting birds. For example, Angradi et al. (2001) showed that macroinvertebrate abundance and species richness were approximately 1.2 and 1.3 times higher in meadow marsh, respectively, compared to common reed. For some marsh-nesting birds, such as Virginia rail, diversity and abundance of food has been shown to be an important nesting habitat feature (Rundle and Fredrickson 1981, Gibbs et al. 1991).

During autumn, American goldfinch (*Carduelis tristis*), American tree sparrow (*Spizella arborea*), common grackle (*Quiscalus quiscula*), dark-eyed junco (*Junco hyemalis*), red-winged blackbird (*Agelaius phoeniceus*), song sparrow (*Melospiza melodia*), and white-throated sparrow (*Zonotrichia albicollis*) occurred more often in common reed. Common reed stands within our study were used by many migrant landbirds as perching and roosting habitat, particularly toward the tip of Long Point where birds were often more concentrated and terrestrial habitat was more limited. Physical attributes of common reed (e.g., tall plant ht, high stem density, and accumulated litter) provide safe roosting habitat for many birds by reducing predation risk and sheltering them from unfavorable weather (Meyerson et al. 2000, Batáry and Báldi 2004, Schiegg et al. 2007). In addition, the rigid and resilient stems of common reed prevent the plant from collapsing from wind, snow, and ice, thereby providing vertical structure and cover throughout autumn migration and into winter (Kiviat 1987). High litter accumulation within stands provides habitat for many terrestrial insects, particularly during cold weather when litter acts as an insulator (Rice et al. 2000, Angradi et al. 2001). Thus, common reed stands provided shelter and food resources for many birds when aquatic foraging habitats became unavailable (i.e., frozen) and thermoregulatory costs became high.

Area and Edge Effects

Stand size also affected bird use of common reed during the breeding season (May to Jul) with large stands used by more species in 2002 compared to 2001. This inter-annual difference in stand size use for some species was due to changes in foraging habitat or prey availability because water levels were approximately 0.2 m higher in 2002 compared to 2001 (Fisheries and Oceans Canada 2008). For some species, such as Virginia rail, flooding resulted in increased foraging habitat availability as common reed stands, particularly edges, became flooded; Virginia rails tend to forage in shallow water or moist soils (Horak 1970). In addition, the diversity of soil conditions and high biodiversity of flora and fauna that exist at edge locations, particularly in common reed, resulted in these birds using large common reed stands, which have more total edge compared to small stands (Angradi et al. 2001, Meyer 2003). For other species (e.g., northern harrier [*Circus cyaneus*]), higher water levels in 2002 resulted in redistribution of some prey (e.g., amphibians and small mammals)

from flooded cattail to drier common reed stands, particularly edge locations and, therefore, resulted in a shift in habitat use based on prey biomass (Preston 1990, Meyer 2003).

MANAGEMENT IMPLICATIONS

The increase in abundance and distribution of common reed is one factor likely contributing to changes in abundances and distributions of some marsh-nesting birds and vegetation communities that have occurred since 1995 at Long Point and elsewhere within the lower Great Lakes region (Wilcox et al. 2003, Crewe et al. 2006). Although our results show that common reed provides suitable habitat for a diversity of landbirds, marsh-nesting birds appear to use this habitat less during breeding. Thus, where management of breeding marsh-nesting birds is a conservation objective in the lower Great Lakes region, wetland managers should consider reducing coverage of common reed and restoring meadow marsh habitat. Habitat management activities should focus on large common reed stands, particularly those adjacent to meadow marsh or other diverse habitat types. If common reed cannot be eliminated, we suggest reducing area, increasing amount of edge, and improving stand structural diversity and local habitat diversity to increase its use by marsh-nesting birds, which could be accomplished by creating irregularly shaped channels and ponds or openings within common reed stands to improve habitat heterogeneity similar to recommendations in other wetland management strategies (Johnson and Dinsmore 1986, Conway and Eddleman 1994, Melvin and Gibbs 1994, Post and Seals 2000). If large-scale eradication of common reed is not a feasible management objective and because this plant does provide habitat for a diversity of nonmarsh-nesting birds, managers might consider smaller scale management directed at stands adjacent to meadow marsh. Decreasing size and increasing edge of common reed stands can minimize potential negative effects on bird communities associated with Great Lakes coastal wetlands.

ACKNOWLEDGMENTS

Financial support was provided by Long Point Waterfowl through the Bluff's Hunting Club. Other supporters included the Aylmer Order of Good Cheer, Bird Studies Canada, Canadian Wildlife Service, Ducks Unlimited Canada, Fuller Foundation, Long Point Waterfowlers' Association, Ontario Ministry of Natural Resources, The Long Point Company, Waterfowl Research Foundation, and University of Western Ontario. M. Schummer and K. Wilcox assisted with data collection. Lastly, we thank M. Gray and 2 anonymous reviewers for providing comments that greatly improved the manuscript.

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Associate Editor: Gray.

Appendix. Percentages of survey stations in common reed, cattail, and meadow marsh habitats at which we detected birds using fixed-distance point counts during summer and autumn at Long Point, Lake Erie, Ontario, Canada, 2001 and 2002.

