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Author: Johnson, David H.

Source: Journal of Raptor Research, 47(3) : 271-281

Published By: Raptor Research Foundation

URL: https://doi.org/10.3356/JRR-12-00006.1

J. Raptor Res. 47(3):271–281

SHORT-EARED OWL (*ASIO FLAMMEUS*) OCCURRENCE AT BUENA VISTA GRASSLAND, WISCONSIN, DURING 1955–2011

DAVID H. JOHNSON
Global Owl Project, 6504 Carriage Drive, Alexandria, VA 22310 U.S.A.

SCOTT R. SWENGEL[1] AND ANN B. SWENGEL
909 Birch Street, Baraboo, WI 59313 U.S.A.

ABSTRACT.—We assembled Short-eared Owl (*Asio flammeus*) abundance data from Buena Vista Grassland, Wisconsin, for the period 1955–2011, primarily from the Hamerstrom (1955–94) and Swengel (1997–2011) research teams. We also gathered owl breeding-season observation data from the Wisconsin state ornithology journal (*Passenger Pigeon*). We tabulated the number of owl breeding areas based on adult territoriality, nests, and family groups, and classified each year's breeding season by abundance categories. Summer detections and evidence of breeding for Short-eared Owls at Buena Vista varied greatly among years in both the Hamerstrom and Swengel datasets. Peak owl years occurred rarely and unpredictably. During the 57 yr of this study we report three very high peak years of owl abundance (1970, 1974, 2000), three high years (2001, 2006, 2009), 11 mid-range years, 13 low years, 14 no-owl years, and 13 years with missing data inferred from corroborative analysis to be low or no-owl years. The data did not reveal a strong cyclical pattern in owl abundance or suggest a directed population trend. We extracted vole (*Microtus*) abundance data for 1964–83 from the Hamerstrom dataset. All pairwise correlations of owl abundance (abundance categories, number of breeding areas) and vole abundance (ranking, abundance categories) were strongly and positively significant.

KEY WORDS: *Short-eared Owl*; Asio flammeus; *breeding*; *monitoring*; *nesting*; *survey*; *Wisconsin*; *United States*.

OCURRENCIA DE *ASIO FLAMMEUS* EN EL PASTIZAL DE BUENA VISTA, WISCONSIN, DE 1955 A 2011

RESUMEN.—Recopilamos datos de abundancia de *Asio flammeus* en el Pastizal de Buena Vista, Wisconsin, para el periodo comprendido entre 1955 y 2011, principalmente de los equipos de investigación Hamerstrom (1955–94) y Swengel (1997–2011). También reunimos datos de observación de la temporada reproductiva de *A. flammeus* del periódico ornitológico estatal de Wisconsin (*Passenger Pigeon*). Tabulamos los números de las áreas de reproducción de búhos basados en la territorialidad de adultos, nidos y grupos familiares, y clasificamos la época reproductiva de cada año por categorías de abundancia. Las detecciones estivales y la evidencia de reproducción para *A. flammeus* en Buena Vista varió mucho entre años en los set de datos de Hamerstrom y Swengel. Los años pico de búhos ocurrieron de manera rara e impredecible. Durante los 57 años de este estudio reportamos tres años con picos de abundancia de búhos muy altos (1970, 1974, 2000), tres años altos (2001, 2006, 2009), 11 años moderados, 13 años bajos, 14 años sin búhos y 13 años con datos perdidos, los cuales fueron inferidos a partir de análisis corroborativos como años bajos o sin búhos. Los datos no revelaron un fuerte patrón cíclico en la abundancia de búhos ni tampoco sugirieron una tendencia poblacional dirigida. Extrajimos datos de abundancia de *Microtus* para 1964–83 del set de datos de Hamerstrom. Todas las correlaciones pareadas de abundancia de búhos (categorías de abundancia, número de áreas de reproducción) y abundancia de *Microtus* (clasificaciones, categorías de abundancia) fueron positivas y altamente significativas.
[Traducción del equipo editorial]

Short-eared Owls (*Asio flammeus*) are of conservation concern in North America due to their decline of >70% over 40–50 yr on Christmas Bird Counts and North American Breeding Bird Surveys (Environment Canada 2010, Sauer et al. 2011, National Audubon Society 2012). This owl is also of conservation concern in Europe (Calladine et al. 2010). Monitoring is essential for successful conservation (Buckland et al. 2008). To be effective, an understanding of variation in annual abundance is necessary (e.g., Poulin et al. 2001). The Short-eared Owl's continental-scale movements, large interannual

