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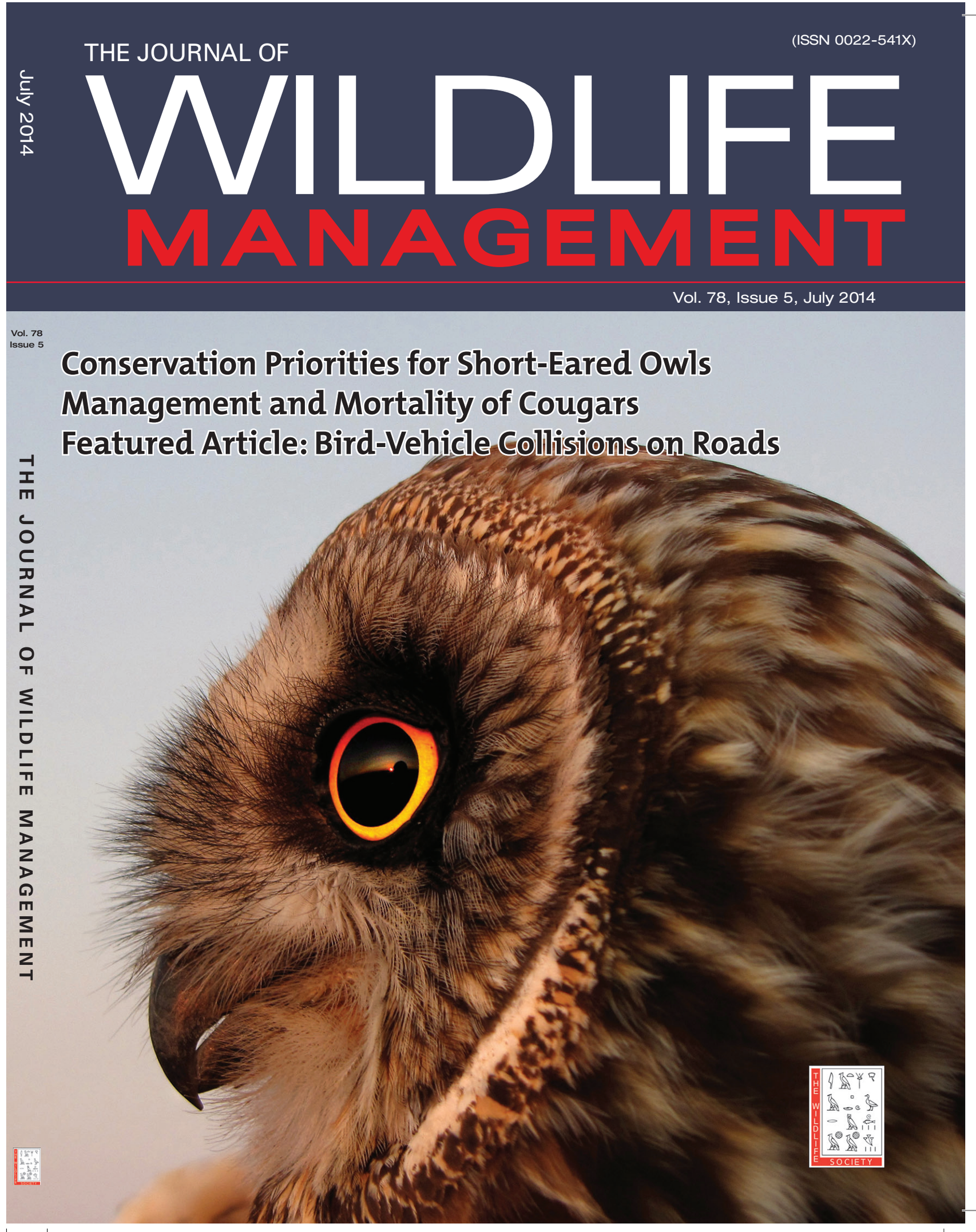

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Commentary

Assessing the Status and Conservation Priorities of the Short-Eared Owl in North America

