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Research article

Multispecies benefits of wetland conservation for marsh birds, frogs, and species at risk

Douglas C. Tozer [a, *], Owen Steele [b], Mark Gloutney [c]

[a] Long Point Waterfowl and Wetlands Research Program, Bird Studies Canada, P.O. Box 160 (Courier: 115 Front Street), Port Rowan, ON N0E 1M0, Canada
[b] Ducks Unlimited Canada, 740 Huronia Road, Unit 1, Barrie, ON L4N 6C6, Canada
[c] Ducks Unlimited Canada, 35 Sparks Street, Suite 702, Ottawa, ON K1R 7S8, Canada

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ABSTRACT

Wetlands conserved using water level manipulation, cattle exclusion, naturalization of uplands, and other techniques under the North American Waterfowl Management Plan ("conservation project wetlands") are important for ducks, geese, and swans ("waterfowl"). However, the assumption that conservation actions for waterfowl also benefit other wildlife is rarely quantified. We modeled detection and occupancy of species at sites within 42 conservation project wetlands compared to sites within 52 similar nearby unmanaged wetlands throughout southern Ontario, Canada, and small portions of the adjacent U.S., using citizen science data collected by Bird Studies Canada's Great Lakes Marsh Monitoring Program, including 2 waterfowl and 13 non-waterfowl marsh-breeding bird species ($n = 413$ sites) and 7 marsh-breeding frog species ($n = 191$ sites). Occupancy was significantly greater at conservation project sites compared to unmanaged sites in 7 of 15 (47%) bird species and 3 of 7 (43%) frog species, with occupancy being higher by a difference of 0.12–0.38 across species. Notably, occupancy of priority conservation concern or at-risk Black Tern (*Chlidonias niger*), Common Gallinule (*Gallinula galeata*), Least Bittern (*Ixobrychus exilis*), Sora (*Porzana carolina*), and Western Chorus Frog (*Pseudacris triseriata*) was significantly higher at conservation project sites compared to unmanaged sites. The results demonstrate the utility of citizen science to inform wetland conservation, and suggest that actions under the North American Waterfowl Management Plan are effective for conserving non-waterfowl species.

1. Introduction

Wetlands are valuable for numerous ecological and social reasons, such as greenhouse gas sequestration, commercial fishing, flood control, pollution mitigation, and recreation (Sierszen et al., 2012). Most importantly, they are critical hotspots for biodiversity conservation (Gibbs, 2000). As a result, various policies, regulations, and other mechanisms exist at a number of scales to conserve wetlands. One of these, the North American Waterfowl Management Plan (NAWMP), strives to conserve wetlands and associated upland habitats for migrating and breeding ducks, geese, and swans (hereafter "waterfowl") through water level manipulation, cattle exclusion, naturalization of uplands, and other techniques (NAWMP Canada, 2013). Such actions are meant to mimic natural water level dynamics, prevent disturbance and nutrient loading, and buffer pollutants and runoff, respectively, among other positive benefits. NAWMP is implemented through Joint Venture partnerships, which focus on conserving habitats or species of concern identified in the plan (e.g., EHJV, 2016). NAWMP has proven to be highly successful in guiding the securement, protection, and enhancement of wetlands, meeting or surpassing population goals for many waterfowl species. Indeed, waterfowl are one of the few groups of birds for which populations have increased over the past few decades in the U.S. and Canada, in large part due to conservation actions under NAWMP (NABCI, U.S. Committee, 2009; NABCI Canada, 2012).

Although the original focus of NAWMP was waterfowl conservation, the plan and its associated Joint Ventures have since shifted to all-bird conservation and consideration of other groups of wildlife (Kennedy et al., 2010). This approach has great potential for conservation of wildlife in addition to waterfowl because there are dozens of non-waterfowl marsh-breeding bird species that might also benefit from wetlands conserved under NAWMP. These species include grebes, bitterns, rails, and terns, some of which are known

* Corresponding author.
E-mail address: dtozer@birdscanada.org (D.C. Tozer).

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to respond positively to the conditions found within wetlands conserved under NAWMP compared to unmanaged wetlands. For instance, in some years at some locations large numbers of at-risk Least Bitterns (*Ixobrychus exilis*) and Black Terns (*Chlidonias niger*) breed only within wetlands conserved under NAWMP, but are absent from adjacent unmanaged wetlands (Wilson and Cheskey, 2001; Tozer, 2002). Wetland conservation under NAWMP may also benefit frog and toad species (Order Anura; hereafter "frogs"). However, the assumption that conservation actions for waterfowl also benefit other groups of wildlife is rarely quantified.

Some previous reports compared non-waterfowl marsh-breeding bird or frog use of naturally occurring wetlands conserved and managed primarily for waterfowl versus similar naturally occurring unmanaged wetlands in the U.S. and Canada (Brown and Smith, 1998; Juni and Berry, 2001; Stevens et al., 2002; Connor and Gabor, 2006; Kaminski et al., 2006; Lehtinen and Galatowitsch, 2001; Galloway et al., 2006; Nedland et al., 2007; O'Neal et al., 2008; Monfils et al., 2013). These studies found that populations of some non-waterfowl marsh-breeding birds and frogs were positively influenced by management. However, the previous studies were limited by relatively small sample sizes, which often precluded species-level analysis. They were also typically conducted over short time frames post restoration, within relatively small wetlands, at limited spatial scales, and most failed to address imperfect detection (Dénes et al., 2015). Here, we build on these previous studies and overcome these challenges by sampling waterfowl and non-waterfowl marsh-breeding bird and frog species at sites within 42 managed wetlands and sites within 52 similar, nearby unmanaged wetlands throughout an extensive region. Our study also included a larger range of wetland sizes and a larger range of times since initiation of management, and accounted for potential differences in detection in statistical models.

