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Effects of Management Practices on Grassland Birds: Short-Eared Owl

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**EFFECTS OF MANAGEMENT PRACTICES
ON GRASSLAND BIRDS:
SHORT-EARED OWL**



Grasslands Ecosystem Initiative
Northern Prairie Wildlife Research Center
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Jamestown, North Dakota 58401

This report is one in a series of literature syntheses on North American grassland birds. The need for these reports was identified by the Prairie Pothole Joint Venture (PPJV), a part of the North American Waterfowl Management Plan. The PPJV recently adopted a new goal, to stabilize or increase populations of declining grassland- and wetland-associated wildlife species in the Prairie Pothole Region. To further that objective, it is essential to understand the habitat needs of birds other than waterfowl, and how management practices affect their habitats. The focus of these reports is on management of breeding habitat, particularly in the northern Great Plains.

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Species for which syntheses are available or are in preparation:

American Bittern	Grasshopper Sparrow
Mountain Plover	Baird's Sparrow
Marbled Godwit	Henslow's Sparrow
Long-billed Curlew	Le Conte's Sparrow
Willet	Nelson's Sharp-tailed Sparrow
Wilson's Phalarope	Vesper Sparrow
Upland Sandpiper	Savannah Sparrow
Greater Prairie-Chicken	Lark Sparrow
Lesser Prairie-Chicken	Field Sparrow
Northern Harrier	Clay-colored Sparrow
Swainson's Hawk	Chestnut-collared Longspur
Ferruginous Hawk	McCown's Longspur
Short-eared Owl	Dickcissel
Burrowing Owl	Lark Bunting
Horned Lark	Bobolink
Sedge Wren	Eastern Meadowlark
Loggerhead Shrike	Western Meadowlark
Sprague's Pipit	Brown-headed Cowbird

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ORGANIZATION AND FEATURES OF THIS SPECIES ACCOUNT

Information on the habitat requirements and effects of habitat management on grassland birds were summarized from information in more than 4,000 published and unpublished papers. A **range map** is provided to indicate the relative densities of the species in North America, based on Breeding Bird Survey (BBS) data. Although birds frequently are observed outside the breeding range indicated, the maps are intended to show areas where managers might concentrate their attention. It may be ineffectual to manage habitat at a site for a species that rarely occurs in an area. The species account begins with a brief **capsule statement**, which provides the fundamental components or keys to management for the species. A section on **breeding range** outlines the current breeding distribution of the species in North America, including areas that could not be mapped using BBS data. The **suitable habitat** section describes the breeding habitat and occasionally microhabitat characteristics of the species, especially those habitats that occur in the Great Plains. Details on habitat and microhabitat requirements often provide clues to how a species will respond to a particular management practice. A **table** near the end of the account complements the section on suitable habitat, and lists the specific habitat characteristics for the species by individual studies. A special section on **prey habitat** is included for those predatory species that have more specific prey requirements. The **area requirements** section provides details on territory and home range sizes, minimum area requirements, and the effects of patch size, edges, and other landscape and habitat features on abundance and productivity. It may be futile to manage a small block of suitable habitat for a species that has minimum area requirements that are larger than the area being managed. The Brown-headed Cowbird (*Molothrus ater*) is an obligate brood parasite of many grassland birds. The section on **cowbird brood parasitism** summarizes rates of cowbird parasitism, host responses to parasitism, and factors that influence parasitism, such as nest concealment and host density. The impact of management depends, in part, upon a species' nesting phenology and biology. The section on **breeding-season phenology and site fidelity** includes details on spring arrival and fall departure for migratory populations in the Great Plains, peak breeding periods, the tendency to renest after nest failure or success, and the propensity to return to a previous breeding site. The duration and timing of breeding varies among regions and years. **Species' response to management** summarizes the current knowledge and major findings in the literature on the effects of different management practices on the species. The section on **management recommendations** complements the previous section and summarizes specific recommendations for habitat management provided in the literature. If management recommendations differ in different portions of the species' breeding range, recommendations are given separately by region. The **literature cited** contains references to published and unpublished literature on the management effects and habitat requirements of the species. This section is not meant to be a complete bibliography; a searchable, annotated bibliography of published and unpublished papers dealing with habitat needs of grassland birds and their responses to habitat management is posted at the Web site mentioned below.