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ABSTRACT The North American Breeding Bird Survey, Christmas Bird Count, and regional and national conservation assessments provide convincing evidence that the short-eared owl (*Asio flammeus*) is experiencing a range-wide, long-term decline in abundance in North America. However, the species has received little conservation or research attention. The short-eared owl is vulnerable to decline because it relies heavily on large, intact grasslands and a specialized diet of unpredictable small mammal prey. The specie's nomadic movements compound these vulnerabilities by making a decline difficult to detect with current monitoring programs while obfuscating stewardship responsibilities for managers. The primary threat to the species is loss, fragmentation, and degradation of large tracts of native grasslands and wetlands. We propose the following conservation priorities to better understand and begin addressing the short-eared owl's decline: 1) better define and protect important habitats; 2) improve population monitoring; 3) determine seasonal and annual movements; 4) re-evaluate NatureServe's short-eared owl national conservation classifications; 5) develop management plans and tools; and 6) classify raptors, including short-eared owls, as migratory birds in Canada. We contend that the short-eared owl's need for habitat conservation at large spatial scales, status as a predator, and high reproductive potential that affords the species capacity to recover, make it an effective and useful candidate as an umbrella species for grassland conservation. © 2014 The Wildlife Society.

KEY WORDS *Asio flammeus*, conservation, decline, grassland, North America, research priorities, short-eared owl, status.

Empirical evidence demonstrates a long-term, range-wide decline in short-eared owl (*Asio flammeus*) abundance in North America since at least 1966. Multiple lines of evidence at several spatial scales corroborate this species' decline, including the North American Breeding Bird Survey (BBS), Christmas Bird Count (CBC), and national and regional status assessments. Despite this decline, the species has received little conservation or research attention in North America (Wiggins 2004, Wiggins et al. 2006). Many biologists and land managers apparently remain unaware of the species' status and consequently, little is being done to gather information needed to understand and address the causes of decline.

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Our objectives in this commentary, based on information from literature, current research, symposia, and discussions held by us as an informal short-eared owl working group, are to 1) assess the status of the species in North America, 2) outline key aspects of its ecology making it vulnerable to decline, 3) describe its primary and secondary exogenous threats, and 4) recommend conservation priorities. Through this commentary, we hope to raise awareness and propose a path forward to better conserve this declining species.

STATUS

The short-eared owl is globally distributed and is represented on 5 continents by 10 subspecies (Holt et al. 1999). In Europe, recent population declines have led to the short-eared owl being listed in the European Commission Wild Bird Directive Annex 1, which confers the highest level of conservation concern (European Commission 2013). In most portions of its range, the species' nomadic and irruptive

nature complicates attempts to estimate and monitor its status. However, in North America, 3 distinct lines of evidence suggest that the short-eared owl has declined in abundance in recent decades.

North American Breeding Bird Survey

In the past 4 years of published BBS reports that analyzed data collected since 1966 (2008–2011), 17 statistically significant negative trends were reported for short-eared owls in regional, national, or survey-wide categories (significance based on 95% confidence intervals not including 0 (Sauer et al. 2012)). Concurrently, no statistically significant positive long-term trends were reported. California reported significant negative annual trends in all 4 years of analyses (range −7.5% to −6.5%) and the Prairie Pothole region reported negative trends in 3 of the 4 years (range −4.7% to −4.4%). Results for the Canada-wide region and survey-wide region (including all of Canada and the USA) were significantly negative in 2 of the 4 years (range −5.5% to −2.5%). Every trend in all regions and years, with 1 exception, was considered "very imprecise" or "quite imprecise," corresponding to insufficient power to detect a 5% or 3% annual change, respectively (Sauer et al. 2012). The only trend for short-eared owls that was considered of "moderate precision" was a statistically significant −2.4% annual decline from across the United States reported in 2009 (Sauer et al. 2012).

Results of the BBS need to be interpreted cautiously because of well-known sampling biases, lack of statistical power, and inference limitations (Bart et al. 1995, Sauer et al. 2012). The short-eared owl is generally poorly suited to BBS methodology because it is not highly vocal and is most active at night and during crepuscular periods. Also, trend estimates from the BBS can vary by analysis year, which is why we assessed the past 4 years of results collectively instead of relying on only 1 year's analyses. We also selected the 2008–2011 report years because they were the only years for which results were based on newer hierarchical models that provide more precise estimates than previous analyses (Sauer and Link 2011).