[1] Email address: swengel@naba.org

variability in local abundance, the difficulty in finding its nests, and its largely crepuscular and nocturnal activity (Beske and Champion 1971, Clark 1975, Holt 1992, Holt and Leasure 1993, Houston 1997, Priestley et al. 2008, Swengel and Swengel 2009) create challenges for effective monitoring (Calladine et al. 2010, Keyes 2011). Here we report long-term observations of Short-eared Owls at a Wisconsin site from two research groups: Hamerstroms during 1955–94 (Hamerstrom 1969, 1986, Hamerstrom et al. 1985) and Swengels during 1997–2011 (Swengel and Swengel 2002, 2009). We obtained additional published and unpubl. data on Short-eared Owl observations at Buena Vista and in the state of Wisconsin to construct and corroborate this long-term dataset. We documented patterns of variation in Short-eared Owl abundance on annual and decadal scales.

METHODS

Our study site was the Buena Vista Grassland (or Marsh) Wildlife Area in Portage County, Wisconsin, with 5000 ha of public land (Toepfer 2003). Frances and Fred Hamerstrom began recording raptors here by 1939 (Berger et al. 1963). In 1959, they and numerous associates began an intensive study of Northern Harrier (*Circus cyaneus*) breeding that pioneered the use of observation and knowledge of raptor behavior to minimize researcher disturbance (Hamerstrom 1969, Follen 1975). This team recorded all raptors seen, including crepuscular and nocturnal observations of Short-eared Owls (Beske and Champion 1971) and raptors noted by observers in blinds for observing Greater Prairie-Chickens (*Tympanuchus cupido*). They also used snap traps (minimum 1200 trap-nights/yr) to estimate vole (*Microtus*) abundance during 1964–83, because voles strongly affect harrier reproduction (Hamerstrom 1986). Using these data, we ranked vole abundance (one for the lowest year and 20 for the highest) in Hamerstrom (1986) and grouped these into four categories (one for lowest and four for highest) for comparison to annual owl abundance indices.

DHJ made photocopies of all pages mentioning Short-eared Owls in the Hamerstroms' ''red books'' (data books) archived at the Julian W. Hill Library Collection, Acopian Center for Conservation Learning at Hawk Mountain Sanctuary. From these and from Hamerstrom et al. (1961) and Beske and Champion (1971), DHJ tabulated all Short-eared Owl observations made by the Hamerstrom team at Buena Vista from 1955–91, as well as the 1994 observations by Stan Moore (pers. comm.).

SRS and ABS chose to emphasize observational study of owls and did not attempt to find nests. We conducted daytime walking surveys at Buena Vista during 1997–2011 in the context of extensive surveys for butterflies and grassland birds in the growing season at 150 grasslands in seven states during 1988–2011 (Swengel and Swengel 1999, 2000). We also conducted driving surveys year-round (usually 1–2 times/mo) during the day, evening, and after evening civil twilight from November 1999–November 2011 at Buena Vista specifically to detect Short-eared Owls and other raptors (Swengel and Swengel 2002, 2009). We noted whether each owl contact (record, or episode of observing an individual owl at a particular time and place) was distinguishable as a juvenile, but likely classified some fledged young as adults in an effort to count young conservatively. Compared to adults, young were darker overall (Beske and Champion 1971), especially on the facial disk, underwing, and back, with upper chests darker or more darkly barred (Mikkola 1983, Johnsgard 1988, Wiggins et al. 2006, König and Weick 2008), and many still had shorter tails. If not clearly identifiable as a juvenile, the owl was considered an adult. We coded each contact as a new or repeat observation of an individual previously recorded during a driving session that day, counting birds in later sessions in the same general area as repeats unless they had different plumages or more individuals were seen at once. This was not an attempt to identify individual birds, but instead to calculate a minimum number of owls present that day based on location and, to a lesser extent, obvious differences in plumage. These tallies were likely to be conservative because individual Short-eared Owls in daylight hours have a very low detection probability (e.g., <5% in Calladine et al. 2010).