This report has been downloaded from the Northern Prairie Wildlife Research Center World-Wide Web site, www.npwr.usgs.gov/resource/literatr/grasbird/grasbird.htm. Please direct comments and suggestions to Douglas H. Johnson, Northern Prairie Wildlife Research Center, U.S. Geological Survey, 8711 37th Street SE, Jamestown, North Dakota 58401; telephone: 701-253-5539; fax: 701-253-5553; e-mail: Douglas_H_Johnson@usgs.gov.

SHORT-EARED OWL (*Asio flammeus*)

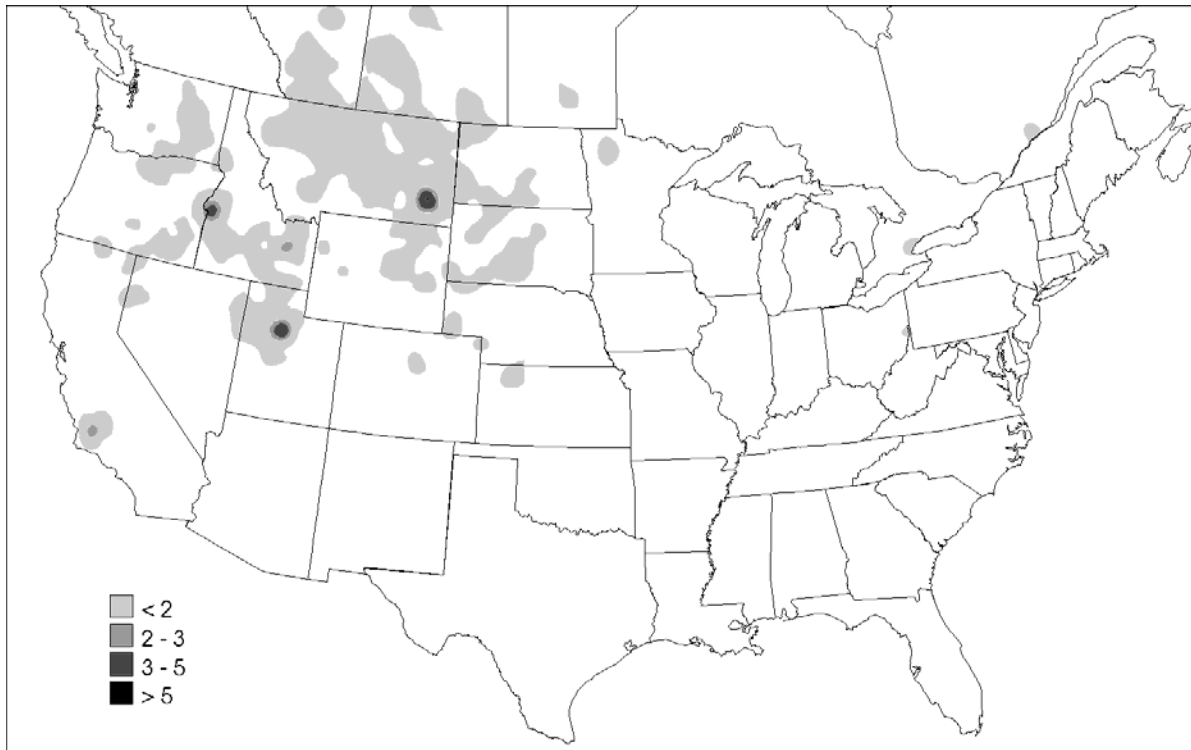


Figure. Breeding distribution of the Short-eared Owl in the United States and southern Canada, based on Breeding Bird Survey data, 1985-1996. Scale represents average number of individuals detected per route per year. Map from J. T. Price, American Bird Conservancy, Boulder, Colorado, pers. comm.