Christmas Bird Count

The CBC data from the United States and Canada between 1966 and 2010 showed a statistically significant decline in the number of owls counted per survey party-hour ($Y = -0.0002x + 0.3452$, $R^2 = 0.344$, $P < 0.05$, $n = 45$ years; Audubon 2012). In the United States and Canada, the number of owls counted per hour dropped from highs of 0.015 and 0.04 in the late 1960s to highs of 0.008 and 0.007 in the 2000s, respectively. This represents an approximate 50% and 80% decline in the number of owls counted per party hour in the United States and Canada, respectively. We find the decreasing number of owls counted in the CBC indicative of a widespread, long-term decline in short-eared owls. Like the BBS, the CBC results must be interpreted cautiously because the survey is not well-matched to the nocturnal or crepuscular activity cycles of short-eared owls and has inherent limitations and biases (Bart et al. 1995, Sauer et al. 2012). However, the CBC covers more of the winter range of short-eared owls than the BBS does of the breeding range, thus it likely monitors a larger percentage of the continent's owl population.

The BBS and CBC remain the only quantitative tools available with which to assess trends of this species across large geographic and temporal scales, and as such, they are imperfect but useful indicators of changes. Their shortcomings also highlight the substantial need for a new, coordinated monitoring strategy that more effectively monitors this species.

National and Regional Conservation Assessments

In Canada, the most recent status review under the federal Species at Risk Act found the short-eared owl nearly met the criteria for threatened status (30% decline in 10 years; Wiggins 2008). It failed this criterion because it had declined by 27% over the previous decade and therefore remains a Species of Special Concern (Wiggins 2008). In Mexico, it is considered "subject to special protection" by the federal government (Semarnat 2010), but no population estimates are available. Though historically it was widespread and abundant in the United States (Nelson 1876, Ridgway 1889), the species is formally recognized as endangered in at least 12 eastern states and has declined in the west (Wiggins 2004). The short-eared owl is designated as a Bird of Conservation Concern (BCC) by the United States Fish and Wildlife Service (USFWS) in 5 of the 7 USFWS regions and is included in the national BCC list (USFWS 2008). Partners in Flight lists the short-eared owl as a "watchlist" species of continental importance (Rich et al. 2004). NatureServe classifies the short-eared owl as critically imperiled, imperiled, or vulnerable in 74% of the 50 states in the United States and 13 Canadian provinces and territories (NatureServe 2013; Table 1) based on rarity, trend, and threat information obtained from diverse data sources at multiple spatial scales. Oddly, NatureServe classifies the species nationally as secure in the United States and apparently secure in Canada (breeding population) even though it is not classified as secure in any state or as secure or apparently secure in any province. These NatureServe national status classifications are inconsistent with available information from state and provincial classifications and need to be re-evaluated.

Although the regional and national status assessments conducted by wildlife agencies and non-governmental organizations reference BBS and CBC results to some extent and are therefore not completely independent, they also draw upon additional sources and types of information including life history, local distribution, knowledge from local and regional biologists, other conservation designations, and threats. Thus, we consider them useful sources of information that rely on a broad scope of available data and provide further evidence of a considerable, widespread decline.

When the 3 lines of evidence are viewed collectively (BBS, CBC, and conservation assessments), we find the weight of evidence convincing. Short-eared owls are experiencing a

Table 1. NatureServe conservation classifications for the short-eared owl by state and province in the United States and Canada in 2014.

	Possibly extirpated	Critically imperiled	Imperiled	Vulnerable	Apparently secure	Secure	Information unavailable	Total
United States	2	15	12	8	7	0	6	50
Canada	0	2	2	8	0	0	1	13
Total	2	17	14	16	7	0	7	63
Percent total	3%	27%	22%	25%	11%	0%	11%	

substantial, wide-spread, and on-going decline in North America. The exact magnitude of the change remains unclear and better information is needed.