We adapted breeding bird atlas methods (Cutright et al. 2006) to group owl contacts by increasing confirmation of breeding: (1) breeding territory (adult seen repeatedly in one area during summer; presence of a pair; territorial defense/vigilance; courtship such as singing, high altitude wing-clapping, flight display, talon-touching [as described by Clark (1975), Mikkola (1983), and Holt and Leasure (1993)]); (2) nests; and (3) family groups (e.g., recently fledged young, adult feeding or supervising a fledgling). We counted the number of areas that had evidence of territoriality, nesting, and family groups separately, then the number of different breeding areas combining these. When we repeatedly observed a pair or family group in one

Table 1. Categories of breeding abundance for Short-eared Owls. A breeding area is a location where any breeding evidence (territoriality, nest, and/or family group) was observed in spring or summer (see Methods).

Category	Definition
0	0 breeding season observations (1 May–31 August)
1	1–5 breeding season observations or 1–3 breeding areas (pairs/nests/families)
2	6–44 breeding season observations or 4–7 breeding areas
3.5	45–99 breeding season observations or 11–14 breeding areas
5	>99 breeding season observations or >14 breeding areas

area, this was considered as one breeding area, even though these might not be the same birds. If we observed territoriality, then a nest (rarely), and then a family group in the same area, it was counted as one breeding area. Only when we saw two pairs or family groups in the same area at the same time did we record two breeding areas there.

Other Datasets. SRS extracted Wisconsin seasonal summary data on Short-eared Owls from the *Passenger Pigeon* to compare to the 1955–2010 Buena Vista data from the Hamerstroms and Swengels. These data included the number of counties throughout the state reporting Short-eared Owls during the breeding season (summer) and reports of owls in Portage County during summer (defined in the *Passenger Pigeon* as 1 June to 15 August through 1972 and 1 June to 31 August thereafter). Summer for Swengels' data was defined as 1 May–31 August based on the timing of Short-eared Owls' breeding. To contribute to *Passenger Pigeon* seasonal summaries, volunteers filled out single- or multi-county bird report forms during each season. In recent years, birds could also be reported electronically using eBird or WisBirdNet, in which more people contribute reports but many reports consist of single species. Fewer complete county reports have been submitted recently (Soulen 2007). A seasonal editor reviewed and collated these reports for publication in *Passenger Pigeon.*

Data Analysis. DHJ devised categories (Table 1) to consistently classify years by owl abundance and extent of breeding behavior observed, even though the Hamerstrom and Swengel datasets were gathered using different methods. In the combined dataset, there were 13 years for which there was no Hamerstrom red book. We treated these years as missing values, and used the corroborative dataset to infer owl abundance at Buena Vista during these years.

We analyzed the raw number of counties reporting Short-eared Owls in summer, as well as the number of counties corrected for observer effort, as there was a marked increase in the number of observers after 2005. It can be beneficial to adjust opportunistic data like season summary reports for observer effort because of the bias resulting from years with considerably more observer effort (Smith and McKay 1984, Bielefeldt and Rosenfield 2003). Because about 80% of the ca. 300 observers contributing records electronically reported just a few birds, this increase in observers did not represent 3–4 times as much effort as the 75–100 ''hard core'' people who reported before eBird. As a result, we corrected for effort by dividing the number of Wisconsin counties reporting Short-eared Owls by the square root of the number of observers instead of by the raw number of observers. This corrected variable was then multiplied by 10 to make it within the same order of magnitude as the raw county total: the mean number of Wisconsin counties statewide reporting Short-eared Owls each summer (uncorrected) = 1.0 (range 0–6); the mean number of Wisconsin counties corrected by dividing by the square root of the number of observers and then multiplying by 10 = 1.436 (range 0–7.385).

We computed all statistical tests using ABstat 7.20 software (Anderson-Bell 1994). Significance was set as a two-tailed $P < 0.05$. We used the Spearman rank correlation to test for significant correlations between different owl datasets and between owl and vole abundance, and the Mann-Whitney *U*-test to test for significant differences between samples.

Results

Summer detections and evidence of breeding for Short-eared Owls at Buena Vista varied greatly among years in the Hamerstrom and Swengel datasets (Fig. 1, Appendix). Three major peak years of owl abundance (1970, 1974, 2000) occurred at Buena Vista during 1955–2011. At least three other years (2001, 2006, 2009) had relatively high numbers. We also categorized 11 years as having