Key to management is providing large grasslands and wetlands, particularly those that can support high densities of meadow voles (*Microtus* spp.).

Breeding range:

In North America, Short-eared Owls breed from Alaska and continental Canada, also including the southern Baffin Islands, south to central California, and east through Kansas, eastern Oklahoma, eastern Ohio, Pennsylvania, Maryland, and Prince Edward Island (National Geographic Society 1987). (See figure for the relative densities of Short-eared Owl in the United States and southern Canada, based on Breeding Bird Survey data.)

Suitable habitat:

Short-eared Owls require large, open grassland or wetland areas, such as native prairie, hayland, retired cropland, small-grain stubble, shrubsteppe, and wet-meadow zones of wetlands (Townsend 1961, Clark 1975, Stewart 1975, Rotenberry and Wiens 1978, Harris 1980, Murphy 1991, Holt and Leasure 1993, Johnson and Schwartz 1993). Local occurrence is unpredictable, because populations fluctuate yearly due to variation in small-mammal populations (Beske and Champion 1971, Clark 1975, Stewart 1975, Harris 1980, Evrard et al. 1991). Given sufficient habitat and food supply, Short-eared Owls are able to colonize new areas (Clark 1975).

Short-eared Owls generally nest on the ground (Stewart 1975, Holt and Leasure 1993). Nests typically are built on dry uplands, but wetter lowlands, such as peat bogs and wetlands, are occasionally used (Clark 1975, Linner 1980, Holt and Leasure 1993). Nests may be fully concealed by dense cover, partially concealed by grasses and forbs, or poorly concealed in open fields and wetlands (Saunders 1913, Townsend 1961, Stewart 1975, Duebbert and Lokemoen 1977, Holt and Leasure 1993). Short-eared Owls also will nest in grain stubble (Clark 1975, Duebbert and Lokemoen 1977). In North Dakota, nests were usually in areas with vegetation 30-60 cm high and 2-8 yr old residual vegetation (Duebbert and Lokemoen 1977). In northwestern North Dakota, most Short-eared Owl nests were in sites dominated by western snowberry (*Symphoricarpos occidentalis*) mixed with herbaceous vegetation (Murphy 1993). Two nests in Conservation Reserve Program fields in Wisconsin were surrounded by quackgrass (*Agropyron repens*) with maximum vegetation heights of 70 and 90 cm (Evrard et al. 1991). A table near the end of the account lists the specific habitat characteristics for Short-eared Owls by study.

Prey habitat:

Voles and other small rodents are the primary prey of Short-eared Owls in the northern Great Plains; other mammals and birds also are taken (Holt and Leasure 1993). Short-eared Owl populations can show considerable local variation due to vole population density, and the owls' reproductive output is linked to fluctuations in vole populations (Holt and Leasure 1993). In Saskatchewan, a dramatic 1-yr increase in the vole population was accompanied by a synchronous increase in the owl population (Poulin et al. 1998). In Nebraska and Kansas tallgrass, voles preferred grassland habitat with ample residual vegetation, such as that provided by mowing or burning at 2-5 yr intervals (Leman and Clausen 1984, Kaufman et al. 1990).

Area requirements:

Short-eared Owls are associated with large, open grassland expanses (Holt and Leasure 1993, Byre 1997). Short-eared Owls were seldom observed in habitat blocks <100 ha in North Dakota Conservation Reserve Program fields (D. H. Johnson, *unpublished data*). In Illinois, nests were found in blocks of managed grassland as small as 28 ha (Herkert et al. 1999). However, the authors suggested that Short-eared Owls may be responding more to the total amount of grassland available in the surrounding landscape than to the sizes of individual grassland fragments; small fragments may be used if located close to larger blocks of contiguous grassland. In Manitoba, mean size of five territories in 1969 was 73.9 ha, and a single territory in 1968 was 121.4 ha (Clark 1975). In Montana, 32 nests were found in 164 ha (Holt and Leasure 1993). In the northeastern United States, breeding territory size generally decreased with increasing vole densities (Clark 1975).