ECOLOGICAL VULNERABILITY

Two key aspects of the short-eared owl's ecology make it particularly vulnerable to population declines. A third aspect makes the species difficult to monitor and hence, difficult to detect a decline that would trigger conservation measures. These 3 characteristics are largely intertwined and when confounded with anthropogenic perturbations, collectively make the species susceptible to decline.

Reliance on Intact Grasslands

The short-eared owl inhabits wetlands, shrub-steppe, tundra, and some agricultural lands, but it primarily relies on large, intact grasslands for survival (Wiggins et al. 2006). This attribute makes them inherently vulnerable to decline because grasslands are among the most endangered habitats in North America (Samson et al. 2004). During the breeding season, short-eared owls are widely distributed across the northern two-thirds of the continent from Alaska and northern Canada to the Central Plains states of the United States. During the non-breeding season, the species occurs across the southern half of the continent, from southern Canada to central Mexico (Wiggins et al. 2006). Although the habitat in the northern part of its breeding distribution (i.e., Alaska and northern Canada) has remained mostly intact, the areas in which the species occurs year-round (southern Canada through the northern half of the contiguous USA) have undergone substantial loss, fragmentation, and degradation of grasslands (Samson and Knopf 1994, North American Bird Conservation Initiative 2011). Hence, not only do owls rely on habitats that have lost 45–99% of their historical extent (see Threats below), the area where they rely on this habitat year-round has sustained some of the worst losses (Samson et al. 2004). Additionally, we lack an adequate understanding of what specific habitat characteristics short-eared owls prefer and how habitat types and management regimes affect their abundance and demography. Given the importance of habitat, these are key information needs.

Unpredictable Food Resource

Short-eared owls are specialist predators of small mammals and often rely on only 1 species of *Microtus* for the majority if their diet (Wiggins et al. 2006). Irruptions of small mammals often vary substantially spatially and temporally, making them an unpredictable food source. When small mammals are abundant, short-eared owls can gather and breed at very high densities (Pitelka et al. 1955) but when scarce, owls either do not breed or may leave the area entirely (Clark 1975, Korpimäki and Norrdahl 1991). In winter, owl survival, abundance, and distribution is not only influenced by small mammal abundance but also by the amount and type of snow that determines prey availability (Priestley et al. 2008). Further, studies from other predator-prey systems at high latitudes have documented small mammal resources becoming even less predictable and abundant than in the past and, in some places, this has led to population-level breeding failures for small mammal specialists (Hörnfeldt et al. 2005, Ims et al. 2008, and Gilg et al. 2009). Hence, the short-eared owl's reliance on essentially 1 food source that is inherently unpredictable in space and time and at least in some areas, is becoming even less predictable, adds to its vulnerability. Presently, we lack an adequate understanding of small mammal spatial and temporal population dynamics and how differing habitat management strategies specifically affect small mammal populations and thus, owls.

Low Site Fidelity

Though the seasonal movements of short-eared owls are just starting to be quantified and need further research, the species generally appears to have low or no site fidelity and variable seasonal and annual movements. This makes the species' status difficult to monitor with existing programs and obfuscates ties to stewardship responsibilities for management agencies, collectively making the species vulnerable to decline. Of the 3,200 short-eared owls that have been banded in Canada and the United States since 1922, 53 (1.6%) have been recovered and of those, only 15 (28%) were recovered more than 100 km from where they were marked (U.S. Geological Survey 2013). Birds marked in the central states and provinces generally moved more longitudinally than did those along either coast, but no reliable patterns can be discerned from the scant banding data. Recent satellite telemetry studies found adult short-eared owls marked while summering in Alaska wintered in areas scattered across the western United States and central Mexico, with several tagged birds congregating in the northern Great Plains (J. Johnson, U.S. Fish and Wildlife Service and T. Booms, Alaska Department of Fish and Game, unpublished data). Of the 3 birds that provided a year or more of movement information, none returned to Alaska and instead maintained small summer home ranges slightly north of their wintering areas in the northern Great Plains. Owl abundance in western Alaska in the year that birds were marked was dramatically higher than in the previous 10 years or the subsequent 3 years (P. Bente, Alaska Department of Fish and