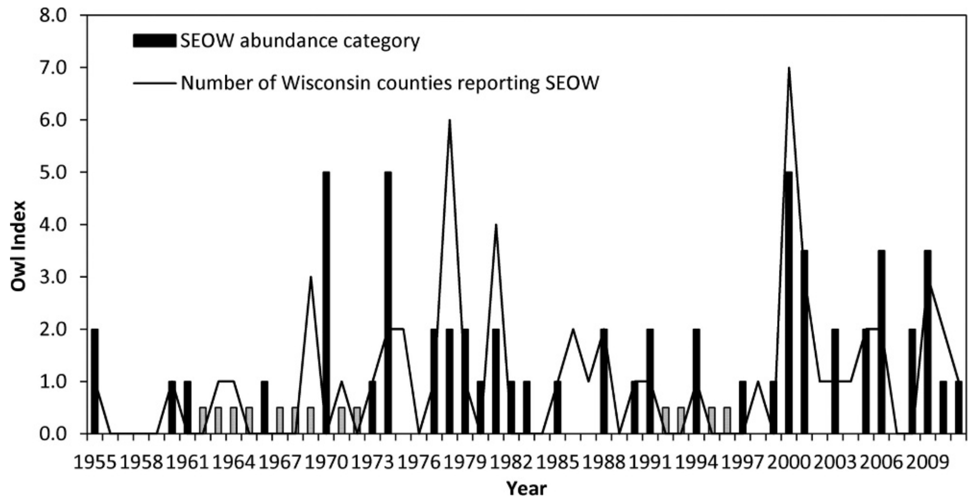

Figure 1. Short-eared Owl abundance categories at Buena Vista compared to the number of Wisconsin counties reporting Short-eared Owls the same summer in the *Passenger Pigeon*. Abundance category bars are gray and set to 0.5 for the 13 years of missing data likely to be category 0 or 1 based on patterns in Table 3.

mid-range abundance, 13 as low years, 14 as no-owl years, and 13 years with missing data—subsequently inferred by corroborative analysis to be low or no-owl years.

Records from the *Passenger Pigeon* season summary correlated well with Buena Vista data. Abundance categories (Fig. 1) and number of breeding areas at Buena Vista correlated positively, usually significantly, with the number of Wisconsin counties (raw or corrected for the number of observers) reporting Short-eared Owls in summer (Table 2). Owl indices from Portage County and other counties were 3–4 times as high when Hamerstroms or Swengels observed a higher owl breeding category (2–5) as when they detected the two lowest categories (Table 3). Whether Short-eared Owls were reported in Portage County in summer in the *Passenger Pigeon* correlated with the species' incidence at Buena Vista: presence-absence, abundance categories, and especially the number of breeding areas recorded at Buena Vista (Table 4).

Four peak years of vole abundance (1966, 1970, 1974, 1979) occurred at Buena Vista during 1964–83 (Fig. 2, Hamerstrom 1986). Owl abundance categories and number of breeding areas both covaried strongly with vole abundance (ranking, abundance categories; Fig. 2, Table 5).

Reports in the *Passenger Pigeon* were useful for inferring owl incidence at Buena Vista in years of no data. Whether Short-eared Owls were reported

Table 2. Spearman rank correlations of Short-eared Owl abundance (categories and number of breeding areas in Appendix) by Hamerstroms (1955–96) and Swengels (1997–2010) at Buena Vista with the number of Wisconsin counties reporting the species in summer in the *Passenger Pigeon* (both untransformed and corrected for the number of observers–see Methods for details).

	1955–96			1997–2010			1955–2010		
CORRELATION	*n*	*r*	*P*	*n*	*r*	*P*	*n*	*r*	*P*
SEOW category to									
N counties recorded	29	0.444	<0.05	14	0.670	<0.01	43	0.494	<0.01
N counties corrected	21	0.347	>0.10	14	0.682	<0.01	35	0.450	<0.01
N breeding areas to									
N counties recorded	29	0.385	<0.05	14	0.769	<0.01	43	0.505	<0.01
N counties corrected	21	0.346	>0.10	14	0.752	<0.01	35	0.435	<0.05

Table 3. Comparison of Short-eared Owl abundance categories in the Hamerstrom and Swengel studies (see Table 2) to whether the species was recorded in Portage County in summer in the *Passenger Pigeon* (0 = no, 1 = yes) and to the number of Wisconsin counties reporting Short-eared Owl in summer in the *Passenger Pigeon*, and the latter corrected for the number of observers. Swengels did crepuscular and nocturnal surveys in summer 2000–10 but not 1997–1999.