Brown-headed Cowbird brood parasitism:

No known records of brood parasitism by Brown-headed Cowbirds (*Molothrus ater*) exist.

Breeding-season phenology and site fidelity:

Short-eared Owls generally breed from early April to late August (Maher 1974, Stewart 1975, Linner 1980, Berkey et al. 1993). In North Dakota, the mean hatch date for Short-eared

Owl nests was mid-June, but hatching dates ranged from early May through late July (Murphy and Ensign 1996). Early dates of arrival on the breeding grounds range from late March to early May; late dates of departure for wintering grounds range from early September to early November (Townsend 1961). In areas where the wintering and breeding grounds overlap, Short-eared Owls may begin nesting by late March (Holt and Leasure 1993). If the first clutch is destroyed, Short-eared Owls may renest (Townsend 1961, Holt and Leasure 1993). There is little evidence of Short-eared Owls producing two successful broods in one breeding season (Holt and Leasure 1993).

Species' response to management:

Although disturbance has a generally negative effect on Short-eared Owls, periodic disturbance may be necessary to maintain suitable habitat. In tallgrass areas, burning or mowing every 3-5 yr is recommended to maintain habitat for voles, the principal small rodent prey of Short-eared Owls (Lemen and Clausen 1984, Kaufman et al. 1990). Berkey et al. (1993) suggested that dense nesting cover in uplands could be hayed periodically to stimulate plant growth. In Illinois, Short-eared Owls preferred rotary-mowed grasslands that were 30-40 cm tall to idle grasslands with taller vegetation (Herkert et al. 1999). In tallgrass areas, mowing or other techniques are recommended to reduce grass heights. In Missouri, Short-eared Owls preferred medium to tall grasslands that were moderately grazed or idle (Skinner et al. 1984). Bock et al. (1993) suggested that Short-eared Owls respond negatively to grazing in the Great Plains and western shrubsteppe. In North Dakota, Short-eared Owls used upland sites with tall, dense vegetation and 2-8 yr accumulations of residual vegetation (Duebbert and Lokemoen 1977). Kantrud and Higgins (1992) found Short-eared Owls nesting in both idle native and seeded grasslands in North Dakota. Fields idled during the current growing season had more nests than fields under long-term grazing; no nests were found in fields grazed during the breeding season (Kantrud and Higgins 1992).

Collisions with barbed-wire fences or power lines may cause mortality or injury. Dead Short-eared Owls have been found hanging from strands of barbed-wire (Fitzner 1975, Knight and Skriletz 1980) and from power lines (Fitzner 1975). One owl was found alive but entangled in a roll of fencing wire; the bird's neck was wedged between two strands of wire (Fitzner 1975).

Management Recommendations:

Create and protect large open areas for Short-eared Owls and their prey (Holt and Leasure 1993). Because Short-eared Owls are nomadic, they may be present only sporadically, but suitable habitat should be maintained (Clark 1975, Holt and Leasure 1993).

Preserve native grassland. Collaborate with ranching and farming advocates to maintain native pasture and rangeland (Johnson 1996). Maintain a mosaic of grasslands and wetlands so that some units are available for nesting, while others are being treated to halt succession (Ryan 1990, Murphy 1993).

Protect grasslands through conservation easements, land purchases, and development of farm programs with wildlife habitat conservation priorities (Johnson 1996). Continue the

Conservation Reserve Program to preserve nesting habitat (Sinclair 1990, Murphy 1991, Bock et al. 1993).

In North Dakota, periodically burn, mow, or graze, to maintain the 2-8 yr old accumulations of residual vegetation preferred by Short-eared Owls in this region (Duebbert and Lokemoen 1977, Berkey et al. 1993, Murphy 1993). In tallgrass areas, burning, mowing, or grazing every 2-5 yr is recommended to maintain habitat for small mammal prey (Leman and Clausen 1984, Kaufman et al. 1990). In Illinois, burn, mow, or use other techniques to reduce grass height and maintain vegetation 30-40 cm tall (Herkert et al. 1999).