Guild and common name	Scientific name	Season and habitat type								
		Summer 2001			Summer 2002			Fall 2001		
		Common reed (n = 16)	Cattail (n = 16)	Meadow marsh (n = 18)	Common reed (n = 18)	Cattail (n = 13)	Meadow marsh (n = 24)	Common reed (n = 16)	Cattail (n = 16)	Meadow marsh (n = 18)
Marsh-nesting spp.										
American bittern	<i>Botaurus lentiginosus</i>	0	0	0	0	8	0	0	0	0
American woodcock	<i>Scolopax minor</i>	6	0	6	0	0	4	0	0	0
Canada goose	<i>Branta canadensis</i>	0	0	6	0	8	8	0	0	0
Common yellowthroat	<i>Geothlypis trichas</i>	81	31	11	89	31	17	0	0	0
Green-winged teal	<i>Anas crecca</i>	0	0	0	0	8	0	0	0	0
Least bittern	<i>Ixobrychus exilis</i>	6	0	0	0	0	4	0	0	0
Mallard	<i>Anas platyrhynchos</i>	0	0	6	0	0	0	0	0	0
Marsh wren	<i>Cistothorus palustris</i>	38	19	28	39	38	42	6	31	11
Sora	<i>Porzana carolina</i>	0	0	0	0	15	4	0	0	0
Swamp sparrow	<i>Melospiza georgiana</i>	94	81	89	100	69	79	31	19	33
Virginia rail	<i>Rallus limicola</i>	0	0	6	6	15	13	0	0	0
Wilson's snipe	<i>Gallinago delicata</i>	0	6	0	0	0	4	0	0	11
Wood duck	<i>Aix sponsa</i>	0	6	11	0	0	8	0	0	0
Other spp.										
American goldfinch	<i>Carduelis tristis</i>	13	0	0	6	0	17	6	0	0
American kestrel	<i>Falco sparverius</i>	0	0	0	0	0	0	0	0	6
American redstart	<i>Setophaga ruticilla</i>	0	0	6	0	0	0	0	0	0
American robin	<i>Turdus migratorius</i>	6	0	11	6	15	4	0	0	0
American tree swallow	<i>Spizella arborea</i>	94	100	83	94	100	96	19	13	0
Bank swallow	<i>Riparia riparia</i>	81	63	50	67	85	79	0	0	0
Barn swallow	<i>Hirundo rustica</i>	63	75	67	83	77	71	0	0	0
Black-capped chickadee	<i>Poecile atricapillus</i>	0	0	0	0	0	0	13	0	11
Brown-headed cowbird	<i>Molothrus ater</i>	0	6	0	0	0	0	0	0	0
Chestnut-sided warbler	<i>Dendroica pensyloanica</i>	0	0	0	6	0	0	0	0	0
Chipping sparrow	<i>Spizella passerina</i>	0	0	6	0	0	0	0	0	0
Cliff swallow	<i>Petrochelidon pyrrhonota</i>	0	6	0	0	0	0	0	0	0
Common grackle	<i>Quiscalus quiscula</i>	0	6	17	11	23	13	13	0	0
Dark-eyed junco	<i>Junco hyemalis</i>	0	0	0	0	0	0	19	13	11
Eastern kingbird	<i>Tyrannus tyrannus</i>	25	0	17	11	8	8	0	0	6
Eastern wood-pewee	<i>Contopus virens</i>	6	0	0	0	0	0	0	0	0
European starling	<i>Sturnus vulgaris</i>	0	0	6	0	0	0	0	0	0
Gray catbird	<i>Dumetella carolinensis</i>	0	0	0	6	0	8	0	0	0
Killdeer	<i>Charadrius vociferus</i>	0	6	11	0	0	4	0	0	0
Mourning dove	<i>Zenaidura macroura</i>	0	0	0	0	0	0	0	6	0
Northern cardinal	<i>Cardinalis cardinalis</i>	0	0	0	6	0	0	0	0	0
Northern flicker	<i>Colaptes auratus</i>	0	0	0	6	0	0	0	0	0
Northern harrier	<i>Circus cyaneus</i>	0	0	0	6	0	0	6	6	6
Northern rough-winged swallow	<i>Stelgidopteryx serripennis</i>	13	6	17	11	0	4	0	0	0
Palm warbler	<i>Dendroica palmarum</i>	0	0	0	0	0	4	0	0	0
Purple martin	<i>Progne subis</i>	13	63	44	28	31	46	0	0	0
Red-breasted nuthatch	<i>Sitta canadensis</i>	0	0	0	6	8	0	0	0	0
Red-winged blackbird	<i>Agelaius phoeniceus</i>	94	94	89	100	85	92	25	6	0
Ruby-crowned kinglet	<i>Regulus calendula</i>	0	0	0	11	0	4	6	0	11
Ruby-throated hummingbird	<i>Archilochus colubris</i>	0	0	0	6	0	0	0	0	0
Savannah sparrow	<i>Passerculus sandwichensis</i>	0	0	0	0	0	4	0	0	0
Song sparrow	<i>Melospiza melodia</i>	13	13	17	22	23	21	6	0	0
Spotted sandpiper	<i>Actitis macularius</i>	0	6	0	0	0	0	0	0	0
Warbling vireo	<i>Vireo gilvus</i>	0	0	0	6	0	0	0	0	0
White-crowned sparrow	<i>Zonotrichia leucophrys</i>	0	0	0	6	0	4	0	0	0
White-throated sparrow	<i>Zonotrichia albicollis</i>	0	0	0	0	0	0	31	25	17
Willow flycatcher	<i>Empidonax traillii</i>	6	0	0	11	0	0	0	0	0
Yellow warbler	<i>Dendroica petechia</i>	50	13	6	72	0	13	0	0	0