Game, personal communication). Apparently, the majority of owls did not return to the area in which they were previously extremely abundant, though where they went is unknown. Nesting owls tagged in central Alberta, Canada, moved south to winter from Montana to Kansas, USA, and returned to within 200 km of their capture site to breed in subsequent years, showing perhaps regional but not site-specific fidelity (G. Holroyd, and H. Trefry, Environment Canada, unpublished data). In Montana, short-eared owls regularly overwinter and breed in similar areas, although it is unknown whether wintering and breeding owls are the same or different individuals (D. Holt, Owl Research Institute, unpublished data). Of 28 females marked there during the breeding season over a 7-year period, none returned (Wiggins et al. 2006). In eastern North America, owls tended to return to their previous wintering sites. Owls radio-marked in the winter in New York, USA, and southern Ontario, Canada moved north to summer in northern Quebec and Labrador, Canada, and then returned to sites near their previous winter locations (P. Nye and P. Novak, New York State Department of Environmental Conservation and D. Badzinski, Bird Studies Canada, unpublished data). Given the above movement data, at least a portion of North America's population appears to be nomadic with some individuals occupying breeding habitats thousands of kilometers apart in consecutive years. In other places or perhaps in some years, owls may show some fidelity to wintering locations and to a lesser degree, summering areas.

The owl's nomadic movements make population monitoring using existing surveys and early detection of population declines difficult. This difficulty could potentially allow a substantial decline to go unnoticed and delay conservation actions that could otherwise slow or reverse the decline. Lack of site fidelity also obfuscates ties to stewardship responsibilities for management agencies because the species may use specific areas irregularly, potentially leading managers to erroneously conclude their lands are of little importance to short-eared owls. However, the species relies on many such areas over broad spatial and temporal scales from Alaska to Mexico, using the landscape in a large patchwork over time as they attempt to locate adequate food and habitat. Therefore, better understanding the temporal and spatial variation in owl movements and whether these vary consistently among flyways or regions would allow us to better design surveys to monitor their populations and provide managers a more useful assessment of where, when, and how short-eared owls use and rely upon their lands.

THREATS

Though the causes of the short-eared owl's decline remain unclear, the most likely candidate is habitat loss, including fragmentation and degradation of large tracts of native grasslands and wetlands. Across the prairie provinces of Canada, native grasslands have declined by 45–99% of their historical extent (World Wildlife Fund Canada 1988, Samson and Knopf 1994). In the United States, native grasslands have declined by 97% of their historical extent (North American Bird Conservation Initiative 2011), and Mexico has undergone similar losses of grassland to cultivation over a similar time period (Gauthier et al. 2003). Though much of the habitat loss predates estimates of owl abundance and trends, losses continued throughout the 20th century and remain substantial and ongoing (Samson et al. 2004, Watmough and Schmoll 2007). For this reason, grassland birds as a group have incurred some of the greatest declines in North America (North American Bird Conservation Initiative 2011). Loss or degradation of grassland habitats in the prairie provinces and states is especially important because these areas are used year-round by short-eared owls. There is also growing concern about loss of coastal grasslands and wetlands where large numbers of owls sometimes overwinter (Wiggins et al. 2006) and where habitat loss has been directly linked to declines in abundance (Campbell et al. 1990). Given that the species relies on grasslands as its primary habitat type and moves nomadically across a large but shrinking patchwork of suitable habitat to find unpredictable food resources, loss or degradation of the habitat type upon which they rely the most, native grasslands, compounds these vulnerabilities. Potential secondary threats include habitat management-induced declines in prey abundance, impacts with man-made structures and vehicles, and increasing predator populations often associated with increasingly fragmented landscapes (Wiggins 2004, 2008; Schmelzer 2005; Wiggins et al. 2006).