Increase the amount of western public rangeland from which livestock are excluded, especially in the United States Forest Service National Grasslands (Bock et al. 1993).

To prevent mortality or injury from collisions with fences, remove unused fences (Fitzner 1975). Increase visibility of fences by hanging pieces of ribbon or foil.

Table. Short-eared Owl habitat characteristics.

Author(s)	Location(s)	Habitat(s) Studied*	Species-specific Habitat Characteristics
Clark 1975	Rangewide	Cropland, hayland, idle, mixed-grass, pasture, tame, wetland	Of 63 nests, 55% were built in grassland, 24% in grain stubble, 14% in hayland, and 6% in low perennials
Duebbert and Lokemoen 1977	North Dakota, South Dakota	Cropland, idle tame	Nested in areas with a 2-8 yr accumulation of residual vegetation and nest cover 30-60 cm high
Evrard et al. 1991	Wisconsin	Conservation Reserve Program: idle tame	Nested in quackgrass (<i>Agropyron repens</i>); maximum vegetation heights around two nests were 70 and 90 cm, and visual obstruction readings were 47 and 36 cm
Herkert et al. 1999	Illinois	Burned, idle tallgrass, idle tame, pasture, tallgrass hayland, tame hayland, tame seed-harvested	Preferred managed grasslands (grasslands managed through rotary mowing, hay mowing, seed-harvesting, grazing, or burning during the 12 mo prior to the breeding season) over undisturbed grasslands (grasslands left undisturbed for at least 12 mo before the beginning of the breeding season); particularly preferred rotary-mowed grasslands that were 30-40 cm tall
Holt and Leasure 1993	Montana	Not given	Nested in grasses and forbs; vegetation around 28 nests was 85% grasses, 8% herbs, and 7% herb/grass; 90% of vegetation around nests was <0.5 m in height, 9% was 0.5-1.0 m and 1% was >1 m
Kantrud and Higgins	Manitoba,	Burned mixed-grass, cropland,	Preferred idle areas to fields under long-term grazing;

1992	Montana, North Dakota, South Dakota	hayland, idle mixed-grass, idle tame, mixed-grass pasture	avoided areas where livestock were present; 58% of 57 nests were found in forbs, especially alfalfa (<i>Medicago sativa</i>), 25% in western snowberry (<i>Symphoricarpos occidentalis</i>), and 17% in grasses, dominated by wheatgrass (<i>Agropyron</i>); 100% visual obstruction of vegetation >20 cm in height was found around most nests, with effective vegetation height >40 cm, and dead vegetation accounting for 12-88% of total vegetation
Linner 1980	Utah	Cropland, idle, tame pasture, wetland	Preferred foraging over wet oldfields and pastures, less so over cropland; avoided habitats with short vegetation
Murphy 1991, 1993	North Dakota	Burned mixed-grass, burned tame, idle mixed-grass, idle tame, mixed-grass pasture, tame pasture, wetland	Used mesic prairie and wetlands with dense ground cover; nested in sites dominated by western snowberry mixed with herbaceous vegetation
Rotenberry and Wiens 1978	Idaho, Oregon, Washington	Shrubsteppe	Used shrubsteppe habitat, were common in bunchgrasses (mostly wheatgrass/fescue [<i>Festuca</i>]) with <5% shrub cover, and uncommon in sagebrush (dominated by sagebrush [<i>Artemesia</i>], shrub cover >5%)
Skinner et al. 1984	Missouri	Burned tallgrass, idle tallgrass, tallgrass hayland, tallgrass pasture, tame pasture	Used medium to tall grasslands (~50% cover at 1 cm, ~30% cover at 25 cm) that were moderately grazed or idle
Stewart 1975	North Dakota	Cropland, hayland, idle, idle mixed-grass, wetland	Nested in fairly dense cover in native prairie, swales and wet-meadow zones of wetlands, hayfields, retired cropland, and fallow stubble fields
Townsend 1961	Rangewide	Cropland, pasture, wetland	Nested on the ground in open fields or wetlands