			Recorded in Portage Co.		N Counties Recorded in WI		N Counties Corrected for N Observers	
Study	Years	Abundance Category	Years	Mean	Mean	Range	Mean	Range
Swengel	1997–10	0–1	7	0.29	0.71	0–2	0.6	0–1.387
	1997–99	0–1	3	0.00	0.33	0–1	0.38	0–1.132
	2000–10	0–1	4	0.50	1.00	0–2	0.87	0–1.387
	2000–10	2–5	7	0.86	2.43	0–6	2.57	0–7.022
Hamerstrom	1955–94	0–1	13,19,12[a]	0.08	0.47	0–2	0.87	0–2.828
	1955–94	2–5	8,10,9[a]	0.25	1.90	0–6	2.59	0–7.385

[a] *n* years is for Portage Co., number of counties, and number of counties corrected, respectively.

from Portage County strongly related to the number of Wisconsin counties reporting owls (Table 6). In years of no data or no owls at Buena Vista (Appendix), Portage County also had no summer owl records in the *Passenger Pigeon* (Table 7). *Passenger Pigeon* data suggest that 1997–99 (low owl detections in Portage and other Wisconsin counties; Fig. 1, Table 3), when Swengels had less effort and no systematic evening or nocturnal surveys, were correctly categorized as 0–1 in owl abundance at Buena Vista (Appendix). Based on *Passenger Pigeon* data (Table 7), the years without Hamerstrom data would also be categorized as having low owl abundance (categories 0 or 1), so that most years (n = 40) during 1955–2011 were probably low owl years at Buena Vista. There was a trend suggesting that owl abundance from 1955 to 2011 was increasing for both owl abundance categories ($r = 0.186$, $n = 44$, $P < 0.10$) and number of breeding areas ($r = 0.223$, $n = 44$, $P < 0.10$), but neither of these was statistically significant.

Within a summer, the number of breeding areas and number of adult owls seen (Appendix) correlated highly within Hamerstroms' ($r = 0.762$, $n = 24$) and Swengels' datasets ($r = 0.972$, $n = 15$: 1997–2011) and for both studies combined ($r = 0.889$, $n = 39$; $P < 0.001$ in all tests).

DISCUSSION

Short-eared Owls occurred in summer and bred regularly at Buena Vista during 1955–2011, but in low numbers most years, with rare and unpredictable peaks in abundance (Fig. 1). Summer abundance at Buena Vista was a rough barometer of county and statewide owl numbers (Tables 2–4, 6–7). Most or all of the 13 years without data (Appendix) were probably low years for Short-eared Owls at Buena Vista, based on correlation of these data to *Passenger Pigeon* reports. As a result, we believe we identified all years of high owl abundance at Buena Vista from 1955 to 2011. We did not find a way to account for observer effort by the Hamerstrom and

Table 4. Comparison of Short-eared Owl detection in summer (0 = no, 1 = yes), their abundance categories, and number of breeding areas (see Appendix) observed by the Hamerstroms and Swengels at Buena Vista by whether the species was recorded in Portage County, Wisconsin in summer in the *Passenger Pigeon* 1955–2010. *P*-value from Mann-Whitney *U*-test presented for each paired comparison within a column.

Recorded in Portage Co. in *Passenger Pigeon*	Years[a]	Recorded at Buena Vista		Owl Abundance Categories		N Breeding Areas	
		Mean	*P*	Mean	*P*	Mean	*P*
No	24	0.625	>0.10	1.04	0.0122	1.375	0.0012
Yes	11	0.909		2.32		7.727	

[a] *Passenger Pigeon* season summary for summer available for all years of this study through 2010 (56 years). For ten years (1955–60, 1965–66, 1968, 1970), it was not possible to determine whether these records included any Short-eared Owls recorded in Portage County. No data are available for 13 yr of the Hamerstrom study (see Appendix).

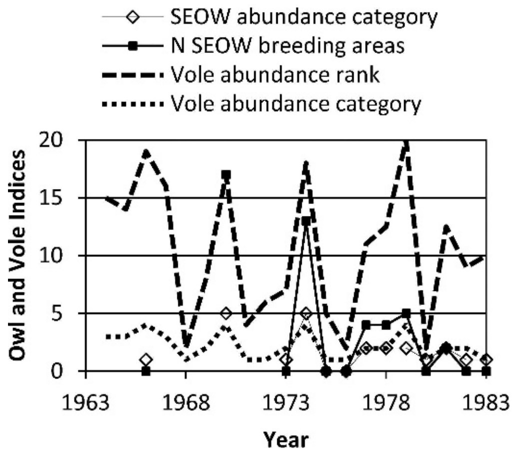

Figure 2. Short-eared Owl abundance categories and number of different breeding areas at Buena Vista (see Tables 1–2) compared to vole abundance (from Hamerstrom 1986) expressed as ranks and abundance categories. See Table 5 for statistical tests.