CONSERVATION PRIORITIES

Effective conservation requires understanding a species' ecology, population trends, and threats and using that information to guide management actions. Presently, substantial gaps in knowledge and action remain in all of these areas. We propose conservation actions including research questions to address key information gaps that would provide a better understanding of the magnitude and cause(s) of the decline, determine ways to slow or reverse it, and better manage the landscapes upon which the species relies. Below we list actions in approximate order of importance, although we acknowledge priorities may vary by season, region, and habitats, and that many are interconnected.

Better Define and Protect Important Habitats

Because habitat loss is likely the primary factor driving the short-eared owl's decline, protecting high quality habitat for the species is a top priority (Dechant et al. 2001, Wiggins 2004). Existing high quality habitat needs to be identified and protected and lower quality habitat needs to be improved. Some areas in which short-eared owls regularly occur in the breeding and wintering seasons are already known and these should be formally recognized, regionally tabulated, and managed to maintain or improve habitat. We have a basic understanding of what defines short-eared owl habitat and how some land management practices generally affect owls (Dechant et al. 2001, Fondell and Ball 2004, Swengel and Swengel 2014). However, we have little quantitative information about how short-eared owl abundance, survival, and reproductive rates vary across different

habitat types and management techniques during the breeding and nonbreeding seasons. A study that explicitly assesses and compares demographic parameters between landscapes managed with various conservation practices (e.g., Conservation Reserve Program, Wetland Reserve Program, Permanent Cover Program; Herkert et al. 1999) is needed. To better understand the actual cause of decline, we should evaluate how historical habitat change may correlate with the species' decline. To do this, regional and route-specific trend data from both BBS and CBC could be compared to historical and modern habitat change in those specific regions and routes. Results from both of these research areas could provide a better understanding of why the species has declined, prioritize existing habitat types for protection and management, and provide specific habitat management goals to maintain or improve the quality of existing habitat.

Improve Population Monitoring

The BBS and CBC are the only large-scale long-term surveys available to generate short-eared owl trend estimates, but both have substantial shortcomings for robustly monitoring this species (see Status above). If a decline cannot be quantified with confidence, our ability to identify if and when to implement conservation actions and justify mobilizing resources to address a decline is greatly reduced. Therefore, managers should develop and implement a standardized survey technique that can more effectively monitor the spatial and temporal patterns in abundance. Previous investigations (Calladine et al. 2005, 2010; Swengel and Swengel 2009; Larson and Holt 2010; Fisher et al. 2011), report that non-random, crepuscular, road-based visual surveys during the courtship period may hold the most promise for systematic surveying of this species. Although road-based surveys have some inherent limitations and biases compared to more random methods, random surveys for short-eared owls may not provide sufficient sample sizes with which to assess abundance or trends (Lehman et al. 1998). Road-based surveys are a pragmatic approach widely used for other surveys including the BBS and the Nocturnal Owl Survey across much of Canada (Takats et al. 2001), and such observational survey results have accurately represented the abundance of owls breeding at a site in a given year (Johnson et al. 2013). Establishing a new North American monitoring program for short-eared owls presents significant challenges. However, it may be feasible to start such a program by coordinating a series of regional efforts in areas known to be of particular importance to short-eared owls such as the northern Great Plains and lower Great Lakes. Initiating a coordinated, regional approach to monitoring would provide better information in those areas where owls occur year-round (presumably among the most important areas) while concurrently assessing to what degree expanding spatial coverage would improve knowledge of the North American population.

Determine Seasonal and Annual Movements

Improving our understanding of owl seasonal and annual movements is needed to implement and design conservation strategies. For example, knowing how spatial and temporal abundance estimates are influenced by short-eared owl movements is needed to properly design a robust monitoring strategy and interpret its results. Is low abundance in an area simply caused by those owls moving to a different area, only to return when food availability or habitat quality is improved? If so, how far do individuals move and where do they go? Should we manage landscapes or regions as metapopulations in which owls colonize and then disperse over time? If so, over how large of an area do these congregations of owls move, how often do they move, what drives these movements, and how can a coordinated monitoring strategy best account for such movements? Answers to these questions would be helpful to guide future conservation actions both in terms of better monitoring the species and implementing on-the-ground habitat management.