*In an effort to standardize terminology among studies, various descriptors were used to denote the management or type of habitat. “Idle” used as a modifier (e.g., idle tallgrass) denotes undisturbed or unmanaged (e.g., not burned, mowed, or grazed) areas. “Idle” by itself denotes unmanaged areas in which the plant species were not mentioned. Examples of “idle” habitats include weedy or fallow areas (e.g., oldfields), fencerows, grassed waterways, terraces, ditches, and road rights-of-way. “Tame” denotes introduced plant species (e.g., smooth brome [*Bromus inermis*]) that are not native to North American prairies. “Hayland” refers to any habitat that was mowed, regardless of whether the resulting cut vegetation was removed. “Burned” includes habitats that were burned intentionally or accidentally or those burned by natural forces (e.g., lightning). In situations where there are two or more descriptors (e.g., idle tame hayland), the first descriptor modifies the following descriptors. For example, idle tame hayland is habitat that is usually mowed annually but happened to be undisturbed during the year of the study.

LITERATURE CITED

- Berkey, G., R. Crawford, S. Galipeau, D. Johnson, D. Lambeth, and R. Kreil. 1993. A review of wildlife management practices in North Dakota: effects on nongame bird populations and habitats. Report submitted to Region 6. U.S. Fish and Wildlife Service, Denver, Colorado. 51 pages.
- Beske, A., and J. Champion. 1971. Prolific nesting of Short-eared Owls in Buena Vista salt marsh. *Passenger Pigeon* 33:99-103.
- Bock, C. E., V. A. Saab, T. D. Rich, and D. S. Dobkin. 1993. Effects of livestock grazing on Neotropical migratory landbirds in western North America. Pages 296-309 in D. M. Finch and P. W. Stangel, editors. Status and management of Neotropical migratory birds. U.S.D.A. Forest Service, General Technical Report RM-229.
- Byre, V. J. 1997. Birds. Pages 327-337 in S. Packard and C. F. Mutel, editors. The tallgrass restoration handbook for prairies, savannas, and woodlands. Island Press, Washington, D.C.
- Clark, R. J. 1975. A field study of the Short-eared Owl, *Asio flammeus* (Pontoppidan), in North America. *Wildlife Monographs* 47:1-67.
- Duebbert, H. F., and J. T. Lokemoen. 1977. Upland nesting of American Bitterns, Marsh Hawks, and Short-eared Owls. *Prairie Naturalist* 9:33-40.
- Evrard, J. O., D. A. Snobl, P. B. Doeneir, and J. A. Dechant. 1991. Nesting Short-eared Owls and voles in St. Croix County. *Passenger Pigeon* 53:223-226.
- Fitzner, R. E. 1975. Owl mortality on fences and utility lines. *Raptor Research* 9:55-57.
- Harris, B. 1980. Unprecedented numbers of Short-eared Owls in northeastern South Dakota during the 1978 breeding season. *South Dakota Bird Notes* 32:24-27.
- Herkert, J. R., S. A. Simpson, R. L. Westemeier, T. L. Esker, and J. W. Walk. 1999. Response of Northern Harriers and Short-eared Owls to grassland management in Illinois. *Journal of Wildlife Management* 63:517-523.
- Holt, D. W., and S. M. Leasure. 1993. Short-eared Owl (*Asio flammeus*). In A. Poole and F. Gill, editors. The birds of North America, No. 62. The Academy of Natural Sciences, Philadelphia, Pennsylvania; The American Ornithologists' Union, Washington, D.C.
- Johnson, D. H. 1996. Management of northern prairies and wetlands for the conservation of Neotropical migratory birds. Pages 53-67 in F. R. Thompson, III, editor. Management of midwestern landscapes for the conservation of Neotropical migratory birds. U.S.D.A. Forest Service General Technical Report NC-187.
- Johnson, D. H., and M. D. Schwartz. 1993. The Conservation Reserve Program: habitat for grassland birds. *Great Plains Research* 3:273-295.