Swengel teams. Both teams may have had enough effort to characterize owl abundance, so that correcting for effort would not change the results. Observer effort correction did not seem to improve accuracy of relating *Passenger Pigeon* data to the 1955–2010 Buena Vista data (Table 2). But for periods more influenced by the recent boom in online reporting, corrected owl indices may have greater concordance with other datasets (Swengel and Swengel 2013).

Relationship to Prey. The abundance of Short-eared Owls correlated highly with vole abundance except during the DDT years (Fig. 2). The Hamerstroms reported few owls in the 1966 vole peak, and the other years of the DDT period that have missing values were presumed to be low years, even though there were two above-median vole years in addition to 1966 (Appendix). An index to harrier abundance corroborated this: in the vole peak of 1966, the number of harriers nesting was far below average, then increased to a low baseline level in 1969, when far less DDT was sprayed than in 1965–68 (Hamerstrom 1986); the number of harriers breeding increased greatly to peak in 1970 in synchrony with peaks in vole and Short-eared Owl abundance. In North America, harriers experienced widespread breeding failure linked to eggshell thinning caused by organochlorine pesticides during the 1940s through 1960s (MacWhirter and Bildstein 1996). These pesticides usually did not build to high concentrations in Short-eared Owls, possibly because the owls' narrow diet consisting primarily of mammals makes them less susceptible to pesticides than many hawks (Blus 1996, Wiggins et al. 2006). However, low owl numbers at Buena Vista during the DDT years suggest that a negative effect did occur there.

Short-eared Owl populations vary in synchrony with voles or other cyclic mammals, which the owls track by long-range dispersal (Clark 1975, Korpimäki and Norrdahl 1991, Holt and Leasure 1993, Williford et al. 2011). Short-eared Owls have a narrower food-niche both locally and among regions than harriers and most owls (Glue 1977, Jáksic 1983). These factors combine to create wide swings in owl abundance (Beske and Champion 1971, Poulin et al. 2001, Saurola 2008). An underlying mechanism for the covariance between statewide and Buena Vista owl indices (Tables 2–4, 6–7; Fig. 1) is the synchrony of vole abundance at Buena Vista both with the vole index in Don Follen's raptor study area 40 km to the northwest and with a regional (Wisconsin, northern Illinois, southeastern Minnesota) vole index (documented by DQ Thompson; Hamerstrom 1986).

Population Variation. In addition to Buena Vista, long-term data on Short-eared Owls have been

Table 5. Spearman rank correlations of vole abundance rankings and abundance categories (based on data in Hamerstrom 1986) to Short-eared Owl abundance categories and breeding areas (see Appendix).

	OWL ABUNDANCE CATEGORY			OWL BREEDING AREAS		
VOLE VARIABLE	*n*	*r*	*P*	*n*	*r*	*P*
Entire dataset 1964–83						
Abundance ranking	13	0.728	<0.01	13	0.691	<0.01
Abundance category	13	0.727	<0.01	13	0.685	<0.01
Excluding vole peak in 1966 DDT year (Hamerstrom 1986)						
Abundance ranking	12	0.887	<0.001	12	0.891	<0.001
Abundance category	12	0.861	<0.001	12	0.861	<0.001

Table 6. Comparison of number of Wisconsin counties reporting Short-eared Owl in summer (raw or corrected for the number of observers) by whether the species was recorded in Portage County, based on records in the *Passenger Pigeon* 1955–2010. *P*-value for Mann-Whitney *U*-test presented for each paired comparison within a column.