We aimed to quantify the assumption that wetland conservation actions implemented under NAWMP also benefit non-waterfowl marsh-breeding bird and frog species. To do this, we focused on the Ontario portion of Bird Conservation Region 13 (hereafter "BCR 13"; Collins and Smith, 2014) within NAWMP's Eastern Habitat Joint Venture area (EHJV, 2016). The area was well-suited for the investigation with an abundance of wetland conservation projects within an intensively farmed and developed portion of the province which has lost up to 90% of its original wetlands (Ducks Unlimited Canada, 2010). Indeed, more than half of non-waterfowl marsh-breeding bird species and at least one marsh-breeding frog species has significantly declined over the past two decades in the region (Tozer, 2013, 2016). Robustly quantifying the extent to which NAWMP wetlands benefit these species is useful information for decision makers tasked with prioritizing limited conservation funds, not only in our region of study, but in other landscapes with similar wetland conservation programs elsewhere in North American and beyond.

We achieved our goal by utilizing data from Bird Studies Canada's Great Lakes Marsh Monitoring Program (GLMMP), a long-term, broad-scale, citizen science program (Tozer, 2013, 2016). This program has sampled birds and frogs using well-established field protocols (Conway, 2011; Weir et al., 2014) at hundreds of wetlands each year since 1995 throughout most of the Great Lakes basin. The extensive GLMMP dataset allowed us to compare occupancy of several non-waterfowl marsh-breeding birds and frogs in naturally occurring wetlands conserved under NAWMP throughout our study area (hereafter "conservation project wetlands") with similar nearby naturally occurring wetlands where conservation actions under NAWMP were not performed (hereafter "unmanaged wetlands"). Although alternative approaches, such as a true matched-pairs design, might have provided stronger comparisons, this approach controlled for unmeasured and unknown confounding factors, strengthening our assessment of the overall collective influence of multiple wetland conservation actions on non-waterfowl marsh-breeding birds and frogs. Using this approach, we were able to model occupancy of 2 waterfowl and 13 non-waterfowl marsh-breeding bird species at 413 sites and 7 marsh-breeding frog species at 191 sites across 42 conservation project wetlands and 52 similar nearby unmanaged wetlands throughout southern Ontario, Canada, and small portions of the adjacent U.S.

2. Methods

2.1. Study design

For this study we used bird, frog, and habitat monitoring results collected by 163 trained GLMMP participants from 1995 to 2014. Participants selected survey marshes, or they were randomly assigned each year, an approach shown to generate results representative of the larger population of un-sampled wetlands across our study area (Miller, 2016). Surveys were conducted within 100-m-radius semicircular plots (hereafter "sites"), most of which (90%) were located within but along the shoreward edge of marshes that were covered mostly by non-woody plants. Sites sampled for birds were >250 m apart, whereas most sites sampled for frogs were >500 m apart to avoid double-counting individuals (Bird Studies Canada, 2009a,b,c). In some cases, sites sampled for frogs faced in opposite directions from the same point without overlap.

We selected sites for analysis by first identifying all sites within publicly-accessible conservation project wetlands managed by Ducks Unlimited Canada and its partners in southern Ontario ($n = 220$ sites; hereafter "conservation project sites"). As defined above, "conservation project wetlands" were naturally occurring wetlands conserved under NAWMP, and were located within diverse land use designations, including national and provincial wildlife areas, federal migratory bird sanctuaries, municipal and First Nations lands, and conservation authority properties (Fig. 1; Gray et al., 2009). There were on average 5.5 sites located within each conservation project wetland (range: 1–21 sites per wetland). Wetlands existed historically at each of the locations, such that conservation project wetlands were best described as enhanced or restored, with no created or artificial habitat (*sensu* Kentula, 2002). Conservation project wetlands were dominated by non-woody emergent and floating plants. We were unable to measure or to obtain accurate area or size estimates for each conservation project wetland, although they ranged from a few hectares to several hundred hectares. The average time since management began at conservation project wetlands was 28 ± 9 yr (mean ± SD; range: 8–53 yr). Note that there were no sites located within publically-accessible conservation project wetlands within our study area where management began within the past 1–7 years. Water levels within conservation project wetlands were manipulated to manage wetland habitat using constructed dikes outfitted with various dams, control weirs, or similar structures. Periodic draw downs occurred at 41% of the conservation project wetlands, undertaken once every 22 ± 11 yr (range: 1–35 yr) to mimic natural water level fluctuations. See Table S.1 for site-specific details.

Next, we identified nearby sites within unmanaged wetlands for comparison ($n = 214$ sites; hereafter "unmanaged sites"), some of which were in the U.S. (Fig. 1). As defined above, "unmanaged wetlands" were naturally occurring wetlands where conservation actions under NAWMP were not performed. There were on average 6.3 sites located within each unmanaged wetland (range: 1–18 sites per wetland). Unmanaged wetlands, similar to conservation project wetlands described above, were located within diverse land use designations, were dominated by non-woody emergent and