- Kantrud, H. A., and K. F. Higgins. 1992. Nest and nest site characteristics of some ground-nesting, non-passerine birds of northern grasslands. *Prairie Naturalist* 24:67-84.
- Kaufman, D. W., E. J. Finck, and G. A. Kaufman. 1990. Small mammals and grassland fires. Pages 46-80 *in* S. L. Collins and L. L. Wallace, editors. *Fire in North American tallgrass prairies*. University of Oklahoma Press, Norman, Oklahoma.
- Knight, R. L. and J. Skriletz. 1980. Four additional cases of bird mortality on barbed-wire fences. *Western Birds* 11:202.
- Leman, C. A., and M. K. Clausen. 1984. The effect of mowing on the rodent community of a native tall grass prairie in eastern Nebraska. *Prairie Naturalist* 16:5-10.
- Linner, S. C. 1980. Resource partitioning in breeding populations of Marsh Hawks and Short-eared Owls. M.S. thesis. Utah State University, Logan, Utah. 66 pages.
- Maher, W. J. 1974. Matador Project: Birds II. Avifauna of the Matador area. Canadian Committee for the International Biological Programme, Matador Project, Technical Report 58. University of Saskatchewan, Saskatoon, Saskatchewan. 31 pages.
- Murphy, R. K. 1991. Ecology and management of prairie raptors. Proceedings of the Nongame Wildlife Workshop. U.S. Fish and Wildlife Service, Region 6.
- Murphy, R. K. 1993. History, nesting biology, and predation ecology of raptors in the Missouri Coteau of northwestern North Dakota. Ph.D. dissertation. Montana State University, Bozeman, Montana. 212 pages.
- Murphy, R. K., and J. T. Ensign. 1996. Raptor nesting chronology in northwestern North Dakota. *Prairie Naturalist* 28:51-57.
- National Geographic Society. 1987. Field guide to the birds of North America, second edition. National Geographic Society, Washington, D.C. 464 pages.
- Poulin, R. G., T. I. Wellicome, and L. D. Todd. 1998. Lagged response of burrowing owls and the overall responses of prairie raptor populations to a vole outbreak. Page 20 *in* Abstracts of the Second International Burrowing Owl Symposium, Ogden, Utah.
- Rotenberry, J. T., and J. A. Wiens. 1978. Nongame bird communities in northwestern rangelands. Pages 32-46 *in* Proceedings of the workshop on nongame bird habitat management in coniferous forests of western United States. U.S.D.A. Forest Service, General Technical Report PNW-64.
- Ryan, M. R. 1990. A dynamic approach to the conservation of the prairie ecosystem in the Midwest. Pages 93-106 *in* J. M. Sweeney, editor. *Management of dynamic ecosystems*. North Central Section, The Wildlife Society, West Lafayette, Indiana.
- Saunders, A. A. 1913. Some notes on the nesting of the Short-eared Owl. *Condor* 15:121-125.

- Sinclair, J. 1990. Interactions between Short-eared Owls and Northern Harriers in Van Buren County. *Iowa Bird Life* 60:60-62.
- Skinner, R. M., T. S. Baskett, and M. D. Blenden. 1984. Bird habitat on Missouri prairies. Terrestrial Series 14. Missouri Department of Conservation, Jefferson City, Missouri. 37 pages.
- Stewart, R. E. 1975. Breeding birds of North Dakota. Tri-College Center for Environmental Studies, Fargo, North Dakota. 295 pages.
- Townsend, C. W. 1961. Short-eared Owl (*Asio flammeus flammeus*). Pages 169-182 in A. C. Bent, editor. Life histories of North American birds of prey, Vol. 2. Dover Publications, Inc., New York, New York.