Recorded in Portage Co.	N Counties Recorded in WI				N Counties Corrected for Observers			
	Years[a]	Mean	Range	*P*	Years	Mean	Range	*P*
No	35	0.743	0–4	0.0008	31	1.024	0–5.000	0.0078
Yes	11	2.545	1–6		11	2.728	0.857–7.385	

[a] *Passenger Pigeon* season summary for summer available for all years of this study through 2010 (56 years). For ten years (1955–60, 1965–66, 1968, 1970), it was not possible to determine whether these records included any Short-eared Owls recorded in Portage County.

published for at least five areas. Houston (1997) reported that in southern Saskatchewan, Canada, during 1952–96 Short-eared Owl nests were found in only 10 years, with 92% of 244 nests in just five years and only six nests in 1975–96. During 1960–85 in the Saskatoon area, other observers reported one nest in 1964, two in 1966, one in 1967, 16 in 1969, and no nests after that (Houston 1997). Roadside counts by Poulin et al. (2001) extended the southern Saskatchewan time series; they saw only two owls each in 1996 and 1998, but a huge peak in 1997 with 604 owl observations, similar in magnitude to the large peak in 1969. At the Illinois Prairie-Chicken Sanctuaries during 1994–2008, owls were seen in only five years (Jasper County) and three years (Marion County), respectively; 62% of all owl nests or families (13/21) found during 1964–2008 were in just one year (1990; Herkert et al. 1999, J. Herkert pers. comm.). Owl nest, territory, and banding data for all of Finland are collected via the Raptor Grid (started in 1982) and the Raptor Questionnaire (started in 1986; Saurola 2009). During 1982–2007, the number of Short-eared Owl territories/yr varied 20- to 40-fold, and nests/yr 300-fold (Saurola 2009). These wide fluctuations made statistical power inadequate for accurate trend estimation (Saurola 2008, 2009). Peter (2006) and Berg and Dvorak (2008) recorded nesting/territorial pairs of owls in Austria during 1966–2008. There was possible or probable Short-eared Owl breeding in 23 of 43 years, with 5 - >19 pairs in 14 of these years. In southern Germany, Hölzinger et al. (1973) found 1–17 owl pairs in seven years during 1956–73, with 83% of all pairs found in 1964, 1967, and 1971.

In these other studies and at Buena Vista, strong peak years occurred irregularly, with low to moderate numbers or no detections most years. Owls were undetected/very rare in local breeding areas in 54% (range 32–80%) of years, in low to moderate numbers in 37% of years, and in peak numbers in about 9% (range 0–22%) of years. This great variability can result if Short-eared Owls returning from widely scattered wintering grounds (Mikkola 1983, Holt and Leasure 1993) encounter areas of high prey density (e.g., voles) and stop to breed, perhaps far short of their natal area or well beyond it. But large fluctuations make Short-eared Owl trend estimation difficult unless populations have a steep trend for >10 yr (several vole cycles), or the dataset covers several decades over large land areas (Saurola 2008).

Implications for Monitoring. Our results support the feasibility of an observational strategy for efficient long-term monitoring of Short-eared Owls.

Table 7. Comparison of Short-eared Owl detection in summer reported by the Hamerstrom team (1955–96; see Appendix) to whether the species was recorded in Portage County that summer in the *Passenger Pigeon* (0 = no, 1 = yes) and to the number of counties reporting Short-eared Owl that summer in the *Passenger Pigeon* (raw or corrected for the number of observers). Within a column of mean values, no pairwise Mann-Whitney *U*-test was significant ($P < 0.05$); for the number of counties recorded in WI, no data and present were $P < 0.10$.

Hamerstrom Study		Recorded in Portage Co.	N Counties in WI			N Counties Corrected		
	Years	Mean	Years	Mean	Range	Years	Mean	Range
no data	13	0.00	11	0.46	0–3	8	0.68	0–4.045
not detected	10	0.00	6	0.50	0–2	6	1.10	0–2.828
present	19	0.20	15	1.21	0–6	15	1.81	0–7.385

Although our primary data were drawn from indices of owl numbers and breeding activity and use both probable (adult territoriality) and confirmed (nests, family groups) breeding, all years with any observed territories also had confirmed breeding (nest/family group; Appendix) and the number of breeding areas found using all types of evidence (territories, nests, families) was closely linked to the number of adults seen in summer. Houston (1997) and Saurola (2009) also found high concordance of owl sightings or territories with nesting results. This indicates that observational studies using an understanding of owl detectability patterns (e.g., Calladine et al. 2010) can be used to efficiently monitor Short-eared Owls, especially if breeding season dusk watches at sites with past owl usage are employed (Swengel and Swengel 2009, Keyes 2011). Our ability to statistically analyze owl data gathered by the Hamerstrom team illustrated the great value of researchers consistently recording observations of a suite of species sharing the same sites as their primary study species. When these data cover long periods of time and are well preserved, they become especially useful for science and conservation. Buena Vista's apparently stable owl trend indicates that this may be among the last places to show a decline, because this highly vagile owl preferentially chooses this high-quality habitat for breeding.