Re-Evaluate NatureServe's National Conservation Classifications

We find the species' NatureServe national classification in the United States and Canada as secure or apparently secure, respectively, to be inconsistent with the available information and contrary to its NatureServe status at state and provincial levels. NatureServe rankings are important because they are widely used by state and other agencies to prioritize funding decisions. For example, at least 42 of the 50 state fish and game agencies in the United States use NatureServe rankings in their state wildlife action plans to create species of concern lists or prioritize efforts and funding (T. Booms, unpublished data). Hence, the short-eared owl's current nationally secure (USA) and apparently secure (Canada) classifications provide the conservation community an inaccurate assessment of the species' status and makes proposed conservation work less competitive and in many instances, ineligible for limited conservation and research funding.

Develop Management Plans and Tools

We need to develop management plans that explicitly identify goals and best practices to guide land management decisions for short-eared owls at multiple spatial scales and integrate these into existing management efforts (e.g., Schmelzer 2005). Few management tools applicable to short-eared owls are currently available and more emphasis needs to be placed on maintaining residual vegetative cover in grasslands (Dechant et al. 2001, Swengel and Swengel 2014). Results from habitat studies should be used to create tangible goals for managing landscapes and to inform what tools may best achieve results. Results from movement studies should be used to better tie stewardship responsibilities to specific areas and convince land owners and managers to explicitly consider short-eared owls in their strategic plans, conservation programs, and management activities (especially timing, intensity, and rotation of grazing, haying, and mowing). The actual development and implementation of management tools and plans could be coordinated through the USFWS, Flyway Councils' Nongame Migratory Bird Technical Committees, joint ventures, and the Bird Conservation Committee of the Association of Fish and Wildlife

Agencies, all of which play key leadership and coordination roles that span geopolitical boundaries.

Classify Raptors, Including Short-Eared Owls, as Migratory Birds in Canada

The Migratory Birds Convention of 1917 between Canada and the United States (and its 1994 update) does not include short-eared owls or any raptors (Holroyd 1993, 1995), meaning raptors in Canada are a provincial rather than federal responsibility. The lack of federal jurisdiction eliminates most federal funding for research and conservation of this and other raptors in Canada until they are listed as federally threatened or endangered (Holroyd and Trefry 2011, Holroyd and Bird 2012). For pro-active conservation of this and other raptor species, the Canada-United States Migratory Birds Convention should be amended to extend federal protection to raptors, including short-eared owls, in Canada, as was done in the 1936 amendment to the United States Migratory Bird Treaty Act.

MANAGEMENT IMPLICATIONS

As a wide-ranging predator, the short-eared owl likely serves as an indicator of the health of its habitats, and conservation efforts for the owl could benefit a suite of other grassland species. Other declining grassland bird species receive some conservation attention (e.g., Sprague's pipit [*Anthus spragueii*], Committee on the Status of Endangered Wildlife in Canada 1999; long-billed curlew [*Numenius americanus*], Fellow and Jones 2009). However, short-eared owl conservation concerns have gone almost unnoticed, even though the species' status as a higher trophic-level predator may provide for more effective conservation of grassland habitats and biodiversity as an umbrella species than lower trophic-level species (Sergio et al. 2006). Multiple lines of evidence support the conclusion that the short-eared owl has undergone a long-term decline in abundance across North America. Presently, no large-scale or coordinated research and management programs are in place that attempt to understand, slow, stop, or reverse this decline. A variety of publications have discussed the species' status and threats to some extent, yet many biologists and land managers apparently remain unaware of the species' decline or feel incapable of addressing it. Likewise, the species' NatureServe national rankings as secure or apparently secure are inconsistent with the cumulative state and provincial rankings where it is nowhere considered secure. Although the species' nomadic nature does present challenges to research and monitoring, we contend its need for habitat conservation at large spatial scales, status as a predator, and high reproductive potential that affords the species capacity to recover, make it an effective and useful candidate as an umbrella species for grassland conservation. Our hope is that this commentary will raise awareness of this declining species in the wildlife and land management communities and provide useful, science-based direction to guide future efforts to help conserve the short-eared owl, its habitats, and co-occurring grassland species across North America.

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