ACKNOWLEDGMENTS

The conservation success at Buena Vista is a credit to the work of the Hamerstroms and their colleagues (listed in Hamerstrom [1986]), and the Wisconsin Department of Natural Resources, Dane County Conservation League, and other partners for preserving and beneficially managing it for grassland birds. We thank Stan Moore for providing 1994 data. We thank the Julian W. Hill Library Collection, Acopian Center for Conservation Learning at Hawk Mountain Sanctuary for archiving the Hamerstrom field books, and Laurie Goodrich, Keith Bildstein, and Wendy Frew for making the books available to DHJ. We greatly appreciate Sandra McKibben and especially William and Elsa Boyce for partially funding the Swengels' research. We thank Denver Holt, two anonymous reviewers, and Cheryl Dykstra for numerous helpful comments on the manuscript.

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Received 12 July 2012; accepted 12 December 2012

Appendix. Short-eared Owl detections in summer (1 May to 31 August) and breeding evidence at Buena Vista Grassland as reported by the Hamerstroms and their associates (1955–96) in Hamerstrom, Hamerstrom, and Berger (1961), Beske and Champion (1971), Red Book field notes by F. Hamerstrom, and by Stan Moore (pers. comm. 30 July 2008 to D. Johnson), and recorded by Swengels (1997–2011). The Hamerstroms' and Swengels' datasets combined: Spearman rank correlation of abundance categories with the number of breeding areas: $r = 0.861$, $n = 44$, $P < 0.001$; abundance category with number of summer detections: $r = 0.983$, $n = 39$, $P < 0.001$.

Year	Abundance Category	No Data[a]	Summer Detection[b]	Territories	Number of Nests	Families	Breeding Areas[c]
1955	2		Yes	5	1	0	6
1956	0		No	0	0	0	0
1957	0		No	0	0	0	0
1958	0		No	0	0	0	0
1959	0		No	0	0	0	0
1960	1		Yes	0	1	1	2
1961	1		Yes	0	2	2	2
1962		X					
1963		X					
1964		X					
1965		X					
1966	1		Yes (1)	0	0	0	0
1967		X					
1968		X					
1969		X					
1970	5		Yes	0	1	17	17
1971		X					
1972		X					
1973	1		Yes (1)	0	0	0	0
1974	5		Yes (150)	0	13	0	13
1975	0		No	0	0	0	0
1976	0		No	0	0	0	0
1977	2		Yes (11)	2	2	0	4
1978	2		Yes (40)	0	4	0	4
1979	2		Yes (23)	0	5	0	5
1980	1		Yes (2)	0	0	0	0
1981	2		Yes (13)	0	2	0	2
1982	1		Yes (2)	0	0	0	0
1983	1		Yes (2)	0	0	0	0
1984	0		No	0	0	0	0
1985	1		Yes (1)	0	1	0	1
1986	0		No	0	0	0	0
1987	0		No	0	0	0	0
1988	2		Yes (7)	0	0	0	0
1989	0		No	0	0	0	0
1990	1		Yes (4)	0	0	0	0
1991	2		Yes (20)	0	1	0	1
1992		X					
1993		X					
1994	2		Yes	0	2	0	2
1995		X					
1996		X					
1997	1		Yes (4)	0	1	0	1
1998	0		No	0	0	0	0
1999	1		Yes (1)	0	0	0	0
2000	5		Yes (202)	26	0	9	26
2001	3.5		Yes (45)	14	0	2	14

Appendix. Continued.

Year	Abundance Category	No Data[a]	Summer Detection[b]	Territories	Number of Nests	Families	Breeding Areas[c]
2002	0		No	0	0	0	0
2003	2		Yes (22)	5	0	1	5
2004	0		No	0	0	0	0
2005	2		Yes (29)	7	0	4	7
2006	3.5		Yes (53)	11	1	5	11
2007	0		No	0	0	0	0
2008	2		Yes (43)	5	0	4	5
2009	3.5		Yes (74)	12	1	5	12
2010	1		Yes (5)	2	0	2	3
2011	1		Yes (5)	2	0	1	2

[a] ''No data'' indicates either no mention of Short-eared Owls in the Hamerstrom field books (whether to note an observation or lack of observation) or no field book was available.

[b] Number in parentheses is the number of summer adult contacts (if available).

[c] See Table 1 and Methods for definition of ''breeding areas.''